HKP
Hin Kong Power Plant Company Limited

No. 1/2

Environmental Impact Assessment of Hin Kong Power Plant

Hin Kong Subdistrict, Mueang Ratchaburi District, Ratchaburi Province

Hin Kong Power Plant Company Limited

Project :
Environmental Impact Assessment of Hin Kong Power Plant

Project Location :
Hin Kong Subdistrict, Mueang Ratchaburi District, Ratchaburi Province

Company :
Hin Kong Power Plant Company Limited

Company Location :
72 Ngamwongwan Road, Bang Khen Subdistrict, Mueang Nonthaburi District, Nonthaburi 11000

Attorney

- ☐ Project owner authorize the Consultant of Technology Co., Ltd. (COT) to conduct the report as the attached power of attorney
- ☑ Project owner does not authorize the Consultant of Technology Co., Ltd. (COT) for lawful attorney

C O T
Consultants of Technology Co., Ltd.

NOVEMBER
2020

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Chapter 1

Introduction

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Introduction

1.1 Project background

The government sector by the Ministry of Energy has created a power development planning for Thailand for B.E.2561-2580 (Power Development Planning : PDP2018) to support the growth rate of Thai economy and the increasing demand for electricity by focusing on the development and emphasizing the importance of the security of the electrical system, the cost of electricity production and appropriate fuel distribution, including an environmental impact. PDP2018 stated the consideration of the security of the Western electrical system that the western power generating capacity cannot handle force majeure when the largest power plant has an emergency stop (N-1) since B.E.2570 (2027). Thus, in order to maintain the security of the electrical system of the country, it is necessary to establish a main power plant for power security in the western region. Such power plants are the substitution power plant project with the net generating capacity of 700 megawatt and the new power plant project with the net generating capacity of 700 megawatt.

For RATCH Group Public Company Limited or RATCH which has a long-established power plant in Ratchaburi, consisting of the combined cycle power plant with the capacity of 700 megawatt of Ratchaburi Electricity Generating Co.,Ltd, **(Tri Energy Power Plant Branch) or called TECO Power Plant**. This power plant is located in Hin Kong Subdistrict, Mueang Ratchaburi District, Ratchaburi province. It has the total installed power capacity of 720 megawatt and has been operated since B.E.2540 (1997). The power purchase agreement of this plant will be expired in B.E.2563 (2020). Ratchaburi Electricity Generating Co., Ltd, is located in Phikun Thong Subdistrict, Mueang Ratchaburi District, Ratchaburi, with the capacity of 1,470 megawatt and the power purchase agreement will be expired in B.E.2568 and B.E.2570 with the capacity of 2,175 MW. This will cause the loss of overall Western power generation capacity as a total of 3,645 megawatt.

Previously, TECO Power Plant had a generating capacity of 700 megawatt. Later on in B.E.2548 (2005), it had the plan to expand the power unit 2 on the vacant area of the power plant, increasing to 700 megawatt. Therefore, a total capacity were 1,400 MW. An environmental impact assessment report (EIA) of the combined gas power plant project, the 2nd unit of Tri Energy Co., Ltd, was prepared and had been approved by the expert committee on November 10th , B.E.2548 (2005) (**Appendix 1**). However, the 2nd unit of the combined gas power plant project had not been constructed. The project is in the process of submitting a withdrawal notice to the Office of Natural Resources and Environmental Policy and Planning.

From this above necessity to strengthen the electrical system in the western region and in accordance with the power development plan of the country, RATCH Group Public Company Limited, the leading private power producer in Thailand, has a new power plant construction project, in order to substitute of electric power from TECO Power Plant on the area of TECO where the facility and suitability of electricity, fuel and raw water delivery systems are located. The establishment of **Hin Kong Power Plant Project, hereinafter referred to as " the project" within Hin Kong Power Co.Ltd, "The project owner"** (affiliated companies of RATCH Group Public Company Limited). The project has a plan to generate electricity and sell electricity to the Electricity Generating Authority of Thailand. There will be 700 MW replacing of the previous power plant and creating a new additional 700 MW to increase the electrical security, as a total of 1,400 MW.

1.2 Related government policies

According government sectors by the Ministry of Energy (Energy) together with the Electricity Generating Authority of Thailand (EGAT) and related agencies have been established the Power Development Planning during 2561-2580 (PDP2018) as the main plan for the power supply of the country that met the demand, to supports the country economic growth, including the increasing of the population. The duration of the plan will be consistent with the 20-year national strategic plan (B.E.2561-2580) (2018-2037). PDP2018 has focused on 3 major following issues.

(1) Energy security: to have the security, covering power generation systems, power transmission systems, and power distribution systems in each region and responding to the demand for electricity to support the national economic and social development plan, including considering power plants for the security at an appropriate level to support an energy crisis event.

(2) Economy: must consider the appropriate cost of electricity production, promote low-cost electricity generation, reduce the burden of electricity consumers and not impede the long-term economic and social development of the country, including the

preparation of the electrical system, in order to create the competition in electricity generation that will help increase overall electricity production efficiency in the country. An electricity generation must reflects the true cost.

(3) Ecology: must reduce environmental impacts by supporting the production of electricity from renewable energy and increasing the efficiency in the electrical system (Efficiency) in both electricity production and electricity consumption with the development of the smart grid network system (Smart grid).

The PDP2018 plan must be consistent with the national economic development direction done by the Office of the National Economic and Social Development Council (NESDC), estimating that there will be a long-term economic growth of 3.8%/year. For the forecasted demand for electricity consumption in PDP2018 during B.E.2561-2580 (2018-2037), it found that the prediction of the total electricity demand of 3 energy systems and the peak power in B.E.2580 (2037) are approximately 367,458 million units and 53,997 MW, respectively, with following details.

Year (B.E) (A.D)	PDP2015		PDP2018		Change (%)	
	Peak Voltage (MW)	Energy (GWh)	Peak Voltage (MW)	Energy (GWh)	Peak Voltage (MW)	Energy (GWh)
2561 (2018)	32,429	212,515	29,969	203,203	-2,460	-9,312
2565 (2022)	36,776	241,273	35,213	236,488	-1,563	-4,785
2570 (2027)	41,693	273,440	41,079	277,302	-614	3,862
2575 (2032)	46,296	303,856	47,303	320,761	1,007	16,905
2580 (2037)	-	-	53,997	367,458	-	-

Source : Thailand Power Development Plan 2018-2037 (PDP2018), Energy Policy and Planning Office, April 2019

For the guidelines of the establishment of PDP2018 plan, it consists of 4 following parts.

(1) Power plants in accordance with the government promotion policy: promote electricity production from renewable energy, such as community waste and Civil state biomass power plants in three southern border provinces, etc.

(2) Main fossil fuel power plants consist of EGAT power plants, Independent Power Producer (IPP) Small Power Producer (SPP), and purchase electricity from abroad.

(3) Renewable power plants under Alternative Energy Development Plan (AEDP) are consisting of biomass, biogas, solar energy, floating buoy solar energy together with hydro power plants and other renewable energy. The target of electrical purchase will be an annual purchase in accordance with the policy of electricity production from renewable energy and will purchase at the price not over the Grid Parity to maintain the same retail price.

(4) Energy Conservation Policy under the Energy Conservation Plan which can prove the confidence with the quality and can compete with the price of not more than Grid Parity.

According to the PDP2018 plan above, at the end of the plan, B.E.2580 (2037), there will be 77,211 megawatt as the total electricity generating capacity from 3 systems. These consist of the current generating capacity at the end of B.E.2560 (2017) which equal to 46,090 megawatt, the new power plant for total of 56,431 megawatt. There are 25,310 megawatt of electricity producing from old expired power plants between B.E.2561 – 2580 (2018-2025). For details of the new power plants classified by power plant types of the PDP2018 plan during B.E.2561- 2580 (2018-2037), they can be summarized as follows.

Classified	New power plants classified (Megawatt ; MW)		
	during 2561-2568[1/] (2018-2025)	during 2569-2580[2/] (2026-2037)	during 2561-2580 (2018-2037)
Renewable power plant	3,839	16,927	20,766
Pump-storage hydro power plant	500	-	500
Cogeneration power plant	2,112	-	2,112
Combined cycle power plant	8,256	4,900	13,156
Coal/Lignite power plant	600	1,140	1,740
Electricity purchased from neighboring countries	2,357	3,500	5,857
Renewable power plant	1,400	6,900	8,300
Energy conservation measures	-	4,000	4,000
Total	**19,064**	**37,367**	**56,431**

Remark : [1/] It is a project that has a commitment and has signed a power purchase agreement. Electric power management pilot project And projects according to the government's promotion policy Including major power plant projects and new renewable energy power plants

[2/] It is a domestic power plant project and receives the purchase of electricity from overseas to maintain the stability of the electricity system and meet the increased demand for electricity, as well as to replace expired old power plants.

Source : Thailand Power Development Plan 2018-2037 (PDP2018), Energy Policy and Planning Office,April 2019

1.3 The necessity to prepare an EIA report

The operation of Hin Kong Power Plant Project of Hin Kong Power Co.Ltd., has the highest installed capacity of 1,540 megawatt with the gross capacity of 1,520 megawatt and the net capacity of 1,400 megawatt. There will be electricity supply to EGAT network under the power purchase agreement at 1,400 MW. This operation falls under the category of thermal power plant projects with electricity generating capacity of 10 megawatt or above, that must undertake an EIA report for business approval, according to the documents attached to the 4th section of the Announcement of the Ministry of Natural Resources and Environment on the identification of project, business or operation that must prepare an EIA report and criteria, procedures and conditions for the EIA report announced on 19th November B.E.2561 (2018).

Therefore, the project has assigned Consultants of Technology Co., Ltd, or COT (the consulting company), which has registered and licensed to prepare an environmental impact assessment report with the Office of Natural Resources and Environmental Policy and Planning (ONEP), to conduct the study and prepare the report to the Office of Natural Resources and Environmental Policy and Planning (ONEP) and the licensing agency (Office of the Energy Regulatory Commission) and the Department of Industrial Works, respectively.

1.4 Objectives of the study

(1) To study project details on both during the construction and the operation phases that will cause environmental impacts in the project area and surrounding areas. Results from this study will be used as important fundamental information in assessing the environmental impact of the project.

(2) To study and analyze current conditions of various resources and environmental values in the project area and nearby areas (hereinafter referred to as "Study area"). It is expected as direct or indirect impacts from the project operations, both during the construction and operation phases.

(3) To assess project impacts which may affected resources and environmental values both in physical, biological resources, value of human use, and the quality of life.

(4) To propose the environmental impact prevention and measures as well as the environmental impact monitoring, in order to minimize the severity of the impact that may occurred, including to monitor environmental impacts as the verification on the effectiveness of proposed measures.

1.5 Guidelines and conceptual framework of the study

The study and preparation of the EIA report of this project has the format and process of the study, in accordance with following guidelines, requirements, and criteria.

(1) Guidelines for the preparation of the EIA report according to the Announcement of the Ministry of Natural Resources and Environment, regarding the project, business or operation which must prepare an EIA report and criteria, procedures and conditions for the EIA report on 19th November, B.E.2561 (2018).

(2) Guidelines for the preparation of the EIA report for the thermal power plant project energy group, Environmental Impact Assessment Division, Office of Natural Resources and Environmental Policy and Planning, October, B.E.2561 (2018).

(3) Announcement of the Office of Natural Resources and Environmental Policy and Planning on guidelines for the public participation in the process of EIA report as announcing in the Government Gazette on 8th February, B.E. 2562 (2019).

(4) Guidelines for the health impact assessment of the power plant project, done by the Department of Health, Ministry of Public Health in July, B.E.2555 (2012).

1.6 Steps and methods of study

1.6.1 The study and preparation of the EIA report

The procedures for preparing the EIA report of the project as seen in **Figure 1.6.1-1.** The study method of each step can be summarized as follows

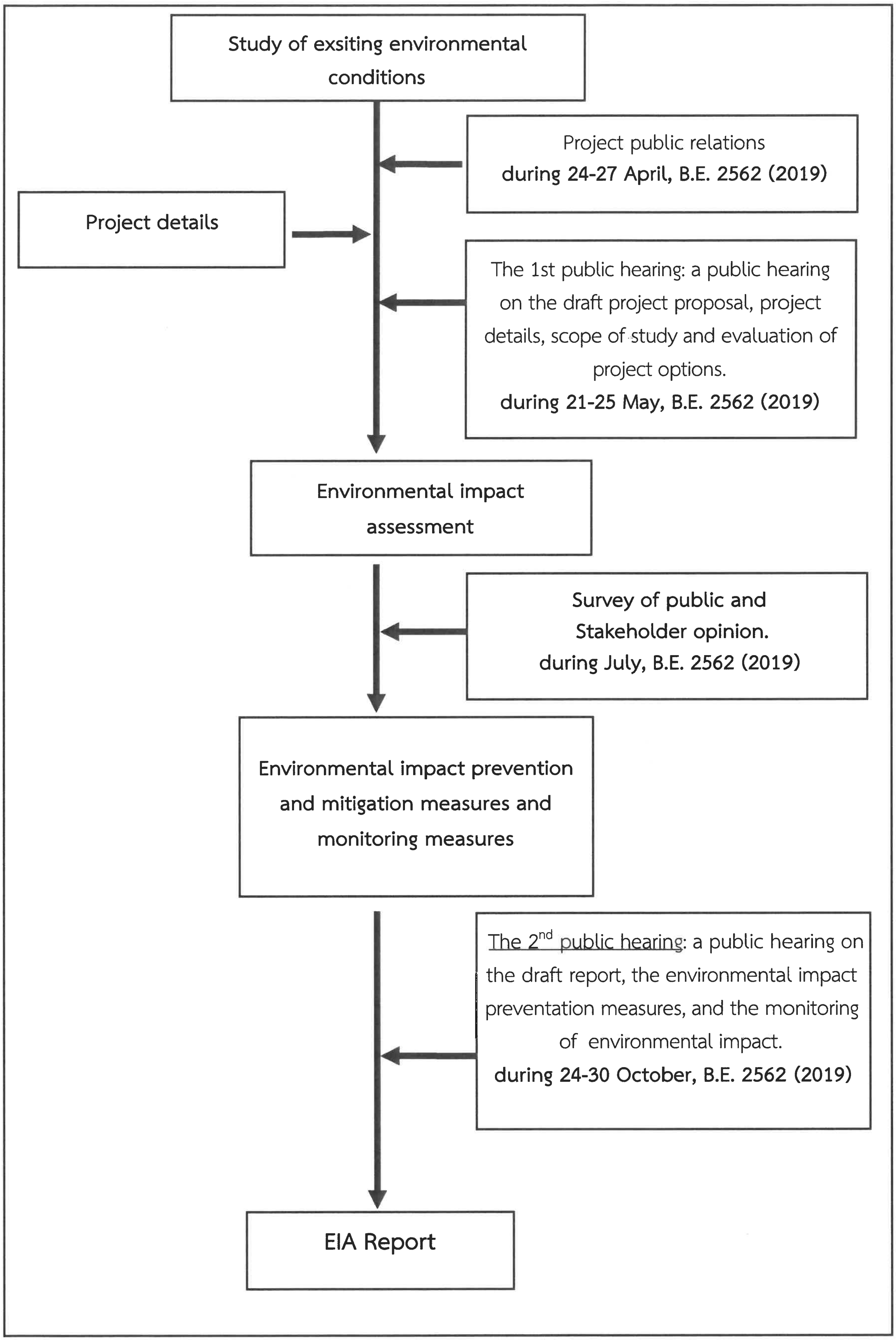


Figure 1.6.1-1 The procedures for preparing the EIA report of the project

(1) Identification of study area

The scope of the study area for general issues has been conducted covering areas for both direct and indirect impacts. Initially, the study area was defined within a radius of 5 kilometers from the project area covering Ratchaburi district area where consisting of 10 communities of Hin Kong Subdistrict Administrative Organization, 8 communities of Huai Phai Subdistrict Administrative Organization, 6 communities of Chedi Hak Subdistrict Administrative Organization, 3 communities of Ko Phlapphla Subdistrict Administrative Organization, 2 communities of Don Tako Subdistrict Administrative Organization, 2 community of Don Rae Subdistrict Administrative Organization and 2 communities of Khao Ngu Subdistrict Municipality as seen in **Figure 1.6.1-2.** For other specific issues, the study area was defined for more than 5 kilometers by considering project activities and nature of each impact, such as;

- The study of air quality covering an area of 20X20 square kilometer
- The study of surface water resources considering watersheds and water networks;
- The study of transportation covering the relevant transportation network.

However, the project also invites communities outside the community in the radius of 5 kilometers of the study area and general public for the participation in the project study.

(2) Study of project details

The study of project details was covering both during construction and operation phases by covering the project location, details of land utilization and project composition layout, machines, equipment and production process, fuel, chemicals, products of the project, production enhancement system, pollution and control, occupational health and safety, community relations and receiving complaints, project management and green areas.

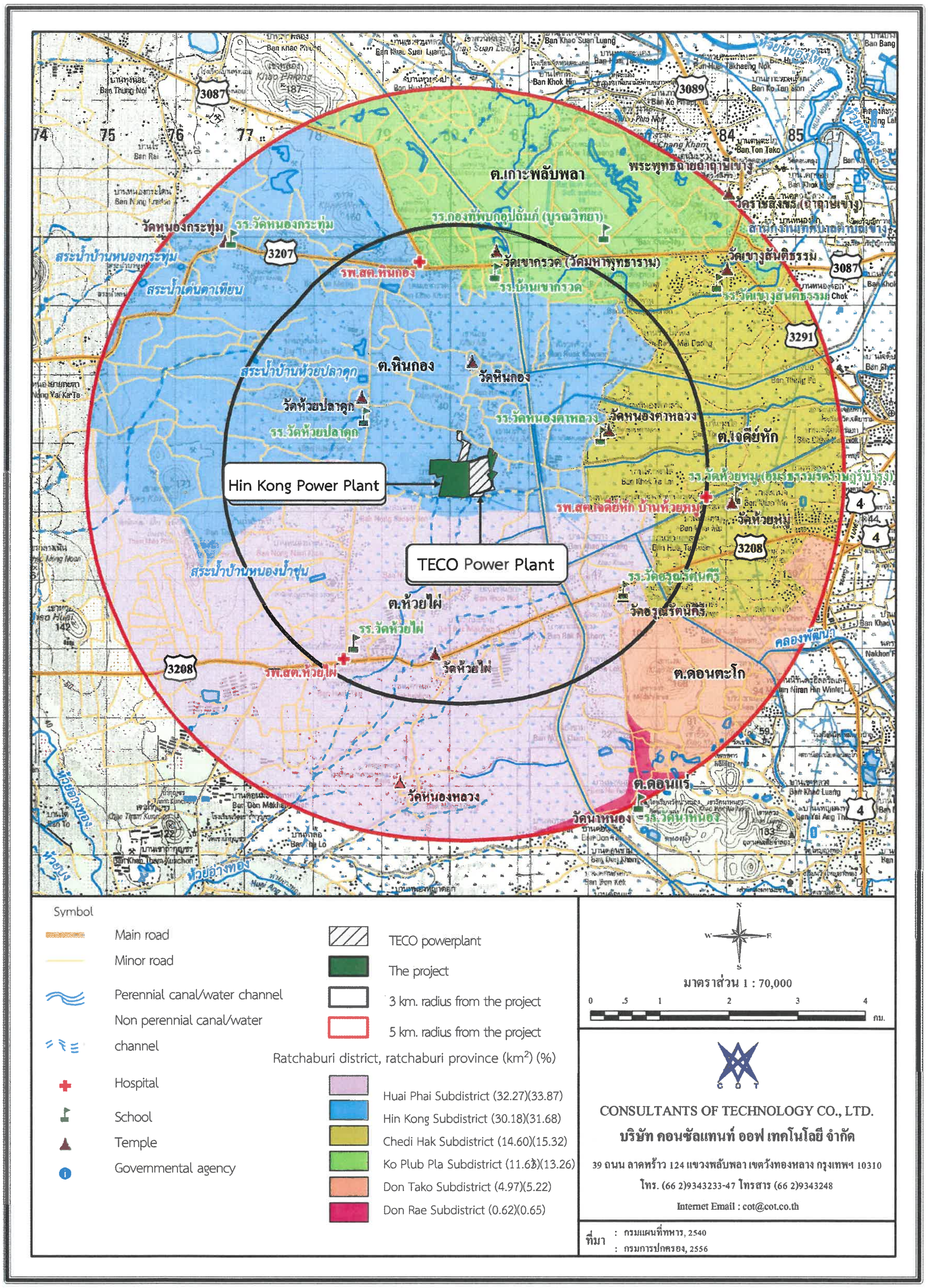


Figure 1.6.1-2 The 5 kilometers Radius of the Project Site and Study Area

(3) Study of natural resources and current environment conditions

To collect the environment data on the project and surrounding areas around the impact zone, covering a radius of at least 5 kilometers from the project area (in case that project activities causing impacts on the radius of more than 5 kilometers, the scope of the study area would be expanded appropriately according to the scope of the impact). The study covered environmental resources in all 4 areas, which were, physical resources, biological resources, value of human use and the quality of life. The study of the existing environemental conditions and natural resources will be collecting the secondary data from government agencies or related organizations together with additional survey data in the field.

(4) The implementation of public participation among people and stakeholders of the project

The study prepared a process for the public participation to cover all parts. This public participation process of stakeholders was done in accordance with the Announcement of the Office of Natural Resources and Environmental Policy and Planning regarding guidelines for public participation in the process of preparing an EIA report, announced in the Government Gazette on 8 February B.E2562 (2019), and applied the time frame in accordance with the Office of the Prime Minister Regulations on the public hearing in B.E.2548 (2005). For organizing public hearing and public participation, the project already organized 2 times which consisting of;

The 1st public participation: it was a public hearing on the draft project proposal, project details, scope of study and evaluation of project options. The objectives of this hearing were to provide information to the public and related agencies on project details and potentially direct and indirect impacts, the scope of the study and the evaluation of project options, to take comments and suggestions into account for the study, and to complete the report. Public hearings were organized during 21-25 May, B.E. 2562 (2019), for a total of 7 stages, with 774 participants.

The 2nd public participation: it was a public hearing on the draft report and environmental impact prevention and measures and environmental impact monitoring. The objective of this public hearing was to ensure that public had a confidence in the report and measures. Comments and suggestions raising from the hearing had been used to improve the report and measures and integrated them as parts of the report. The project was implemented the public hearing during 24-25 October and 29-30 October, B.E.2562 (2019), for a total of 7 stage, with 1,028 participants in total.

(5) Environmental impact assessment

An environmental impact assessment due to project operation were in consistent and covering issues of public concerns. Detailed information used in the evaluation would be in accordance with academic principles, modern techniques and technology. It was also followed guidelines and standards that are accepted by relevant agencies or international standards.

(6) Health impact assessment

The health impact assessment in the EIA report was done by applying guidelines in accordance with the provisions of laws and regulations that are currently announced, which are, the Announcement of the National Health Commission on criteria and methods for the health impact assessment from the public policy, No. 2 B.E.2559 (2016), guidelines for health impact assessment in the EIA report of the Office of Natural Resources and Environmental Policy and Planning (issued in April B.E2550 (2007)) and the health impact assessment guidelines for the power plant project of the Department of Health, Ministry of Public Health (issued in July B.E. 2555 (2012)).

(7) Proposal of environmental impact prevention and measures

For an environmental impact assessment, If it was found that the project operation caused significant negative impacts, the consulting company would propose appropriate and practical preventive and mitigation measures for both during the construction and operation phases of the project. The scope, objectives, methods of operation, location, duration and responsible person for both during the construction and the operation phases would be specified, in order to ensure the efficiency of the implementation since the process of the project construction plan.

(8) Proposing of an environmental impact monitoring

Proposing of an environmental impact monitoring with details about measurement stations, methods for sample collecting and analysis, and the frequency of measurement, etc., (it was proposed by considering the expected impact assessment), in order to verify that proposed measures were appropriate, effective and practical as well as to monitor the environmental impact causing form the project.

1.6.2 Study plan and an EIA report preparation

The study and preparation of the environmental impact assessment report of the project during January B.E. 2562 (2019) to January, B.E.2563 (2020) was divided into 2 parts. Part 1 was the study and preparation of the EIA report. Part 2 was the public participation which took approximately 1 2 months. Details of activities are seen in **Table1.6.2-1.**

Table 1.6.2-1.
Study plan and an EIA report preparation

Detail	B.E 2562 (2019)												B.E. 2563 (2020)
	Jan	Fab	Mar	April	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan
1. Public participation													
1.1 Project Public Relations													
1.2 Disseminate information and schedule of the 1st meeting.													
1.3 The 1st public participation						21-25 May 2562 (2019)							
1.4 Notice of summary of the 1st Public participation result													
1.5 Opinion survey (questionaries)													
1.6 Analyze and process polls/surveys													
1.7 Disseminate information and schedule of the 2nd Meeting													
1.8 The 2nd public participation											24-30 Oct 2562 (2019)		
1.9 Notice of summary of the 2nd Public participation result													
2. EIA Report prepatation													
2.1 Project details collection													
2.2 The study of secondary data of the project area and the study area.													
2.3 Field Survey													
2.4 Environmental and Health Impact Assessment													
2.5 Propose environmental impact prevention and mitigation measures and monitoring measures													
2.6 Propose an environmental impact assessment report to ONEP													

1.7 The Project plan

The project will start the construction after the EIA report had been approved. The construction period, from the beginning of the site preparation until the production of electricity can take approximately 33- 42 months. Activities during the construction phase consist of a site preparation, foundation structure work, building construction, combustion system and boiler systems, steam turbine system, generators and cooling tower systems, machines/equipment installation, installation of the pipe system, electrical system and control system. Details of operation plans as seen in **Table1.7-1.**

Table 1.7-1.

Project Development plan

No	Details	B.E.2562 (2019)				B.E.2563 (2020)				B.E.2564 (2021)				B.E.2565 (2022)				B.E.2566 (2023)				B.E.2567 (2024)				B.E.2568 (2025)			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	EIA Study																												
2	Permit from government agencies																												
3	Construction contract																												
4	Engineering and Design																												
5	Site Mobilization / preparation																												
6	Construction Work														Estimated time 3 Year														
7	Commissioning and Testing																												
	Block #1 (700 MW)																												
	Block #2 (700 MW)																												
8	Commercial Operation Date																												
	Block #1 (700 MW)																			Block #1 : 700 MW									
	Block #2 (700 MW)																						Block#2 : 700 MW						

Source : Hin Kong Power Co.Ltd., 2563 (2020)

1.8 The coordination process of relevant departments

The development of Hin Kong Power Plant Project of Hin Kong Power Co.Ltd, had procedures for requesting the permission from government agencies in various matters, as seen in **Figure1.8-1** and were concluded in **Table1.8-1.**

Table1.8-1

Permission from Government Agencies

Permission	Contact agency	Requesting permission	Timeline
The electricity sale offering to EGAT	Electricity Generating Authority of Thailand (EGAT)	Electricity sale and electrical system connectivity application form	60 days
Power generation license	Office of Energy Regulatory Commission	Application form for electricity business license / electricity distribution system / distribution of electricity (Form ERC.01-1 / 3/4).	90 days
Controlled energy production permit	Office of Energy Regulatory Commission	Application form for a license to produce controlled energy (Form CE1).	45 days
Factory operation permit	Office of Energy Regulatory Commission	License application Ror.Ngor.3.	120 days
Application for the investment promotion	The Board of Investment of Thailand	Application form for the investment promotion (BOI.01)	120 days
construction licnese/permit	Office of Energy Regulatory Commission	Form for a license (Form Kho.1)	45 days
Route connection	Department of Highways	Application form for the permission to connect routes with the highway.	90 days

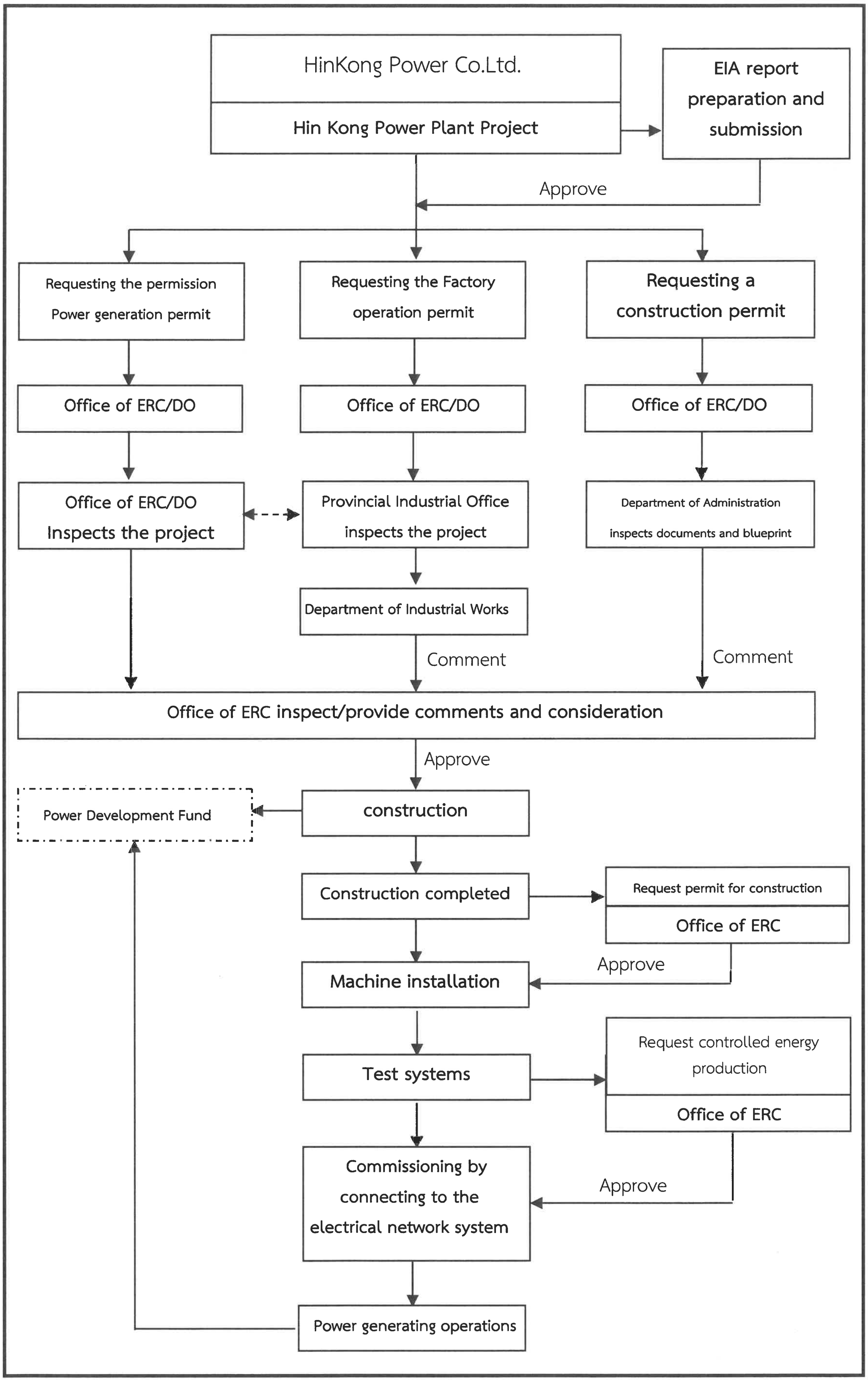


Figure 1.8-1 Steps of coordinating with related agencies

1.9 Related laws, regulations and standards

Laws and standards on environment and health relating to project development were summaried in **Table1.9-1.**

Table 1.9-1.

List of related health and environmental laws and environmental standard

Table 1.9-1 (conts.)

Related law	Detail in brief
1. The Constitution of the Kingdom of Thailand B.E.2560 (2017)	- Section 4 Under the constitution enforcement, dignity, right, freedom, and equity of Thais which were protected under the ruling national democratic system with the king as head of state and international agreements in which Thailand is a member must be protected by this constitution. - Section 43 to acknowledge and access public information or information in the possession of government agencies as required by law, (2) to present a complaint to a government agency and receive notice of the outcome of the hearing as soon as possible, (3) to sue the government agency for liability for the actions or omissions of the actions of the public employees or employees of government agencies. - Section 58 Any state or state action that will allow anyone to take action. If this may have a serious impact on natural resources, environmental quality, health, health, quality of life, or any other significant interests of the people or communities or the environment. The state must conduct an environmental and public health impact assessment and to provide a listening hearing of stakeholders and concerned communities. to be considered, conducted or permitted as required by law.
2. Environmental Promotion and Conservation Act (No.2) B.E.2561 (2018)	This act is the core environmental law of the country to control activities with environmental standards. The main elements of the act are pollution control and reduction, natural resources restoration, environmental impact assessment, environmental planning, public participation in decision-making process, and responsibility of the national environmental board.

Table 1.9-1 (conts.)

Related law	Detail in brief
2.1 Ambient air standards	- Notification of the National Environmental Board No.2 1 (B.E.2544 (2001)) on standard of sulfur dioxide concentration in ambient air in period of one hour - Notification of the National Environmental Board No.24 (B.E.2547 (2004)) on ambient air quality standard - Notification of the National Environmental Board No.33 (B.E.2552 (2009)) on standard of nitrogen dioxide concentration in ambient air - Notification of the National Environmental Board No.36 (B.E.2553(2010)) on standard of particulate matter size not exceeding 2.5 microns in ambient air
2.2 Factory Air Quality Standards	- Notification of the Ministry of Industry : Requiring different types of factories to install special tools or equipment to monitor air quality from the chimney automatically, B.E. 2544 (2001) - Notification of the Ministry of Industry on The Configuration of Air Borne Additives Electricity Transmission or Distribution B.E. 2547 (2004) - Notification of ministry of natural resources and environment on Set new electricity plant waste emission control standards B.E. 2553 (2010) - Notification of ministry of natural resources and environment on Designating a new power plant as a source of pollution that must be controlled by the release of polluted air into the atmosphere, B.E. 2553 (2010)
2.3 Ambient Noise Standard	
(1) Ambient noise level	- Notification of the National Environmental Board No.15 (B.E.2540 (1997)) on ambient noise level standard - Notification of the Ministry of Industry on Configuring Noise And Noise Levels arising from Factory Operations, B.E. 2548 (2005) - Notification of the National Environmental Board No.29 (B.E.2550 (2007)) on disturbance noise level -Notification of Pollution Control Department about how to perceive basic sound and ambient noise level

Table 1.9-1 (conts.)

Related law	Detail in brief
	without any interference, measure and calculate the ambient sound level with interference, and calculate the ambient noise level and the records measuring noise disturbance (B.E.2550 (2007))
(2) Noise Level at Workplace	-Notification of Department of Labour Protection and Welfare on ambient noise standard permitted in workplace each day (B.E.2561 (2018))
2.4 Surface Water Standard	
(1) Surface Water	- Announcement of the National Environment Board No. 8 (B.E. 2537(1994)) Re: Setting Water Quality Standards in Surface Water Bodies B.E.2537 (1997)
(2) Ground water standard	- Notification of the National Environmental Board No.20 (B.E.2543 (2000)) on standard of ground water quality - Notification of the Ministry of Natural Resources and Environment on area scope and depth of ground water B.E.2554 (2011) - Notification of the Ministry of Natural Resources and Environment on criteria and academic measures for public health and environmental pollution preventions B.E.2551 (2008)
(3) Wastewater standard	- Notification of the Ministry of Natural Resources and Environment Re: Establishment of Industrial Sewerage Control Standards Industrial estate And industrial enterprises B.E. 2559 (2016) - Notification of the Ministry of Industry Re: Establishment of Factory Sewage Control Standards (B.E. 2560 (2017)) - Ministerial regulations prescribing rules Methods and forms of statistics and data collection; Preparation of detailed records And a summary report of the performance of the wastewater treatment (B.E.2555 (2012)) -Ministerial regulations No.63 (B.E.2551 (2008)) based on the enactmemnt of building control B.E 2522 (1979) - Notification of the Ministry of Industry on the specification of type and size of the factory, pollution

Table 1.9-1 (conts.)

Related law	Detail in brief
	and waste control and discharge, and responsible personal for pollution treatment system as well as criteria for registering of pollution treatment system controller B.E.2545 (2002) - Notification of the Ministry of Industry on specification of type and size of factory, pollution and waste control and discharge, and responsible personal for pollution treatment system as well as criteria for registering of pollution treatment system controller (No. 2) B.E.2554 (2011)
2.5 Standard soil quality	-Notification of National Environmental Board No.25 (B.E.2547 (2004)) on setting the standard soil quality
3. National Health Act B.E.2550	Article 1 Section11 A person or a group of people has right to request and participate in health impact assessment of public policy project. A person or a group of people has right to receive information, clarification, and reason from government agencies prior approving or during project operation which possible to have a health impact on the person or community as well as the persons must be able to express their opinions. - Notification of National Health Commission Office about charter of system of National Health Commission No.2 B.E.2559 (2016)
4. Occupational Health and Safety and Working Environment Act B.E.2554 (2011)	These acts are the laws to control welfare, working environment, and safety of enterprises. The business must provide committee, policy, and plan to monitor working environment as well as medical checkup that suitable with the characteristics of the business activity. - Ministerial Notification (Ministry of Labor) on standard of occupational health and safety management and working environment related to heat, light, and noise B.E.2559 (2016) - Notification of Department of Labor Protection and Welfare on criteria of monitoring of working environment related to heat, light, and noise and period and types of business to be followed B.E.2550 (2007)

Table 1.9-1 (conts.)

Related law	Detail in brief
	- Notification of Department of Labor Protection and Welfare on criteria of monitoring of working environment related to noise of business to be followed B.E.2560 (2017) -Notification of Department of Labor Protection and Welfare on standard equipments for personal safety B.E.2554 (2011) - Notification of Department of Labor Protection and Welfare about warning symbols, safety signs, occupational health/sanity, working environment and message showing rights of employer and employee B.E.2554 (2011) -Ministerial Notification (Ministry of Labor) about setting standards for managing and enforcing safety, occupational health/sanity, and working environment relating to dangerous chemicals B.E.2556 (2013) -Notification of Ministry of Labor on managing dangerous chemicals and for employer to give medical attention to employee B.E.2552 (2009) - Ministerial Regulation on criteria and method of medical checkup for employees and sending of results to the official B.E.2547 (2004) -Ministrial Regulations on standard of management and sanity and safety in working environment relating to construction work. B.E.2551 - Notification of Department of Labor Protection and Welfare about guidelines on work planning relating to safety at construction work site B.E.2552 (2009) - Ministrial Regulation on setting standards in management, execution, and enforcement for safety, occupational health/sanity, and working environment involving electricity B.E.2558 (2015) - Ministrial Regulation on setting standards in management and enforcement of safety, occupational health/samity, and working environment relating to machines, derrick crane, and boiler B.E.2552 (2009)

Table 1.9-1 (conts.)

Related law	Detail in brief
	- Notification of Department of Labor Protection and Welfare about guidelines, methods, and conditions on training executives, employers, and employees relating to safety, occupational health/sanity, and appropriate working environement B.E.2555 (2012) - Regulation of Ministry of Labor on setting standards in management and enforcement on safety, occupational health/sanity, and working environment B.E.2549 - Regulation of Ministry of Labor on setting standards for management and enforcement on safety, occupational health/sanity, and working environment (2nd edition) B.E.2553 (2010) - Ministrial Regulation on setting standard for management, execution, and enforcement for safety, occupational health/sanity, and working environment involving protection against fire B.E.2555 (2012)
5. Enactment of Dangerous Objects B.E 2535	- Notification of Ministry of Industry on system of documents regarding transportation of toxic wastes B.E.2547 - Notification of Ministry of Industry on getting rid of wastes, dirts, and unused materials B.E. 2548 - Notification of Ministry of Industry on getting rid of wastes, dirts, and unused materials(2nd edition) B.E.2560 (2017) - Notification of Department of Industrial Work on sorting out, getting rid of types of wastes and unused materials, and asking for permits and rights to transport wastes and unused materials out of the factory area automatically through the usage of electronic systems/technologies B.E.2561 (2018)
6. Factory Act B.E.2535	- Notification of the Ministry of Industry on safety measures in factory related to working environment B.E.2546 - Notification of the Ministry of Industry on specification of

Table 1.9-1 (conts.)

Related law	Detail in brief
	disturbance noise level from factory B.E.2548 (2005) - Notification of the Ministry of Industry on sorting types and speciations of the factories that need documentations about the type and quantity of pollutants that the factory emitted B.E.2553 - Notification of the Ministry of Industry on regulating the amount of foreign chemicals in the air that was released from the factory B.E.2549 - Ministrial Regulation on the regulation/criteria of soil and underground water contamination in factory areas B.E.2559 (2016) - Notification of the Ministry of Industry about setting the criteria and regulation in soil and underground water contamination, checking the soil and underground water quality, reporting information regarding reports/documentations about the results of soil and underground water quality, and outlining measures for controlling and reducing contaminations in soil and underground water B.E.2559 (2016) - Notification of Ministry of Industry on protection against fire in the facory B.E.2552 (2009)
7. Compensation Act B.E.2537	Specification of diseases caused by characteristic or condition of work or related to work
8. Making Use of the Land	-Ministrial Regulation on governing the city planning of Ratchaburi Province B.E.2555 (2012) and B.E.2558 (2015)

1.10 Summarization of the TECO Power Plant and Hin Kong Power Co.L.td

The intention of the Hin Kong Power Plant is to substitute and reinforce the production capacity of the soon-to-be depleted TECO Power Plant. In addition to this, the consultant coporation has compared the information of the TECO power plant in accordance to EIA report B.E.2540 (1997) edition and information of the current production of Power Plamt TECO in B.E.2561 (2018) with the information of the Hin Kong Power Plant. See details in Table **1.10-1**.

Table 1.10-1

Compare TECO and Hinkong Power Plant Information

Details:	TECO Power Plant		Hin kong Power Plant Project
	EIA Report B.E.2540 [1/] (1997)	The actual operation is currently	
1. Project Location	- Moo 5, Hin Kong Sub-district, Mueang Ratchaburi District Ratchaburi Province Total area is approximately 200 rai (320,000 sq.m.).	- Moo 5, Hin Kong Sub-district, Mueang Ratchaburi District Ratchaburi Province Total area is approximately 328 rai (Ratchaburi Electricity Generating Company had bought additional land)	- Moo 5, Hin Kong Sub-district, Mueang Ratchaburi District Ratchaburi Province - Total area is approximately 188 rai (302,073 sq.m.).
2. Green Area	- Not specified	- 22 rai	- 15,646 m^2, representing 5.18%
3. Products			
* Installed capacity	- 775 MW	- 720 MW	- 1,540 MW
* Gross capacity	- 742.50 MW	- 713.44 MW (maximum value as of May 5, 2019)	- 1,520 MW
* Net capacity	- 700 MW	- 702.70 MW (maximum value as of May 5, 2019)	- 1,400 MW
* Supplied to the grid of EGAT.	- 700 MW	- 700 MW	- 1,400 MW
4. Mechanical			
- Gas Turbine	- 2 sets * 250 MW/set	- 2 sets *223 MW/set	- 2 sets * 535 MW/set
- Steam Turbine	- 1 set *275 MW	- 1 set *260 MW	- 2 sets * 235 MW/set
- HRSG	- 2 sets	- 2 sets	- 2 sets
- Chiller	- None	- None	- None
5 Fuel Usage			
- Primary Fuel	- Natural Gas	- Natural Gas	- Natural Gas
- Back up Fuel	- Diesel	- Diesel	- Diesel
Fuel Consumption			
- Natural Gas	- 140 Millions ft^3 per day	- 13,862,681 MMBTU per Year (According to information from year B.E.2561 (2018))	- 200.78 Millions ft^3 per day
- **Diesel**	- 3.15 Million liter /day (emergency usage only)	- No usage of Diesel in year B.E.2561 (2018)	- 4.62 Million liter /day (emergency usage only)

Table 1.10-1 (conts.)

Details:	TECO Power Plant		Hin kong Power Plant Project
	EIA Report B.E.2540 [1/] (1997)	The actual operation is currently	
Fuel transport			
- Natural Gas	- Pipeline transportation system from the station for controlling pressure sized 24 inches	- Pipeline transportation system from the station for controlling pressure sized 24 inches	- Pipeline transportation system from the station for controlling pressure sized 24 inches
- **Diesel**	- Transporting from dealers inside the country via wagon truck	- Transporting from dealers inside the country via wagon truck	- Transporting from dealers inside the country via wagon truck
Amount of Diesel Oil reserves	- 1 Diesel oil barrel	- 1 Diesel oil barrel: 10 Million liter Information in accordance to year B.E.2561 (2018)	- 2 Diesel oil barrels sized 12,700 cubic mete
6 **Chemical Usage**			
RO system			
- Oxygen Scavenger		- B.E. 2561 (2018) Not used	- 15 cubic meter/year
- Aqueous Ammonia		- 0.94 cubic meter/year	- 90 cubic meter/year
- Trisodium Phosphate	- 0.4 tons/year	- 0.20 cubic meter/year	- 20 cubic meter/year
Cooling water			
- Corrosion Inhibitor		- 11 cubic meter/year	- 15 cubic meter/year
- Scale Inhibitor	- 35 tons/year		- 25 cubic meter/year
- Sodium Hypochlorite ; NaOCl		- 193 cubic meter/year	- 440 cubic meter/year
- Sulfuric Acid ; H_2SO_4	- 650 tons/year	- 178 cubic meter/year	- 150 cubic meter/year
- Chlorine	- 120 tons/year	- Not used	- Not used
Water treament plant			
- Sodium Hypochlorite ; NaOCl		- 209 cubic meter/year	- 1,000 cubic meter/year
- Poly Aluminium Chloride		- 19 tons/year	- 482 tons/year
- Polymer		- 0.6 tons/year	- 13.5 tons/year
- Sodium Hydroxide ; NaOH	- 160 tons/year	- 210 cubic meter/year	- 300 cubic meter/year
- Hydrochloric acid ; HCl		- 34 cubic meter/year	- 20 cubic meter/year
- Sodium bisulfate	- 1.9 tons/year	- Not used	- 0.6 tons/year
- Antiscalant		- Not used	- 0.5 cubic meter/year
- Biocide		- Not used	- 1.131 cubic meter/year
- Citric Acid		- Not used	- 0.12 cubic meter/year
- Amene	- 2.7 tons/year	- Not used	- Not used
- Ammonia		- Not used	- Not used

Table 1.10-1 (conts.)

Details:	TECO Power Plant		Hin kong Power Plant Project
	EIA Report B.E.2540 [1/] (1997)	The actual operation is currently	
7 Water Supply			
Water Resources	- Mae Klong River	- Mae Klong River	- Mae Klong River
Raw Water Reservoir	- 60,000 cubic meter (storage for 3 days)	- 60,000 cubic meter (storage for 3 days)	- 92,838 cubic meter (storage for 3 days)
Pipeline size	- 24 inch	- 24 inch	- 24 inch
Distance from pumping station to project site	- 13 kilometer	- 13 kilometer	- 13 kilometer
Raw water from Mae Klong river (max water usage)	- 21,312 cubic meter/day	- 1,0891 cubic meter/day	- 30,946 cubic meter/day
Cooling Water Makeup	- Not specified	- 1,0437 cubic meter/day	- 30,820 cubic meter/day
Demineralization Water	- Not specified	- 156 cubic meter/day	- 208 cubic meter/day
Potable Water	- Not specified	- 29 cubic meter/day	- 30 cubic meter/day
Laboratory	- Not specified		- 5 cubic meter/day
Sampling Rack & Chemical Dosing Area	- Not specified		- 35 cubic meter/day
8 Pollution Control			
8.1 Air Emissions			
- Source	- 2 Stack	- 2 Stack	- 2 Stack
Stack Height (m)	- 38 meter	- 38 meter	- 60 meter
- Design basis for NOx			
* Natural Gas	- Dry Low NOx	- Dry Low NOx	- Dry Low NOx
* Diesel	- Water Injection	- Water Injection	- Water Injection
- **Concentation and Emission**			
<u>Case of natural gas use Full Load</u>			
* **TSP**			
* HRSG stack 1	- Concentration : 10 milligrams / cubic meter Emission : Not specified	- Concentration : 10 milligrams / cubic meter Emission : 2.7 grams/sec	- Concentration : 20 milligrams / cubic meter Emission : 9.70 grams/sec
* HRSG stack 2	- Concentration : 10 milligrams / cubic meter Emission : Not specified	- Concentration : 10 milligrams / cubic meter Emission : 2.7 grams/sec	- Concentration : 20 milligrams / cubic meter Emission : 9.70 grams/sec

Table 1.10-1 (conts.)

Details:	TECO Power Plant		Hin kong Power Plant Project
	EIA Report B.E.2540 [1/] (1997)	The actual operation is currently	
* SO_2			
* HRSG stack 1	- No control	No control	- Concentration : 10 ppm Emission : 13.90 grams/sec
* HRSG stack 2	- No control	No control	- Concentration : 10 ppm Emission : 13.90 grams/sec
* NO_x			
* HRSG stack 1	- Concentration : 119 ppm Emission : 60.28 grams/sec	- Concentration : 119 ppm	- Concentration : 59 ppm Emission : 59.0 grams/sec
* HRSG stack 2	- Concentration : 119 ppm Emission : 60.28 grams/sec	- Concentration :119 ppm	- Concentration : 59 ppm Emission : 59.0 grams/sec
Case of Diesel use Full Load			
* TSP			
* HRSG stack 1	- Concentration : 17 milligrams / cubic meter Not specified	- No control	- Concentration : 35 milligrams / cubic meter Emission : 14.0 grams/sec
* HRSG stack 2	- Concentration : 17 milligrams / cubic meter Not specified	- No control	- Concentration : 35 milligrams / cubic meter Emission : 14.0 grams/sec
* SO_2			
* HRSG stack 1	- Concentration : 26 ppm Emission : 15.4 grams/sec	- Concentration : 26 ppm	- Concentration : 20 ppm Emission : 22.9 grams/sec
* HRSG stack 2	- Concentration : 26 ppm Emission : 15.4 grams/sec	- Concentration : < 26 ppm	- Concentration : 20 ppm Emission : 22.9 grams/sec
* NO_x			
* HRSG stack 1	- Concentration : 179 ppm Emission : 95 grams/sec	- Concentration : < 179 ppm	- Concentration : 99 ppm Emission : 81.4 grams/sec
* HRSG stack 2	- Concentration : < 179 ppm Emission : 95 grams/sec	- Concentration : < 179 Pppm	- Concentration : 99 ppm Emission : 81.4 grams/sec
- The Continuous emissions monitoring system (CEMS)	- Use	- Use	- Use

Table 1.10-1 (conts.)

Details:	TECO Power Plant		Hin kong Power Plant Project
	EIA Report B.E.2540 [1/] (1997)	The actual operation is currently	
8.2 Wastewater management			
Waste water discharge point	- Mae Klong River	- Mae Klong River	- Mae Klong River
Pipeline size from project site to waste water reservoir	- 12 inch	- 12 inch	- 12 inch
Volume Holding pond	- 6,913 Cubic meter (2 pond)		- 6,913 cubic meter (2 pond)
Volume			
- Waste water from daily lives of employees	- Not specified	- 2,562 cubic meter/ year (according to information from year 2018) or approximately 13 m^3/day	- 30 cubic meter/ day Treated by septic tank system; gathered into waste water treatment system Finised model (Septic tank) which is installed in every building before pumped to Holding pond
- Waste water with oil contamination	- Not specified	- 65,958.60 cubic meter/ year (information from year 2018) or approximately 354.61 cubic meter/ day	- 92 cubic meter/ day Will be send to Water-Oil Seperater to separate water from oil Rain water that was seperated will be sent to Retention pond Oil that was seperated will be eliminated by the permitted agency
- Waste water from the production process			
* Drainage water from Cooling Tower	- Not specified	- 320,433 cubic meter/ year (infromation from year 2018) or approximately 1,722.75 cubic meter/ day	- 6,836 cubic meter/ day Pump to Holding Pond prior other usages/benefits in the project area
* Drainage water from boiler	- Not specified		- 72 cubic meter/ day Reuse in cooling system
- Waste water from the production auxiliatory system			
* Drainage water from chemical labatory	- Not specified	- 3,157.37 cubic meter/ year (information from year 2018) or approximately 16 cubic meter/ day	- 5 cubic meter/ day Examince the water quality then send them to Holding Pond before being sent away for other usages /benefits in the project area

Table 1.10-1 (conts.)

Details:	TECO Power Plant		Hin kong Power Plant Project
	EIA Report B.E.2540 [1/] (1997)	The actual operation is currently	
* Drainage water from Demineralized System		-	- 100 cubic meter/ day Gathered and sent back to basic water treatment plant
Total Drainage/waste water			- 6,963 m^3/day by watering 50 cubic meter/ day
Total drainage water onto the Mae Klong River	- 2,928 cubic meter/ day	- 2,108.12 cubic meter/ day	- 6,913 cubic meter/ day
8.3 **Waste management**			
Waste residue from working office			
- Normal trash/waste	- Not specified	- 26 tons/year government agencies waste collection in project area. Collected waste shall be carried for disposal by the permitted agency from government agencies	- 24.8 tons/year Set up trash cans for normal wastes in areas of the project before sending them to certified agency for further disposal
Waste residue from production process			
- Used lubricating oil	- Not specified	- 11 tons/year	- 800 liters/month Collected barrels of 200 L stored in storage building Waste residue sent to certified agency from the industrail plant to dispose
- Filter for the water filtering system	- Not specified	- None	- 60 pieces/5 year collected in black platic bag and safely stored away in waste residue building and then sent to certified agency from the industrial plant to dispose off afterward
- Air filter	- Not specified	- 1.13 tons/year	- 1,600 pieces/year Collected in black platic bag and safely stored away in waste residue building and then sent to certified agency from the industrial plant to dispose off afterward

Table 1.10-1 (conts.)

Details:	TECO Power Plant		Hin kong Power Plant Project
	EIA Report B.E.2540 [1/] (1997)	The actual operation is currently	
Sludge from Water treatment plant	- Not specified	- 196 tons/year	- 401.5 tons/year collected inside Water demineralized system (in buildings for clear water production and waste residue storage) then sent to certified agency from the industrial plant to dispose off
9 Number of workers (employees)/ management of the project - Number of employees/workers (people)	- Not specified	- 50 people	- 60 people

Notation : information in accordance to year 2561 (2018) of 186 days of operating of power plant

Origin : [1/] report on envgironmental impact of 700 MegaWatt gas power plant from Ratchaburi province by the Energy Company Limited in year 2540 (1997)

Chapter 2

Project's details

Chapter 2
Project's detail

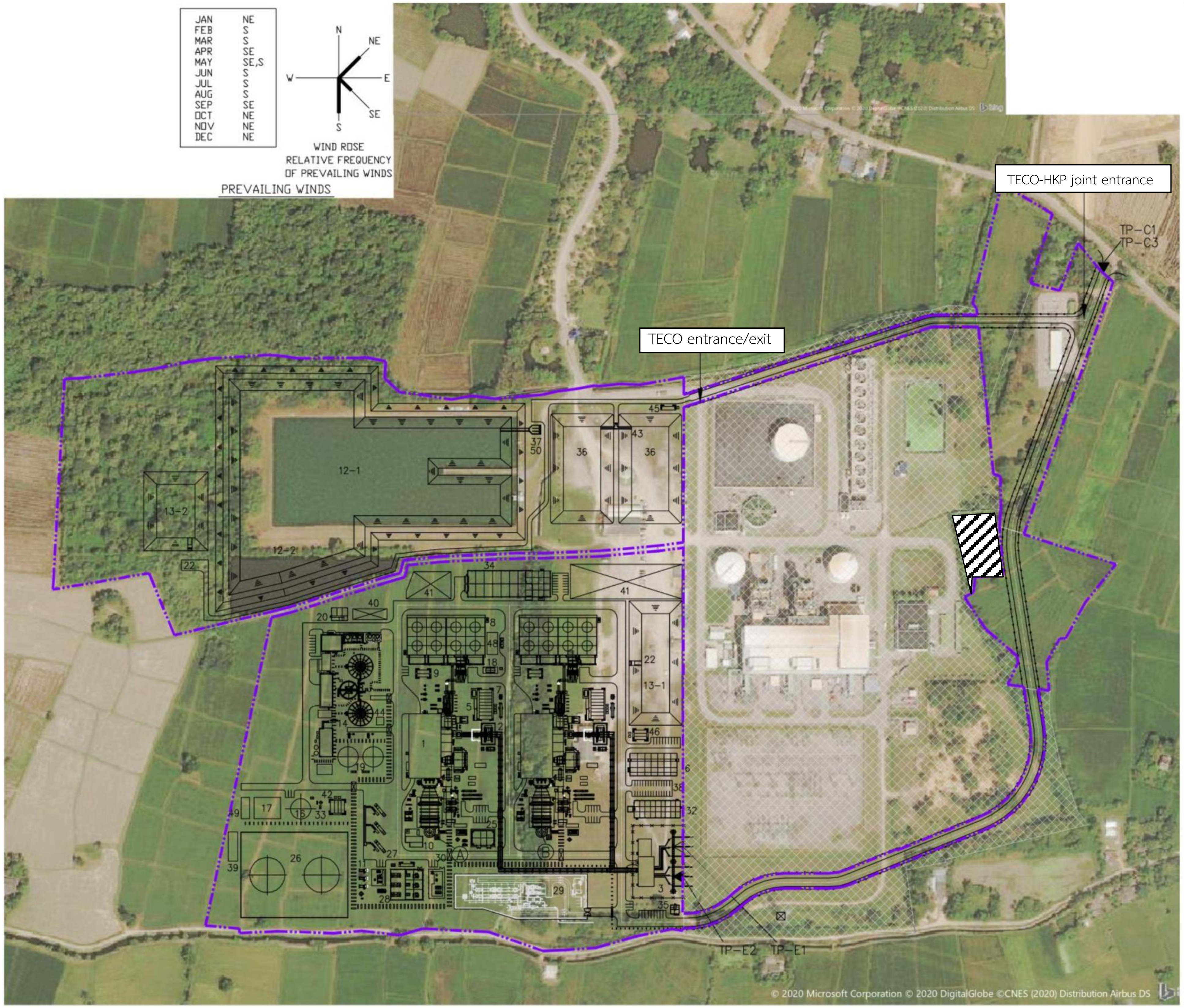
2.1 Location

Hin Kong power plant project of the Hin Kong Power Co. Ltd. (the project) is located in Hing Kong subdistrict, Mueang Rachaburi district, Rachaburi province. The project layout for the current location was shown in **Figure 2.1-1.** By which, the project had signed in a land lease agreement from the Rachaburi Power Plant Co., Ltd. who is the land owner of the Tri Energy Power Plant (TECO). Entire area of the project is 188-3-18 Rai (Thai unit; approximately 302,073 square meters). Details of land area were shown in **Table 2.1-1,** and land authority map of the project was shown in **Figure 2.1-2** (Land owner licensing documents were shown in **Appendix 2-1**).

According to the land authority map, it was found that there is a public irrigation canal which is adjacent to the title deed no. 6901, 6613, 6903, 6607, 40458, 40457, 40456, and 17746. However, the canal is not used for water supply nor fishery purposes (current condition of the canal was shown in **Figure 2.1-3).** Surrounding area of the project is consist of public roads, and public canals. However, a public well was changed to be used as village sport area as shown in **Figure 2.1-4.**

While another private land which is located in the central area of the TECO power plant (as shown in **Figure 2.1-2** of the land authority map the project), the consultant company had performed opinion surveying from land owner, and it was found that the past operation of the power plant did not cause any problem of land use. Furthermore, land utilization for neighboring areas of the project was planned for used as residential and commercial areas, sales, etc. For the question about transportation route by using the entrance area of the project, the land owner agreed to use the entrance area as public transportation route without any worrying about the transportation route. For safety measure about the transportation route using the power plant entrance area, it was mentioned that the entrance area (connected to Nongrak-Huai Pladuk road) which is the entrance road to the neigboring area would not close, therefore; it will not affect land owner of the surrounding area. The project will provide securitry guards (in the electricity generation area) to maintain safety operation with related services at the entrance area of the project.

However, the project had designed land utilization plan without any public land land using according to the Ministry Regulation Issued 55 (B.E. 2543 (2000)) under the Building Control Act. B.E. 2522 (1979) (as shown in **Figure 2.1-5**). Therefore, local people can use the area as transportation routes without any restriction. As for other land owner, the TECO allow the land owner use transportation roads in the central part of the power plant.



	EQUIPMENT LIST
1	TURBINE BUILDING
2	STEP-UP TRANSFORMER
3	GIS
4	NOT USED
5	ELECTRICAL PACKAGE
6	CENTRAL CONTROL BUILDING
7	EMERGENCY D/G PACKAGE
8	COOLING TOWER
9	COOLING TOWER ELECTRICAL PACKAGE
10	AUX. BOILER
11	AIR COMPRESSOR
12-1	RAW WATER POND (EXISTING)
12-2	RAW WATER POND (NEW)
13-1	STORM WATER POND-1
13-2	STORM WATER POND-2
14	WATER TREATMENT PLANT
15	NOT USED
16	SERVICE & FIRE WATER STORAGE TANK
17	F/F PUMP SKID (SUNSHADE)
18	CW CHEMICAL DOSING
19	DEMI. WATER TANK
20	LABORATORY HOUSE
21	NOT USED
22	STORM WATER DISCHARGE PUMP
23	NOT USED
24	NOT USED
25	GAS STORE (H2,CO2,N2 BOTTLE) (SUNSHADE)
26	FUEL OIL TANK
27	FUEL OIL UNLOADING STAITION & TRANSFER PUMP AREA
28	GAS COMPRESSOR
29	GAS METERING STATION AREA
30	FUEL GAS TREATMENT SYSTEM
31	NOT USED
32	ADMINISTRATION BUILDING
33	POTABLE WATER SYSTEM
34	MAINTENANCE WORK SHOP / WAREHOUSE BUILDING
35	GUARD HOUSE
36	COOLING WATER HOLDING POND
37	COOLING TOWER MAKE UP PUMP
38	PARKING SPACE FOR ADMINISTRATION BUILDING
39	OIL SEPARATOR
40	SITE OFFICE & CONTAINER AREA FOR MAINTENANCE
41	LAYDOWN AREA FOR MAINTENANCE
42	COMMON FACILITIES ELECTRICAL PACKAGE
43	COOLING WATER DISCHARGE PUMP
44	CHEMICAL STORAGE BUILDING
45	POND AREA ELECTRICAL PACKAGE
46	CENTRAL CONTROL BUILDING CONTROL PACKAGE
47	NOT USED
48	CHLORINE DIOXIDE DOSING
49	FOAM SKID
50	STOPLOG RACK FOR COOLING TOWER MAKEUP PUMP PIT

40 0 80 160m
SCALE 1:4000

PRELIMINARY

Customer

บริษัท หินกองเพาเวอร์ จำกัด
HIN KONG POWER COMPANY LIMITED

<u>Figure 2.1-1</u> Project Scope

Table 2.1-1
Land Details and Project Title Deed's Sequence

Order	Title Deed No.	Size (m^2)	Area			Ownership
			Rai	Ngan	Wah²	
(1) Deed for Rented						
1	6901	112,504	70	1	26	Ratchaburi Electricity Generating Co.,Ld (land space indicated by the 101 rai 1 ngan 26 wah² title deed) divides space for rent for the Hin Kong Power Plant Co.,Ld as indicated -Power plant areas take the west side of the rented area
1.1	6901	3,500	2	0	75	-roads and water pipelines take the right area of the north side of the rented area
2	6613	60,944	38	0	36	Ratchaburi Electricity Generating Co.,Ld (land space indicated by the 108 rai 3 ngan 53 wah² title deed) divides space for rent for the Hin Kong Power Plant Co.,Ld as indicated -Power plant areas take the west side of the rented area
2.1	6613	7,665	4	3	16	-Roads and water pipelines take from the southeast side to the south side of the rented area
(2) Title deed for Entire Plot of land						
3	6903	20,884	13	0	21	Hin Kong Power Plant Co.,Ld rents land from Ratchaburi Electricity Generating Co.,Ld
4	6607	19,324	12	0	31	
5	40458	6,952	4	1	38	
6	40457	15,760	9	3	40	
7	40456	8,628	5	1	57	
8	17746	10,948	7	0	6	
9	24219	8,040	5	0	10	
10	24220	15,836	9	3	59	
11	16054	11,088	8	1	40	
	Total	**302,073**	**188**	**3**	**18**	

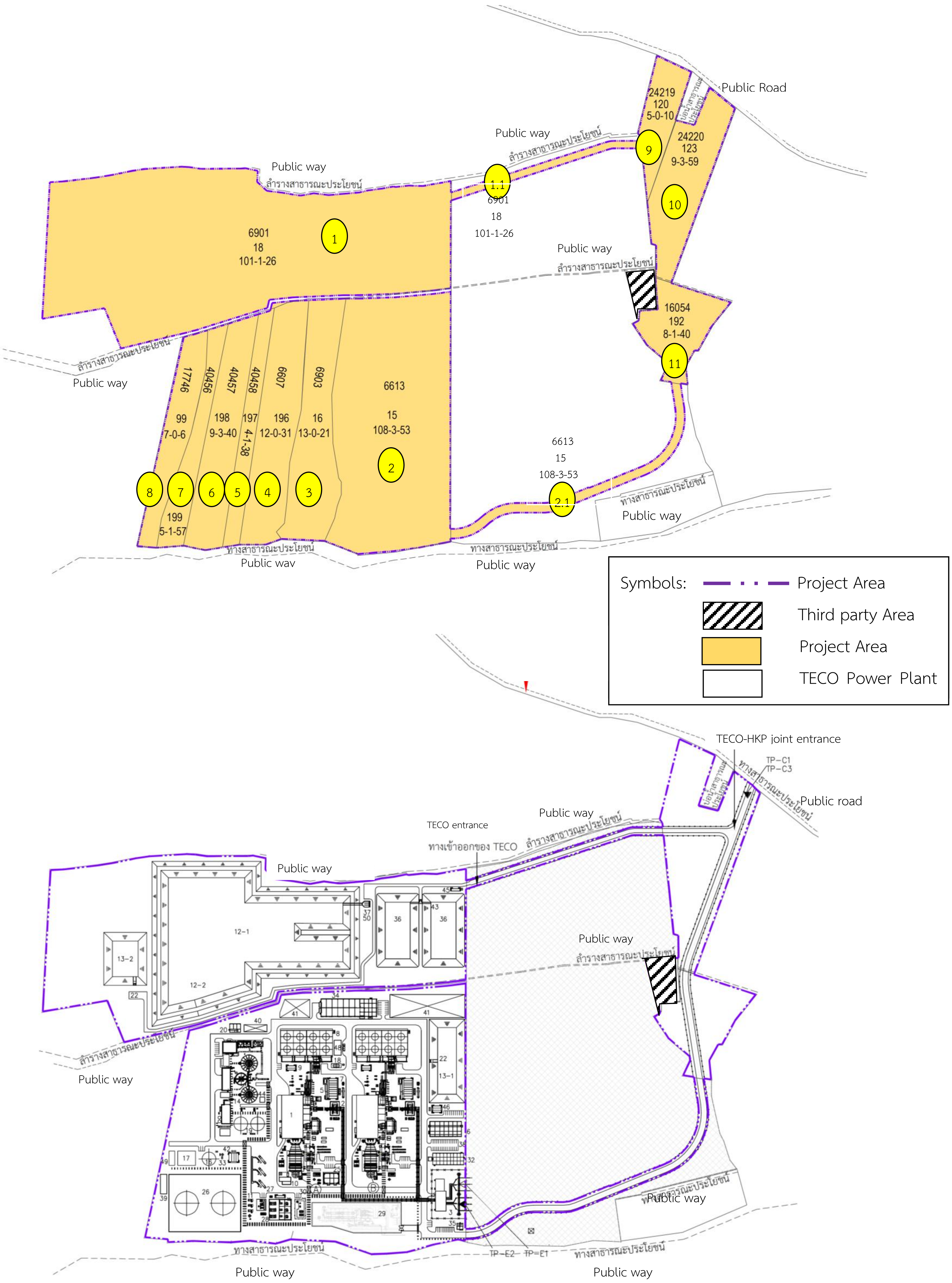
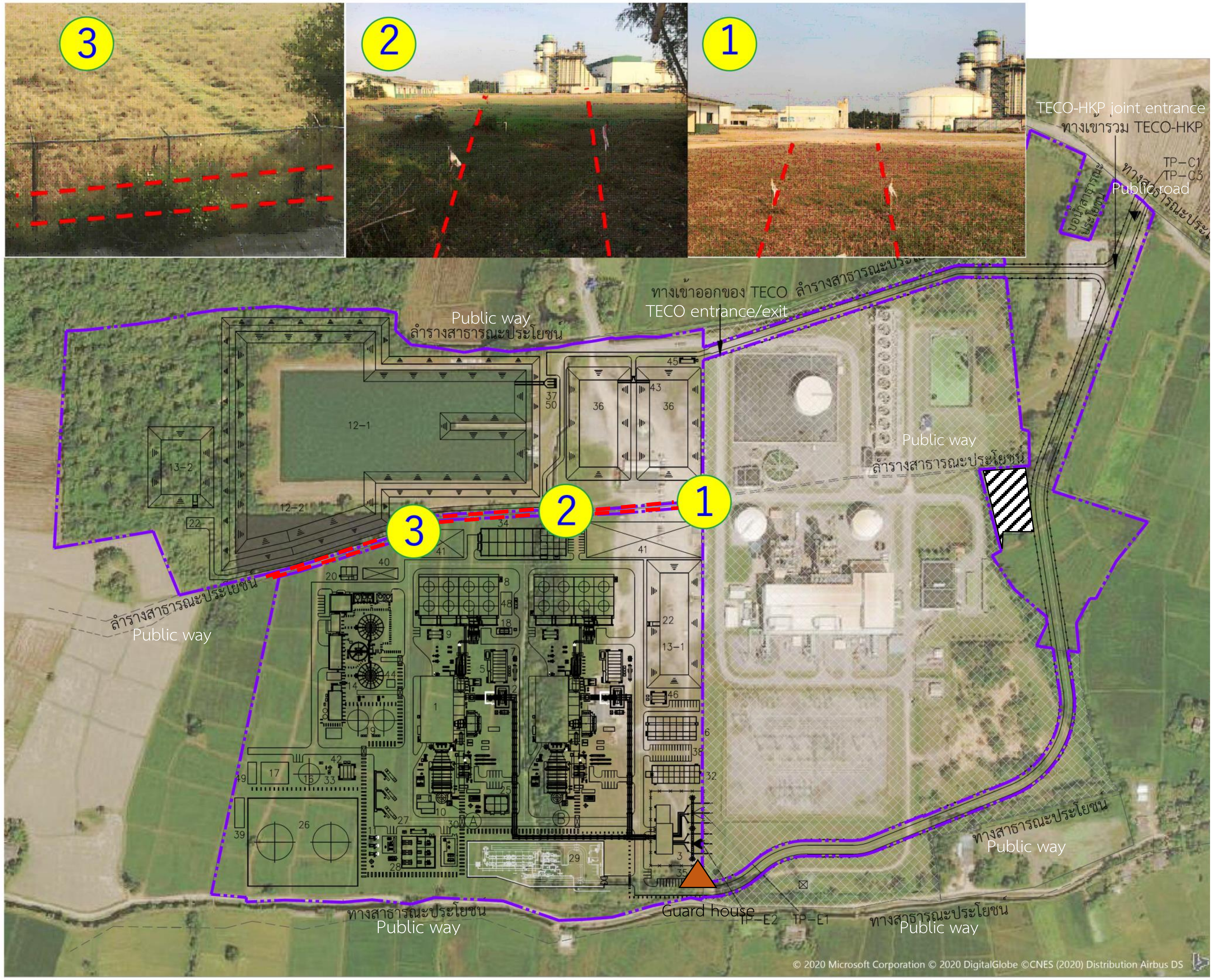


Figure 2.1-2 **Project's Title Deed Plan**



	EQUIPMENT LIST
1	TURBINE BUILDING
2	STEP-UP TRANSFORMER
3	GIS
4	NOT USED
5	ELECTRICAL PACKAGE
6	CENTRAL CONTROL BUILDING
7	EMERGENCY D/G PACKAGE
8	COOLING TOWER
9	COOLING TOWER ELECTRICAL PACKAGE
10	AUX. BOILER
11	AIR COMPRESSOR
12-1	RAW WATER POND (EXISTING)
12-2	RAW WATER POND (NEW)
13-1	STORM WATER POND-1
13-2	STORM WATER POND-2
14	WATER TREATMENT PLANT
15	NOT USED
16	SERVICE & FIRE WATER STORAGE TANK
17	F/F PUMP SKID (SUNSHADE)
18	CW CHEMICAL DOSING
19	DEMI. WATER TANK
20	LABORATORY HOUSE
21	NOT USED
22	STORM WATER DISCHARGE PUMP
23	NOT USED
24	NOT USED
25	GAS STORE (H2,CO2,N2 BOTTLE) (SUNSHADE)
26	FUEL OIL TANK
27	FUEL OIL UNLOADING STAITION & TRANSFER PUMP AREA
28	GAS COMPRESSOR
29	GAS METERING STATION AREA
30	FUEL GAS TREATMENT SYSTEM
31	NOT USED
32	ADMINISTRATION BUILDING
33	POTABLE WATER SYSTEM
34	MAINTENANCE WORK SHOP / WAREHOUSE BUILDING
35	GUARD HOUSE
36	COOLING WATER HOLDING POND
37	COOLING TOWER MAKE UP PUMP
38	PARKING SPACE FOR ADMINISTRATION BUILDING
39	OIL SEPARATOR
40	SITE OFFICE & CONTAINER AREA FOR MAINTENANCE
41	LAYDOWN AREA FOR MAINTENANCE
42	COMMON FACILITIES ELECTRICAL PACKAGE
43	COOLING WATER DISCHARGE PUMP
44	CHEMICAL STORAGE BUILDING
45	POND AREA ELECTRICAL PACKAGE
46	CENTRAL CONTROL BUILDING CONTROL PACKAGE
47	NOT USED
48	CHLORINE DIOXIDE DOSING
49	FOAM SKID
50	STOPLOG RACK FOR COOLING TOWER MAKEUP PUMP PIT

NOTE

: EXISTING FACILITY AREA

: PERSONAL LAND OTHER THAN THE TECO/HKP

1. CHEMICAL STORAGE AREA ARE LOCATED INSIDE WATER TREATMENT BUILDING WITH STORAGE AREA OF 70 m2.

LOCATION	NORTH	EAST
A	1496314.696	580044.200
B	1496314.696	580149.200

Figure 2.1-3 Current State of the Public Canal in Project Area

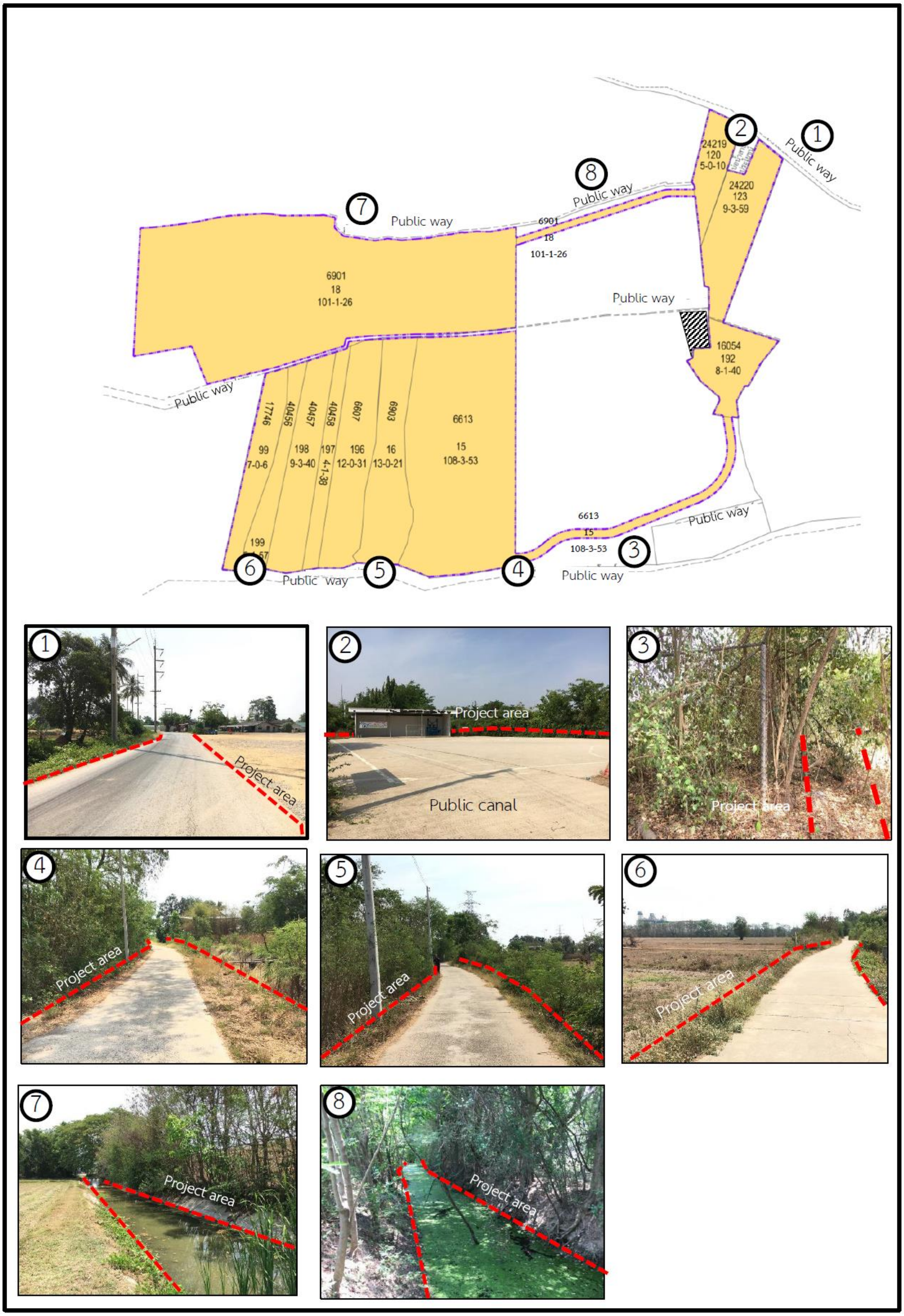


Figure 2.1-4 Current State of the Public Canal and Public Road Surrounding Project Area

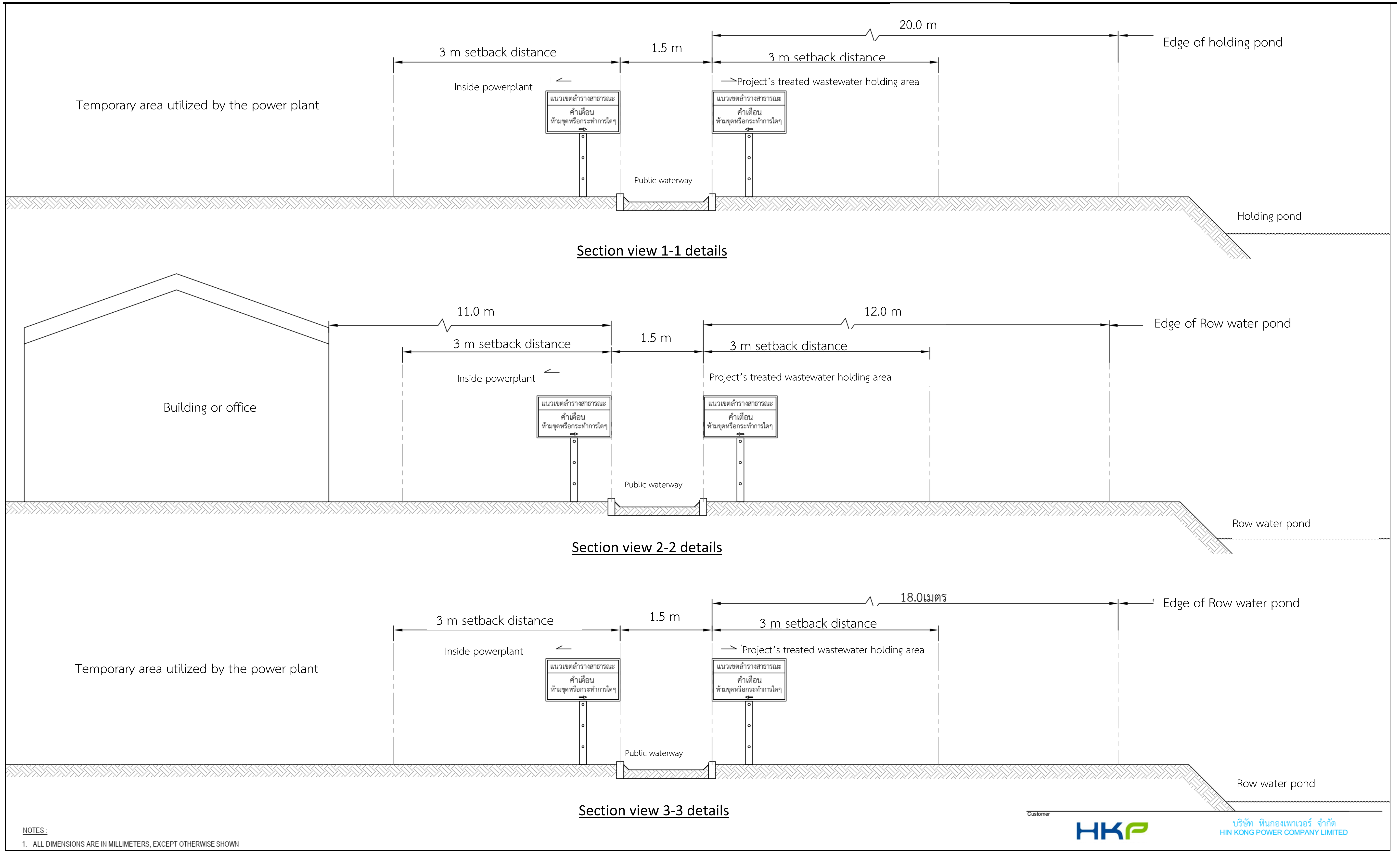


Figure 2.1-5 Setback distance Between Project Area and the Public Area

2.1.1 Consistency of land utilization

According to land utilization surveying from the Rachaburi City Plan Office, it was found that the project is located in the residential and agricultural area (green shade) under the Rachaburi Total City Plan (2nd edition) which was promulgated on 9th December B.E. 2558 (2015). The area is allowed to use for agricultural activity, instution, religion purpose, governmental office, and facility purpose, by which; other land utilization purposes should have open space at least 20% of the entire permission area without using as restriction activites (except for some factory type according to the enclosed list under the Ministry Regulation). Therefore, thermal power plant which is not using coal or nuclear as fuel could be installed in this area. Nervertheless, comparison of land utilization condition with land using of the project under the Ministry Regulation was shown in **Table 2.1.1-1.**

Therefore, project operation is not violating the Ministiral regulation of city planning of Ratchaburi province (2nd edition) (confirmation of land utilization was shown in **Appendix 2-2)**

Table 2.1.1-1

Comparison between the Speficication of Ministrial Regulation of City Planning of Ratchaburi Province (2nd edition) and the Specification of the Project

Table 2.1.1-1 (continue)

Condition	Project Operation
Issued 10 Agricultural area is allowed to use for agricultural activity, instution, religion purpose, governmental office, and facility purpose other land utilization purposes should have open space at least 20% of the entire permission area	Other land utilization purposes should have open space at least 20% of the entire permission area, the project has open space area which is compose of reservoir, water treatment plant, retention pond, and rain water retention pond under total area of 78,275 square meters or 25.91% of entire permission area (302,073 square meters) Remark: Open space means those area without roof or structure with roof, by which the area could be used as water pond, swimming pool, wastewater holding pond, waste storage area, or parking area outside a

Table 2.1.1-1 (continue)

Condition	Project Operation
	building. The area includes small structure with height less than 1.20 meters. without roof according to the Ministry Regulation Issued 55 (B.E. 2543 (2000)) under the Building Control Act. B.E. 2522 (1979)
This land type is not allowed to use by the following purposes; (1) All factory types according to the factory law except for some types issued in the enclosed list under the the Ministry Ragulation and community wastewater treatment plant (2) Oil depot and oil storage typr 3 according to the fuel control for commercial law page 12, issued 132, section 118 Kor of the Royal Gazette issued on 9th December 2015 (3) Liquidfied petroleum storage, pressurized LPG, LPG confined area, and LPG storage area according to the fuel control law (4) Land management for industry (5) Land management for commercial except for Jombung subdistrict of Jombung district, and Nongkob, Nongor, Suanklui subdistricts of Pangpong district which are allowed to operate with residential area under the condition of those commercial area must less than 5% of total area (6) Land management for residential except for Jombung subdistrict of Jombung district, and Nongkob, Nongor, Suanklui subdistricts of Pangpong district which are allowed to operate under the condition of those area must less than 5% of each area and sub area should has total area more than 200 square meters as in accordance to the law. (7) Residential or commercial area, and large building construction in the land	- Hin Kong Power Plant project (using natural gas as fuel) is classified as thermal power plant which could be operated under the condition - the project has oil storage for using by emergency case without commercial purpose - do not operate - do not operate - do not operate - do not operate - do not operate

Table 2.1.1-1 (continue)

Condition	Project Operation
transformation area is used for argricultural purpose under the land transformation for agricultural purpose law, and land utilization for factory purpose nearby river bank or canal bank should have buffer area at least 15 m from the river bank	

2.1.2 Scope of the study area and surrounding area

The project is located in Hin Kong subdistrict, Mueang Rachaburi district, Rachaburi Province. It occupies entire area of 188-3-18 Rai (302,073 square meters). Location of the project and surrounding area were shown in **Figure 2.1.2-1.** Transportation routes to the project could be performed by using highway no. 4 (Pethkasem Rd.) and go to highway no. 3208, then turn to local road no. Kor-Jor 4004 (parallel to irrigation canal) brfore go to local road Ban Nongrak-Huai Pladuk, and reach to the power plant. Transportation routes to the project area was shown in **Figure 2.1.2-2.** Surrounding areas of the study area and neighboring area of the power plant are summarized by;

North adjacent to Ban Nongrak,
South adjacent to Agricultural area,
East adjacent to the power plant of TECO and Ban Nongrak community, and
West adjacent to Agricultural area.

Considering for consistency condition of the Ministry Ragulation Issued 2 (B.E. 2535 (1992)) under the Factory Act. B.E. 2535 (1992) was mentioned by;

Topic 2 Do not install factory type 3 unless receiving permission for factory type, and size more than 50 Hp and workers more than 50 persons in the following areas;

1) Resdiential area or building area for living purpose, and
2) Within a distance of 100 meters. from public buildings which are school or instution, temple or religion building, hospital, historical area, and governmental office. By which the definition includes natural resources or environmental conservation areas under the agreement of the cabinet. However, the nearest school or instution, temple or religion building, hospital, historical area, and governmental office to the project is Wat Huai Pladuk School which has approximate distance of 1.7 kilometers., and Hin Kong Temple which has approximate distance of 1.75 kilometers.

From the condition, it was found that location of the project is not againt the condition, consequently; location of the project is far from those sensitive areas.

Figure 2.1.2-1 Project's surrounding

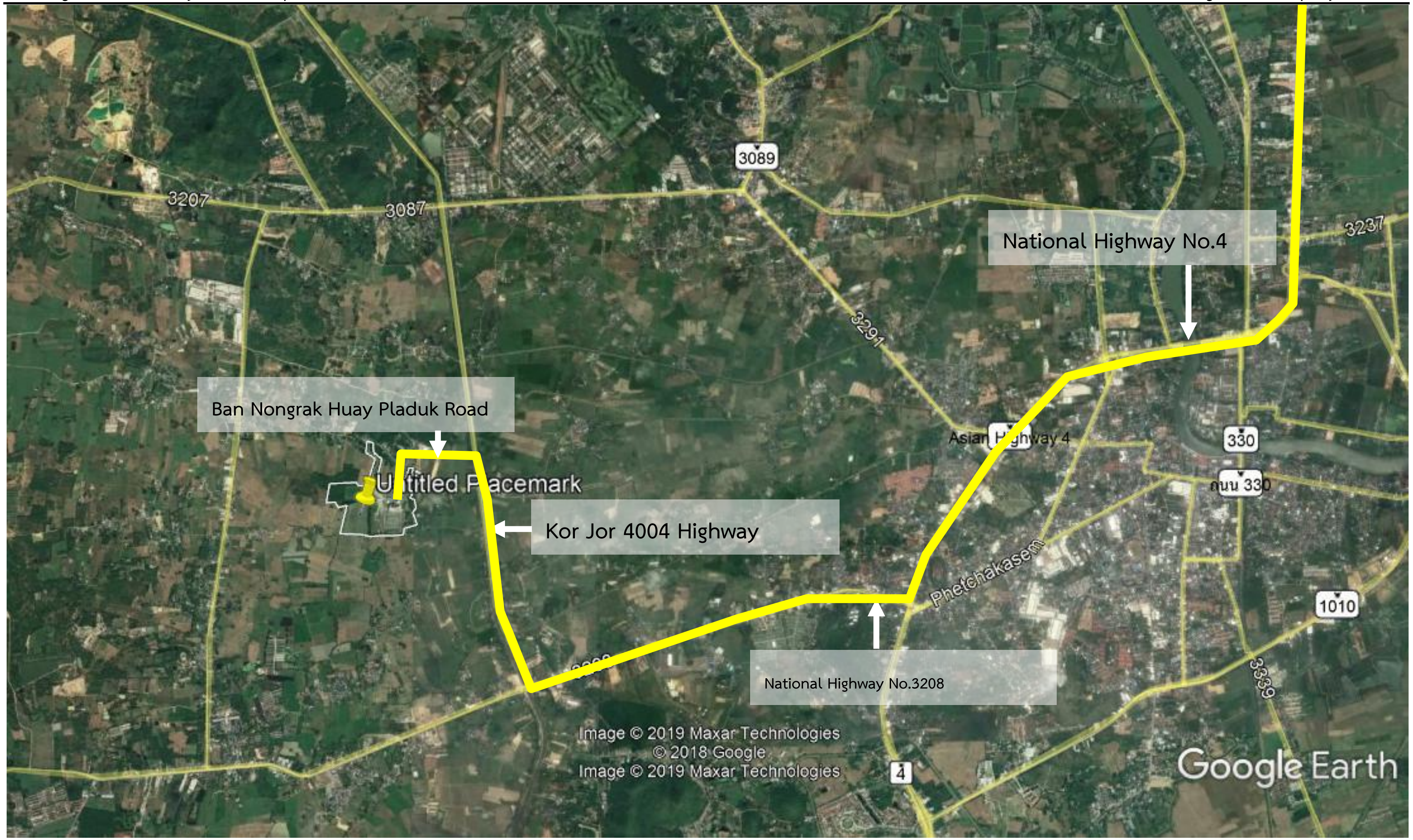


Figure 2.1.2-2 Route into the Project Area

The consultant company had performed environmental Impact Assessment for a radius of 5 kilometers. from boundary area of the TECO power plant and boundary area of Hin Kong Power Plant project. Environmental sensitive areas and distance between sensitive areas and the project were summarized and shown in **Figure 2.1.2-3** and **Table 2.1.2-1.**

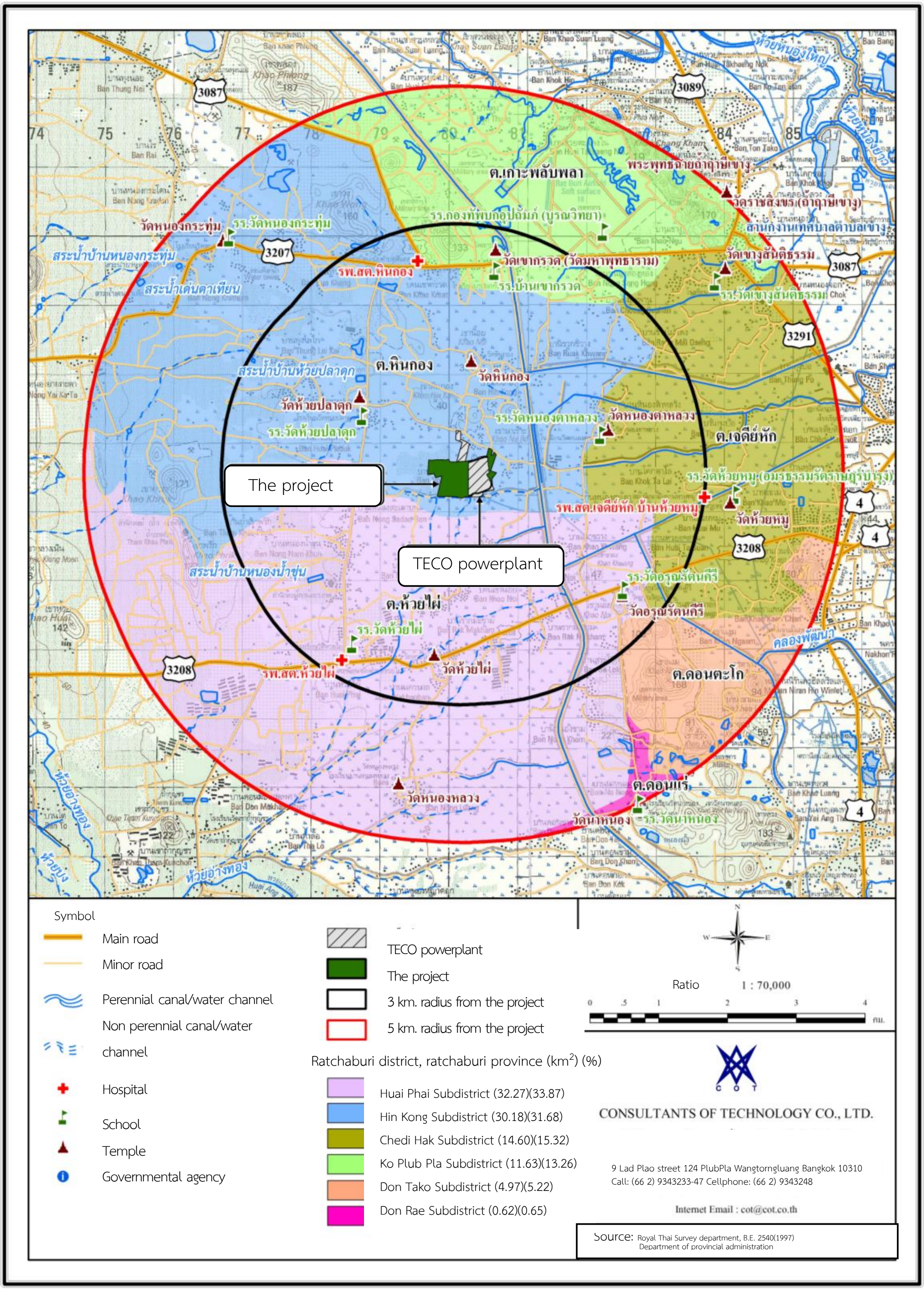


Figure 2.1.2-3 Location of the Project Site and Study Area Scope

Table 2.1.1-2

Sensitive Receptors Surrounding Project Site

Order	Location	Geographic Coordinate		Distance From Project Site (km)
		X	Y	
Educational Place				
1	Wat Huai Pladuk School	13.544222	99.727864	1.70
2	Wat Nong Ta Luang School	13.541221	99.759433	2.09
3	Wat Arun Ratanasiri School	13.521077	99.762611	2.86
4	Huai Phai School	13.511769	99.726784	3.00
5	Ban Khao Kruad School	13.563203	99.745708	3.02
6	Wat Huai Mhu School	13.532517,	99.777768	3.99
7	Gong Tup Bok Upatum School	13.567812	99.760194	4.10
8	Wat Nong Gratum School	13.567197	99.709938	4.82
9	Wat Khao Ngu Suntitum School	13.563177	99.776487	4.90
Religious Place				
10	Hin Kong Temple	13.551223	99.742617	1.75
11	Huai Pladuk Temple	13.544245	99.727456	1.80
12	Ta Luang Temple	13.542000	99.760142	2.20
13	Nong Luang Temple	13.495839	99.732632	2.20
14	Num Koon Temple	13.521929	99.722965	2.47
15	Huay Phai Temple	13.512186	99.736760	2.65
16	Arun Ratanasri Temple	13.520150	99.761665	2.91
17	Khao Kruad Temple	13.565040	99.745939	3.30
18	Huai Mhu Temple	13.532719	99.777257	3.93
19	Nong Gratum Temple	14.019579	99.853627	4.90
20	Khao NguSuntitum Temple	13.562463	99.776560	4.91
21	Na Nong Temple	13.492158	99.762642	5.40
22	Phra Phutthachai Thum Ruesi Khao Ngu Temple	13.574232	99.777310	5.85
Healthcare/Hospital				
23	Huai Phai Subdistrict Health Promoting Hospital	13.512060	99.724160	3.17
24	Hin Kong Subdistrict Health Promoting Hospital	13.563987	99.735201	3.24
25	Chedi Hak (Ban Huai Mhu) Subdistrict Health Promoting Hospital	13.533051	99.773624	3.55
26	Gor Plubpla Subdistrict Health Promoting Hospital	13.587828	99.759515	6.10
27	Don TaKo Subdistrict Health Promoting Hospital	13.499619	99.795186	7.08
28	Don Rae Subdistrict Health Promoting Hospital	13.471582	99.760324	7.40

2.2 Alternative choice of the project

2.2.1 Alternative choice for location consideration of the project

The project aims to replace electricity generation capacity of the TECO power plant and increase energy capacity of this area in the future. Presently, there area free space in the area of the TECO power plant which is suit for developing new power plant of the project. Current facilities of the TECO power plant could be used by the new power plant economically such as raw water Reservoir, and electricity supply cable. And, current technology has higher efficicency with more environmental friendly than the older power plant. Furthermore, surrounding communities are living with the TECO for long term which is familiar with the operation and easy for providing operation perception.

2.2.2 Technical consideration

Hin Kong Power Plant project is thermal power plant using Single Shaft Combined Cycle with natural gas as main fuel. Gross capacity of the power plant is 1,520 Megawatt, and Net capacity is 1,400 Megawatt. The electricity is supplied to the EGAT network under electricity selling contract.

The project had compared advantages and disadvantages of thermal power plant technology using Single Shaft Combined Cycle and Multi Shaft Combined Cycle which were summarized by;

Detail	Advantage-Disadvantage	
	Single Shaft Combined Cycle	**Multi Shaft Combined Cycle**
1. Plant Availability	Higher plant availability due to free train operation	Dependency train operation
2. Start-up and Shutdown	High agility for start-up and shutdown	Middle agility for start-up and shutdown
3.Part Load Operation	High efficiency with good control for NO_x emission	-
4. Lay Down Area	-	Using lower area

(1) Plant Availability : Single Shaft Combined Cycle Power Plant (Single Shaft) has higher readiness of electricity supplying than Multi Shaft Combined Cycle Power Plant (Multi Shaft), because; the maintainance operation is separated for each Train. While Multi Shaft Combined Cycle Power Plant requires full system shutdown (Block) for maintainance especially for Steam Turbine Unit,

(2) Start-up, Shutdown and Load Response : The Single Shaft Combined Cycle Power Plant (Single Shaft) has higher operation agility than the Multi Shaft Power Plant (Multi Shaft),

(3) Part Load Operation of the Single Shaft Combined Cycle Power Plant (Single Shaft) has higher efficiency with good control for NOx emission than the Multi Shaft Combined Cycle Power Plant (Multi Shaft), and

(3) Lay Down Area of the Multi Shaft Combined Cycle Power Plant (Multi Shaft) only for Power Block requires less area than the Single Shaft Combined Cycle Power Plant (Single Shaft).

2.3 Details of land utilization and plant layout of the project

Plant layout of the project is separated from area operation of the TECO power plant, by which; the TECO power plant will uninstall any construction parts on the title deed no. 6613. Those uninstallation constructions are storage buildings, and helicopter platform (**Figure 2.3-1**). Uninstallation process will be finished before sending area to the Hin Kong Power Plant except for underground facilities (water pipeline and electricity cable). Uninstallation activity is under responsibility of the project which is conducted only for area that obstructs construction, while those Raw water Reservoir of the TECO power plant (located in the project area) will be expanded for maintaining higher capacity.

Details of construction composition and land utilization of the project was shown in **Table 2.3-1** and **Figure 2.3-2.**

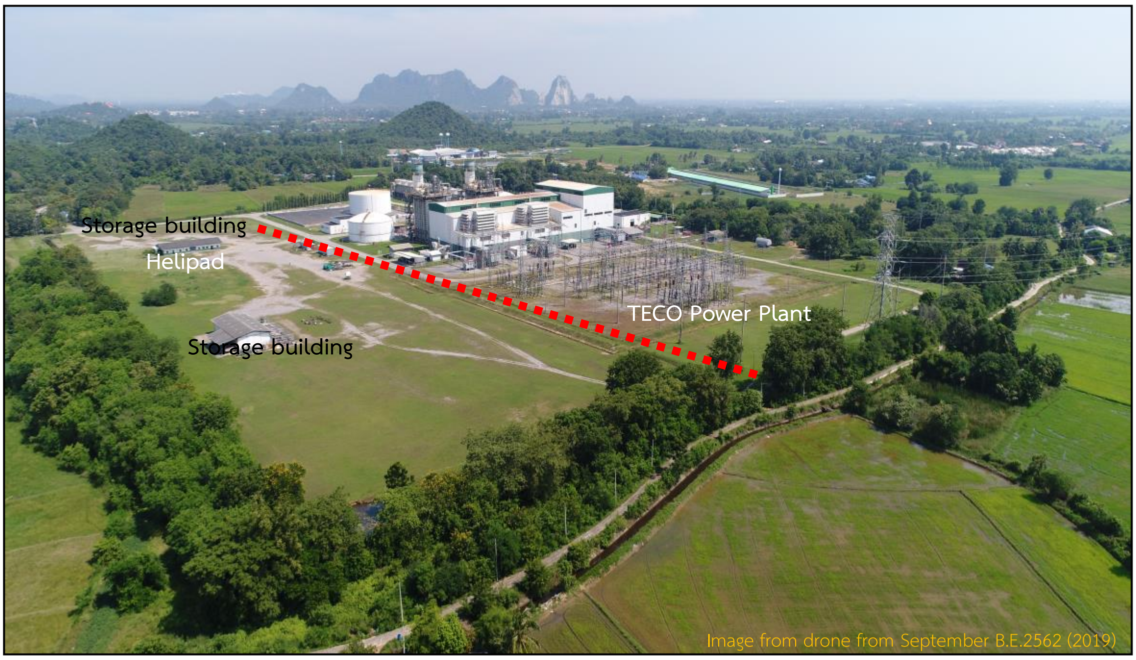


Figure 2.3-1 State of Storage Building and the Helipad

2.4 Machine, equipment, and manufacturing process

2.4.1 Machine and equipment

Main machine and equipment used by manufacturing process of the project compose of gas turbine, electricity generator, steam turbine, condenser, and cooling tower which are summarized by;

(1) Gas Turbine Generator (GTG; capacity 535 Megawatt)

There are 2 units of GTG which is convert heat energy from natural gas combustion to mechanical energy for driving propeller of electricity generator. The GTG Dry Low NOx Combustion/Water Injection system to control NOx emission according to national emission standard,

(2) Steam Turbine Generator (STG; capacity 235 Megawatt)

There are 2 units of STG to receive high pressured steam from Heat Recovery Steam Generators (HRSG) for driving propeller of electricity generator,

(3) Heat Recovery Steam Generators (HRSG)

There are 2 units of HRSG to convert heat from natural gas to produce steam before using for driving propeller of electricity generator,

Table 2.3-1

Details on Benefit of the Project Area

Order	Location	Area Size				Proportion of Area
		M^2	Rai	Ngan	Wah^2	(Percentage)
1	Production Area : consist of Gas Turbine Generater and Water Turbine Generater buildings	24,754	15	1	88	8.19
2	Production Auxilitary Area: consist of Pressure Control Station, electricity station,Demineralized Water Tank, and Cooling Tower	41,904	26	0	76	13.87
3	Diesel Oil Storage Area	10,882	6	3	20	3.60
4	Office Area	9,974	6	0	93	3.30
5	Water Treatment Area	11,460	7	0	65	3.80
6	Water Pond Area	52,999	33	0	49	17.55
7	Cooling water holding Area	14,301	8	3	75	4.73
8	Storm Water Pond Area	10,975	6	3	43	3.63
9	Green Area	15,646	9	3	11	5.18
10	Road Area	34,126	21	1	31	11.30
11	Not used Area	75,052	46	3	63	24.85
	Total	**302,073**	**188**	**3**	**18**	**100.00**
	Open area: consist of water pond area, sewage pond and treatment area, and rain water pond area.	78,275	47	7	67	25.91

Remark : Open space means those area without roof or structure with roof, by which the area could be used as water pond, swimming pool, wastewater holding pond, waste storage area, or parking area outside a building. The area includes small structure with height less than 1.20 m. without roof according to the Ministry Regulation Issued 55 (B.E. 2543(2000)) under the Building Control Act. B.E. 2522(1979)

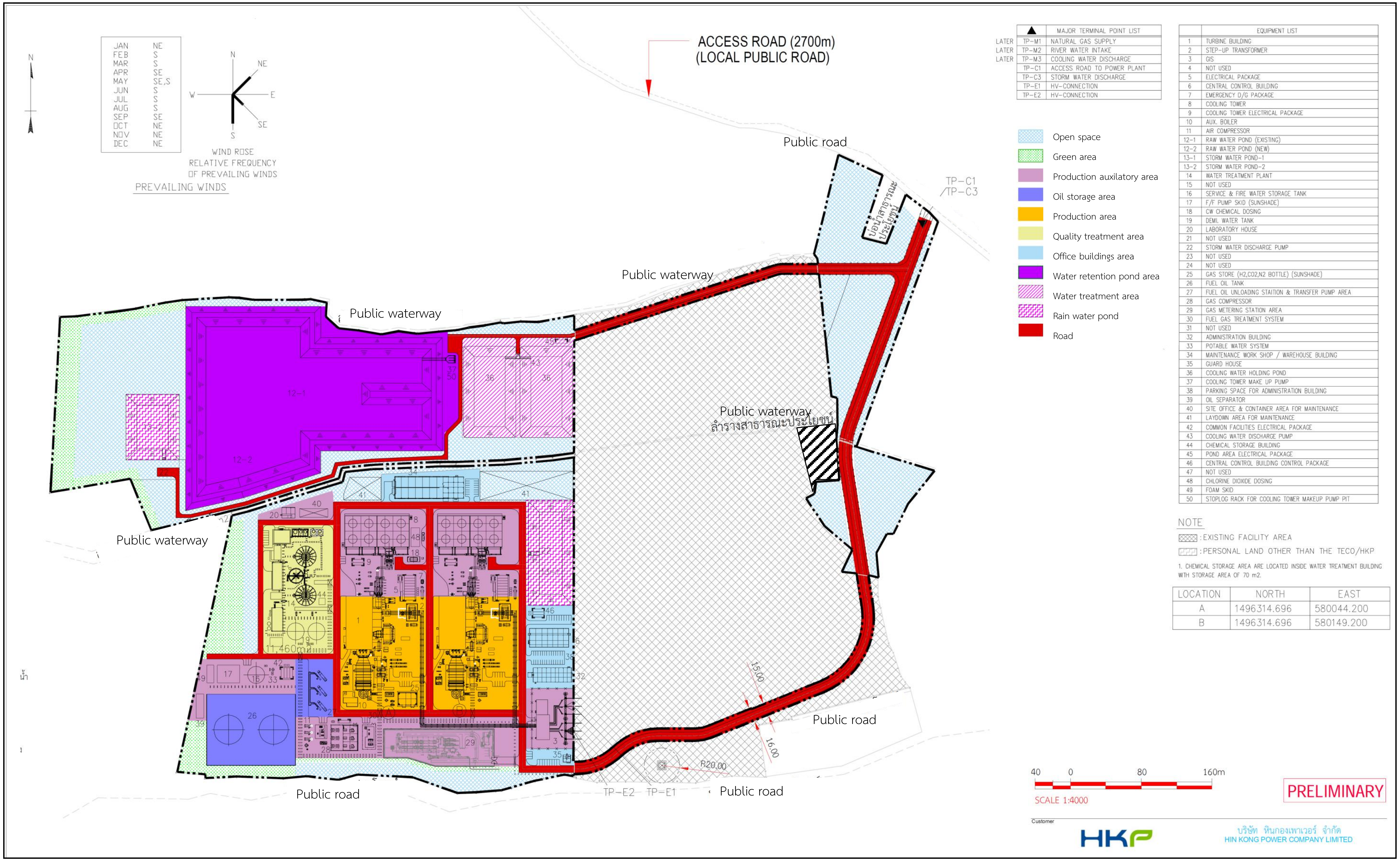


Figure 2.3-2 Project layout

(4) Condenser

There are 2 units of condenser to be used for steam condensation from STG by heat exchanging between cooling water supplied from Cooling Tower in pipeline system before sending condensation water back to the HRSG, and

(5) Cooling Water System

The project had designed the Cooling Water System using 2 units of induced draft fan which are consist of 8 continuous cells to reduce temperature of water from condenser. The Cooling Tower is sent to Cooling Tower Basin and reused in the system. Excess cooling water is sent to Water Holding pond for maintaining water quality in the system.

The cooling tower has to reduce water temperature by blowing counter air flow to the high temperature water. Therefore, steam in the system is lost by this process and water temperature is decreased as shown in **Figure 2.4.1-1.** Innitial designing of this process has water capacity of 40,000 m^3/h with inlet water temperature around 43.3 °C, while outlet water temperature is around 34.3 °C. System summary was shown in **Table 2.4.1-1.**

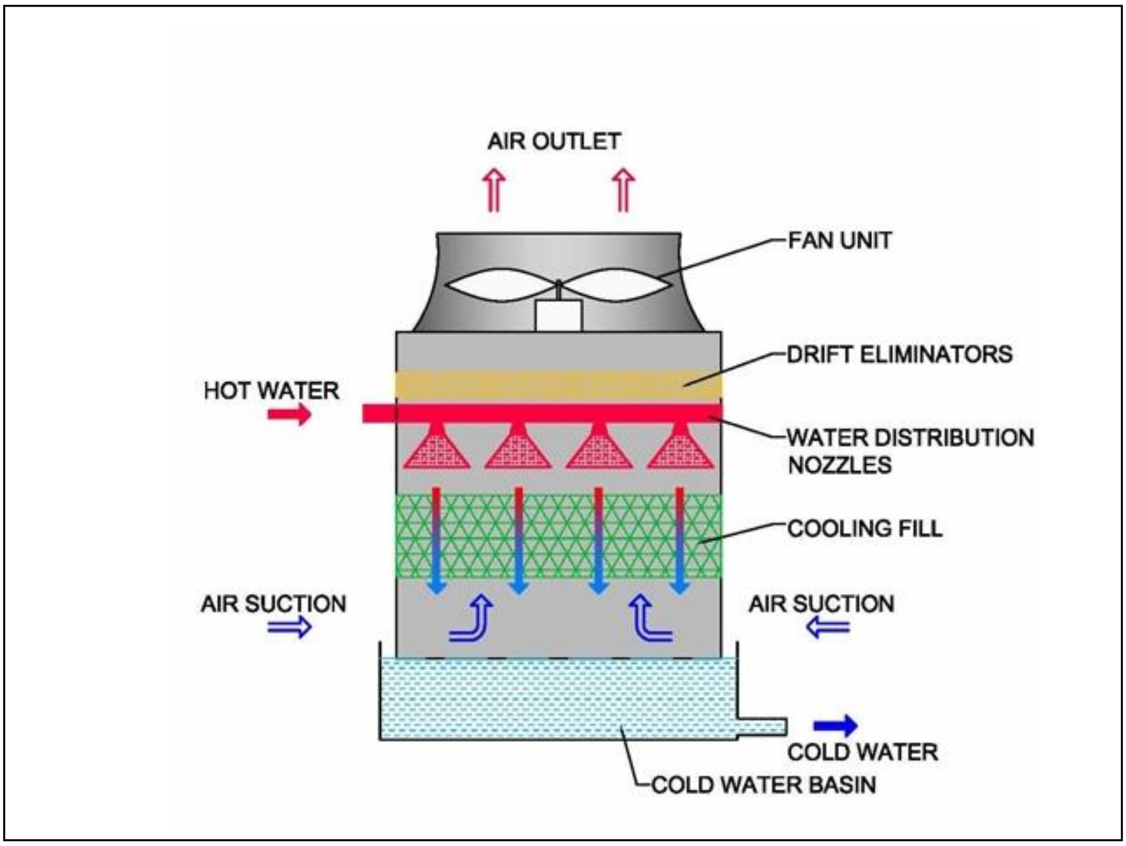


Figure 2.4.1-1 Working Principle of the Cooling Tower

Table 2.4.1-1
Summary of initial designing for cooling tower system

Data	Unit	Designed Parameter
Type of cooling tower	Counter Flow Wet Type Cooling Tower	
Amount of cooling water in the system	m^3/h	40,000
Temperature of inlet water	°C	43.3
Temperature of outlet water	°C	34.3
Cooling Range	°C	9
Wet bulb air temperature	°C	28.8
Dry bulb air temperature	°C	32.5
Pressure	Mbar	1,010
Relative humidity	%	76
Water vaporization amount	m^3/day	23,984 (@ design condition)
Water compensation amount	m^3/day	30,820 (@ design condition)
Discharging water	m^3/day	6,836 (@ design condition)

Remark : 1) Providing data were obtained from initial designing of the system which is require further refinement for maintaining system efficiency

2) Water compensation amount composes of make up water from primary water adjustment system which is around 30,507 cubic meter/day, and reused water around 313 cubic meter/day

Importance technical details were summarized as shown in **Table 2.4.1-2.** Heat balance of the project for full operation (100%) using natural gas as main fuel and diesel oil as substitutional fuel were shown in **Figure 2.4.1-2** to **Figure 2.4.1-5.**

Table 2.4.1-2

Details on Shape and Technical Aspects of the Machine

Table 2.4.1-1 (cont)

Details	Technical Information of the Machine		
	Unit	Natural Gas	Diesel Oil
1. Gas Turbine Generator			
-Exhaust Gas Flow	Ton/hr	2,850.0	2,980.0
-Exhaust Gas Temperature	Deg.C	670.0	550.0
2. Heat Recovery Steam Generator			
-High Pressure			
Steam Flow	Ton/hr	451.0	313.7
Steam Temperature	Deg.C	601.4	508.4
Steam Pressure	Bar	160.8	104.9
-Intermediate Pressure			
Steam Flow	Ton/hr	492.6	388.4
Steam Temperature	Deg.C	600.7	494.9
Steam Pressure	Bar	34.5	25.3
-Low Pressure			
Steam Flow	Ton/hr	50.0	-
Steam Temperature	Deg.C	315.3	-
Steam Pressure	Bar	6.6	-
3.Steam Turbine Generator			
-High Pressure			
Steam Flow	Ton/hr	451.0	313.7
Steam Temperature	Deg.C	600.0	507.0
Steam Pressure	Bar	158.0	103.0
-Intermediate Pressure			
Steam Flow	Ton/hr	492.6	388.4
Steam Temperature	Deg.C	600.0	494.2
Steam Pressure	Bar	33.8	24.7
-Low Pressure			
Steam Flow	Ton/hr	50.0	-
Steam Temperature	Deg.C	313.3	-
Steam Pressure	Bar	6.2	-
4. Condenser			
Temperature	Deg.C	43.3	40.5
Pressure	Bar absolute	0.0877	0.0760

Source : Hin Kong Co.,Ltd, B.E. 2563 (2020)

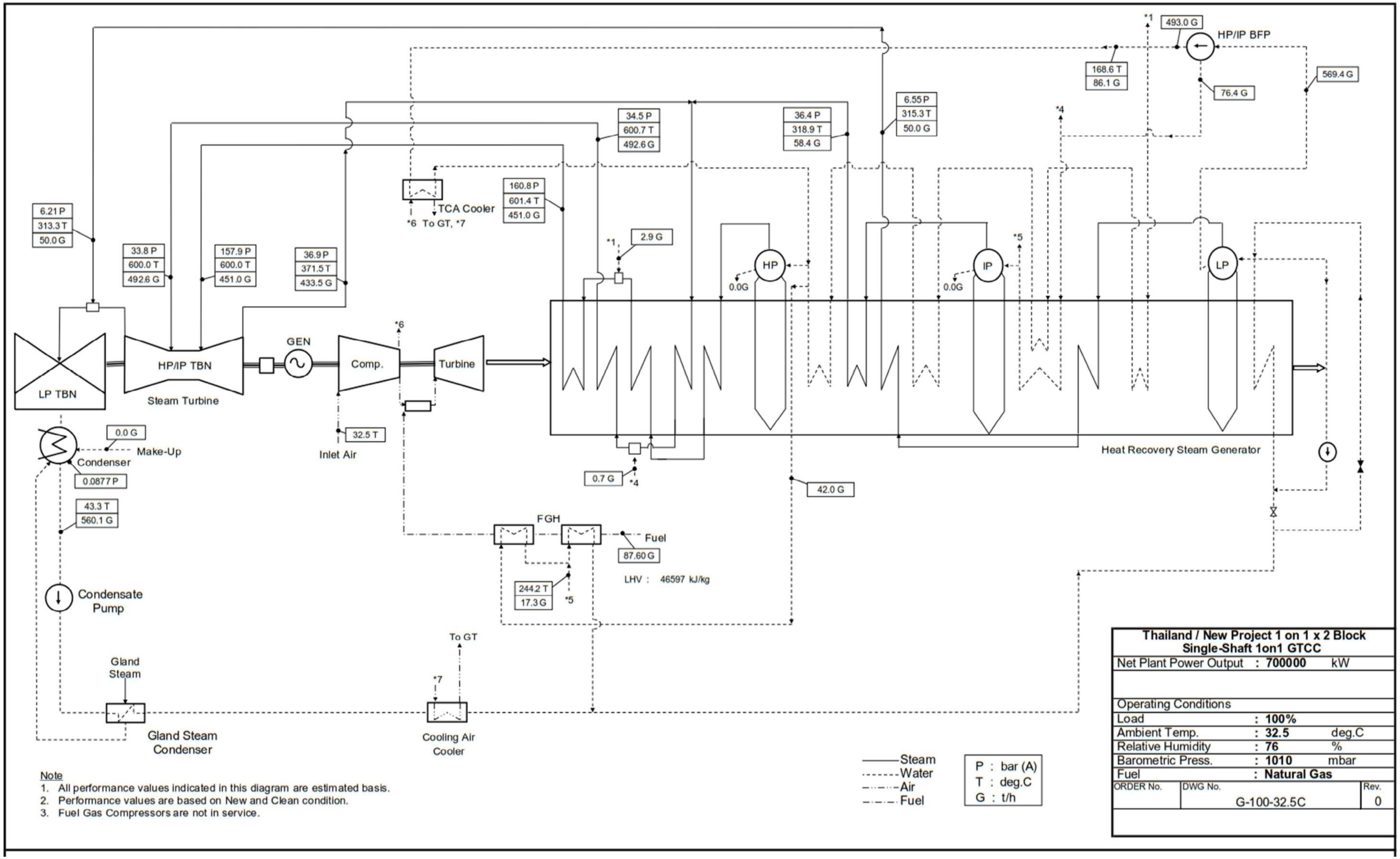


Figure 2.4.1-2 Blueprint on Production and Heat Balance in case of Natural Gas Usage at 100% Production Power (Full Load)

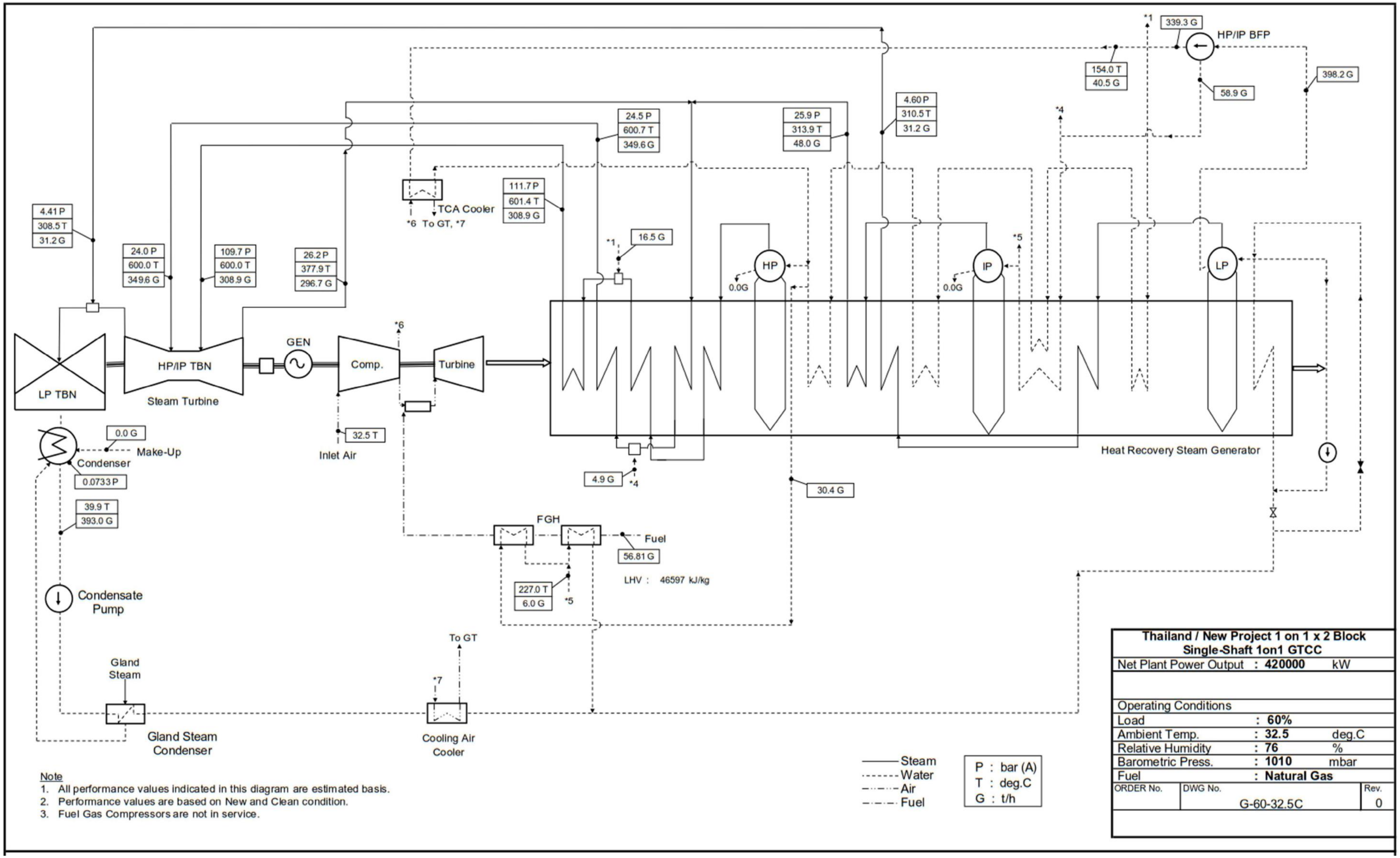


Figure 2.4.1-3 Blueprint on Production and Heat Balance in case of Natural Gas Usage at 60% Production Power (Minimun Load)

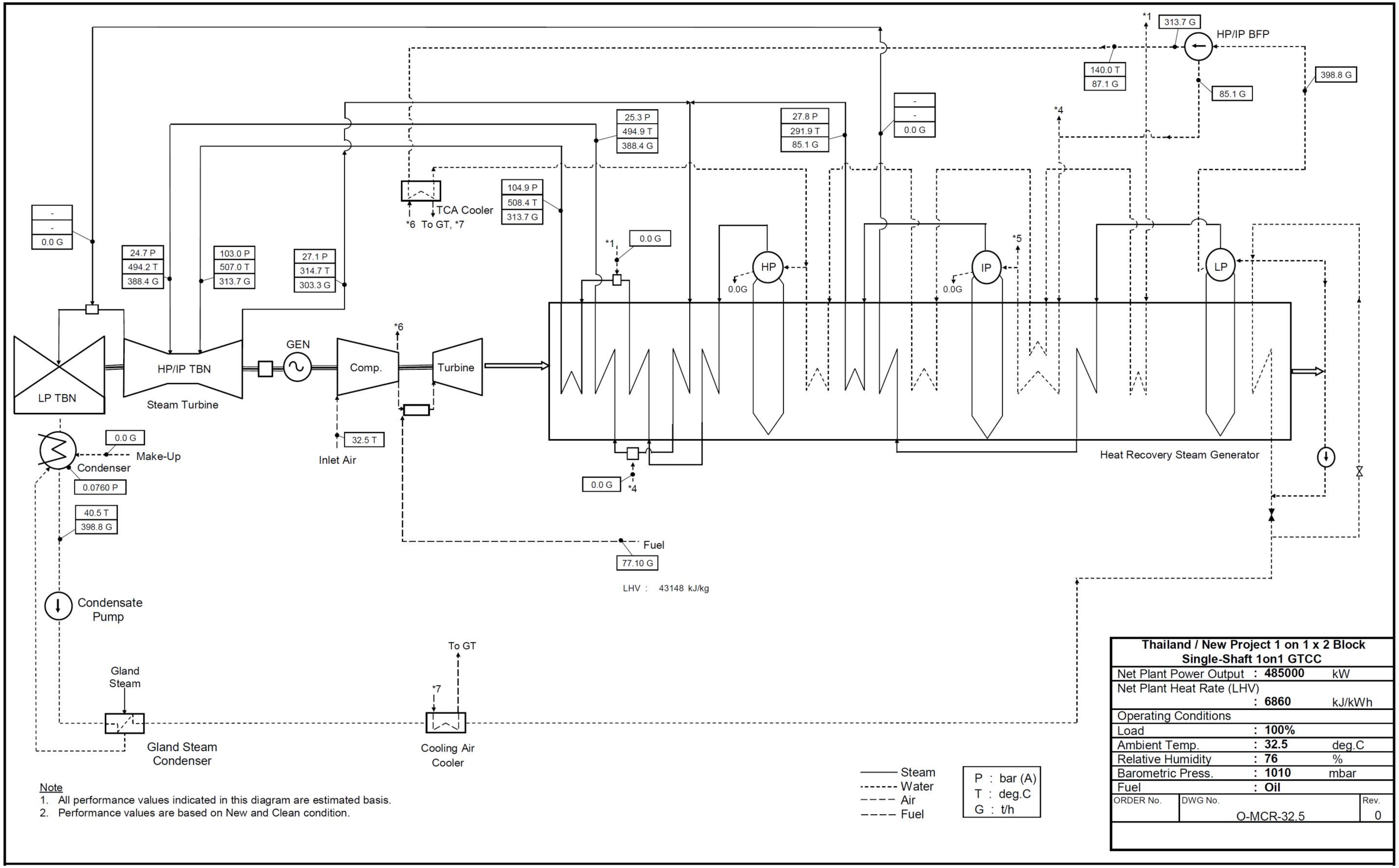


Figure 2.4.1-4 Blueprint on Production and Heat Balance in case of Diesel Oil Usage at 100% Production Power (Full Load)

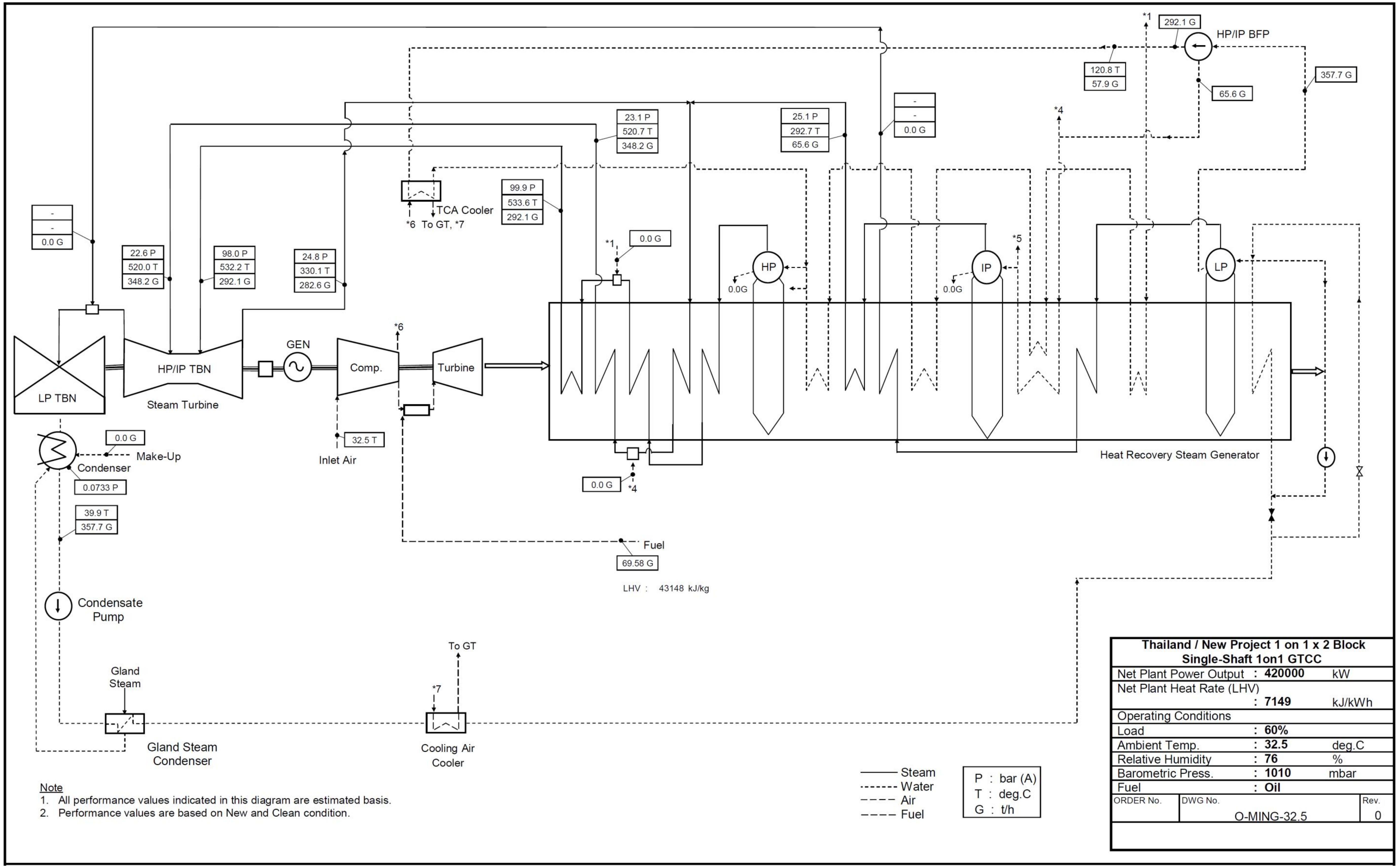


Figure 2.4.1-5 Blueprint on Production and Heat Balance in case of Diesel Oil Usage at 60% Production Power (Minimum Load)

2.4.2 Fuel

2.4.2.1 Main fuel (Natural Gas)

(1) Source and transportation system of natural gas

The project obtains natural gas from authorized company to supply natural gas to the project by using 24 inches diameter pipeline from natural gas controlling station (BVW12). The station is located in Moo 10, Kor Plab Pla subdistrict, Rachaburi district, Rachaburi province. to gas metering station inside the project area. Transportation pipeline is around 10.30 kilometers., by which; the pipeline system is currently under environmental impact assessment studying. Detail of natural gas pipeline system to the project was shown in **Figure 2.4.2.1-1.**

(2) Consumption rate and property

In case of full operation, the project requires natural gas around 200.78 million ft^3/day (calculated from natural gas specific heat around 1,024 BTU/cu.ft). Property of natural gas used in this project was shown in **Table 2.4.2.11-1.**

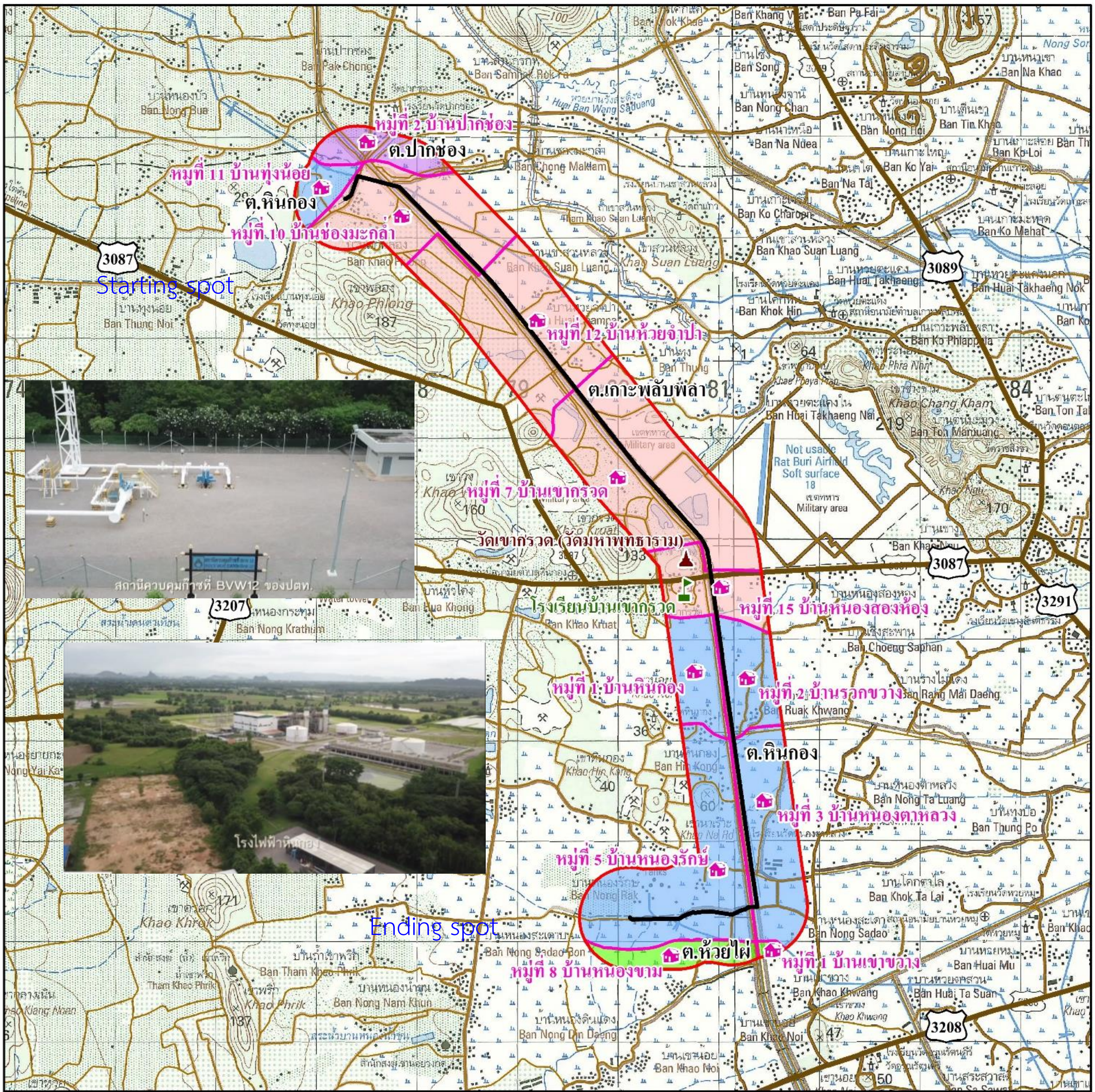
Table 2.4.2.1-1

Characteristics of Natural Gas used in the Project

COMPOSITION	GAS COMPOSITION (MOLE%) FUTURE WOBBE INDEX BAND (NOTE 2)		
STREAM NO.	1		
	MIN.	NOR.	MAX.
CO2	4.16	4.72	0.00
C1	73.80	78.10	89.33
C2	1.64	2.73	8.53
C3	0.42	0.67	1.00
iC4	0.08	0.14	0.20
nC4	0.08	0.15	0.20
iC5	0.02	0.06	0.10
nC5	0.01	0.03	0.00
C6	0.02	0.04	0.00
C7	0.00	0.01	0.00
C8+	0.00	0.00	0.00
N2	19.79	13.35	0.64
Total	100.00	100.00	100.00
HHV sat (Btu/scf)	780	856	1,079
SG	0.691	0.681	0.615
WI : HHVdry/ sqrt (SG)	955	1,055	1,400
* NATURAL GAS FROM BVW#12 IS SOUR SERVICE.			
	WI BAND : 955 – 1,400 Btu/scf		

Remark: Minimum Median and Maximum refers to the minimum, median, and maximum of Wobble Index

Source : Hin Kong Co.,Ltd



Symbols

- Community/village boundary
- Main road
- Secondary road
- Educational institutions
- Temple
- Community/village
- Natural gas pipeline
- 500 m study area

Ratchburi subdistrict, Ratchaburi province (m^2) (%)

- Kor Plub Pla (5.83)(53.05)
- Hin Kong (4.37)(35.76)
- Huai Phai (0.39)(3.55)

Jormbueng subdistrict, Ratchaburi province (m^2) (%)

- Parl Chong (0.40)(3.64)

Ratio
1 : 60,000
0 300 600 1,200 1,800 2,400 เมตร

CONSULTANTS OF TECHNOLOGY CO., LTD.
9 Lad Plao street 124 PlubPla Wangtorngluang
Bangkok 10310
Call: (66 2) 9343233-47 Cellphone: (66 2) 9343248

Source: Royal Thai Survey department, B.E. 2540(1997)
Department of provincial administration

Figure 2.4.2.1-1 Natural Gas Pipeline System from Gas Metering Station to Project Site

(3) Natural gas leakage control measure and safety measure

Natural gas leakage control in the power plant

1) Assigning inspection staffs to monitor natural gas pressure from Control Room daily,

2) Providing Visual Inspection Staffs to randomly monitoring thickness of the pipeline yearly, and maintaining the pipeline according to the standard of ASME B 31.8 including maintenance of the natural gas pipeline system,

3) Providing natural gase pipeline boundary labelling,

4) Providing natural gas detector equipment,

5) Providing emergency center of the natural gas pipeline system with emergency response plan, and

6) Installation Catholic Protection System to avoid pipeline corrosion and testing the system yearly.

Inspection by the PTT (PLC)

To maintain safety operation of natural gas pipeline system, the project will transfer authority of the pipeline system to the PTT Plc. after the pipeline system installation finished. The PTT Plc. has safety measures including detection system and isolation system according to both national and internation standards which is controlled by automatic system at Chonburi Pipeline Center. The system is continuous assessment system for controlling natural gas supplying in the pipeline, by which; gas leakage could be detected autimatically (On-line Report). Inspection staffs are monitoring the system over 24 hours, the; the Chonburi Pipeline Center can shut down the operation immediately by Block Valve Station. Furthermore, the project had designed gas controlling station nearby gas pressure monitoring station of the pipeline, and there is gas volume detection station inside the power plant area for shut down the operation for various purposes such as maintenance, or emergency case. However, the project area is under responsibility of pipeline installation center region 5 (Rachaburi).

2.4.2.2 Substitutional fuel (diesel)

(1) Source and transportation system

Diesel fuel is supplied by domestic oil retailers and transported to the project area by trucks. Diesel fuel is kept in substitution oil storage tanks inside the project area. Theere are 2 cylindrical shape of substitution oil storage tanks with capacity of 12,700 cubic meter/tank (for using by 3 days). Actual capacity per tank is 10,300 cubic meter or around 81.10% of tank volume. The tank is surrounded by concrete barrier with capacity of 24,900 cubic meter (width 100 meter long 83 meter height 3 meter). In case of oil leak, the concrete barrier has the capacity to withstand all the amount of oil leak (as shown in **Figure 2.4.2.2-1**). The measure follows the Ministry Regulation Issued 2 (B.E.2535 (1992)) under the Factory Act. B.E. 2535 (1992) Section 2 Article 6 (7) which is mentioned that " container of hazardous material with capacity over 25,000 liters (such as flammable substance, chemicals, or hazardous liquid affecting human, plants, anumals, properties, and environment) must be stable and strong enough according to acceptable standards, by which; the container must be recommended by authorized engineer or permitted person by the minister under the royal gazette. Furthermore, the container must be surrounded by barrier which has capacity to capture any leakage of those material. Except for the case that there are more than 1 tank, the barrier must have capacity to capture material leakage approximately for the largest tank volume. And, the operator has to prepare chemicals or material for preventing and lessening the leakage severity in case of emergency, properly." And, the measure also follows the Ministry Regulation B.E. 2551 (2008) about oil storage, and the Ministry Regulation about oil depot of the Ministry of Energy which was promulgated in the Royal Gazette on 27th March B.E. 2556 (2013) under the Fuel Oil Control Act. B.E. 2542 (1999) (and revision). Therefore, the consultant had reviewed oil storage capacity of the project to follow related laws by;

the Ministry Ragulation about fuel storage B.E. 2556 (2013) Section 3 Article 23	**Project Operation**
(4) Tank or group of tanks should has barrier, wall or surrounding pit under the following conditions; (A) Barrier capacity must equal to or larger	the project has 2 oil storage tanks with capacity of 12,700 cubic meter/tank. Actual storage capacity is 10,300 cubic meter/tank which is surrounded by bund wall with capacity of 24,900 cubic meter.

the Ministry Ragulation about fuel storage B.E. 2556 (2013) Section 3 Article 23	Project Operation
than the volume of the largest tank, and it should be stable and strong enough for maintaining material leakage	(width 100 meter long 83 meter height 3 meter)
(B) Height not over 3 meter by which measurement is performed from the top of the outside wall to ground. If the topographic is inconvenient, wall height should be larger than 3 meter, but it should be permitted by the DOEB.	
(C) Group of flamable storage tanks should be surrounded by barrier, wall or surrounding pit. If tank diameter is more than 45 meter heigh of barrier, wall or surrounding pit should be around 0.45-3 meter, by which; barrier volume should be around 10% of tank volume. If tank diameter is less than 45 meter barrier, wall or surrounding pit may not necessary.	the project uses diesel oil as substitution fuel in case of emergency by which diesel oil has flash point temperature less than 52°C according to the DOEB Promulgation about property and quality of diesel oil which is moderate flammable material. Furthermore, the tank diameter is less than 45 meter and surrounded by 3 meter height bund wall.

The project will install Oil Separator Pond to capture contaminated rain precipitation in area with oil-leak risk to manage treated water so that the Grease and Oil contamination are less than 5 milligrams/liter.

(2) Consumption rate and property

The project uses diesel oil as substitution fuel in case of emergency (no natural gas supplied) with maximum flow rate of 4.62 million liters/day. The diesel fuel is high speed diesel with sulfur content less than 0.005% by weight according to the DOEB Promulgation about Property and Quality of Diesel Oil B.E. 2562 (2019) as shown in **Table 2.4.2.2-1.** The diesel oil is used in case of emergency only.

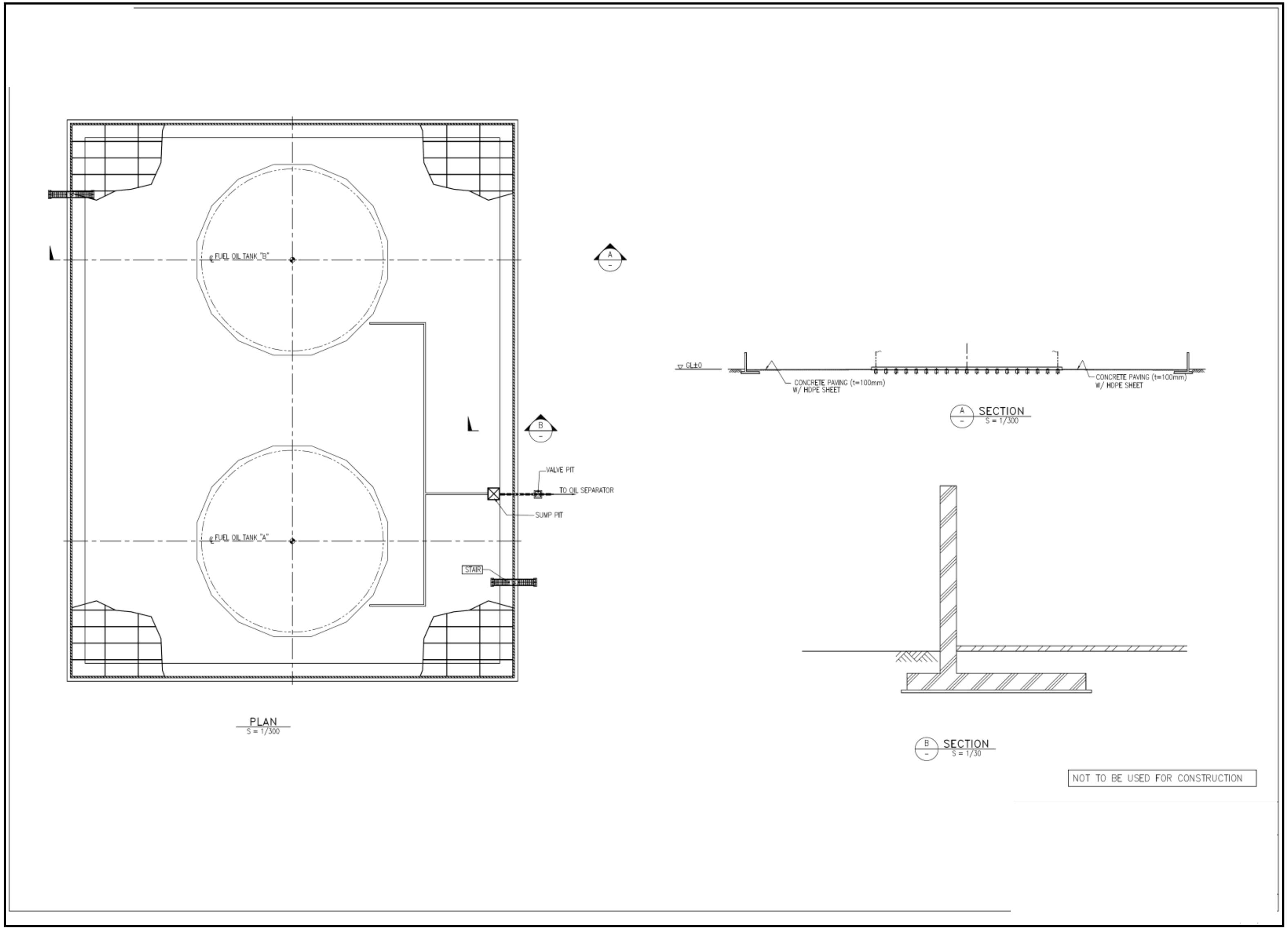


Figure 2.4.2.2-1 Diesel Tank

Table 2.4.2.2-1

Properties of Oil

List	Specification		High-Low Rate	Diesel Oil Characteristics			Testing Method
				Normal	B 10	B 20	
1	Specific Gravity at 15.6/15.6 °C		Not lower than And Not higher than	0.81 0.87	0.81 0.87	0.81 0.87	ASTM D 1298
2	Cetane Number or Calculated Cetane Index		Not lower than Not lower than	50	50	50	ASTM D 613 ASTM D 976
3	Viscosity 3.1 at 40 °C 3.2 at 50 °C	cSt	Not lower than And Not higher than Not higher than	1.8 4.1 -	1.8 4.1 -	1.8 4.1 -	ASTM D 445
4	Pour Point	°C	Not higher than	10	10	10	ASTM D 97
5	Sulphur	% wt	Not higher than	0.005	0.005	0.005	ASTM D 2622
6	Copper Strip Corrosion		Not higher than	Number 1	Number 1	Number 1	ASTM D 130
7	Oxidation Stability	g/m^3 Hr.	Not higher than Not lower than	25 35	25 35	25 35	ASTM D 2274 EN 15751
8	cabon Rediment on 10% distillation residue	% wt.	Not higher than	0.30	0.30	0.30	ASTM D 4530
9	Water and Sediment	% vol	Not higher than	-	-	-	ASTM D 2709
10	water	mg/kg	Not higher than	300	200	300	EN ISO 12937

Table 2.4.2.2-1 (continue)

List	Specification		High-Low Rate	Diesel Oil Characteristics			Testing Method
				Normal	B 10	B 20	
11	Total contamination	mg/kg	Not higher than	24	24	24	EN 12662
12	Ash	% wt	Not higher than	0.01	0.01	0.01	ASTM D 482
13	Flash Point	°C	Not lower than	52	52	52	ASTM D 93
14	Distillation temperature from the distillable (90% Recovered	°C	Not higher than			357	ASTM D 86
15	Polycyclic Aromatic Hydrocarbons	%wt.					
16	Colour 14.1 Hue 14.2 Intensity		Not lower than and Not higher than	Yellow - 4.0	Purple Equal to Standard	Red Equal to Standard- 4.0	ASTM D 1500 or ASTMD 2392
17	Methyl ester of fatty acids	% vol.	Not lower than and Not higher than	6.6 7	9 10	19 20	EN 14078
18	Lubricity, Water Scar	µm	Not higher than			460	CEC F-06-96
19	(Additives, if Any)			In accordance to the approval of Director General of DOEB			

Source : Announce to DOEB on diesel properties and quality on 14 May B.E.2562 (2019)

(3) Diesel oil leakage control measure and safety measure

1) Oil pipeline leakage control

- Installing Cathodic Protection System to avoid pipeline corrosion and monitoring yearly,

- Providing sings/ labels showing project's boundary, oil supply stations with cautions, telephone number, and address. This is to avoid any activities that might affect oil supply system and allow for accident witnesses to inform the responsible party.

- Inspect around the station, oil tank, and pipeline monthly. In case of oil using, inspection is performed daily.

2) Oil leakage control during transportation and storage

- In case of leakage, the operation unit of the project will action by pumping oil to retention tank, immediately, and

- Tank storage area is surrounded by Bund Wall which has capacity to receive oil leakage from the largest tank.

2.5 Chemicals

Chemicals and additives used by the project are those slags prevention in pipeline, boiler, and cooling tower. The chemicals are not toxic substance as mentioned in **Appendix 2-3** which are;

(1) Steam production system composes of Oxygen Scavenger (25%), Aqueous Ammonia (25%), and Trisodium Phosphate (25%),

(2) Cooling system composes of Corrosion Inhibitor, Scale Inhibitor, Sodium Hypochlorite (NaOCl 10%), and Sulfuric Acid (H_2SO_4; 98%), and

(3) Water quality treatment system composes of Sodium Hypochlorite (NaOCl; 10%), Poly Aluminium Chloride (PAC;10%), Polymer, Sodium Hydroxide (NaOH), Hydrochloric acid (HCl), Sodium bisulfite, Antiscalant, Biocide, and Citric Acid.

Detail of consumption volume, source, transportation, storage, and utilization of each chemicals were shown in **Table 2.5-1.** Those chemicals are transported to the project area using trucks. Then, those chemicals are kept in chemicals storage building at the water adjustment system area (location no. 44 in **Figure 2.3-1**). Chemicals are classified and kept by their properties for maintaining safety for those flammable material. Chemicals storage follows the Department of Industrial Works Promulgation about Manual for Chemicals and Hazardous Material Storage B.E. 2550 (2007) by which storage building floor must strong enough to support chemicals weight (as shown in **Figure 2.5-1**). Construction material should innert to chemical reaction and corrosion. Floor should not absorb chemical nor slippery, by which; the floor must be easy to clean and capture all chemical leakage or washing water. The building floor must be made by concrete to avoid chemical leakage, by which it should be surrounded by Bund wall to avoid chemical dispersion to ground.

Details and layout of chemical storage building are in accordance to the announcement and regulations from Department of Industrial Works on how to store chemicals and dangerous objects B.E.2550 (2007). The regulations for doors and emergency exit of the building with chemicals and dangerous objects are as followed:

(1) There must be at least 2 doors including emergency exit door at the opposite end.
(2) The door for transporting goods must be safe for the workers and employees to safely pass through without any interference or obstacles and have clear signs/symbols.
(3) The emergency exit door must be easy to open from the inside and have a minimum width of 1.1 meters. In addition, it cannot be locked, lead to death end, or be a sliding door.
(4) Areas close to the emergency exit door must have clear sign of appropriate size that can be seen even in the dark and no obstacles and interference blocking the path.
(5) There must be at least 2 emergency exit door in 2 opposing direction. In case of a big building, there must be emergency exits every 35 meters.
(6) Fireproof door must have the same efficiency as the fireproof wall that it is a part of.
(7) Fireproof door must be a part of a fireproof wall that act as a partition for 2 rooms which can be close automatically in case the emergency siren rings.
(8) Entry/exit door, door for transporting goods, and fireproof door (that is a sliding door) must have safety equipments in case that the door collapse out of the frame.

There will be clear division of storage area between chemicals. The division will be sort in 3 parts with concrete wall separating them: oxidizing substances type 5.1 (oxidizing substance), toxic substances type 6.1 (flammable/non-flammable objects with toxic characteristics), and corrosive substances type.8 (flammable/non-flammable with corrosive characteristics). This correspond with informations and regulations regarding storing chemicals and dangerous objects by the Department of Industrial Work B.E. 2550 (2007) which states that oxidizing substance type 5.1 must be stored with Separate Storage method and toxic substance type 6.1 and corrosive substance type 8, in case of being stored in the same area, must be separated from other substances with a fireproof wall that can withstand at least 90 minutes of fire. In addition, this project also has 2 fire extinguishers type ABC installed at the area of the chemical storage building's entry/exit.

Measures for chemical storage are;

1) Using closed storage system with high roof for maintain ventilation, the building must has convenient entrance and the storage area must has Concrete Curbing to avoid chemical leakage. Those chemicals must be kept in their usage area such as demineralized water area. The storage area must have Floor Drain in the Concrete Curbing to capture chemicals or waste water from washing equipments,

2) Using closed transportation system by using pipeline to avoid chemical leakage, and subcontractors must follow safety measures strictly,

3) Labelling warning sign for chemical storage area according to the MSDS,

4) Preparing preventive maintenance plan for chemical equipment routinely,

5) Preparing emergency response plan for chemical leakage, and practicing the plan yearly,

6) Following the work instruction according to the MSDS strictly such as using Air Mask and Breathing Apparatus,

7) Providing PPE to operation staffs such as Safety Shower and Eyewasher, mask, gloves for chemical transportation,

8) Preparing chemical leakage washing material properly and adequately for using in emergency case,

9) Training operation staffs about safety operation with chemicals before working, and

10) Prepare plans to monitor atmospheric chimical concentration once a year in each area with chemical usages and storages by comparing with standards under the Ministry of Interior Promulgation about Environmental safety Operation (for Chemicals) on 30th May B.E. 2556 (2013), and recommendation of the American Conference of Governmental Industrial Hygienists (ACGIH)

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Table 2.5-1
Main Chemicals Used

Type	State	Main components	Origin	Amount Used		Transportation System	Amount Stored (Ton/Year)	Amount of transportation per year	Storage Container	Uses
Steam System										
Oxygen Scavenger, 25%	liquid	CH_6N_4O	Bougth from domestic distributor	15	m^3/year	Transported through chemical tank	15	12	PE Chemical tank / concrete dyke	Get rid of oxygen in circulating steam system
Aqueous Ammonia, 25%	liquid	NH_3	Bougth from domestic distributor	90	m^3/year	Transported through chemical tank	90	12	PE Chemical tank / concrete dyke	Control acid-base in circulating steam system
Trisodium Phosphate, 25%	liquid	Na_3PO_4	Bougth from domestic distributor	20	m^3/year	Transported through chemical packaging bag	20	12	PE Chemical tank / concrete dyke	Get rid of dregs/scale/slag in circulating steam system
Cooling Water System										
Corrosion Inhibitor	liquid	$ZnCl_2$	Bougth from domestic distributor	15	m^3/year	Transported through chemical tank	15	12	PE Chemical tank / concrete dyke	Control Corrosion in cooling water system
Scale Inhibitor	liquid	NaOH	Bougth from domestic distributor	25	m^3/year	Transported through chemical tank	25	12	PE Chemical tank / concrete dyke	Control formation of dregs/scale/slag in cooling water system
Sodium Hypochlorite ; NaOCl 10%	liquid	NaOCl	Bougth from domestic distributor	440	m^3/year	Transported through chemical-transport truck	440	12	HDPE Chemical tank / concrete dyke	Control microbes in cooling water system
Sulfuric Acid ; H_2SO_4 98%	liquid	H_2SO_4	Bougth from domestic distributor	150	m^3/year	Transported through chemical-transport truck	150	12	Carbon Steel Chemical tank/ concrete dyke	Control acid-base in cooling water system
Water Treatment System										
Sodium Hypochlorite ; NaOCl 10%	liquid	NaOCl	Bougth from domestic distributor	1000	m^3/year	Transported through chemical-transport truck	1,000	12	HDPE Chemical tank / concrete dyke	Control microbes in water treatment system
Poly Aluminium Chloride (PAC), 10%	liquid	Poly Aluminium Chloride	Bougth from domestic distributor	482	Ton/year	Transported through chemical packaging bag	74	12	FRP Chemical tank / concrete dyke	For silt and precipitation in water treatment system

Type	State	Main components	Origin	Amount Used		Transportation System	Amount Stored (Ton/Year)	Amount of transportation per year	Storage Container	Uses
Polymer	solid	2-Propenamide, homopolymer, hydrolyzed, sodium salts	Bougth from domestic distributor	13.5	Ton/year	Transported through chemical packaging bag	6	12	FRP Chemical tank / concrete dyke	For silt and precipitation in water treatment system
Sodium Hydroxide ; NaOH	liquid	$NaOH$	Bougth from domestic distributor	300	m^3/year	Transported through chemical-transport truck	210	12	PE Chemical tank / concrete dyke	For recovery of demineralized water production system and treat waste water
Hydrochloric acid ; HCl	liquid	HCl	Bougth from domestic distributor	20	m^3/year	Transported through chemical-transport truck	20	12	FRP Chemical tank / concrete dyke	For recovery of demineralized water plant and treat waste water
Sodium bisulfite	solid	$NaHSO_3$	Bougth from domestic distributor	0.6	Ton/year	Transported through chemical packaging bag	0.6	6	FRP Chemical tank / concrete dyke	Control free chlorine in demineralized water plant and treat waste water
Antiscalant	liquid	$C_9H_{13}N_3Na_{20}O_{30}P_{10}$ - Diethylenetriamine penta methylene phosphonic acid (10%-30% Wt	Bougth from domestic distributor	0.5	m^3/year	Transported through chemical tank	0.5	6	FRP Chemical tank / concrete dyke	Prevent the formation of dregs/scale/slag in demineralized water plant
Biocide	liquid	$NaOH$	Bougth from domestic distributor	1.131	m^3/year	Transported through chemical tank	1.131	6	FRP Chemical tank / concrete dyke	Control microbes in demineralized water plant
Citric Acid	liquid		Bougth from domestic distributor	0.12	m^3/year	Transported through chemical tank	0.12	6	FRP Chemical tank / concrete dyke	Control microbes in demineralized water plant

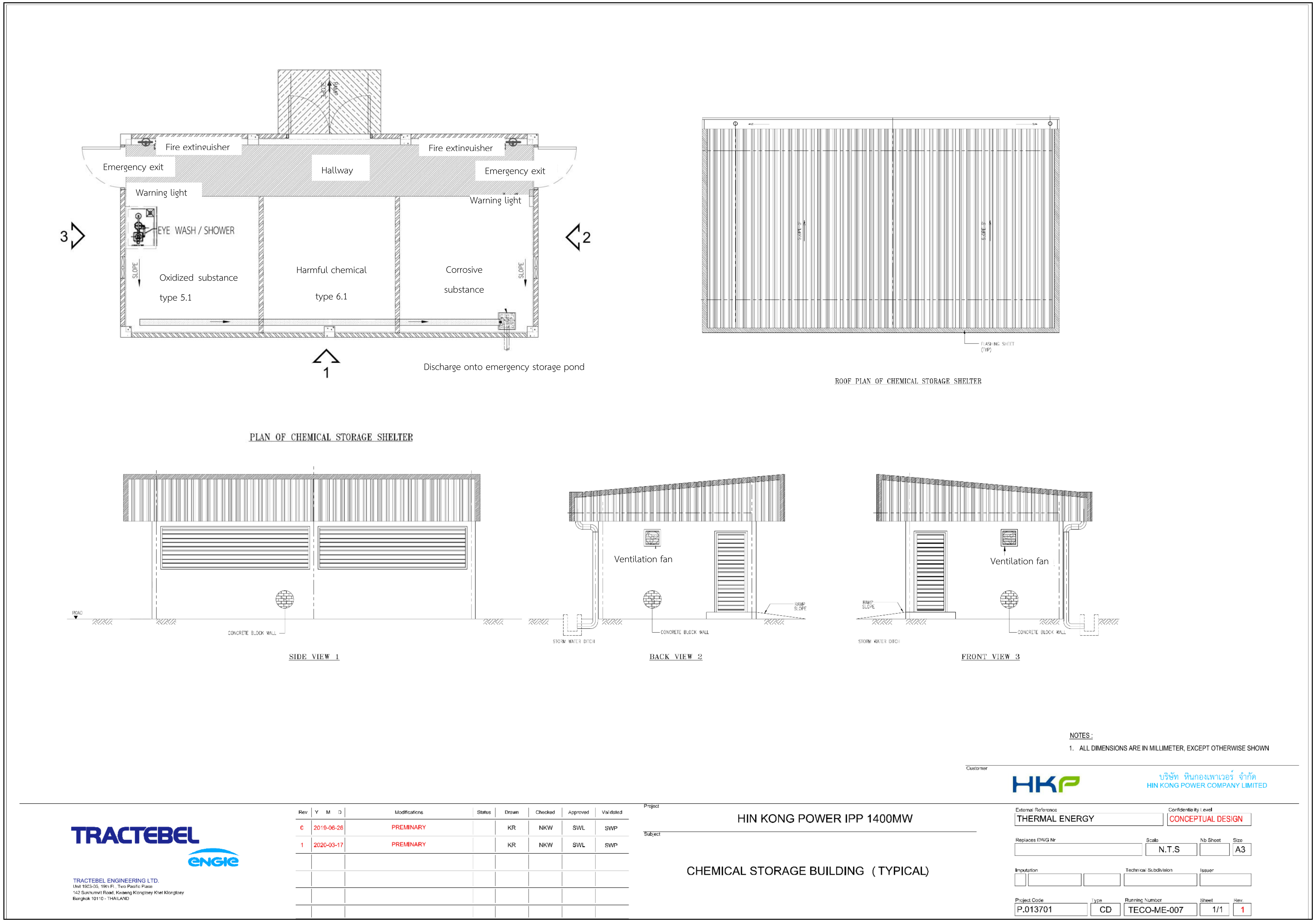


Figure 2.5-1 Chemical Storage building blueprint

2.6 Product of the project

Project development is under the regulation for electricity buying from Indepedence Power Producer (IPP) of the Ministry of Energy. The project has installed capacity of 1,540 MW, and gross capacity of 1,520 Megawatt ; MW. Selling capacity to the EGAT under electricity selling contract is 1,400 MW, while; those excess capacity will be used by the project.

Power generation pattern of the project consists of Full Load, and Minimum Generation Load as shown in **Table 2.6-1.**

Table 2.6-1
The Project's Electrical Production Capacity

In case of usages (performance)	Gross Output : MW	Auxiliary Load : MW	Net Output:MW
1. Full Load (Natural Gas)			
- HRSG Stack Unit 1	760	60	700
- HRSG Stack Unit 2	760	60	700
2. Full Load (in case of emergency) (Diesel)			
- HRSG Stack Unit 1	527	42	485
- HRSG Stack Unit 2	527	42	485
3. Minimum Generation Load (Natural Gas)			
- HRSG Stack Unit 1	456	36	420
- HRSG Stack Unit 2	456	35	420
4. Minimum Generation Load (Diesel)			
- HRSG Stack Unit 1	456	36	420
- HRSG Stack Unit 2	456	36	420

2.7 Electricity supplying system and generation process controlling system

(1) Electricity supplying system

The project will supply electricity to the EGAT by installing supply grid with capacity of 230 kV inside the EGAT area.

(2) Generation process controlling system

Base Load Plants are those power plants which are operating continuously over 24 hours/day, by which the power plants require time for start up the operation. This type power plants use low cost per unit and stable supplying fuel. The fuels such as coal, nuclear, and natural gas (hydro power or fuel oil in some countries) are easy to find and are sustainably produced. The fuel usually combined together to operate the power plants. Therefore, the Hin Kong Power Plant project is classified as a base load plant as mentioned above. The power plant is operated continuously which is under controlled by the EGAT, and it has lower start up frequency than those Small Power Producer (SPP).

The start up operation of the combined thermal power plant is started by an operation of the Gas Turbine under high-speed driving force from electricity motor, then; Air Compressor blows ambient air under high pressure to an Air Filter House for feeding to Combustion Chamber. Next, fuel is supplied and mixed with high pressure air to an ignitor system for combustion. Heat generated from the combustion chamber is driving the gas turbine continuously and the electricity motor stop its operation. Later, more fuel is supplied for maintaining Full Speed No Load. And, the end of the Gas Turbine is connected with an Electricity Generator for making electricity current continuously which is sending to a Transformer before feeding to a Switchyard and connecting to electricity grid system of the EGAT.

Start up procedure from gas turbine system activation to combustion takes up around 10 minutes. After combustion takes place, the gas turbine will spin at the fastest speed and connect to transport system of Electrical Generating Authority of Thailand takes up another 10 minutes. The connection between the two will produce 5 Megawatt of electricity at first. Then, an operation is increasing to full load operation to support electricity selling contract at 700 MW/unit which is using 15-30 minutes for maintaining an operation.

The start up period of the project needs maximum loading around 24 MW, by which; the project uses electricity from the EGAT. Then, electricity is supplied by the project after normal operation.

Shut down

In case of emergency (when the system is not function nor under system maintenance), the project requires electricity around 1.5 MW which is supplied by the EGAT. There are 2 units of Gas Turbine, by which; the shut down operation will be performed for only 1 unit for each time. Shut down operation will drcreases electricity production from the Full Load to Full Speed No load which is using around 10 minutes. Then, the system is unconnected with the electricity grid of the EGAT before turning off gas supplying valve to stop an ignition in the chamber. Then, gas turbine speed is reducing to 120 rpm which is called Cool Down. The Shut Down is performed yearly and it will be informed to the EGAT before operation.

2.8 Infrastructure system and facilities

2.8.1 Consumption water

(1) Construction period

Water consumption during construction period is classified to 2 types which are worker consumption, and construction activities as described below;

1) Worker consumption: During construction, the maximum workers will be around 3,000 persons, by which; those workers are traveling to the construction site without living in the area. Water consumption will be around 300 cubic meter/day (calculated from water consumption rate of 100 Liters/person/day x 3,000 persons). Those consumption water will be supplied by subcontractors sufficiently, by which; drinking water will be supplied from local markets, and

2) Construction activities: water consumption is used for equipment washing, and concrete mixing which is consumed at low quantity, because; the project is mainly use mixed concrete. Water consumption will be around 50 cubic meter/day which is supplied by the same sources as those for worker consumption.

(2) Operation period

The project will use water from the Mae Klong River which is the current water source for the TECO power plant. The pumping station of the project is located at the bank of the Mae Klong River in Ban Lumdin, Lumdin subdistrict which is far from the project in east direction around 13 kilometers. Water is pumped to the raw water pond before using. Water consumption in the operation period is planned to use by recycle policy, by which; wastewater from Laboratory is sent to the pre-treatment system. While water from Boiler Blowdown is reused in the cooling system, and treated wastewater is used for plantation or washing activity in the project.

Comparison for using water from CT Blowdown to reuse requires additional budget for improving water treatement system. Because, water from CT Blowdown has higher TDS than raw water from the Mae Klong River. Therefore, the water treatment system for CT Blowndown could not use the same equipment as those normal water treatment system. An additional system investment for CT Blowndown are those Clarifier, Micro Filter, and Reverse Osmosis (RO Units) which has higher operation cost (chemicals, wages, filters, and energy). Total budget is around 14 Baht/1 cubic meter water. And, system installation cost is around 68.4 million Baht.

In case of water discharging from CT Blowdown to the Mae Klong River, water treatment operating cost is around 2 Baht/1 cubic meter water. The cost composes of Clarifier Operation, by which; water discharging from CT Blowdown to the Mae Klong River requires pipeline installation using 12” diameter of HDPE pipe from the power plant to the Mae Klong River over a distance of 13 kilometers. Pipeline installation cost is around 43.7 million Baht (equipment cost, land preparation cost, and installation cost). Therefore, water discharging from CT Blowdown to the Mae Klong River is possible as considered by the economic of scale. Details was shown in **Table 2.8-1**

Table 2.8-1
Comparison between discharge all of CT Blowdown onto the Mae Klong River and the resues of CT Blowdown in water treatment

Water treatment system (Using raw water as consumption water) Fully discharging to the Mae Klong River		Water treatment system (Using water from CT Blowdown) reuse water from CT Blowdown	
Technology	**Cost (Baht / cubic meter)**	**Technology**	**Cost (Baht / cubic meter)**
Clarifier	2.0	Clarifier	2.0
		Micro Filter	5.0
		Reverse Osmosis	7.0
Total	**2.0**	**Total**	**14.0**
Budget	**Million Baht**	**Budget**	**Million Baht**
12” diameter HDPE Pipe over 13 km.	43.7	Water treatment system (maintaining 6,836 cubic meter/day)	68.4

1) Water source

The project will use water from the Mae Klong River which is the current water source for the TECO power plant. The pumping station of the project is located at the bank of the Mae Klong River in Ban Lumdin, Ban Lumdin subdistrict which is far from the project in east direction around 13 kilometers. (**Figure 2.8.1-1**).

2) Raw water pipeline of the project

According to the current pipeline system of the TECO power plant is very old, the project had considered to install a new pipeline system along the irrigation canal. By which, the new pipeline system has 24” diameter for supplying water pipe, and 12” diameter for discharging water pipe. Pipeline installation is classified to 2 types which are;

- On-ground installation over pipe bridge by using carbon steel pipe for a distance of 70 meter,

- Underground installation using high density polyethylene pipe (HDPE) over a distance of 13.8 kilometers. (including the project area).

Raw water and discharging pipeline installation will be performed at the depth around 1.5-5 meter from ground level. The project will use 2 technics for pipeline installation which are soil removal and Horizontal Directional Drilling (HDD), by which; installation method is depend on operation area and traffic/environmental conditions. Existing pipeline of TECO Power Plant must be uninstalled before installation new pipeline. The installation will be conducted for 50 Cubic meter /day using 2 operation units operating at the same time along with pipeline installation (details were described **Appendix 2-4**).

There is 20 inches diameter pipe submerged to the Mae Klong River, while; 24 inches diameter outlet pipe will be connected to a pumping station at the level of -0.70 m.msl. Pipe length connected to the Mae Klong River is around 30 meter (width of the Mae Klong River at the pumping station is around 165 meter). The discharging point is the same location as the water intake location, by which; 12 inches diameter discharging pipe will be used at the the level around +0.50 m.msl. Pipe length in the Mae Klong River is around 10 meter Distance between the raw water pipe and discharging pipe is around 1.7 meter (as shown in **Figure 2.8.1-2**).

The project had acquired permission from related organization for pipeline installation already (permission documents were shown in **Appendix 2-5**).

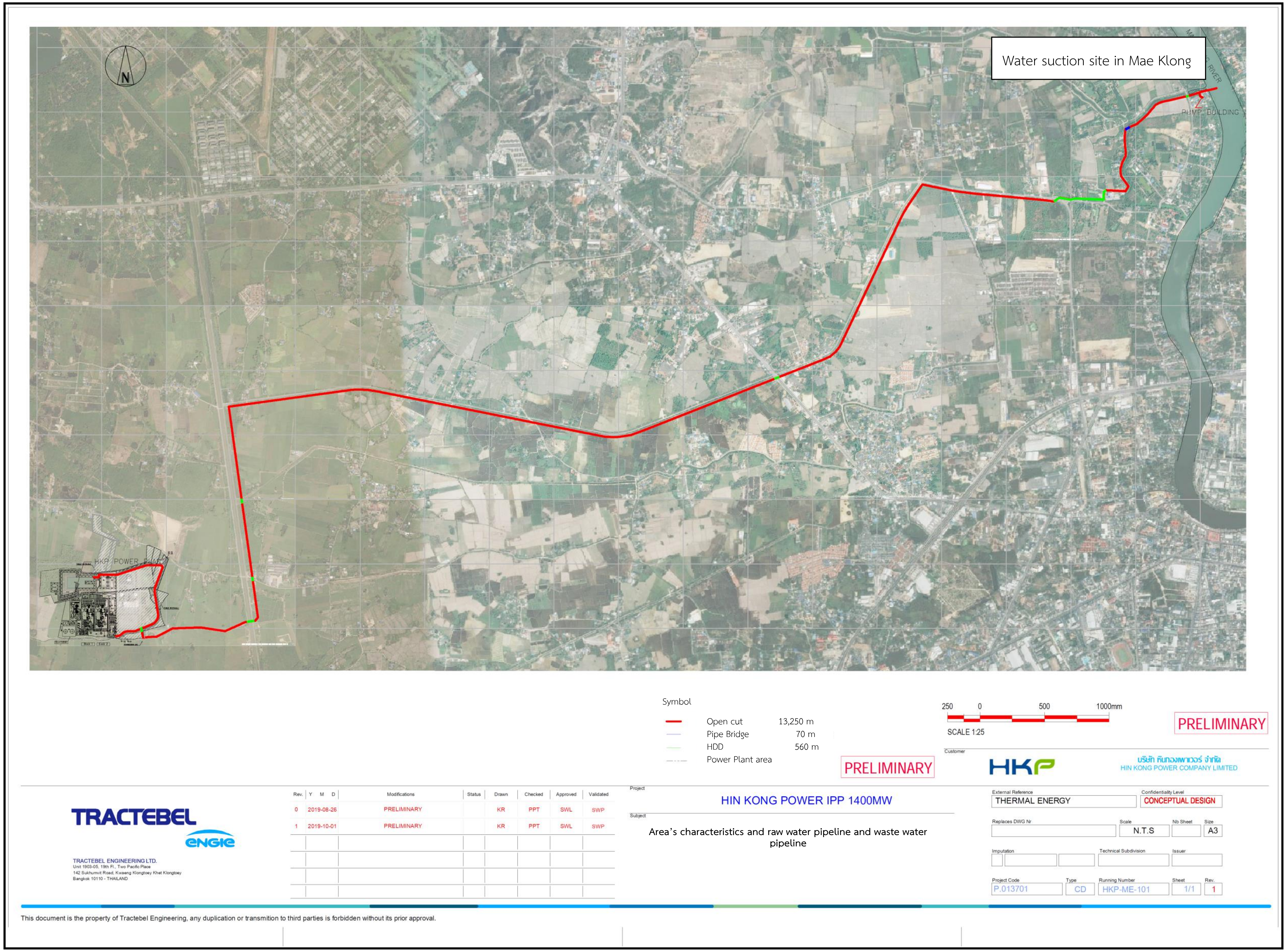
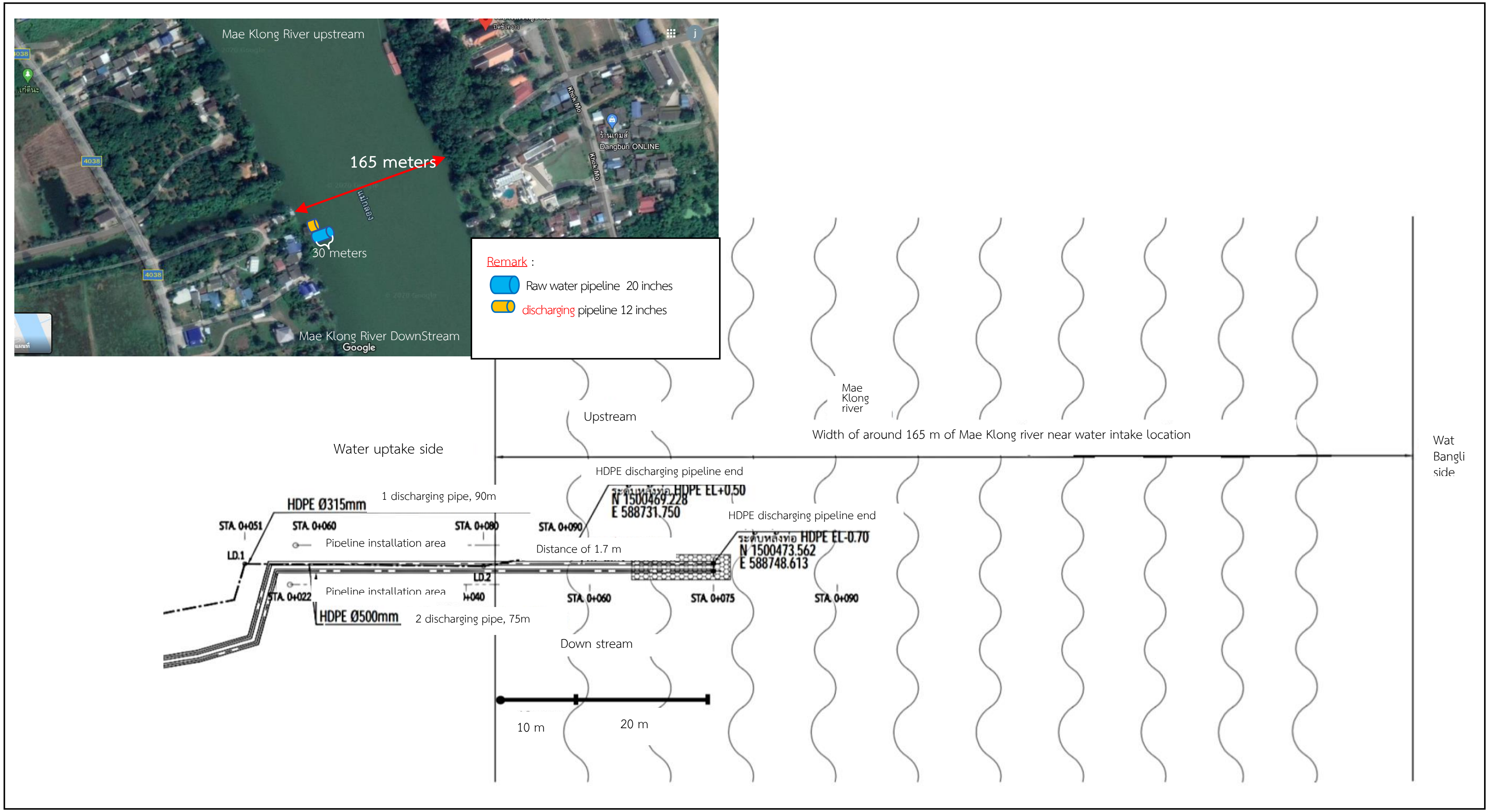


Figure 2.8.1-1 Pipeline from water intake location to project site



<u>Figure 2.8.1-2</u> Indicating Raw Water and Waste Water Pipeline near Mae Klong River

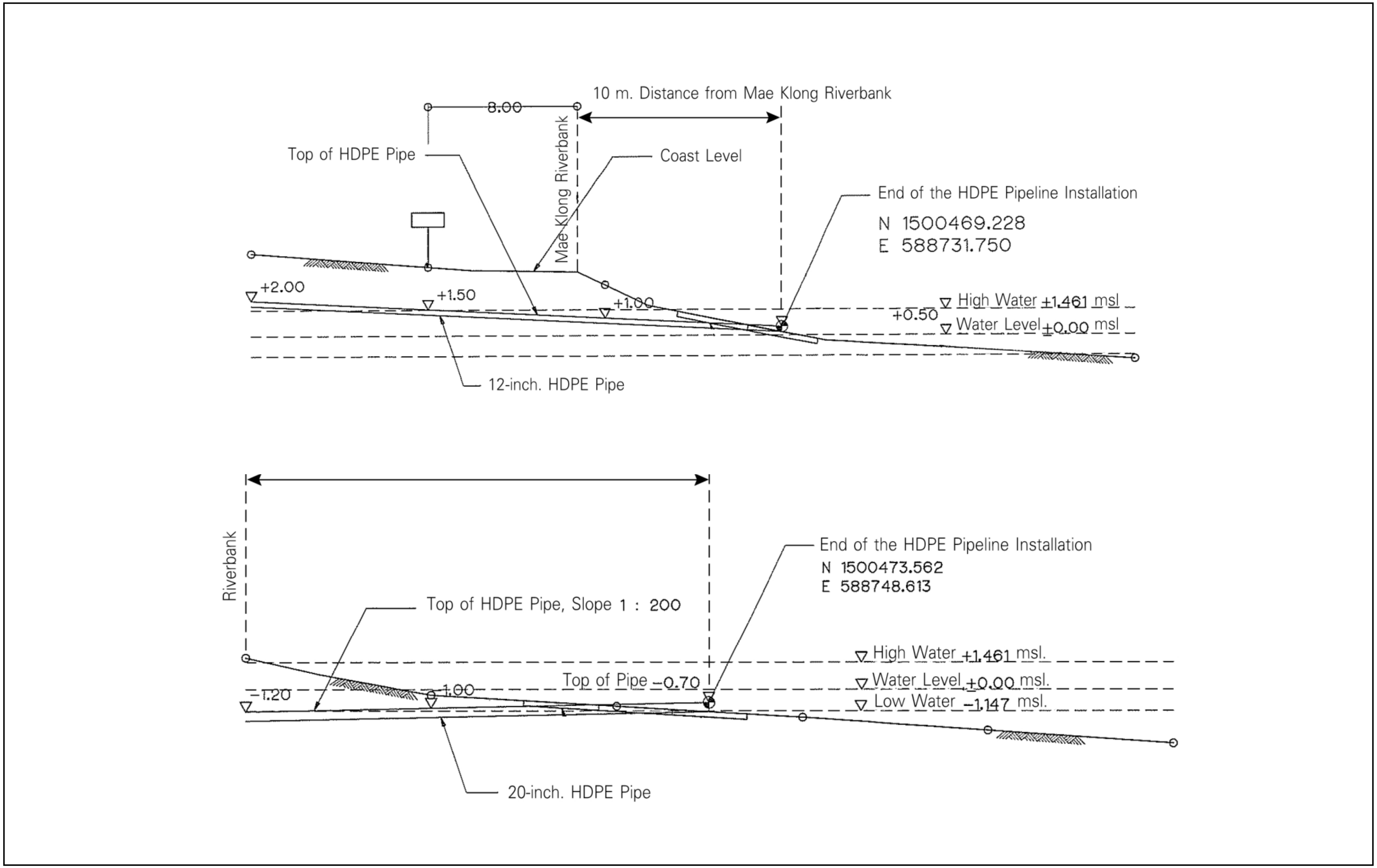


Figure 2.8.1-2 (continue) **Indicating Raw Water and Waste Water Pipeline near Mae Klong River**

Water consumption from the Mae Klong Riverthe project was assessed from water supply potential of the Mae Klong River to the Hin Kong Power Plant project. The study area covers the Mae Klong River since the downstream of the Mae Klong River Dam to the Gulf of Thailand. The study assessed water amount of the Mae Klong River for maintaining various activities, water mass balance, consumption sufficiency, and sea water dispersion to the Mae Klong River (details were described in the **Chapter 5**) which are summarized by;

(a) Assessment of the lowest water level in the Mae Klong River

Water level assessment in the Mae Klong River was limited from the downstream of the Mae Klong River Dam to the Gulf of Thailand. Section view pictures of the river in each area were used as input for modelling using MIKE11 which was developed by the Danish Hydraulic Institute (DHI) of Denmark. The studying performed by using the lowest water level after used by current activities (except for maintaining ecological system) to forecast water consumption in the future,

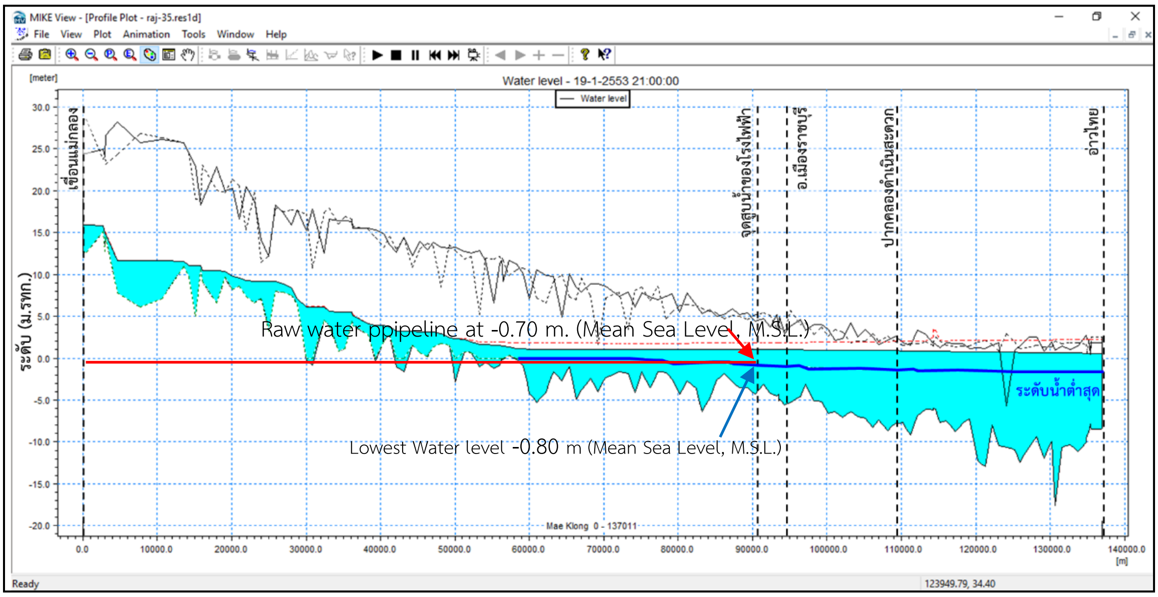
a) Current situation

The lowest water quantity after used by current activities (except for maintaining ecological system) was 91.60 million cubic meter/month (35.34 cubic meter/sec). The lowest water level since the downstream of the Mae Klong River Dam to the Gulf of Thailand was shown in **Figure 2.8.1-3.** By which; the water intake location of the power plant had the lowest water level around **-0.80 m.msl.,**

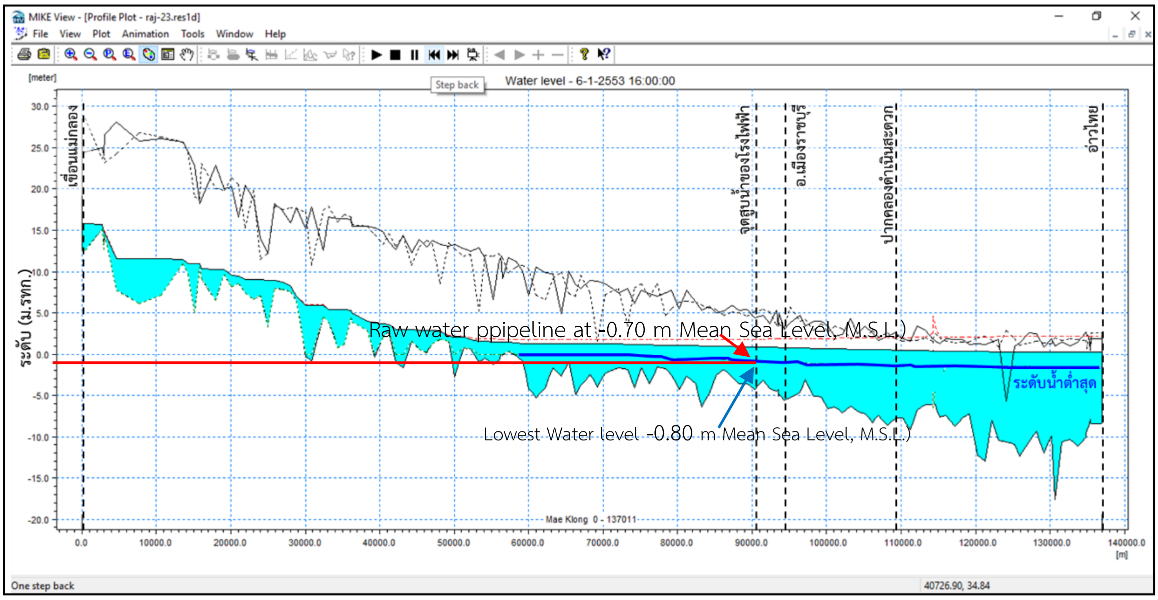
b) Forecasting water level after operation **(excluding Side flow)**

Water quantity for the future case after the power plant operation (excluding Side flow) will be around 62.70 million cubic meter./month (or 24.19 cubic meter/sec) which was assessed by remaining water after used by various activities (except for maintaining ecological system). Assessment results were shown in **Figure 2.8.1-4.** By which; the water intake location of the power plant had the lowest water level around **-0.85 m.msl.**

Water level studying from the Mae Klong River at the water intake location after project operation revealed that the lowest water level was -0.85 m.msl. which was lower than the level of raw water pipe of the project,



<u>Figure 2.8.1-3</u> Result Measuring Lowest Water level in Mae Klong River from Current Water Uses



<u>Figure 2.8.1-4</u> Result Measuring Lowest Water Level in Mae Klong River from Predicted Future Water Uses

Pipeline installation of the project in the Mae Klong River had to acquire permission from the Marine Department who has responsibility to maintain facilities in canals, receivers, lakes, and shoreline. The consideration criterion is mainly focus on marine transportation and environment. Currently, marine transportation in the Mae Klong River at the water intake location is low, by which; majority boats are those small boats of local peoples which have 8 ft length and depth of 2.6 ft.

Therefore, raw water pipeline installation of the project at water level of -0.70 m.msl. and distance of 30 m from the river bank, and discharging pipeline installation at water level of +0.50 m.msl. and distance of 10 m (river width at the water intake location is 165 meter) will not affecting marine transport safety in the Mae Klong River. And, water level assessment after project operation at -0.85 m.msl. will not affect water consumption of other activities. However, the project will not use raw water from the Mae Klong River, if water level is lower than -0.70 m.msl.

Nevetheless, water consumption from the Mae Klong River by the project will be performed under related laws or conditions strictly for maintaining confident of local peoples. The project will use raw water at the quantity under permission level without affecting water consumption of local peoples. By which; the project will record daily water consumption and report monthly water consumption for monitoring by related organizations.

(b) Water mass balance

Water mass balance studying was conducted for 1) current water consumption, 2) future water consumption without project operation, and 3) future water consumption including project operation. Studying results revealed that annually water amount of the Mae Klong River from downstream of the dam to the Gulf of Thailand was around 7,004 million cubic meter/year. Current water consumption without the hinkong power plant development indicated that water flow for maintaining ecological system during the drought year was lower than the threshold of the Royal Irrigation Department. However, water supply is still sufficience for other activities. In the future after project development, water consumption by the project from the Mae Klong River will be around 11.54 million cubic meter /year (0.16% of annual average water supply). Then, water consumption by the project tends to reduce water flow for maintaining ecological system which is mainly used for preventing sea water around 0.02% - 3.54% of annual average.

The decreasing amount of water will not affect water consumption for agricultural, livestocks, consumption, tourism, and industrial purposes.

It was predicted that, water supply for maintaining ecological system in the Mae Klong River will be decreased, however; salinity of the Mae Klong river will not exceeding water quality standard for agricultural purpose. Therefore, hinkong power plant development will not affect water consumption for agricultural, livestocks, consumption, tourism, and industrial purposes. In the Mae Klong River Basin.

The project had attended a meeting with the Mae Klong River Basin Committee for the meeting no. 3/2562 on 6th December, B.E. 2562(2019). The committee had submitted meeting report on 21st January B.E. (detail was shown in **Appendix 2-6**). The meeting secretary had offered a request for using water from the Mae Klong River to the committee, but the committee had informed that the Water Resources Act. B.E. 2561 (2018) will be actived within 2 years. Therefore, the permission should be considered after the related laws have promulgated, and the request should be resubmitted.

Furthermore, water pumping from the Mae Klong River to the project should follow related laws. Then, any operation should be performed under those Ministry Ragulations, Department Promulgations, and related laws which are promulgated later on.

3) Pumping station

The pumping station of the project still using current pumping house of the TECO power plant. By which, the project will change raw water pipeline, and install 3 new pumps (pumping capacity is 11,000 liter/min for each unit). Pumping system will be conducted by sending water to the pumping station before sending to Raw water pond of the project. An operation will be performed daily by using suction pipe at the level above water bottom around -0.7 m.msl. The project will install 6 mm. filtering screen at the intake of the pumping station to avoid impact to aquatic animals. Air Back Wash is also used to remove residues by making bubbles at the screen to reduce risk of aquatic animal suction to the system. For permit documentation to Marine Department as shown in appendix 2-7

4) Raw water Reservoir of the project

The project will pump water from the Mae Klong River to the Raw water pond inside the project area. The pond will be modified from the current pond to has capacity around 92,838 cubic meter which could be used during power plant operation by 3 days. Details of the Raw water Reservoir of the project were shown in **Figure 2.8.1-3.**

Land preparation should be performed under engineering safety without any impacts to lives, and properties according to the Operation Standard Manual for Soil Removal and Back-filling of the Department of Public Works and Town & Country Planning, Ministry of Interior B.E.2552(2009) which is refers to the Soil Removal and Back-filling Act. B.E.2543 (2000), and the Ministry Ragulation about Measures for Soil or Construction Collapsing Prevention in Land Preparation B.E.2548 (2005).

Soil removal of the project will be performed for expanding current raw water reservoir of the power plant as shown in **Figure 2.8.1-4.** Soil removal activity includes transporting dug up soil onto outside of the area or leaving the soil for the project to dispose.

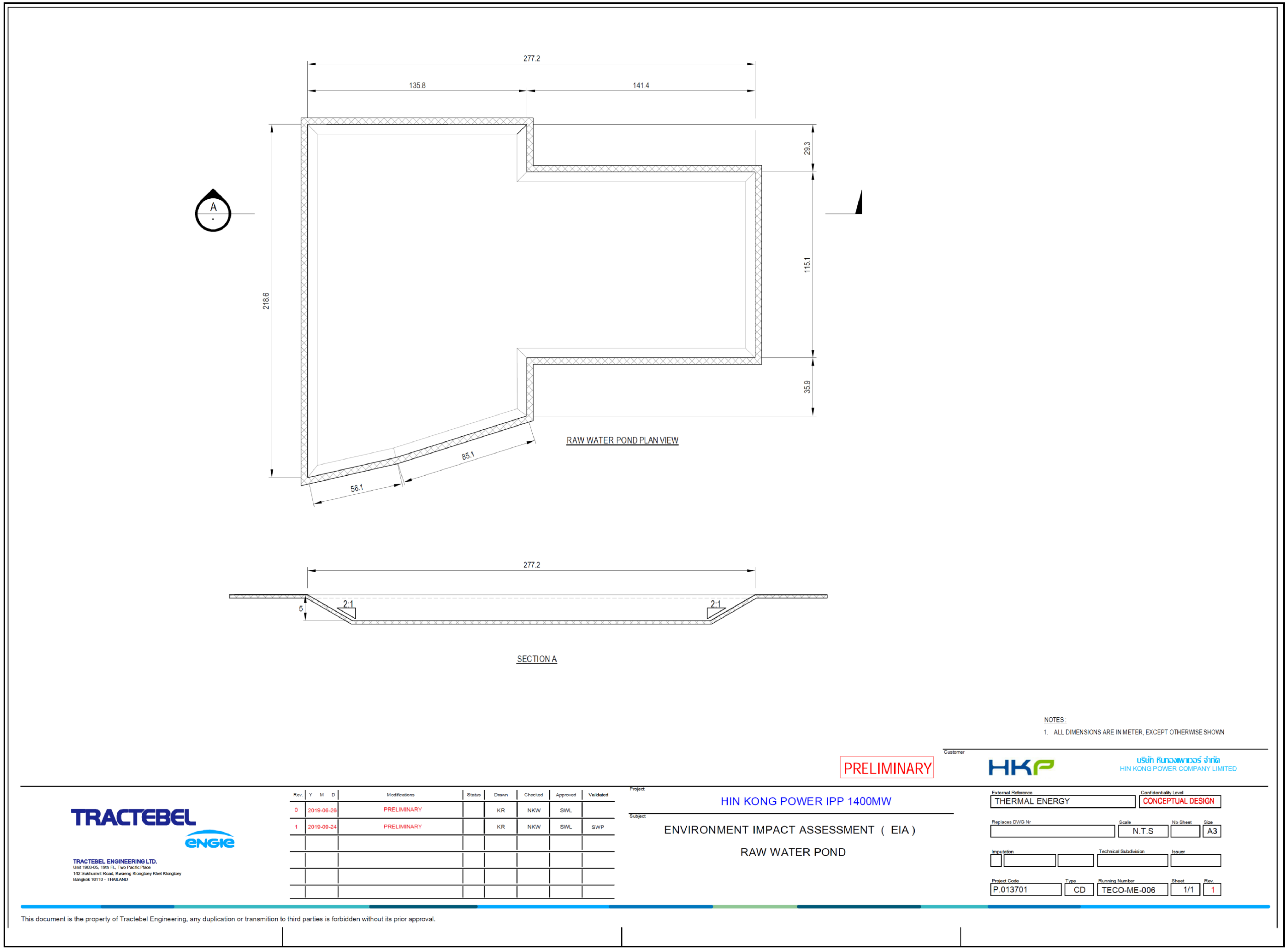


Figure 2.8.1-5 Details Regarding Raw Water Pond

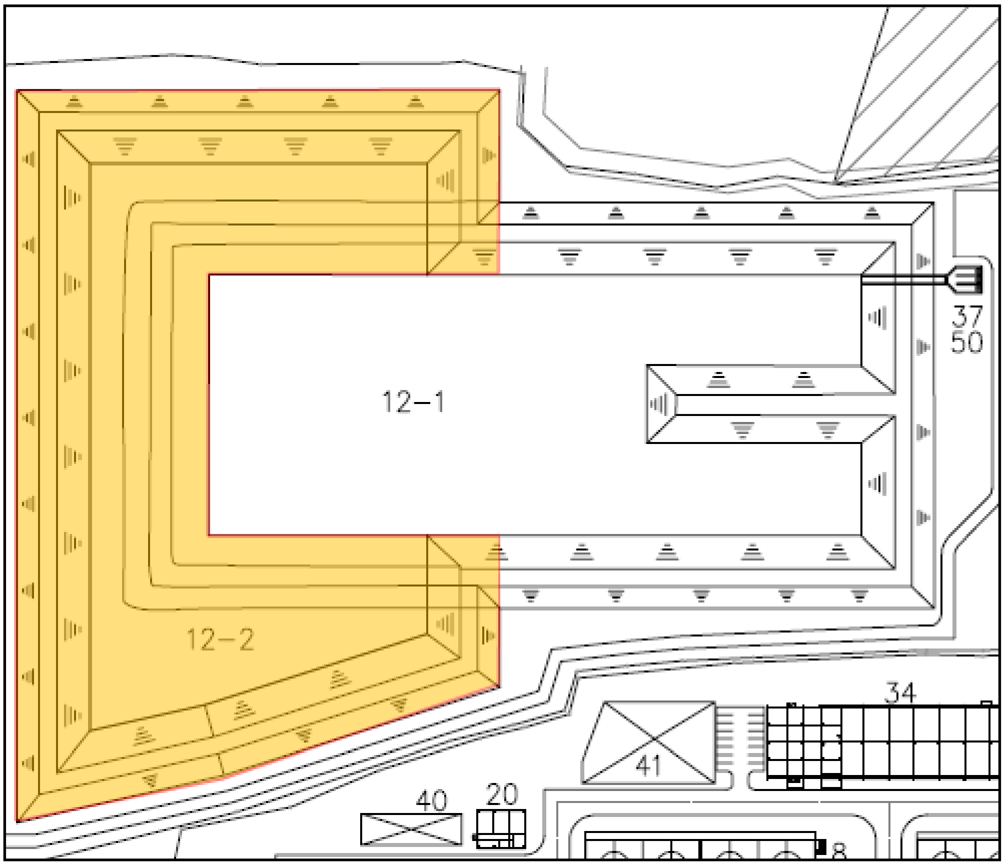


Figure 2.8.1-6 **Indicate Boundary for further expansion of the Raw Water Pond for the Power Plant**

5) Consumption water

The project requires water for 2 cases which are around 30,946 cubic meter/day when using natural gas as fuel, and around 23,166 cubic meter/day when using diesel as fuel (water mass balance of the project was shown in **Figure 2.8.1-5** to **Figure 2.8.1-8**).

Details of water consumption in each activity was shown in **Table 2.8.1-1** which were summarized by;

Table 2.8.1-1

Peak Wate Usage during operation Period

Order	Type of Water	Amount of Water Use (m^3 per day)	
		Natural Gas as fuel	Diesel as fuel
	Raw Water from Mae Klong River (stored in Raw Water Pond)	**30,946**	**23,166**
1	Water used for watering plant and cleaning roads	**30**	**30**
2	Water used for daily uses and drinking (Potable Water)	30	30
3	Back-up water for the evaporated water from the cooling tower (Cooling Water make-up)	30,627	22,011
4	Sludge from the Water Treatment System (Sludge Cake)	51	39
5	Demineralized Water (Demin Water Storage Tank) for uses such as	**208**	**1,056**
	- Laboratory water	5	5
	- Water in water testing system (Sampling Rack & Chemical Dosing Area)	35	35
	- Circulating water in Steam Bottoming System(Steam Bottoming System Cycle Leak)	29	29
	- Circulating water in cooling water system (Closed Cooling water Cycle Leak)	7	7
	- Misellaneous Drain	50	50
	- HRSG blow down	82	66
	- GT water Injection	0	2,600

Remark **:** * Amount of water from the Basic Water Treatment system is greater than the raw water coming into the system. This is because the Basic Water Treatment system (Water Treatment Plant) treats and then reuses about 2,875 m^3 of water.

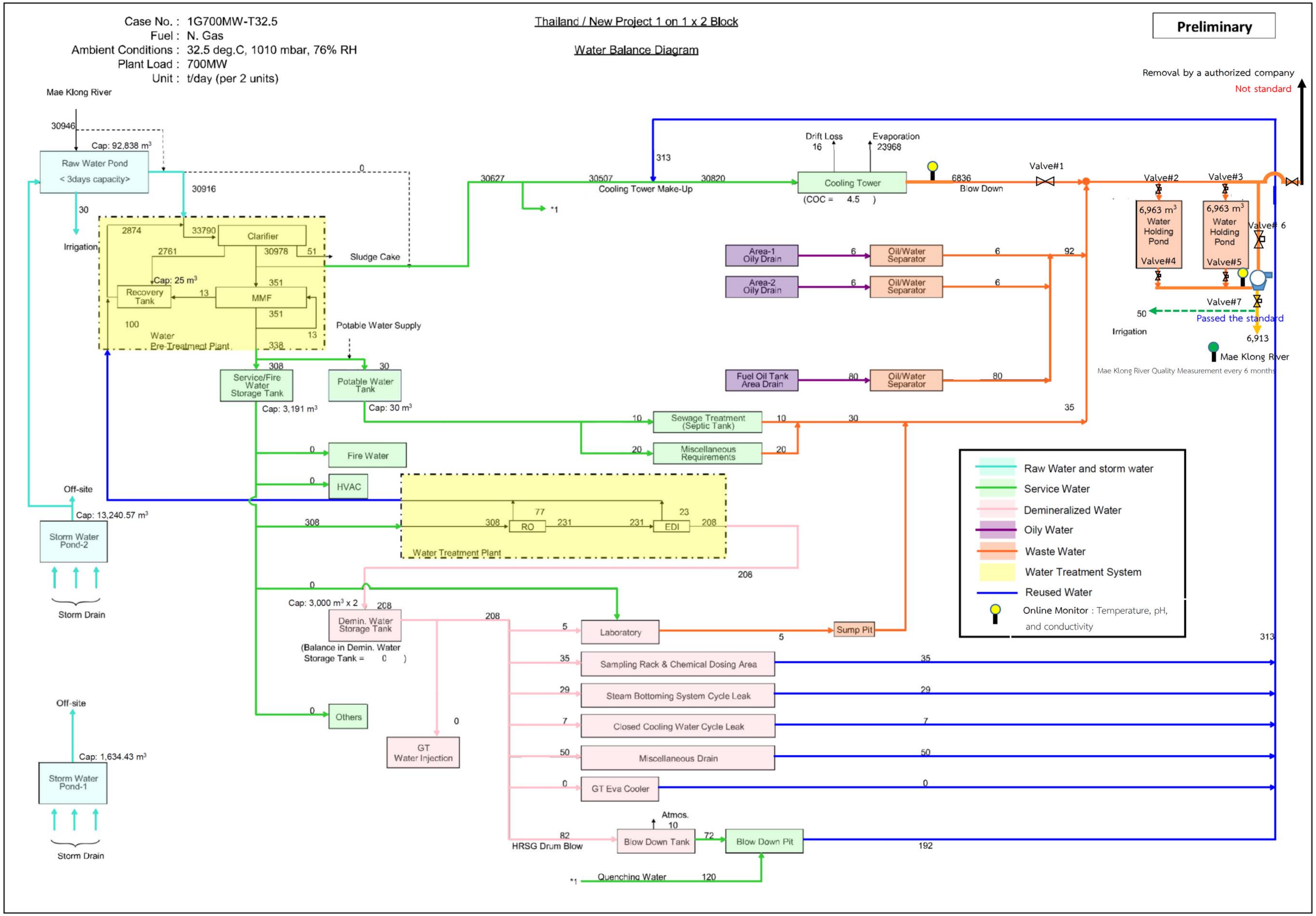


Figure 2.8.1-7 Chart showing water balance in case of using natural gas as fuel for running 100% Full Load

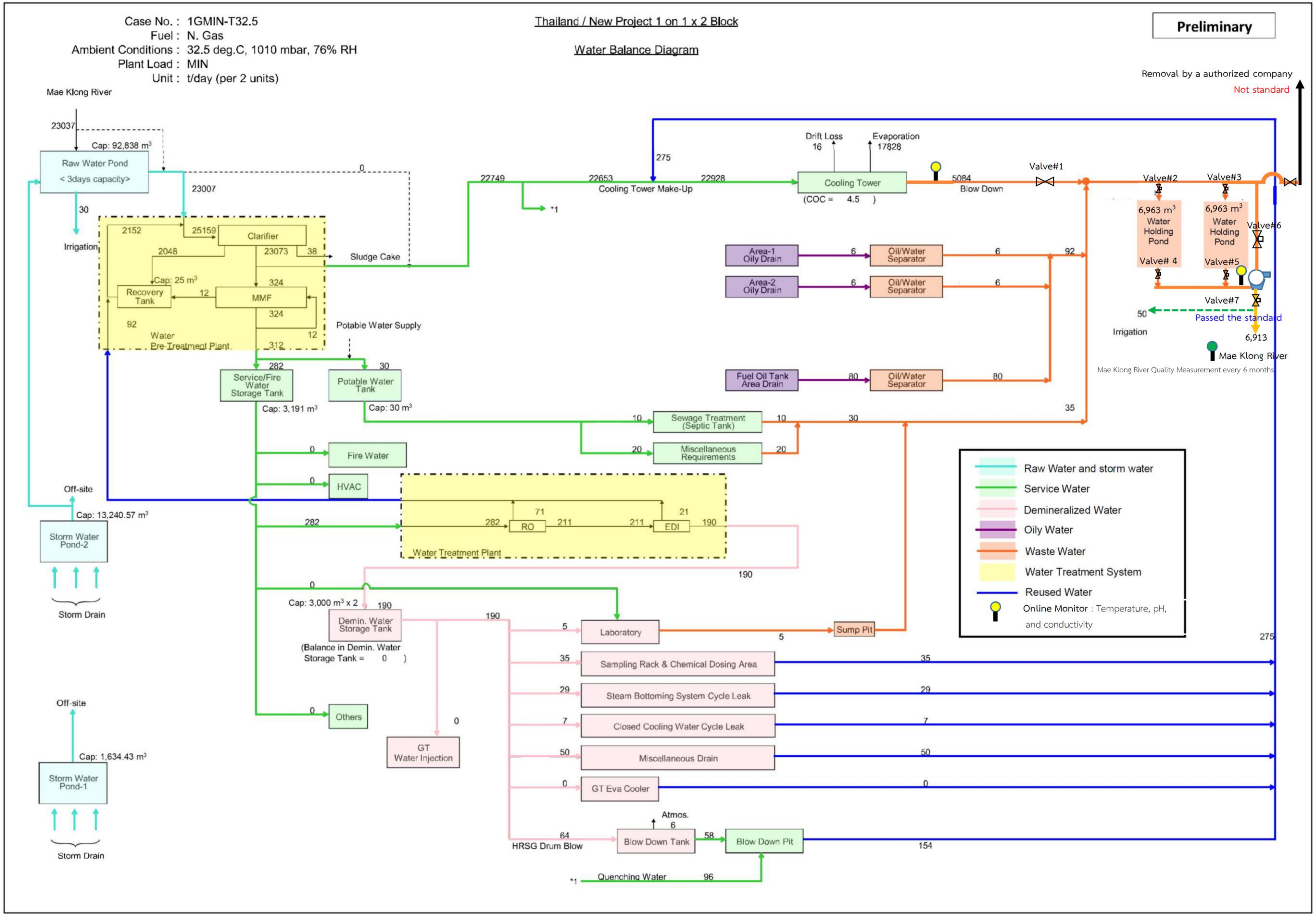


Figure 2.8.1-8 Chart showing water balance in case of using natural gas as fuel for Minimum Load

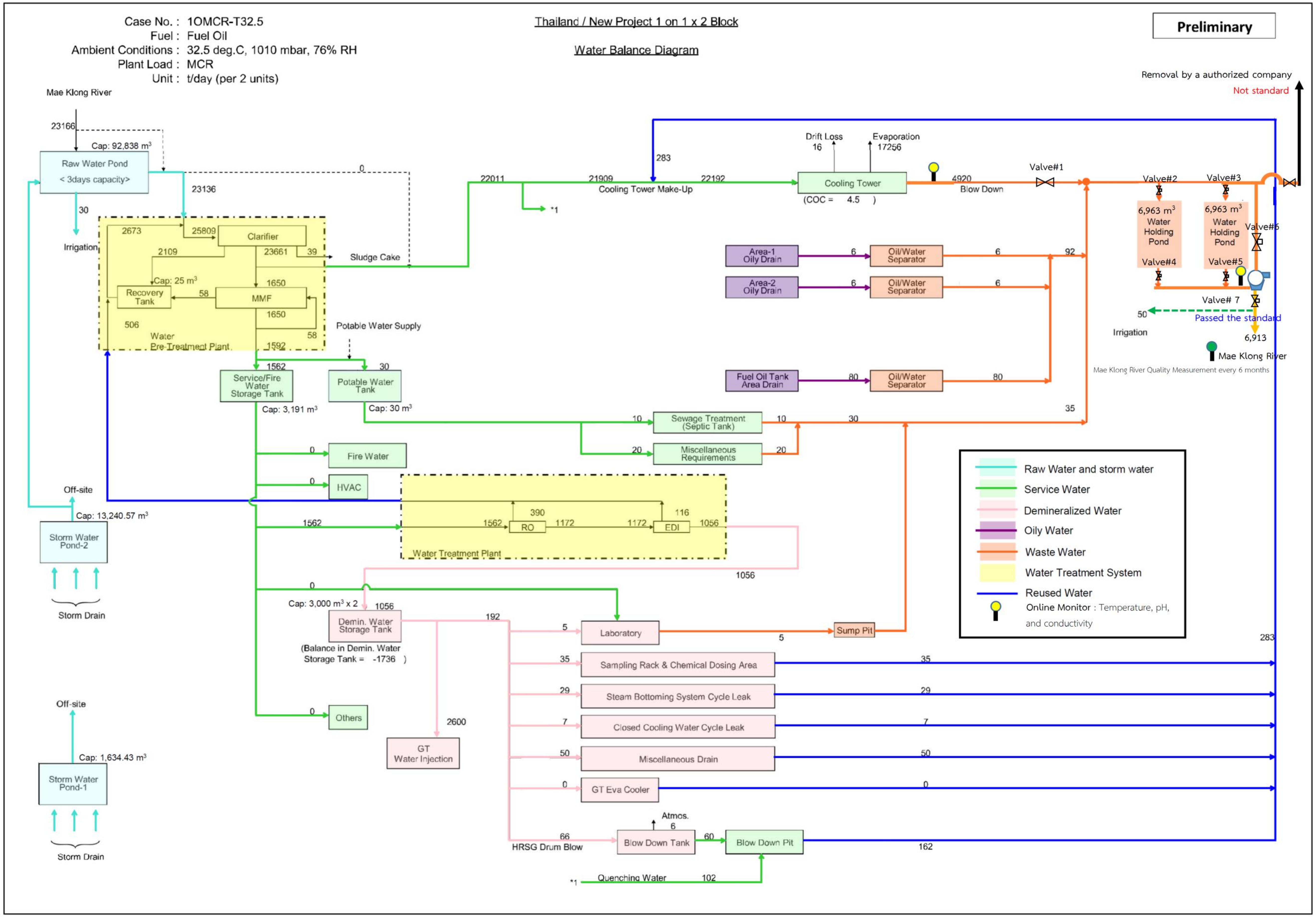


Figure 2.8.1-9 Chart showing water balance in case of using diesel oil as fuel for running 100% Full Load

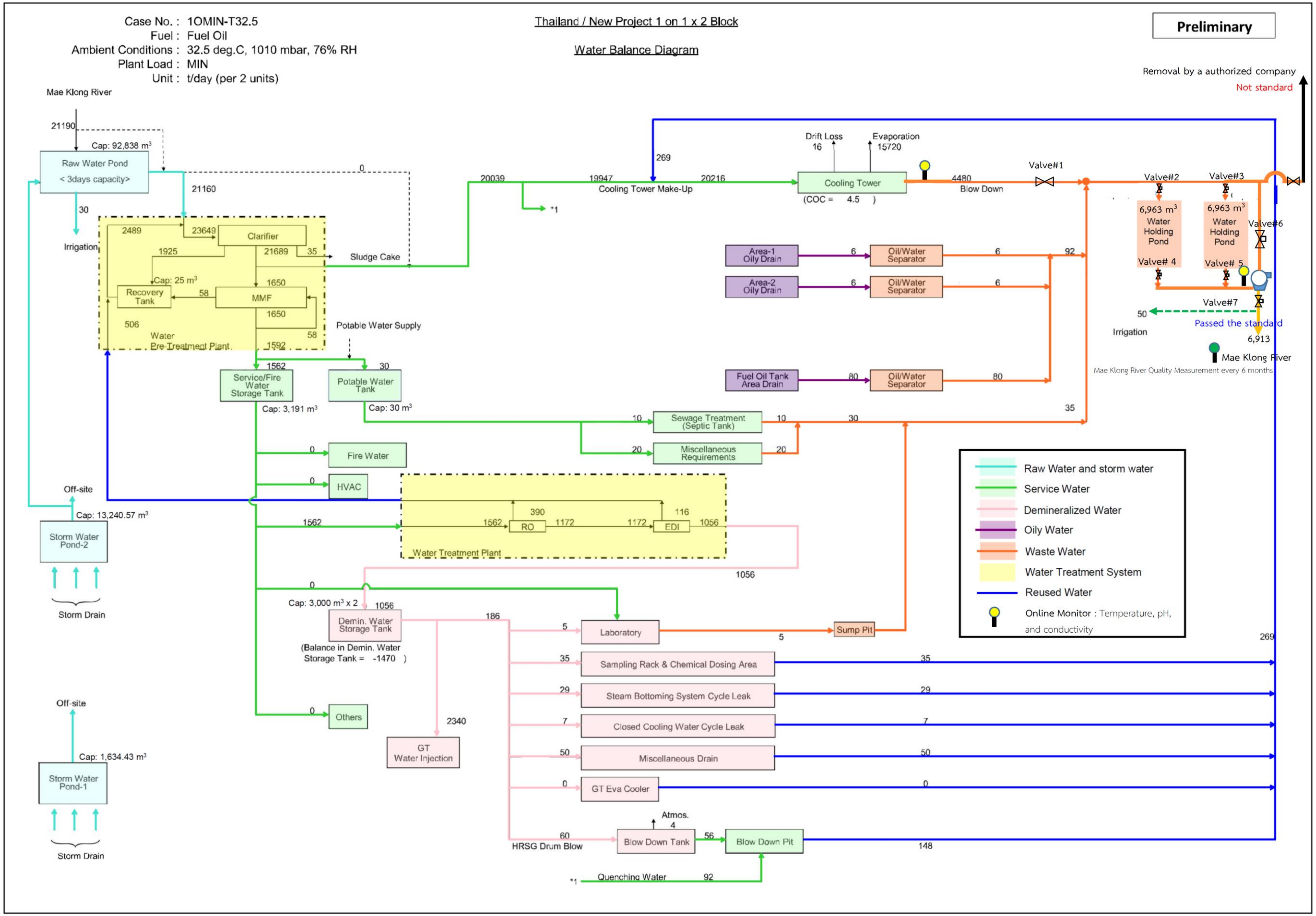


Figure 2.8.1-10 Chart showing water balance in case of using diesel oil as fuel for running Minimum Load

2.8.2 Water quality treatment system

Water quality treatment system of the project is classified to 2 systems which are Water Pre-treatment, and Water Quality Treatment used by Demineralization Plant for the manufacturing process of the power plant. Details of water quality treatment system was shown in **Figure 2 .8.2-1** (calculation details for water treatment system of the project was shown in **Appendix 2-8).** Summary of the system are;

(1) Water Pre-treatment

Raw water pumped from the Mae Klong River will be filtered by sand filtration before sending to the Raw water pond of the project. Then, filtered water is sent to Water Pre-treatment System which are;

- Clarifier; the process for removing suspended particulate (sand, soil, bacteria, and colloids) by using Coagulation, Flocculation, and Sedimentation. Large particle has potential to precipitate by itself, while fine particle requires chemicals for sedimentation such as PAC, and Polymer. Equipment in the system composes of 1,300 cubic meter Clarifier Tank (total sedimentation rate around 1,308 cubic meter/hr). Clear water on the top will be senty to cooling tower under quality adjustment using Multimedia Filter (MMF). Sludge at the bottom part of the tank around 51 tonne/day will be sent to Filter Press for water removal before elimination by authorized organizations,

- Multimedia Filtration (MMF) ; water obtained from sedimentation process will be sent to a unit of Multimedia Filter (MMF) with capacity of 14.625 cubic meter/hr. Water from this process (MMFX will be used by 2 parts which are demineralization water system, and fire prevention storage system. Treated water is kept in 3,191 cubic meter Service/Fire water Storage Tank, and 30 cubic meter water consumption tank,

(2) Water quality treatment system for Demineralization Plant

Water quality treatment system composes of Reverse Osmosis (RO), and Electro De-Ionization (EDI). The system using RO Membrane, and Ion Exchange without Mixed Bed Exchanger (MBE). The EDI does not require chemicals for resin regenerating as the MBE system. Therefore, the system can work continuously without operation shutdown for cleaning filtrate. System capacity of RO is 9.7 cubic meter/hr for feeding to EDI by 8.7 cubic meter/hr. Purified water from EDI will be kept in 2 units of 3,000 cubic meter Demin Water Storage Tank. Demin water usage for natural gas fuel is around 208 cubic meter/day, and those diesel fuel uses around 1,056 cubic meter/day.

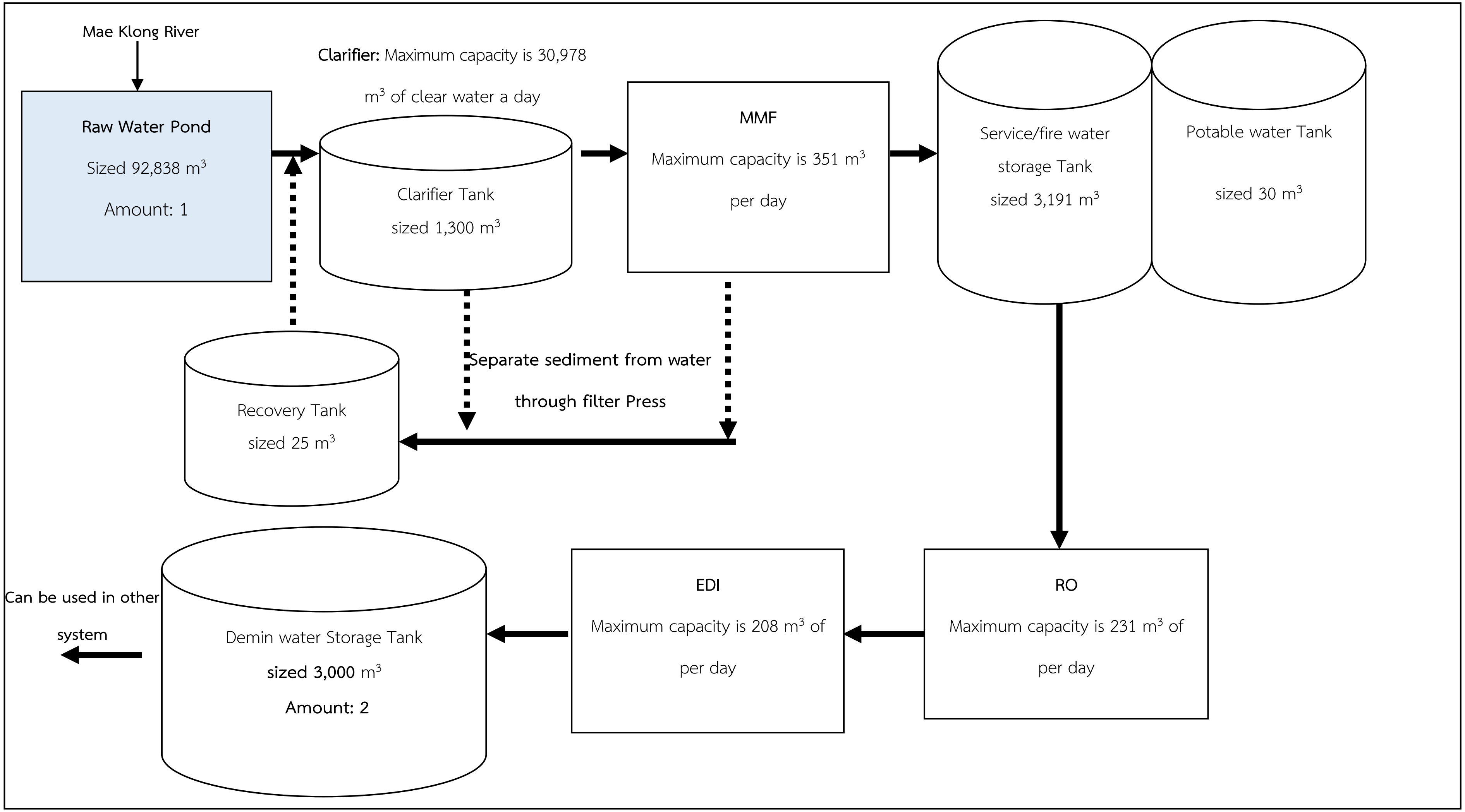


Figure 2.8.2-1 Water Treatment System Chart

2.8.3 Water irrigation and flood prevention

(1) Construction period

The project will install temporary spillway inside the project area in the same location of permanent spillway for removing rain water and waste from construction material such as soil, gravel, rock, and residues. Therefore, the project will make temporary sedimentation pond for capturing rain water to use for dust controlling in drought period. Subcontractor has to maintain spillway to avoid water flow blocking in wet season and controlling flow direction to public irrigation canal in the north. For oil contamination prevention, the project will install roof covering with supporting tray for oil contamination risk areas.

(2) Operation period

Water irrigation system inside the project is separated between rain water and discharging water. Rain water irrigation is divided to contaminated water and uncontaminated water by;

1) Rain water collection

There are 2 systems according to area chartacteristic which are uncontaminated water area, and contaminated water area as summarized by;

(a) Contaminated rain water: Rain precipitation in oil operation area such as electricity transformers, and diesel (The calculation of the oil separator tank as **Appendix 2-9**) storage area are controlled by using pipeline system inside the barrier for removing oil contamination water to Oil Separator Tank. Rain precipitation in the first 15 minutes will sent to rain water retention pond of the project, while oild contamination water will be eliminated by authorized organization by the DIW,

(b) Uncontaminated rain water: Uncontaminated rain water is those rain precipitation over building roof, and roads. Contour line surveying of the studying area was used for rain water irrigation designing for installing rain water spillway (**Figure 2.8.3-1**). The concrete spillway was designed to be constructed beside the power plant according to soil level for sending rain water to 2 rain water retention ponds. The ponds were separated by their locations which are;

(a) retention pond no.1 with capacity of 13,240.57 cubic meter to support rain water from the lower areas of the project which are those power plant area, and office area, and

(b) retention pond no. 2 with capacity of 1,634.43 cubic meter to support rain water from the upper areas of the project which are raw water pond, and water treatment ponds (including discharging water retention pond).

Calculation details for designing the retention ponds of the project were using Rational Method by,

Formular	Q	=	0.278×10^{-6} CIA,
When	Q	=	Irrigation flow rate (cubic meter/sec),
	C	=	Irrigation flow rate coefficient,
	I	=	Precipitation rate (mm./hr), and
	A	=	Retention area (square meters)

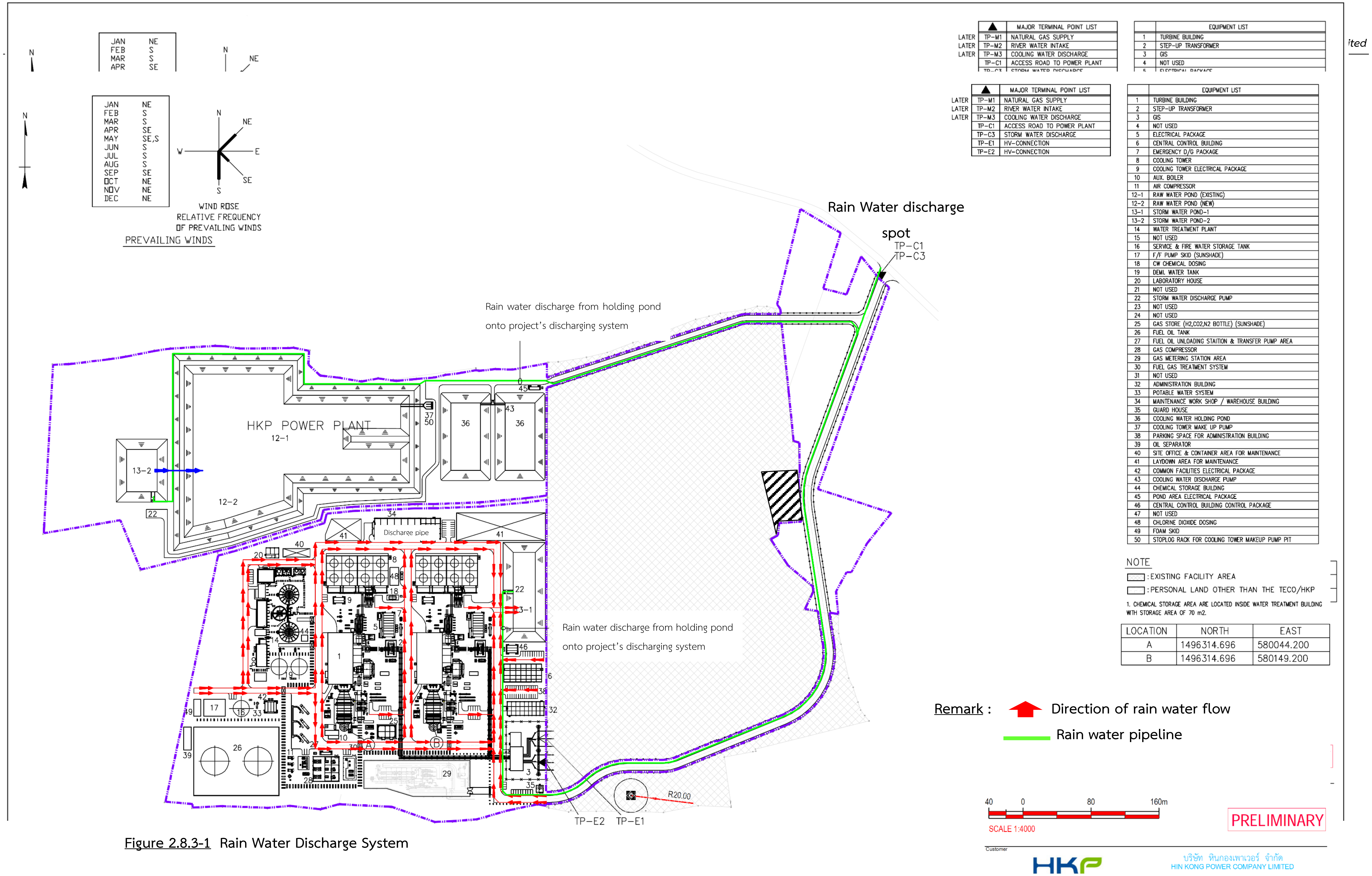


Figure 2.8.3-1 Rain Water Discharge System

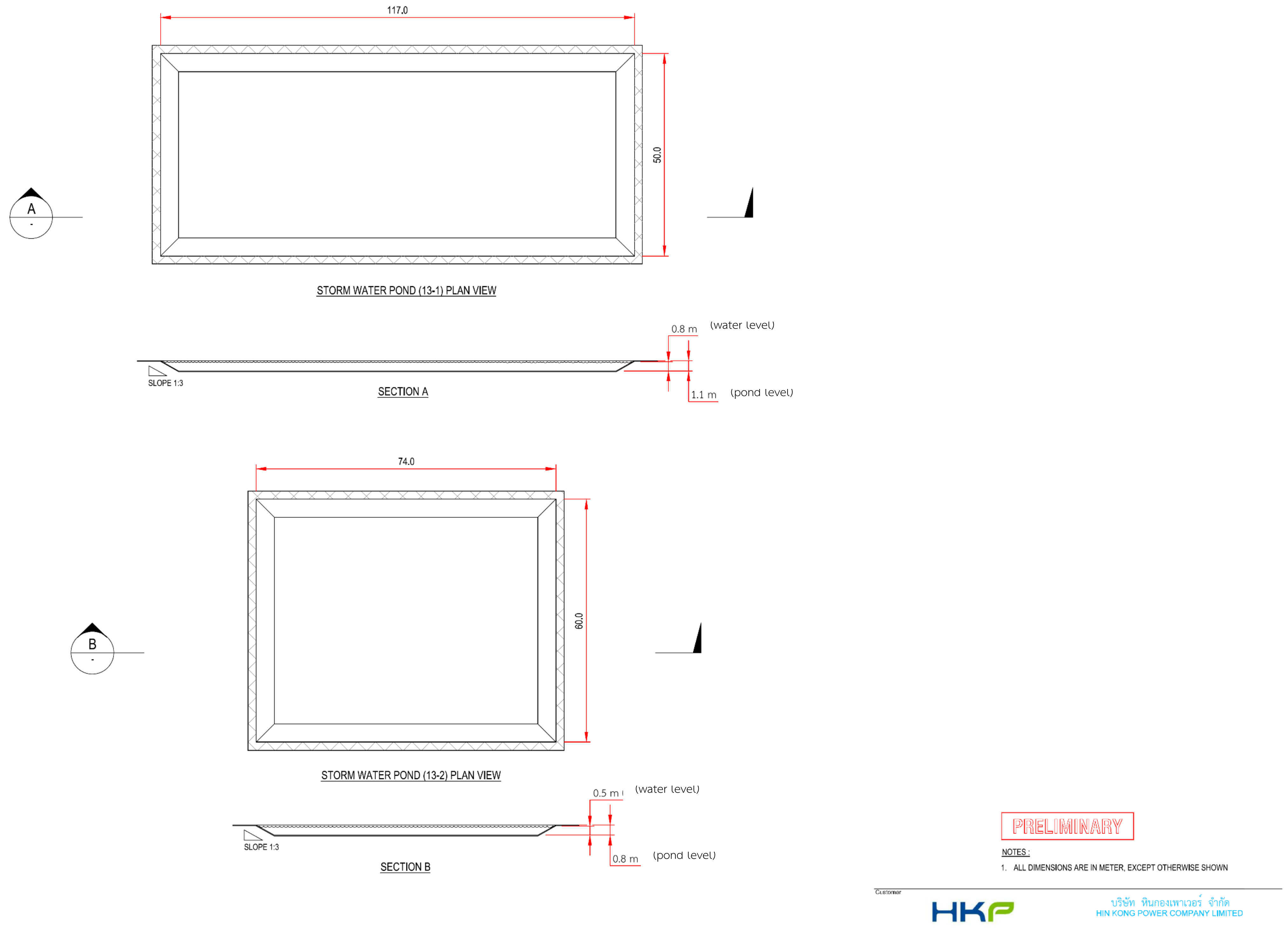


Figure 2.8.3-2 Section view of Storm Water Pond 1 and Strom Water Pond 2

Table 2.8.3-1
Amount of annual runoff from rain water for 25 years at Hin Kong Power Plant

Time (hr.)	Time (Min)	Precipitation rate 25 year (mm./hr.)	Accumilated rain depth rate 25 year (mm.)	Upper Area				Lower Area				Total Runoff
				C Average	Depth Runoff (mm.)	Location size (m^2.)	Runoff (m^3.)	C Average	Depth Runoff (mm.)	Location size (m^2.)	Runoff (m^3.)	
0	0	0	0	0.25	0	49,793	0	0.76	0	132,183	0	0
0.25	15	202.4	25.3	0.25	63	49,793	315	0.76	19.3	132,183	2,551	2,866
0.5	30	177.6	69.7	0.25	17.4	49,793	888	0.76	53.2	132,183	7,028	7,895
0.75	45	139	96.5	0.25	24.1	49,793	1,202	0.76	73.6	132,183	9,734	10,936
1	60	119	111.6	0.25	27.9	49,793	1,389	0.76	85.1	132,183	11,255	12,645
2	120	70.4	129.8	0.25	32.5	49,793	1,616	0.76	99.1	132,183	13,098	14,709
3	180	46.2	141.8	0.25	35.4	49,793	1,765	0.76	108.2	132,183	14,298	16,063
6	360	24.1	143.3	0.25	36.9	49,793	1,787	0.76	109.5	132,183	14,480	16,267
12	720	129	149.5	0.25	37.4	49,793	1,861	0.76	114	132,183	15,072	16,933
24	1440	69	159.9	0.25	40	49,793	1991	0.76	122	132,183	16,129	18,120
30	1800	No rain	165.3	0.25	41.3	49,793	2,057	0.76	126.1	132,183	16,668	18,724
36	2160		165.3	0.25	41.3	49,793	2057	0.76	126.1	132,183	16,668	18,724

Calculate C Value in Upper Area	Concrete Area	Seepage Area
Location size (m^2)	0	49,793
C value	0.85	0.25
Average C value	0.25	

Calculate C Value in Lower Area	Concrete Area	Seepage Area
Location size (m^2)	112,996	19,187
C value	0.85	0.25
Average C value	0.76	

Capacity of retention pond analysis in case of discharging water from the power plant was using the current condition by holding only exceeding water to assess discharging rate outside the power plant. Retention water quantity in the power plant area was shown in **Table 2.8.3-2 and Table 2.8.3-3.**

Table 2.8.3-2
Allowed Discharge rate onto outside of the power plant
in case the discharge water is equal to the current condition

Year	Amount of runoff in current condition (m^3/sec)	Amount of runoff outside power plant (m^3/sec)	Allowed discharge rate onto outside of power plant (m^3/sec)
5	0.98	0.91	0.07
10	1.16	1.07	0.09
15	1.26	1.17	0.09
25	1.39	1.28	0.11
50	1.55	1.42	0.13
100	1.71	1.57	0.14

Table 2.8.3-3
Amount of excess runoff that needed to be keep in Retention Tank
in case the discharge water is equal to the current condition
Table 2.8.3-3 (continue)

Time (Hour)	Time (min)	Total Runoff (m^3)	Water discharge rate (m^3/sec)	Amount of water dicharge (m^3)	Necessary amount of water keep (m^3)
0	0	0	0.11	0	0
0.25	15	2,866	0.11	99	2,767
0.50	30	7,895	0.11	198	7,697
0.75	45	10,936	0.11	297	10,639
1	60	12,645	0.11	396	12,249
2	120	14,709	0.11	792	13,917

Table 2.8.3-3 (continue)

Time (Hour)	Time (min)	Total Runoff (m^3)	Water discharge rate (m^3/sec)	Amount of water dicharge (m^3)	Necessary amount of water keep (m^3)
3	180	16,063	0.11	1,188	14,875
6	360	16,267	0.11	2,376	13,891
12	720	16,933	0.11	4,752	12,181
24	1440	18,120	0.11	9,504	8,616
30	1800	18,725	0.11	11,880	6,845
36	2160	18,725	0.11	14,256	4,469
42	2520	18,725	0.11	16,632	2,093
48	2880	18,725	0.11	19,008	-

From Table 2.8.3-3, it was found that the repeating situation in case of discharging water from the power plant was using the current condition by holding only exceeding water was 25 years. Therefore, the lowest capacity of the retention pond would be around 14,875 cubic meter (excluding free board) (calculated from water quantity ratio in **Table 2.8.3-1**). Thus, discharging rate outside the power plant would be around 0.11 cubic meter/sec with total discharging period around 48 hrs. The retenstion pond must has capacity at least 14,875 cubic meter (for holding rain water over 3 hrs). By which, water holding processes of the project are;

(a) retention pond no.1 with capacity of 13,240.57 cubic meter (width 50 meter, length 117 meter, and depth 1.1 meter using holding level at 0.8 meter and free board 0.3 meter), and

(b) retention pond no.2 with capacity of 1,634.43 cubic meter (width 60 meter, length 74 meter, and depth 0.8 meter using holding level at 0.5 meter and free board 0.3 meter) (Section view of the retention pond was shown in **Figure 2.8.3-2).**

Water irrigation from the retention ponds was separated by discharging from the retention pond no.2 to the raw water pond, and discharging from the retention pond no. 1 to outside area after rain precipitation finished to maintain retention capacity of the surrounding area, by which; current situation of the project area has capacity to maintain rain precipitation already and the project could holding rain precipitation for 1 day. Furthermore, the project had submitted requestion form to discharge rain water outside the area to authorized organization already (**Appendix 2-10**).

Environmental impact protection measures

- Providing rain water spillway around buildings and processing units to support uncontaminated water before sending to rain water irrigation system of the project,
- Maintaining and monitoring spillway and irrigation system inside the project regularly by removing blocking material out of the system with repairing the spillway routinely, and
- Removing sediment from the spillway frequently to avoid irrigation blocking.

2.8.4 Transportation

(1) Construction period

Majority transportation vehicles are soil trucks and construction equipment and worker trucks. Traffic loading during the construction period will be 120 trips/day for heavy duty soil trucks over 6 months which is limited for land preparation period, 90 trips/day for heavy duty construction material and worker trucks (normal case will be around 74 trips/day). Transportation route will be the country road no. 4031 and turn to the project at the entrance are of the TECO power plant. Those machine and equipment trucks should use only limited route, while the worker trucks which are around 132 trips/day (normal case around 111 trips/day) should use country road no. 4004.

However, the project had assigned subcontractors to response for providing worker shelters and travelling trucks by following related laws strictly. Transportation conditions during construction period were summarized as shown in **Table 2.8.4-1.**

Table 2.8.4-1
Amount of Transportation during Construction

Table 2.8.4-1

Car type	Regular period		Peak period	
	Amount of vehicles (vehicle/ day)	Amount of round trip (trip/day)	Amount of vehicles (vehicle/ day)	Amount of round trip (trip/day)
1. Dumper 10 wheel truck	60	120	60	120
2. Transportation of machines, equipments and production units				
Semi-trailer truck	10	20	12	24
Trailer truck	12	24	14	28
10 wheel truck	7	14	9	18
6 wheel truck	8	16	10	20
Total	**37**	**74**	**45**	**90**
3. Shuttle for construction workers				
Big sized bus	20	40	24	48
Medium sized bus	15	30	18	36
Small sized bus	12	24	15	30
4 wheel truck	8	16	10	20
Total	**55**	**110**	**67**	**134**
4. Building contracters car				
Car for 7 or less than 7 passengers	43	86	43	86
Car for more than 7 passengers	11	22	11	22
Total	**54**	**108**	**54**	**108**
Totals	**206**	**292**	**226**	**452**

Remark : Amount of transporation trips has taken in the account for the worst case scenario, of there being more than 3,000 workers

(2) Operation period

The project obtained natural gas using pipeline system. Therefore, transportation activity during operation period are those chemicals, waste/sediments from water quality treatment system, and staff transportations. The transportation routes will be mainly country road no. 4031, and no. 4004 to the project. Transportation activity during operation period was summarized as shown in **Table 2.8.4-2.**

Table 2.8.4-2

Chemical and Worker Transportaion

Transport	Car type	Amount of Vehicles (vehicle/day)	Amount of round trips (trip/day)
Chemiscal substance	4 wheel, 10 wheel, or trailer truck	1	2
Trash and sludge that form from Water Treatment System	4 wheel or 10 wheel truck	1	2
Workers,employees, and visitors	7-passenger car, 7 or more passenger car, and motorcycle	50	100
	Total	**52**	**104**

Source : Hin Kong Co.,Ltd, 2563 (2020)

2.9 Construction workers and staffs

(1) Construction period

Construction period of the project will have maximum workers around 3,000 persons/day, by which; the construction period of the project will take around 35-42 months. Those workers transportation will be round-trip without staying overnight inside the project area.

During **c**onstruction period, subcontractors have to provide worker shelters from private land rental, and preparing worker trucks for worker travelling to the construction site under the condition by;

1) Providing waste containers to maintain cleanliness in the construction area by distribution those bins evenly, and collecting waste daily, and

2) Providing worker shelters without staying overnight inside the project area, and maintaining sanitary system by providing toilet, waste management, and disease carrier prevention properly without affecting surrounding communities.

(2) Operation period

Total operation staffs during operation will be around 60 persons. Organization structure of the project was shown in **Figure 2.9-1.**

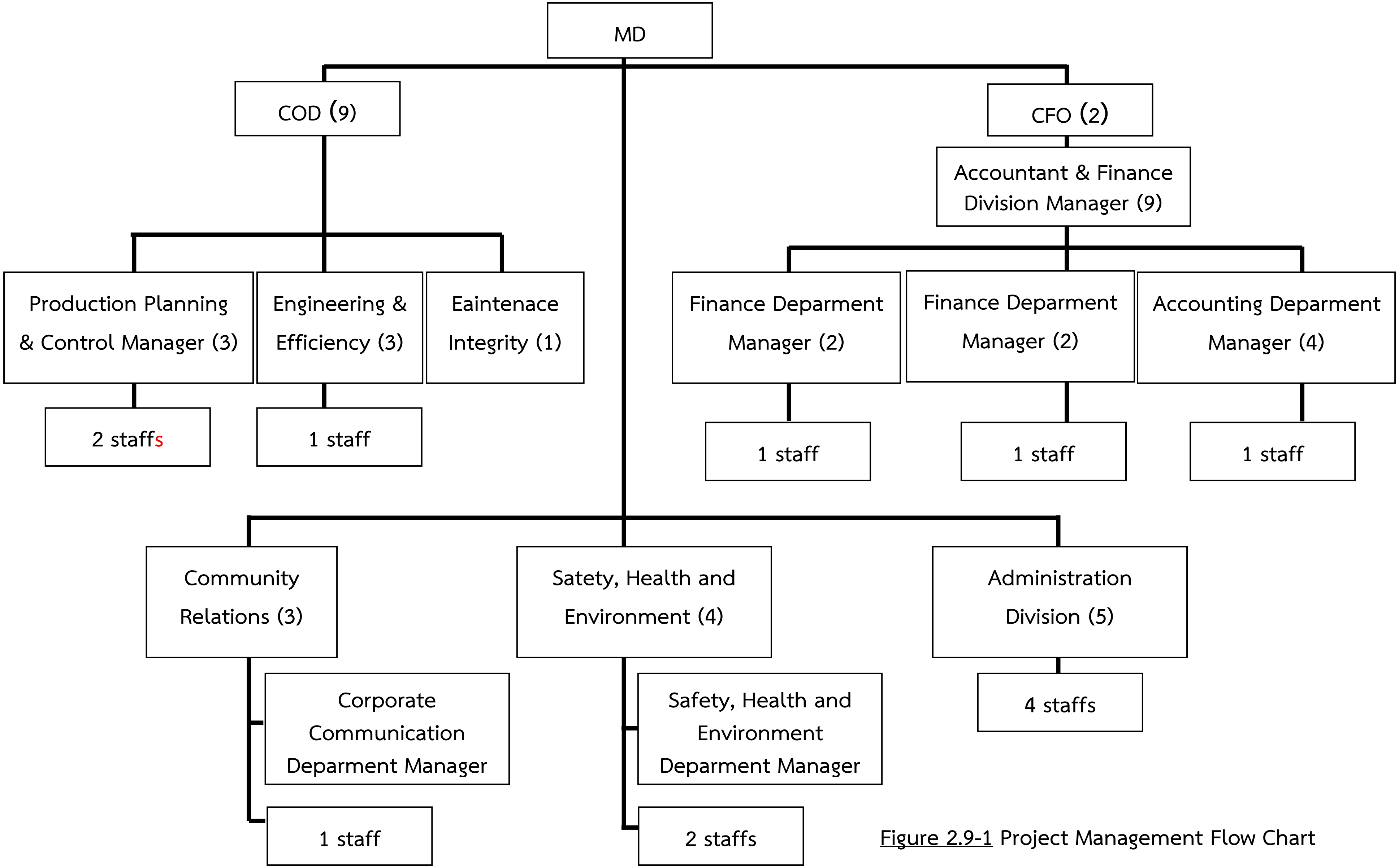


Figure 2.9-1 Project Management Flow Chart

2.10 Pollution and control

2.10.1 Air pollution and control

(1) Construction period

Project operation during construction period will generates air pollutants which are dust from land preparation, and soil removal. The dust is mostly Total Suspended Particulate (TSP), by which; the impact is considered as short-term impact. The project has environmental measures and mitigations which are ;

1) water spraying to construction site that is under working by light and heavy vehicle to generate dust. The water spraying will be performed for both construction and transportation areas at least 2 times/day (morning and afternoon sessions). And, additional water spraying time will be considered under dry condition or windy day to avoid dust dispersion causing impact to neigboring communities,

2) Covering transportation trucks using for transporting particulate material such as soil or cement by canvas or polymer sheet,

3) Washing truck wheels before entering public roads to avoid dust dispersion from wheel attaching dust, and

4) Limiting truck speed inside the construction area less than 20 km/hr to avoid dust dispersion.

(2) Operation period

1) Source

Significant air pollution sources after operation are 2 units of 60 m. HRSG Stack.

Air pollution during operation period of the power plant is generally generated from natural gas burning for driving gas turbine. For normal operation, air pollutants are emitted through the HRSG stacks. Main sirpollutants are NOx, SO_2, and TSP.

Technology used for controlling NOx in this project is Dry Low NOx (DLN) Combusion for controlling NOx from natural gas burning. While, water injection is used under diesel oil burning for controlling temperature to reduce NOx emission to an emission standard of the project according to the Natural Resources and Environment Promulgation about Controlling Measures for New Power Plant issued on 20th December, B.E. 2552, and Ministry of Industry Promulgation B.E. 2547 about Ambient Air Pollution Emitted from Electricity Generation Plants.

2) Emission rate

Emission rate control of the project for both natural gas and diesel combustion was shown in **the table 2.10.1-1.** For natural gas burning, emission rate for NOx is 59 ppm at 7% O_2 (legislative standard is 120 ppm). And for diesel burning, emission rate for NOx is 99 ppm at 7% O_2 (legislative standard is 180 ppm). Therefore, emission rate of the project is better than the legislative standard.

3) Continuous Emission Monitoring (CEMs)

The project will install Continuous Emission Monitoring System (CEMs) which is consist of monitoring and presenting devices for showing monitoring data of NOx, SO_2, TSP, excessing O_2, Flow Rate, and temperature. All operation will be conducted according to the U.S.EPA standard or equivalence. The CEMs will be installed at the top-end of the HRSG stacks for presenting air pollution monitoring results continuously. Furthermore, the project will perform Manual Sampling at the top-end of each steam boiler.

The project also prepares protective plan to avoid higher NOx Emission which is exceeding the controlling value of 59, and 99 ppm for dry air and excessing oxygen is 7% for both natural gas and diesel burning, respectively. Under anomaly data obtaining from the Continuous Emission Monitoring System (CEMs), warning signeal will be sent to the control room for analyzing the cause of anomaly data and solving the problem.

Furthermore, the project also prepares preventive mentainance to maintain efficiency of air pollution control equipment regulary for avoiding unusual case affecting the system.

Table 2.10.1-1

Concentration control index of chemicals released from the project's boiler chimney

Case	Chimney's size		NO_X		SO_2		TSP	
	height(m)	diameter (m)	Concentration (PPM)	Emission rate (g/sec)	Concentration (PPM)	Emission rate (g/sec)	Concentration (mg/m^3)	Emission rate (g/sec)
1. Full Load (natural gas)								
- HRSG Stack Unit 1	60	7.34	59	59.00	10	13.90	20	9.70
- HRSG Stack Unit 2	60	7.34	59	59.00	10	13.90	20	9.70
Total				**118.00**		**27.80**		**19.40**
2. Emergency (diesel oil)								
- HRSG Stack Unit 1	60	7.34	99	81.40	20	22.90	35	14.0
- HRSG Stack Unit 2	60	7.34	99	81.40	20	22.90	35	14.0
Total				**162.80**		**45.80**		**28.0**
3. Minimum Generation Load (natural gas)								
- HRSG Stack Unit 1	60	7.34	59	36.70	10	8.60	20	6.10
- HRSG Stack Unit 2	60	7.34	59	36.70	10	8.60	20	6.10
Total				**73.40**		**17.20**		**12.20**
4. Minimum Generation Load (diesel oil)								
- HRSG Stack Unit 1	60	7.34	99	67.80	20	19.10	35	11.70
- HRSG Stack Unit 2	60	7.34	99	67.80	20	19.10	35	11.70
Total				**135.60**		**38.20**		**23.40**
Standard value for the power plant in case of using natural gas 1/			120	-	20	-	60	-
Standard value for the power plant in case of using diesel 1/			180	-	320	-	120	-

Remark : 1/ Measures in accordance with the Announcement of Ministry of Industry (B.E. 2547) on regulating standard chemical emission from the electricity factory and power plant into the air (in case of new power plant that just got permission rights after October 1 B.E. 2547) and the Annoucement of Ministry of Natural Resources and Environment (B.E. 2552) on regulating pollants emission from the new power plant.

Source : Hin Kong Power Co.,Ltd, B.E. 2563

2.10.2 Noise pollution and control

(1) Construction period

Noise from construction period of the project caused by main activities such as land preparation, transportation, building construction, and decoration/inspection. The avtivities have difference noise level depend on their operating equipment as shown in **the table 2.10.2-1.**

Table 2.10.2-1

Noise level within 15 meters from the source in each stage of the construction

Construction steps*	Type of buildings/construction							
	Residential building		Office building, hotel, school, and public utilities		Industrial factory, parking area, mall, and service staion		Road, highway, and draiage system	
	I	II	I	II	I	II	I	II
Area adjustment	83	83	84	84	84	83	84	84
Dig to prepare for foundation	88	75	89	79	89	71	88	78
Lay foundation	81	81	78	78	77	77	88	88
Build buildings and construction	81	65	87	75	84	72	79	78
Decoration/Inspection	88	72	89	75	89	74	84	84

Remark : I = Maximum noise level for All pertinent Equipment

II = Maximum noise level for Minimum Requirement

Source : Carry W. Canter, Environmental Impact Assessment, (1997)

However, the project had assigned subcontractors to follow noise control measures by;

- Stopping construction activity during 17.00 hrs - 07.00 hrs of the next day to reduce community impact during that time, by which; any required activity must be informed to local communities before operation,

-Using Portable Steel Sheet Barrier to reduce noise impact at the fenceline between construction site of the project and the nearest communities,

- Assigning subcontractors to install temporary fenceline around the operation area inside the power plant area and construction area,

- Using low noise equipment and performing preventive mentainance regularly to reduce noise impact,

- Providing noise protective equipment such as ear plug or ear muff to those workers who are woring in loud noise area which is exceeding 85 dB(A),

- Labelling warning signs to use Personal Protective Equipment in those loud noise areas according to area characterized by the occupational health and safety staffs,

- Making public relation to inform construction plan with noise controlling measure to local communities, and

- Providing project staffs to perform noise impact surveying from construction activity regularly overall the construction period to reduce noise impact during operation.

(2) Operation period

The project will use low noise equipment for operation which have noise level less than 85 dB(A) at distance of 1 m. from an electricity generator, except for the Cooling Tower which has maximum noise from dropping of water less than 91.0 dB(A) at distance of 1 m. as shown in **the table 2.10.2-2**. However, the project will control noise level at the fenceline which is not exceeding 70 dB(A).

Table 2.10.2-2

Noise level from the project's operation activities

Noise level from source	Noise level from machines locating 1 meters from source (decibel A)
1. Cooling Tower Make up Pump	85
2. Cooling Tower #1	91
3. Cooling Tower #2	91
4. Steam Turbine #1	85
5. Steam Turbine #2	85
6. Generator #1	85
7. Generator #2	85
8. Gas Turbine #1	85
9. Gas Turbine #2	85
10. HRSG #1	85
11. HRSG #2	85
12. Air Compressor #1	85
13. Air Compressor #2	85
14. Gas Compressor Station#1	85
15. Gas Compressor Station#2	85
16. Gas MR Station	85
17. Cooling Water Discharge Pump	85

During operation period, the project has noise control measures by;

1) Installing noise reducing device such Silencer at Boiler or other loud noise equipment,

2) Checking efficiency of Silencer regularly,

3) Installing warning signs at loude noise areas which have noise level more than 85 dB(A),

4) Providing noise protective equipment such as ear plug or ear muff to those workers who are woring in loud noise area which is exceeding 85 dB(A),

5) Limiting loud noise areas such as Boiler, Gas Chamber, and Electricity Generator with warning signs for those staffs who have to work in the areas, by which; working staffs have to use protective equipment such as ear plug or ear muff while operation in tha areas, and

6) Managing operation time for staffs to reduce loud noise exposure by limiting operation time or moving to another low noise areas.

2.10.3 Wastewater and management

(1) construction period

Waste water from construction activity is separated to 2 parts which are wastewater from worker consumption and construction such as equipment washing as shown in **the table 2.10.3-1.** Details of wastewater are;

1) General wastewater from worker consumption

General wastewater from worker consumption will be around 240 cu.m./day (calculated from 80% of consumption rate at 100 liters/day x number of maximum construction workers around 3,000 persons, Kriangsak Udomsinroj, 2550). By which; the project has assigned subcontractors to provide sanitary toilets for workers which is using Septic Tank for preliminary treatment before sending to eliminated by an authorized organization.

2) Wastewater from construction

Wastewater from construction (equipment washing) will be around 50 cu.m./day

Table 2.10.3-1

Wastewater source and management during construction period

Type	Amount (m^3/ day)	Measure/treatment system	Elimination
General wastewater from worker consumption [1/]	240	- Providing sanitary toilets sufficiently according to related laws	Treated by Septic Tank, by which; top part of clear water will be sent to holding pond before using as water for plantation
Wastewater from construction	50	Holding pond	Sedimentation in a retention pond, by which; clear water which is used for plantation must be tested as mentioned in the Ministry of Industry Promulgation 2nd Issued (B.E. 2539) about Wastewater Quality Before Discharging from the Factory

Remarks: [1/]Calculated from maximum number of construction workers at 3,000 person/day without overnight staying in the construction site

(2) Operation period

1) Wastewater source, amount, and management

Wastewater of the project is separated to 3 parts which are 1) wastewater from staff consumption, 2) wastewater from manufacturing (cooling tower and boiler), and 3) oil contamination rain water. Majority of wastewater is from the cooling tower. In case of natural gas is used as main fuel, maximum wastewater will be around 6,913 cu.m./day. That fraction of wastewater is low dirty, and the project has wastewater holding pond for quality checking to follow wastewater quality standard before discharging to the Maeklong River.

Sources and amount of wastewater from various activities and management are summarized in **the table 2.10.3-2, and the figure 2.10.3-1** as described by;

(a) Wastewater from staff consumption

a) wastewater from toilet which is around 10 cu.m./day will be sent to an On-Site Package Sanitary Treatment Tank using Anaerobic Treatment System (installed in all buildings), before sending to a Wastewater Holding Pond of the project,

b) wastewater from general consumption which is around 20 cu.m./day will be sent to a Wastewater Holding Pond of the project,

(b) wastewater from manufacturing consists of 2 parts which are

a) Discharging water from the Cooling Water Blowdown which is around 6,836 cu.m./day will be kept in the bottom part of the cooling tower (Cooling Tower basin) that is used as collecting pond for discharging water from the cooling tower to reduce temperature at least 1 day. Then, it will be sent to combine with wastewater from other parts at 2 units of Wastewater Holding Pond, by which; each pond has capacity to keep wastewater at least 1 day including emergency case. The ponds have Online Monitoring Device to monitor wastewater quality continuously for checking temperature, pH, and conductivity (for assessing total dissolved solid),

b) discharging water from boiler which is around 192 cu.m./day is reused in the cooling system,

Table 2.10.3-2

Summarization on the project's waste water source, amount, and management

Source	Highest Amount (m^3/ day)	Management
(1) wastewater from staff consumption		
1) Toilet	10	Wastewater from toilet is collected to Septic tanks (installed in all buildings), before sending to a Wastewater Holding Pond
2) From general consumption	20	Sending to the Holding Pond
(2) wastewater from manufacturing		
1) discharging water from the cooling tower	6,836	Collected and sent to the Wastewater Holding Pond
2) discharging water from boiler	(192)	Reusing in the Cooling System
(3) wastewater from manufacturing assistant system		
1) discharging water from chemical laboratory	5	Wastewater quality checking before sending to the Wastewater Holding Pond
2) wastewater from demineralization system	(100)	Collecting and sending to preliminary wastewater treatment system
3) wastewater from other activities such as surcharging water in water quality sampling	(121)	Reusing in the Cooling System
(4) Oil contaminated rain water	92	Sending to oil separation pond before sending separated rainwater to a retention pond, while; removing oil is sent for elimination by an authorized organization
Combined wastewater to wastewater holding pond	6,963	Some fraction of quality checking wastewater which is around 50 cu.m./day will be used for plantation
Plantation	50	Using as plantation water
Combined discharging water to the Maeklong River	6,913	Performing water quality checking in the Maeklong River every 6 months

Remarks: ( ) Not be considered as wastewater due to reusing in the cooling tower

Source : Hin Kong Power Co.,Ltd 2563

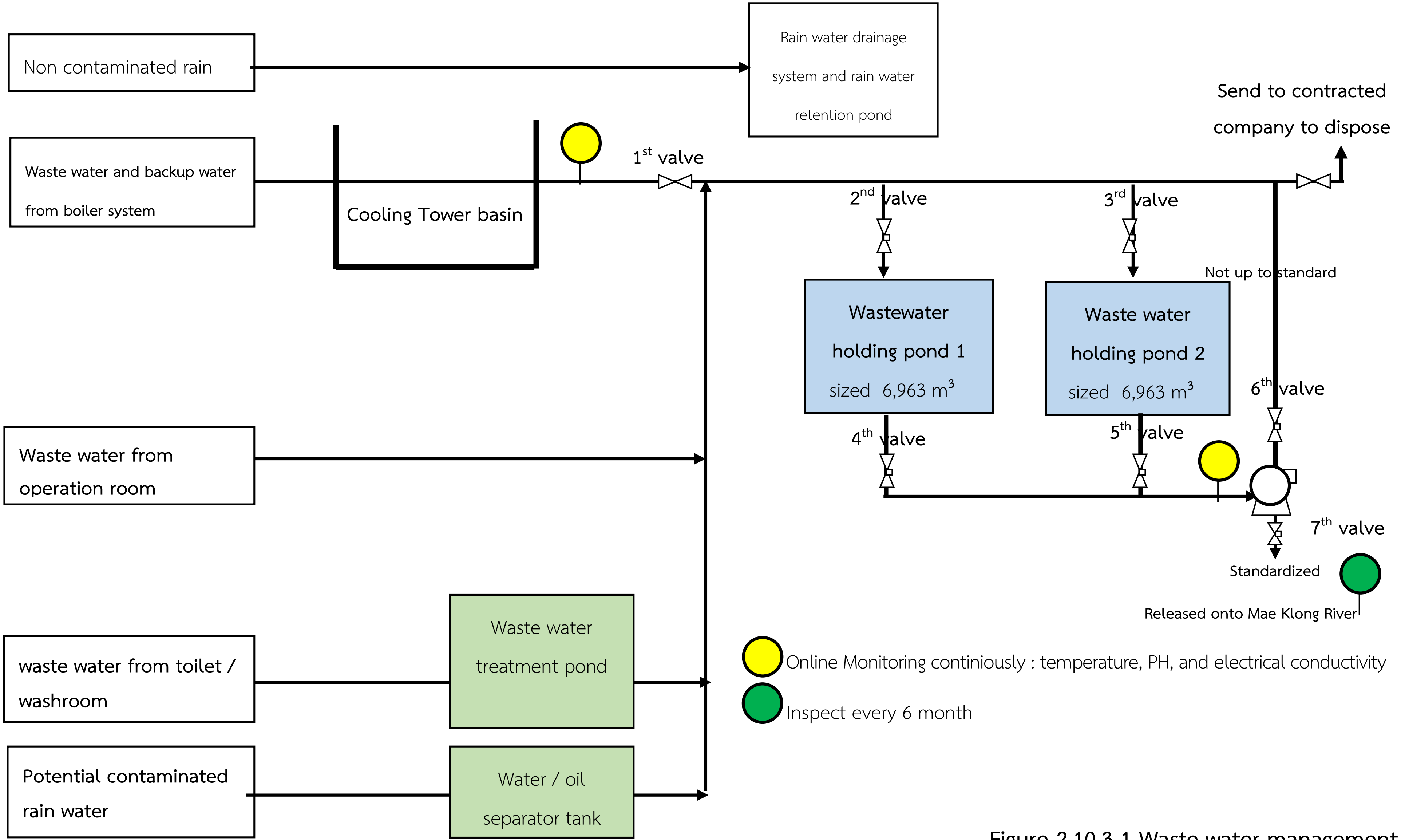


Figure 2.10.3-1 Waste water management

(c) wastewater from manufacturing assistant system consists of 3 parts which are;

a) discharging water from chemical laboratory which is around 5 cu.m./day will be sent to water quality monitoring pond before sending to the Wastewater Holding Pond,

b) wastewater from demineralization system which is around 100 cu.m./day will be sent to a preliminary wastewater treatment system,

c) wastewater from other activities such as surcharging water in water quality sampling which is around 121 cu.m./day will be reused,

(d) Oil contaminated rain water

Oil contaminated rain water which is around 92 cu.m. will be sent to oil separation pond before sending separated rainwater to a retention pond, while; removing oil is sent for elimination by an authorized organization.

2) Wastewater collection and elimination system

Wastewater treatment system of the project for consumption wastewater will use Septic tanks (installed in all buildings) for water treatment, before sending to a Wastewater Holding Pond. Pipeline installation for wastewater treatment of the project is shown in **the figure 2.10.3-3.** By which; wastewater from each activity after preliminary treatment is collected in the Holding Pond (as shown in **the figure 2.10.3-4**). The project had designed by using 2 ponds which are covering by HDPE to collect wastewater at least 1 day of 1 pond, while another pond is used as an Emergency pond. Wastewater management of the project is described by (the figure **2.10.3-1) ;**

- wastewater holding pond and emergency pond: discharging water from the Cooling Water Blowdown will be kept in the bottom part of the cooling tower (Cooling Tower basin) which is a concrete pond used for collecting discharging water from the cooling tower and reducing temperature at least 1 day. The system has Online Monitoring System for testing wastewater quality before discharging to 2 units of the Wastewater Holding Pond. The ponds are covered with HDPE to collect wastewater at least 1 day by using one pond for operation, while another pond is used for emergency case (Emergency pond). The ponds have Online Monitoring Device to monitor wastewater quality continuously for checking temperature, pH, and conductivity (for assessing total dissolved solid) to comply with related laws before discharging to the Maeklong River.

- Control valve: Main valve is the 1st valve used for shutdown discharging pipe when water quality from the cooling tower exceeding standard. The 2nd, and 3rd valves are used for controlling wastewater to the 1st, and 2nd Holding Ponds. While, the 4th, and 5th valves are used for releasing water from the ponds after water quality is follow water quality standard. The 6th valve is used for sending wastewater to the 2nd wastewater holding pond if water quality is exceeding the standard of the DIW promulgation. The 7th valve is used to control discharging water from the cooling tower for releasing to the Maeklong River when water quality is following the standard of the DIW promulgation.

According to wastewater pipeline of the TECO is very old, the project had considered to replace wastewater pipeline system along the roadside and irrigation canals. The new wastewater pipeline has diameter of 12 inches which is installed parallel to raw water pipeline of the project at level of 1.5-5 m. underground. The project uses 3 methods for installing pipeline which are surface soil removal, Horizontal Directional Drilling (HDD), and steel frame installation. Method selection depends on surrounding condition, by which; the project had considered a proper method for each area. Pipeline installation requires uninstalling pipeline system of the TECO power plant. Pipeline installation could be performed for 50 m./day by using 2 operation teams which are working together. The project had asked for permission from authorized organizations already (pipeline installation details are shown in the appen**dix 2-4**).

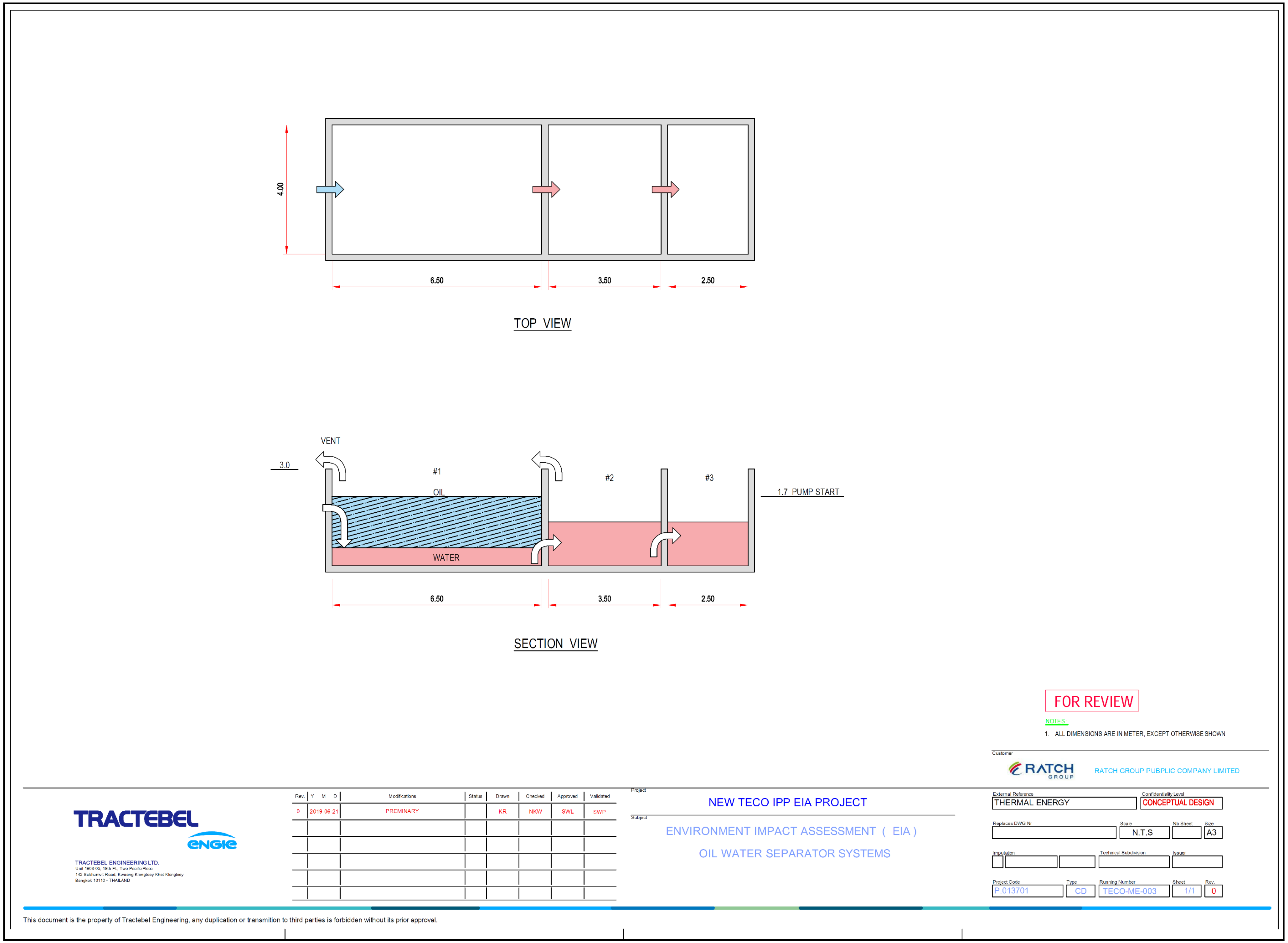


Figure 2.10.3-2 Section View of oil-water seperator

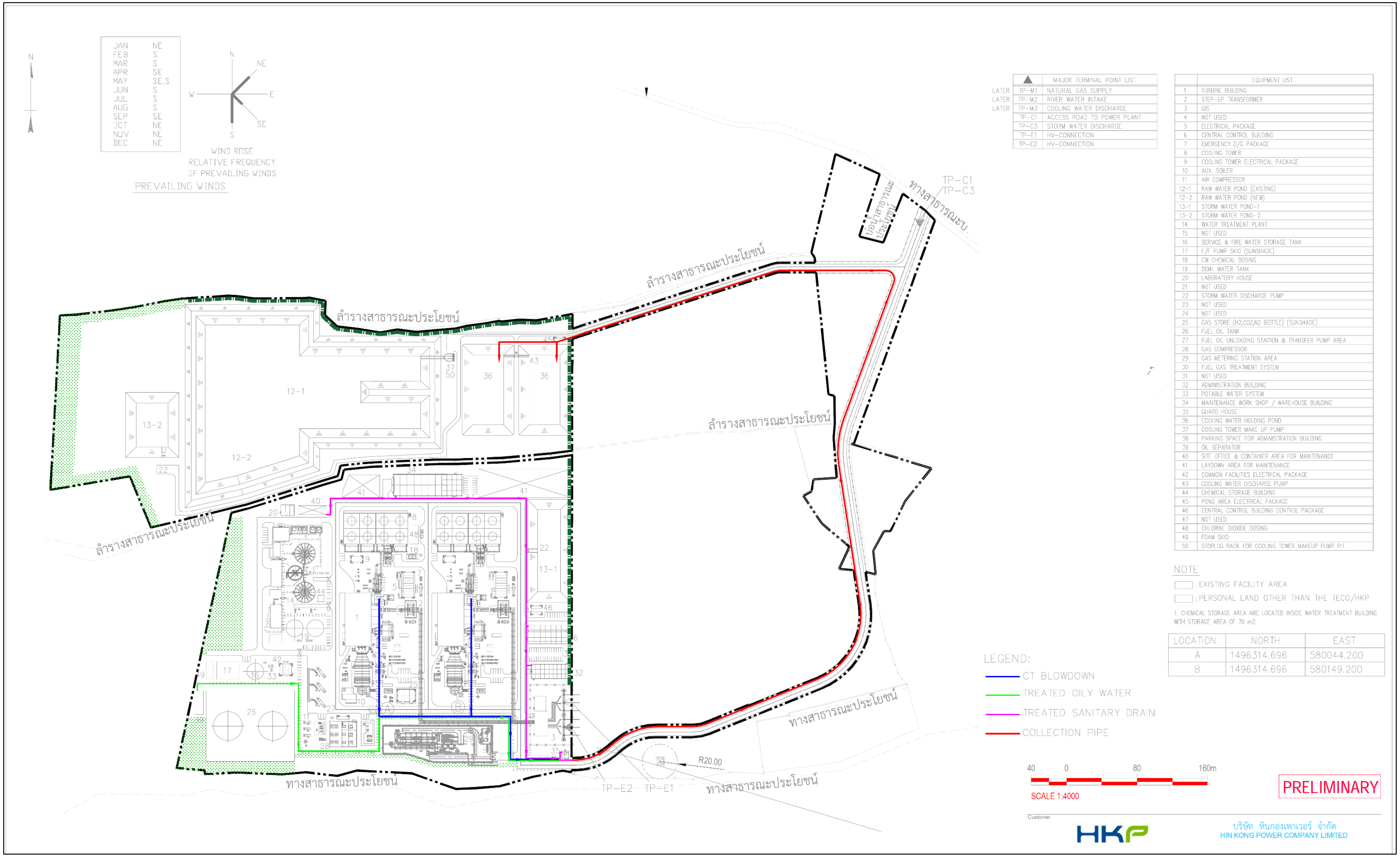


Figure 2.10.3-3 Characteristics of the area and wastewater pipeline system

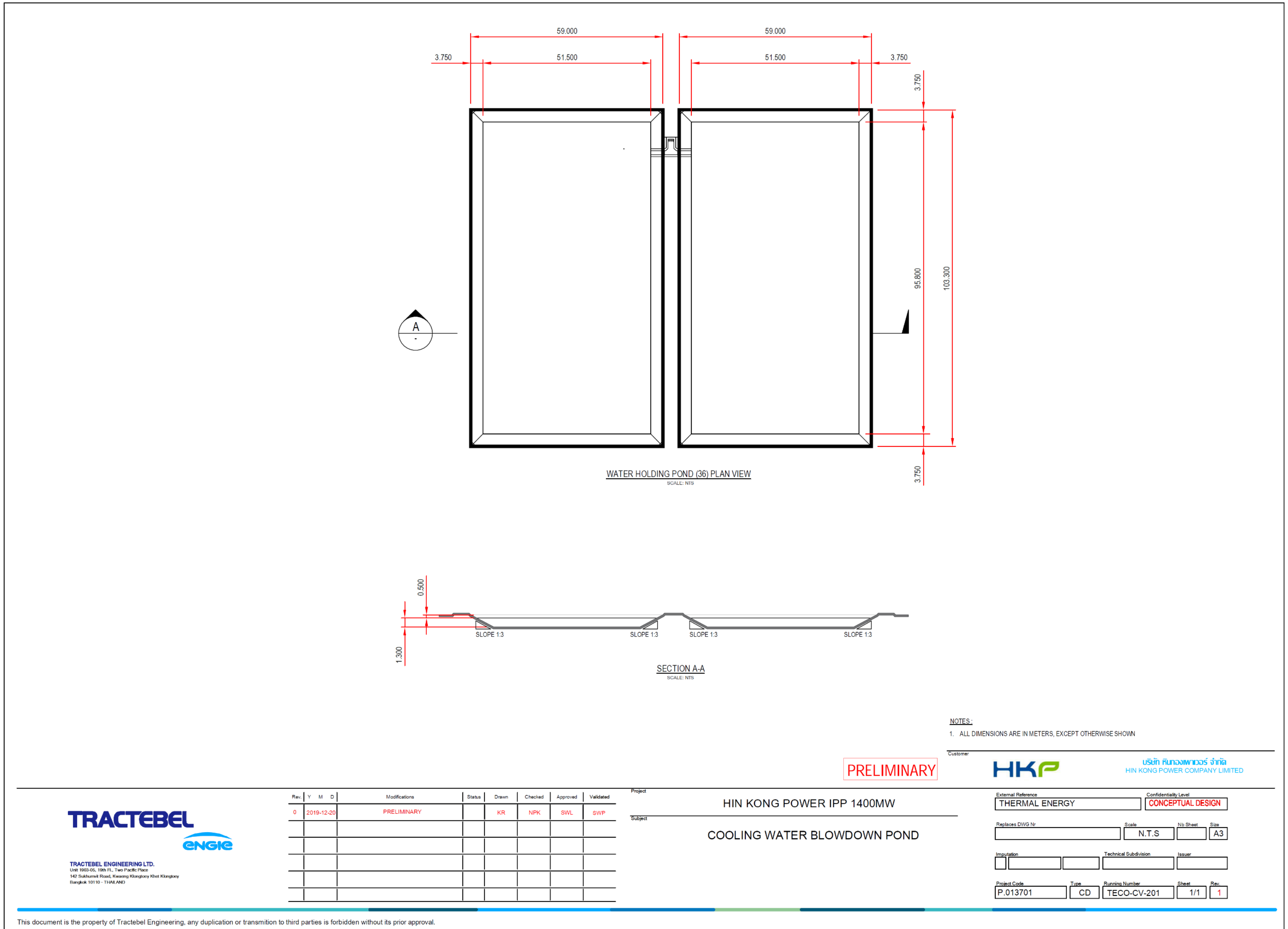


Figure 2.10.3-4 Design of the project's water holding pond

2.10.4 Waste and management

(1) construction period

Waste and garbage from construction period are separated to 2 types which are;

1) Waste generated from worker consumption such as food residues, and plastic bags which has maximum load around 3,000 kg/day (calculated from average waste generation around 1 kg/person/day). The project will provide 200 liters waste bin with lid covering for maintaining waste according to related laws, and

2) Waste generated from construction activity, by which; some waste could be recycled such as iron pieces, woods, and bricks which are kept in the area for selling as recycling waste.

All waste types are separated in the providing waste storage area properly. The project will assign authorized company to eliminate waste daily according to waste type as shown in **the table 2.10.4-1.**

Table 2.10.4-1
Material leftovers and wastes from construction

Waste type	Container	Method/Elimination organizations
1. Office waste	Black bags	Sending to local authorized organizations for elimination
2. Iron piece	Iron piece pile	Selling to Local Recycle Retailers (Issuing in the contract for selling by subcontractors)
3. Cement waste	Stock pile	Subcontractors have to remove from the area (issuing in the contracts)
4. Woods	Stock pile	Selling to Local Recycle Retailers (Issuing in the contract for selling by subcontractors)
5. Oil contamination waste (remaining fuel oil from pipeline washing)	200 liters waste bin	Subcontractors have to send to authorized organizations from the DIW for elimination

(2) Operation

Waste generated during operation is classified to 2 types which are office and staff waste, and Manufacturing waste. Details of waste elimination are summarized in **the table 2.10.4-2.**

1) office and staff waste

Those waste are gemerated from office operation and staff consumption, by which; majority of the waste is paper piece, residue material, and food residues which is approximately 68 kg/day (calculated from average waste generation of 1.1 kg/person/day from 60 staffs). Recyclable waste will be collected for selling, while non recycle waste will be kept in proper containers and sent for elimination by local authorized organization daily.

Unwanted material will be managed under related laws such as Public Health Act. B.E. 2535 without any impact to health and environment, by which; the project will assign authorized organizations for elimination properly.

2) Manufacturing waste

Waste generated from manufacturing is those waste under the Ministry of Industry Promulgation B.E. 2548 which is require permission before transportation. The waste is;

(a) Non Hazardous Wastes

Such as sludges from wastewater treatment system, deteriorate resin from Ion Exchange System, and used activated carbon,

(b) Hazardous Wastes

Such as used lubricants from manufacturing, oil contamination air filter of Gas Turbine, and filter from Reverse Osmosis.

Those manufacturing waste will be collected in the waste storage building which is separated properly for sending to eliminated by authorized organizations.

Table 2.10.4-2

Type of waste, waste amount, and waste management during operation period

Source	Waste code and type of waste[1/]	Amount	Container	Storage area	Eliomination method
1. **General waste**	- Does not counted as hazardous waste, but classified as waste under the Public Health Act. (2nd Issued) B.E. 2550	68 kg per day 24.8 ton / year	Plastic bin according to waste type	Waste storage building	- sending to eliminated by authorized organizations
2. **Industrial waste**					
2.1 Unused material - Water filter - Air filter	 - 19 09 05 (saturated or spent ion exchange resins) (HM) - 19 09 99 (wastes not otherwise specified) (HM)	 60 pieces / 5 years 1,600 pieces / year	Plastic bin or 200 liters bin	Waste storage building	- sending to authorized organizations from the DIW for elimination
2.2 Used lubricants from mentainance or oil contamination from separate equipment (including used oil and grease)	- 13 02 08 (engine oil, gear oil, and lubricants) (HA) - 13 05 06 (separated oil from oil-water separation system) (HA)	800 L /month	Used oil bin (200 liters bin) inside concrete barrier	Waste storage building	- sending to authorized organizations from the DIW for elimination
2.4 Sludge from water quality treatment system	- 19 09 02 (sludge from purifying system) (Non-haz)	401.5 ton / year	Iron barrier	Purify water building	- sending to authorized organizations from the DIW for elimination

Remark: [1/] code and type of waste from the project
non-haz: non-hazardous waste
HA: Hazardous waste – Absolute entry waste without concentration consideration
HM: Hazardous waste – Mirror entry or potentially hazardous waste after proving

2.11 Occupational health and safety

2.11.1 Safety management

(1) Occupational health and safety policy

The project had assigned occupational health and safety policy by;

1) Environment, and occupational health and safety is the main responsibility of the business,

2) Everybody has responsible for themselves, co-workers, visitors, communities, and environment,

3) Working safely, protect environment, and follow company rules accrding to related laws,

4) Staffs, subcontractors, and visitors have right to stay in safely workplace for their lives and properties with environmental friendly. Everybody has to stop operation if the situation is not safe,

5) Promote staffs for improving occupational health and safety measures with sufficient budget for maintaining safety operation,

6) Punishing staffs who do not follow the occupational health and safety condition of the company,

7) Environmental occupational health and safety must be performed before, during, and after operation without exception,

8) Training operation staffs to concern for importance about environmental occupational health and safety for working which is including risk identification and management to reduce impact, and support sustainable resource utilization, and

9) Revising environmental occupational health and safety for improving safety measure continuously.

(2) Occupational health and safety management structure

1) Assigning occupational health and safety committee

There will be around 60 staffs after operation, therefore; the project has to employ a safety officer according to the Ministry Regulation about “Safety, Occupational Health, and Environment for Working B.E. 2549 and 2553”. Furthermore, the project has to employ a safety officer professional level to work for;

(a) Considering occupational health and safety policies and plans for both inside and outside workplace to avoid accidents nor danger including illness according to working or unsafe operation to offer to an employer,

(b) Reporting revision measures or guidelines for improving occupational health and safety measures to employer according to related laws or standards for maintaining safety operation for both employees, suncontractors, and visitors who are entering the workplace,

(c) Promotion and support safety operation in the workplace,

(d) Consideration regulation and manual according to article 3 in the Ministry Regulation (article 3 employer has to set up safety regulation and manual in a workplace) including safety operation standard in the workplace to offer to an employer,

(e) Surveying and recording safety operation including accidental statistic in a workplace monthly,

(f) Consideration project or training plan for safety operation including safety responsibility training plan to offer to an employer,

(g) Making reporting system for unsafe operation for all employees to follow,

(h) Monitoring safety issues which are offered to an employer,

(i) Reporting yearly operation including problems, threats, and suggestions about committee operation to offer to an employer at the end of each year,

(j) Assessing safety operation results in a workplace, and

(k) Working for other safety operation according to employer opinions.

Furthermore, occupational health and safety committee will be working in the position for 2 years which coukld be re-selected for the next round.

2) Assigning safety officer

The project has to employ a safety officer according to the Ministry Regulation about "Safety, Occupational Health, and Environment for Working B.E. 2549" or changing by other laws. The regulation enforces those entrepreneurs to have safety officer at least 3 levels (for entrepreneur who has staff more than 50 persons; this project has 60 staffs) which are;

(a) safety officer supervisor level,

(b) safety officer high technical level, and

(c) safety officer executive level.

(3) Occupational health, safety, and environment plan

The project had set up a yearly occupational health and safety plan by;

1) Method operation for electricity danger area,
2) Chemical transportation method,
3) Working in risk area,
4) Fire protection equipment usage,
5) Safety monitoring in factory, and
6) Training according to fire protection plan.

2.11.2 Safety operation

The project aims to follow related occupational health, safety, and environment regulations by;

(1) Construction period

The project takes responsibility for all related safety activities inside the project area including responsibility to public safety according to project operation for both project area and surrounding area. An operation support operation confidence about welfare and hygine measures which are related to domestic regulations and laws during construction period. By which; the project will apply occupational health and safety management plan to set up occupational health and safety regulation for using as operation standard for subcontractors.

Danger situation prevention measure during construction period are;

1) PPE

- Providing proper PPE according to construction type such as safety helmet, safety shoes, safety gloves, safety glasses, ears plugs, and ears muffs, by which; the project will monitor safety PPE usage strictly, and
- Providing first aid equipment including patient car to transport injury person to hospital immediately.

2) Maintaining construction area

- Separating construction area by dividing to construction site, equipment storage area, material storage area, and unused material area,
- Installing fence or barrier with construction boundary labelling around the construction area,

- Providing safety tools such as falling support net, material support sheet, and light during nighttime,
- Installing warning signs around the construction area such as "safety operation", "danger area", or "beware falling material", and
- Assigning security staffs for safety maintaining over 24 hours at the entrance area to support safety and traffic operations.

(2) operation period

The project had designed fire protection system according to international standard of the National Fire Protection Association (NFPA) and orther standard regulations which are;

- Fire protection standard of the Engineering Council of Thailand,
- Ministry Regulation Issued 33rd (B.E. 2535) according to Building Control Act. B.E. 2522,
- Ministry of Interior about Fire Protection and Prevention in an Entrepreneur for Maintaining safety for employees B.E. 2534, and
- Ministry of Industry Promulgation about Fire Protection in Factory B.E. 2552.

(1) Fire protection equipment

Details of number and area of fire protection equipment of the project are shown in **the table 2.11.2-1.** The project will install fire protection equipment according to international standards and related laws by;

1) Installing fire warning signal system which is consist of Heat Detector, Smoke Detector, and Flame Detector to all buildings and risk areas,

2) Fire protection equipment are;

(a) Fire Hydrant, and Fire Hose which are installed over entire project area,

(b) Portable Fire Extinguisher which is compose of CO_2 type, Dry Chemical type, and Non CFC type according to fire situation in each area,

(c) Automatic CO_2 fire protection equipment at gas turbine using automatic detection device, and

(d) Portable foam fire extinguisher at the gas turbine building.

Fire warning signal system, and fire protection equipment installation area are shown in **the figure 2.11.2-1** which clude be summarized by **the figure 2.11.2-2.**

Table 2.11.2-1

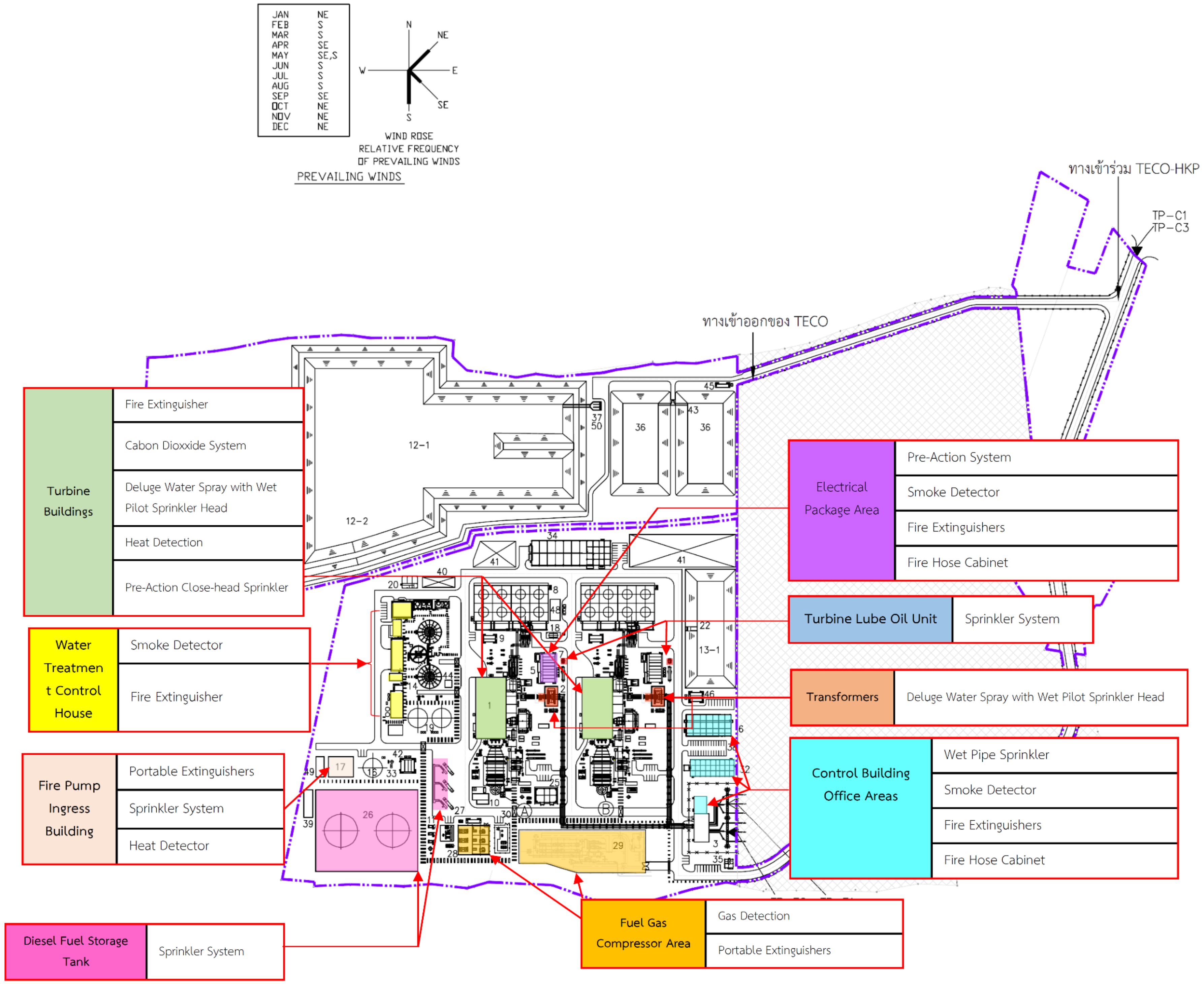
Equipment for fire protection and prevention

Table 2.11.2-1 (cont)

Area	Fire Protection System	Operation System	Amount (set)	Principle	International Standard Model	Thailand Standard Model
Control Buildings						
Control Building Office Areas	• Pre-Action System	- Automatic	60	- Hydrant system installation according to related standards	- NFPA 13 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
	• Smoke Detection	- Automatic	20	- Installation at ceiling height less than 10.5 m. with detection distance less than 9 m.	- NFPA 72 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
	• Fire Extinguishers; CO_2 and Dry chemical types	- Manual	10	- Installing at a proper area and those computers, machine, and pumps installation rooms	- NFPA 10	- Royal Patronage Engineering Insitution of Thailand
	• Fire Hose Cabinet	- Manual	2 sets per floor	- Installing at a proper area and convenience to use	- NFPA 24	- Royal Patronage Engineering Insitution of Thailand
Toilet	• Smoke Detection	- Automatic	2	- Installation at ceiling height less than 10.5 m. with detection distance less than 9 m.	- NFPA 72 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
Computer server room	• Smoke Detection	- Automatic	1	- Installation at ceiling height less than 10.5 m. with detection distance less than 9 m.	- NFPA 72 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
	• Fire Extinguishers	- Manual	1	- Installing at a proper area and those computers, machine, and pumps installation rooms	- NFPA 10 -	- Royal Patronage Engineering Insitution of Thailand
Electrical Package Area						
Electrical control building	• Smoke Detector	- Automatic	2 sets/production unit	- Installation at ceiling height less than 10.5 m. with detection distance less than 9 m.	- NFPA 72 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
	• Fire Hose Cabinet	- Manual	2 sets per floor	- Installing at a proper area and convenience to use	- NFPA 24	- Royal Patronage Engineering Insitution of Thailand
	• Fire Extinguishers; CO_2 type	- Manual	2	- Installing at a proper area and those computers, machine, and pumps installation rooms	- NFPA 10	- Royal Patronage Engineering Insitution of Thailand
Turbine Buildings						
Gas turbine and steam room	• Fire Extinguishers; CO_2 type	- Manual	10 sets/production unit	- Installing at a proper area and those computers, machine, and pumps installation rooms	- NFPA 10	
	• Carbon Dioxide System	- Automatic	4 sets/production unit	- Installing isde gas turbine	- NFPA12	-
Turbine Lube Oil Unit	• Deluge Water Spray with Wet-Pilot Sprinkle Head	- Automatic	4 sets/production unit	- Installing inside steam turbine	- NFPA 15 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
Generator Bearings	• Heat Detection	- Automatic	2 sets/production unit	- Installation at ceiling height less than 4 m. with detection distance over horizontal platform less than 7.2 m. and walking area less than 9.5 m.	- NFPA 72 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
	• Pre-Action Close-head Sprinkler	- Automatic	4 sets/production unit	-	- NFPA 13 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand

Table 2.11.2-1 (cont)

Area	Fire Protection System	Operation System	Amount (set)	Principle	International Standard Model	Thailand Standard Model
Fuel Gas Compressor Area						
Gas Compressor	• Gas Detection	- Automatic	4	- Installation at ceiling height less than 4 m. with detection distance over horizontal platform less than 7.2 m. and walking area less than 9.5 m.	- NFPA 72 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
	• Portable Extinguishers	- Manual	4	- Installing at a proper area and those computers, machine, and pumps installation rooms	- NFPA 10	- Royal Patronage Engineering Insitution of Thailand
Electrical equipment room	• Smoke Detection	- Automatic	6	- Installation at ceiling height less than 10.5 m. with detection distance less than 9 m.	- NFPA 72 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
	• Portable Extinguishers	- Manual	2	- Installing at a proper area and those computers, machine, and pumps installation rooms	-	-
	• Fire Hose Cabinet	- Manual	1 set per room	- Installing at a proper area and convenience to use	-	-
Water Treatment Control House						
Control room	• Smoke Detection	- Automatic	4	- Installation at ceiling height less than 10.5 m. with detection distance less than 9 m.	- NFPA 72 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
	• Portable Extinguishers	- Manual	2	- Installing at a proper area and those computers, machine, and pumps installation rooms	- NFPA 10	-
500 kV Switchyard Control Building						
Electrical and electronic control room	• Smoke Detection	- Automatic	4	- Installation at ceiling height less than 10.5 m. with detection distance less than 9 m.	- NFPA 72 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
	• Portable Extinguishers	- Manual	2	- Installing at a proper area and those computers, machine, and pumps installation rooms	- NFPA 10	- Royal Patronage Engineering Insitution of Thailand
Transformers						
Step-up Transformers	Deluge Water Spray with Wet Pilot Sprinkler Head	- Automatic	60 sets/production unit	- Water spraying installation according to related standards	- NFPA 15 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand
Unit Transformers	Deluge Water Spray with Wet Pilot Sprinkler Head	- Automatic	20 sets/production unit	- Water spraying installation according to related standards	- NFPA 15 - NFPA 850	- Royal Patronage Engineering Insitution of Thailand



	EQUIPMENT LIST
1	TURBINE BUILDING
2	STEP-UP TRANSFORMER
3	GIS
4	NOT USED
5	ELECTRICAL PACKAGE
6	CENTRAL CONTROL BUILDING
7	EMERGENCY D/G PACKAGE
8	COOLING TOWER
9	COOLING TOWER ELECTRICAL PACKAGE
10	AUX. BOILER
11	AIR COMPRESSOR
12-1	RAW WATER POND (EXISTING)
12-2	RAW WATER POND (NEW)
13-1	STORM WATER POND-1
13-2	STORM WATER POND-2
14	WATER TREATMENT PLANT
15	NOT USED
16	SERVICE & FIRE WATER STORAGE TANK
17	F/F PUMP SKID (SUNSHADE)
18	CW CHEMICAL DOSING
19	DEMI. WATER TANK
20	LABORATORY HOUSE
21	NOT USED
22	STORM WATER DISCHARGE PUMP
23	NOT USED
24	NOT USED
25	GAS STORE (H2,CO2,N2 BOTTLE) (SUNSHADE)
26	FUEL OIL TANK
27	FUEL OIL UNLOADING STAITION & TRANSFER PUMP AREA
28	GAS COMPRESSOR
29	GAS METERING STATION AREA
30	FUEL GAS TREATMENT SYSTEM
31	NOT USED
32	ADMINISTRATION BUILDING
33	POTABLE WATER SYSTEM
34	MAINTENANCE WORK SHOP / WAREHOUSE BUILDING
35	GUARD HOUSE
36	COOLING WATER HOLDING POND
37	COOLING TOWER MAKE UP PUMP
38	PARKING SPACE FOR ADMINISTRATION BUILDING
39	OIL SEPARATOR
40	SITE OFFICE & CONTAINER AREA FOR MAINTENANCE
41	LAYDOWN AREA FOR MAINTENANCE
42	COMMON FACILITIES ELECTRICAL PACKAGE
43	COOLING WATER DISCHARGE PUMP
44	CHEMICAL STORAGE BUILDING
45	POND AREA ELECTRICAL PACKAGE
46	CENTRAL CONTROL BUILDING CONTROL PACKAGE
47	NOT USED
48	CHLORINE DIOXIDE DOSING
49	FOAM SKID
50	STOPLOG RACK FOR COOLING TOWER MAKEUP PUMP PIT

Figure 2.11.2-1 Project's fire protection system

Remark:

Emergency Solution Radius

Location Fire Water Pump installment

Location of auxiliary water tank used for quelling the fire

Assembly Point

	EQUIPMENT LIST
1	TURBINE BUILDING
2	STEP-UP TRANSFORMER
3	GIS
4	NOT USED
5	ELECTRICAL PACKAGE
6	CENTRAL CONTROL BUILDING
7	EMERGENCY D/G PACKAGE
8	COOLING TOWER
9	COOLING TOWER ELECTRICAL PACKAGE
10	AUX. BOILER
11	AIR COMPRESSOR
12-1	RAW WATER POND (EXISTING)
12-2	RAW WATER POND (NEW)
13-1	STORM WATER POND-1
13-2	STORM WATER POND-2
14	WATER TREATMENT PLANT
15	NOT USED
16	SERVICE & FIRE WATER STORAGE TANK
17	F/F PUMP SKID (SUNSHADE)
18	CW CHEMICAL DOSING
19	DEMI. WATER TANK
20	LABORATORY HOUSE
21	NOT USED
22	STORM WATER DISCHARGE PUMP
23	NOT USED
24	NOT USED
25	GAS STORE (H2,CO2,N2 BOTTLE) (SUNSHADE)
26	FUEL OIL TANK
27	FUEL OIL UNLOADING STAITION & TRANSFER PUMP AREA
28	GAS COMPRESSOR
29	GAS METERING STATION AREA
30	FUEL GAS TREATMENT SYSTEM
31	NOT USED
32	ADMINISTRATION BUILDING
33	POTABLE WATER SYSTEM
34	MAINTENANCE WORK SHOP / WAREHOUSE BUILDING
35	GUARD HOUSE
36	COOLING WATER HOLDING POND
37	COOLING TOWER MAKE UP PUMP
38	PARKING SPACE FOR ADMINISTRATION BUILDING
39	OIL SEPARATOR
40	SITE OFFICE & CONTAINER AREA FOR MAINTENANCE
41	LAYDOWN AREA FOR MAINTENANCE
42	COMMON FACILITIES ELECTRICAL PACKAGE
43	COOLING WATER DISCHARGE PUMP
44	CHEMICAL STORAGE BUILDING
45	POND AREA ELECTRICAL PACKAGE
46	CENTRAL CONTROL BUILDING CONTROL PACKAGE
47	NOT USED
48	CHLORINE DIOXIDE DOSING
49	FOAM SKID
50	STOPLOG RACK FOR COOLING TOWER MAKEUP PUMP PIT

Figure 2.11.2-2 Project's Location of Fire Fighting System

3) Hydrant system of the project

(a) Fire protection pump

Fire protection pump of the project using Water Fire Pump according to the NFPA 20 which is consist of;

- 1 unit of A/C Main Water Fire Pump with capacity of 3,000 gallons/min, pressure around 90 m. water, and driving force around 250 kW,
- 1 unit of Diesel Water Fire Pump with capacity of 4,000 gallons/min pressure around 90 m. water, and driving force around 250 kW, and
- 1 unit of Jockey Pump with capacity of 50 gallons/min, pressure around 90 m. water, and driving force around 5 kW.

(b) Auxilialy fire protection tank

The project had designed to use Service/Fire Water Storage Tank as auxilialy fire protection tank with capacity around 3,191 cu.m. An operation is separated to 2 patterns which are using water from the top part of the Service/Fire Water Storage Tank as processing water, and water from the bottompart as fire protection water. However, the project had designed to has an auxiliary tank with capacity of at least 1,832 cu.m. for using in an emergency case according to fire prevention calculation which is exceeding threshold value of related laws. Those water could be used for 2 hours (calculated from fire fighting pump rate around 4,000 gallons/min which is containing raw awter around 1,817 cu.m.). Calculation detail was shown in the **appendix 2-11**

2.11.3 Personal Protective Equipment

The project has assigned all staff who are working in risk areas to use proper Personal Protective Equipment, by which details were shown in **the table 2.11.3-1.**

Furthermore, the project also has installed warning signs with campaigns for those staffs to concern about using Personal Protective Equipment including monitoring of the Personal Protective Equipment sufficiency according to work types.

Table 2.11.3-1

Protection equipments in different operation areas

Operation area	Personal Protective Equipment
1. Manufacturing	- Helmet, Safety shoes, Ear Plug, Ear Muff, and Safety glasses
2. Mentainance	- Helmet, Safety shoes, Safety glasses, leather gloves, and Ear Plug
3. Chemical operation	- Chemical protection glasses, Chemical protection uniform, face shield, Chemical protection gloves, Rubber boots, and Chemical protection mask

Remarks: Basic Personal Protective Equipment are those Safety helmet, and Safety shoes, while other Personal Protective Equipment are provided according to operation types.

2.11.4 Emergency plan

(1) Emergency specification and responsing preparation for emergency cases

1) Emergency specification and responsing preparation for emergency cases by section heads to characterize cause of emergency cases and environmental impacts,

2) Section head of emergency risk operation designs responsing preparation for the emergency cases by registering the plans including responsing guidelines for significant environmental impacts in an emergency list book,

(2) Readiness preparation for emergency cases

1) section heads and the safety committee have to prepare readiness operation and responsing plan by concerning about;

- suddenly operation for emergenct case,
- Prevention or mitigation for accidents and emergency cases such as waste or contaminated wastewater,
- Information channels and responsibility staffs,
- External communication channels in case of helping required,
- Necessary equipment for responsing the emergency cases,
- Necessary Personal Protective Equipment,
- Causes investigation and solving guidelines, and
- Reviewing operation plans after the emergency cases existed.

2) Readiness preparation for responsing those emergency cases are;

- Preparation plan for fire prevention,

- Preparation plan chemicals and oil leakage, and
- Preparation plan for flammable gases leakage.

3) Section head and environmental and safety staffs have to prepare necessary equipment for emergency responsing regularly,

4) Related staffs have to check necessary equipment for emergency responsing regularly according to preparation plan and emergency responsing plan, and

5) Environmental and safety staffs have to train operation staffs to concern for their duties and operation procedures for preparation plan and emergency responsing plan, particularly those revising operations.

(3) Monitoring preparation plan and emergency responsing plan

1) Safety, occupational, and environmental committee has to assign for a yearly monitoring preparation plan and emergency responsing plan, and performing the monitoring according to the plans,

2) Safety, occupational, and environmental committee has to prepare "yearly monitoring preparation plan and emergency responsing plan report" for both pre and post training with assessment report for submitting to an executive board,

(4) Emergency responsing operation

Emergency responsing operation should follow the plan article 2) (b) by the safety and environmental staff has to record Accident/Nearmiss Report and Investigation with emergency situation report for submitting to the Power Plant Manager within 7 days after the case happened.

In case of fire or explosion, the project had classified the emergency cases into 3 levels as shown in **the figure 2.11.4-1** which are described by;

<u>emergency case level 1</u>: emergency case happened inside the area including responsibility properties of the project and it could be controlled by project staffs and emergency responsing equipment inside the area or Emergency Response Team,

<u>emergency case level 2</u>: emergency case happened inside the area including responsibility properties of the project and surrounding area of the power plant which is considered by the OC for asking helping from the Emergency Response Team,

<u>emergency case level 3</u>: emergency case happened inside the area including responsibility properties of the project and surrounding areas which could not be controlled by the project staffs and it need helping from external governmental organizations (local or regional levels) for stopping the case.

In case of emergency, the project had set up an Emergency Response Team for stopping the case as shown in **the figure 2.11.4-2** as described by;

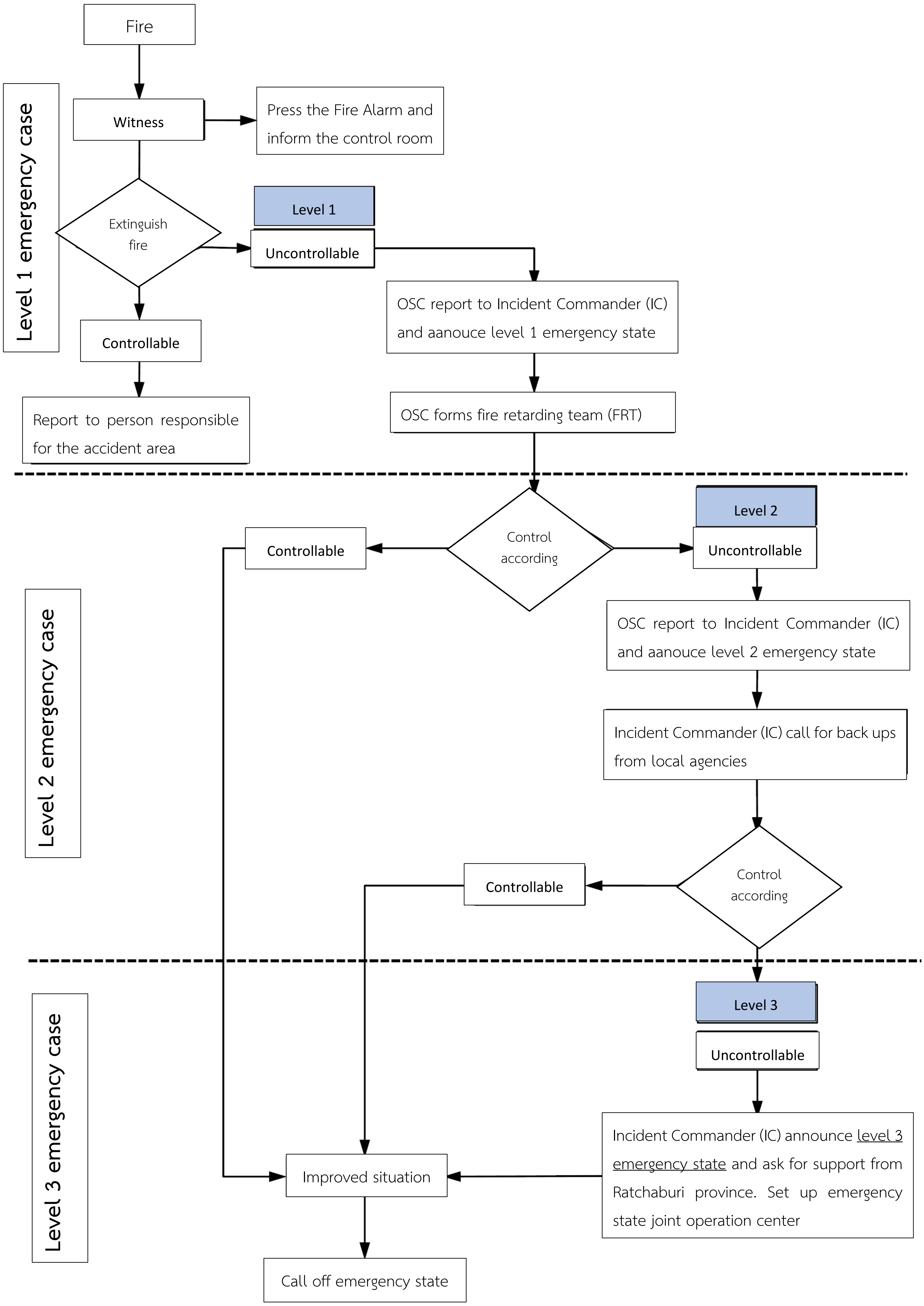


Figure 2.11.4-1 Emergency Plan of the project

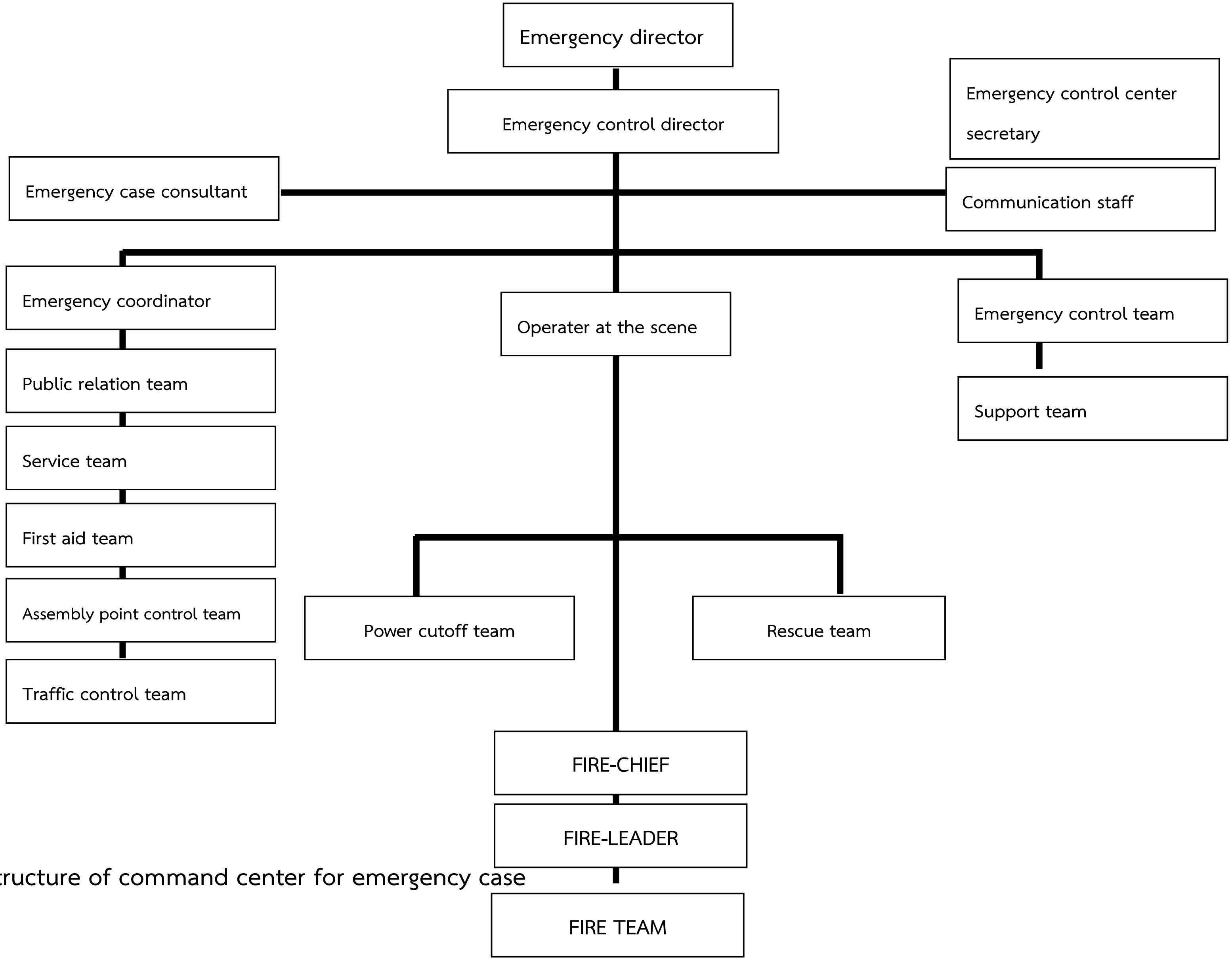


Figure 2.11.4-2 Structure of command center for emergency case

(a) Emergency Director (ED): Power Plant Manager who has the highest position when emergency case happened has to work by

- **Before emergency situation, ED** has to assign emergency operation guidelines for maintaining emergency response efficiency and support related activities for controlling emergency cases,
- **During emergency situation, ED** has to command for controlling emergency situation at the emergency response center including communication with related organizations for controlling the emergency case, and
- **After emergency situation, ED** has to investigate causes of the emergency case for reporting to an executive board for communication with medias, and recovery mental condition of those staffs with repairing the factory.

(b) On-scene Commander (OC): Manufacturing manager who is assigned by ED to work for;

- **Before emergency situation,** OC has to control the safety operation of the factory and preparing emergency response center including emergency response equipment,
- **During emergency situation,** OC has to conmand for emergency responsing at the on-scene area with communication with an ED, and
- **After emergency situation,** OC has to help for investigating causes of the emergency case for reporting to an executive board, and repairing the factory.

(c) Mutual Aid Co-Ordinator (MC): Administrative and finance manager who is assigned by the ED for;

- **Before emergency situation,** MC has to control the safety operation of the factory and preparing communication system including emergency response budget,
- **During emergency situation,** MC has to work as OC for external cooperation, press conference, equipment preparation for emergency controlling including data collection for giving to the ED, and
- **After emergency situation, MC** has to help for investigating causes of the emergency case for reporting to an executive board, and recovery mental condition of those staffs with repairing the factory.

(d) First-aid and Security (FS): Safety staffs have to work by;

- **Before emergency situation,** FS have to control safety operation inside the factory, provide emergency response equipment, prepare yearly emergency response training for maintaining safety operation efficiently,
- **During emergency situation,** FS have to prepare for first-aid operation before transferring injured staffs to nearby hospitals and providing convenient operation to those security staffs for maintaining traffic condition during emergency caase, and
- **After emergency situation,** Monitoring emergency response equipment after using and revising operation plan with submitting emergency report to the EC.

(e) Emergency Responder (ER): Manufactuing head and mentainance head have responsibilities by;

- **Before emergency situation,** following safety operation and joining the safety training,
- **During emergency situation,** stopping the emergency case under commanding by the OC, and
- **After emergency situation,** assisting for factory repairing.

(f) Emergency Responder & Rescue (ERR): Manufactuing staffs and mentainance staffs have responsibilities by;

- **Before emergency situation,** following safety operation and joining the safety training,
- **During emergency situation,** stopping the emergency case under commanding by the ER including finding those victims, and
- **After emergency situation,** assisting for factory repairing.

(g) Subcontractor staffs

- **Before emergency situation,** following safety operation and joining the safety training,
- **During emergency situation,** incase of being in the area, those staffs have to stop the emergency case and reporting to the emergency response center. If those staffs are not being in the emergency area, those staffs have to relocated to the Assembly Point and reporting missing person to the OC for finding them, and
- **After emergency situation,** working by their duties.

External communication to ask for helping will be conducted after operation by providing emergency call number for related persons to use easily.

5) Guideline for reporting accidental cases or nearmiss event

(a) In case of accident which has injury person, first aid will be performed immediately and sending injury person to nearby hospital by informing operation unit of the injury person (medical treatment form for injury person must be included in the accidental report),

(b) Event founder and head of the unit must report accidental cases or nearmiss event within 48 hours after the case happended, except for violent case which has violent injury person or losing properties; the case must be reported within 24 hours,

- If possible, an investigation must be performed immediately by sketching or taking photos of the accidental area to avoid evident losing,
- Recording all details of the accidental case completely,

(c) Accidental section manager has to investigate and suggest revising measures including assigning responsibility person to submit to safety and environmental staff within 1 day after receiving the report,

(d) safety and environmental staff checking a completeness of the accidental investigation report including measure revision, and assigning reporting accidental cases or nearmiss event number by starting from 001 and follows by year (No. xxx/B.E.). Then, the safety and environmental staff has to register for Accident/ Nearmiss Investigation Report Status Log,

(e) safety and environmental staff submit the report to the Power Plant Manager within 1 day,

(f) Power Plant Manager receiving the report and assigning the safety and environmental staff within 1 day to monitor the revision plan. Then, the safety and environmental staff has to copy the order to accidental section head,

(g) responsibility section head has to follow the revision measure within the assigning date,

(h) safety and environmental staff monitors the 1st revision measure result within 7 days according to the assigning date issued in the Accident/ Nearmiss Investigation Report,

(i) If the operation could not be finished within the assigning date, the safety and environmental staff has to make an appointment with the section head for perforing the 2nd monitoring,

(j) safety and environmental staff monitors the 2nd revision measure result according to the appointment date. If the operation could not be finished within the assigning date, the safety and environmental staff has to report to the safety committee in the monthly meeting for revising the measure,

(k) a completerevision of the Accident/ Nearmiss Investigation Report must be recorded by the safety and environmental staff in the Accident/Nearmiss Investigation Report Status Log by submitting original document to the Power Plant Manager for case closing permission, and using the record as accidental historical data, and

(l) In case of injury person stop working more than 3 days, the administrative section head has to submit compensation form to the safety officer for submitting the compensation form to local welfare office.

6) Emergency control center and assembly points

The project has set up an emergency control center at the control room. Inside the emergency control center, there are various types of communication equipment such as direct phone, and external fax. During nighttime, emergenct team head (shift head) could imform situation to the emergency commander (vice-manufacturing director) to khow the situation and operate as commanded by the emergency commander.

For the assembly points, there are safety locations for relocation staffs and counting number of staffs for further migration.

There are 2 assembly points of the project which are free space infront of the project area and free space nearby the wastewater retention pond (locations are shown in **the figure 2.11.2-2**).

7) Process restarting after an emergency case

Process restarting after an emergency case is depended on properties losing of the project, cleaning process, and reparing process or emergency investigation procedures. Process restarting consideration is under responsibility of the manufacturing director according to an agreement from the mechanical head, electricity head, and safety and environmental section.

Local organizations have ability to help the project for stopping emergency case. The project could ask for assistant from nearby local organizations, by which; yearly emergency response training will be performed with those local organizations, routinely. Furthermore, fire fighting equipment will be checked monthly according to the fire prevention standard and fire alarming system standard of the Council of Engineering of Thailand (C.E.T.) B.E. 2543. Potential of local organizations for stopping emergency case are described as following.

Agency	Phone number
Ratchaburi Hospital	032-719600
Ratchaburi Office of Disaster Prevention and Mitigation	032-332571-2,4
Ratchaburi Police Station	0-3232-7912
Hin Kong Subdistrict Administrative Organization	032-240261
Huai Phai Subdistrict Administrative Organization	0-3237-0415

2.12 Community relationship and complaint case receiving

(1) Community relationship

Public relation

1) Media distribution for public relation of the project will be performed to those governmental organizations in a radius of 5 to post send information related to local communities monthly. That information is job application, environmental management, problem solving, and environmental quality monitoring results,

2) Providing complaint case receiving box infront of the project, Ratchaburi District Office, and Local Administration Office in the study area, and sending staffs to collect the complaint forms 2 times/month,

3) Set up open house activity to invite local governmental organizations for both provincial, district, and subdistrict including community leadres and local peoples to visit the project and sharing opinions about project operation.

P**ublic service and community service**

The project has prepared plans and budget to support public service and community service according to their activities by;

Table 2.12-1

Public relations and mass relations plans

Activity	Details	Target Group	Objective	funds[5/] (baht)	Duration/ frequency	Operation period	Success Index
1) Pre-construction phase [1/]							
1 Public Health							
1.1 Mobile medical unit	- Establish a mobile medical unit project.	- People living nearby the project area.	- Promote community health	700,000	- 1 time for each subdistrict covering 6 subdistrict and 1 municipality	Before construction between March B.E. 2563 to May B.E. 2564	- Participants is not less than 500 people.
1.2 Prevention project	- Promote disease prevention guidelines, such as promoting exercise of the community and providing knowledge management on nutrition.	- People living nearby the project area.	- Promote community health	350,000	- Once before construction period	Before construction btween August to January	- Participants is not less than 200 people.
2 Education							
Educational support	- Study demands of schools to plan the next development. In this phase, the project will provide supports according to demands of schools in the first year.	- Schools nearby the project development area	- Develop education in the area	350,000	- At least once before construction period	Before construction btween August to January	Establishing an education plan during the construction of the project
3 Sports							
Promote traditional sports of the community	- Together with the community to create annual traditional sports project in the area.	- People living nearby the project area.	- Promote exercise - Promote community health - Build good relationships with the community	480,000	- At least once before construction period	Before construction btween August to December	- Participants is not less than 100 people.
4 Communication Relations							
4.1 Neighbor Project	- Let the community visits the power plant to enhance knowledge and understanding on the power plant operation.	- People living nearby the project area.	- Build knowledge and understanding on the power plant operation.	2,800,000	- At least 3 times before construction period	Before construction btween August to January	- Satisfaction survey have an assessment of more than 80%
4.2 Support activities and organize public relations activities with the media	- Support media activities on various occasions and arrange relations activities with the media, including support capacity building activities for local media.	- Local media	- Build knowledge and understanding on the power plant operation - Build capacity for local media - Build a good relationship	800,000	- At least once before construction period	Before construction btween August to January	- Local media participate more than 20 media

Table 2.12-1

Public relations and mass relations plans

Activity	Details	Target Group	Objective	funds[5/] (baht)	Duration/ frequency	Operation period	Success Index
5 Social Support							
5.1 Support organization activities in Ratchaburi.	- Support activities in Ratchaburi/traditional activities in the community.	Organizations in Ratchaburi/ community nearby the project	- Build a good relationship and support the social responsibility.	1,500,000	- At least 2 times before construction period	- Before construction btween January to December B.E. 2563	- Participating in or supporting provincial activities at least 2 times.
5.2 Support the organization of activities for the communities nearby the project	- Allocate budget for the community development according to the objectives of each area by establishing guidelines for budget use, establishing of community committees for each district to consider the use of the budget for the most benefit of the community as well as reporting results of using the budget.	- People living nearby the project area. - Community leaders	- Carry on the tradition - Build a good relationship - Develop community - Build a good relationship and support the community	8,500,000	- 1 time for each subdistrict covering 6 subdistrict and 1 municipality	- Before construction btween January to December B.E. 2563	- Participate in community activities of 6 sub-districts, 1 municipality - Budget report
6 Environment							
Environmental inspection of Hin Kong Power Plant	- Establish an environmental inspectorate of Hin Kong Power Plant which consists of representatives from government agencies, public, local government organization, administrative and the power plant to be responsible for verifying various information on environmental aspect since the construction of the power plant started.	- People living nearby the project area. - Community leaders - Related agencies	- Establishing a committee to provide project information	50,000	- At least 1 meeting before construction	- Before construction btween August to December	- Complete the establishment of a committee before the construction starts.
2) Construction phase [2/]							
1 Public health							
1.1 Mobile medical unit	- Establish a mobile medical unit project.	- People living nearby the project area.	- Promote community health	700,000 per year	- At least once a year covering 6 subdistrict and 1 municipality	July to December	- Participants is not less than 500 people.
1.2 Prevention project	- Promote disease prevention guidelines, such as promoting exercise of the community and providing knowledge management on nutrition.	- People living nearby the project area.	- Promote community health	350,000 per year	- At least once a year covering 6 subdistrict and 1 municipality	July to December	- Participants is not less than 200 people.

Table 2.12-1
Public relations and mass relations plans

Activity	Details	Target Group	Objective	funds[5/] (baht)	Duration/ frequency	Operation period	Success Index
2 Education							
2.1 Community development scholarships	- Collaborate with the Office of the Education and study demands of the community to provide appropriate scholarships such as grants for primary, secondary, tertiary students or as an ongoing scholarship.	- Local children, youth and students	- Increase educational opportunities - Promote education	1,000,000 per year	- All year	January to December	- Provide suitable scholarships for communities in 6 Sub districts and 1 municipality.
2.2 Teacher network for the development	- Establish a network of teachers in 6 sub-districts and 1 municipalities in order to be able to exchange knowledge and convey the benefits to the development of education in the area, including develop the knowledge and abilities of teacher personnel in the area.	- Teachers of 6 sub-districts and 1 municipality	- Develop an education in the area	500,000 per year	- Twice a year	January to June and July to December	- Organize teacher network meetings within January - June. Satisfaction survey - have an assessment of more than 80%
3 Sports							
Promote traditional sports of the community	- Together with the community to create annual traditional sports project in the area.	- People living nearby the project area.	- Promote exercise - Promote community health - Build good relationships with the community	480,000 per year	- Once a year	November	- Participants is not less than 100 people in each year.
4 Communication Relations							
4.1 Neighbor Project	- Let the community visits the power plant to enhance knowledge and understanding on the power plant operation.	- People living nearby the project area.	- Build knowledge and understanding on the power plant operation.	)50,000 per ar	- At least 3 times a year	- January to December	- Satisfaction survey have an assessment of more than 80%
4.2 Support activities and organize public relations activities with the media	- Support media activities on various occasions and arrange relations activities with the media, including support capacity building activities for local media.	- Local media	- Build knowledge and understanding on the power - plant operation Build capacity for local media	800,000 per year	- All year	- January to December	- Local media participate more than 20 media
5 Social Support							
5.1 Support organization activities in Ratchaburi.	- Support activities in Ratchaburi/traditional activities in the community.	Organizations in Ratchaburi/ community nearby the project	- Build a good relationship and support the social responsibility.	1,000,000 per year	- All year	- January to December	- Participating in or supporting provincial activities at least 2 times.

Table 2.12-1
Public relations and mass relations plans

Activity	Details	Target Group	Objective	funds[5/] (baht)	Duration/ frequency	Operation period	Success Index
5.2 Allocate budget to communities	- Allocate budget for the community development according to the objectives of each area by establishing guidelines for budget use, establishing of community committees for each district to consider the use of the budget for the most benefit of the community as well as reporting results of using the budget.	- People living nearby the project area. - Community leaders	- Carry on the tradition - Build a good relationship - Develop community	3,500,000 per year	- All year	- January to December	- Participate in community activities of 6 sub-districts, 1 municipality. - Budget report
6 Environment							
6.1 Environmental inspection of Hin Kong Power Plant	- Organize a meeting or study visit of the environmental inspectorate of Hin Kong Power Plant which consists of representatives from government agencies, public, local government organization, administrative and the power plant to be responsible for monitoring various information on environment.	- People living nearby the project area. - Community leaders - Related agencies	- Provide project information - Listen to opinions	1,000,000 per year	- Meeting twice a year	- March to September	- Concerns are completely clarified. - Meeting summary at least twice a year.
6.2 Prepare an annual environmental report.	- Prepare annual environmental reports and send to government agencies, local government organization, administrative organization and general public who are interested in the project.	- People living nearby the project area. - Community leaders - Related agencies	- Provide project information	200,000 per year	- Once a year	- September	- Submit a report to all 6 sub-districts, 1 municipality
3) Operation phase [3/]							
1 Public health							
1.1 Mobile medical unit	- Establish a mobile medical unit to the Sub district once per year.	- People living nearby the project area.	- Promote community health	700,000 per year	- Once a year covering 6 subdistrict and 1 municipality	- February to May	- Participants is not less than 500 people.
1.2 Prevention project	- Promote disease prevention guidelines, such as promoting exercise of the community and providing knowledge management on nutrition.	- People living nearby the project area.	- Promote community health	350,000 per year	- Once a year covering 6 subdistrict and 1 municipality	- October	- Participants is not less than 200 people.

Table 2.12-1

Public relations and mass relations plans

Activity	Details	Target Group	Objective	funds5/ (baht)	Duration/ frequency	Operation period	Success Index
1.3 Joint development of the Ratchaburi Center Hospital	- Support the development of hospitals at Ratchaburi Center to be sufficient and ready for supporting patients in Ratchaburi.	- Ratchaburi Center Hospital	- Able to support the health services of communities appropriately.	1,000,000 per year	- Once a year	- January	- Ratchaburi Center Hospital is well equipped to properly accommodate patients in Ratchaburi.
2 Education							
2.1 Community development scholarships	- Collaborate with the Office of the Education and study demands of the community to provide appropriate scholarships such as grants for primary, secondary, tertiary students or as an ongoing scholarship.	- Local children, youth and students	- Increase educational - opportunities Promote education	1,000,000 per year	- All year	- January to December	- Provide suitable scholarships for communities in 6 Sub districts and 1 municipality
2.2 Teacher network for the development	- Establish a network of teachers in 6 sub-districts and 1 municipalities in order to be able to exchange knowledge and convey the benefits to the development of education in the area, including develop the knowledge and abilities of teacher personnel in the area.	- Teachers of 6 sub-districts and 1 municipality	- Develop an education in the area	500,000 per year	- Once-twice a year	- February to March or any period that the education institution is avaliable	- Participants were more than 80% satisfied.
3 Sport							
Promote traditional sports of the community	- Together with the community to create annual traditional sports project in the area.	- People living nearby the project area.	- Promote exercise - Promote community health - Build good relationships with the community	480,000 per year	- Once a year	November	- Participants is not less than 100 people in each year.
4 Communication Relations							
4.1 Neighbor Project	- Let the community visits the power plant to enhance knowledge and understanding on the power plant operation.	- People living nearby the project area.	- Build knowledge and understanding on the power plant operation.	1,050,000 per year	- At least 3 times per year	January to December	- Satisfaction survey have an assessment of more than 80%
4.2 Support activities and organize public relations activities with the media	- Support media activities on various occasions and arrange relations activities with the media, including support capacity building activities for local media.	- Local media	- Build knowledge and understanding on the power plant operation - Build capacity for local media	800,000 per year	- All year	January to December	- Local media participate more than 20 media

Table 2.12-1

Public relations and mass relations plans

Activity	Details	Target Group	Objective	funds[5/] (baht)	Duration/ frequency	Operation period	Success Index
5 Community Support							
5.1 Support organization activities in Ratchaburi.	- Support activities in Ratchaburi/traditional activities in the community.	Organizations in Ratchaburi/ community nearby the project	- Build a good relationship and support the social responsibility.	1,000,000 per year	- All year	- January to December	- Participating in or supporting provincial activities at least 2 times.
5.2 Allocate budget to communities	- Allocate budget for the community development according to the objectives of each area by establishing guidelines for budget use, establishing of community committees for each district to consider the use of the budget for the most benefit of the community as well as reporting results of using the budget.	- People living nearby the project area. - Community leaders	- Carry on the tradition - Build a good relationship - Develop community	3,500,000 per year and will increase for every 5 years by 10	- All year	January to December	- Participate in community activities of 6 sub-districts, 1 municipality - Budget report
6 Environment							
6.1 Environmental inspection of Hin Kong Power Plant	- Organize a meeting or study visit of the environmental inspectorate of Hin Kong Power Plant which consists of representatives from government agencies, public, local government organization, administrative and the power plant to be responsible for monitoring various information on environment.	- People living nearby the project area. - Community leaders - Related agencies	- Provide project information - Listen to opinions	1,000,000 per year	- Meeting twice a year	March to September	- Concerns are completely clarified. - Meeting summary at least twice a year.
6.2 Prepare an annual environmental report.	- Prepare annual environmental reports and send to government agencies, local government organization, administrative organization and general public who are interested in the project.	- People living nearby the project area. - Community leaders - Related agencies	- Provide project information	200,000 per year	- Once a year	September	- Submit a report to all 6 sub-districts, 1 municipality

Remark : [1/] Before construction period starts in B.E. 2563 and ends in May B.E. 2564

[2/] Construction period starts in B.E. 2564 and ends in B.E. 2566 (3 years duration)

[3/] Operation period start in B.E. 2567

[4/] During construction period, due to Covid- 19, the project will cooperate with Mobile Medical Unit and local public health organization to prevent the spread of Covid-19 via providing masks and hand cleaning gel to the citizens

[5/] Activities and funds may vary year by year in accordance to the discussion and agreement with the community.

1) Public health such as portable medical unit, sport activity, public health construction/equipment and other public service including donation by request,

2) Education and youth development such as scholarship, food and nutrition fund, training support, and educational open house. Furthermore, the project has support local people to work in their homeland by giving sponsorship for career improvement, and giving opportunity for youth people to work in the business path of the project,

3) Sport such as sponsorship for local traditional activity or sport equipment,

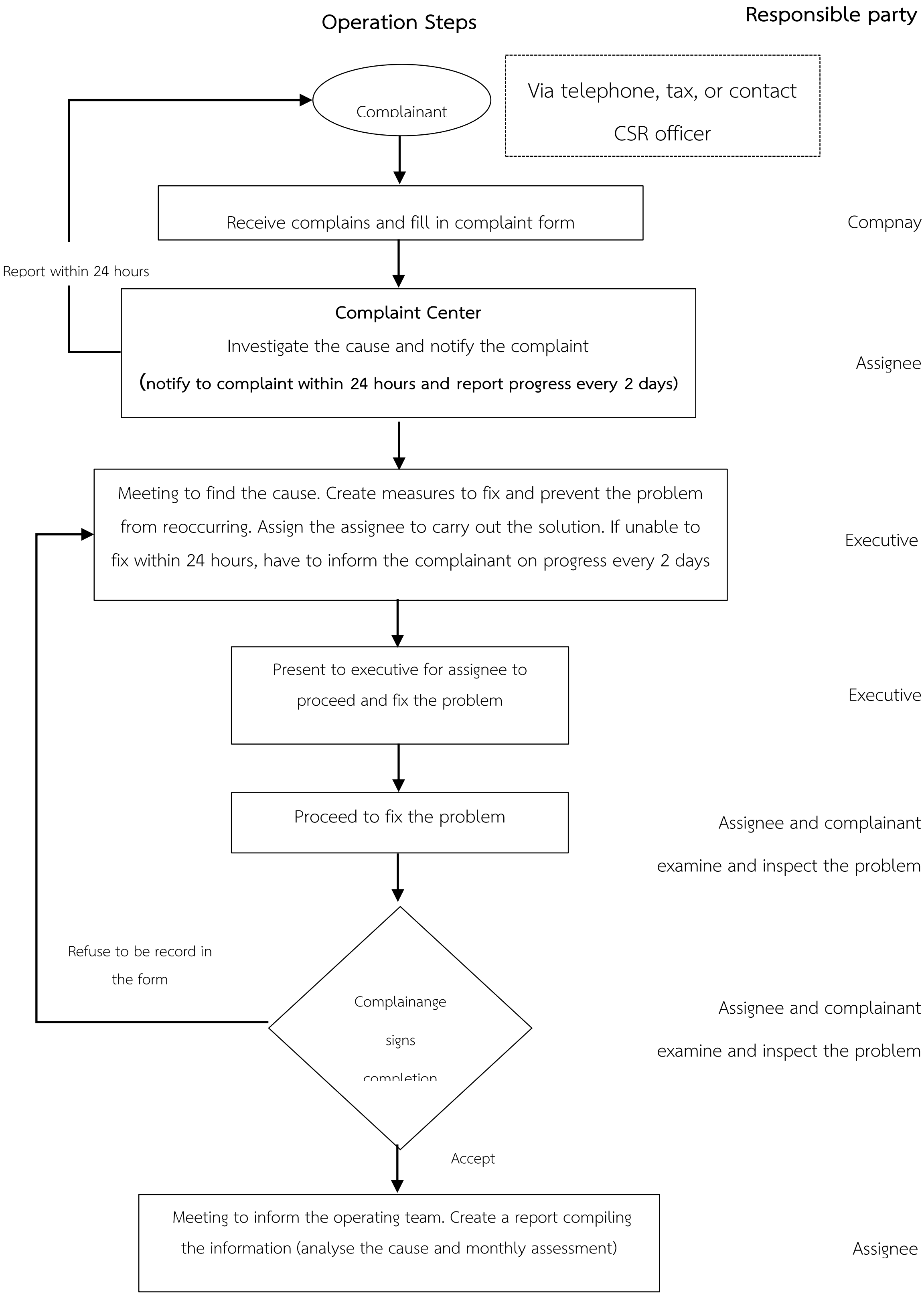
4) Public relation such as maintaining good relationship with local communities,

5) Environment such as setting environmental monitoring committee and training activity, and

6) Community sponsorship and governmental sponsorship by donation for traditional activities such as children's day, new year party, royal family's ceremony and redcross festival including reparing public buildings such as schools, temples, hospital, etc.

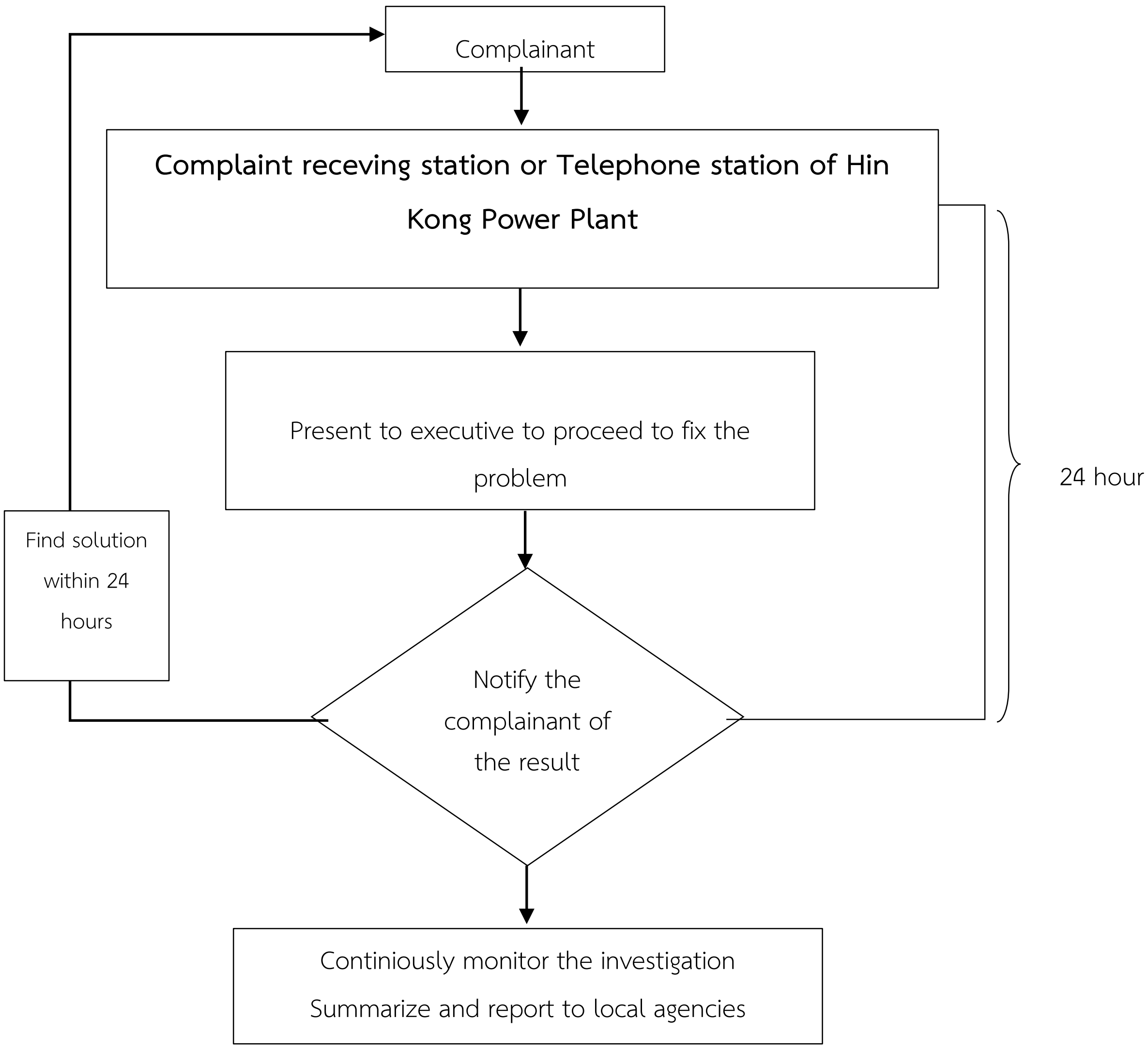
(2) Complaint case receiving

In case of communities affected by project operation, complaint case receiving could be performed by various channels such as phone call, fax, or project staffs. The public relation unit will reponses back to the complainer within 1 day to inform solving procedures within 7 days (if the problem doesnot caused by the project), before informing again after the problem is solved. Complaint case receiving diagram was shown in**the figure 2.12-1.**



<u>Remark</u> : complaints mean complains from the citizen in the proximity area that receive troubles and annoyance to living quality, health, sanitary and safety, and environment from the project

<u>Figure 2.12-1</u> Flow chart showing complaints procedure



Source : Hin Kong Power Co.,Ltd, B.E. 2563

Figure 2.12-1 (cont) **Flow chart showing emergency complaints of Hin Kong Power Co.,Ltd**

2.13 Green space

The project has green space area for plantation around 15,646 sq.m. or 5.18% of the entire project area. Those green space areas are used as Protection Strip for maintaining environmental quality and safety zone between the project area and surrounding community areas (source: Problem solving for distancing area between industrial zone and community zone in the Map Ta Phut Industrial Area, and Information Distribution About Consideration Result of the City Planing Committee According to the Article 67 Paragraph 2 of the Royal Thai Constitution, 2553).

According to the project location, the project is located in the free space between the Tri-energy Power Plant, by which; surrounding area are (Layout was shown in**the figure 2.13-1**);

North	adjacent to	Ban Nongrak (124 houses) which is around 300 m far from the project area
South	adjacent to	Agricultural area and low-density residential area (7 houses) which is around 30-100 m far from the project area
East	adjacent to	TECO Power Plant
West	adjacent to	Agricultural area

Therefore, buffer zone of the project is using green space for maintaining safety area between community zone and the power plant area. The green space also used as engineering safety zone, by which; total green space area is around 15,646 sq.m. or about 5.18% of entire project area. The green space is separated to 3 zones which are 1) zone A in the east area of the project occupying area around 10,321sq.m. using plantation distance around 2 m. for atleast 3 rows in zigzag pattern, 2) zone B in the west area nearby raw water pond of the project occupying area around 4,022 sq.m. using plantation distance around 2 m. for atleast 2 rows in zigzag pattern, and zone C in the south area nearby fenceline of the project occupying area around 1,303 sq.m. According to zone C is used for installing concrete wall, therefore; plantation distance is 2 m. for only 1 row to be used as safety area (green space zones were shown in**the figure 2.13-2**).

Furthermore, the east area of the project which is adjacent to the TECO power plant and north area nearby the raw water pond are used for plantation without damaging those buildings and water ponds.

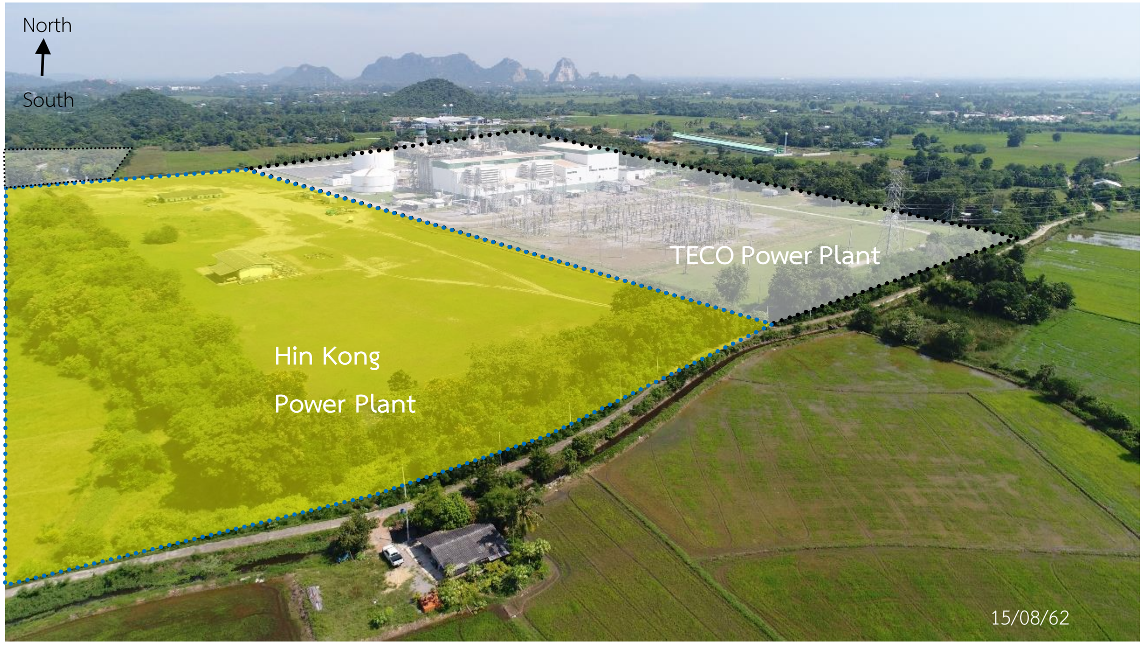


Figure 2.13-1 Image showing the project area

Figure 2.13-2 **Green area of the project**

Plantation detail of the project is summarized by;

1) **Air pollution reduction;** potential trees should have thick, broad, oily and smooth leaves to adsorb NO_x, and SO_2 such as the mast tree, eucalyptus, cedar, and mahogany,

2) **Shadow shading and buffer zone;** potential trees should be the mast tree, and eucalyptus, and

3) **Decoration;** potentiona trees should have beautiful shape or bush such as the mast tree, and cedar.

The project considered to use trees according to the above purposes for plantation in the green spaces. Example of trees are shown in the following table.

Type	General characteristic
The mast tree	Tall tree which is resisting to tropical climate. It is popular for using as fenceline for blocking wind and sun light
Cedar	Tall tree with small leaves. The tree could be 10-20 m. tall with low branches. Leaf is smooth and broad. It has potential to adsorb NO_x, and SO_2
Mahogany	It is medium to large size tree with smooth and broad leaves to adsorb NO_x and SO_2. It is popular for using as fenceline for shadow shading and wind blocking
Wild mango	It is medium to large size tree which is around 10-40 m tall without shed leaves. It has potential to adsorb NOx, SO2, and dust
Fox tail plam	It is plam tree which is easily to grow in sand or loose soil. It is resisting to hot climate which has beautiful bush, and popular for using as decoration trees

Furthermore, soil testing in the study area revealed that the area is classified as Khaoyoi and Pakthor Series (Kyo&Pth), by which soil property is shown in the following table.

Soil series	Physical property	Other property
Khaoyoi	color: grey to brown grey, or redish brown soil texture: top layer is loose sand, or loose clay	- poor to very poor permeability - weak to moderate acid
Pakthor	color: light grey with yellow or brown impurity soil texture: top soil is loose soil or silt soil	- poor to very poor permeability - weak to moderate acid

According to soil type, trees to be grown in the green spaces should be resisting to the soil stypes.

The project has performed plantation plan for green space areas by applying fertilizers, removing pest, and maintaining plants in the green spaces by;

1) soil modification, fertilizer apllyingh, and using pesticide

The project will perform soil improvement and applying fertilizer regularly by assigning plantation staffs to use organic fertilizers, and applying pesticide yearly,

2) Branches cutting, and pest or grass removing

The project will perform branches cutting routinely, and perform pest or grass removing yearly,

3) Repairing green space

In case of damaging trees in the green spaces, the project will perform plantation replacing within 30 days by using the same size of trees according to plantation plan,

4) Watering

The project has considered water consumption according to tree type by watering plantation area at least 1 time/day during the incubation period by spraying water to those plants to avoid any damaging due to water pressure for 1-2 times/day. Water supply will be pumped from raw water pond or using water truck for low pressured area. The watering will not be performed in a rainy day.

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Chapter 3

Existing environmental

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Existing environmental

The consulting company conducted a study of the current conditions of natural resources and environmental values. The study area covered areas of 5 kilometers in the radius from the project area. From the study areas, it consisted of 6 sub-districts in Mueang Ratchaburi district, Ratchaburi, to cover the project area and areas that are expected to be affected by the environment and health from the project operation in all aspects. The sconsulting company conducted a comprehensive study of 4 natural resources and environmental values, in accordance with the guidelines for the EIA report for thermal power plant projects of the Office of Natural Resources and Environmental Policy and Planning.

For the study of natural resources and environmental values in all 4 aspects, the details were as follows.

3.1 Physical environmental resources

3.1.1 Topography

(1) Topographical conditions of Ratchaburi Province

Ratchaburi locates in the western region of Thailand, regarding to geographical division and located in the western central region, according to the administrative division of the Ministry of Interior. Ratchaburi locates between the latitude 13 degrees 10 minutes north to 13 degrees 45 minutes north and between the longitude at 99 degrees 10 minutes east to 100 degrees 5 minutes east. It is approximately 100 kilometers away from Bangkok along Petchkasem Road or the National Highway No.4. Ratchaburi has the Mae Klong River, as a main river flowing through the total area which is approximately 45 kilometers in length. Ratchaburi has a total area approximately 5,196,372 sq.km., or 3.2 million rais with following contact territory.

North	connects to	Mueang and Tha Maka Districts, Kanchanaburi
East	connects to	Kamphaeng Saen District, Mueang Nakhon Pathom District and Sam Phran District, Nakhon Pathom Ban Phaeo District, Samut Sakhon, Bang Khonthi District and Amphawa District Samut Songkhram Province

South	connects to	Khao Yoi District and Nong Ya Plong District, Phetchaburi
West	connects to	Tanaosri in Myanmar

The topographical characteristics of Ratchaburi were divided into 4 characteristics which were;

1) **High mountain area** such as the **west** side is a border with Myanmar and connects to the southern of Phetchaburi. Area is covered with evergreen forest, mixed with deciduous forest, dipterocarp forest and bamboo forest, with an altitude of 200-1,000 meters in Suan Phueng District, Ban Kha District, and west Pak Tho District.

2) **Plateau** area such as the area next to the mountain locating in the east to the middle of the province is a plateau with slope and the Phachi River, the main branch of the creek. The soil condition is sandy soil and soil erosion occurred quite often locating in Suan Phueng District, Ban Kha District, Chom Bueng District, and west of Pak Tho District Mueang Ratchaburi, Photharam District and Ban Pong District.

3) **Basin area** such as both banks of the Mae Klong River and the east side of the province, the soil texture is loam and loam mixed with clay and it is abundant In Ban Pong District, Photharam District, Bang Dae District, Mueang Ratchaburi District and Pak Tho District.

4) **Lowlands** such as at the end of the Mae Klong River connecting to Samut Songkhram which the height of 1-2 meters above sea level. The soil is fertile and suitable for fruit and vegetable farming.

(2) Topographical characteristics of the study area

1) Huai Phai Subdistrict

Huai Phai Subdistrict locates to the west of Mueang District, it has a sloping terrain of about 1 - 5% from west to east. The western area is an area with high slopes. There is a field of crops and fruit trees growing on the east side in lowland areas. There is a lot of rice fields and planting vegetables in the eastern part of the area and spread out in agricultural areas. In the area of the sub-district, there is a creek flowing through the area of every village with a total length is approximately 16 kilometers.

2) Chedi Hak Subdistrict

Chedi Hak Subdistrict locates to the south of Mueang Ratchaburi District, approximately 5 kilometers away from Ratchaburi city. It has a basin landscape suitable for agriculture. There are natural water sources scattered throughout the area, Importantly, irrigation canals pass through many areas and cover all agricultural villages. This makes it conducive to cultivation and other agriculture.

3) Ko Plub Pla Subdistrict

Ko Plub Pla Subdistrict locates on the north of Mueang Ratchaburi District which approximately 11 kilometers from Ratchaburi town. The topography is flat, undulating and slightly steep. Mountains are scattered in the area, the lowland area locates in the east, suitable for cultivation or agriculture. In the west, there are Khao Plong, Khao Suan Luang, Khao Ling, Khao Kruat and Khao Phaya Prab with creeks running through almost every village.

4) Don Tako Subdistrict

Don Tako Subdistrict locates on the west of Ratchaburi with Petchkasem Road cutting through the area with approximately 3 kilometers away from the district. The topography is a mountainous area in the west, and lowlands on the east. Don Tako Subdistrict locates in the irrigation area, some parts of the sub-district are urban areas.

5) Don Rae Subdistrict

Don Rae Subdistrict locates in the southwest of Mueang Ratchaburi district for approximately 10 kilometers from the district. Its topography is surrounded by mountains with an approximate slope 0-1%, some areas are military restricted areas. There is an irrigation canal on the right side of Ratchaburi which flows through areas of villages 1, 2 and 3 of the subdistrict. However, a water pump will be used to bring water for consumption because Don Rae Subdistrict is an upland area and the irrigation canal is deep.

6) Hin Kong Subdistrict (the project aera)

The project area is located in the Hin Kong Subdistrict area of Mueang Ratchaburi district. Ratchaburi topography of Hin Kong Subdistrict is a long line from east to west. The west side is more steeper than the east side. There is an agricultural area and the density of population more than the east side. No natural water source but there are irrigation canals run through 1,2,3,4 and 5 villages as seen in **Figure 3.1.1-1.**

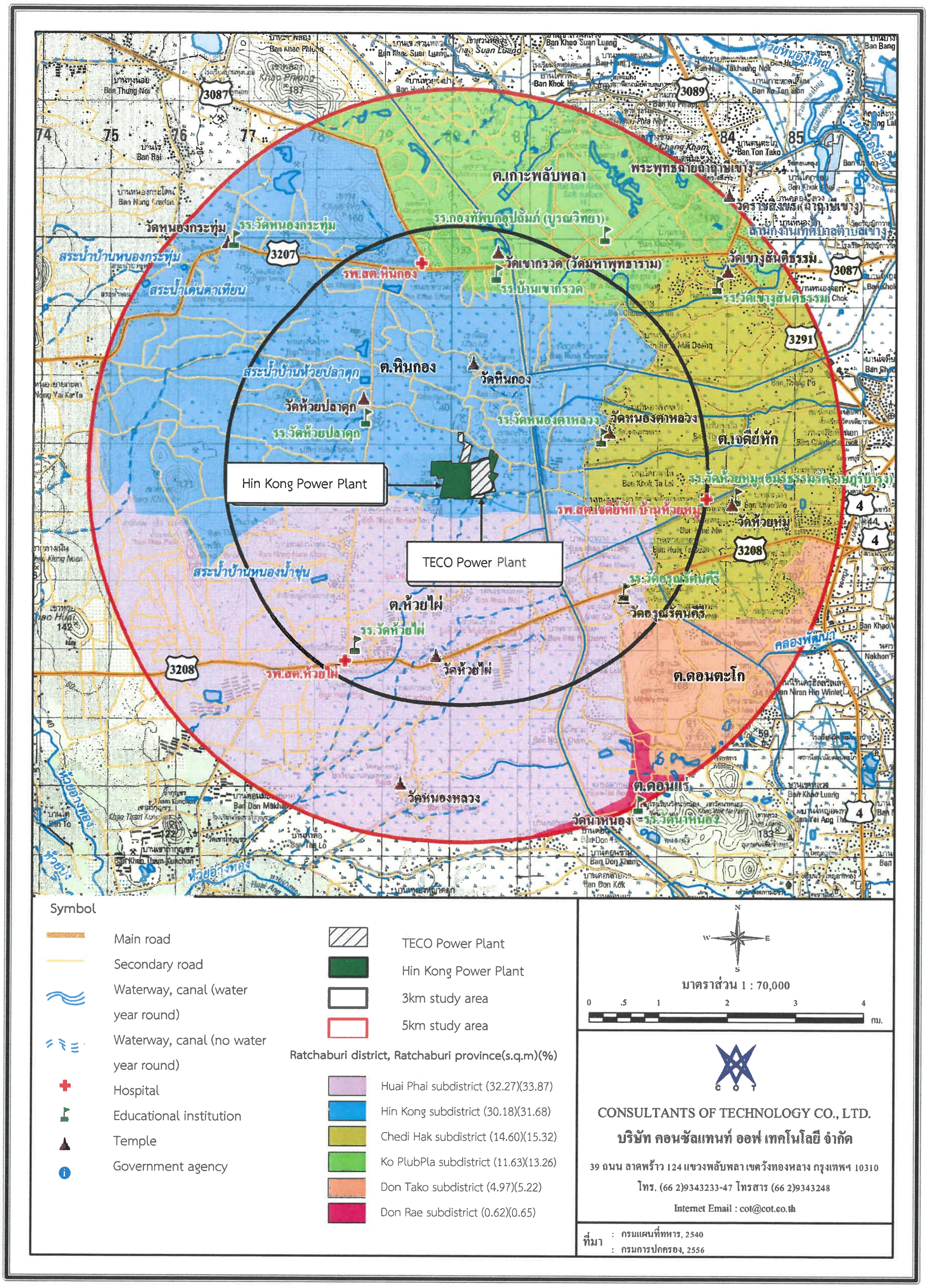


Figure 3.1.1-1 Location of project and study area

3.1.2 Geological features, earthquake and agronomy

(1) Geological features

Structural geology of Ratchaburi caused by the influence of the movement of the earth's crust. It can be observed from the rock laying character and curves that appear in the area of sedimentary rocks and many metamorphic mountains Including faults and cracks in rock supported areas. All of which occurred by the action of the motion of the earth's crust.

Rock formation, most of rock layers are laid approximately in the northwest-southeast direction. In addition, it is found that in some areas the rocks lie in the northeast-southwest direction and some laid in almost north-south direction.

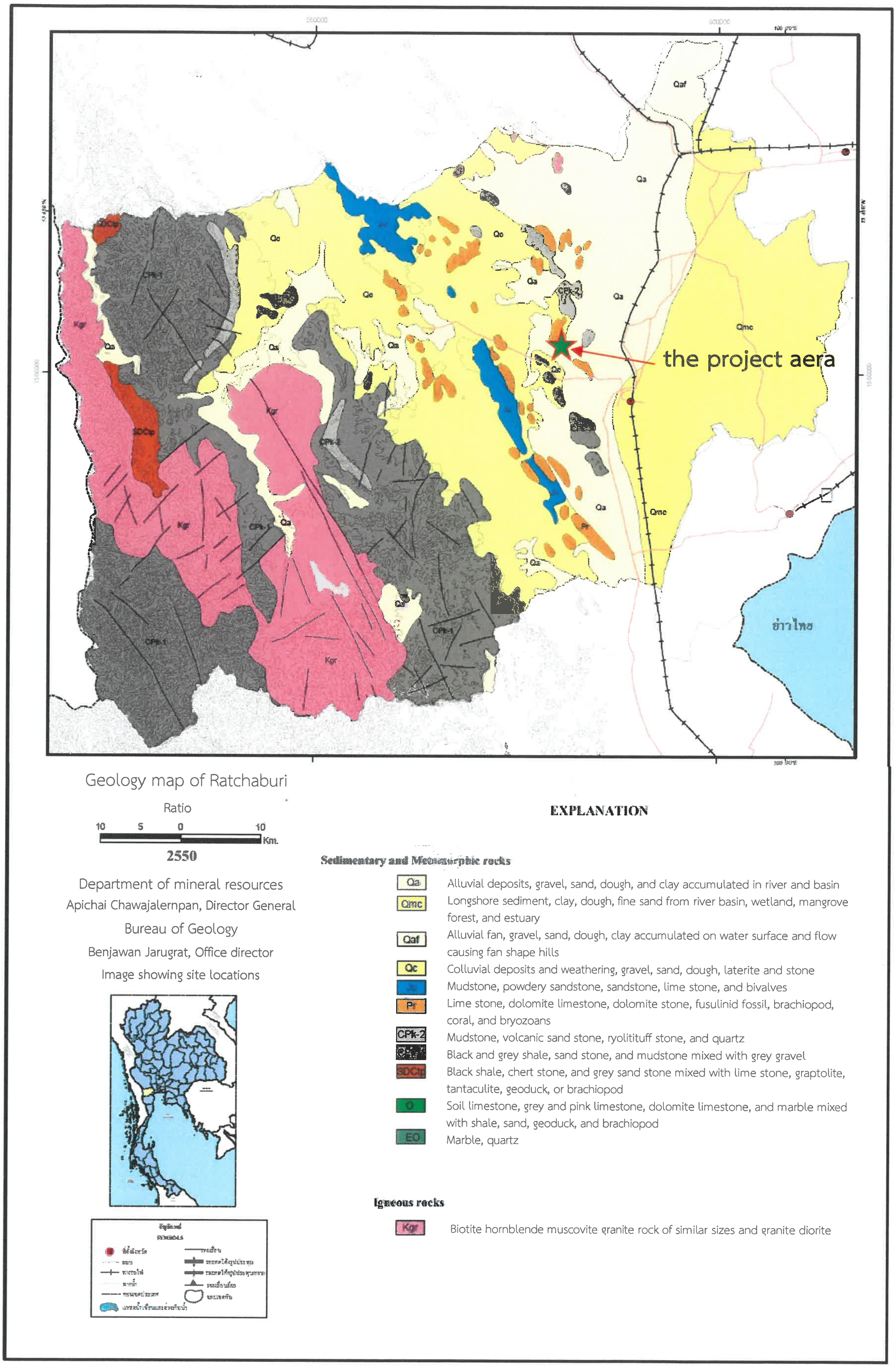
Folds of the rock, folds of rocks in the area appear to be anticlines and synclines in many places. The main axis is approximately in the northwest-southeast direction.

Ratchaburi has a mountainous landscape on the western side of the area. The middle of the area is a mountain and inselberg with descending heights. They consists of hard rock aged between 570 to 66.4 million years for approximately 40%. The remaining area of approximately 60% is a flat area, such as the flat hillside and floodplains. It consists of sediment layers that are approximately 1.6 to 0.01 million years old, most of them covering the eastern area and northern part of the province. Rocks in Ratchaburi consist of sedimentary rocks, metamorphic rocks and igneous rocks. In addition, various sediments are found. The geological structure found in the area consists of faults, cracks and folds in the rock layer. Details are decribed as follows (**Figure 3.1.2-1**).

There are many types of sedimentary rocks, metamorphic rocks, and sediment found in Ratchaburi, which aged between 570 to 0.01 million years. The rocks can be sorted from the age range as follows:

1) Metamorphic rock during Ordovician to Cambrian period (EO)

It consists of various types of metamorphic rocks such as cale-silicate stone, marble, quartzite, quartz-schist, mica-schist and phyllite stones. These stones are approximately 570-438 million years old and have been continuously found down from Kanchanaburi. They appear patchy on the northwest side of the province in Suan Phueng District, is a part of the Tenasserim Mountains.



ource : Department of Mineral Resources, B. E.2550.

Figure 3.1.2-1 Geological characteristics of Ratchaburi

2) Sedimentary and metamorphic rocks during silurian-devonian rocks (SD) periods

It consists of sedimentary rocks and metamorphic rocks of various types of Bo Phloi stone, such as, quartz sandstone, sandstones in brown and gray shades, shale and powder sandstone. Some of them have been transformed into quartzite, phyllite and slate rocks. Marine invertebrates fossils were found. Stone in this period are approximately 4 3 8 -3 6 0 million years old. It is found small area which continuously come from Kanchanaburi to the northwest side of the province in Suan Phueng District, showing topographical features as part of Tenasserim Mountains.

3) Sedimentary and metamorphic rocks during Permian to Carboniferous (CPkp and CPkc) periods

These periods consist of sedimentary and metamorphic rocks of Khao Phra Formation (CPkp) and sedimentary rocks in Khao Chao Formation (CPkc) with approximately 360-245 million years old.

(A) Khao Phra Formation, the older ones laid below consisting of greywacke and gray to medium gray shale, white to yellowish brown arkose sandstone. In the area that is exposed to intrusive igneous rocks, it was found that rocks of Khao Phra formation have been changed into quartzite rocks, hornfels rocks and slate. Khao Phra Formation continuously surfaced from Kanchanaburi. The terrain is mountainous, inselbergs and hills covering the area around Tenasserim Mountains and in the middle of Ratchaburi, such as Khao Khiaw and Khao Krachai in Mueang Ratchaburi district.

(B) Khao Chao Formation, resting on Khao Phra Formations consisting of white to yellowish brown arkose sandstone, white and gray mudstone. This rock category contains fossils of marine animals, lamp shell, crinoidea or sea lily and bryozoa. Khao Chao Formation has a distinctive inselbergs, found in patches in the north and central areas such as Khao Wang Sa Dung in Mueang Ratchaburi District.

4) Permian Sedimentary Rocks (P2)

It consisting of various types of sedimentary rock of Ratchaburi rock group, such as gray to dark gray limestone, dolomite limestone, sandstones and shale. There are fossils of marine animals such as fusulinid, lamp shell, corals, ammonite and crinoidea or sea lily (P2). This stone is approximately 286-245 million years old. It can be found in the middle of the area as a continuous line descending from Kanchanaburi. The topography is inselbergs, such as Khao Ngu, Mueang District and Khao Chong Pran in Photharam District.

5) Cretaceous to Jurassic Sedimentary Rocks (JK)

These kind of stones consisting of various types of sedimentary rocks, including white to reddish brown arkose sandstone, alternating with white to gray mudstones, round gravel sandstone, and rounded gravel limestone. This stone is approximately 210-66.4 million years old. It can be found along a continuous line down from Kanchanaburi across the middle of the area. The topography is inselbergs and hills, such as Khao Luang and Khao Hin Lub in Chom Bueng District.

6) Sedimentation in Quaternary Period (Qc Qt Qbo Qa Qff Qtf and Qfl)

It consists of various sediments which their are between 1.6-0.01 million years old. It can be divided into 7 following types according to the type and environment of the accumulation.

(A) Colluvium and residual deposits (Qc), consisting of sedimentary quartzite fragments, sandstone fragments, siltstone remnants, granite debris, sand sediment, siltstone silt, red earth soil and terra rosa soil. It shows the topography as a plain spread over the foothills or sediment accumulation on edges. This type of deposit can be found in Suan Phueng District, Chom Bueng District, Ban Pong District, Photharam District, Mueang Ratchaburi District and Pak Tho District.

(B) Terrace deposits (Qt), consisting of sediment, gravel and sand as a flat topographic feature along the river that has a lot of vertical erosion. This type of deposit is usually found near the watershed area in Suan Phueng District, Chom Bueng District, and Pak Tho District.

(C) Transgressive beach deposits (Qbo), consisting of sand sediment with medium to rough texture and shell fragments which could be found as a long line in the district of Ratchaburi and Pak Tho District.

(D) Alluvial deposits (Qa), consisting of sediment, gravel, sand, silt and clay. Each size of sediment has nonsystematic accumulation and the sediment layer is not very thick. The topography is a plain, low level with flooding along the river. It could be found in Suan Phueng District, Chom Bueng District, Ban Kha District, Ban Pong District, Photharam District, Mueang Ratchaburi District and Pak Tho District.

(E) Allurival plain deposits (Qff), consisting of sediment sediment, gravel, sand, silt and clay. The topography is a plain, low level with flooding along the river. Each type of sediment has a good size selection with the systematic accumulation and the sediment layer is thicker than the alluvial deposits (Qa). This type of deposit can be found on the west bank in parallel to the Mae Klong River, since Ban Pong District to Mueang Ratchaburi District.

(F) Tidal flat deposit (Qtf), consisting of clay in gray and green mixed gray, with a thick layer of fine sand and peat layers interleaved with some shells could be found. This deposit covers almost all east side areas of the Mae Klong River In Ban Pong District, Photharam District, Bang Phae District, Damnoen Saduak District, Mueang Ratchaburi District, Wat Phleng District, Pak Tho District.

(G) Natural levee deposit (Qfl), consisting of silt and silt mixed with loam clay, sand layers mixed with gravel and plant roots. It can be found along the banks of the Mae Klong River in Ban Pong District, Photharam District, and Mueang Ratchaburi District.

7) Granite

Granite found in Ratchaburi is an intrusive Igneous rock with a granite type from the Cretaceous period (Kgr). It was laid down continuously from Kanchanaburi covering the area on the west side and southwest. It consists of light color granite with the texture of medium to rough. In addition, aplite granite with fine to medium texture. This granite is approximately 140-66.4 million years old, pushing up through sedimentary rocks and the metamorphic rocks which laying on the top with older ages. The topographic landscape is the Tenasserim mountain range in the border area of Thailand and Myanmar and there are some hills found in Suan Phueng District and Ban Kha District.

For geological characteristics in the study area (**Figure 3.1.2-2**), the consulting company collected the data from the Geographic Information System (GIS) of the Department of Mineral Resources, B.E.2550 and found that most of the study areas are sediment, gravel, sand, silt and clay builded-up along the riverbed, earthen and flooded basins (Qa). It consisted of sediment, gravel, sand, silt and clay with each size had a non-systematic accumulation of deposits. The sediment layer was not very thick. The topography showed as a plain, low level area of flooding along the river and found in Suan Phueng District, Chom Bueng District, Ban Kha District, Ban Pong District, Photharam District, Mueang District and Pak Tho District, with an area of 61.07 sq.km., or 64.10% of the study area. Then followed by the colluvium and residual deposits, gravel, sand, silt, laterite and rubble (Qc). These deposits consisted of quartzite fragments, sandstone fragments, siltstone remnants, granite debris, sand sediment, siltstone silt, red earth soil and terra rosa soil. The topography showed as a plain spread over the foothills or sediment accumulation edges. It was found in Suan Phueng District,

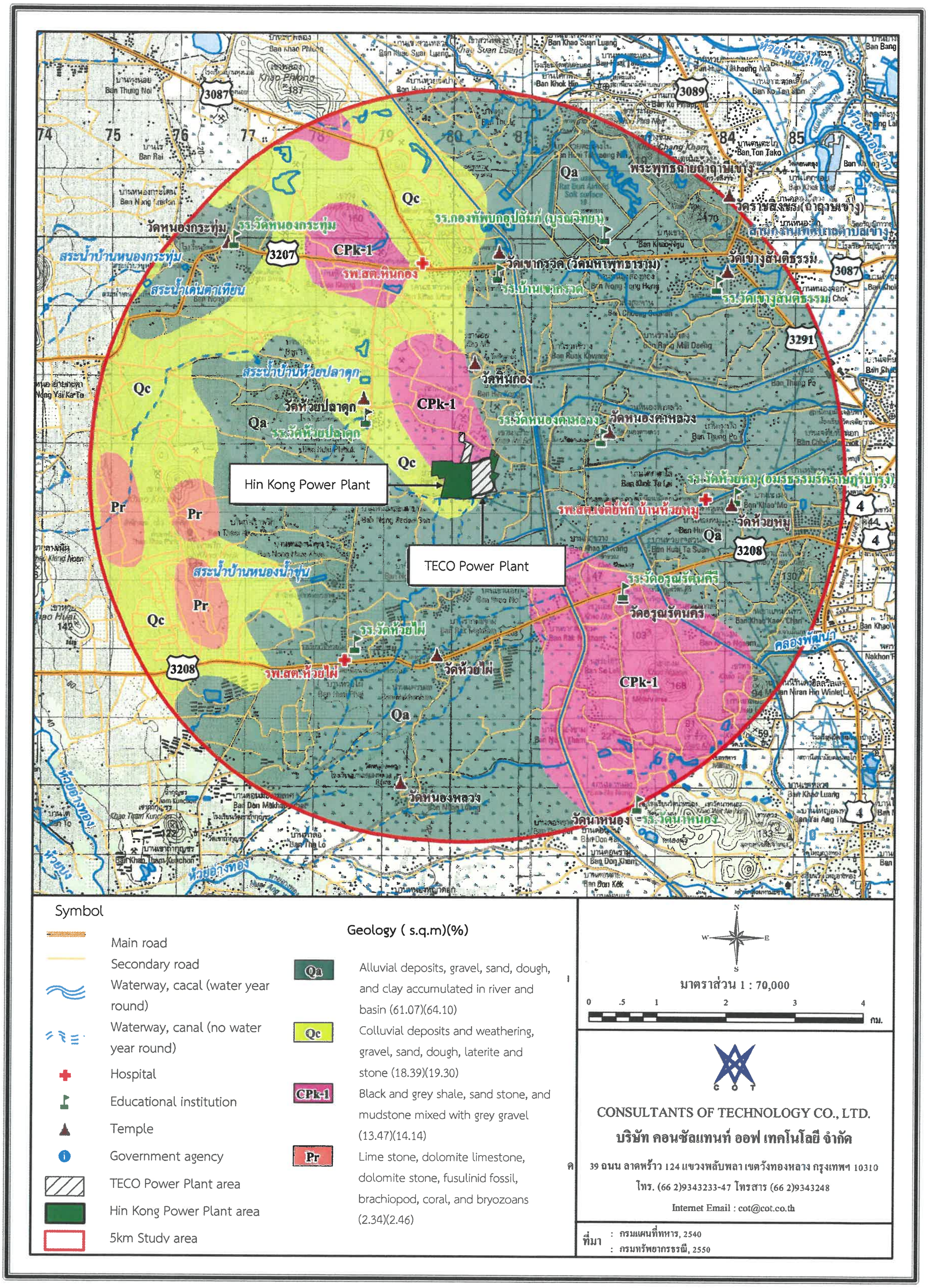


Figure 3.1.2-2 Geological characteristics in the study area

Chom Bueng District, Ban Pong District, Photharam District, Mueang District and Pak Tho District, with an area of 18.39 sq.km., or 19.30% of the study areas. Then followed by the soil formation like dark gray to black shale, poorly sized sandstone, dark gray mudstone (CPk-1) which consisting of white to yellowish brown arkose sandstone, white and gray mudstone. This rock category contained fossils of marine animals, lamp shell, crinoidea or sea lily and bryozoan. This Khao Chao Formation had a distinctive inselbergs, found in patches in the north and central areas such as Khao Wang Sa Dung in Mueang Ratchaburi District with the area of 13.47 sq.km., or 14.14% of the study area. It contained limestone, dolomite limestone with chert inserting as lumpish and layer, dolomite stone with fusulinid remains, Brachiopods, coral and bryozoars (Pr). Sediments of Ratburi group were found such as gray to dark gray limestone, dolomite limestone and some sandstone and shale found patches in the middle area which continuous laid descending from Kanchanaburi. Its topographical features showed as a inselberg, such as Khao Ngu in Mueang District and Khao Chong Pran in Photharam district with an area of 2.34 sq.km., or 2.46 % of the study area.

(2) Earthquake

1) Earthquake

Earthquakes are divided into 2 major categories, spontaneous earthquake and human made, with following details.

(A) Spontaneous earthquake (Continental Drift)

There are 2 reasons.

- **Volcanism**

Volcanism is small and earthquake will occur only in the area of volcanic eruptions.

- **Tectonism**

The movement of the earth's crust (Tectonism) is often a large and very violent earthquake, mostly occur at deep and continuous levels for a long time, according to the Plate Tectonics theory. For this theory, the tectonic plates collapsed beneath the other plates (Subduction), continental dift, collision and spreading occurred. Plate tectonics also cause faults on continental plates due to the force exerts on the rock mass in the world causes energy and stress in the rock mass and such stress keep accumulates until it is more than the power that the rock mass can handle. The rock will break into a line called "cracking" or "fault" causing an earthquake underneath the earth's surface. Cracking will not appear on the soil surface. The point deep down causes a cracking line called the "Focus or Hypocenter". The point on the Earth's surface in the middle of the earthquake on earth is called "Epicenter" which is the area receiveing the most impact.

(B) Earthquake occurring from human activities

Earthquakes are caused by humans changing the balance of the earth's crust, some of which are known as induced seismicity, such as large containment of water reservoirs, pumping too much groundwater, including oil and natural gas production processes. All mentioned activities are triggers for earthquakes to occur causing the change of the stress condition in that area beyond the initial stress energy that can be received. Therefore, the movement, in terms of earthquake, along the existing fault or joint or crack, will occur, in order to release energy.

2) Fault with the power passing through Thailand

Faults and cracks are rocks in the area showing cracks and faults in 2 directions: northwest-southeast and northeast-southwest, including almost north-south direction for some parts. Geophysical data on air showed that there is a continuous fault line from Three Pagodas Fault in Kanchanaburi province which rested in the northwest-southeast direction. The fault line is in a hard rock area that is covered with sediments of the Quaternary period. This fault line is passing down the northeast area of Ratchaburi in Ban Pong District and has a continuous path to Nakhon Pathom, Samut Sakhon, Bangkok and Samut Prakan.

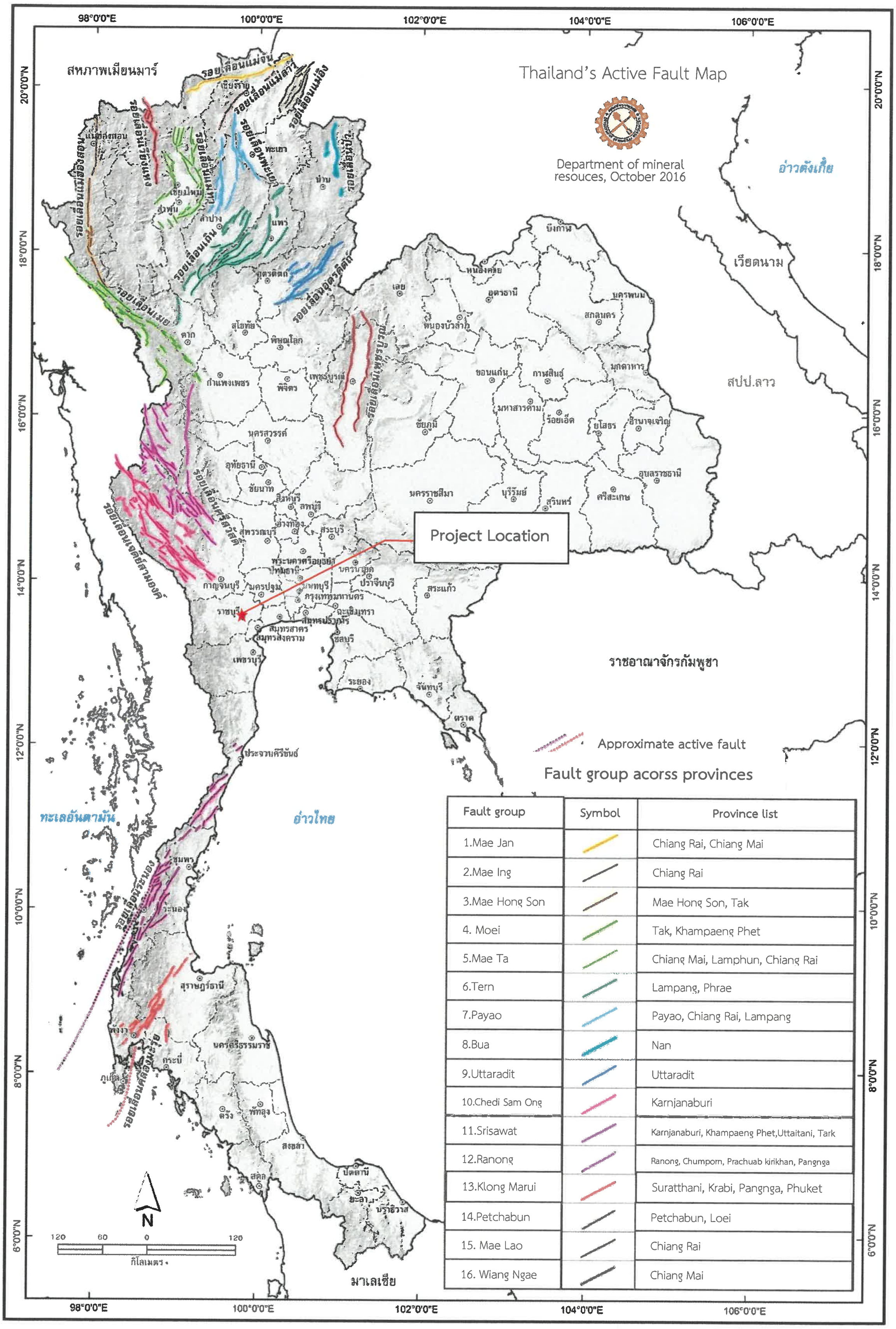
The earthquake in Thailand is caused by the movement of rocks on both sides of the fault. There are 16 faults found in Thailand, as seen in **Figure 3.1.2-3.**

(A) North region

- Mae Chan Fault: laying in the west-east direction which is somewhat twisted tp the south and slightly upward to the north with a length, approximately 170 kilometers across from Fang District, Mae Ai District of Chiang Mai, Mae Chan District, Chiang Saen District, Doi Luang District and Chiang Khong District of Chiang Rai and continuously to Laos PDR. There are 3 hot spring sources along the length of this fault.

- Mae Ing Fault: laying in the northeast-southwest direction, starting from Thoeng District, Khun Tan District, Chiang Khong District, Wiang Kaen District of Chiang Rai and continuously lengthened into into Laos PDR. This fault has a length of approximately 70 kilometers.

- Mae Hong Son Fault: laying in the north to south direction, starting from Mueang Mae Hong Son District through Khun Yuam district, Mae Lan District



Source : Department of Mineral Resources, B.E.2562

Figure 3.1.2-3 Faults in Thailand

and Mae Sariang District of Mae Hong Son. It is continuing down to the north of Tha Song Yang District in Tak, with approximately 2 0 0 kilometers in length. It is a very prominent geomorphology in Mae Sariang District as a water feature like a wine glass valley, indicating that the area has been continuously raised from the past to the present. This causes the water channel to erode deeper into the bottom rather than the side.

- Moei Fault : it begins to appear in the area of the Union of Myanmar, continuously move into Thailand in the area of the Moei River at Ban Tha Song Yang, Tha Song Yang District of Tak. This fault lays along the northwest-southeast direction across Mae Ramat District, Mae Sot District, Phop Phra District, Mueang Tak District, Wang Chao District of Tak, including across Kosamphi Nakhon District and Khlong Lan District of Kamphaeng Phet, with a total length, approximately 260 kilometers. The important geomorphology are overlape streams, ridge, straight valley, and the faulty cliff. Evidences of the overlapped stream appears clearly in the southeast area of Ban Tha Song Yang, Tha Song Yang District. The small creek has been cut to a distance of 5 0 0 meters and indicated that it was a fault along the right plane. Moei Fault shift caused a major earthquake in Thailand on 17 February B.E.2518 with a magnitude 5.6 with a center at Ban Tha Song Yang, Tha Song Yang District, where public was aware of the vibrant.

- Mae Tha Fault: there are many faults separated into regions creating the letter S (S-shape) feature. Each fault region has different movement characteristics. Starting from laying in the north-south in Phrao District and passing down in Saket District of Chiang Mai, this direction has a normal fault shift. Then the fault twists to the southeast in the area of Sankampang District with the movement of a right plane overlap fault shift. Then, the fault has turned to the southwest, in parallel to the river in Mae Tha District of Lamphun, with the movement as the left plane overlap fault fault with a total length approximately 100 kilometers. This fault appears in many hot springs. The north of the fault in Phrao District still has small to medium-sized earthquakes occur regularly. The geomorphology of this group of faults are the cliff, faults and overlapped streams.

- Thoen Fault : laying in the northeast-southwest direction, cutting through the foothills at the boundary between Phrae basin and the Lampang basin which is the fault that runs through Mueang Phrae district, down to Sungmen District, Long District and Wang Chin District of Phrae. Then it is continuously down to Mae Tha District, Sop Prap District and Thoen District of Lampang, with a total length of approximately 1 3 0 kilometers. This fault shows the geophysical feature as many of new shifts, causing many steep cliffs. The new shift is at the edge of the bottom sediment basin near the plain. From satellite images, it is evident that the triangular cliffs are lined up continuously, which are very clearly in the eastern part of Sop Prap District. and shifting along the plane. It was found a clear evidence of bending of water in many branches in the same direction. For example, at Ban Mai area, Mae Tha District in Lampang, the waterway that cuts through the fault in this area had been cut in the left overlapped style with a distance of approximately 500 meters in many provinces in the north region including Bangkok.

- Phayao Fault: it Is a fault that has two parts, with different position and clearly separated from each other. The fault on the southern hemisphere is positioned almost north-south with mostly northwest direction. This fault appears on the west side of the Phayao basin, at the boundary between Phan District of Chiang Rai, Mueang District of Phaya and Wang Nuea District of Lampang with a length of approximately 35 kilometers. It shows the characteristics of the various fault cliffs and continuous straight lines facing the east. In Wang Nuea District, there are cliffs that are 200 meters height and various water branches that cuts through this fault. Signs of deep vertical erosion to the subsoil showing that the fault still has the power, not rest until now. This corresponds to the event of a large earthquake and the most damage that Thailand has experienced on May 5, B.E. 2557. At that time, it had a magnitude of 6.3, and the center was located in Mae Lao District in Chiang Rai causing a lot of damages to buildings. Most of damages appeared on buildings, historic sites, government buildings transportation routes and public households.

- Pua Fault : laying in the north-south direction with an inclined angle to the west, classifying as a normal fault. This is a fault that mostly has a long position around the eastern part of the Pua basin, beginning at the junction of Thailand - Laos PDR and continuously down in the area of Thung Chang District, Chiang Klang District, Pua District and continuously to Santisuk District of Nan with a total length of approximately 110 kilometers. This fault consists of 3 parts which are, Thung Chang Fault, Pua Fault and the Santisuk Fault.

- Uttaradit Fault: laying in the northeast-southwest direction with an inclined angle to the northwest, approximately 130 kilometers in length. This fault began to appear from Fak Tha District, down to Nam Pat District, Thong Saen Khan District of Uttaradit and continuing through Phichai District Of Phitsanulok.

- Mae Lao Fault: at 18.08 hrs on May 5th, B.E.2557, a 6.3 richter magnitude earthquake with the center of an earthquake at 19.68 degrees north and

99.69 degrees east at 7 kilometers depth in Sai Khao Subdistrict, Phan District in Chiang Rai (data from the Meteorological Department). The public was aware of the vibration throughout the northern region, including those who live in high-rise buildings in Bangkok and severe damages occurred in many areas, in particularly, within a radius of about 30 kilometers from the earthquake center. The cause of this earthquake was a result of the horizontal overlapping left shift of the northern part of Phayao Fault (Mae Lao Fault) which laying in the northeast-southwest direction.

- Wiang Haeng Fault: from the study with assumptions starting with the use of satellite image data, aerial photograph variable with areas that have faults across combined with the study area, Ban Wiang Haeng forest area, Wiang Haeng District, Chiang Mai, it was found that the geomorphology occurred as the result of the faults shift, consisting of the fault cliff, triangular cliff and straight valley indicating that it was a powerful normal fault type. This was based on the guidelines of international principles considering the power faults, which the fault must move at least once in 10,000 years. Therefore, the fault in Wiang Haeng, therefore, met the condition of the power fault as the 16th Muang Haeng Fault Group, the power fault of Thailand. This fault group consisted of Wiang Haeng Fault, Pai Fault, Chiang Dao Fault and Chaiprakarn Fault which laying along the north-south direction near the border of Myanmar. The length of this fault from Wiang Haeng District to Samoeng District, Chiang Mai is approximately 100 kilometers with th rate of longitudinal movement is 0.11 millimeters per year.

(B) West region

- Three Pagodas Fault: is a fault that began to appear in the Union of Myanmar into the border of Thailand at the Three Pagoda Pass in Sangkhlaburi District across Thong Pha Phum District, Si Sawat District, Mueang Kanchanaburi District, and ending in Dan Makham Tia District in Kanchanaburi. It lays in parallel to the River Kwai Noi with a total length of approximately 200 kilometers. Evidence of geomorphology such as overlapped streams, fault cliffs, ridges, headless streams, Nong puddles, hot water springs and triangle cliffs are occurred, indicating that this fault moves horizontally to the right and vertically backward as a reverse fault.

- Si Sawat Fault: is a fault laying in the west of Thailand and has a length of approximately 220 kilometers, starting from across the Union of Myanmar and continuing into Thailand in the area of Umphang District of Tak, Thong Pha Phum District of Kanchanaburi, and passing Huai Kha Khaeng National Park, Ban Rai District, Uthai Thani. Then the fault continuously move to Si Sawat District, Nong Prue District and Bo Phloi District of

Kanchanaburi and Dan Chang District of Suphan Buri. This fault runs parallel to the Kwai Yai River.

(C) South region

- Ranong Fault: laying in the northeast-southwest direction. Starting from the Andaman sea to the land in Takua Pa District and Kuraburi District of Phang Nga and running through Ranong, Chumphon and continuously in the area of Prachuap Khiri Khan. It then comes to the Gulf of Thailand around the east of Sam Roi Yot District, Prachuap Khiri Khan with a total length of approximately 300 kilometers.

- Khlong Ma Lui Fault: this fault lays in parallel to the Ranong Fault Group. It is the left overlapping fault group and move vertically as a reverse fault. This fault line began to appear in the Andaman Sea around the east of Phuket and Ko Yao in Phang Nga Bay area. This fault continuously run into the Maru canal area, Thap Put District, Takua Thung District and Thai Mueang District Of Phang Nga. It lso continuously runs in Surat Thani with the total length of approximately 140 kilometers only on the land. Chaiya District has many hot springs flowing along this fault.

(D) Northeast region

- Phetchabun Fault: laying in the north-south direction which flanked on both sides of the Phetchabun basin which is tilted towards the center of the basin on both sides. This fault is a normal fault which passes through Phetchabun with the length approximately 60 kilometers.

The closest fault to the project area is the Three Pagoda Fault which located approximately 200 kilometers from the project area.

3) Earthquake prone areas of Thailand

According to the Environmental Geology Study of the Department of Mineral Resources, B.E.2556, The disaster earthquake map had been established in Thailand by compiling geological data on powerful faults and earthquakes. The Department of Mineral Resources and other agencies, has divided the earthquake severity in Thailand into 5 levels of the Mercury Section, as seen in **Figure 3.1.2-4**, with following details.

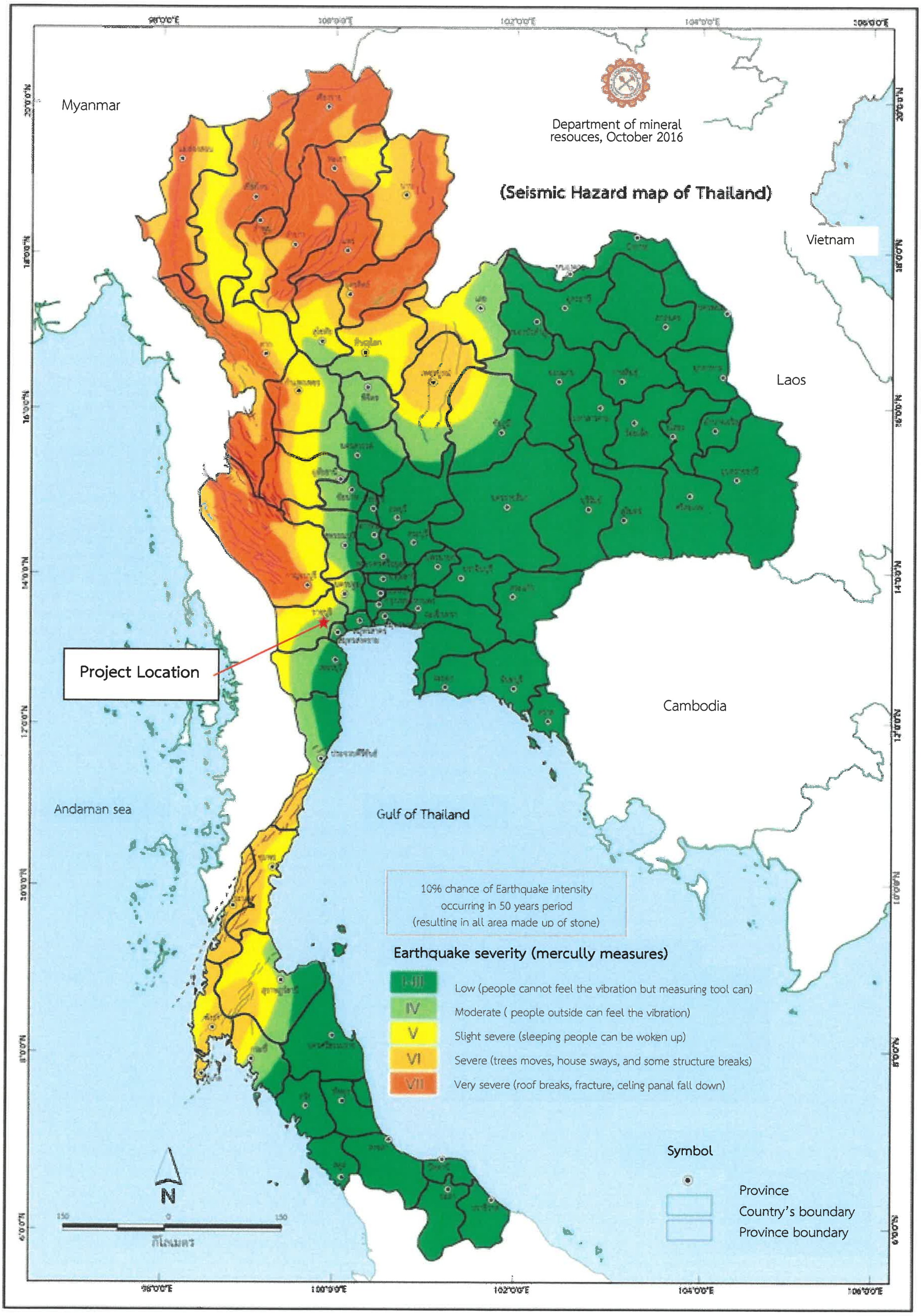


Figure 3.1.2-4 The earthquake disaster map in Thailand

(a) Light level (<III), severity <3 Mercalli or an earthquake magnitude less than 3.9 which can be measured only by vibration measuring devices, cannot be felt unless it is in a suitable environment, in particularly, areas that are sensitive to vibration. Sometimes, it may be observed from abnormal symptoms of birds and animals, feeling numb or nausea or vomiting. Sometimes trees, buildings, liquids and water may sway. The door may swing very slowly. Somebody may feel the vibration, especially, those living on high buildings.

(b) Moderate level (IV), severity of 4 Mercalli or the magnitude of the earthquake is approximately 4.0-4.9. If it occurred during the day, those in the house could feel it. However, there are a few people living outside of the house can feel an earthquake. If it was at night, those who were asleep would panic, dishes will move, the window and the door will shake, the wall will sound loudly, like a heavy truck hit the building, car shaking with clearly noticeable.

(c) Relatively strong level (V), severity of 5 Mercalli, or the magnitude of an earthquake is approximately 4.0-4.9. If an earthquake occurred, most of people can feel it. Many people could be panic, dishes falling, broken windows, broken objects, unstable things, pendulum clocks may stop working.

(d) Major level (VI), severity of 6 Mercalli or the magnitude of an earthquake is approximately 5.0-5.9. If an earthquake occurred, everyone can feel it. Many people could be panic and run outside, some heavy house ornaments/decorations can be moved. In very rare cases, the plastering will fall down. The damage is considering as a minor.

(e) Great level (VII), severity of 7 Mercalli or the magnitude of an earthquake is approximately 6.0-6.9. In buildings that are well designed and constructed, there will be very minor damage. As for the normal construction, the building is slightly to moderate damaged. Buildings that are poorly constructed and designed will be quite damaged. Some chimneys are broken.

For the project area, it is located at the moderate risk level (IV), the severity of 4 Mercalli, or the magnitude of the earthquake is approximately 4.0-4.9. Poeple who live outside the house can feel an earthquake. If it occurred at night, sleeping people would panic, dished will move, the window and the door will shake, the wall will sound loudly, feeling like a heavy truck hit the building, car shaking with clearly noticeable.

4) Earthquakes in Thailand

From collecting earthquake data and the earthquake announcement of the Bureau of Earthquake Surveillance, The Meteorological Department, it was found that the earthquake in Thailand during B.E.2 5 5 3 -2 5 6 2 frequently occurred but no severity. Most of earthquake centers were in neighboring countries resulting in vibration in an area that close to the earthquake epicenter. However, Ratchaburi has areas locating in the risk area of relatively strong level (V), severity of 5 Mercalli, or the magnitude of an earthquake is approximately 4.0-4.9 If an earthquake occurred, most of people can feel it. Many people could be panic, dishes falling, broken windows, broken objects, unstable things, pendulum clocks may stop working. Moreover, some areas of Ratchaburi is also located in the moderate level (IV), severity of 4 Mercalli or the magnitude of the earthquake is approximately 4.0-4.9. If it occurred during the day, those in the house could feel it. However, there are a few people living outside of the house can feel an earthquake. If it was at night, those who were asleep would panic, dishes will move, the window and the door will shake, the wall will sound loudly, like a heavy truck hit the building, car shaking with clearly noticeable. From the earthquake statistics, it was found that Mueang Ratchaburi District Ratchaburi was not affected or had the low impact from the earthquake as shown in **Table 3.1.2-1.**

Table 3.1.2-1
The earthquake in Thailand during B.E.2553-2562

Date	Earthquake statistics	Magnitude
20 March B.E.2553	Earthquake centers were in Myanmar resulting in vibration in Chiang Rai.	5.0
5 April B.E.2553	Earthquake centers were in Wiang Chai District Chiang Rai resulting in vibration in Muang Chiang Rai District Chiang Rai.	3.5
7 April B.E.2553	Earthquake centers were in North Sumatra Indonesia resulting in vibration on many high-rise buildings in Bangkok. Tsunami occurred near the epicenter.	7.6
9 May B.E.2553	Earthquake centers were in North coast of Sumatra Indonesia resulting in vibration on other high-rise buildings in Phuket, Phang Nga, Surat Thani, Songkhla and Bangkok.	7.3
6 July B.E.2553	Earthquake centers were in Myanmar resulting in vibration in Mae Sai District, Mae Chan District, Mae Fah Luang District Chiang Saen District And Mueang Chiang Mai District Chiang Mai.	4.5

Table 3.1.2-1 (cons.)

Date	Earthquake statistics	Magnitude
16 August B.E.2553	Earthquake centers were in Si Sawat District Kanchanaburi resulting in vibration in Si Sawat District Kanchanaburi.	3.3
25 October B.E.2553	Earthquake centers were in South Sumatra Indonesia resulting in vibration in Phuket.	7.1
4 February B.E.2554	Earthquake centers were in The border of India-Myanmar resulting in vibration On a high-rise building in Bangkok.	6.4
23 February B.E.2554	Earthquake centers were in Laos resulting in vibration in Many provinces such as Loei, Nan, Phrae, Udon Thani, Nong Khai and Nong Bua Lam Phu.	5.3
24 March B.E.2554	Earthquake centers were in Myanmar resulting in vibration in many provinces in the north Northeast And many high-rise buildings in Bangkok.	6.1 and 6.7
22 April B.E.2554	Earthquake centers were in Myanmar resulting in vibration in Mae Sai District, Chiang Rai.	4.0
30 April B.E.2554	Earthquake centers were in Andaman Sea on the south-west of Phuket Island resulting in vibration in Phuket.	4.4
10 May B.E.2554	Earthquake centers were in Myanmar resulting in vibration in Mae Sai District, Chiang Rai.	4.0
24 June B.E.2554	Earthquake centers were in Hat Samran District, Trang resulting in vibration in Kantang District, Yan Ta Khao District And Muang District, Trang.	3.5
26 August B.E.2554	Earthquake centers were in Pong District, Phayao resulting in vibration in Pong District, Phayao.	3.7
6 September B.E.2554	Earthquake centers were in North of sumatra Indonesia resulting in vibration in Mueang District, Phuket Hat Yai District, Songkhla and many areas in the South.	6.7
11 January B.E.2555	Earthquake centers were in West coast of North sumatra Indonesia resulting in vibration in Phuket.	7.0
5 March B.E.2555	Earthquake centers were in North of sumatra Indonesia resulting in vibration in Phuket.	5.2
11 April B.E.2555	Earthquake centers were off the west coast of North sumatra Indonesia resulting in vibration in Phuket.	8.1

Table 3.1.2-1 (cons.)

Date	Earthquake statistics	Magnitude
16 April B.E.2555	Earthquake centers were in Thalang District, Phuket And off the western coast of north Sumatra Indonesia resulting in vibration in Phuket.	4.3 and 5.5
4 June B.E.2555	Earthquake centers were in Mueang Ranong District, Ranong resulting in vibration in Mueang Ranong District, Ranong.	4.0
23 June B.E.2555	Earthquake centers were in North sumatra Indonesia resulting in vibration in Phuket and Songkhla.	6.3
13 September B.E.2555	Earthquake centers were in Chom Mok Kaew subdistrict Mae Lao district Chiang Rai resulting in vibration in Phan District, Chiang Rai	3.4
11 November B.E.2555	Earthquake centers were in Myanmar Away from Pang Mapha district. Mae Hong Son 438 kilometers resulting in vibration on high rise building in many areas of Bangkok and Chiang Mai.	5.8 and 6.6
20 December B.E.2555	Earthquake centers were in Myanmar resulting in vibration in Mae Sai District, Chiang Rai.	4.6
7 February B.E.2556	Earthquake centers were in Myanmar resulting in vibration in Mae Sai District, Chiang Rai.	4.3
2 March B.E.2556	Earthquake centers were in Mueang Lampang District, Lampang resulting in vibration in Mueang Lampang District, Lampang.	3.4
5 April B.E.2556	Earthquake centers were in Mae Win Sub-district, Mae Wang District, Chiang Mai resulting in vibration in Mae Wang, Hang Dong District, Chiang Mai.	2.9
11 April B.E.2556	Earthquake centers were in Myanma resulting in vibration in Mae Hong Son.	5.1
7 May B.E.2556	Earthquake centers were in Myanma resulting in vibration in Houses and buildings in Mae Sai District, Chiang Saen District And Mueang Chiang Rai District, Chiang Rai.	5.4
7 June B.E.2556	Earthquake centers were in Mae Wang District, Chiang Mai resulting in vibration in Mae Wang District and San Pa Tong District, Chiang Mai.	3.1
2 July B.E.2556	Earthquake centers were in North sumatra Indonesia resulting in vibration in Phuket and high rise buildings in Bangkok.	6.0

Table 3.1.2-1 (cons.)

Date	Earthquake statistics	Magnitude
17 July B.E.2556	Earthquake centers were in North sumatra Indonesia resulting in vibration Phuket, Phang Nga and Satun.	5.3
11 October B.E.2556	Earthquake centers were in Thung Luang Subdistrict, Phrao District, Chiang Mai resulting in vibration in Phrao District, Chiang Mai.	4.1
21 March B.E.2557	Earthquake centers were in Nicobar Islands India resulting in vibration in Muang Phuket, Phuket.	6.3
5 May B.E.2557	Earthquake centers were in Sai Khao Sub-district, Phan District, Chiang Rai resulting in vibration in Sai Khao Sub-district, Phan District, Chiang Rai.	6.3
9 June B.E.2557	Earthquake centers were in Myanmar resulting in vibration in Wiang Chai District, Mae Sai District and Mueang Chiang Rai District Chiang Rai.	5.1
26 June B.E.2557	Earthquake centers were in Phan District, Chiang Rai resulting in vibration in Mae Lao and Mueang Chiang Rai districts Chiang Rai.	3.2
26 June B.E.2557	Earthquake centers were in Mae Lao District, Chiang Rai resulting in vibration in Chiang Rai And Chiang Mai.	4.6
15 July B.E.2557	Earthquake centers were in Phan District, Chiang Rai resulting in vibration in Phan District, Mae Lao District, Mueang Chiang Rai District And Mae Suai District Chiang Rai.	4.3
16 August B.E.2557	Earthquake centers were in Mae Suai District, Chiang Rai resulting in vibration in Mae Suai District, Chiang Rai.	4.1
25 August B.E.2557	Earthquake centers were in Mae Suai District, Chiang Rai resulting in vibration in Chiang Rai.	4.8
27 October B.E.2557	Earthquake centers were in North sumatra Indonesia resulting in vibration in Phuket.	5.3
23 November B.E.2557	Earthquake centers were in Myanmar resulting in vibration in Mueang Chiang Rai District and Chiang Saen District Chiang Rai.	4.4
6 December B.E.2557	Earthquake centers were in Yunnan China resulting in vibration in Mueang Chiang Rai and Mueang Chiang Mai District Chiang Mai.	5.9

Table 3.1.2-1 (cons.)

Date	Earthquake statistics	Magnitude
20 February B.E.2558	Earthquake centers were in South Koh Yao, Phang Nga Province, about 2 kilometers depth resulting in vibration in Phang Nga, Phuket And Krabi.	4.0
25 March B.E.2558	Earthquake centers were off the east coast of Phuket 23 kilometers depth resulting in vibration in Phuket Province And Phang Nga.	3.8
7 May B.E.2558	Earthquake centers were in South of Koh Yao, Phang Nga about 4.5 kilometers depth resulting in vibration in Phang Nga,Phuket And Krabi.	4.5
24 May B.E.2558	Earthquake centers were in Myanmar resulting in vibration in Chiang Mai Province Chiang Rai And Mae Hong Son.	5.1
6 January B.E.2559	Earthquake centers were in Mae Ho Subdistrict, Mae Sariang District Mae Hong Son resulting in vibration in Mae Sariang District Mae Hong Son.	3.5
10 January B.E.2559	Earthquake centers were in Nong Bua Subdistrict, Mueang Kanchanaburi District Kanchanaburi resulting in vibration in Mueang Kanchanaburi District Kanchanaburi.	2.3
31 March B.E.2559	Earthquake centers were in the sea near Koh Yao Yai, Phang Nga resulting in vibration in Koh Yao Yai District, Phang Nga.	2.4
18 June B.E.2559	Earthquake centers were in the sea near Koh Yao Yai, Phang Nga resulting in vibration in Koh Yao Yai District, Phang Nga.	3.1
24 August B.E.2559	Earthquake centers were in Myanmar 91 kilometers depth resulting in vibration in High-rise buildings of Bangkok and Chiang Mai.	7.0
14 October B.E.2559	Earthquake centers were in Pak Chong District, Nakhon Ratchasima 7 kilometers resulting in vibration in Pak Chong District, Nakhon Ratchasima	3.0
29 October B.E.2559	Earthquake centers were in Myanmar 8 kilometers depth resulting in vibration in Tha Song Yang District And Mae Sot District, Tak	4.4
2 November B.E.2559	Earthquake centers were in Mae Suai District, Chiang Rai 2 kilometers depth resulting in vibration in Mae Lao and Mueang Chiang Rai districts Chiang Rai.	3.6

Table 3.1.2-1 (cons.)

Date	Earthquake statistics	Magnitude
25 November B.E.2559	Earthquake centers were in ae Lao District, Chiang Rai 1 kilometers depth resulting in vibration in Mueang Chiang Rai districts Chiang Rai.	3.2
7 December B.E.2559	Earthquake centers were in North Sumatra Indonesia 26 kilometers depth resulting in vibration in Phang Nga, Phuket Krabi and Trang.	6.4
15 January B.E.2560	Earthquake centers were in Chom Thong District, Chiang Mai 4 kilometers depth resulting in vibration in Chom Thong District, Muang Chiang Mai District, Chiang Mai.	4.2
14 April B.E.2560	Earthquake centers were in Myanmar 2 kilometers depth resulting in vibration in Mueang Chiang Rai District, Mae Sai District, Mae Chan District and Chiang Saen District Chiang Rai.	5.1
22 April B.E.2560	Earthquake centers were in Na Noi District, Nan 3 kilometers depth resulting in vibration in Wiang Sa District, Nan.	3.9
2 May B.E.2560	Earthquake centers were in Mae Lao District, Chiang Rai 6 kilometers depth resulting in vibration in Mae Lao District, Chiang Rai.	3.1
6 May B.E.2560	Earthquake centers were in Laos 10 kilometers depth resulting in vibration in Mueang Nan District, Nan.	4.9
24 May B.E.2560	Earthquake centers were in Koh Yao, Phang Nga 2 kilometers depth resulting in vibration in Koh Yao District, Phang Nga.	3.4
27 May B.E.2560	Earthquake centers were in Mae Suai District, Chiang Rai 8 kilometers depth resulting in vibration in Phan District, Mae Suai District, Mae Lao District, Wiang Pa Pao District, Mae Korn District, Mae Fah Luang District Chiang Rai.	4.0
31 May B.E.2560	Earthquake centers were in Mae Suai District, Chiang Rai 5 kilometers depth resulting in vibration in Mae Suai District, Chiang Rai Province and Fang District, Chiang Mai.	3.8
5 August B.E.2560	Earthquake centers were in Mae Suai District, Chiang Rai 11 kilometers depth resulting in vibration in Mae Suai District, Chiang Rai.	3.6

Table 3.1.2-1 (cons.)

Date	Earthquake statistics	Magnitude
31 August B.E.2560	Earthquake centers were in Mae Suai District, Chiang Rai 5 kilometers depth resulting in vibration in Mae Suai District, Chiang Rai and Fang District, Chiang Mai	3.8
10 September B.E.2560	Earthquake centers were in Mueang Lamphun District, Lamphun 3 kilometers depth resulting in vibration in Mueang Lamphun District, Lamphun.	3.1
22 November B.E.2560	Earthquake centers were in San Sai District, Chiang Mai 2 kilometers depth resulting in vibration in San Sai District, Mae Rim District, and Mueang Chiang Mai District Chiang Mai.	3.0
12 January B.E.2561	Earthquake centers were in Myanmar 10 kilometers depth resulting in vibration in Chiang Mai Province and high-rise buildings in Bangkok.	5.9
3 February B.E.2561	Earthquake centers were in Myanmar 5 kilometers depth resulting in vibration in Mueang Chiang Rai District, Mae Sai District, Mae Chan District and Chiang Saen District Chiang Rai.	5.1
4 February B.E.2561	Earthquake centers were in Myanmar 5 kilometers depth resulting in vibration in Mae Fah Luang District Chiang Rai.	4.0
29 May B.E.2561	Earthquake centers were in Mae Lao District, Chiang Rai 2 kilometers depth resulting in vibration in Mae Lao District, Chiang Rai .	2.7
30 December B.E.2561	Earthquake centers were Si Sawat district Kanchanaburi 2 kilometers depth resulting in vibration in Kanchanaburi Chainat and Uthai Thani.	4.9
22 January B.E.2562	Earthquake centers were in San Sai District, Chiang Mai 1 kilometers depth resulting in vibration in San Sai District and Mae Rim District Chiang Mai.	3.1
20 February B.E.2562	Earthquake centers were in Wang Nuea district, Lampang 21 kilometers depth resulting in vibration in Chiang Mai, Chiang Rai, Phayao.	4.9
14 March B.E.2562 At 00.04 a.m.	Earthquake centers were in Wang Nuea district, Lampang 2 kilometers depth resulting in vibration in Lampang Chiang Rai.	4.1
14 March B.E.2562 At 09.15 p.m.	Earthquake centers were in Wang Nuea district, Lampang 3 kilometers depth resulting in vibration in Wiang Pa Pao District Chiang Rai.	2.9

Table 3.1.2-1 (cons.)

Date	Earthquake statistics	Magnitude
14 March B.E.2562 At 09.55 p.m.	Earthquake centers were in in Wang Nuea district, Lampang 1 kilometers depth resulting in vibration in Lampang, Chiang Rai, Chiang Mai and Phayao.	4.0
15 March B.E.2562	Earthquake centers were in Phan District, Chiang Rai 1 5 kilometers depth resulting in vibration in Phan and Mae Lao districts Chiang Rai	3.0
18 April B.E.2562	Earthquake centers were in Wang Nuea District, Lampang 3 kilometers depth resulting in vibration in Wang Nuea District, Lampang.	2.9
23 April B.E.2562	Earthquake centers were in Fang District, Chiang Mai 4 kilometers depth resulting in vibration in Fang District, Chiang Mai.	2.8

3.1.3 Air quality

(1) Climate condition

The study area has a Tropical Savanna Climate (AW) with relatively stable temperatures which under the influence of 2 types of monsoon in Thailand, the northeast monsoon occurs around mid-October to mid-February and the southwest monsoon occurs during the rainy season, around mid-May to mid-October. The direction of the win mostly blows from the southwest and bring moisture and steam entering the study area causing the moisted air and generally rainy. The climate is under the influence of 3 types of winds. which are.

1) Seasonal wind

It called monsoon with a stable and consistent direction. The main cause is the difference between the temperature of the ground and the water surface. In the winter, the temperature of the ground is cooler than water temperature in the ocean, the air above the water surface has a higher temperature and floats upwards. The cold air over the continent flows instead, causing it to blow out of the continent. By the summer, the temperature of the continental soil is warmer than the ocean water, causing the wind to blow in the opposite direction. Thailand is under the influence of 2 types of monsoon which are.

(A) Southwest monsoon

This monsoon blows over Thailand between mid-May to mid-October which originated from the high pressure area in the southern hemisphere around the Indian Ocean. It blows from the center into the southeast and changes to southwest wind when crossing the equator. This monsoon will bring moist air mass from the Indian Ocean to Thailand causing cloudy and general rain, espectially, in coastal areas and mountains, on the receiving side, there will be more rain than other areas.

(B) Northeast monsoon

This monsoon blows over Thailand around mid-October until mid-February which originated from high pressure areas on the northern hemisphere, Mongolia and China,. Then it blows away the cool and dry air from the source to cover the sky. The weather is then cold and dry.

2) Diurnal wind

It is the wind blowing at a clearly certain time during the day. This type of wind is not very violent, such as;

(A) Land breeze

It is a coastal wind that blows from the shore into the sea at night which occur because at night the ground is cooler than the water surface. Therefore, the air above the water surface is lighter and floats higher. The wind then blows from a cooler land, meaning that it blows from the shore to the sea wich is warmer causing a land breeze.

(B) Sea breeze

It is the coastal wind that blows from the sea into the shore during the daytime because the ground is hotter than the water surface. Therefore, the air above the ground is lighter and floats higher. The air from the sea will then move in instead (entering the shore) causing the sea breeze.

3) Local wind

It is a short-distance wind that is created by uneven heat of the earth surface and occurs at different times of the year. It was called with different names for different places, such as.

(A) Lom Tapoa

It blows from south to north in the middle of summer, especially in April. The wind strongly blows during the day because it joins the sea breeze. As for the night, it will blow softly because there is landbreeze blows against it. People often misunderstand that Lom Tapoa is a kite wind because during the March to April, people like to play kites.

(B) Kite wind

It is a cool breeze blowing from the north to Chao Phraya River Basin or from the north to the south in the cold season between September and November, which is the northeast monsoon period blowing over Thailand. It is also known as "kao bao wind" because it occurs during the period of kao bao harvest. (Fast-growing rice that is harvested in the twelfth lunar month).

(C) U-Thra wind

It is the wind that blows from northeast to southwest in the beginning of the summer, around March and April. It is the northeast monsoon during the season changing from northeast monsoon to southwest monsoon. During this period, the northeast monsoon may blow from time to time causing thunderstorm and the fluctuated weather occuring for many days.

(D) Pattaya Wind

It is the wind that blows from the southwest to the northeast at the beginning of the rainy season, around May, which is the southwest monsoon at the beginning of the season.

(E) Tako wind

It is the wind that blows from northwest to southeast at the end of the rainy season, around October, which is the changing season from southwest monsoon to northeast monsoon. Therefore, Tako wind is the northeast monsoon at the beginning of the season, with the uncertain direction.

(F) Tornado

It is the wind in the sea that blows from southwest to northeast during the late rainy season (the southwest monsoon season) or a large storm.

From the influence of mentioned winds, resulting in 3 seasons which consisting of ;

- Summer starts from the middle of February until the end of April, approximately 3 month, due to there will be a wind from the south or southeast, blowing from the sea into the shore, causing the general air not very hot.

- The rainy season starts from May to October for about 6 months due to the influence of the southwest monsoon that blows from the sea into the shore. It brings moisture from the equator and southern hemisphere around the Indian Ocean, resulting in cloudy and abundant rainfall. At the beginning of the season, rain and thunderstorm occurs quite often and decreas in June. From then, more rain will occur again in July until November. However, sometimes the depression storm moving from the South China Sea will cause more heavy rain.
- Winter starts from November to February for approximately 2-3 months due to the influence of northeast monsoon bringing cold and drought wind from the People's Republic of China, resulting in cool and dry weather.

(2) Meteorology

For the meteorological condition in the study area, the consulting company had collected meteorological data for a period of 13 years (B.E.2549-2561) of Ratchaburi Weather Measurement Station as a representative. Since it is the station that is closest to the project, it is located at the latitude of 13 degrees, 29 minutes north and 99 degrees long, 47 minutes east, details as seen in **Table 3.1.3-1.** The wind chart for the 13 year period (B.E. 2549-2561) were shown in **Figure 3.1.3-1** and were explained as follows.

1) Air pressure

The average annual atmospheric pressure is 1,009.14 Hectopascals, with a range between 1,006.6 and 1,012.2 Hectopascals. The difference of average daily atmospheric pressure is 3.62 Hectopascals. The maximum atmospheric pressure is 1,031.65 Hectopascals, which was detected in October. The lowest pressure 994.19 hectopascals was detected in September.

2) Temperature

The average annual temperature is 33.2° C. The highest average temperature throughout the year is 41.5° C. The average temperature of the lowest - highest are 19.2-23.9°C, the lowest temperature is 12°C which detecting in January. The highest temperature is 41.5°C, detecting in April.

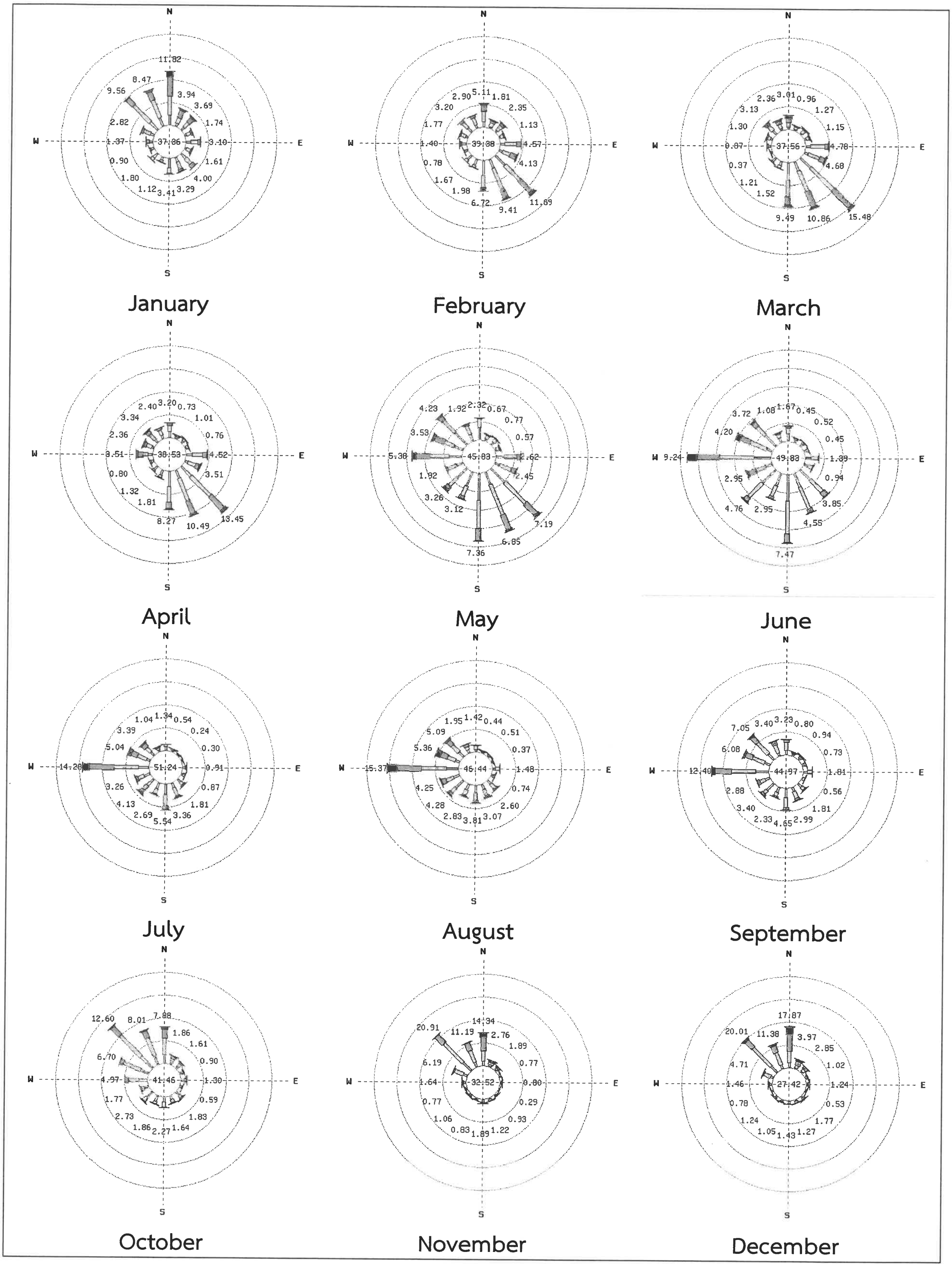
Table 3.1.3-1

Meteorological data for 13 years period (B.E.2549-2561) of Ratchaburi Weather Measurement Station

Station	Ratchaburi	Elevation of station above MSL	5.00 meters
Index station	48464	Height of barometer above MSL	0.00 meters
Latitude	13 degrees, 29 minutes north	Height of thermometer above ground	1.50 meters
Longitude	99 degrees long, 47 minutes east	Height of Anemometer above ground	10.00 meters
		Height of raingauge	0.80 meters

	jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Air pressure (Hectopascals)													
Mean	1012.2	1010.9	1010	1008.6	1007.2	1006.6	1006.8	1007.1	1007.8	1009.7	1010.8	1012.0	1009.14
Mean daily range	4.0	4.0	4.1	4.0	3.7	3.0	2.8	3.0	3.8	3.8	3.5	3.8	3.62
Max.	1022.75	1020.81	1018.35	1016.69	1013.98	1013.24	1012.84	1012.11	1015.82	1031.65	1017.99	1022.48	1031.65
Min.	1003.77	1003.0	1002.03	1001.18	1001.50	995.99	1000.69	1001.3	994.19	1002.63	1003.8	1003.55	994.19
Temperature (° C)													
Mean max.	31.6	33.8	35.2	36.2	35	33.8	33.1	33.2	33	31.9	31.3	30.8	33.2
Ext. max.	36.5	37	40	41.5	39.7	37	36.5	37	36.6	36.5	36	35.5	41.5
Mean min.	20.5	22	23.9	25.2	25.6	25.3	25	25	24.8	24.6	23.4	21.4	23.9
Ext. min.	12	14.4	17.5	21.4	23	23.4	23.5	23	22.5	21.3	15.5	13.1	12
Mean	25.4	27.2	28.7	29.7	29.1	28.5	28	28.1	27.8	27.2	26.6	25.4	27.6
Dew point (° C)													
Mean	19.5	21.3	23.1	24	24.8	24.5	24.1	24	24.4	24.5	22.7	20.1	23.1
Relative humidity (ร้อยละ)													
Mean	72	73	74	74	80	80	81	80	83	86	81	74	78.1
Mean max.	91	93	93	92	95	95	95	94	96	97	94	90	93.7
Mean min.	49	48	49	50	58	61	61	60	64	68	62	53	56.9
Ext. min.	17	18	24	28	33	44	17	45	48	45	40	29	17
Visibility (kilometers)													
7.00 a.m.	5.3	4.1	5.1	7.5	9.2	9.9	9.8	10.1	10.1	7.3	7.2	6.9	7.7
Cloud volume (1-10)													
Mean	2.7	1.9	2.5	4.2	6.9	7.8	8.5	8.4	8.3	7.2	4.7	3.5	5.6
Wind (knots)													
Directions	N,NW	SE	SE	SE	SE	W	W	W	W	NW	NW	NW	-
Mean	2.7	2.5	2.8	2.6	2.2	2	2.2	2.5	2.3	2.2	3	3.5	2.5
Max.	37	25	27	31	35	45	43	40	40	34	38	32	45
Evaporation (Millimeter)													
Average	125.9	135.1	160.2	179.8	166	137.7	132.3	139.3	133.9	111.2	107.1	121.6	1650.1
Rainfall volume (Millimeter)													
Mean	4.6	5.8	34.5	42.6	151.2	130.9	125.5	115.1	225.1	239.8	64.2	10.6	1149.9
Mean rainy day	1.6	1.2	3.7	5.2	15.7	16.3	18	17.9	19.8	18.1	6.3	1.9	125.7
Daily maximum	34.3	19.7	93.9	94.7	98.2	86.6	83.1	62.3	113	141.3	304.9	27	304.9
Natural phenomena (day)													
Fog	0.2	0.5	0.5	0	0.1	0	0	0	0.1	0.1	0.1	0	1.6
Haze	23.1	22.6	22.9	10.2	0.8	0.4	0	0.1	0.2	3.7	9.2	19.1	112.3
Hail	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0.2
Thunderstorm	0.4	0.8	2.1	5	12.4	7.8	6.4	5.6	7.7	9.5	1.9	0	59.6
Squall	0	0	0	0	0	0	0	0	0	0.1	0	0	0.1

Source : Thai Meteorological Department, B.E.2561



Source : Thai Meteorological Department, B.E.2561

Figure 3.1.3-1 Wind chart for period of B.E. 2549-2561_of Ratchaburi Weather Measurement Station

3) Relative humidity

The average relative humidity throughout the year is 78.1%, with a range between 72.0% to 86.0%. The highest average relative humidity throughout the year is 93.7. The lowest average relative humidity throughout the year is 56.9 %. The highest average relative humidity that ever measured is 97% in the October. The lowest average relative humidity that ever measured is 17% in January. In general, the relative humidity will increase in the rainy season and during the winter.

4) Cloud volume

The average amount of clouds in the sky ranges from 1.9 to 8.5 parts in 10 parts. The cloudiest period is July, which is the rainy season. It could be measured for 8.5 parts in 10 parts of the sky. The period with the least amount of cloud is February. Clounds in February was measured for 1.9 parts in 10 parts of the sky.

5) Wind

The most common wind direction according to the frequency of occurrence in each month consists of 5 directions which are from the north, southeast northwest, west and northeast. The wind speed in each month ranges from 2.0 to 3.5 knots. The highest wind speed is 45 knots found in June.

6) Rainfall volume

The average annual rainfall is 1,149.9 millimeters. The month with the highest rainfall is October, for 239.8 millimeters. The month with the least average rainfall is January for 4.6 millimeters. The maximum daily rainfall is 125.7 millimeters.

7) Thunderstorm

The number of days with thunderstorms in the year is equal to 59.6 days. The month with the most thunderstorms is May for 12.4 days. The month with the least thunderstorms is January, for 0.4 days.

8) Cloud

The average number of days of fog occurring during the year is 112.3 days, January is the month of the most cloudy for 23.1 days. August is the month with the least amount of fog for 0.1 day.

(3) Air quality

The study of air quality around the project area will be an indicator of the current air quality level and the potential to handle the air pollution of the area. Therefore, the consulting company collected the secondary data on air quality measurement results of the project area, both from continuous air quality measurement stations of the Department of Pollution Control B.E.2558-2562. The measurement done by TECO and from the measurement done by the consulting company. Details were as follows.

1) Information on measurement results of the Pollution Control Department

The consulting company collected data from the Air Quality Monitoring Report of the Pollution Control Department at the station in the Regional Environment Office 8 , Na Mueang Subdistrict, Mueang Ratchaburi District, Ratchaburi which was 8 kilometers away from the project location. The data came from the measurement during B.E. 2558-2562. For the highest air quality measurement results, details were shown in **Table 3.1.3-2** and summarized as follows

(A) Particulate matter less than 10 microns (PM-10) average 24 hours

From the measurement results from January to December, it was found that in B.E.2558, the maximum concentration of Particulate matter less than 10 microns in an average of 24 hours was in the range of 24-134 $\mu g/m^3$. When comparing the above concentration with atmosphere air quality standards in accordance with the Announcement of the National Environment Board No.24 (B.E.2547), on the determination of general air quality standards in which determined the concentration of Particulate matter less than 10 microns in an average of 24 hours, not more than 120 $\mu g / m^3$, it was found that it exceeded the standards in February.

In B.E.2559, the maximum concentration of Particulate matter less than 10 microns in an average of 24 hours was in the range of 34-167 $\mu g/m^3$. When comparing the above concentration with atmospheric air quality standards as announced by the National Environment Board, issue No.24 (B.E.2547), on the setting of air quality standards in general atmosphere. Which determined the concentration of Particulate matter less than 10 microns in an average of 24 hours, not more than 120 $\mu g/m^3$, it was found that it exceeded the standards in February and March.

Table 3.1.3-2

The highest air quality measurement results in the Regional Environment Office 8, Na Mueang Subdistrict, Mueang Ratchaburi District, Ratchaburi during B.E. 2558-2562

Months	Particulate matter less than 10 microns (PM-10)					Particulate matter less than 2.5 microns (PM-2.5)					Sulfur dioxide (SO_2)					Nitrogen dioxide (NO_2)				
	average 24 hours (μg/m^3)					average 24 hours (μg/m^3))					average 1 hour (μg/m^3)					average 1 hour (μg/m^3)				
	2558	**2559**	**2560**	**2561**	**2562**	**2558**	**2559**	**2560**	**2561**	**2562**	**2558**	**2559**	**2560**	**2561**	**2562**	**2558**	**2559**	**2560**	**2561**	**2562**
January	116	108	90	114	144*	84*	78*	55*	73*	102*	50	42	24	16	29	120	85	75	103	128
February	134*	167*	121*	133*	102	105*	136*	84*	89*	78*	34	26	24	26	21	72	145	90	72	81
March	74	146*	116	108	85	54*	108*	82*	74*	60*	31	21	31	13	31	68	94	60	47	56
April	76	76	77	80	60	54*	49	40	39	33	47	39	13	21	21	51	36	32	38	28
May	40	41	45	49	74	23	43	20	22	37	16	10	10	34	10	32	34	19	32	30
June	24	35	62	52	40	18	18	22	17	25	34	10	16	13	8	30	23	17	32	26
July	48	46	43	57	45	25	15	15	34	26	47	13	10	21	8	34	24	24	28	23
August	26	46	44	64	46	17	18	17	21	15	16	16	10	8	8	34	24	24	26	23
September	51	34	33	40	69	39	18	12	23	35	31	13	5	26	8	36	21	28	43	38
October	77	47	95	80		49	30	57	44		448	10	18	31		55	36	53	58	
November	73	61	87	79		39	34	50	45		21	24	26	21		58	58	66	68	
December	102	83	112	88		71	56	66	60		79	24	39	52		81	73	79	100	
standards 1/	**120**					**50**					**780**					**320**				

Note : *Measurement results exceed the standard limit as the weather will be less floating, calm wind, causing the amount of dust to accumulate.

1/ Announcement of the National Environmental Board No.24 (B.E.2547) on ambient air quality standard

Announcement of the National Environmental Board No.36 (B.E.2553) on standard of particulate matter size not exceeding 2.5 microns in ambient air

Announcement of the National Environmental Board No.21 (B.E.2544) on standard of sulfur dioxide concentration in ambient air in period of one hour

Announcement of the National Environmental Board No.33 (B.E.2552) on standard of nitrogen dioxide concentration in ambient air

Source : Pollution Control Department (search 6 December B.E. 2562 from : http://air4thai.pcd.go.th/)

In B.E. 2560, the highest concentration of Particulate matter less than 10 microns, averaging 24 hours, was in the range of 33-121 μg/m^3. When comparing the above concentration with atmospheric air quality standards as announced by the National Environment Board. No. 24 (B.E.2547), regarding the setting of air quality standards in general atmosphere determining the concentration of Particulate matter less than 10 microns in an average of 24 hours, not more than 120 μg/m^3, it was found that it exceeded the standards in February.

In B.E.2561, the highest concentration of Particulate matter less than 10 microns, averaging 24 hours, was in the range of 40-133 μg/m^3. When comparing the above concentration with atmospheric air quality standards as announced by the National Environment Board. No. 24 (B.E.2547), regarding the setting of air quality standards in general atmosphere determining the concentration of Particulate matter less than 10 microns in an average of 24 hours, not more than 120 μg/m^3, it was found that it exceeded the standards in February.

In B.E. 2562, the highest concentration of Particulate matter less than 10 microns, averaging 24 hours, was in the range of 40-144 μg/m^3. When comparing the above concentration with atmospheric air quality standards as announced by the National Environment Board. No. 24 (B.E.2547), regarding the setting of air quality standards in general atmosphere determining the concentration of Particulate matter less than 10 microns in an average of 24 hours, not more than 120 μg/m^3, it was found that it exceeded the standards in January.

(B) Particulate matter less than 2.5 microns (PM-2.5) average 24 hours

From the measurement results from January to December, it was found that in B.E.2558, the maximum concentration of dust less than 2.5 microns in average 24 hours was in the range of 17-105 μg/m^3. When comparing the above concentration with the air quality standards in the atmosphere, according to the National Environment Board's announcement, No.3 6, B.E.2553 on the standard of general Particulate matter less than 2 .5 microns in the atmosphere determining the concentration of Particulate matter in average 24 hours, not more than 50 μg/ m^3, it was found that it exceeded the standard criteria since December to April.

In B.E. 2559, it was found that the maximum concentration of Particulate matter less than 2.5 microns in average 24 hours was in the range of 15-136 μg/m^3 . When comparing the above concentration with atmospheric air quality standards as announced by the National Environment Board, Issue No. 3 6 , B.E. 2553 on the standardization for general Particulate matter less than 2 .5 microns in atmosphere determining the concentration of Particulate matter less than 2.5 microns in average 24 hours, not more than 50 µg/m^3, it was found that it exceeded the standard criteria since December to March.

In B.E.2 5 6 0 , it was found that the maximum concentration of Particulate matter less than 2.5 microns in average 24 hours was in the range of 12-84 µg/m^3. When comparing the above concentration with atmospheric air quality standards as announced by the National Environment Board, Issue No. 3 6 , B.E. 2553 on the standardization for general Particulate matter less than 2 .5 microns in atmosphere determining the concentration of Particulate matter less than 2.5 microns in average 24 hours, not more than 50 µg/m^3, it was found that it exceeded the standard criteria since October and December to March.

In B.E. 2 5 6 1 , it was found that the maximum concentration of Particulate matter less than 2.5 microns in average 24 hours was in the range of 17-89 µg/m^3. When comparing the above concentration with atmospheric air quality standards as announced by the National Environment Board, Issue No. 3 6 , B.E. 2553 on the standardization for general Particulate matter less than 2 .5 microns in atmosphere determining the concentration of Particulate matter less than 2.5 microns in average 24 hours, not more than 50 µg/m^3, it was found that it exceeded the standard criteria since December to March.

In B.E. 2 5 6 2 , it was found that the maximum concentration of Particulate matter less than 2.5 microns in average 24 hours was in the range of 15-102 µg/m^3. When comparing the above concentration with atmospheric air quality standards as announced by the National Environment Board, Issue No. 3 6 , B.E. 2553 on the standardization for general Particulate matter less than 2 .5 microns in atmosphere determining the concentration of Particulate matter less than 2.5 microns in average 24 hours, not more than 50 µg/m^3, it was found that it exceeded the standard criteria since December to March.

According to Pollution Control Department data from January to February , it was found that Particulate matter less than 2.5 microns in average 24 hours มี was exceeded 50 µg/m^3, which was quite over the standard value. Particulate matter less than 2.5 microns had heavily accumulated. Ratchaburi is considered a province with cars traveling 24 hours a day and has Petchkasem Road cutting through as it is the main route heading to the southern region. It is also a source of factories of many sizes, the mall and communities with many car passes. Therefore, the amount of cars, many diesel-powered trucks that gather in this area causing the engine combustion all the time. Thus, dust was accumulated in Ratchaburi. Due to many stages of road construction, building a double-track railway, waste incineration, grass burning, charcoal burning, field-burning, etc. By the latest situation, Mr. Chayawut Chanthara, the governor of Ratchaburi issued a letter of express order, signed on January 26th, B.E.2562, on absolutely prohibiting the burning of rubbish, farms, etc., in Ratchaburi area. The letter was sent to inform the sheriff district director of every district, mayors of every city, local directors for the purposing of notify businesses, Industrial plants and people who violate the law to cooperate with all parties. The province will intensify the law enforcement from requesting cooperation, prohibiting the violation of the law, criminal proceedings, until claiming compensation for civil damages to protect the public interest. The governor requeasted public to cooperate for overcoming the crisis in January – February, B.E.2562.

(C) Sulfur dioxide (SO_2), average 1 hour

From the measurements during January to December, it was found that in B.E.2558, the highest concentration of sulfur dioxide for 1 hour was in the range of 16-448 μg/m^3. When comparing values with the standard values to the standard value in air quality atmosphere according to the National Environment Board Announcement No.21 (B.E.2544), regarding the establishment of general air quality standards determining the average concentration of sulfur dioxide for 1 hour, not more than 780 μg/m^3, it was found that it was within the specified standard criteria.

In B.E. 2559, it was found that the highest concentration of sulfur dioxide for 1 hour was in the range of 10-12 μg/m^3. When comparing values with the standard values to the standard value in air quality atmosphere according to the National Environment Board Announcement No.21 (B.E.2544), regarding the establishment of general air quality standards determining the average concentration of sulfur dioxide for 1 hour, not more than 780 μg/m^3, it was found that it was within the specified standard criteria.

In B.E. 2560, it was found that the highest concentration of sulfur dioxide for 1 hour was in the range of 5-39 μg/m^3. When comparing values with the standard values to the standard value in air quality atmosphere according to the National Environment Board Announcement No.2 (B.E.2544), regarding the establishment of general air quality standards determining the average concentration of sulfur dioxide for 1 hour, not more than 780 μg/m^3, it was found that it was within the specified standard criteria.

In B.E.2561, it was found that the highest concentration of sulfur dioxide for 1 hour was in the range of 8-52 μg/m^3. When comparing values with the standard values to the standard value in air quality atmosphere according to the National Environment Board Announcement No.21 (B.E.2544), regarding the establishment of general air quality standards determining the average concentration of sulfur dioxide for 1 hour, not more than 780 μg/m^3, it was found that it is within the specified standard criteria.

In B.E.2562, it was found that the highest concentration of sulfur dioxide for 1 hour was in the range of 8-31 μg/m^3. When comparing values with the standard values to the standard value in air quality atmosphere according to the National Environment Board Announcement No.21 (B.E.2544), regarding the establishment of general air quality standards determining the average concentration of sulfur dioxide for 1 hour, not more than 780 μg/m^3, it was found that it is within the specified standard criteria.

(D) Nitrogen dioxide (NO_2), average 1 hour

From the measurement results during January to December, it was found that in B.E.2558, the maximum concentration of nitrogen dioxide for 1 hour was in the range of 30-120μg/m^3. When comparing the above mentioned values with the standard value of nitrogen dioxide for the air quality in the atmosphere, accoring the Announcement of the National Environment Board No.33 (B.E.2552) on the establishment of general air quality standards determining the average concentration of nitrogen dioxide for 1 hour, not more than 320μg/m^3, it was found that the value was within the specified standard criteria.

In B.E. 2559, the maximum concentration of nitrogen dioxide for 1 hour is in the range of 21-145 μg/m^3. When comparing the above mentioned values with the standard value accoring the Announcement of the National Environment Board No.33 (B.E.2552) on the establishment of general air quality standards determining the average concentration of nitrogen dioxide for 1 hour, not more than 320μg/m^3, it was found that the value was within the specified standard criteria.

In B.E. 2560, the maximum concentration of nitrogen dioxide for 1 hour is in the range of 17-90 μg/m^3. When comparing the above mentioned values with the standard value accoring the Announcement of the National Environment Board No.33 (B.E.2552) on the establishment of general air quality standards determining the average concentration of nitrogen dioxide for 1 hour, not more than 320µg/m^3, it was found that the value was within the specified standard criteria.

In B.E. 2561, the maximum concentration of nitrogen dioxide for 1 hour is in the range of 26-103 µg/m^3. When comparing the above mentioned values with the standard value accoring the Announcement of the National Environment Board No.33 (B.E.2552) on the establishment of general air quality standards determining the average concentration of nitrogen dioxide for 1 hour, not more than 320µg/m^3, it was found that the value was within the specified standard criteria.

ปี B.E. 2562, the maximum concentration of nitrogen dioxide for 1 hour is in the range of 23-128 µg/m^3. When comparing the above mentioned values with the standard value accoring the Announcement of the National Environment Board No.33 (B.E.2552) on the establishment of general air quality standards determining the average concentration of nitrogen dioxide for 1 hour, not more than 320 µg/m^3, it was found that the value was within the specified standard criteria.

2) Measurement results done by TECO

The consulting company collected the data from the report on the implementation of the environmental impact prevention and measures and the environmental impact monitoring measures of the Combined Cycle Power Plant (Gas Power) Project, 700 MW, Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch) located in Hin Kong Subdistrict, Mueang Ratchaburi District Ratchaburi during B.E.2558-2562 (5 years), twice a year. It had the measurement index such as, total suspended particulate matter Particulate matter less than 10 microns, nitrogen dioxide and sulfur dioxide. The measurement was done in 4 stations, which were, Ban Hin Khong, Ban Nong Kham, Khao Dinso and Ban Nong Song Hong (**Figure 3.1.3-2**). Details were shown in **Table 3.1.3-3**, and were summarized as follows.

(A) Total Suspended Particulate Matter (TSP) average 24 hours

From the measurement during B.E. 2558-2562, it was found that the average of total suspended particulate matter concentration of 24 hours in the Ban Hin Kong area was in the range of 46-167 µg/m^3. The area of Ban Nong Kham was in the range of 42-145 µg/m^3. In the Khao Dinso area, it was in the range of 35- 107 µg/m^3 and the area of Ban Nong Song Hong was in the range of 48-165 µg/m^3.

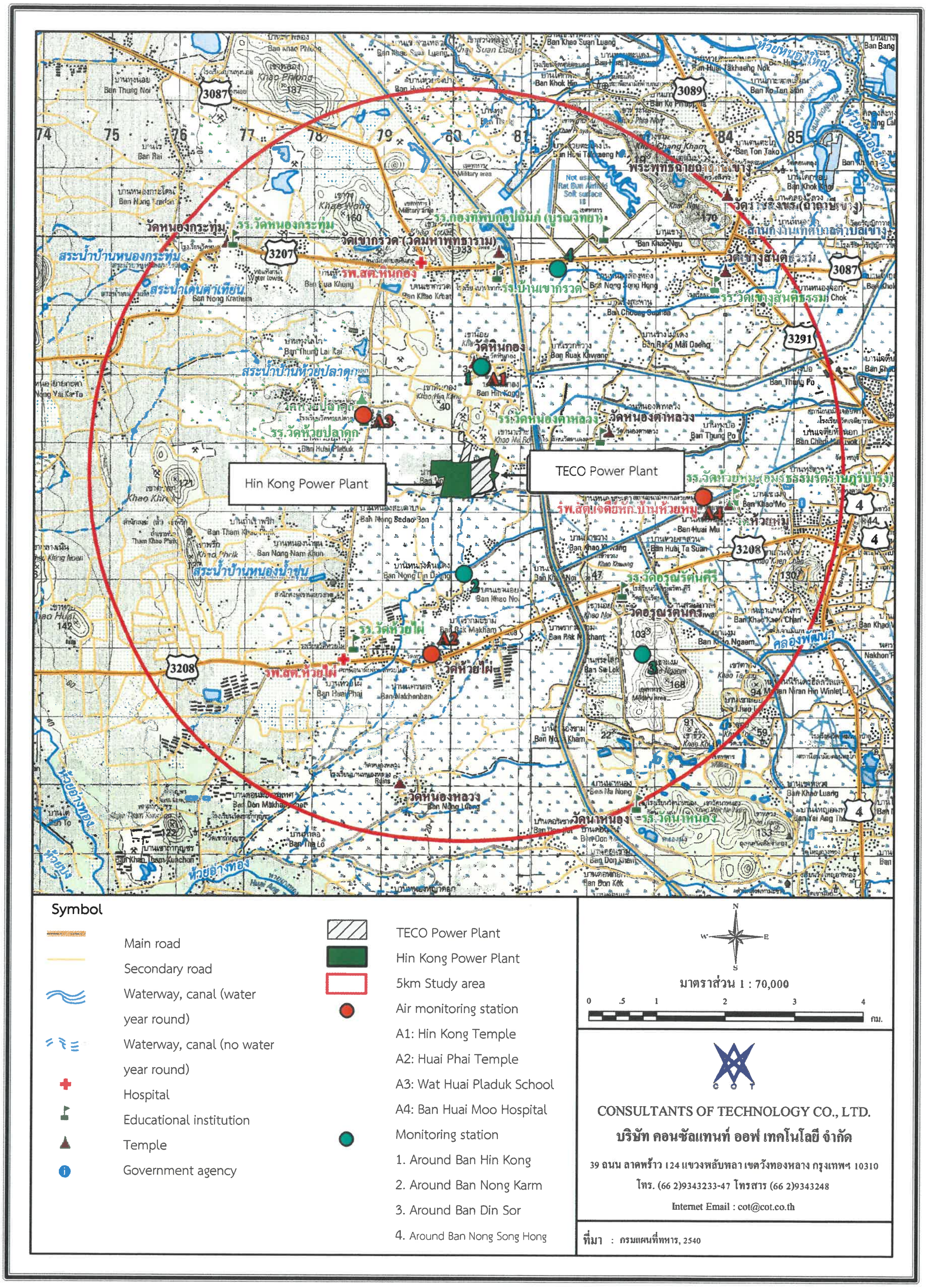


Figure 3.1.3-2 The measurement stations.

Table 3.1.3-3

Data from the report on the implementation of the environmental impact prevention and measures and the environmental impact monitoring measures of the Combined Cycle Power Plant (Gas Power) Project, 700 MW, Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch) located in Hin Kong Subdistrict, Mueang Ratchaburi District Ratchaburi during B.E.2558-2562

station	Time[2/]	measurement results (μg/m³)				
		Total Suspended Particulate Matter (TSP) average 24 hours	Particulate matter less than 10 microns (PM-10) average 24 hours	Sulfur dioxide (SO_2)		Nitrogen dioxide (NO_2)
				average 1 hour	average 24 hours	average 1 hour
Ban Hin Khong	1/2558	53-61	34-41	2.62-10.48	5.24-7.86	13.10-55.03
	2/2558	59-68	28-46	5.24-20.96	7.86-10.48	2.36-52.41
	1/2559	103-110	50-54	5.24-18.34	7.86-10.48	1.83-39.31
	2/2559	52-71	25-51	2.10-18.34	7.86-10.48	5.24-70.75
	1/2560	95-167	47-80	5.24-13.10	7.86-10.48	18.34-55.03
	2/2560	53-65	24-31	5.24-13.10	7.86	20.96-47.17
	1/2561	54-78	27-36	5.24-13.10	7.86	18.34-44.55
	2/2561	47-58	20-27	5.24-10.48	10.48	18.34-52.41
	1/2562	46-55	21-26	5.24-10.48	7.86-10.48	15.72-52.41
Min.-Max.		**46-167**	**20-80**	**2.10-20.96**	**7.86-10.48**	**2.36-70.75**
Ban Nong Kham	1/2558	62-145	37-54	2.62-10.48	5.24-7.86	5.24-83.85
	2/2558	61-72	47-57	1.05-23.58	5.24-7.86	2.62-65.51
	1/2559	78-126	40-60	15.72-18.34	7.86-10.48	7.86-34.07
	2/2559	60-90	25-38	2.62-23.58	7.86-10.48	7.86-41.93
	1/2560	90-128	43-58	5.24-13.10	7.86-10.48	23.58-57.65
	2/2560	42-56	20-27	5.24-10.48	7.86	18.34-44.55
	1/2561	65-98	30-47	5.24-13.10	7.86	18.34-44.55
	2/2561	45-54	22-26	5.24-10.48	7.86	18.34-47.17
	1/2562	42-52	20-25	5.24-13.10	7.86-10.48	18.34-52.41
Min.-Max.		**42-145**	**20-58**	**1.05-23.58**	**5.24-10.48**	**2.62-83.85**

Table 3.1.3-3 (cons.)

station	Time[2/]	measurement results ($\mu g/m^3$)				
		Total Suspended Particulate Matter (TSP) average 24 hours	Particulate matter less than 10 microns (PM-10) average 24 hours	Sulfur dioxide (SO_2)		Nitrogen dioxide (NO_2)
				average 1 hour	average 24 hours	average 1 hour
Khao Dinso	1/2558	38-48	23-38	5.24-20.96	13.10	13.10-99.58
	2/2558	52-64	31-39	5.24-23.58	10.48-15.72	18.34-52.41
	1/2559	51-62	35-43	2.62-7.86	5.24-7.86	5.24-34.07
	2/2559	47-53	29-37	1.31-20.96	2.62-10.48	5.24-65.51
	1/2560	83-107	36-48	5.24-13.10	10.48	23.58-60.27
	2/2560	35-44	16-21	5.24-13.10	7.86	18.34-65.51
	1/2561	49-69	23-35	5.24-13.10	7.86-10.48	18.34-49.79
	2/2561	37-49	18-24	5.24-13.10	7.86	18.34-47.17
	1/2562	35-45	16-22	5.24-13.10	7.86-10.48	18.34-47.17
Min.-Max.		**35-107**	**16-48**	**1.31-23.58**	**2.62-15.72**	**5.24-99.58**
Ban Nong Song Hong	1/2558	56-67	9-44	2.62-7.86	5.24-7.86	5.24-41.93
	2/2558	68-98	32-86	5.24-28.82	7.86-15.72	2.62-68.13
	1/2559	134-165	52-63	0.52-20.96	5.24-7.86	5.24-34.07
	2/2559	56-95	30-49	5.24-15.72	7.86-10.48	5.24-94.34
	1/2560	94-140	44-67	5.24-13.10	10.48	31.45-62.89
	2/2560	51-68	23-32	5.24-13.10	7.86	18.34-65.51
	1/2561	51-75	24-38	7.86-15.20	10.48	20.96-49.79
	2/2561	52-57	25-28	5.24-13.10	7.86	15.72-41.93
	1/2562	48-60	23-27	5.24-13.10	7.86-10.48	18.34-55.03
Min.-Max.		**46-167**	**20-80**	**2.10-20.96**	**7.86-10.48**	**2.36-70.75**
Standard [1/]		**330**	**120**	**780**	**300**	**320**

Source : The report on the implementation of the environmental impact prevention and measures and the environmental impact monitoring measures of the Combined Cycle Power Plant (Gas Power) Project, 700 MW, Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch) located in Hin Kong Subdistrict, Mueang Ratchaburi District Ratchaburi during B.E.2558-2562

Note : [1/] Announcement of the National Environmental Board No.24 (B.E.2547) on ambient air quality standard.
Announcement of the National Environmental Board No.21 (B.E.2544) on standard of sulfur dioxide concentration in ambient air in period of one hour
Announcement of the National Environmental Board No.33 (B.E.2552) on standard of nitrogen dioxide concentration in ambient air

[2/] 1st/2558 Date 7-10 March B.E. 2558 — 2nd/2558 Date 8-11 December B.E. 2558
1st/2559 Date 7-10 April B.E. 2559 — 2nd/2559 Date 14-17 December B.E. 2559
1st/2560 Date 14-17 February B.E. 2560 — 2nd/2560 Date 9-12 October B.E. 2560
1st/2561 Date 26-29 March B.E. 2561 — 2nd/2561 Date 5-8 September B.E. 2561
1st/2562 Date 29 April -2 May B.E. 2562

When comparing the above concentration with the air quality standards in the atmosphere according to the National Environment Board No.24 (B.E. 2547) which requires that total suspended particulate matter concentration of in 24 hours must not more than 330 µg/m^3. It was found that values from all measurement stations were within the specified standard criteria.

(B) Particulate matter less than 10 microns (PM-10) average 24 hours

From the measurement during B.E.2558-2562, it was found that the average of Particulate matter less than 10 microns of 24 hours in the Ban Hin Kong area was in the range of 20-80 µg/m^3. The area of Ban Nong Kham was in the range of 20-58 µg/m^3. In the Khao Dinso area, it was in the range of 16-48 µg/m^3 and around and the area of Ban Nong Song Hong was in the range of 9-86 µg/m^3.

When comparing the above concentration with the air quality standards in the atmosphere according to the National Environment Board No.24 (B.E. 2547) which requires that Particulate matter less than 10 microns concentration of in 24 hours must not more than 120 µg/m^3. It was found that values from all measurement stations were within the specified standard criteria.

(C) Sulfur dioxide (SO_2), average 1 hour

From the measurement during B.E. 2558-2562, it was found that the value of sulfur dioxide average 1 hour at the Ban Hin Kong area was in the range of 2.10 - 20.96 µg/m^3. The area of Ban Nong Kham was in the range of 1.05-23.58 µg/m^3. In the Khao Dinso area, it was in the range of 1.31-23.58 µg/m^3, and the area of Ban Nong Song Hong was in the range of 0.52-28.82 µg/m^3.

When comparing the above concentration with the air quality standards in the atmosphere according to the National Environment Board No. 21 (B.E. 2544) on he establishment of general air quality standards determining the concentration of sulfur dioxide (SO_2) in an average of 1 hour, not more than 780 µg / m^3, it was found values from all measurement stations were within the specified standards.

(D) Sulfur dioxide (SO_2), average 24 hours

From the measurement during B.E. 2558-2562, it was found that the value of sulfur dioxide average 24 hours at the Ban Hin Kong area was in the range of 7.86-10.48 µg/m^3. The area of Ban Nong Kham was in the range of 5.24-10.48 µg/m^3. In the Khao

Dinso area, it was in the range of 2.62-15.72 μg/m^3, and the area of Ban Nong Song Hong was in the range of 5.24-15.72 μg/m^3.

When comparing the above concentration with the air quality standards in the atmosphere according to the National Environment Board No.21 (B.E. 2544) on the establishment of general air quality standards determining the concentration of sulfur dioxide (SO_2) in an average of 24 hours, not more than 300 μg/m^3. it was found values from all measurement stations were within the specified standards.

(E) Nitrogen dioxide (NO2), average 1 hour

From the measurement during B.E. 2558-2562, it was found that the value of nitrogen dioxide (NO2), average 1 hour at the Ban Hin Kong area was in the range of 2.36-70.75 μg/m^3. The area of Ban Nong Kham was in the range of 2.62-83.85 μg/m^3. In the Khao Dinso area, it was in the range of 2.62-15.72 μg/m^3, and the area of Ban Nong Song Hong was in the range of 5.24-15.72 μg/m^3.

When comparing the above concentration with the air quality standards in the atmosphere according to the National Environment Board No.33 (B.E. 2552) on the establishment of general air quality standards determining the concentration nitrogen dioxide (NO2), average 1 hour, not more than 320 μg/m^3. it was found values from all measurement stations were within the specified standards.

(3) Air quality measurement results done by the consulting company

The consultant company measured the air quality in the atmosphere in the study area. The index for the measurement was total suspended particulate matter on 24 hours average, particulate matter less than 10 microns on average 24 hours, particulate matter less than 2.5 microns on average 24 hours, sulfur dioxide on average 1 hour and 24 hours, and nitrogen dioxide on 1 hour average. Details were described as follows.

The project had conducted the air quality measurement in the atmosphere in 4 following stations **(Figure 3.1.3-2)**.

A1 = Wat Hin Kong (it was away from the project location to the north, approximately 1.75 kilometers). The surrounding environment of the measurement station was a community.

A2 = Wat Huay Phai (it was away from the project location to the south, approximately 2.65 kilometers). The surrounding environment of the measurement station is a community.

A3 = Wat Huai Pladuk School (it was away from the project location to the west, approximately 1.70 kilometers). The surrounding environment of the measurement station is a community.

A4 = Health Promotion Hospital Chedi Hak Subdistrict (Ban Huai Mu) (it was away from the project location to the east, approximately 3.55 kilometers). The surrounding environment of the measurement station is a agricultural area.

For atmospheric quality measurement results. details were shown in **Table 3.1.3-4**. It can be summarized as follows:

1) Total Suspended Particulate Matter (TSP), average 24 hours

From the measurement during 12-18 February and 10-16 July B.E. 2562, it was found that the concentration of total suspended particulate matter, average 24 hours at Wat Hin Kong was in the range of 25-185 μg/m^3. Wat Huai Pai had the average total suspended particulate matter of 24 hours in thr range of 28-170 μg/m^3. In the area of Huai Pladuk School, it was in the range of 19-140 μg/m^3. Finally, in the area of Ban Huai Mu Health Promotion Hospital, it was in the range of 17-433 μg/m^3.

When comparing the above concentration with the air quality standards in the atmosphere according to the National Environment Board, No.24 (B.E. 2547), which requires that the average of total suspended particulate matter in 24 hours not more than 330 μg/m^3. It was found that most of the measurement stations were within the specified standard criteria except for Chedi Hak Subdistrict Health Promotion Station (Ban Huai Mu) which exceeded the standard limit 1 during the 1st inspection period on 12th February , B.E.2562 (433 μg/m^3). For the measurement results during 13-18 February B.E.2562, the total particulate matter was in the range 48-230 μg/m^3, which was within the specified standard (**Figure 3.1.3-3**).

<u>Table 3.1.3-4</u>

<u>Air quality measurement results</u>

Stations	Date	Measurement results (µg/m³)						
		Total Suspended Particulate Matter (TSP), average 24 hours	Particulate matter less than 10 microns (PM-10), average 24 hours	Particulate matter less than 2.5 microns (PM-2.5) average 24 hours	Sulfur dioxide (SO_2),		Nitrogen dioxide (NO_2)	
					average 1 hour	average 24 hours	average 1 hour	average 24 hours
Wat Hin Kong	12 February 62	185	95	61	2.62	2.62	24.46	13.17
	13 February 62	151	77	58	2.62	2.62	20.70	13.17
	14 February 62	123	53	20	2.62	2.62	15.05	11.29
	15 February 62	117	54	33	2.62	2.62	15.05	11.29
	16 February 62	107	50	30	2.62	2.62	15.05	9.41
	17 February 62	118	44	30	2.62	2.62	20.70	11.29
	18 February62	50	28	16	2.62	2.62	15.05	7.53
	10 July 62	68	22	6	5.24	2.62	5.24	2.62
	11 July 62	62	28	13	7.86	5.24	2.62	2.62
	12 July 62	58	33	15	7.86	5.24	2.62	2.62
	13 July 62	35	18	11	10.48	5.24	2.62	2.62
	14 July 62	45	18	6	7.86	5.24	2.62	2.62
	15 July 62	25	14	8	7.86	5.24	2.62	2.62
	16 July 62	25	12	<5	7.86	7.86	2.62	2.62
	Min.-Max.	**25-185**	**12-95**	**<5-61**	**2.62-10.48**	**2.62-7.86**	**2.62-24.46**	**2.62-13.17**

Table 3.1.3-4 (cons.)

Stations	Date	Measurement results (μg/m³)						
		Total Suspended Particulate Matter (TSP), average 24 hours	Particulate matter less than 10 microns (PM-10), average 24 hours	Particulate matter less than 2.5 microns (PM-2.5) average 24 hours	Sulfur dioxide (SO_2),		Nitrogen dioxide (NO_2)	
					average 1 hour	average 24 hours	average 1 hour	average 24 hours
Wat Huay Phai	12 February 62	170	86	62	5.24	2.62	35.75	16.94
	13 February 62	160	87	52	5.24	2.62	28.23	15.05
	14 February 62	131	56	34	5.24	2.62	18.82	13.17
	15 February 62	124	63	33	5.24	2.62	26.35	13.17
	16 February 62	126	59	31	5.24	2.62	18.82	9.41
	17 February 62	89	45	31	5.24	5.24	30.11	11.29
	18 February 62	58	26	17	5.24	5.24	15.05	11.29
	10 July 62	37	23	11	5.24	2.62	23.58	7.86
	11 July 62	73	29	21	5.24	2.62	20.96	7.86
	12 July 62	58	34	15	5.24	2.62	20.96	7.86
	13 July 62	56	24	19	5.24	2.62	7.86	5.24
	14 July 62	84	30	23	5.24	2.62	13.10	5.24
	15 July 62	28	14	7	5.24	2.62	20.96	7.86
	16 July 62	55	49	32	2.62	2.62	10.48	5.24
	Min.-Max.	**28-170**	**14-87**	**7-62**	**2.62-5.24**	**2.62-5.24**	**7.86-35.75**	**5.24-16.94**
Wat Huai Pladuk School	12 February 62	140	85	58	5.24	2.62	28.23	13.17
	13 February 62	135	83	54	5.24	5.24	26.35	13.17

Table 3.1.3-4 (cons.)

Stations	Date	Measurement results (μg/m³)						
		Total Suspended Particulate Matter (TSP), average 24 hours	Particulate matter less than 10 microns (PM-10), average 24 hours	Particulate matter less than 2.5 microns (PM-2.5) average 24 hours	Sulfur dioxide (SO_2),		Nitrogen dioxide (NO_2)	
					average 1 hour	average 24 hours	average 1 hour	average 24 hours
	14 February 62	103	58	30	5.24	2.62	18.82	11.29
	15 February 62	88	46	39	2.62	2.62	15.05	7.53
	16 February 62	92	51	27	5.24	2.62	26.35	16.94
	17 February 62	99	47	28	2.62	2.62	20.70	11.29
	18 February 62	81	42	27	5.24	2.62	18.82	9.41
	10 July 62	32	19	7	7.86	5.24	10.48	5.24
	11 July 62	43	29	12	7.86	5.24	7.86	5.24
	12 July 62	47	25	12	7.86	5.24	7.86	5.24
	13 July 62	29	14	6	7.86	5.24	7.86	2.62
	14 July 62	26	15	5	5.24	5.24	5.24	5.24
	15 July 62	26	14	6	7.86	5.24	5.24	5.24
	16 July 62	19	12	6	7.86	5.24	7.86	5.24
	Min.-Max.	**19-140**	**12-85**	**5-58**	**2.62-7.86**	**2.62-5.24**	**5.24-28.23**	**5.24-16.94**
Health Promotion Hospital Chedi Hak Subdistrict (Ban Huai Mu)	12 February 62	433	198	52	13.10	2.62	31.99	16.94
	13 February 62	230	105	57	10.48	5.24	31.99	15.05
	14 February 62	114	59	29	7.86	2.62	18.82	11.29
	15 February 62	104	61	32	7.86	2.62	20.70	11.29

Table 3.1.3-4 (cons.)

Stations	Date	Measurement results (μg/m³)						
		Total Suspended Particulate Matter (TSP), average 24 hours	Particulate matter less than 10 microns (PM-10), average 24 hours	Particulate matter less than 2.5 microns (PM-2.5) average 24 hours	Sulfur dioxide (SO_2),		Nitrogen dioxide (NO_2)	
					average 1 hour	average 24 hours	average 1 hour	average 24 hours
	16 February 62	111	58	29	7.86	2.62	26.35	11.29
	17 February 62	76	45	26	5.24	2.62	26.35	16.94
	18 February 62	48	31	16	7.86	2.62	20.70	13.17
	10 July 62	45	22	12	5.24	2.62	15.72	5.24
	11 July 62	48	25	12	5.24	2.62	10.48	5.24
	12 July 62	47	26	15	5.24	2.62	15.72	7.86
	13 July 62	17	10	9	7.86	2.62	13.10	7.86
	14 July 62	26	13	10	5.24	5.24	13.10	7.86
	15 July 62	22	13	6	5.24	2.62	10.48	7.86
	16 July 62	17	9	6	5.24	2.62	10.48	7.86
	Min.-Max.	**17-433**	**9-198**	**6-57**	**5.24-13.10**	**2.62-5.24**	**10.48-31.99**	**5.24-16.94**
Standard value		**330 1/**	**120 1/**	**50 2/**	**780 3/**	**300 1/**	**320 4/**	-

Source : Measurement by ALS Laboratory Group (Thailand) Co.,Ltd.

Note: 1/ Announcement of the National Environmental Board No.24 (B.E.2547) on ambient air quality standard

2/ Announcement of the National Environmental Board No.36 (B.E.2553) on standard of particulate matter size not exceeding 2.5 microns in ambient air

3/ Announcement of the National Environmental Board No.21 (B.E.2544) on standard of sulfur dioxide concentration in ambient air in period of one hour

4/ Announcement of the National Environmental Board No.33 (B.E.2552) on standard of nitrogen dioxide concentration in ambient air

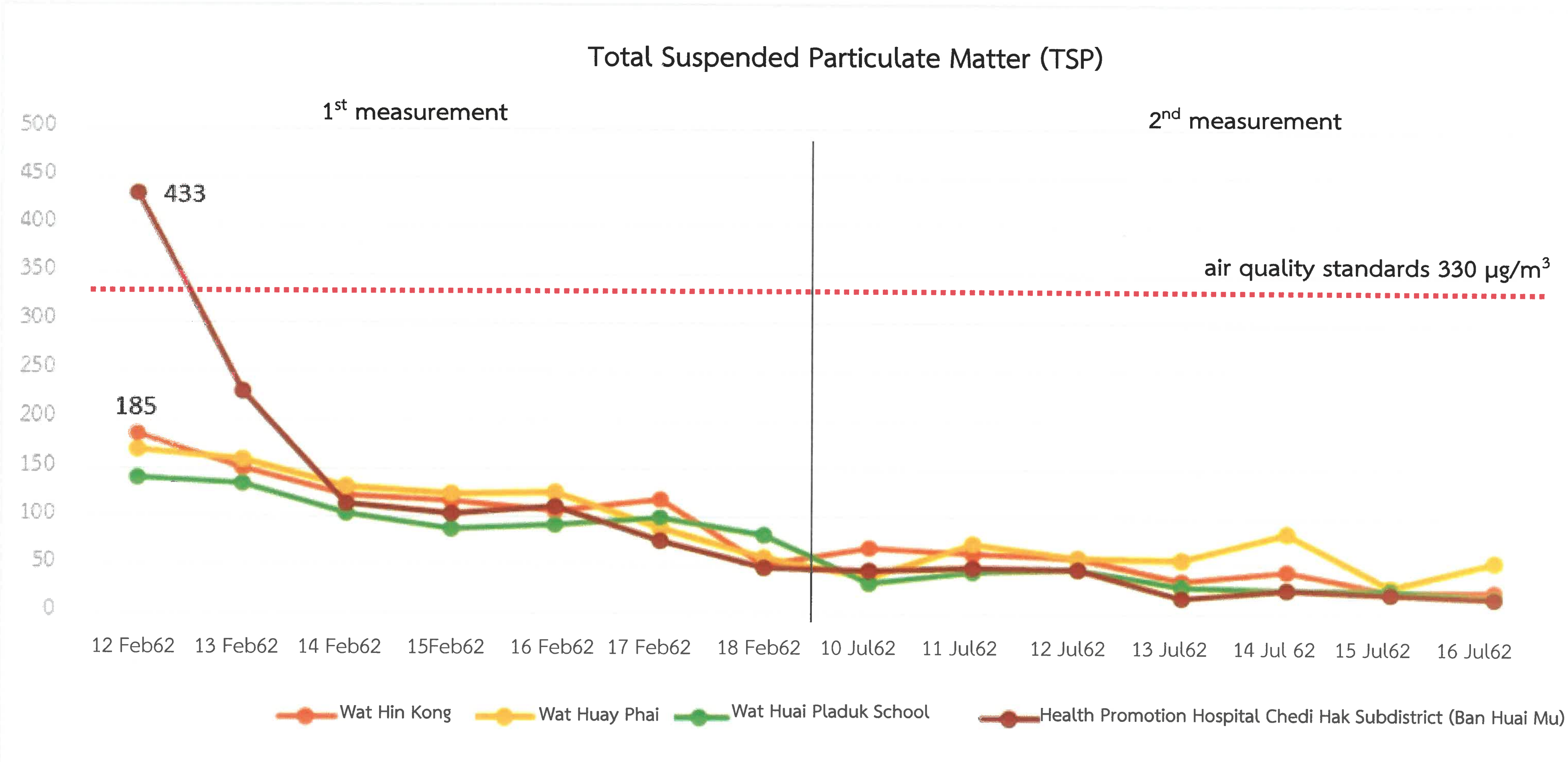


Figure 3.1.3-3 Chart of measurement results of Total Suspended Particulate Matter (TSP), average 24 hours

2) Particulate matter less than 10 microns (PM-10), average 24 hours

From the measurement during 12-18 February and 10-16 July B.E. 2562, it was found that the concentration of particulate matter less than 10 microns (PM-10) average 24 hours at Wat Hin Kong was in the range of 12-95 μg/m^3. Wat Huai Pai had the concentration of particulate matter less than 10 microns in the range of 14-87 μg/m^3. In the area of Huai Pladuk School, it was in the range of 12-85 μg/m^3. Finally, in the area of Ban Huai Mu Health Promotion Hospital, it was in the range of 9-198 μg/m^3.

When comparing the above concentration with the air quality standards in the atmosphere according to the National Environment Board, No.24 (B.E. 2547), which requires that the average of the concentration of particulate matter less than 10 microns (PM-10) average 24 hours not more than 120 μg/m^3. It was found that most of the measurement stations were within the specified standard criteria except for Chedi Hak Subdistrict Health Promotion Station (Ban Huai Mu) which exceeded the standard limit 1 during the 1st inspection period on 12th February B.E. 2562 (198 μg/m^3). For the measurement results during 13-18 February B.E.2562, particulate matter less than 10 microns was in the range 31-105 μg/m^3, which was within the specified standard (**Figure 3.1.3-4**).

From the dust measurement results (TSP and PM-10) in the study area, in particularly, the dry season (November to February), it was found at the measurement stations (Wat Hin Kong, Wat Huai Phai and Huay Pla Duk School) test results for all 7 days were within the standard criteria except for Chedi Hak Subdistrict Health Promotion Hospital (Ban Huai Mu). It was exceeding the standard limit ofr 1 day, 12th February B.E.2562.

3) Particulate matter less than 2.5 microns (PM-2.5) average 24 hours

From the measurement during 12-18 February and 10-16 July B.E. 2562, it was found that the concentration of particulate matter less than 2.5 microns (PM-2.5) average 24 hours at Wat Hin Kong was in the range of less than 5-61 μg/m^3. Wat Huai Pai had the concentration of particulate matter less than 2.5 microns in the range of 7-62 μg/m^3. In the area of Huai Pladuk School, it was in the range of 5-58 μg/m^3. Finally, in the area of Ban Huai Mu Health Promotion Hospital, it was in the range of 6-57 μg/m^3.iu

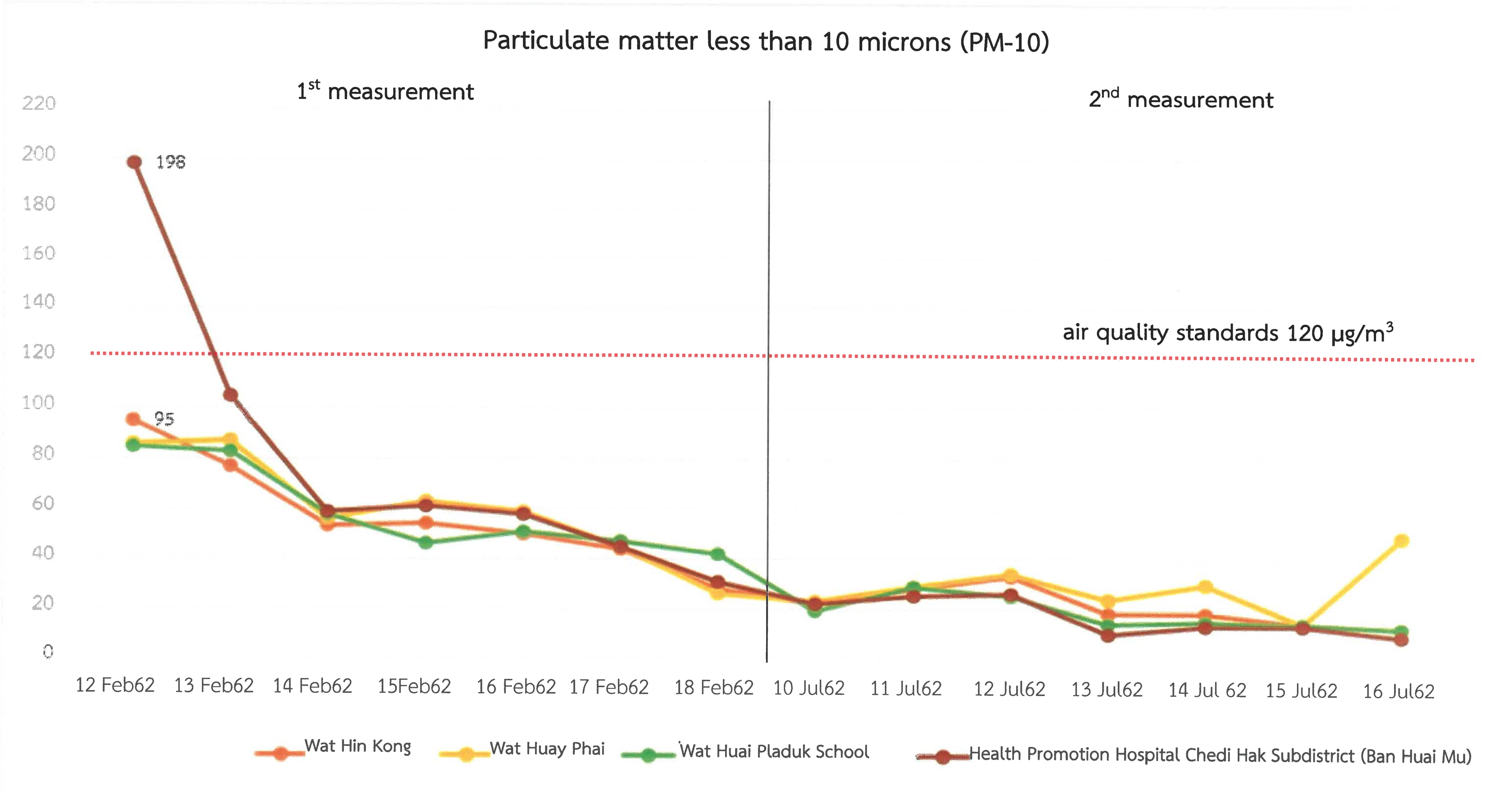


Figure 3.1.3-4 Chart of measurement results of Particulate matter less than 10 microns (PM-10), average 24 hours

When comparing the above concentration with the air quality standards in the atmosphere according to the National Environment Board, No.36, B.E. 2553 on the general standard in the atmosphere determining the concentration of particulate matter less than 2.5 microns (PM-2.5) average 24 hours with a value not exceeding 50 μg/m^3. It was found that during the 14-18 February , B.E.2562, all measurement stations had values exceeding the standard for 2 days (from 7 day measurement). It was on 12-13 February , B.E.2562 (**Figure 3.1.3-5**).

For the data monitoring, the dust measurement results in the atmosphere around the project location had been measured the for 2 times, the first time was measured during 12-18 February, B.E.2562 and the second time was measured during 10-16 July, B.E.2562, in which the 2 measurements were done at both TECO power plant did not run an electricity generator. It was found that the dust measurement results exceeded the standards by 1-2 days in the same period, which were summarized as follows.

Total Suspended Particulate Matter average 24 hours: *Chedi Hak Subdistrict Health Promotion Hospital Station (Ban Huai Mu) exceeded the standard value for 1 day (from 7 day measurement) in the first measurement on 12 February B.E.* 2562 *(433 μg/m^3)*

Particulate matter less than 10 microns (PM-10) average 24 hours : *Chedi Hak Subdistrict Health Promotion Hospital Station (Ban Huai Mu) exceeded the standard value for 1 day (from 7 day measurement) in the first measurement on 12 February B.E.* 2562 (198 μg/m^3).

Particulate matter less than 2.5 microns (PM-2.5) average 24 hours : *all stations exceeded the standard value for* 2 days *(from 7 day measurement) in the first measurement on 12-13 February B.E. 2562.*

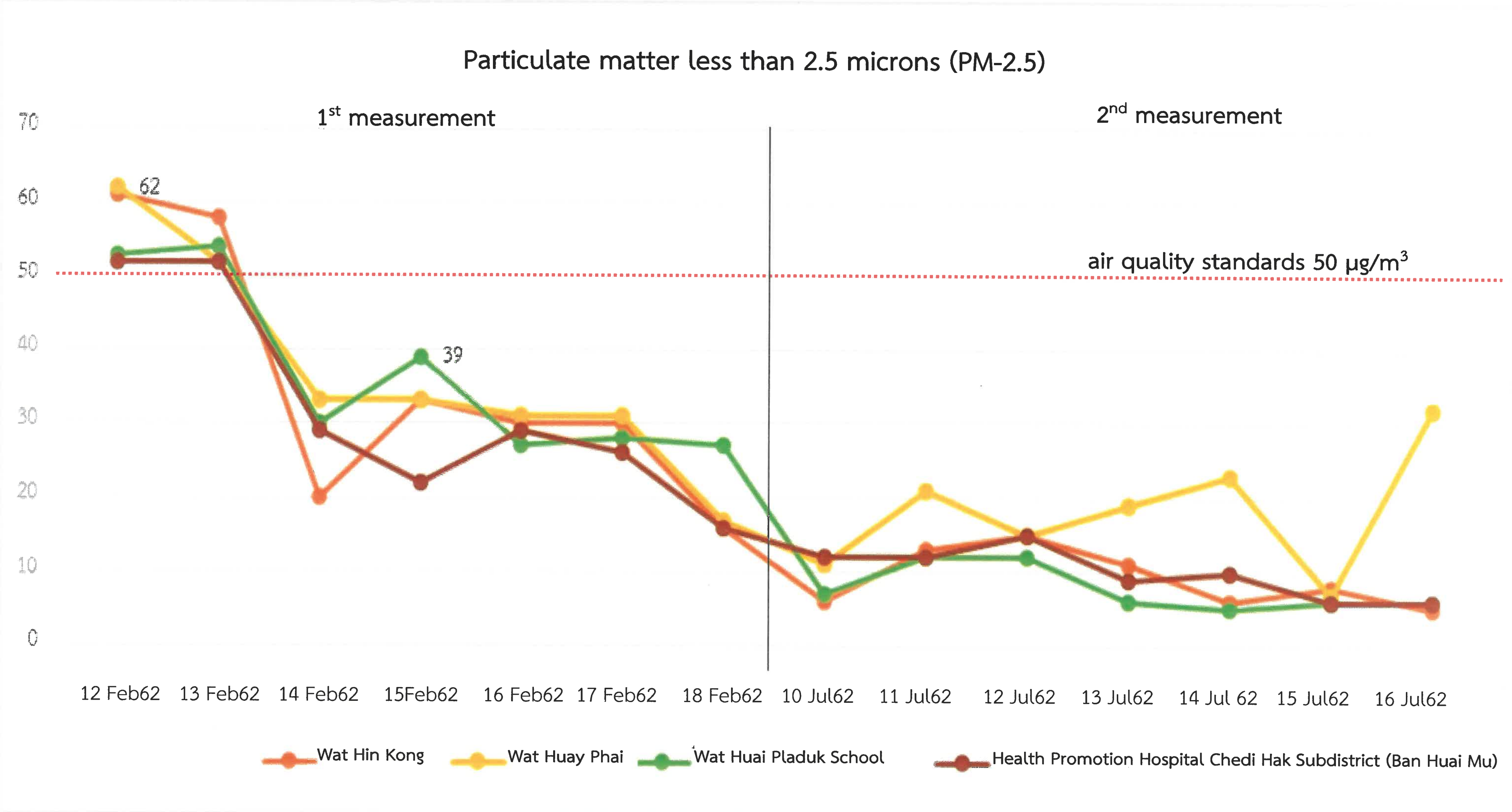


Figure 3.1.3-5 Chart of measurement results of Particulate matter less than 2.5 microns (PM-2.5) average 24 hours

From the data on the air quality measurement in the atmosphere, it was found that during the 1 st measurement period between 12-18 February , B.E.2562 in Thailand, *the weather conditions were less floating and the wind was calm, causing the amount of dust to accumulate*. *As a result, the dust situation is greater than the standard limit as well as the measurement results from the Pollution Control Department that had been measured in Ratchaburi province iIn the area of Regional Environment Office Station 8, Na Mueang Subdistrict Mueang Ratchaburi District Ratchaburi, from the Pollution Control Department data from December to March* (details as seen in **Table 3.1.3-5** and **Figure 3.1.3-6** to **3.1.3-7**). The dust situation, such as, particulate matter less than 10 microns (PM-10) and particulate matter less than 2.5 microns (PM-2.5) average 24 hours was more than 120 and 50 μg/m^3. These exceeds the standard limit, respectively. *The reason for small dust particles quite accumulated was that during December until April, it was during the opening season of the sugar factory causing sugarcane farmers to accelerate the harvest in this period. In addition, during February , the weather will be less floating, calm wind, causing the amount of dust to accumulate*.

4) Sulfur dioxide (SO_2), average 1 hour

From the measurement during 12-18 February and 10-16 July B.E. 2562, it was found that the concentration of sulfur dioxide (SO_2), average 1 hour at Wat Hin Kong was in the range of 2.62-10.48 μg/m^3. Wat Huai Pai had the concentration of sulfur dioxide (SO_2), average 1 in the range of 2.62-5.24 μg/m^3. In the area of Huai Pladuk School, it was in the range of 2.62-7.86 μg/ m^3. Finally, in the area of Ban Huai Mu Health Promotion Hospital, it was in the range of 5.24-13.10 μg/m^3.

When comparing the above concentration with the air quality standards in the atmosphere according to the Annoucement of National Environment Board, No.21 (B.E. 2544) on the general standard in the atmosphere determining the concentration of sulfur dioxide (SO_2), average 1 hour not exceeding 780 μg/m^3, it was found that it wass within the specified standard criteria.

5) Sulfur dioxide (SO_2), average 24 hours

From the measurement during 12-18 February and 10-16 July B.E. 2562, it was found that the concentration of sulfur dioxide (SO_2), average 24 hours at Wat Hin Kong was in the range of 2.62-7.86 μg/m^3. Wat Huai Pai had the concentration of sulfur dioxide (SO_2), average 24 hours in the range of 2.62-5.24 μg/m^3. In the area of Huai Pladuk School, it was in the range of 2.62-5.24 μg/m^3. Finally, in the area of Ban Huai Mu Health Promotion Hospital, it was in the range of 2.62-5.24 μg/m^3.

Table 3.1.3-5

The highest air quality measurement results in the Regional Environment Office 8, Na Mueang Subdistrict, Mueang Ratchaburi District, Ratchaburi during B.E. 2558-2562

Months	Measurement results ($\mu g/m^3$)									
	Particulate matter less than 10 microns (PM-10)					Particulate matter less than 2.5 microns (PM-2.5)				
	2558	2559	2560	2561	2562	2558	2559	2560	2561	2562
January	116	108	90	114*	144*	84*	78*	55*	73*	102*
February	134*	167*	121*	133*	102	105*	136*	84*	89*	78*
March	74	146*	116	108	85	54*	108*	82*	74*	60*
April	76	76	77	80	60	54*	49	40	39	33
May	40	41	45	49	74	23	43	20	22	37
June	24	35	62	52	40	18	18	22	17	25
July	48	46	43	57	45	25	15	15	34	26
August	26	46	44	64	46	17	18	17	21	15
September	51	34	33	40	69	39	18	12	23	35
October	77	47	95	80	74	49	30	57*	44	35
November	73	61	87	79	101	39	34	50	45	58*
December	102	83	112	88	122*	71*	56*	66*	60*	75*
Standard	120					50				

Note : *Measurement results exceed the standard limit as the weather will be less floating, calm wind, causing the amount of dust to accumulate.

[1/] Announcement of the National Environmental Board No.24 (B.E.2547) on ambient air quality standard

Announcement of the National Environmental Board No.36 (B.E.2553) on standard of particulate matter size not exceeding 2.5 microns in ambient air

Source : Pollution Control Department (search18 April B.E. 2562 from : http://air4thai.pcd.go.th/)

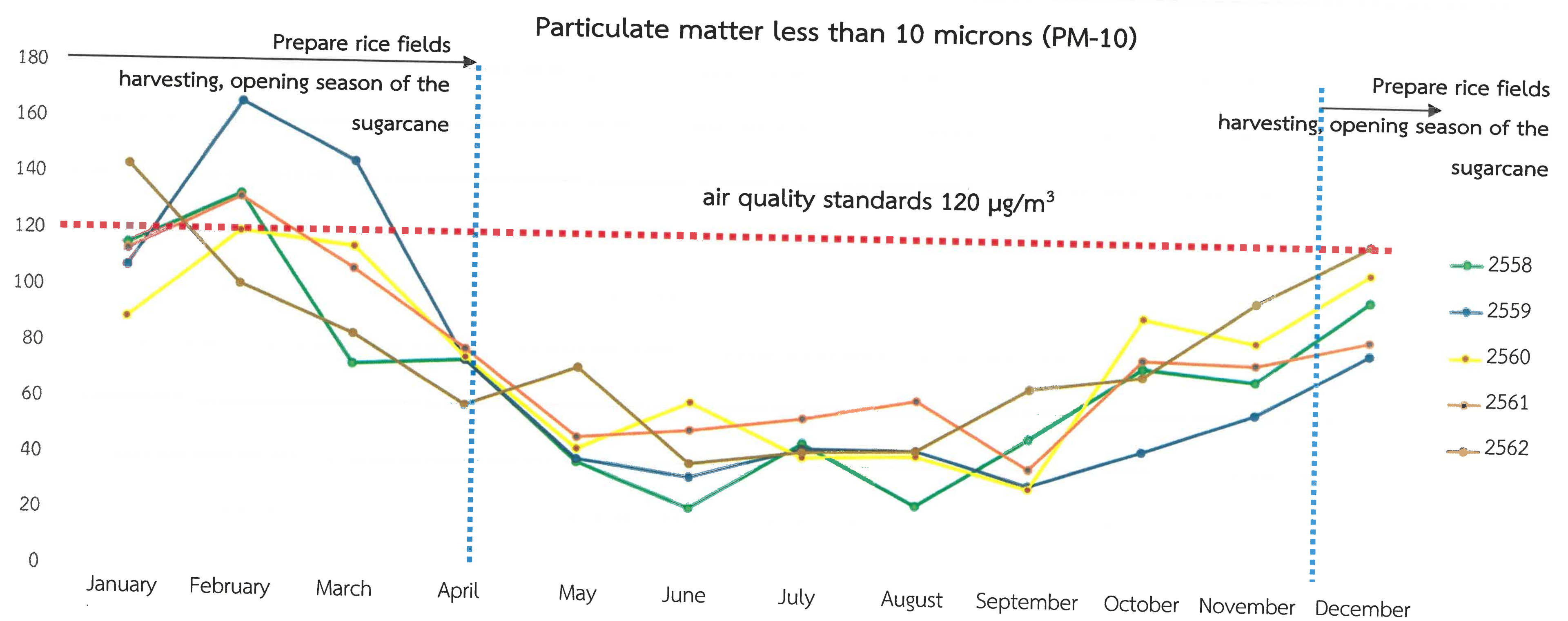


Figure 3.1.3-6 Chart of measurement results of Particulate matter less than 10 microns (PM-10), average 24 hours from the Regional Environment Office 8, Na Mueang Subdistrict, Mueang Ratchaburi District, Ratchaburi during B.E. 2558-2562

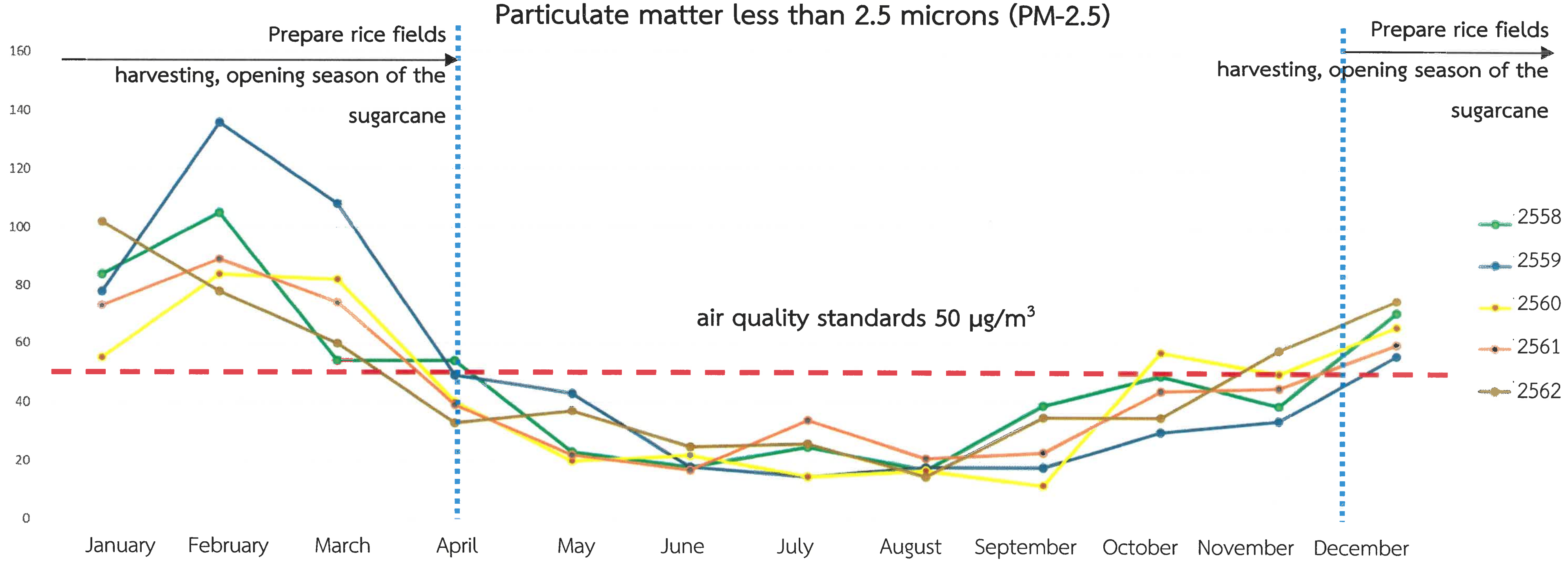


Figure 3.1.3-7 Chart of measurement results of Particulate matter less than 2.5 microns (PM-2.5), average 24 hours from the Regional Environment Office 8, Na Mueang Subdistrict, Mueang Ratchaburi District, Ratchaburi during B.E. 2558-2562

When comparing the above concentration with the air quality standards in the atmosphere according to the Annoucement of National Environment Board, No.21 (B.E. 2544) on the general standard in the atmosphere determining the concentration of sulfur dioxide (SO_2), average 24 hours not exceeding 300 μg/m^3, it was found that it wass within the specified standard criteria.

6) Nitrogen dioxide (NO_2), average 1 hour

From the measurement during 12-18 February and 10-16 July B.E. 2562, it was found that the concentration of nitrogen dioxide (NO_2), average 1 hour at Wat Hin Kong was in the range of 2.62-24.46 μg/m^3. At Wat Huai Pai was in the range of 7.86-35.75 μg/m^3. In the area of Huai Pladuk School, it was in the range of 5.24-28.23 μg/m^3. Finally, in the area of Ban Huai Mu Health Promotion Hospital, it was in the range of 10.48-31.99 μg/m^3.

When comparing the above concentration with the air quality standards in the atmosphere according to the National Environment Board, No.33 (B.E. 2552) on the general standard in the atmosphere determining the concentration of nitrogen dioxide (NO_2), average 1 hour, not exceeded 320 μg/m^3. It was found that values from all stations were within the specified standard criteria.

7) Wind speed and wind direction

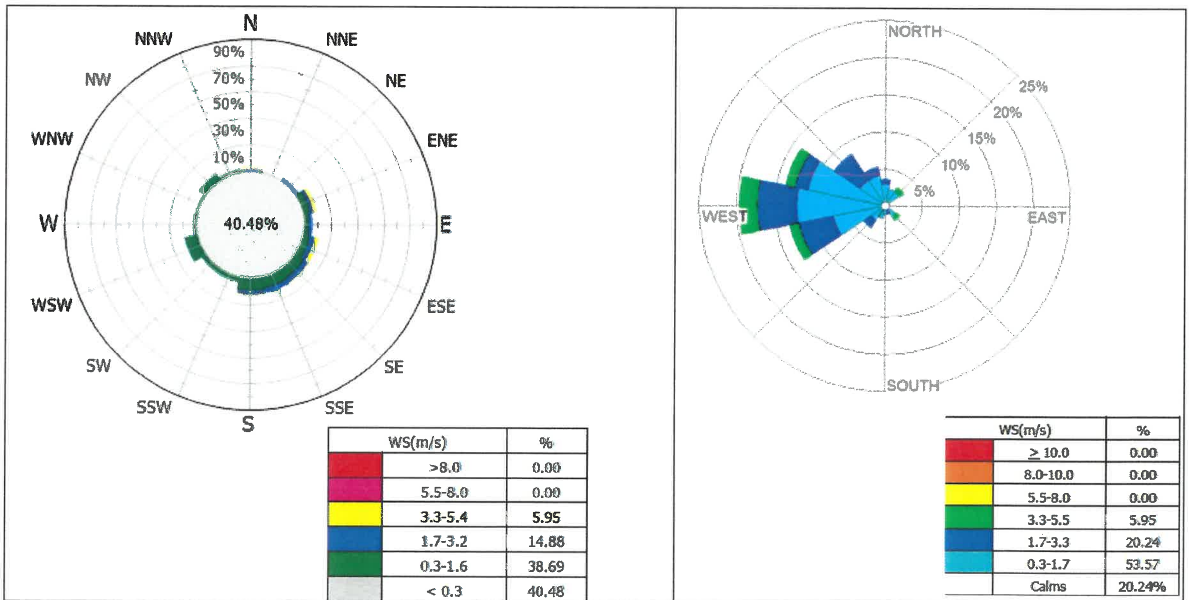
From the measurement of wind speed and direction of the A3 Station in Huai Pladuk School in the dry season (11-18 February B.E.2562), it was found that most of the wind were from the southeast to the east (ESE) for 33.5%, The followed by winds coming from the southeast (SE) for 22.5% and 4.7% were calm wind, with a wind speed of 0.0-0.4 meters per minute.

In the rainy season (10-16 July B.E.2562), the results showed that most of the wind were 56.3% from the west (W), followed by 42.6% from the southwest to the westward (WSW) and 1.7 % from calm winds, with a wind speed range of 0.0 -0.4 meters per minute. Details were shown in **Table 3.1.3-6** and **Figure 3.1.3-8.**

Table 3.1.3-6
The measurement of wind speed and direction of the A3 Station in Huai Pladuk School

Wind direction	Percentage of wind direction	
	1st (12-18 February B.E. 2562)	2nd (10-16 July B.E. 2562)
N	9	6.9
NNE	0	1.8
NE	5.7	6.4
ENE	21.4	0.6
E	7.7	0
ESE	33.5	0
SE	22.3	5.5
SSE	20	3.6
S	16.2	1.2
SSW	3.7	3.2
SW	1.9	8.2
WSW	1.4	42.6
W	1.6	56.3
WNW	1.2	31.1
NW	1.8	23
NNW	0.3	9.7
Total	**103.9**	**200.1**
calm winds (<0.4 m/s)	**4.7**	**1.7**

Source : Measurement by ALS Laboratory Group (Thailand) Co.,Ltd.



1st (12-18 February B.E. 2562) (Dry season) | 2nd (10-16 July B.E. 2562) (Rainy season)

Figure 3.1.3-8 Data of wind speed and direction

3.1.4 Noise

(1) Measurement results done by TECO

The consulting company collected results from the report on the implementation of the environmental impact prevention and measures and the environmental impact monitoring of the 700 MW of Combined Cycle Power Plant Project of Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch) during B.E.2558-2562. Meassurement were conducted at 8 stations for 4 times a year, with 3 consecutive days which were, 200 meters from the south fence, 100 meters from the north fence, 600 meters at Ban Nong Rak, the northwest of the power plant with the distance of 400 meters north of the power plant, 240 meters to the southeast of the power plant, 280 meters from the north of the power plantfrom, Ban Nong Kham, location 1, at distance of 820 meters and Ban Nong Kham location 2, at the distance of 650 meters. Measurement results were shown in **Table 3.1.4-1** with following details.

1) The average noise level of 24 hours ($L_{eq\ 24\ hr}$)

The results of the 24 hour average noise level ($L_{eq\ 24\ hr}$) between B.E. 2558-2562 showed that the northern edge of the fence had a noise level in the range of 52.3-66.0 dB (A). The southern edge of the fence had a noise level in the range of 46.5-69.7 dB (A). The area around Ban Nong Rak had a noise level in the range of 48.3-64.3 dB (A). In the northwest of the power plant, the noise level was in the range of 46.4-63.9 dB (A). The southeast of the power plant had a noise level in the range of 49.4-64.6 dB (A). The north of the power plant had a noise level in the range of 50.2-63.1 dB (A). At Ban Nong Kham, location 1 had a noise level in the range of 45.9. -63.3 dB (A). In Ban Nong Kham, location 2, the noise level was in the range of 48.7-64.5 dB (A).

When comparing the measurement results with the standard values in accordance with the Announcement of the Ministry of Industry, on the determination of noise and noise levels caused by factory operation B.E.2548, and the standards according to the Announcement of National Environment Board No.15 (B.E.2540) on the establishment of general noise level, determining not more than 70 dB (A), it was found that all measurement results from all stations were within the specified standards.

Table 3.1.4-1

Noise measurement results between B.E. 2558-2562

Station	Year	Results dB (A)	
		L_{eq24hr}	L_{90}
1. The south fence	2558	58.1-64.5	47.1-64.4
	2559	56.6-66.0	44.9-64.3
	2560	53.7-60.8	50.1-60.7
	2561	52.8-63.0	42.2-59.0
	2562	52.3-54.3	40.9-53.8
Min.-Max.		**52.3-66.0**	**40.9-64.4**
2. The north fence	2558	49.3-67.0	36.4-66.7
	2559	58.2-65.1	54.3-69.5
	2560	66.9-69.7	64.2-68.5
	2561	46.5-68.3	40.2-68.4
	2562	47.0-51.4	38.8-50.0
Min.-Max.		**46.5-69.7**	**38.8-69.5**
3. Ban Nong Rak	2558	52.9-57.7	39.5-56.4
	2559	52.5-64.3	41.4-61.9
	2560	56.1-61.0	45.1-61.8
	2561	52.6-56.8	41.6-54.8
	2562	48.3-51.7	41.2-49.9
Min.-Max.		**48.3-64.3**	**39.5-61.9**
4. The northwest of the power plant	2558	47.9-63.9	30.4-71.5
	2559	46.4-56.9	33.4-57.3
	2560	47.1-58.8	38.4-60.4
	2561	48.4-53.7	40.1-55.2
	2562	49.0-51.3	38.4-50.5
Min.-Max.		**46.4-63.9**	**30.4-71.5**
5. The southeast of the power plant	2558	55.8-64.3	38.2-69.1
	2559	53.7-58.1	41.3-59.2
	2560	57.4-64.6	52.3-66.1
	2561	52.9-59.1	44.5-57.1
	2562	49.4-52.5	40.5-52.4
Min.-Max.		**49.4-64.6**	**38.2-69.1**

Table 3.1.4-1 (cons.)

Station	Year	Results dB (A)	
		L_{eq24hr}	L_{90}
6. The north of the power plant	2558	53.6-61.6	35.6-66.6
	2559	52.2-63.1	36.2-63.6
	2560	50.7-58.4	42.5-57.0
	2561	50.2-56.5	40.2-53.5
	2562	51.5-57.9	40.6-57.2
Min.-Max.		**50.2-63.1**	**35.6-66.6**
7. Ban Nong Kham, location 1	2558	48.3-59.5	31.5-64.9
	2559	45.9-63.3	33.0-63.0
	2560	48.8-63.3	39.7-67.6
	2561	54.4-60.9	41.2-61.0
	2562	47.6-55.5	40.0-55.2
Min.-Max.		**45.9-63.3**	**31.5-67.6**
8. Ban Nong Kham location 2	2558	48.7-59.9	33.0-60.0
	2559	53.4-64.5	32.4-39.4
	2560	53.4-63.2	41.0-62.8
	2561	52.5-63.8	40.2-63.0
	2562	56.2-60.6	44.0-59.8
Min.-Max.		**48.7-64.5**	**32.4-63.0**
Standard 1/		70	-

Note : 1/ Announcement of the National Environmental Board No.15 (B.E.2540) on standard of noise in ambient.

Source : The report on the implementation of the environmental impact prevention and measures and the environmental impact monitoring of the 700 MW of Combined Cycle Power Plant Project of Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch) during B.E.2558-2562

2) Basic noise level (L_{90})

The results of the basic noise level (L_{90}) between B.E. 2558-2562 showed that the northern edge of the fence had a noise level in the range of 40.9-64.4 dB (A). The southern edge of the fence had a noise level in the range of 38.8-69.5 dB (A). The area around Ban Nong Rak had a noise level in the range of 39.5-61.9 dB (A). In the northwest of the power plant, the noise level was in the range of 30.4-71.5 dB (A). The southeast of the power plant had a noise level in the range of 38.2-69.1 dB (A) The north of the power plant had a noise level in the range of 35.6-66.6 dB (A). In Ban Nong Kham, location 1 had a noise level in the range of 31.5-67.6 dB (A). In Ban Nong Kham, location had a noise level in the range of 32.4-63.0 dB (A).

(2) The noise measurement results done by the consulting company

The consulting company conducted a noise level measurement in the study area with measurement index such as the average sound level of 8 hours, the averag sound level of 2 4 hours and the maximum sound level. There were 3 measurement stations, which were, Ban Nong Rak area, Ban Nong Kham area, and householdes locating behind the Tri Energy Power Plant (**Figure 3.1.4-1**). The 1st measurement was done during 12-18 February B.E. 2562 and the 2nd measurement was during 25-31 October B.E. 2562. The measurement results were shown in **Table 3.1.4-2** with following details.

1) The average noise level of 24 hours ($Leq_{24\ hr}$)

The results of the 24 hour average noise level ($L_{eq\ 24\ hr}$) during 12-18 February B.E.2562 showed that, Ban Nong Rak had a noise level in the range of 51.2-54.4 dB (A). In Ban Nong Kham had a noise level in the range of 52.2-55.4 dB (A). During 25-31 October B.E.2562, it was found that householdes locating behind the Power Plant had a noise level in the range of 51.5-56.5 dB (A).

When comparing the measurement results with the standard values in accordance with the Announcement of the Ministry of Industry, on the determination of noise and noise levels caused by factory operation B.E.2548, and the standards according to the Announcement of National Environment Board No.15 (B.E.2540) on the establishment of general noise level, determining not more than 70 dB (A), it was found that all measurement results from all stations were within the specified standards.

2) Basic noise level (L_{90})

The results of the basic noise level ($L_{eq\ 24\ hr}$) during 12-18 February B.E. 2562 showed that, Ban Nong Rak had a noise level in the range of 39.4-50.5 dB (A). Ban Nong Kham had a noise level in the range of 44.7-48.4 dB (A). During 25-31 October B.E. 2562, it was found that householdes locating behind the Power Plant had a noise level in the range of 41.8-48.4 dB (A).

When comparing the measurement results with the standard values in accordance with the Announcement of the Ministry of Industry, on the determination of noise and noise levels caused by factory operation B.E.2548, and the standards according to the Announcement of National Environment Board No.15 (B.E.2540) on the establishment of general noise level, determining not more than 70 dB (A), it was found that all measurement results from all stations were within the specified standards.

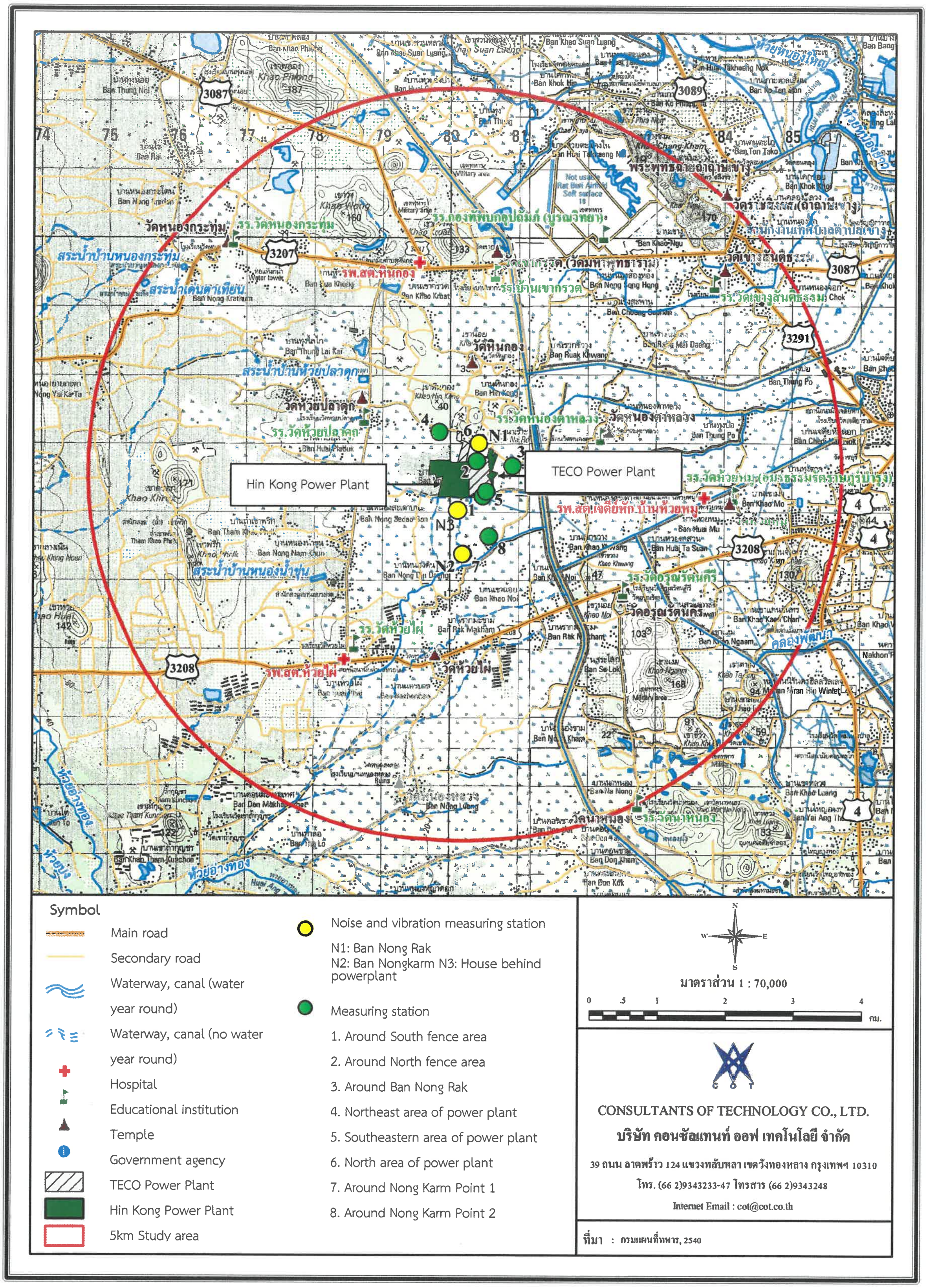


Figure 3.1.4-1 Noise level and vibration measurement stations

Table 3.1.4-2
The noise measurement results by the consulting company

Station	Date	Results dB (A)[1/]		
		L_{eq24hr}	L_{90}	L_{max}
1. Ban Nong Rak	12-Feb-62	52.2	39.4	87.9
	13-Feb-62	51.2	39.9	83.6
	14-Feb-62	52.8	41.0	89.0
	15-Feb-62	52.6	40.8	91.4
	16-Feb-62	53.6	40.0	84.6
	17-Feb-62	54.4	41.0	82.6
	18-Feb-62	54.4	50.5	86.8
	Range	**51.2-54.4**	**39.4-50.5**	**82.6-91.4**
2. Ban Nong Kham	12-Feb-62	52.2	45.2	89.0
	13-Feb-62	53.8	46.0	82.5
	14-Feb-62	53.4	47.1	84.4
	15-Feb-62	52.2	45.1	78.5
	16-Feb-62	55.4	44.7	79.3
	17-Feb-62	55.3	48.4	83.3
	18-Feb-62	55.0	47.3	86.2
	Range	**52.2-55.4**	**44.7-48.4**	**78.5-89.0**
3. householdes locating behind the Power Plant	25-Oct-62	52.0	43.4	91.7
	26-Oct-62	53.4	43.7	95.4
	27-Oct-62	56.5	41.8	86.7
	28-Oct-62	54.3	44.1	86.0
	29-Oct-62	55.8	48.4	91.0
	30-Oct-62	53.3	43.2	87.0
	31-Oct-62	51.5	44.8	88.1
	Range	**51.5-56.5**	**41.8-48.4**	**86.0-95.4**
Standard[2/]		**70**	**-**	**115**

Source : [1/] Measurement by ALS Laboratory Group (Thailand) Co.,Ltd., 12-18 February B.E. 2562

Note: [2/] Announcement of the Ministry of Industry, on the determination of noise and noise levels caused by factory operation B.E.2548 and Announcement of the National Environmental Board No.15 (B.E.2540) on standard of noise in ambient

3) Maximum noise lvel (L_{max})

The results of the maximum noise level (L_{max}) during 12-18 February B.E. 2562 showed that, Ban Nong Rak had a noise level in the range of 82.6-91.4 dB (A). Ban Nong Kham had a noise level in the range of 78.5-89.0 dB (A). During 25-31 October B.E. 2562, it was found that householdes locating behind the Power Plant had a noise level in the range of 86.5-95.4 dB (A).

When comparing the measurement results with the standard values in accordance with the Announcement of the Ministry of Industry, on the determination of noise and noise levels caused by factory operation B.E.2548, and the standards according to the Announcement of National Environment Board No.15 (B.E.2540) on the establishment of general noise level, determining not more than 115 dB (A), it was found that all measurement results from all stations were within the specified standards.

3.1.5 Hydrology and water quality

(1) Surface water hydrology

1) Mae Klong river basin conditions and the sub-basin watershed division

Mae Klong Basin is located in the western region of Thailand. With a total basin of approximately 30,180.78 sq.km., covering parts of Tak, Uthai Thani, Suphan Buri, Kanchanaburi, Nakhon Pathom, Ratchaburi, Samut Sakhon and Samut Songkhram. The upper basin and the western region are mountainous with the highest level at 2,117 meters from the mean sea level (MSL.). In the central and lower areas, from Muang Kanchanaburi area, up to Mueang Samut Songkhram District is a relatively flat and a low plain areas at the mouth of the river. The main river of the Mae Klong River Basin is the Mae Klong River which was generated by the combination of the Kwai Noi River and Kwai Yai River.Mae Klong River mainly flows from the north to the south before flowing to the Gulf of Thailand at Muang District, Samut Songkhram. The topography of the Mae Klong Basin were in **Figure 3.1.5-1.**

From the report of the Department of Water Resources B.E. 2554 on watershed systems and administrative divisions of Thailand, it was found that the Mae Klong River Basin is divided into 11 river basins.*The area of the Hin Kong Power Plant Project is located in the Mae Klong River Basin*, as seen in the watershed boundary of the Mae Klong River Basin in **Figure 3.1.5-1 and Table 3.1.5-1**.

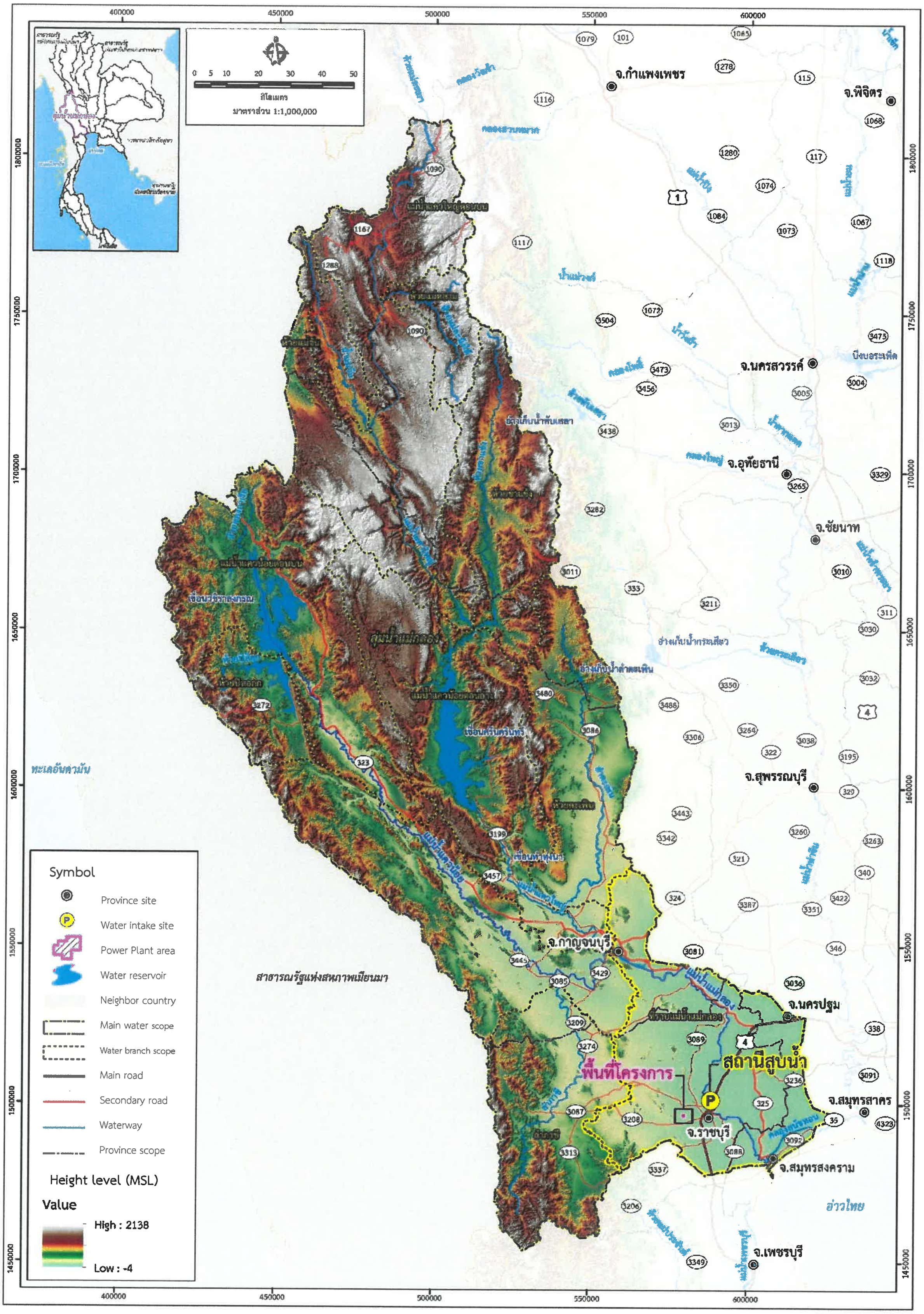


Figure 3.1.5-1 The topography and sub-basin watershed of the Mae Klong Basin

Table 3.1.5-1

Sub-basin watershed of the Mae Klong Basin

Sub-basin	Province	District	Watershed area (Sq km.)
Upper Khwae Yai Basin	Tak	Umphang	5,066.80
	Kanchanaburi	Thongphaphum, Srisawat, Sangkhlaburi	
	Uthai Thani	Ban rai	
Huai Mae Lamung Basin	Tak	Umphang	694.36
	Uthai Thani	Ban rai	
Huay Mae Chan Basin	Tak	Umphang	700.66
Huai Kha Khaeng Basin	Uthai Thani	Ban rai, Lan Sak, Huai Khot	2,361.50
	Kanchanaburi	Srisawat	
Lower Khwae Yai River Basin	Kanchanaburi	Thongphaphum, Sai Yok, Mueang Kanchanaburi, Si Sawat	4,024.80
Huay Taphen Basin	Kanchanaburi	Bo Ploy, Nong Prue, Muang Kanchanaburi, Lao Khwan	2,506.15
	Suphan Buri	Dan Chang	
Upper Kwai Noi River Basin	Kanchanaburi	Thongphaphum, Sai Yok, Sangkhlaburi	4,115.71
Huai Pilok Basin	Kanchanaburi	Thong Pha Phum	952.66
Lower Kwai Noi River Basin	Kanchanaburi	Dan Makham Tia, Muaeng Kanchanaburi, Sai Yok, Thong Pha Phum	3,383.36
Lam Phachi Basin	Kanchanaburi	Dan Makham Tia	2,574.74
	Ratchaburi	Chom Bueng, Suan Phueng, Pak Tho, Ban Kha	
River plains Mae Klong river Basin	Kanchanaburi	Tha Maka, Tha Muang, Phanom Thuan, Bo Phloi, Mueang Kanchanaburi	3,800.04
	Ratchaburi	Ban Kha, Chom Bueng, Damnoen Saduak, Bang Phae, Ban Pong, Pak Tho, Wat Pleng, Muaeng Ratchaburi, Photharam, Suan Phueng	
	Nakhon Pathom	Muaeng Nakhon Pathom, Samphran	
	Samut Songkhram	Bang Khonthi, Amphawa, Muang Samut Songkhram	
	Samut Sakhon	Ban Phaeo, Mueang Samut Sakhon	
Total of Watershed area (Sq km.))			**30,180.78**

Source : The report of the Department of Water Resources B.E. 2554

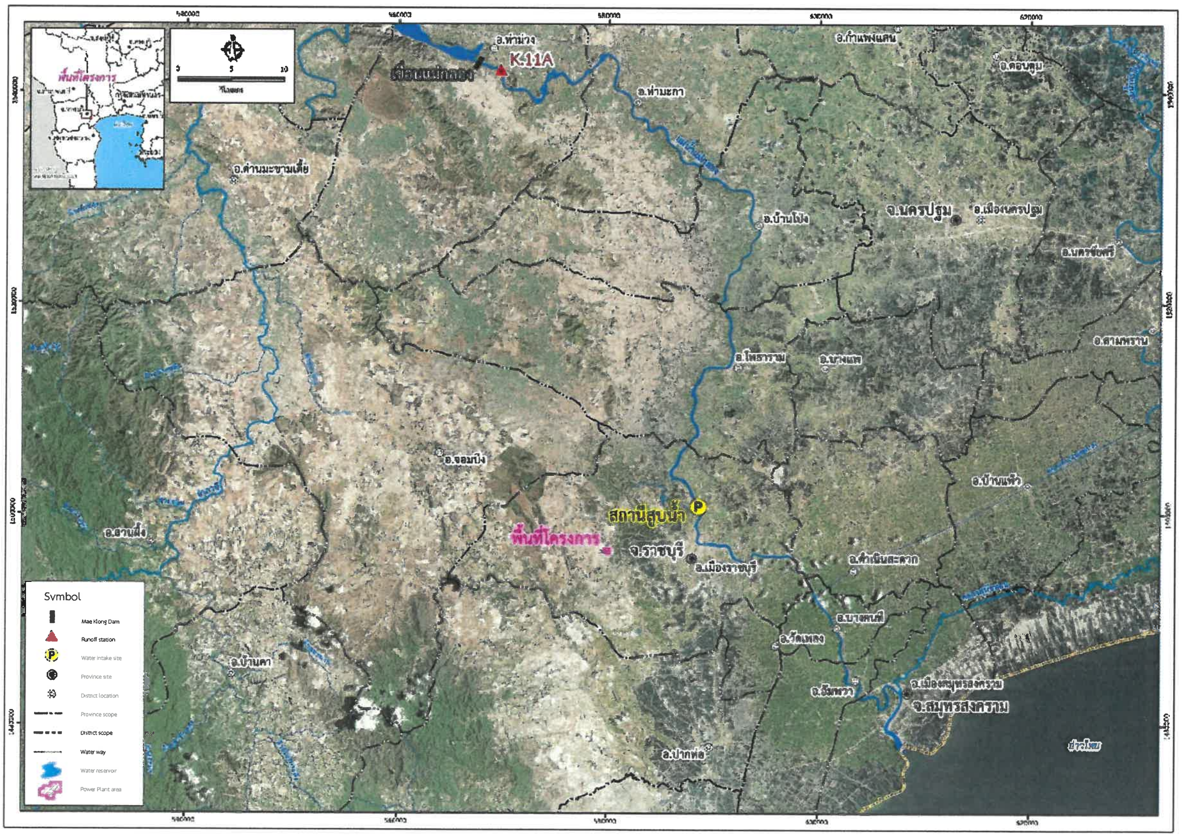
2) The water content in the Mae Klong River.

Due to Hin Kong Power Plant planed to use water from the Mae Klong River. Therefore, there was a study and analysis to assess the amount of water only in the Mae Klong River. The assessment was done by evaluating the runoff data from the Irrigation Department. There was 1 station monitoring the current water flow in the Mae Klong River, which was K.1 1 A Station, together with the amount of water flowing to fill the side flow of the Mae Klong River.

(A) Estimation of water content at K.11A station

The K.1 1 A station located at the foot of Mae Klong Dam at Wangkanai Sub-district, Tha Muang District, Kanchanaburi, as shown in **Figure 3.1.5-2.** Due to the K.11A station located at 2.3 kilometer, therefore, it could be a representative of amount of water releasing from the Mae Klong Dam flowing through the pumping point of the Hin Kong Power Plant.

Based on data collected from K.11A station for 25 years, from April B.E.2536 - March B.E.2561, the calculation for the monthly and annually amount of water as seen in **Table 3.1.5-2, Figure 3.1.5-3** and **Figure 3.1.5-4.**

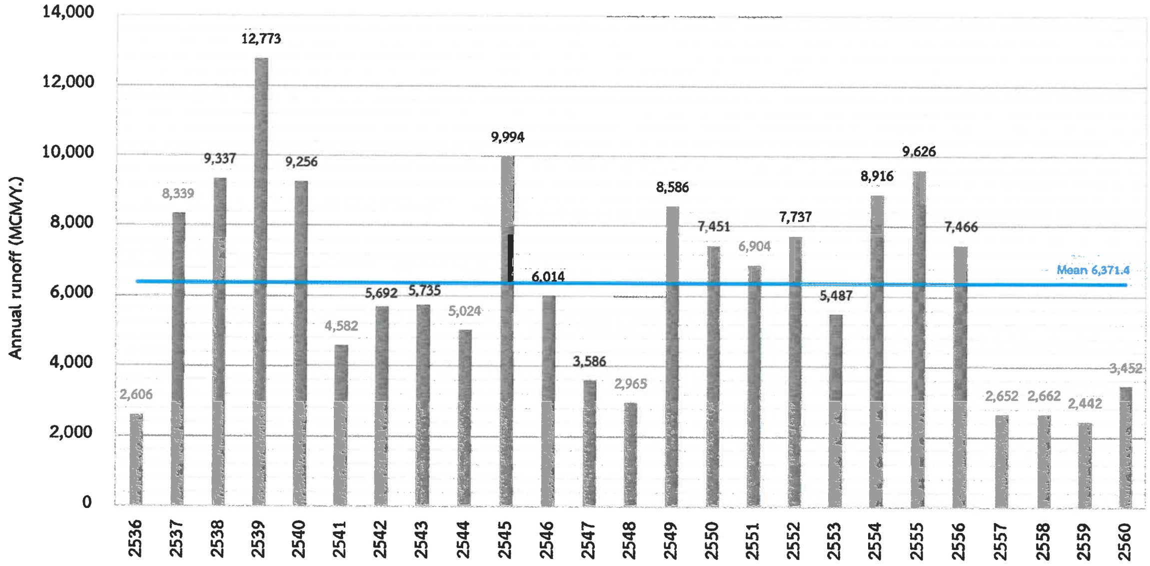


<u>Figure 3.1.5-2</u> Runoff measurement station located at Mae Klong River of Royal Irrigation epartment

Table 3.1.5-2
Monthly and annually amount of water at K.11A station

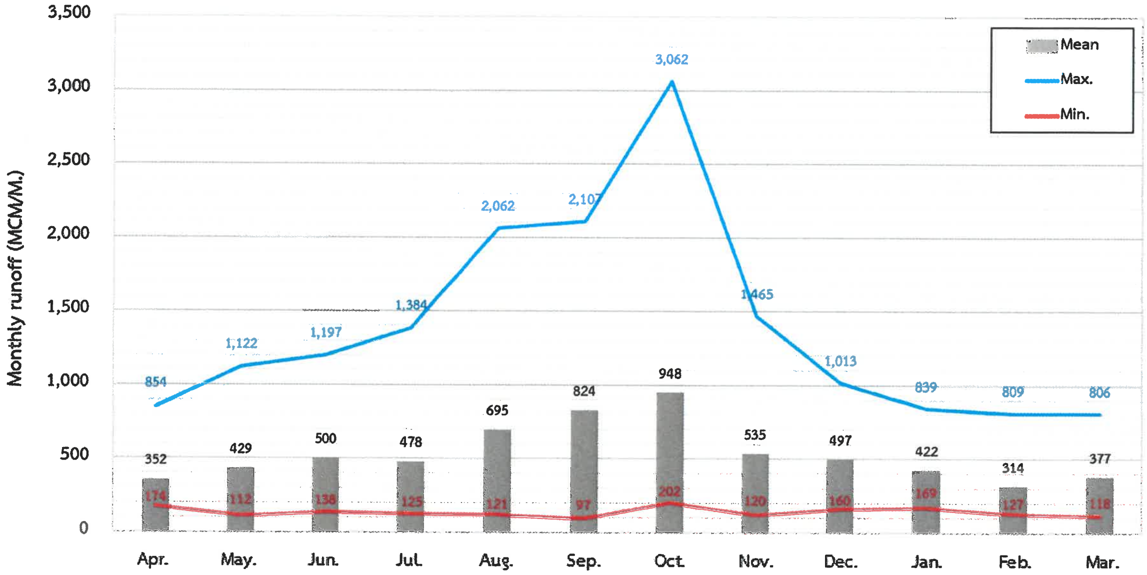
Hydrological year	Monthly runoff (Million cubic meters / month)												Annual runoff (Million cubic meters / year)
	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
2536	193.8	168.4	449.1	125.2	136.2	325.6	428.0	120.3	159.5	168.6	185.2	146.4	2,606.2
2537	200.0	181.0	238.0	529.2	1,343.5	1,457.7	1,027.3	819.3	1,013.4	697.7	376.6	455.5	8,339.1
2538	341.7	562.9	1,129.3	689.6	457.6	1,710.8	1,621.1	753.5	588.3	668.7	267.0	547.1	9,337.2
2539	358.4	599.9	1,196.6	988.7	1,052.3	1,831.4	3,061.6	1,465.2	776.2	621.1	420.7	401.1	12,773.1
2540	335.4	440.5	650.0	570.2	2,061.5	1,327.1	1,223.4	738.9	778.2	529.6	212.7	388.3	9,255.9
2541	462.7	556.0	649.6	396.4	317.0	285.6	836.4	262.9	235.6	249.8	167.7	162.6	4,582.2
2542	224.4	384.1	293.4	225.6	505.6	283.4	1,030.4	1,150.6	358.5	436.3	417.2	382.8	5,692.0
2543	514.7	612.7	568.3	431.3	263.1	784.1	501.7	405.2	568.6	303.1	292.4	490.2	5,735.2
2544	321.2	299.2	425.9	441.6	583.5	759.2	650.2	278.0	443.1	317.8	157.1	347.4	5,024.3
2545	251.3	511.5	478.9	463.8	1,048.9	2,107.2	1,628.2	897.4	907.5	838.9	434.0	426.5	9,994.2
2546	384.7	508.4	594.0	703.1	526.4	429.6	910.2	287.8	483.3	532.0	319.0	335.7	6,014.2
2547	289.1	450.8	248.8	237.3	411.1	418.2	202.2	263.7	327.1	251.6	190.5	296.1	3,586.3
2548	197.7	112.3	137.7	129.0	229.5	406.9	513.3	288.4	200.3	245.5	234.9	268.9	2,964.6
2549	263.6	413.5	854.0	1,384.3	1,581.0	1,653.5	907.9	401.3	372.3	265.0	218.2	271.6	8,586.0
2550	539.8	1,121.7	656.9	801.1	716.0	725.1	716.0	442.3	607.8	319.9	343.9	460.3	7,450.6
2551	505.7	640.7	825.6	614.0	628.7	624.5	614.5	666.1	420.3	495.9	401.5	467.0	6,904.4
2552	384.6	525.6	344.3	502.2	1,195.8	602.8	1,352.7	522.8	819.2	489.3	418.0	579.1	7,736.5
2553	452.4	540.8	446.2	459.3	446.1	462.8	905.0	268.5	506.3	245.0	364.2	390.9	5,487.4
2554	272.2	253.2	317.3	347.4	1,208.7	1,122.3	1,516.9	616.1	840.9	806.2	808.9	805.9	8,916.0
2555	854.1	528.3	438.4	690.8	1,273.6	1,561.3	1,517.4	796.3	752.3	375.7	406.2	431.4	9,625.8
2556	566.0	458.2	684.3	388.8	567.2	971.8	1,274.2	745.0	402.8	729.5	393.6	284.0	7,465.5
2557	288.8	170.3	207.8	196.0	259.1	96.7	266.5	288.3	208.2	222.4	209.1	239.4	2,652.4
2558	229.4	233.1	194.7	204.8	241.0	234.1	234.5	161.4	192.4	198.9	235.3	301.9	2,661.6
2559	199.1	207.4	231.2	167.1	120.5	207.0	283.5	357.9	173.1	250.0	127.1	117.5	2,441.5
2560	173.9	256.4	235.7	251.4	213.0	221.8	469.0	366.4	284.0	300.2	258.1	422.0	3,451.9
Max.	854.1	1,121.7	1,196.6	1,384.3	2,061.5	2,107.2	3,061.6	1,465.2	1,013.4	838.9	808.9	805.9	12,773.1
Mean	352.2	429.5	499.8	477.5	695.5	824.4	947.7	534.5	496.8	422.3	314.4	376.8	6,371.4
Min.	173.9	112.3	137.7	125.2	120.5	96.7	202.2	120.3	159.5	168.6	127.1	117.5	2,441.5

Source : Royal Irrigation Department



Source: Consulting Company (Data analysis from Royal Irrigation Department)

Figure 3.1.5-3 Annual runoff at K.11A station



Source: Consulting Company (Data analysis from Royal Irrigation Department)

Figure 3.1.5-4 Monthly runoff at K.11A station

From **Table 3.1.5-2** and **Figure 3.1.5-3**, it was found that K.11A station had average annual water volume of 6,371.4 million m^3/year. It had the amount of water during the rainy season (June - Nov) of approximately 3,979.4 million m^3 and the amount of water in the dry season (December - May) was 2,392.0 million m^3. However, the year with the highest water volume wasin B.E.2539 with the volume of 12,773.1 million m^3/year. The year with the lowest water volume was in B.E. 2559 with only 2,441.5 million m^3/year.

Considering the monthly runoff at the foot of Mae Klong Dam at K.11A station as seen in **Figure 3.1.5-4**, it was found that the month with the highest average monthly runoff was in October with an average runoff of 947.7 million m^3/month. While the February was the month with the lowest monthly average runoff with an average of 314.4 million m^3/month. The month with the lowest monthly runoff from B.E.2536 - B.E.2560 was September B.E. 2557, with a runoff of only 96.7 million m^3/month. B.E.2557 was the year that Thailand had experienced continuous drought since the end of B.E.2556.

(B) The assessment of side flow water content flowing in the Mae Klong River

The assessment of the amount of side flow water flowing in the Mae Klong River took rainwater receiving areas from the foot of the Mae Klong Dam to the Gulf of Thailand into the consideration.

In studying the amount of side flow water flowing to fill the river, the study was done by analysis of the relationship between average annual runoff at various stations in Mae Klong Basin and the size of the rainwater receiving area of that station. There were 20 water station of the Royal Irrigation Department in the Mae Klong River Basin. The list of water stations in the Mae Klong River Basin, the size of the rainwater receiving area and average annual runoffwere shown in **Table 3.1.5-3**. The relationship between average annual runoff and rainfall area sizes of water stations in Mae Klong Basin was shown in **Figure 3.1.5-5.**

From **Figure 3.1.5-5**, the relationship between the average annual runoff volume and the size of the rainwater receiving area of the Mae Klong water station in the Mae Klong River Basin was shown in **Equation 1**.

$$Q = 0.3122\,A^{1.0091} \qquad \textbf{(Equation 1)}$$

When Q is average annual water volume (million m^3/year)
A is the size of rainwater receiving area (sq.km)

Table 3.1.5-3

List of water stations in the Mae Klong River Basin

No.	Station ID	Rivers / Canals	District	Province	Watershed (Sq km.)	Average annual runoff (MCM/Y.)
1	K.10	Kwai Noi River	Saiyok	Kanchanaburi	6,991	6,474
2	K.11A	Mae Klong River	Tha Muang	Kanchanaburi	26,449	6,371
3	K.12	Lam Ta Phen	Mueang	Kanchanaburi	2,375	238
4	K.17	Lam Phachi	Suan Phueng	Ratchaburi	1,344	250
5	K.22C	Huay Maenamnoi	Saiyok	Kanchanaburi	311	206
6	K.25A	Huay Tha Kiew	Banka	Ratchaburi	367	65
7	K.30	Huay Maenamhlor	Saiyok	Kanchanaburi	466	264
8	K.31	Huay Maenamnoi	Saiyok	Kanchanaburi	799	572
9	K.32A	Huay Bong Ti	Saiyok	Kanchanaburi	518	97
10	K.35A	Kwai Yai River	Mueang	Kanchanaburi	44,444	4,664
11	K.37	Kwai Noi River	Mueang	Kanchanaburi	10,557	7,329
12	K.38A	Huay Lin Thin	Thong Pha Phum	Kanchanaburi	122	40
13	K.39	Huay Ongthi	Thong Pha Phum	Kanchanaburi	51	22
14	K.50	Huay Din So	Thong Pha Phum	Kanchanaburi	123	33
15	K.53	Huay Mae Kradan	Saiyok	Kanchanaburi	308	44
16	K.54	Kwai Noi River	Thong Pha Phum	Kanchanaburi	4,774	6,100
17	K.58	Kwai Noi River	Saiyok	Kanchanaburi	6,725	6,926
18	K.60	Huay Kui Mang	Thong Pha Phum	Kanchanaburi	128	50
19	K.61	Lam Phachi	Dan Makham Tia	Kanchanaburi	1,844	377
20	K.62	Lam Phachi	Dan Makham Tia	Kanchanaburi	1,950	353

Source : Royal Irrigation Department

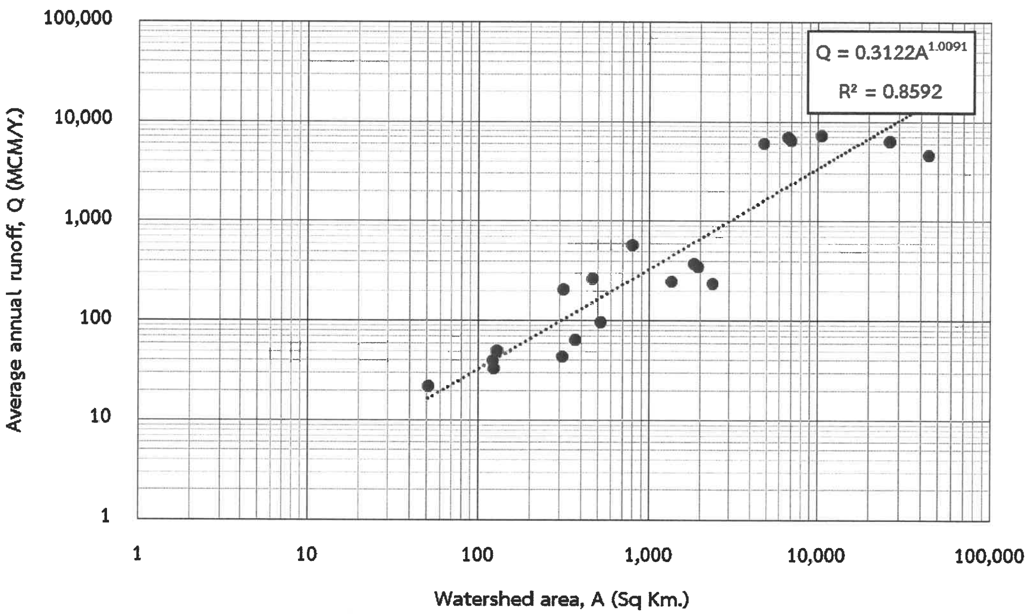
After that, the equation was adjusted and correct to be suitable for the project study area by using the average annual runoff data with the rainwater receiving area of K.11A Station, the station locating in the study area boundary with **Equation 2.**

$$Q / Q_i = (A / A_i)^{1.0091} \qquad \textbf{(Equation 2)}$$

When Q is average annual amount of side flow water flowing to the Mae Klong River (million m^3/year)

Q_i is	annual average runoff at K.11A station = 6,371 million m^3/year
A is	size of the rainwater receiving area of the watershed branch, Mae Klong River Basin to the Gulf of Thailand = 2,683 sq.km
A_i is	size of the rainwater receiving area of the K.11A station = 26,449 sq.km

From **equation 2**, it was found that the average annual side flow water of the Mae Klong River was 632.9 million m^3/year. The amount of monthly side flow water flowing from the side of the Mae Klong during B.E. 2536 – B.E. 2560 were described in **Table 3.1.5-4**.



Source: Consulting Company (Data analysis from Royal Irrigation Department)

Figure 3.1.5-5 **The relationship between average annual runoff and rainfall area sizes of water stations in Mae Klong Basin**

Table 3.1.5-4

The amount of monthly side flow water flowing from the side of the Mae Klong

Hydrological year	Monthly runoff (Million cubic meters / month)												Annual runoff (Million cubic meters / year)
	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
2536	0.5	6.4	53.2	79.2	74.7	70.4	112.0	62.7	15.7	6.8	2.1	0.7	484.3
2537	0.5	36.7	73.7	149.1	200.3	119.2	120.9	58.9	41.2	31.5	20.1	13.6	865.7
2538	23.4	68.6	98.9	118.6	92.1	178.3	165.8	75.5	46.8	33.7	8.1	8.2	917.9
2539	13.7	65.8	101.1	129.4	234.5	154.7	220.7	126.5	71.2	47.2	21.4	1.4	1,187.7
2540	15.4	46.7	62.4	99.7	233.7	111.8	123.4	86.9	21.4	9.5	2.6	0.6	814.0
2541	0.1	23.3	71.4	90.7	61.1	67.1	126.9	38.2	17.9	7.0	1.1	0.3	504.9
2542	13.1	98.2	95.7	110.8	129.3	85.7	132.7	155.3	72.4	52.1	33.1	22.7	1,001.3
2543	54.1	103.5	102.4	136.2	76.4	66.3	115.4	81.9	54.3	28.4	2.3	8.1	829.3
2544	31.0	49.7	85.3	111.6	86.0	65.1	98.3	60.2	23.8	8.4	2.5	0.9	622.8
2545	0.2	62.2	88.5	121.1	107.2	125.8	131.3	81.2	63.5	33.4	6.2	13.5	834.0
2546	48.8	72.2	80.4	102.4	128.4	88.6	126.3	55.2	13.2	5.3	2.0	0.7	723.6
2547	0.3	65.6	122.9	130.4	74.4	62.4	51.8	15.7	7.4	2.6	0.5	0.3	534.4
2548	0.6	13.7	47.2	74.7	151.8	90.8	115.3	89.7	34.9	10.4	3.6	1.1	633.8
2549	4.3	18.4	40.8	78.6	82.3	100.0	68.2	26.3	22.8	15.6	13.9	14.7	485.9
2550	26.9	72.6	38.4	53.8	41.0	47.3	56.8	33.0	43.3	22.9	20.9	24.6	481.6
2551	28.9	40.1	45.7	49.7	42.7	40.1	43.4	59.8	39.7	27.1	29.3	26.3	472.9
2552	23.0	33.4	30.3	39.1	73.9	48.5	94.4	56.5	47.7	43.3	22.3	29.6	541.9
2553	30.1	29.9	26.3	31.7	35.7	42.6	86.1	42.3	42.1	22.1	20.3	24.4	433.5
2554	16.1	15.9	18.8	21.0	65.8	71.6	112.3	58.4	57.2	52.5	43.3	46.5	579.4
2555	46.2	35.0	27.2	32.0	72.4	97.8	118.9	62.7	63.9	34.7	24.0	26.4	641.2
2556	30.0	28.0	35.6	32.3	34.1	56.2	99.6	70.0	43.0	42.9	31.7	16.9	520.2
2557	16.2	10.3	11.2	13.0	16.0	13.8	26.5	39.9	29.5	27.2	19.4	17.1	240.2
2558	13.5	14.4	14.1	15.5	20.3	26.1	29.9	21.1	17.5	14.8	8.1	11.3	206.6
2559	19.0	43.9	59.6	79.2	92.8	79.6	103.3	63.4	38.7	25.2	14.8	13.5	633.0
2560	19.0	43.9	59.6	79.2	92.8	79.6	103.3	63.4	38.7	25.2	14.8	13.5	633.0
Max.	54.1	103.5	122.9	149.1	234.5	178.3	220.7	155.3	72.4	52.5	43.3	46.5	1,187.7
Mean	19.0	43.9	59.6	79.2	92.8	79.6	103.3	63.4	38.7	25.2	14.7	13.5	632.9
Min.	0.1	6.4	11.2	13.0	16.0	13.8	26.5	15.7	7.4	2.6	0.5	0.3	206.6

Source: Consulting Company

(C) Summary of the water content in the Mae Klong River Basin from the foot of Mae Klong Dam to the Gulf of Thailand

The amount of water in the Mae Klong Basin from the foot of the Mae Klong Dam to the Gulf of Thailand was calculated from the amount of water released from the Mae Klong Dam at K.11A Station (**Table 3.1.5-2**), in combination with the amount of side flow water flowing between paths of the Mae Klong River from the foot of Mae Klong Dam to the Gulf of Thailand. (**Table 3.1.5-4**). Then the amount of water in the Mae Klong River in the study area were shown in **Table 3.1.5-5, Figure 3.1.5-6** and **Figure 3.1.5-7.**

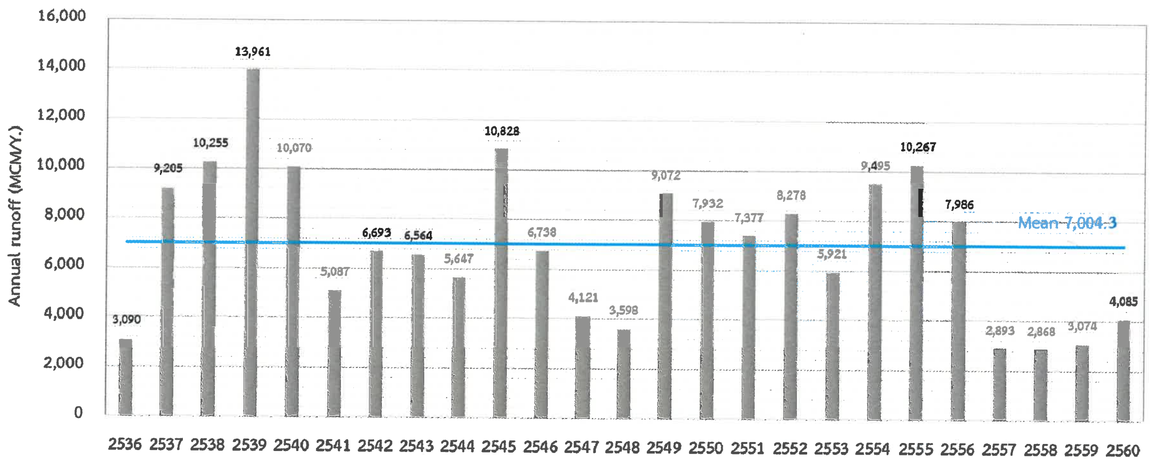
Table 3.1.5-5

The amount of water in the Mae Klong River in the study area

Hydrological year	Monthly runoff (Million cubic meters / month)												Annual runoff (Million cubic meters / year)
	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
2536	194.3	174.7	502.2	204.3	210.9	395.9	540.0	183.0	175.2	175.4	187.4	147.1	3,090.5
2537	200.5	217.7	311.7	678.4	1,543.8	1,576.9	1,148.2	878.2	1,054.6	729.2	396.7	469.1	9,204.8
2538	365.0	631.5	1,228.2	808.1	549.6	1,889.0	1,786.9	829.0	635.1	702.4	275.0	555.2	10,255.1
2539	372.1	665.7	1,297.7	1,118.2	1,286.8	1,986.0	3,282.4	1,591.7	847.4	668.2	442.1	402.5	13,960.8
2540	350.7	487.2	712.4	669.9	2,295.2	1,439.0	1,346.8	825.8	799.6	539.1	215.3	388.9	10,069.9
2541	462.7	579.3	720.9	487.0	378.1	352.7	963.3	301.1	253.5	256.8	168.8	162.9	5,087.1
2542	237.5	482.3	389.1	336.5	634.9	369.1	1,163.0	1,305.8	430.9	488.4	450.3	405.5	6,693.3
2543	568.8	716.2	670.7	567.5	339.5	850.4	617.1	487.1	622.9	331.5	294.7	498.2	6,564.5
2544	352.2	348.9	511.2	553.2	669.5	824.3	748.5	338.3	467.0	326.3	159.6	348.2	5,647.1
2545	251.5	573.7	567.3	584.9	1,156.1	2,233.0	1,759.5	978.6	971.0	872.3	440.1	440.0	10,828.2
2546	433.5	580.6	674.4	805.5	654.9	518.2	1,036.5	343.0	496.5	537.3	320.9	336.4	6,737.8
2547	289.4	516.4	371.7	367.6	485.5	480.6	254.0	279.4	334.5	254.2	191.0	296.4	4,120.7
2548	198.3	126.0	184.9	203.7	381.3	497.8	628.6	378.1	235.2	255.9	238.5	270.0	3,598.4
2549	267.9	431.9	894.8	1,462.8	1,663.3	1,753.5	976.1	427.6	395.0	280.6	232.1	286.3	9,071.9
2550	566.8	1,194.4	695.2	855.0	756.9	772.4	772.7	475.3	651.1	342.8	364.8	484.9	7,932.2
2551	534.6	680.8	871.3	663.6	671.4	664.7	657.9	725.9	460.1	523.0	430.8	493.2	7,377.4
2552	407.6	559.0	374.5	541.4	1,269.7	651.3	1,447.0	579.3	866.9	532.6	440.3	608.8	8,278.5
2553	482.4	570.7	472.5	490.9	481.9	505.3	991.1	310.8	548.3	267.1	384.4	415.3	5,920.9
2554	288.3	269.1	336.1	368.5	1,274.5	1,193.9	1,629.2	674.5	898.1	858.6	852.2	852.4	9,495.4
2555	900.3	563.2	465.6	722.8	1,346.0	1,659.1	1,636.3	859.0	816.2	410.5	430.2	457.8	10,267.0
2556	596.0	486.1	720.0	421.1	601.3	1,028.0	1,373.7	815.0	445.8	772.5	425.3	300.9	7,985.8
2557	305.0	180.6	219.0	209.0	275.1	110.5	292.9	328.2	237.7	249.5	228.5	256.5	2,892.5
2558	242.9	247.5	208.7	220.4	261.3	260.2	264.4	182.4	209.9	213.8	243.4	313.2	2,868.2
2559	218.1	251.3	290.8	246.3	213.3	286.6	386.9	421.3	211.8	275.2	141.9	131.0	3,074.5
2560	192.9	300.4	295.3	330.5	305.8	301.4	572.3	429.8	322.7	325.4	272.9	435.5	4,084.9
Max.	900.3	1,194.4	1,297.7	1,462.8	2,295.2	2,233.0	3,282.4	1,591.7	1,054.6	872.3	852.2	852.4	13,960.8
Mean	371.2	473.4	559.4	556.7	788.3	904.0	1,051.0	597.9	535.5	447.5	329.1	390.3	7,004.3
Min.	192.9	126.0	184.9	203.7	210.9	110.5	254.0	182.4	175.2	175.4	141.9	131.0	2,868.2

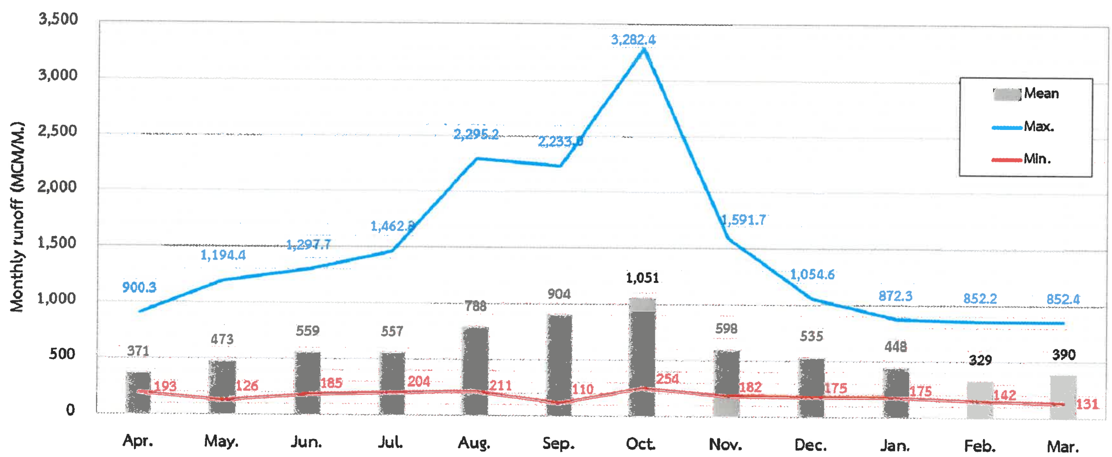
Note : The amount of water released from the Mae Klong Dam at K.11A Station , in combination with the amount of side flow water flowing between paths of the Mae Klong River.

Source: Consulting Company (Data analysis from Royal Irrigation Department)



Source: Consulting Company (Data analysis from Royal Irrigation Department)

Figure 3.1.5-6 Annually runoff of the Mae Klong River from the foot of Mae Klong Dam to the Gulf of Thailand.



Source: Consulting Company (Data analysis from Royal Irrigation Department)

Figure 3.1.5-7 Monthly runoff of the Mae Klong River from the foot of Mae Klong Dam to the Gulf of Thailand.

Figure 3.1.5-6 showed that on the downstream side of the Mae Klong Dam, there was an average annual volume of 7,004.3 million m^3/year. The highest runoff was in B.E. 2539 with a volume of 13,960.8 million m^3/year. The lowest runoff quantity was in B.E.2558, with a volume of only 2,868.2 million m^3/year.

When considering the downstream monthly runoff of Mae Klong Dam from **Figure 3.1.5-7,** it showed that the month with the highest average monthly runoff was October, with an average runoff of 1,051.0 million m^3/month. While the lowest average monthly runoff was in February, with an average runoff of 329.1 million m^3/month. The month with the lowest monthly runoff from B.E. 2536 - B.E. 2560 was

September B.E. 2557, with only 110.5 million m^3/month. In B.E.2557, it was the year that Thailand had experienced continuous drought since the end of B.E.2556.

(2) Surface water source network

The consulting company collected data on the study of water content in the Mae Klong River as seen as **Figure 3.1.5-8**. Data from the river network in the area together with the initial inspection of the rainwater drainage canal on 10 July B.E. 2562 and 26 August B.E.2562 were also collected. The direction of the flow from various rivers and irrigation canals in the area as shown in **Figure 3.1.5-9** and **Figure 3.1.5-10**. Various rivers in the area surrounding the power plant finally flew into the Mae Klong River.

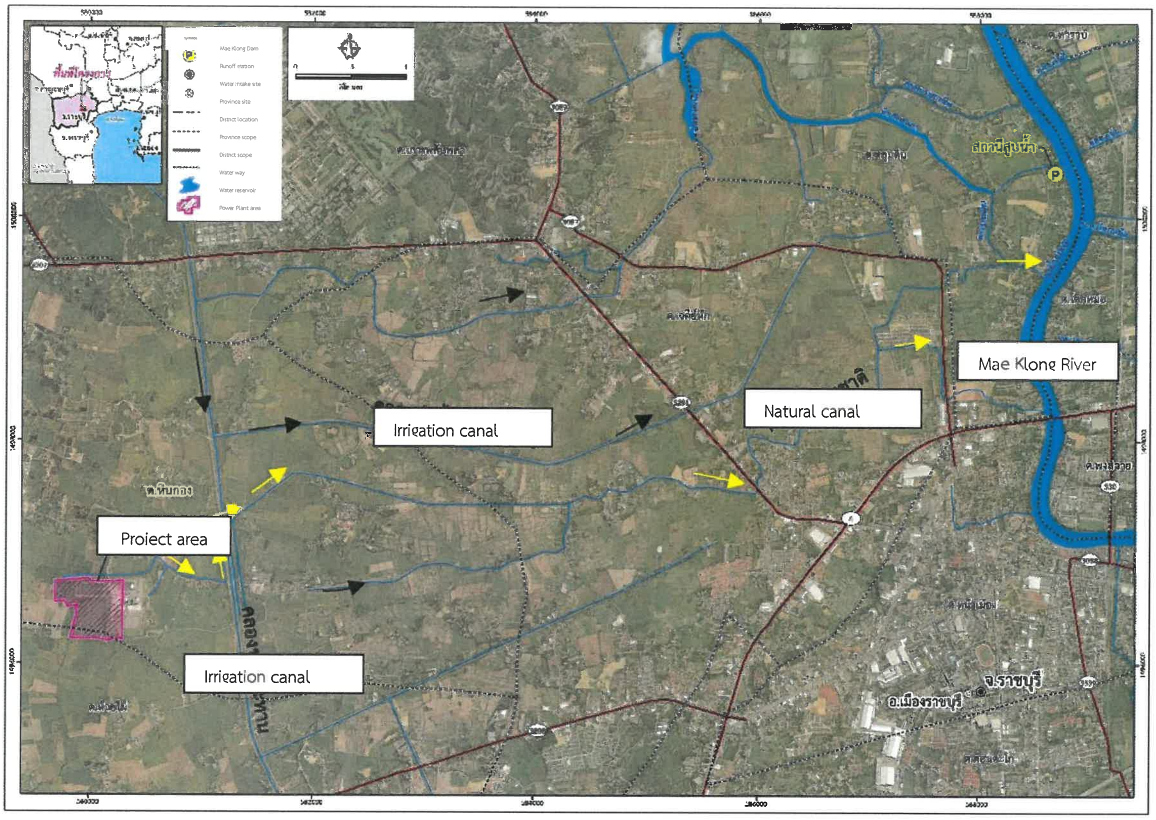
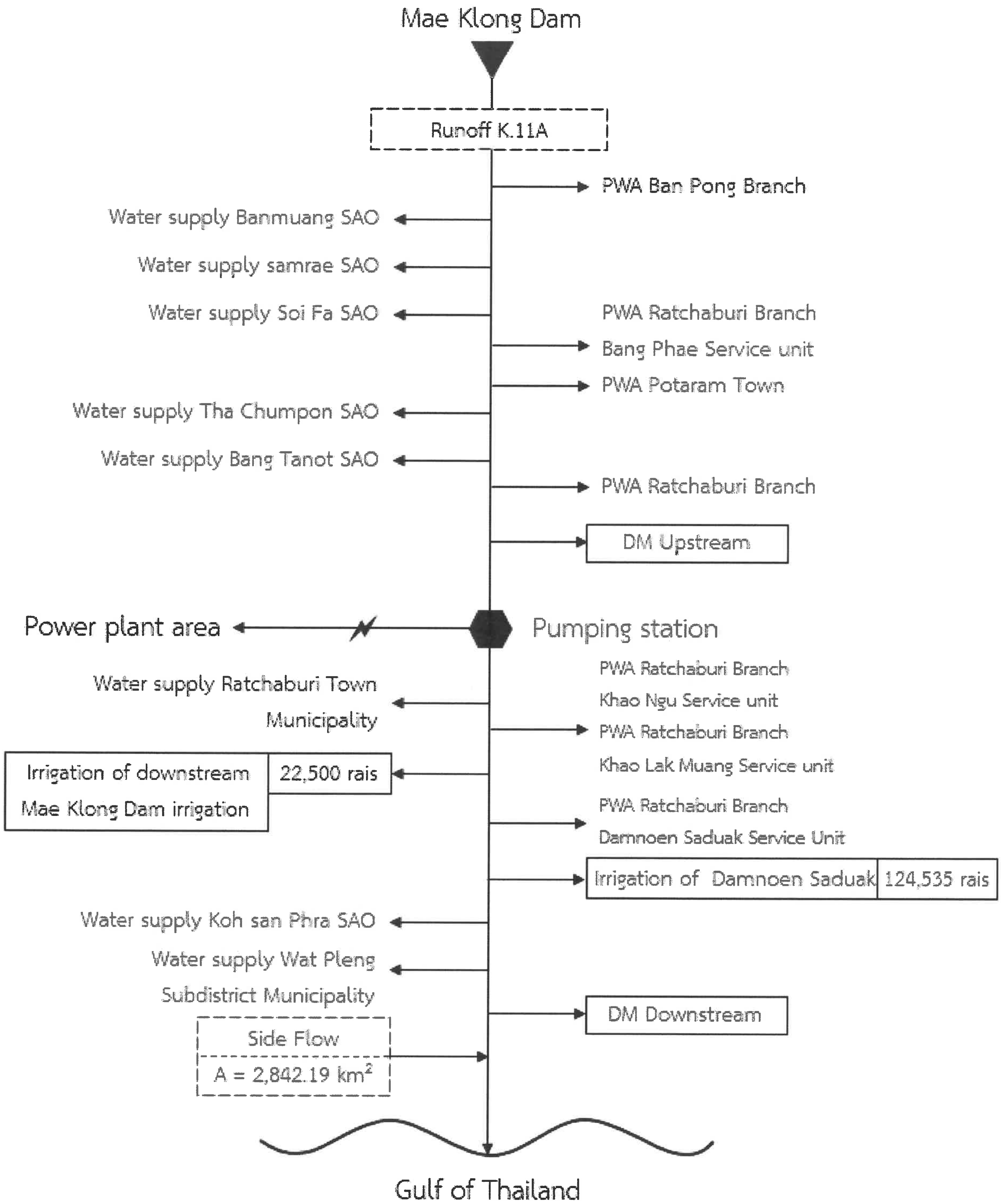


Figure 3.1.5-9 **The direction of the flow from various rivers and irrigation canals in the area.**



Note:
DM Water demand of Livestock, Industry, and tourism.

SAO =Subdistrict Administrative Organization PWA =Provincial Waterworks Authority

Source: Consulting Company

Figure 3.1.5-8 River network system chart

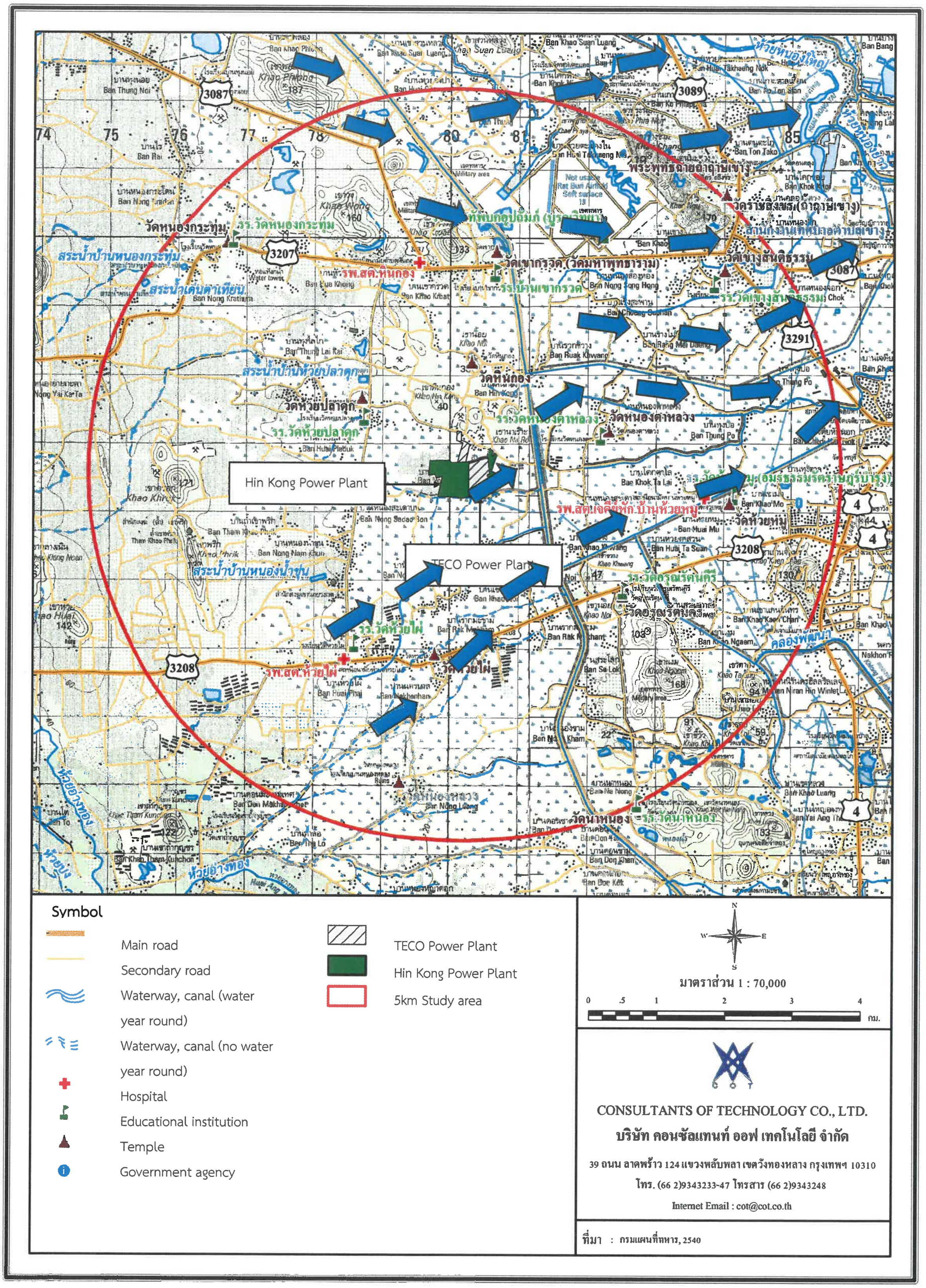


Figure 3.1.5-10 Surface water resource in the study area and the direction of the flow

(3) Surface water quality

Activities that will occur during the construction and operation phases may cause impact of surface water sources near the project area. Therefore, it is necessary to have an analysis of the water quality of current surface water sources including collection of information on the public surface water consumption. Results will be used as baseline information in assessing potential environmental impacts of the project. Data can be applied as a comprehensive and appropriate measures to prevent and solve environmental impacts and the environmental impact monitoring in the future.

1) Measurement data of the Pollution Control Department

The consulting company collected data from surface water source quality database system, Mae Klong river water quality checkpoint at Sirilak Bridge locating in front of Panurangsi Camp on August 5, B.E. 2562. It was found that dissolved oxygen (DO) was 6.6 mg/L. Organic matter was 1.3 mg/L. The total amount of coliform bacteria (TCB) was 4,600 MPN/100 ml. The total amount of bacteria in the form of phenol coliform (FCB) was 790 MPN/100 ml. Ammonia - nitrogen (NH3- N) was 0.03 mg/L and the Water Quality Index (WQI) was 80, indicating that the water quality was good.

2) Measurement results done by TECO

The consulting company collected results from the report on the implementation of the environmental impact prevention and measures and the environmental impact monitoring of 700 MW of Combined Cycle Power Plant Project of Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch) during B.E. 2558-2562. The measurement was conducted 2 times a year, consisting of 5 stations, which were, Wat Bang Chong area, Wat Bang Li, Wat Khok Mo, Sirilak Bridge area and Wat Koh area. The measurement indexes were: pH, temperature, salinity, conductivity, Total Dissolved Solids (TDS), Total Suspended Solids (SS), Dissolved Oxygen (DO), BOD5, Grease & Oil, and Phosphate. Water quality measurement results of surface water as shown in **Table 3.1.5-6** and were summarized as follows.

According to the results of surface water quality monitoring of the Mae Klong River during B.E. 2558-2562, temperature, pH, DO and BOD5 were in the standard values, according to the Announcement of the National Environment Board, No. 8, B.E. 2537, on the determination of water quality standards for surface water sources (Category 3) for analysis at all stations.

For Total Dissolved Solids, Total Suspended Solids, Grease & Oil, Phosphate, Salinity, and Conductivity values, Their standard value had not yet been set for the control.

Table 3.1.5-6

Water quality measurement results of surface water of the Mae Klong River during B.E. 2559-2562

The measurement index	unit	Year	The measurement station										Standard[1/]
			Wat Bang Chong		Wat Bang Li		Wat Khok Mo		Sirilak Bridge		Wat Koh		
			Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	
Temperature	C°	2558	26.7	30.4	27.1	31.2	27.2	31.7	27.2	31.3	27.5	31.4	ธ’
		2559	29.9	30.8	30.1	31.3	30.1	31.4	30.1	31.4	30.1	31.6	
		2560	28.9	30.0	28.4	30	27.8	30.3	27.6	30	27.8	30.0	
		2561	30.3	27.8	30.1	28.1	29.9	27.8	29.9	27.9	29.9	28.1	
		2562	30.0	-	29.9	-	30	-	29.9	-	30.5	-	
pH	-	2558	7.7	7.6	7.8	7.8	7.7	7.9	7.7	7.8	7.7	7.7	5.0-9.0
		2559	7.8	7.54	7.6	7.61	7.5	7.56	7.6	7.53	7.7	7.59	
		2560	6.9	7.59	6.59	7.61	7.26	7.46	7.29	7.61	7.31	7.62	
		2561	7.98	7.3	7.98	7.64	8.01	7.42	8	7.38	8.01	7.49	
		2562	7.07	-	7.4	-	7.73	-	7.59	-	8.14	-	
Total Dissolved Solids (TDS)	mg/l	2558	166	124	172	122	162	134	226	135	174	174	-
		2559	158	166	176	164	177	165	170	165	170	167	
		2560	124	150	178	150	136	136	112	146	148	158	
		2561	216	130	224	140	208	154	204	158	294	134	
		2562	136	-	138	-	166	-	196	-	172	-	
Total Suspended Solids (SS)	mg/l	2558	6	<5	8	<5	10.0	<5	8	<5	6	<5	-
		2559	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	
		2560	7.8	20.7	5	15.3	6.0	10.0	6.3	17.8	8.3	19.8	

Table 3.1.5-6 (cons.)

The measurement index	unit	Year	The measurement station										Standard[1/]
			Wat Bang Chong		Wat Bang Li		Wat Khok Mo		Sirilak Bridge		Wat Koh		
			Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	
		2561	4.3	36	11	39	11.5	30.5	13.8	33.5	13.8	31.5	
		2562	7.3	-	4.3	-	6.0	-	3.8	-	4	-	
BOD5	mg/l	2558	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	≤2
		2559	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
		2560	1.8	0.6	1.8	0.8	1.4	1.5	1.3	0.8	1.1	1.2	
		2561	1.3	0.6	1.0	1.3	1.3	1.1	1.1	1.0	1.2	0.8	
		2562	0.7	-	1.2	-	1.1	-	1.3	-	1.1	-	
Dissolved Oxygen (DO)	mg/l	2558	4.5	5.2	4.4	5.4	4.1	5.5	4.1	5.7	4.0	5.4	≥4.0
		2559	5.4	5.3	5.5	6.6	5.5	5.5	5.2	6.2	5.3	6.8	
		2560	5.2	5.4	5.3	5.2	5.7	4.5	5.8	5.4	6.0	5.6	
		2561	5.6	6	5.4	5.4	5.2	5.7	5.2	5.9	5.5	6.3	
		2562	5.5	-	5.6	-	2.8	-	5.7	-	5.6	-	
Grease & Oil	mg/l	2558	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
		2559	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
		2560	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	
		2561	<2	<2	<2	<2	<2	<2	<2	2	<2	2	
		2562	<2	-	<2	-	<2	-	<2	-	<2	-	
Phosphate	mg/l	2558	0.04	0.06	0.05	0.1	0.05	0.07	0.05	0.08	0.06	0.08	-
		2559	0.07	0.18	0.09	0.19	0.08	0.2	0.09	0.2	0.09	0.21	
		2560	0.08	<0.03	<0.03	0.04	0.11	0.15	0.09	0.06	0.12	0.06	

Table 3.1.5-6 (cons.)

The measurement index	unit	Year	The measurement station										Standard[1/]
			Wat Bang Chong		Wat Bang Li		Wat Khok Mo		Sirilak Bridge		Wat Koh		
			Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	
		2561	0.03	0.03	<0.03	<0.03	<0.03	0.03	<0.03	<0.03	<0.03	0.05	
		2562	<0.03	-	<0.03	-	<0.03	-	<0.03	-	<0.03	-	
Salinity	ppt	2558	0	0	0	0	0	0	0	0	0	0	-
		2559	0	0	0	0	0	0	0	0	0	0	
		2560	0.1	0.14	0.1	0.14	0.1	0.15	0.1	0.13	0.1	0.14	
		2561	0.16	0.13	0.15	0.12	0.16	0.15	0.16	0.19	0.16	0.13	
		2562	0.13	-	0.12	-	0.12	-	0.13	-	0.13	-	
Conductivity	µm/cm	2558	251	216	273	218	274	218	275	221	287	229	-
		2559	225	287	255	288	259	286	262	287	250	286	
		2560	286	329	303	316	304	345	281	349	280	319	
		2561	462	242	320	234	317	245	314	254	320	232	
		2562	242	-	172	-	249	-	256	-	256	-	

Note : [1/] The Announcement of the National Environment Board No.8 (B.E.2537), issued under the National Environmental Quality Promotion and Preservation Act, B.E.2535on water quality standards in surface water sources, type 3, such as water sources receiving wastewater from some activities and can be useful for consumption through normal disinfection and general water quality improvement processes.

ธ = Not higher than natural temperature more than 3 degrees Celsius

3) The result of surface water quality measurement done by a consulting company

The consulting company conducted the surface water quality measurement in the study area with indexes for measurement such as temperature, salinity, pH, Ammonia - nitrogen, conductivity, BOD, nitrate, arsenic, cadmium, lead, chromium hexavalence, mercury, coliform bacteria and fecal coliform bacteria. The measurement was done in 2 seasons, dry season and rainy season. During the dry season, samples were collected on 18 February, B.E.2562. During the rainy season, samples were collected on 18 July, B.E.2562. Sampling was done by using the grab sampling method for the 3 checkpoints (**Figure 3.1.5-11**) as follows:

Surface water quality analysis results were shown in **Table 3.1.5-7** with following details.

(A) Wat Bang Li

According to the dry season measurements on 18 February B.E. 2562, results of physical water quality tests showed that the water temperature was 29.8 °C, pH was 8, conductivity was 373 micrometers per centimeter. Suspended solids was less than 5.0 mg/L and the salinity value of 0.2 parts per thousand. For chemical water quality, BOD was less than 2 mg/L. Nitrate was less than 0.2 mg/L. Biological water quality showed that 1,300 MPN per 100 ml of coliform bacteria and 490 MPN of fecal coliform bacteria per 100 ml.

According to the measurement during the rainy season on 18 July B.E. 2562, the results of physical water quality tests showed that the water temperature was 29.7 °C, pH was 8.1, the conductivity was 236 micrometers per centimeter. Suspended solids was less than 5.0 mg/l and the salinity value of 0.2 parts per thousand. For chemical water quality, BOD was less than 2 mg/l. Nitrate was 0.2 mg/l. Biological water quality showed that Coliform bacteria was 300 MPN/100 ml and fecol coliform bacteria was 79 MPN/100 ml.

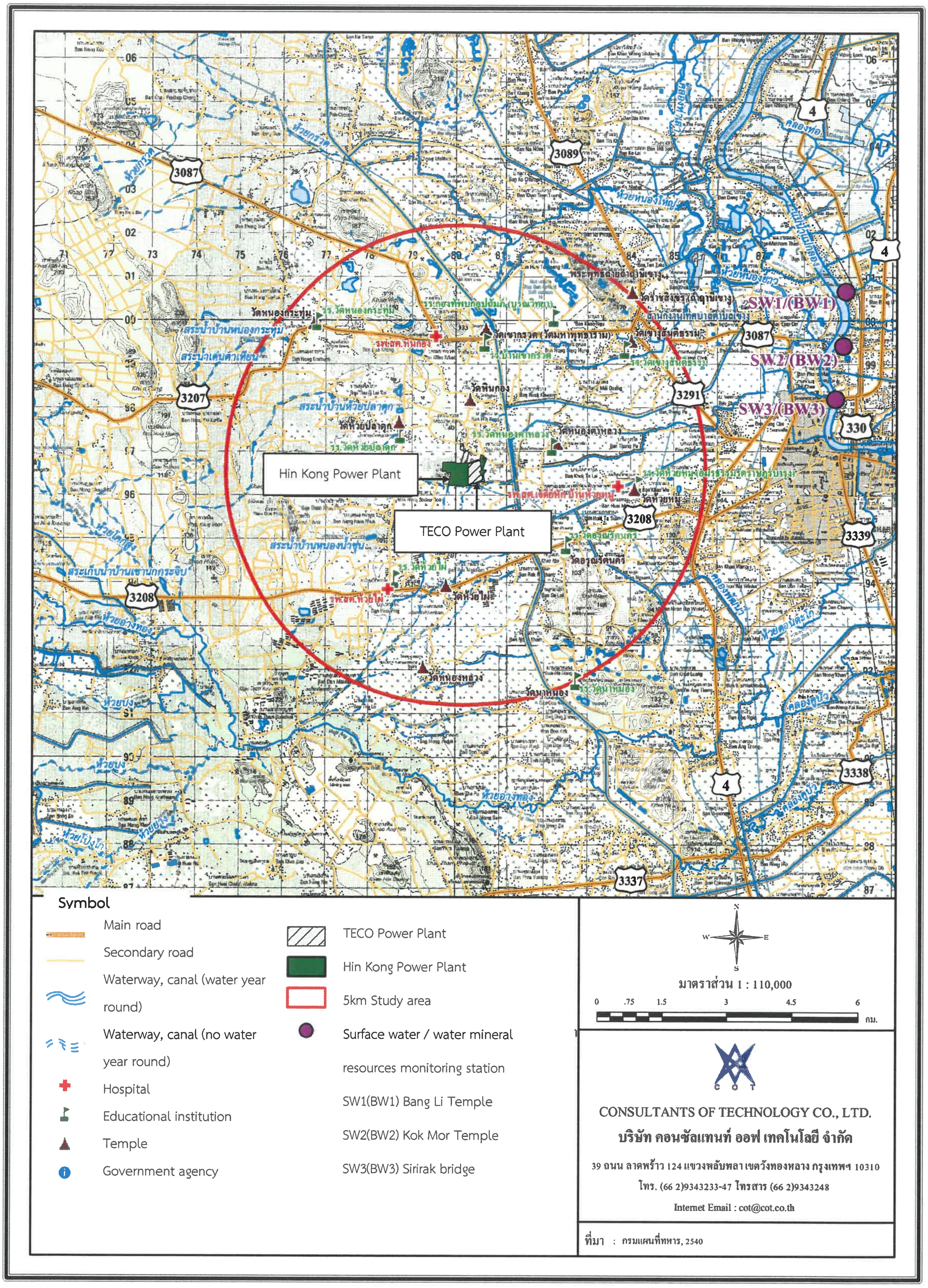


Figure 3.1.5-11 The surface water quality measurement station

Table 3.1.5-7

Surface water quality analysis results

The measurement index	Unit	The surface water quality measurement station[2/]						the standard values [1/]	
		SW1		SW2		SW3		type 4	type 3
		1/62	2/62	1/62	2/62	1/62	2/62		
Temperature	C	29.8	29.7	29.7	29.5	29.7	29.7	ธ	ธ
Salinity	ppt	0.2	0.2	0.2	0.2	0.2	0.2	-	-
pH	-	8	8.1	8	8.2	8	8.1	5-9	5-9
Odor	-	scentless	scentless	scentless	scentless	scentless	scentless	ธ	ธ
Ammonia-nitrogen	mg/l	<0.06	<0.06	<0.06	0.23	<0.06	0.08	0.5	0.5
Cnductivity	µmol/cm	373	236	350	246	349	243	-	-
Color	Color Unit	<5	5	<5	<5	<5	<5	ธ	ธ
BOD	mg/l	<2	<2	<2	<2	<2	<2	Not more than 4	Not more than 2
Nitrate	mg/l	<0.2	0.2	0.2	<0.2	0.2	<0.2	5	
Arsenic	mg/l	0.006	0.004	0.005	0.004	0.005	0.004	0.01	
Cadmium	mg/l	ND	ND	ND	ND	ND	ND	0.005	
Lead	mg/l	0.0008	0.0002	0.0006	0.003	0.0006	0.0002	0.05	
Hexavalent chromium	mg/l	ND	ND	<0.01	ND	<0.01	<0.01	0.05	
Mercury	mg/l	ND	<0.0001	ND	<0.0001	<0.0001	<0.0001	0.002	
Coliform	MPN/100 mL	1,300	330	2,400	790	24,000*	330	-	20,000
fecal coliform bacteria	MPN/100 mL	490	79	1,300	170	4,900*	130	-	4,000

Source : Measurement by ALS Laboratory Group (Thailand) Co.,Ltd.

Note : [1] /The Announcement of the National Environment Board No.8 (B.E.2537), issued under the National Environmental Quality Promotion and Preservation Act, B.E.2535on water quality standards in surface water sources, type 3,such as water sources receiving wastewater from some activities and can be useful for consumption through normal disinfection and general water quality improvement processes. For agriculture type 4 such as, water sources that receive wastewater from certain activities and can be useful for consumption through normal disinfection and special water quality improvement process. For industrial activities.

ธ = Not higher than natural temperature more than 3 degrees Celsius

* หมายถึง Exceeded the standard Value

[2/] SW1 = Wat Bang Li SW2 = Wat Khok Mo SW3 = Sirilak Bridge

1st/2562 (dry season) 18 February B.E.2562 2nd/2562 (rainy season) 18 July B.E.2562

When compared with the standard values, according to the Announcement of the National Environment Board No.8 (B.E.2537), issued under the National Environmental Quality Promotion and Preservation Act, B.E.2535on water quality standards in surface water sources, type 3 ,such as water sources receiving wastewater from some activities and can be useful for consumption through normal disinfection and general water quality improvement processes. For agriculture type 4 such as, water sources that receive wastewater from certain activities and can be useful for consumption through normal disinfection and special water quality improvement process. For industrial activities, it was found that the results of surface water quality measurement in both the dry season and the rainy season were within the standard criteria.

(B) Wat Khok Mo

According to the dry season measurements on 18 February B.E. 2562, results of physical water quality tests showed that the temperature was 29.7°C, pH was 8, the conductivity was 350 micrometers per centimeter. Suspended solids was less than 5.0 mg/L and the salinity value was 0.2 parts per thousand. For chemical water quality, BOD was less than 2 mg/L. Nitrate was 0.2 mg/L. Biological water quality showed 2,400 MPN/100 ml of coliform bacteria and 1,300 MPN/100 ml of fecal coliform bacteria.

From the measurement in the rainy season on 18 July B.E. 2562, results of physical water quality tests showed the water temperature was 29.5°C, pH was 8.2 and the conductivity was 246 micrometers per centimeter. Suspended solids was less than 5.0 mg/l. The salinity value was 0.2 parts per thousand. For chemical water quality, BOD was less than 2 mg/l. Nitrate was less than 0.2 mg/l. Biological water quality, it was found that coliform bacteria was 790 MPN/100 ml and fecal coliform bacteria was 170 MPN/ 100 ml.

When compared with the standard values, according to the Announcement of the National Environment Board No.8 (B.E.2537), issued under the National Environmental Quality Promotion and Preservation Act, B.E.2535 on water quality standards in surface water sources, type 3 ,such as water sources receiving wastewater from some activities and can be useful for consumption through normal disinfection and general water quality improvement processes. For agriculture type 4 such as, water sources that receive wastewater from certain activities and can be useful for consumption through normal disinfection and special water quality improvement process. For industrial activities, it was found that the results of surface water quality measurement in both the dry season and the rainy season were within the standard criteria.

(C) Sirilak Bridge

According to the dry season measurements on 18 February B.E. 2562, results of physical water quality tests showed that the temperature was 29.7 °C, pH was 8. The conductivity was 349 micrometers per centimeter. Suspended solids was less than 5.0 mg/l. The salinity value was 0.2 parts per thousand. For chemical water quality, BOD was less than 2 mg/l. Nitrate was less than 0.2 mg/l. For biological water quality, it was found that coliform bacteria was 24,000 MPN/100 ml and fecal coliform bacteria was 4, MPN/100 ml.

From the measurement in the rainy season on 18 July B.E. 2562, results of physical water quality tests showed the water temperature was 29.7°C, pH was 8.1. The conductivity was 243 micrometers per centimeter. Suspended solids was less than 5.0 mg/l. The salinity value was 0.2 parts per thousand. For chemical water quality, BOD was less than 2 mg/l. Nitrate was less than 0.2 mg/l. For biological water quality, it was found that coliform bacteria was 330 MPN/100 ml and fecal coliform bacteria was 130 MPN/100 ml.

When compared with the standard values, according to the Announcement of the National Environment Board No.8 (B.E.2537), issued under the National Environmental Quality Promotion and Preservation Act, B.E.2535 on water quality standards in surface water sources, type 3 ,such as water sources receiving wastewater from some activities and can be useful for consumption through normal disinfection and general water quality improvement processes. For agriculture type 4 such as, water sources that receive wastewater from certain activities and can be useful for consumption through normal disinfection and special water quality improvement process. For industrial activities, it was found that the results of surface water quality measurement in the dry season were within the standard criteria. However, the coliform bacteria was exceptable due to its value was exceeded the standard value. It showed that around Sirilak Bridge was a location of the dense community with a direct source of wastewater. There may be washing and blowing sewage into the Mae Klong River. During the rainy season, all values were within the standard criteria.

(4) Hydrology and groundwater quality

1) Hydrological characteristics

Ratchaburi has 2 major types of groundwater, which are, 1) Unconsolidated Aquifer, consisting of 2 aquifer units which area Chao Phraya aquifer and Coluvium Aquife and 2) Consolidated Aquifer with the hydrological characteristics are as follows.

(A) Unconsolidated Aquifer

A) Chao Phraya aquifer is the water layer that occurs in the area of the Mae Klong River Basin as part of the basin in the southern central region. This aquifer covered Ban Pong, Bang Phae, Photharam, Damnoen Saduak, Pak Tho and Muang Districts. It consists of sediment, gravel, sand, clay and sandy clay in which the gravel layer will be the body holding groundwater. This area is divided into 3 zones, the first zone is at a depth of about 50 meters. The second zone is at a depth of about 80-90 meters. Both zones contain brackish and saltwater. The third zone is at a depth of more than 120 meters contaning a freshwater table with a flow volume of more than 200 m^3/hour.

B) Coluvium Aquife is the water table in the plain of the hill, occurring from the accumulation of broken sediment from original mountain rocks. There are 2 plains at the foothills: alluvial plains on the east side next to the flood plain, covering some parts of Ban Pong District, Photharam District, Mueang District, and Pak Tho District. The 2nd area is located in the valley next to the west, covering some areas of Jom Bueng. Groundwater is stored in porous or gaps of gravel, sand and rubble that serves as the groundwater which may look like a layer or lens image. The depth of the water table is approximately 15 meters. The maximum amount of water does not exceed 15 m^3/hour. The water quality is within the consumption criteria.

(B) Consolidated Aquifer, Ratchburi has the groundwater table which consisting of metamorphic rock aquifer, semi-metamorphic rock aquifer, limestone aquifer, lower Korat aquifer, and the granite and gneiss aquifers. These aquifers have boundaries with the distribution in the northwest-southeast direction. From data of groundwater drilling and development done by The Department of Geological Resources in the past, it was found that, in general, groundwater levels in hard rock providing less amount of water, water quality in general is good, unless there was having relatively high amounts of iron in the water. However, the expanding groundwater table on the east side connected with flood plains which is a saltwater aquifer.

From the study of hydrological map data done by the Department of Groundwater Resources, B.E.2547, it was found that aquifers of the study area (**Figure 3.1.5-12**) consisting of Permian-Carboniferous Metasediments Aquifer (PCms) for 75.40 sq.km., or 79.14% of the study area. The Younger Terrace Deposits Aquifer (Qyt) for 16.02 sq.km., or 16.82% of the study area, the Permian Carbonate Aquifer (Pc) for 3.85 sq.km., or 4.04% of the study areawith following details.

(A) Metasediments Aquifers (PCms)

This aquifer consists of quartzitic sandstone, phyllitic to slaty shale) and rounded gravel with the depth of approximately 10-60 meter. The water yield is in the range of 1-20 m^3/hour.

(B) Younger Terrace Deposits Aquifer (Qyt)

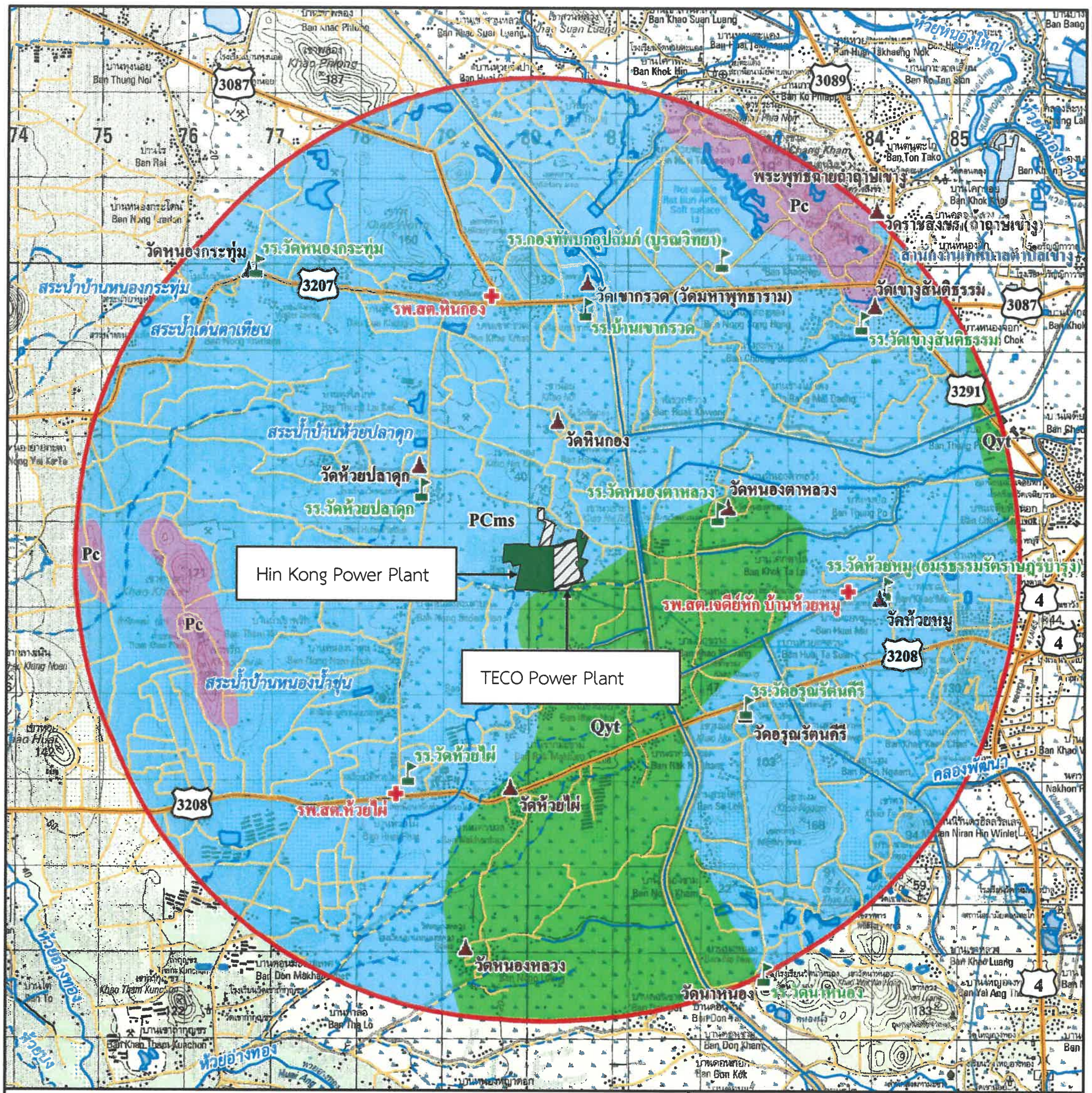
It consists of sediments, gravel, sand and clay that accumulate during the Pistocene period (from 8,000 years to 1.8 million years) or the upper Tertiary (1.8-10 million years). Most of them consist of clay and fine sand with a thin layer of sand gravel inserted in the thin layer. It has been found in various basins in the northern and northern central regions. The thickness of the aquifers has an average of 20-50 meters. The average watering yield is 7-10 m^3/hour. This is a specific low potential aquifer.

(C) Permian Carbonate Aquifer (Pc)

It consists of gray limestone balck chert, gray shale, sandstone and gray-white gravel and brownish red gravel inbetween. For example, the limestone in Ratburi Group has the depth of groundwater at approximately 20-40 meters. The water yield is in the range of 1-40 m^3/hour.

2) Direction of groundwater flow

From the map showing the direction of groundwater as seen in **Figure 3.1.5-13**, it can be found from the data collected from the database of groundwater wells of the Department of Groundwater Resources in B.E.2553 with 37 wells and water depth measurements in groundwater wells in the field. All data of groundwater wellswere taken to create a map showing the groundwater depth line which have equivalent values. After that, it was further analyzed to find the flow direction of the groundwater. The nature of the groundwater flow is to flow from the high level to the lower level area, or flow from the water zone into the river or sea. The analysis showed that in the west area, northwest area and southeast area of the study, there were



Symbol

- Main road
- Secondary road
- Waterway, canal (water year round)
- Waterway, canal (no water year round)
- Hospital
- Educational institution
- Temple
- Government agency
- TECO Power Plant
- Hin Kong Power Plant
- 5km Study area

Hydrology characteristic (s.q.km)(%)

- PCms Permian-Carboniferous Metasediment Aquifer (75.40)(79.14)
- Qyt Young terrace deposits aquifer (16.02)(16.82)
- Pc Permian carbon aquifer (3.85)(4.04)

N W E S

มาตราส่วน 1 : 70,000

0 .5 1 2 3 4 กม.

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Figure 3.1.5-12 Hydrological characteristics of the study area

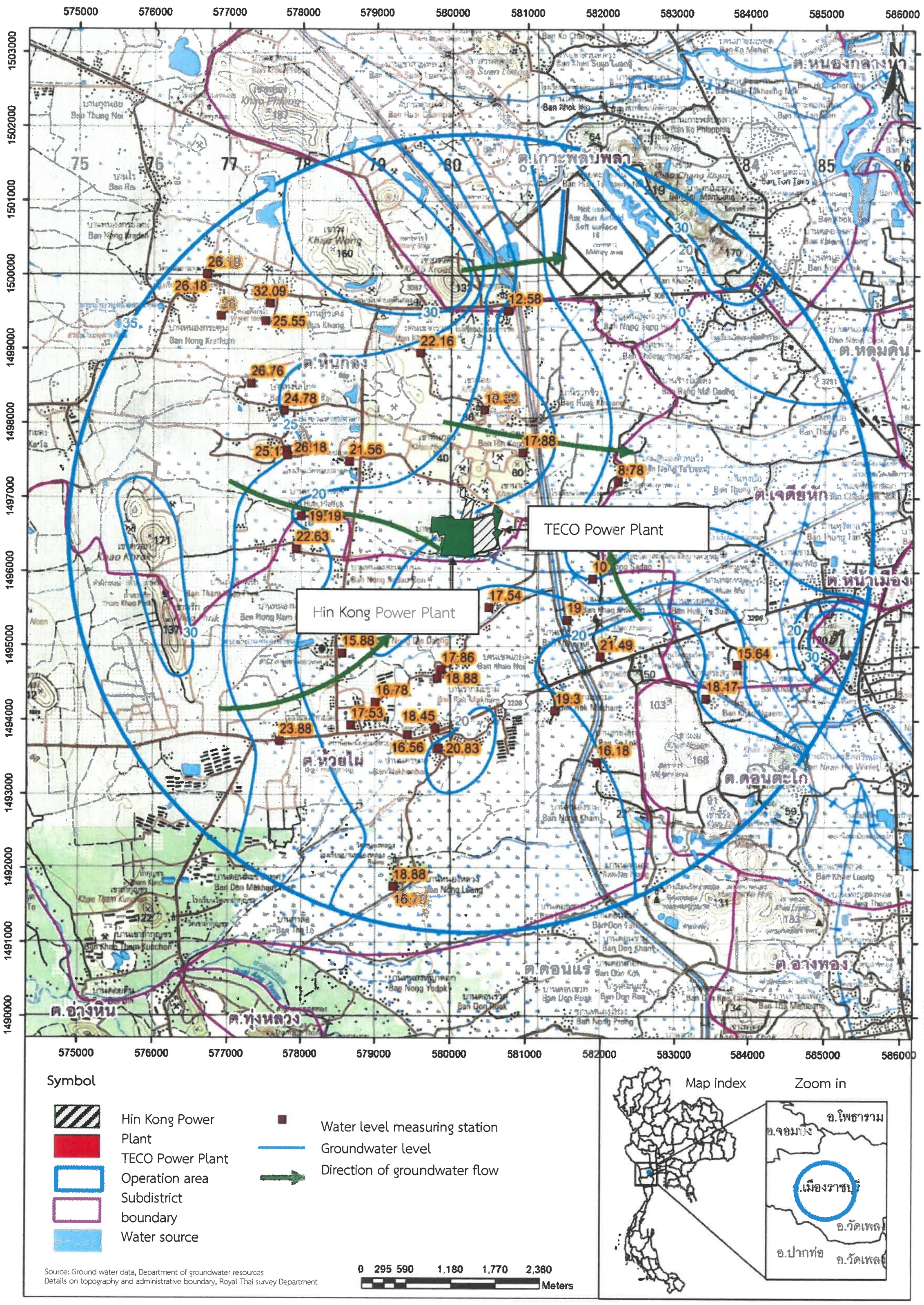


Figure 3.1.5-13 Direction of groundwater flow

an area that had the highest groundwater level due to their topography were mountainous landscapes, hills and inselberg. Next to the mentioned area, the groundwater level will gradually decrease.

Number of artesian wells in the study area covering an area of 6 sub-districts with a total of 81 wells. They were consumed and used for agricultural ponds (shallow levels) as seen in **Table 3.1.5-8** as follows.

Table 3.1.5-8

Number of artesian wells in the study area

District	Number of ponds	Drilling depth (m.)	Development depth (m.)	Water Value (m^3/h.)	ระดับน้ำปกติ (m.)
Huay Phai	24	51.21	46.36	3.70	5.11
Hin Kong	26	78.98	68.64	4.94	5.70
Chedi Hak	2	65.60	25.45	3.00	5.00
Ko Plub Pla	7	68.21	41.87	10.84	11.15
Don Tako	1	80.00	80.00	15.00	27.00
Don Rae	21	56.33	43.94	4.98	5.37
Total	**81**				

3) Groundwater quality

The consulting company conducted the groundwater quality measurement in the study area of the project by collecting samples during the dry season on 18 February, B.E.2562 and collecting samples during the rainy season on 19 July,B.E. 2562. There were measurement indices such as pH, chloride, arsenic, cadmium, iron, lead, manganese and mercury for 3 stations (**Figure 3.1.5-14**).

Groundwater quality analysis results were shown **Table 3.1.5-9** with following details.

(A) Station 1, Ban Nong Krathum Community Area

From groundwater quality tests on 18 February B.E.256, it was found that for chemical water quality, pH was 7.5, chloride was 1,157 mg/l, Iron was 0.03 mg/l, and manganese was 0.02 mg/l, arsenic was 0.004 mg/l, cadmium was less than 0.0001 mg/l and lead was less than 0.0002 mg/l.

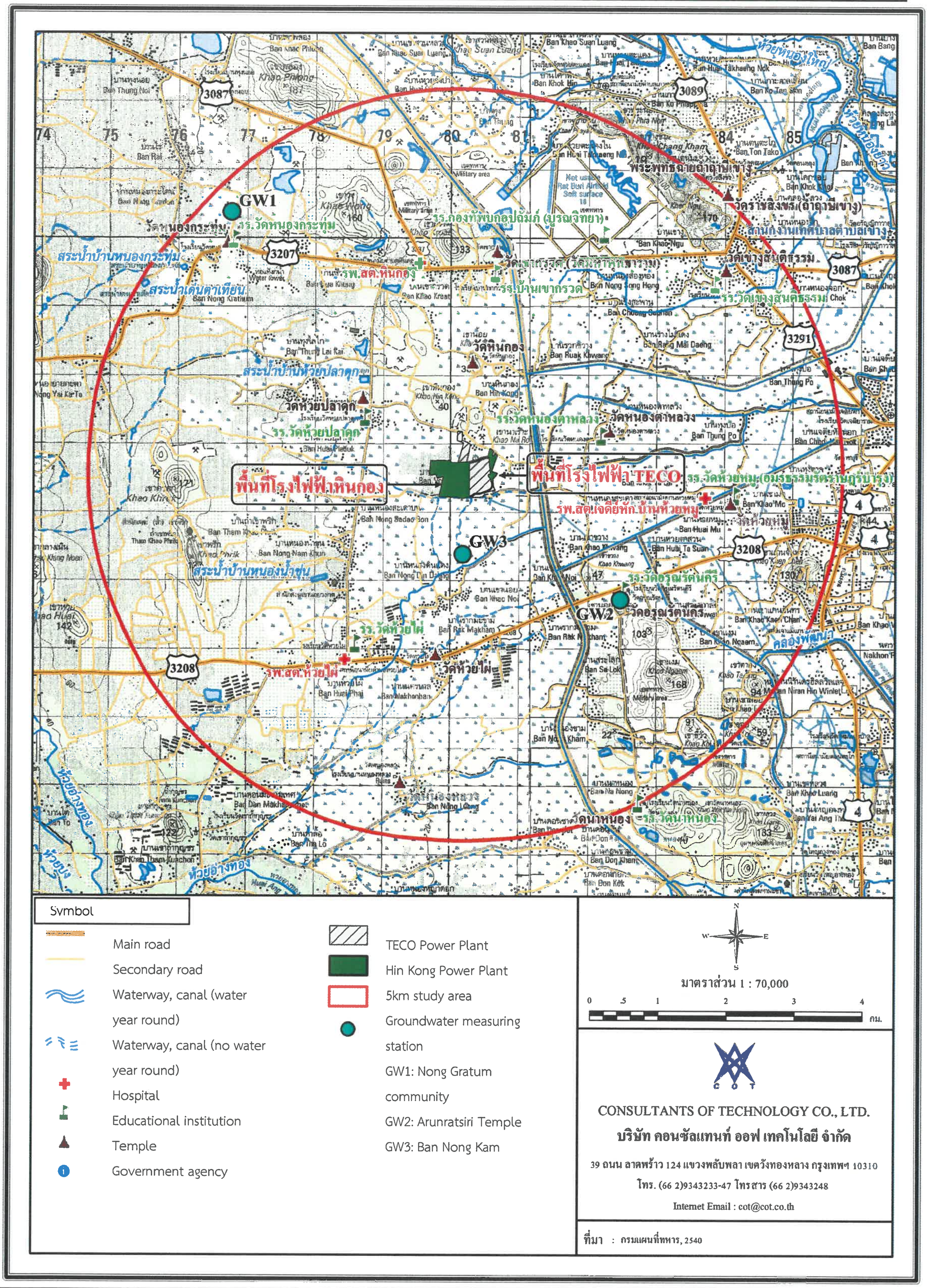


Figure 3.1.5-14 Groundwater quality measurement station

Table 3.1.5-9

Groundwater quality analysis results

Measurement Index	Unit	Measurement Station[1/]						Standard[2/]	
		GW1		GW2		GW3		optimum limits	maximum allowable limits
		1/62	2/62	1/62	2/62	1/62	2/62		
pH	-	7.5	7.2	7.3	7	7.3	7.1	7.0-8.5	6.5-9.2
Turbidity	NTU	0.41	0.72	1.69	1.28	0.98	1.21	5	20
Chloride	mg/l	1,157	1,138	134	130	139	148	< 200	600
Arsenic	mg/l	0.004	0.004	0.0008	0.0004	0.002	0.001	ต้องไม่มี	0.05
Cadmium	mg/l	<0.0001	ND	ND	ND	0.0002	ND	ต้องไม่มี	0.01
Iron	mg/l	0.03	0.02	0.24	0.11	0.11	0.07	< 0.5	1.00
Lead	mg/l	<0.0002	<0.0002	0.0004	<0.0002	0.0007	<0.0002	ต้องไม่มี	0.05
Manganese	mg/l	0.02	0.07	0.02	0.02	0.06	0.04	< 0.3	0.5
Mercury	mg/l	ND	<0.0001	ND	<0.0001	ND	<0.0001	ต้องไม่มี	0.001

source : Measurement by ALS Laboratory Group (Thailand) Co.,Ltd.

Note : [1/] GW1 = Ban Nong Krathum Community Area GW2 = Wat Arun Rattanakiri GW3 = Ban Nong Kham
1st/2562 (dry season) 18 February B.E.2562 2nd/2562 (rainy season) 19 July B.E.2562
[2/] Announcement of the Environmental Committee, No.20 (B.E.2543) issued under the National Environmental Quality and Promotion Act, B.E.2535, regarding groundwater quality standards
Announcement of the Ministry of Natural Resources and Environment on rules and regulations for prevention of public health and environmental protection, B.E.2551

From groundwater quality tests on 19 July 2562 B.E.256, it was found that for chemical water quality, pH was 7.2 , chloride was 1,138 mg/l, Iron was 0.02 mg/l, and manganese was 0.07 mg/l, arsenic was 0.004 mg/l, cadmium was less than 0.0002 mg/l and lead was less than 0.0001 mg/l.

When compared with the groundwater quality standards according to the Announcement of the Environmental Committee, No.20 (B.E.2543) issued under the National Environmental Quality and Promotion Act, B.E.2535, regarding groundwater quality standards and the Announcement of the Ministry of Natural Resources and Environment on rules and regulations for prevention of public health and environmental protection, B.E.2551, it was found that chloride values exceeded the optimum and maximum allowable limits. Other values were in the highest allowable limit. Natural water may received chloride in many ways. In some cases, the water may contained chloride above 1,000 mg/l, without salty taste due to the water may contain less sodium but had high calcium and magnesium.

(B) Station 2 at Wat Arun Rattanakiri area

From groundwater quality tests on 18 February B.E.256, it was found that for chemical water quality, pH was 7.3, chloride was 134 mg/l, Iron was 0.24 mg/l and manganese was 0.02 mg/l, arsenic was 0.0008 mg/l and lead was less than 0.0004 mg/l.

From groundwater quality tests on 19 July B.E. 2562 it was found that for chemical water quality, pH was 7, chloride was 130 mg/l, Iron was 0.11 mg/l and manganese was 0.02 mg/l, arsenic was 0.004 mg/l, lead was less than 0.0002 mg/l and mercury was less than 0.0001 mg/l.

When compared with the groundwater quality standards according to the Announcement of the Environmental Committee, No.20 (B.E.2543) issued under the National Environmental Quality and Promotion Act, B.E.2535, regarding groundwater quality standards and the Announcement of the Ministry of Natural Resources and Environment on rules and regulations for prevention of public health and environmental protection, B.E.2 5 5 1, it was found that all values were in the appropriate criteria and the highest allowable limit.

(C) Station 3, at Ban Nong Kham area

From groundwater quality tests on 18February, B.E.256, it was found that for chemical water quality, pH was 7.3, chloride was 133 mg/l, iron was 0.11 mg/l and manganese was 0.02 mg/l, arsenic was 0.002 mg/l, cadmium was 0.0002 mg/l and lead was 0.0007 mg/l.

From groundwater quality tests on 18February, B.E.256, it was found that for chemical water quality, pH was 7.1, chloride was 148 mg/l, iron was 0.07 mg/l and manganese was 0.04 mg/l, arsenic was 0.001 mg/l, lead was less than 0.0002 mg/l and mercury was less than 0.0001 mg/l.

When compared with the groundwater quality standards according to the Announcement of the Environmental Committee, No.20 (B.E.2543) issued under the National Environmental Quality and Promotion Act, B.E.2535, regarding groundwater quality standards and the Announcement of the Ministry of Natural Resources and Environment on rules and regulations for prevention of public health and environmental protection, B.E.2 5 5 1, it was found that all values were in the appropriate criteria and the highest allowable limit.

3.1.6 Soil resources

(1) Ratchaburi province

From the basic data of Ratchaburi in B.E.2559, it was found that the characteristics and properties of soil in Ratchaburi could be classified into 26 groups of soil series, with area of approximately 2,986,123.09 rais or 91.94% of the provincial area. Moreover, there were 10 miscellaneous areas with area of approximately 261,665,91 rai or 8.06% of the provincial area. It was classifed suitability and limitations of soil for crop cultivation in Ratchaburi, according to the terrain as follows.

1) **High mountain areas** such as the western border connecting to the Republic of the Union of Myanmar. The south area connecting to Phetchaburi. It is a high mountain range, rich in evergreen forest, mixed deciduous forest, dipterocarp forest and bamboo forest, located in Suan Phueng District, Ban Kha District and Pak Tho District. The soil texture is quite sandy soil with low fertility and contains an acid reaction, less water absorbing causing shortage of water during dry season. Without soil and water conservation measures, there may be problems of soil erosion.

2) **Plateau** such as areas next to the mountain range to the east until the middle of the province. It is a plateau and a slope area. The soil is sandy loam so that, the erosion of the top soil is quite high. The condition is suitable for growing crops and fruit trees, but there are restrictions on soil fertility and the risk of dehydration. Some of these areas are in Suan Phueng District, Ban Kha District, Chom Bueng District, and in the west of Pak Tho District, Mueang Ratchaburi District, Photharam District and Ban Pong District.

3) **Basin areas** such as areas on both banks of the Mae Klong River and the east side of Ratchaburi. It has s a loamy soil condition and sticky loam. There is quite a good fertility with the Mae Klong irrigation system, a large irrigation system in the area. This area is sitable for rice and vegetable farming. It is located in Chom Bueng District, Pak Tho District, Mueang Ratchaburi District, Photharam District, Ban Pong District and Bang Phae District.

4) **Lowland areas** such as the eastern region of the province which is a lowland plain with a canal and ditch connecting the Mae Klong River, flowing through the area of Wat Phleng District and Damnoen Saduak District. The soil condition is quite a clay texture, bad drainage, medium to high natural fertility. It is suitable for the cultivatation for rice and and vegetables farming.

(2) Soil characteristics in the study area

The consulting company collected data from soil survey and classification reports done by the Land Development Department (B.E.2547), it was found that Soil Series in the study area were totally 14 soil series, 2 combined units of soil series, 1 complex unit, 1 relational unit, sediment pond, gravel pond and area. Of complex slope as shown in **Figure 3.1.6-1** .

1) Combined units of Khao Yoi and Pak Tho soil series (Kyo&Pth)

The mapping unit within the boundary contain two or more soil types, but all of them are not different in terms of land use and management. Therefore, there is no need to separate the boundaries with an area of 39.72sq.km., or 41.69% of the study area. The characteristics and properties of these 2 soil series are as follows.

(A) Khao Yoi series caused by sediment continuously deposited on the back of low-level terrace or alluvial fan. The condition of the area is smooth to relatively smooth with a slope of 0-2%. Drainage is quite bad to bad. Characteristics and properties of the soil are deep soil, top soil is loamy or sandy loam with grayish brown or brown or reddish brown color. There is a medium to slightly acidic acid reaction (pH 6.0-6.5). The lower and upper soil is sandy clay loam or loam mixed with clay. The color would be in light colors of a brown-gray, pink-gray, or a light-colored red-brown with dotted brown spots or red-yellow throughout the soil. Reaction of the soil is Strong to medium acid (pH 5.5-6.5). For the lower ground soil, there is both soft and hard round mass of iron and manganese in the lower deep soil with a neutral soil reaction (pH 7.0).

(B) Pak Tho series (Pth) causing by sediment deposited on top of a alluvial fan or sediment terrace. The condition of the area is smooth and undulating, with a slope of 0 -2 %. Drainage is relatively bad to bad. The characteristics and properties of the soil are deep soil, top soil is loamy or silty loam with light gray color and brownish brown dots. The reaction is strong to medium acid (pH 5.5-6.0). The lower top soil is light brown with dark brown or yellowish brown spots. For the soil reaction, it is very strong acid soil (pH 5.0). Lower bottom soil is sandy clay loam with light brown or light gray and a red yellow dots or red dots. It is a soft laterite material with a volume of more than 5-50%, a depth of 150 centimeters from the soil surface. Nodules of manganese may be found in the area.

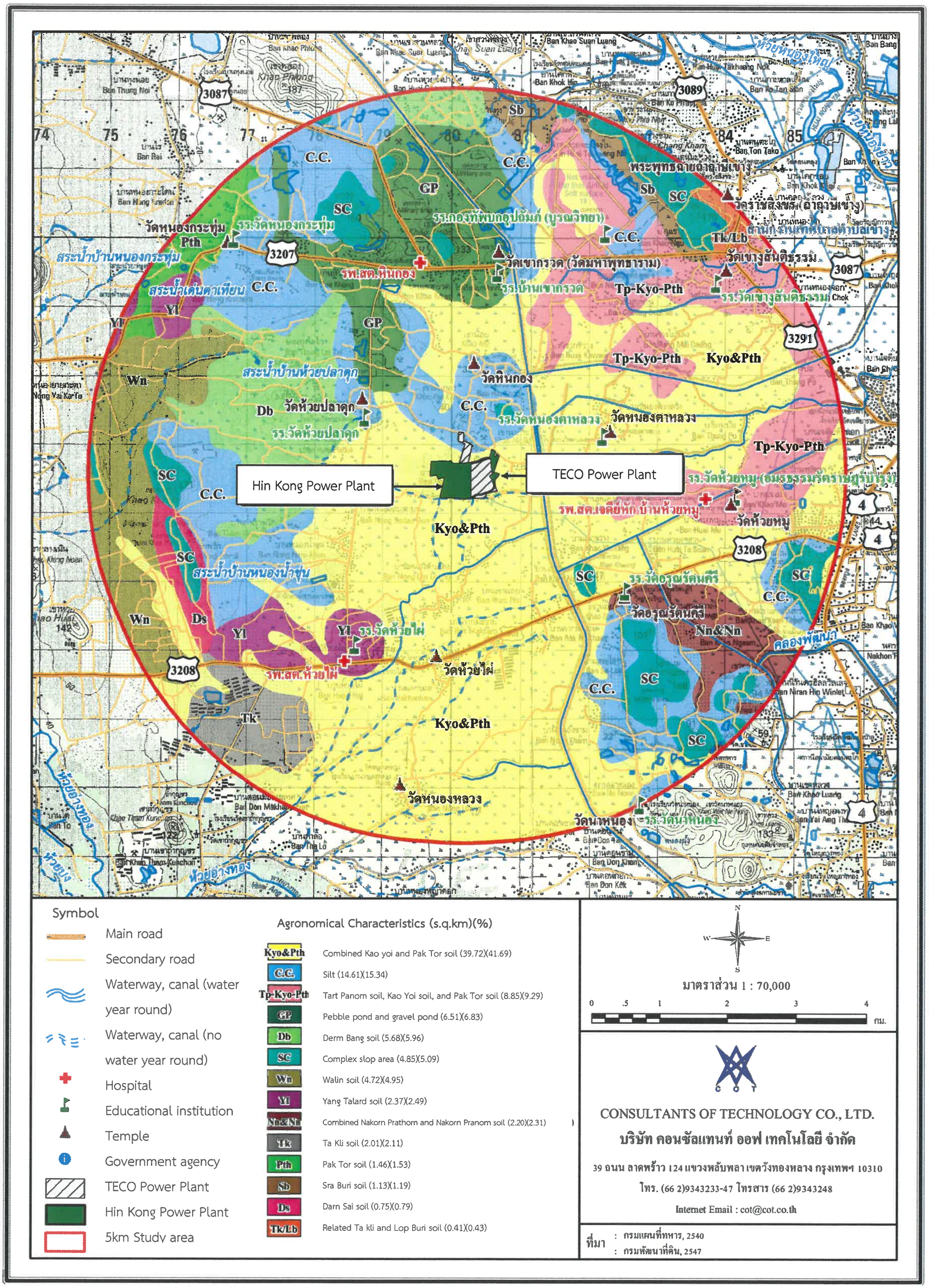


Figure 3.1.6-1 Map of soil series in study area

2) Sediment

It is a particle of soil or sand with a diameter between 0.004 to 0.062 millimeters and has fineness and non-stick particles. Sediment characteristics caused by the accumulation of material that water flow it in the reservoir or delta or flooded plains with an area of 14.61 sq.km., or 15.34% of the study area.

3) Complex units of That Phanom series, Khao Yoi series and Pak Tho series

The mapping units within that boundary have 2 or more soil series or have the soil and miscellaneous areas as same as the relational unit, even though the scale of the map is larger.It still cannot separate the boundaries of the soil or those miscellaneous spaces, may be due to the complexity of the area covers 8.85 sq.km., or 9.29% of the study area. The characteristics and properties of all 3series of soil are as follows.

a) That Phanom Series (Tp), caused by sediment deposited in the ridge along the river. The area is relatively flat to undulating waves with a slope of 1-4%. The drainage is moderate. Its characteristics and properties are deep soil. Top soil is silty loamy or loam wih brown or grayish brown color. The lower soil is silty loam or silty clay loam with reddish-brown or brown color, inlcusing silty clay loam or clay loam with red, yellow, or red. In the lower soil will find a gray-pink color dots, dark brown or yellowish brown in the lower soil. Soil reaction is a stron acid to neutral (pH 5.5-7.0).

b) Khao Yoi series (Kyo), caused by sediment continuously deposited on the back of low-terrace or alluvial fan. The condition of the area is smooth to relatively smooth with a slope of 0-2%. Drainage is relatively bad to bad. The characteristics and properties of the soil are deep soil, top soil is loamy or sandy loam with grayish brown or brown or reddish brown. The reaction is medium to slightly acid (pH 6.0-6.5). The lower upper soil is sandy clay loam or loam mixed with clay with light colors of a brown-gray, pink-gray, or a light-colored red-brown containging dotted brown spots or red-yellow dots throughout the soil. The reaction is strong to medium acid (pH 5.5-6.5). Lower ground soil contains a round mass of iron and manganese both soft and hard in the lower deep soil with neutral soil reaction (pH 7.0).

c) Pak Tho series (Pth), caused by sediment continuously deposited on the back of low-terrace or alluvial fan. The condition of the area is smooth and undulating, with a slight slope of 0 -2 %. Drainage is relatively bad to bad. The characteristics and properties of the soil are deep soil as the top soil is loamy or silty loam with light gray color and brownish brown dots. The reaction od the soil is strong to medium acid (pH 5.5-6.0). The lower upper soil is light brown with dark brown or yellowish brown spots with a strong acid reaction (pH 5.0). Lower bottom soil is sandy loam soil with light brown or light gray with a red and yellow, or red dots. It contains a soft laterite material with a volume of more than 5 -5 0% within a depth of 1 5 0 centimeters from the soil surface. Nodules of manganese may be found as well.

4) Pebble pond, laterite pond (GP)

This is a soil with rock fragments of 2 millimeters in diameter or larger in the amount of 35% which can be both sandy, loam and clay. This can occur in all conditions. Its characterisctic is a shallow soil or soil with laterite layers occurring in the cross-section with an area of 6.51 sq.km., or 6.83% of the study area.

5) Doem Bang Series (Db)

This caused by sediment deposited on older terrace deposits or alluvial fan. The condition of the area is smooth to relatively smooth with a slope of 0-2 %. Drainage is quite poor. The characteristics and properties of the soil are deep soil. The top soil is sandy loam to sandy clay loam or sandy clay with grayish brown color. The soil reaction is a medium acid (pH 6.0). The lower upper soil is loamy clay, clay or silty clay with a grayish brown or brownish gray with brown, yellowish brown, brownish yellow dots. The reasction is a medium acid (pH 6.0). The lower soil is clay with light brown gray color with red dots. The reaction is a medium acis to a medium alkaline (pH 7.0-8.0). This series has an area of 5.68 sq.km., or 5.96% of the study.

6) Slope complex area (Sc)

The complex slope consists of mountains and mountain range with a slope of more than 35%. The soil found in this area has different soil texture and natural fertility depending on the origin of rock in the area. It is often fragments, rocks, boulders scattering around the area. It has an area of 4.85 sq.km., or 5.09% of the study area.

7) Warin series (Wn)

This series caused by coarse sediment accumulating on the surface. The surface area is a wave that has a slightly wave to undulating waves with a slope of 2-8%. It has a good drainage. The characteristics and properties of the soil are deep soil. The top soil is sandy loam or loamy sand with dark brown or grayish brown color. The lower soil is sandy clay loam with reddish yellow or yellowish red color. Soil reaction is strong acid to slightly acid (pH 5.0-6.5). The upper soil is a strong acid to slightly acid (pH 4.5-6.5). The lower soil has an area of 4.72 sq.km., or 4.95% of the study area.

8) Yang Talat series (Yl)

This series caused by sedimentation of coarse sedimentary rocks deposited on the surface. The land area is slightly wave to undulating waves with a slope of 2-8%. The drainage is good. The soil characteristics and properties are deep soil. The top soil is sandy loam or loam sand with dark brown or reddish-brown and sandy loam with reddish-brown in the deep bottom. Brown spots also found in this soil layer. The soil reaction is strong acid to slightly acidic (pH 5.5-6.5), with an area of 2.37 sq.km., or 2.49% of the study area.

9) Unit of Nakhon Pathom and Nakhon Phanom series (Np&Nn)

The mapping unit within the boundary contains two or more soil series, but all of them are not different in terms of land use and management. Therefore, there is no need to separate the boundaries with an area of 2.20 sq.km., or 2.31% of the study area. The characteristics and properties of these 2 soil series are as follows.

A) Nakhon Pathom series (Np), caused by sedimentation deposited on the plain or the terrace. The area condition is smooth to relatively smooth with a slope of 0-2%. Drainage is relatively bad to bad. The characteristics and properties of the soil are deep soil. The top soil is loam, silty clay loam or loamy clay with grayish brown or dark brown color. The soil reaction is strong to slightly acid (pH 5.0-6.5). The upper soil is the clay or loamy clay with dark gray mix with brown, including dark brown or yellowish brown spots in the upper soil. The lower soil has the soil reaction of slightly acidic to medium alkaline (pH 6.5-8.0). The lower soil will find the mass of iron and manganese mixed together, including nodular mass of cement in the lower soil at a depth of 80 cm from the soil surface. The soil reaction is medium alkaline (pH 8.0).

B) Nakhon Phanom series (Nn), caused by alluvial deposits on the plains. This sedimentation led to the state of flat to quite smooth area with a slope of 0-1%. The drainage is quite bad. Soil characteristics and properties are very deep soil. The top soil is silty loam or loamy clay with yellowish brown or brown with dark brown spots or a yellowish brown colosr. The lower soil is silty clay or clay with brownish light gray, light gray or gray colors. Red spots of soft laterite in the bottom soil in the amount of 5-50 percent by volume within a depth of 150 centimeters from the soil surface. Iron and manganese deposits may be found in the lower soil. Soil reaction is slightly acid (pH 5.5-6.5) in the upper soil and very strong acid (pH 4.5-5.0) in the lower soil. Soils on the lower soil are sandy silt clay or clay with light gray, light brown, faded gray or gray colors. There are red laterite dotted in the lower soil for 5-50% by volume within a depth of 150 cm from the soil surface. Iron and manganese lumps may be found in the lower soil. The soil reaction is strong acid to slightly acid (pH 5.5-6.5) in the upper soil and very strong acid (pH 4.5-5.0) in the lower soil.

10) Takhli series (Tk)

This series caused by sedimentation depositing on the marl layer at the alluvial fan. The condition of the area are undulating area, slightly slope to undulating with the slope of 3-12%. It has a good drainage. For soil characteristics and properties, it is shallow soil to marl layer and found within 50 cm from the soil surface. Upper soil is loamy clay, silt clay with black, very dark gray, very dark grayish brown or very dark brown colors. The soil reaction is neutral to moderate alkaline (pH 7.0-8.0). The lower soil is loamy clay or silty loam with clinker. It has brown or dark brown and has a white color of secondary lime powder or marl. The soil reaction is moderate alkaline (pH 8.0). Under the soil layer, it is formed a white layer of both clinker and densed marls, covering an area of 2.01 sq.km., or equivalent to 2.11% of the study area.

11) Pak Tho series (Pth)

It is caused by sediment deposited on an alluvial fan or the low older terrace deposits. The condition of the area is flat to undulating, slightly sloping, with a slope of 0-2%. The drainage is quite bad to bad. For soil characteristics and properties, it is deep soil. Top soil is loam or silty loam with light gray color with yellowish brown dotted. The soil reaction is strong acid to moderate acid (pH 5.5-6.0). Upper of the lower soil is light brown color with dark brown or yellowish-brown dots. Soil reaction is very strong acid (pH 5.0). The lower of the lower soil is sandy clay loam with light brown or light gray colors mixed red and yellow dots or red dots. It has a light laterite with more than 5-50% by volume. Within a depth of 150 cm from the surface, manganese nodules may be found with an area of 1.46 sq,km., or equivalent to 1.53 % of the study area.

12) Saraburi series (Sb)

It is caused by sediment on the low of the lower older terrace deposits or the junction area between the floodplain the lower older terrace deposits. The condition is flat to relatively smooth, with a slope of 0-1%. The drainage is quite bad to bad. Soil characteristics and properties is a very deep soil. The top soil is dark gray or dark gray-brown clay with dark brown and yellowish brown dots. Soil reaction is moderate acid (pH 6.0). The lower soil is clay or silty clay with brown color mixing a yellowish brown or dark brown dots. The reaction is alkaline (pH 8.5). It is found slipping on the soil surface. Accumulated iron and manganese are found in the lower soil. White clinker may be found deep in the soil. In the dry season, the soil will crack. There is 1.13 sq.km., or equivalent to 1.19% of the study area.

13) Dan Sai series (Ds)

It is caused by the decay of sandstone and quartzite around mountain areas and also caused by soil or rock material moved at close distances by gravity around the foothills. The area condition is undulating area with slopes of 5-35%. It has a good drainage. For soil characteristics and properties, it is a very deep soil. The top soil is sandy loam or loam with dark brown or dark reddish brown colors. The soil reaction is acid to moderately acid (pH 5.5-6.0). The lower soil is sandy clay loam with reddish yellow to red colors. The soil reaction is very strong acid to very acid (pH 4.5-5.5) with an area of 0.75 sq.km., or equivalent to 0.79% of the study area.

14) Relational units of Takhli series and Lop Buri series (Tk/Lb)

The relative units of this soil set generated from the same origin and on the same terrain which continuous or alternating. Therefore, in the land planning, the boundaries of each type of soil cannot be separated because of the scale is unfavorable. It is included in the scope of the same map unit with an area of 0.41 km^2, or representing 0.43% of the study area. The characteristics and properties of both these soil series are as follows.

A) Takhli series (Tk) , caused by sediment depositing on the marl layer at an alluvial fan. The area condistion is undulating area, slightly undulating with the slope of 3-12%. It has a good drainage. For soil characteristics and properties, It is shallow soil to marl layer and has been found within 50 cm from the soil surface. Upper soil is loamy clay or silty clay with black, very dark gray, very dark grayish brown or very dark brown colros. The soil reaction is neutral to moderate alkaline (pH 7.0-8.0). The lower soil is loamy clay or silty clay loam mixed with clinker brown or dark brown colors. It has a white color of secondary lime powder or marl as well. The soil reaction is moderate alkaline (pH 8.0). Beneath the soil layer, it is a white, clinker-liked and dense layer of marl.

B) Lop Buri series (Lb) caused by sediment containing clay minerals. Most of them are montmorillonite depositing on the marl layer or limestone colluvial deposits. The area condition is flat to relatively smooth, with a slope of 1-5%. It has a good drainage. For soil characteristics and properties, it is deep soil with black or dark gray clay on top. The soil reaction is slightly acid to moderate alkaline (pH 6.5-8.0). Upper of the lower soil is black or very dark gray clay. A layer of marl is found 80 cm in depth from the soil surface. In dry season, it will crack into furrows of more than 1 cm in width, at a depth of 50 cm. This cracks will persist for a long time. Skid marks are found in general surface soil area with a round mass of cement accumulating everywhere. The soil reaction is medium to strong alkaline (pH 8.0-9.0). The lower soil is black or grayish brown clay. The soil reaction is moderate alkaline (pH 8.0).

(3) Soil quality

The project conducted a study survey, analyzed the soil properties around the project area from 4 stations (**Figure 3.1 .6 -2**), in order to establish the baseline data for the impact assessment as follows.

1) Soil sampling

Soil sampling was performed by using composite sampling method to analyze soil chemical properties such as soil pH (related to the solubility of heavy metals), nutrient content and heavy metals in the soil.

2) Results of soil quality measurement of the project

The project conducted a study survey, analyzed soil properties around the project area in 4 stations, which were, Station 1 around the project construction area (S1), Station 2 at Ban Nong Kham (S2), Station 3 at Wat Hin Kong (S3), and Station 4 at Wat Huai Pladuk school (S4). It was done on 18 February B.E.2562. According to the Department of Land Development and results of soil quality measurement showed that the soil at the sampling station was in Khao Yoi and the Pak Tho soil series (Kyo & Pth), which was the most common soil series of all study areas. The details were shown as **Table 3.1.6-1** and can be summarized as follows.

(A) Soil pH

Most soil around the project area had its pH in the range of 81-9.8. When compared with the range of the 10 levels of pH (Soil Survey Division Staff, 1993). There were 2 conditions of alkalinity as follows.

- A medium alkaline soil. Its pH was in the range of 7.90-8.40. It was found in the 1st, 2nd and 4th stations.

- A very alkaline soil, Its pH was more than 9.00. It was found in the 3rd station.

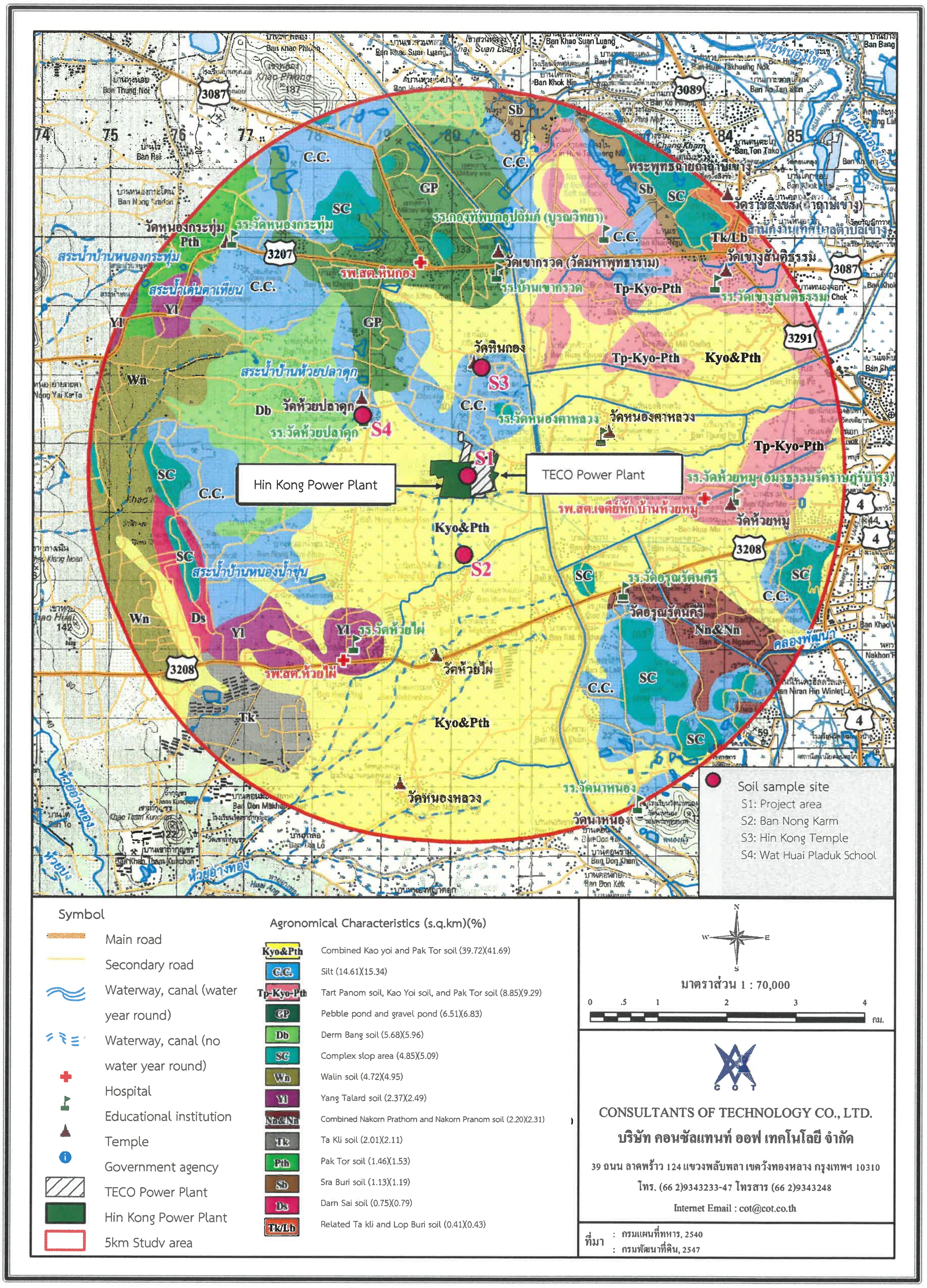


Figure 3.1.6-2 Soil sampling station

Table 3.1.6-1

Results of soil quality measurement of the project

Measurement Index	Unit	Results [1/]			
		S1	S2	S3	S4
1. pH	-	8.2	8.3	9.8	8.1
2. Salinity	Part per million	0.04	0.04	0.06	0.13
3 Conductivity	Micro mohs per centimeter	88.9	72.7	125	239
4. Chloride	Milligrams per kilogram	39.4	47.2	56	149
5. Texture	-	Sandy clay loam	Sand loam	Sandy clay	Clay loam

Source : Measurement by ALS Laboratory Group (Thailand) Co.,Ltd., 18 February B.E. 2562

Note : [1/] Analysis standard according to SW-846 by Us Environmental Protection Agency (US.PEA)

(B) Salinity

Soil salinity values was in the range of 0.04-0.13 ppm. From the above analysis, it were concluded that the soil of the project had the salinity within the normal range. No saline soil conditions and it was suitable for crop cultivation.

(C) Soil electrical conductivity (EC)

For soil electrical conductivity around the project area, it was found that all soil had a low electrical conductivity (EC, 1: 5), 72.7-239 micrometers per centimeter and had no different trend in both top and bottom soil. Most soil had a conductivity of less than 200 micrometers per centimeter. When comparing to the salinity values of the soil, it could be concluded that all soil was normal soil.

(D) Chloride (Cl)

From the analysis of chloride in the soil around the project area, the chloride content was in the range 39.4-149.0 mg/kg. Chloride is an element that plants need in a very small amount but important for plant growth due to chloride stimulates the reaction of certain enzymes and helps in the metabolism and the photosynthesis process of plants.

3.2 Biological environmental resources

3.2.1 Biological resources on land

(1) Forest resources

1) General condition

For the forest area of Ratchaburi and forest resource, there are approximately 1,239,236 rais of forest land or 38.16% of the provincial area. Most forests are in the mountains and the Tenasserim mountains as forest area locates in the western region. It is connected to the Thung Yai Naresuan forest, a world heritage site, and Kaeng Krachan forest. It is also connecting with neighboring forest areas as a tropical forest area that had an importance of asia. The abundance of plants and rare wildlife are such as hornbills (White-breasted birds), White-faced Gibbons. Most forests in Ratchaburi locate in Suan Phueng District, Ban Kha District and Chom Bueng District. Forest area in Ratchaburi was classified as follows.

(A) National forests

There are 7 forests in the total area of 1,165,593.75 rais, consisting of;

- National Forest on left bank of the Phachi river located in Suan Phueng District, Ban Kha Pak Tho and Photharam District with an area of 977,250 rais.
- Pa Phu Yang - Phu Sam Son National Forest ara is located in Pak Tho district with an area of 87,656.25 rais.
- Dan Thap Tako National Forest Reserve is located in Chom Bueng District with an area of 71,875 rais.
- Khao Bin National Forest is located in Mueang Ratchaburi District and Chom Bueng District with an area of 21,250 rais.
- Khao Kruat-Khao Phlong National Forest Reserve is located in Mueang Ratchaburi District with an area of 4,787.50 rais
- Nong Klang Noen National Forest is located in Mueang Ratchaburi District with an area of 150 rais
- Cham Sam National Forest is located in Ban Pong District with an area of 2,625 rais.

(B) National forest

- National Forest preparation for the Khao Tan forest conservation In the area of Photharam district with an area of 2,625 rais.

(C) Forests in the conservation area

- Phachi River Wildlife Sanctuary is located in the area of Suan Phueng District and Ban Kha District with an area of 305,820 rais (overlapping in the national forest reserve of the left bank of the Phachi River).
- Thai Prachan Chaloem Phrakiat National Park is located in Pak Tho area and Ban Kha District with an area of 205,463 rais, 3 ngan, 59 wah^2 (overlapping in the National Forest Reserve on the left of the Phachi River and the National Forest Reserve, Phu Yang - Phu Sam Son Forest).

In addition, there is an area of state property in Chom Bueng District. and Suan Phueng District for 500,000 rais under the responsibility of the Treasury of Ratchaburi area, which the army, the 1st Development Division, is overseeing and utilizing the area of 261,000 rais. Department of Engineers Supervising is also utilizing the area of 202,275 rais and the Army returning the area to the Treasury Department in the amount of 36,725 rais (Source: Office of Natural Resources and Environment, Ratchaburi).

2) Field survey

The overall area has a variety of land use patterns. Mostly for agricultural areas, especially, rice fields and livestock, including areas of government agencies which still have some original forest conditions. From the observation some prominent plant species, it shows that the area used to be dry evergreen forest, (according to animal husbandry areas or areas with shallow soil conditions is sandy or gravel soil), mixed forest and dry evergreen forest (along the limestone mountains or forests). There are also wasteland areas, roads, ponds and hump areas near the watercourse, which still has some original plants. The consulting company, therefore, selected an observation survey as a method to study tree species by focusing on trees, shrub, and other undergrowth plants that have been recorded as well , in order to be a representative covering the overall study area in a radius 5 kilometers (**Figure 3.2.1-1**). Then evaluating the plant data in the study area. The information obtained from the survey were used to create a species list which shows the species, characteristics and family of all the plants found and grouped them according to the characteristics of plants found in the survey area as native plants or exotic plants.

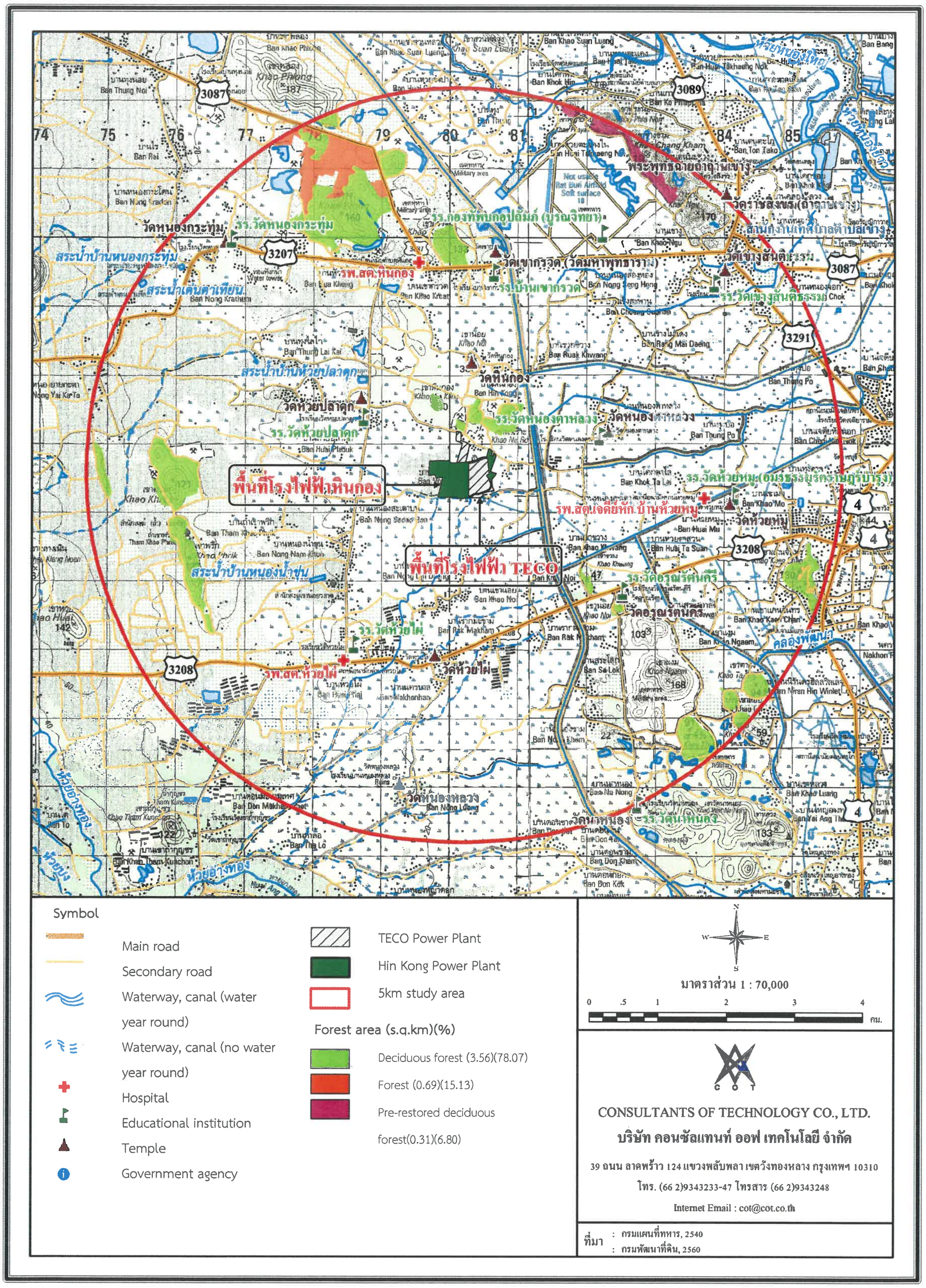


Figure 3.2.1-1 Survey area covering the overall study area in a radius 5 km

Plant specimens are selected in the event that species cannot be identified and photographed to record various characteristics such as habitat, characteristics, shape, color and color of leaves, flowers, and fruit, etc. Then plant species identification was done by using various methods, such as a detailed study in the laboratory by using taxonomy images (Identification key) from the plant taxonomy reference document, including the comparison of dried plant specimens with the specimens which had been correctly identified as such tree species from the Department of National Parks, Wildlife and Plant Conservation. So that the consulting company could identified the correct botanical names.

The survey found 63 species of trees, 178 genera, 250 species (**Table 3.2.1-1**). Considering the nature of the plant species found in the survey area, there were at least 187 native plants. The nature of trees and shrubs throughout the area of the project were such as Teak (*Tectona grandis*), Pradu (*Pterocarpus macrocarpus*), Chin (*Albizia lebbekoides*), Cassia fistula Mango (*Buchanania lanzan*), Lemon ghost (*Atalantia monophyla*) and giant leucaena (*Leucaena leucocephala*), etc. Other lower tree species were such as *Azima sarmentosa*, *Coccinia grandis*, *Ipomoea aquatica*, *Olax psittacorum*, *Aeschynomene indica,* Chain (*Solanum trilobatum*), etc.

However, some areas had land utilizing patterns as residences. wasteland, road, pond, etc. Due to the disturbed and transformed areas by human nature, many exotic plants were found around households, roadside, highway or grow on the desolate areas. From the survey, at least 63 exotic plants were found. Most of them were woody plants, such as Chamchuri (*Albizia saman*), *Delonix regia*, *Muntingia calabura*, *Tamarindus indica*, *Plumeria obtusa* and *Eucalyptus. Lipus* (*Eucalyptus camaldulensis*), etc. There were shrubs found in the area such as, *Jatropha gossypifolia*, *Tecoma stans*, *Cereus hexagonus*, *Mimosa pudica* and *Calotropis gigantean*, etc. Palm trees were also found in the area, such as *Cocos nucifera*, *Areca catechu*, *Roystonea regia* and *Wodyetia bifurcata*, etc. Other lower tree species were, such as *Crotalaria juncea*, *Chromolaena odorata*, *Ruellia tuberosa*, *Passiflora foetida* and *Lantana camara*.,etc (**Figure 3.2.1-2**). However, this survey did not find any area where a large natural plant society located. However, not all plant species were rare or endangered in any way.

Figure 3.2.1-1

The plant species list in the survey area

NO.	Common name	Botanical name	Family	Habit
1	ต้อยติ่ง	*Ruellia tuberosa* L.	Acanthaceae	ExH
2	มะม่วงหัวแมงวัน	*Buchanania lanzan* Spreng.	Anacardiaceae	T
3	รักใหญ่	*Gluta usitata* (Wall.) Ding Hou	Anacardiaceae	T
4	กุ๊ก	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	T
5	มะม่วง	*Mangifera indica* L.	Anacardiaceae	T
6	รักขี้หมู	*Semecarpus albescens* Kurz	Anacardiaceae	T
7	มะกอกฝรั่ง	*Spondias dulcis* Parkinson	Anacardiaceae	ExT
8	มะกอก	*Spondias pinnata* (L. f.) Kurz	Anacardiaceae	T
9	น้อยหน่า	*Annona squamosa* L.	Annonaceae	ExS/ST
10	กะเจียน	*Hubera cerasoides* (Roxb.) Chaowasku	Annonaceae	ST
11	ลำดวน	*Melodorum fruticosum* Lour.	Annonaceae	T
12	อโศกอินเดีย	*Monoon longifolium* (Sonn.) B. Xue & R. M. K. Saunders	Annonaceae	ExT
13	กลึงกล่อม	*Polyalthia suberosa* (Roxb.) Thwaites	Annonaceae	S/ST
14	นมวัว	*Uvaria dulcis* Dunal	Annonaceae	C
15	นมแมว	*Uvaria siamensis* (Scheff.) L. L. Zhou, Y. C. F. Su & R. M. K. Saunders	Annonaceae	C
16	บานบุรีเหลือง	*Allamanda cathartica* L.	Apocynaceae	ExC
17	สัตตบรรณ	*Alstonia scholaris* (L.) R. Br.	Apocynaceae	T
18	รักดอก	*Calotropis gigantea* (L.) W. T. Aiton	Apocynaceae	ExS/ST
19	โมกหลวง	*Holarrhena pubescens* Wall. ex G. Don	Apocynaceae	S/T
20	ยี่โถ	*Nerium oleander* L.	Apocynaceae	ExS
21	จมูกปลาหลด	*Oxystelma esculentum* (L. f.) Sm.	Apocynaceae	C
22	ลั่นทมขาว	*Plumeria obtusa* L.	Apocynaceae	ExST
23	ลั่นทม	*Plumeria rubra* L.	Apocynaceae	ExST
24	โมกมัน	*Wrightia arborea* (Dennst.) Mabb.	Apocynaceae	ST
25	โมกบ้าน	*Wrightia religiosa* (Teijsm. & Binn.) Benth. ex Kurz	Apocynaceae	S
26	สนฉัตร	*Araucaria columnaris* (G. Forst.) Hook.	Araucariaceae	ExT
27	ตาล	*Borassus flabellifer* L.	Arecaceae	P
28	เต่าร้าง	*Caryota mitis* Lour.	Arecaceae	P
29	มะพร้าว	*Cocos nucifera* L.	Arecaceae	ExP
30	ปาล์มน้ำมัน	*Elaeis guineensis* Jacq.	Arecaceae	ExP
31	ปาล์มสิบสองปันนา	*Phoenix roebelenii* O'Brien	Arecaceae	P

Figure 3.2.1-2 (cons.)

NO.	Common name	Botanical name	Family	Habit
32	หมากเขียว	*Ptychosperma macarthurii* (H. J. Veitch) H. Wendl. ex Hook. f.	Arecaceae	ExP
33	ปาล์มขวด	*Roystonea regia* (Kunth) O. F. Cook	Arecaceae	ExP
34	ปาล์มหางกระรอก	*Wodyetia bifurcata* A. K. Irvine	Arecaceae	ExP
35	จันทน์ผา	*Dracaena cochinchinensis* (Lour.) S. C. Chen	Asparagaceae	S/ST
36	สาบแร้งสาบกา	*Ageratum conyzoides* L.	Asteraceae	H
37	สาบเสือ	*Chromolaena odorata* (L.) R. M. King & H. Rob.	Asteraceae	ExH
38	ขลู่	*Pluchea indica* (L.) Less.	Asteraceae	S
39	แคนา	*Dolichandrone serrulata* (Wall. ex DC.) Seem.	Bignoniaceae	T
40	แคบิด	*Fernandoa adenophylla* (Wall. ex G. Don) Steenis	Bignoniaceae	T
41	แคหางค่าง	*Markhamia stipulata* (Wall.) Seem. var. kerrii Sprague	Bignoniaceae	T
42	ปีบ	*Millingtonia hortensis* L. f.	Bignoniaceae	T
43	เพกา	*Oroxylum indicum* (L.) Benth. ex Kurz	Bignoniaceae	ST
44	ปีบทอง	*Radermachera hainanensis* Merr.	Bignoniaceae	T
45	เหลืองปรีดียาธร	*Roseodendron donnell-smithii* (Rose) Miranda	Bignoniaceae	ExT
46	ชมพูพันธุ์ทิพย์	*Tabebuia rosea* (Bertol.) Bertero ex A. DC.	Bignoniaceae	ExT
47	ทองอุไร	*Tecoma stans* (L.) Juss. ex Kunth	Bignoniaceae	ExS
48	คอร์เดีย	*Cordia sebestena* L.	Boraginaceae	ExST
49	ก้อม	*Ehretia laevis* Roxb.	Boraginaceae	ST
50	ตะคร้ำ	*Garuga pinnata* Roxb.	Burseraceae	T
51	กระบองเพชร	*Cereus hexagonus* (L.) Mill.	Cactaceae	ExS/ST
52	พังแหร	*Trema angustifolia* (Planch.) Blume	Cannabaceae	ST
53	พังแหรใหญ่	*Trema orientalis* (L.) Blume	Cannabaceae	ST
54	กุ่มน้ำ	*Crateva religiosa* G. Forst.	Capparaceae	T
55	แจง	*Maerua siamensis* (Kurz) Pax	Capparaceae	T
56	มะละกอ	*Carica papaya* L.	Caricaceae	ExST
57	สนทะเล	*Casuarina equisetifolia* L.	Casuarinaceae	T
58	สนประดิพัทธ์	*Casuarina junghuhniana* Miq.	Casuarinaceae	ExT
59	มะดูก	*Siphonodon celastrineus* Griff.	Celastraceae	T
60	สะแกนา	*Combretum quadrangulare* Kurz	Combretaceae	T
61	สมอพิเภก	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	T
62	หูกวาง	*Terminalia catappa* L.	Combretaceae	T
63	สมอไทย	*Terminalia chebula* Retz. var. chebula	Combretaceae	T
64	ขี้อ้าย	*Terminalia nigrovenulosa* Pierre	Combretaceae	T
65	ผักปลาบนา	*Cyanotis axillaris* D. Don ex Sweet	Commelinaceae	H

Figure 3.2.1-2 (cons.)

NO.	Common name	Botanical name	Family	Habit
66	คำรอก	*Ellipanthus tomentosus* Kurz	Connaraceae	ST
67	ผักบุ้งไทย	*Ipomoea aquatica* Forssk.	Convolvulaceae	CrH
68	ตำลึง	*Coccinia grandis* (L.) Voigt	Cucurbitaceae	HC
69	ขี้กาแดง	*Gymnopetalum scabrum* (Lour.) W. J. de Wilde & Duyfjes	Cucurbitaceae	HC
70	มะระขี้นก	*Momordica charantia* L.	Cucurbitaceae	HC
71	ยางนา	*Dipterocarpus alatus* Roxb. ex G. Don	Dipterocarpaceae	T
72	เต็ง	*Shorea obtusa* Wall. ex Blume	Dipterocarpaceae	T
73	พะยอม	*Shorea roxburghii* G. Don	Dipterocarpaceae	T
74	รัง	*Shorea siamensis* Miq.	Dipterocarpaceae	T
75	สั่งทำ	*Diospyros buxifolia* (Blume) Hiern	Ebenaceae	T
76	ตะโกพนม	*Diospyros castanea* (Craib) H. R. Fletcher	Ebenaceae	ST
77	จันอิน	*Diospyros decandra* Lour.	Ebenaceae	T
78	มะเกลือ	*Diospyros mollis* Griff.	Ebenaceae	T
79	ถ่านไฟผี	*Diospyros montana* Roxb.	Ebenaceae	T
80	ตะโกนา	*Diospyros rhodocalyx* Kurz	Ebenaceae	ST
81	ตำแยแมว	*Acalypha indica* L.	Euphorbiaceae	H
82	โกสน	*Codiaeum variegatum* (L.) Rumph. ex A. Juss.	Euphorbiaceae	ExS
83	เปล้าแพะ	*Croton hutchinsonianus* Hosseus	Euphorbiaceae	S/ST
84	เปล้าใหญ่	*Croton persimilis* Müll. Arg.	Euphorbiaceae	S/ST
85	หญ้ายาง	*Euphorbia heterophylla* L.	Euphorbiaceae	ExH
86	น้ำนมราชสีห์	*Euphorbia hirta* L.	Euphorbiaceae	H
87	สบู่แดง	*Jatropha gossypifolia* L.	Euphorbiaceae	ExS
88	มะฝ่อ	*Mallotus nudiflorus* (L.) Kulju & Welzen	Euphorbiaceae	T
89	ละหุ่ง	*Ricinus communis* L.	Euphorbiaceae	S/ST
90	ขันทองพยาบาท	*Suregada multiflora* (A. Juss.) Baill.	Euphorbiaceae	S/T
91	กระถินณรงค์	*Acacia auriculiformis* A. Cunn. ex Benth.	Fabaceae	ExT
92	กระถินเทพา	*Acacia mangium* Willd.	Fabaceae	ExT
93	มะกล่ำต้น	*Adenanthera pavonina* L.	Fabaceae	T
94	โสนหางไก่	*Aeschynomene indica* L.	Fabaceae	US
95	มะค่าโมง	*Afzelia xylocarpa* (Kurz) Craib	Fabaceae	T
96	พฤกษ์	*Albizia lebbeck* (L.) Benth.	Fabaceae	T
97	คาง	*Albizia lebbekoides* (DC.) Benth.	Fabaceae	T
98	กางขี้มอด	*Albizia odoratissima* (L. f.) Benth.	Fabaceae	T
99	ทิ้งถ่อน	*Albizia procera* (Roxb.) Benth.	Fabaceae	T
100	จามจุรี	*Albizia saman* (Jacq.) Merr.	Fabaceae	ExT
101	กาหลง	*Bauhinia acuminata* L.	Fabaceae	ExS

Figure 3.2.1-2 (cons.)

NO.	Common name	Botanical name	Family	Habit
102	ชงโค	*Bauhinia purpurea* L.	Fabaceae	ExST
103	หางนกยูงไทย	*Caesalpinia pulcherrima* (L.) Sw.	Fabaceae	ExS
104	ฝาง	*Caesalpinia sappan* L.	Fabaceae	ST
105	พู่จอมพล	*Calliandra haematocephala* Hassk.	Fabaceae	ExS
106	กัลปพฤกษ์	*Cassia bakeriana* Craib	Fabaceae	T
107	คูน	*Cassia fistula* L.	Fabaceae	T
108	อัญชัน	*Clitoria ternatea* L.	Fabaceae	ExC
109	คำบูชา	*Crotalaria juncea* L.	Fabaceae	ExH
110	พะยูง	*Dalbergia cochinchinensis* Pierre	Fabaceae	T
111	ฉนวน	*Dalbergia nigrescens* Kurz	Fabaceae	T
112	กำพี้	*Dalbergia ovata* Graham ex Benth. var. *ovata*	Fabaceae	T
113	หางนกยูงฝรั่ง	*Delonix regia* (Bojer ex Hook.) Raf.	Fabaceae	ExT
114	พันซาด	*Erythrophleum succirubrum* Gagnep.	Fabaceae	T
115	กระถินยักษ์	*Leucaena leucocephala* (Lam.) de Wit	Fabaceae	S/ST
116	กระพี้จั่น	*Millettia brandisiana* Kurz	Fabaceae	T
117	สาธร	*Millettia leucantha* Kurz var. leucantha	Fabaceae	T
118	จักจั่น	*Millettia xylocarpa* Miq.	Fabaceae	T
119	ไมยราบ	*Mimosa pudica* L.	Fabaceae	ExS
120	อะราง	*Peltophorum dasyrrhachis* (Miq.) Kurz	Fabaceae	T
121	นนทรี	*Peltophorum pterocarpum* (DC.) Backer ex K. Heyne	Fabaceae	T
122	ประดู่บ้าน	*Pterocarpus indicus* Willd.	Fabaceae	T
123	ประดู่ป่า	*Pterocarpus macrocarpus* Kurz	Fabaceae	T
124	ชุมเห็ดเทศ	*Senna alata* (L.) Roxb.	Fabaceae	ExS
125	ขี้เหล็กอเมริกา	*Senna floribunda* (Cav.) H. S. Irwin & Barneby	Fabaceae	ExS
126	แสมสาร	*Senna garrettiana* (Craib) H. S. Irwin & Barneby	Fabaceae	T
127	ขี้เหล็ก	*Senna siamea* (Lam.) H. S. Irwin & Barneby	Fabaceae	T
128	ทรงบาดาล	*Senna surattensis* (Burm. f.) H. S. Irwin & Barneby	Fabaceae	ExST/T
129	ขี้เหล็กเลือด	*Senna timoriensis* (DC.) H. S. Irwin & Barneby	Fabaceae	ST
130	แคบ้าน	*Sesbania grandiflora* (L.) Poir.	Fabaceae	ExST
131	โสนกินดอก	*Sesbania javanica* Miq.	Fabaceae	US
132	มะค่าแต้	*Sindora siamensis* Teijsm. ex Miq. var. *siamensis*	Fabaceae	T
133	มะขาม	*Tamarindus indica* L.	Fabaceae	ExT
134	แดง	*Xylia xylocarpa* (Roxb.) W. Theob. var. *kerrii* (Craib & Hutch.) I. C. Nielsen	Fabaceae	T
135	โกงกางเขา	*Fagraea ceilanica* Thunb.	Gentianaceae	ES/ST

Figure 3.2.1-2 (cons.)

NO.	Common name	Botanical name	Family	Habit
136	กันเกรา	*Fagraea fragrans* Roxb.	Gentianaceae	T
137	ติ้วเกลี้ยง	*Cratoxylum cochinchinense* (Lour.) Blume	Hypericaceae	T
138	กระบก	*Irvingia malayana* Oliv. ex A. W. Benn.	Irvingiaceae	T
139	จันมัน	*Premna mollissima* Roth	Lamiaceae	ST/T
140	สัก	*Tectona grandis* L. f.	Lamiaceae	T
141	ผ่าเสี้ยน	*Vitex canescens* Kurz	Lamiaceae	T
142	สวอง	*Vitex limonifolia* Wall. ex Walp.	Lamiaceae	T
143	กาสามปีก	*Vitex peduncularis* Wall. ex Schauer	Lamiaceae	T
144	ตีนนก	*Vitex pinnata* L.	Lamiaceae	T
145	อีแปะ	*Vitex scabra* Wall. ex Schauer	Lamiaceae	ST/T
146	หมีเหม็น	*Litsea glutinosa* (Lour.) C. B. Rob.	Lauraceae	T
147	จิกน้ำ	*Barringtonia acutangula* (L.) Gaertn.	Lecythidaceae	ST/T
148	กระโดน	*Careya arborea* Roxb.	Lecythidaceae	T
149	สาละลังกา	*Couroupita guianensis* Aubl.	Lecythidaceae	ExT
150	ตะแบกเกรียบ	*Lagerstroemia cochinchinensis* Pierre.	Lythraceae	T
151	ตะแบกนา	*Lagerstroemia floribunda* Jack var. *floribunda*	Lythraceae	T
152	อินทรชิต	*Lagerstroemia loudonii* Teijsm. & Binn.	Lythraceae	T
153	อินทนิลน้ำ	*Lagerstroemia speciosa* (L.) Pers.	Lythraceae	T
154	ทับทิม	*Punica granatum* L. var. granatum	Lythraceae	ExS
155	จำปี	*Magnolia alba* (DC.) Figlar	Magnoliaceae	T
156	จำปา	*Magnolia champaca* (L.) Baill. ex Pierre var. *champaca*	Magnoliaceae	T
157	มะก่องข้าว	*Abutilon indicum* (L.) Sweet	Malvaceae	US
158	งิ้วบ้าน	*Bombax ceiba* Pierre	Malvaceae	T
159	งิ้วป่าดอกแดง	*Bombax insigne* Wall.	Malvaceae	T
160	ปอมื่น	*Colona floribunda* (Kurz) Craib	Malvaceae	T
161	ปอแก่นเทา	*Grewia eriocarpa* Juss.	Malvaceae	T
162	ปอบิด	*Helicteres isora* L.	Malvaceae	S
163	พลับพลา	*Microcos tomentosa* Sm.	Malvaceae	T
164	ตะขบฝรั่ง	*Muntingia calabura* L.	Malvaceae	ExST
165	ปออีเก้ง	*Pterocymbium tinctorium* (Blanco) Merr.	Malvaceae	T
166	ขามคัวะ	*Pterospermum semisagittatum* Buch.-Ham. ex Roxb.	Malvaceae	T
167	หญ้าขัดใบยาว	*Sida acuta* Burm. f.	Malvaceae	US
168	ปอขาว	*Sterculia pexa* Pierre	Malvaceae	ST/T
169	สะเดาเทียม	*Azadirachta excelsa* (Jack) Jacobs	Meliaceae	T
170	สะเดา	*Azadirachta indica* A. Juss.	Meliaceae	T

Figure 3.2.1-2 (cons.)

NO.	Common name	Botanical name	Family	Habit
171	ยมหิน	*Chukrasia tabularis* A. Juss.	Meliaceae	T
172	กระท้อน	*Sandoricum koetjape* (Burm. f.) Merr.	Meliaceae	T
173	มะฮอกกานีใบใหญ่	*Swietenia macrophylla* King	Meliaceae	T
174	เถาย่านาง	*Tiliacora triandra* (Colebr.) Diels	Menispermaceae	C
175	ชิงช้าชาลี	*Tinospora baenzigeri* Forman	Menispermaceae	C
176	ขนุน	*Artocarpus heterophyllus* Lam.	Moraceae	ExT
177	มะหาด	*Artocarpus lacucha* Roxb. ex Buch.-Ham.	Moraceae	T
178	ปอกระสา	*Broussonetia papyrifera* (L.) L'Hér. ex Vent.	Moraceae	ST
179	กร่าง	*Ficus altissima* Blume	Moraceae	T
180	นิโครธ	*Ficus benghalensis* L.	Moraceae	ExT
181	ไทรย้อยใบแหลม	*Ficus benjamina* L.	Moraceae	T
182	สลอดน้ำ	*Ficus heterophylla* L. f.	Moraceae	CrS
183	มะเดื่อปล้อง	*Ficus hispida* L. f.	Moraceae	ST
184	ไทรย้อยใบทู่	*Ficus microcarpa* L. f.	Moraceae	T
185	โพศรีมหาโพ	*Ficus religiosa* L.	Moraceae	ExT
186	โพขี้นก	*Ficus rumphii* Blume	Moraceae	T
187	ข่อย	*Streblus asper* Lour.	Moraceae	T
188	กล้วยน้ำว้า	*Musa xparadisiaca* L.	Musaceae	H
189	ยูคาลิปตัส	*Eucalyptus camaldulensis* Dehnh.	Myrtaceae	ExT
190	ฝรั่ง	*Psidium guajava* L.	Myrtaceae	ExST
191	ชมพู่มะเหมี่ยว	*Syzygium malaccense* (L.) Merr. & L. M. Perry	Myrtaceae	ST
192	แสงจันทร์	*Pisonia grandis* R. Br.	Nyctaginaceae	ExST
193	บัวสาย	*Nymphaea pubescens* Willd.	Nymphaeaceae	AqH
194	ช้างน้าว	*Ochna integerrima* (Lour.) Merr.	Ochnaceae	S/ST
195	น้ำใจใคร่	*Olax psittacorum* (Lam.) Vahl	Olacaceae	C
196	ผักหวานป่า	*Champereia manillana* (Blume) Merr.	Opiliaceae	ST
197	กระทกรก	*Passiflora foetida* L.	Passifloraceae	ExC
198	เม่าสร้อย	*Antidesma acidum* Retz.	Phyllanthaceae	S/ST
199	เม่าไข่ปลา	*Antidesma ghaesembilla* Gaertn.	Phyllanthaceae	S/T
200	พริกไทยดง	*Aporosa planchoniana* Baill. ex Müll. Arg.	Phyllanthaceae	S/ST
201	เหมือดโลด	*Aporosa villosa* (Wall. ex Lindl.) Baill.	Phyllanthaceae	S/ST
202	มะกา	*Bridelia ovata* Decne.	Phyllanthaceae	ScanS/ST
203	เต็งหนาม	*Bridelia retusa* (L.) A. Juss.	Phyllanthaceae	T
204	มะกาเครือ	*Bridelia stipularis* (L.) Blume	Phyllanthaceae	ScanS/ST
205	สีฟันกระบือ	*Bridelia tomentosa* Blume	Phyllanthaceae	ScanS/ST
206	พันตา	*Cleistanthus denudatus* Airy Shaw	Phyllanthaceae	S/ST
207	แข้งแคะ	*Cleistanthus papyraceus* Airy Shaw	Phyllanthaceae	S/ST

Figure 3.2.1-2 (cons.)

NO.	Common name	Botanical name	Family	Habit
208	ก้างปลาขาว	*Flueggea virosa* (Roxb. ex Willd.) Voigt	Phyllanthaceae	S
209	มะยม	*Phyllanthus acidus* (L.) Skeels	Phyllanthaceae	ExST
210	ลูกใต้ใบ	*Phyllanthus amarus* Schumach. & Thonn.	Phyllanthaceae	H
211	แขนงพร้อย	*Phyllanthus collinsiae* Craib	Phyllanthaceae	S/ST
212	มะขามป้อม	*Phyllanthus emblica* L.	Phyllanthaceae	ST/T
213	ลูกหมึก	*Phyllanthus reticulatus* Poir.	Phyllanthaceae	S/ST
214	พริกไทย	*Piper nigrum* L.	Piperraceae	ExC
215	ผักตบชวา	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	ExAqH
216	พุทรา	*Ziziphus jujuba* Mill.	Rhamnaceae	ExST
217	ส้มกบ	*Hymenodictyon orixense* (Roxb.) Mabb.	Rubiaceae	T
218	กระทุ่มนา	*Mitragyna diversifolia* (Wall. ex G. Don) Havil.	Rubiaceae	S/ST
219	ยอบ้าน	*Morinda citrifolia* L.	Rubiaceae	ST
220	ยอป่า	*Morinda coreia* Buch.-Ham.	Rubiaceae	ST
221	ยอเถื่อน	*Morinda elliptica* (Hook. f.) Ridl.	Rubiaceae	ST
222	หญ้าลิ้นงู	*Oldenlandia corymbosa* L.	Rubiaceae	H
223	ตดหมูตดหมา	*Paederia linearis* Hook. f.	Rubiaceae	C
224	ตะลุมพุก	*Tamilnadia uliginosa* (Retz.) Tirveng. & Sastre	Rubiaceae	ST
225	มะตูม	*Aegle marmelos* (L.) Corrêa ex Roxb.	Rutaceae	T
226	มะนาวผี	*Atalantia monophylla* (L.) DC.	Rutaceae	ST
227	มะนาว	*Citrus xaurantifolia* (Christm.) Swingle	Rutaceae	ExST
228	มะกรูด	*Citrus hystrix* DC.	Rutaceae	ST
229	กระแจะ	*Naringi crenulata* (Roxb.) Nicolson	Rutaceae	ST
230	ตะขบป่า	*Flacourtia indica* (Burm. f.) Merr.	Salicaceae	ST
231	หนามพุงดอ	*Azima sarmentosa* (Blume) Benth. & Hook. f.	Salvadoraceae	C
232	ต่อไส้	*Allophylus cobbe* (L.) Raeusch.	Sapindaceae	S/ST
233	คงคาเดือด	*Arfeuillea arborescens* Pierre ex Radlk.	Sapindaceae	T
234	ลำไย	*Dimocarpus longan* Lour. var. *longan*	Sapindaceae	T
235	ชำมะเลียง	*Lepisanthes fruticosa* (Roxb.) Leenh.	Sapindaceae	S/ST
236	มะหวด	*Lepisanthes rubiginosa* (Roxb.) Leenh.	Sapindaceae	S/ST
237	หมากว้อ	*Lepisanthes senegalensis* (Poir.) Leenh.	Sapindaceae	S/ST
238	ตะคร้อ	*Schleichera oleosa* (Lour.) Merr.	Sapindaceae	T
239	ขี้หนอน	*Zollingeria dongnaiensis* Pierre	Sapindaceae	T
240	พิกุล	*Mimusops elengi* L.	Sapotaceae	T
241	หนามคนทา	*Harrisonia perforata* (Blanco) Merr.	Simaroubaceae	ScanS
242	พริก	*Capsicum annuum* L.	Solanaceae	ExUS
243	มะแว้งเครือ	*Solanum trilobatum* L.	Solanaceae	C
244	เหมือดหอม	*Symplocos racemosa* Roxb.	Symplocaceae	ST

Figure 3.2.1-2 (cons.)

NO.	Common name	Botanical name	Family	Habit
245	ธูปฤาษี	*Typha angustifolia* L.	Typhaceae	ExAqH
246	บุหงาส่าหรี	*Citharexylum spinosum* L.	Verbenaceae	ExS
247	เทียนหยด	*Duranta erecta* L.	Verbenaceae	ExS/ST
248	ผกากรอง	*Lantana camara* L.	Verbenaceae	ExC
249	เถาคัน	*Cayratia trifolia* (L.) Domin	Vitaceae	C
250	ข่า	*Alpinia galanga* (L.) Willd.	Zingiberaceae	ExH

Note : C = ไม้เถาหรือไม้เลื้อย (climber), CrH = ไม้ล้มลุกเกาะเลื้อย (creeping herb), EX = พืชต่างถิ่น (Exotic plants)
H = ไม้ล้มลุก (herb), HC = ไม้เถาล้มลุก (herbaceous climber), P = หมากหรือปาล์ม (palm), S = ไม้พุ่ม (shrub)
ScanS = ไม้พุ่มรอเลื้อย (scandent shrub), ST = ไม้ต้นขนาดเล็ก (shrubby tree), T = ไม้ต้น (tree)
US = ไม้พุ่มขนาดเล็ก (undershrub)


ผกากรอง


หนามพุงดอ


ลั่นทม


ขามคัวะ


ปอบิด


มะค่าแต้


รักดอก


สบู่แดง


คำรอก


สวอง

Figure 3.2.1-2 Some species of trees found in study area

	
มะแว้งเครือ	ตะโกนา
	
ละหุ่ง	แสมสาร
	
ขันทองพยาบาท	ไมยราบ
	
มะม่วงหัวแมงวัน	อินทรชิต

Figure 3.2.1-2 (cons.)

(2) Wildlife resources

1) Study method

Wildlife resource study had been conducted in four main groups of wildlife, mammals, poultry, reptiles, and amphibians. The study had been done by surveying and collecting data to cover the study area within 5 kilometers radius from the project area. In order to obtain the most complete data, it was necessary to conduct surveys using multiple methods, consisting of;

(A) Direct survey from the sightings of searchers, vocals, traces of use, etc., for further classify.

(B) Indirect survey as support data to complete survey methods by examining documents before entering the survey area, including inquiring of people living in the study area about the identification and use of wildlife.

(C) Data analysis done by collecting data from the survey, classification and listing, then arranged according to taxonomy by specifying genealogy, common name, and scientific name. Then the assessment on the abundance and status were proceeded.

a) Abundance; in order to clarify the magnitude of the encounter, the method of Pettingill had been modified (1950) by the following calculation from the formula.

$$\text{Abundance\%} = \frac{\text{Number of times found}}{\text{Number of total survey}} \times 100$$

The percentage of abundance of each animal was then divided into 3 following groups.

More than 50%	=	common
21 – 49%	=	moderate
Less than 20%	=	rare

b) Status; it was done by assessing legal and current status of wildlife by using the following criteria.

- Legal status, according to the Wildlife Preservation Act, B.E.2535, which defined the status of wildlife into 3 types, reserved wildlife, protected wildlife and wildlife that is not protected by law.

- Current status; according to the classification of biological resources in Thailand by the Office of Natural Resources and Environmental Policy and Planning B.E. 2560 and from the Red Data List of the International Union Conservation of Nature; IUCN (2019), defining the status of wildlife into 9 categories, extinct (EX), extinct in the wild (EW), critically endangered (CR), endangered (EN), vulnerable (VU), near threatened (NT), least concern (LC), data deficient (DD) and not yet evaluated (NE).

2) Field survey results

From field survey, it was found that the area around the project area within 5 kilometers was an agricultural area with irrigation canals, making the study area looks like a wetland. There were many forest areas around the project, including limestone forests. There were agricultural communities such as rice fields, forest plantations in connection with the degraded forests and urban areas. Resulting in diverse ecological characteristics, therefore, the study was able to find a variety of wildlife and their types that were commonly found in the area. In this study, a total of 84 wildlife species were identified, 53 species of birds, 6 species of reptiles, 7 species of amphibians and 18 species of mammals (**Table 3.2.1-2** to **Table 3.2.1-3**) as follows.

(A) Wildlife divesity

From a survey, 84 species of wildlife from in 51 families, 18 orders were found, as seen in **Table 3.2.1-2**, with following details.

- A total of 53 species of birds from 45 genera, 34 families, 12 orders were found in the study and were the most numbers and diverse group of animals. Birds were a group of wildlife that fly, making them move to find habitat and livelihoods quickly, as well as birds had more metabolism than other animals. Birds therefore must have activities to find food and eat all the time, causing a wide spread of birds, especially, with birds living and finding food in the air, they would be more widespread. However, there were many kinds of birds having habitat and livelihood boundaries in certain areas and in some ecological conditions. Many species of birds lived in areas with various ecological conditions. The surveyed birds were classified as a group of field birds, wild birds and water birds. Field birds lived and fed in agricultural areas, or with open conditions or areas where trees are generally scattered but not a forest. Species of surveyed birds were included, *Merops orientalis*, *Cacomantis merulinus*, *Centropus sinensis*, *Cypsiurus balasiensis*, *Geopelia striata, Dicrurus macrocercus, Hirundo rustica, Cisticola juncidis and Lonchura striata*, etc. These birds could be found in general agricultural areas in Thailand. For wild birds that live and feed in wooded areas with dense trees, observed species were, *Caprimulgus macrurus, Rhipidura javanica, Dicrurus* *paradiseus, Cyornis tickelliae, Copsychus malabaricus, Pycnonotus aurigaster*, Common Warbler (*Orthotomus sutorius*), and *Anthreptes malacensis*. For water birds, they lived and fed on water resources and agricultural areas. Observed species were *Dendrocygna javanica, Halcyon smyrnensis, Actitis hypoleucos, Metopidius indicus, Himantopus himantopus, Tachybaptus ruficollis, Microcarbo niger, Ardea alba* and *Anastomus oscitans*, etc.

- There were 18 species of mammals from 12 genera and 10 families. The top 4 mammals were both medium and small mammals living in various agricultural areas. The forest area was characterized as limestone mountains and often had caves inside. A medium sized wildlife found in the primates was primates in the old world monkey family (Cercopithecidae) which was macaque (*Macaca fascicularis*). For carnivora in Mustelidae family, the small weasel (*Herpestes javanicus*) were found. A small wild animal found in the Rodebtia and in the Sciuridae families living in the limestone forest and nearby areas was the black-tailed squirrel (*Callosciurus caniceps*). Moreover, a small wildlife in the bat (Chiroptera) family living in the sugar palm trees and caves were also found. Due to bats are the only mammals that can fly, causing a wide distribution away from where they lives during the day. Therefore, bats can often be found everywhere throughout the country. The variety of bat species depends on their habitats. This survey was done in areas of limestone mountains with bat caves were nearby, therefore, many types of bats were found, including fruit-eating bats in the Pteropodidae family, such as the central white-eared bat (*Cynopterus sphinx*) and the nail-claw bat (*Eonycteris spelaea*). Insect-eating bats in Emballonuridae family were also found, such as the black-winged bats (*Taphozous melanopogon*). Insect-eating bats in Megadermatidae family were found, such as the small vampire bat (*Megaderma spasma*). Insect-eating bats in Rhinolophidae family, such as the Rhinolophus pusillus were found. A species of insect-eating bats in Hipposideridae family, such as *Hipposideros armiger* were found. A species of insect-eating bats in Vespertilionidae family, such as *Scotophilus kuhlii* and the insect-eating bat in the Molossidae family, such as *Tadarida teniotis* were also found.

Table 3.2.1-2

Species, Abundance and Legal status in study ara

No.	Orders, families, species of wildlife (Scientific name)	Legal status			Abundance	Abundance Level			Seasonal	source	
		Act	ONEP	IUCN	(%)	Abundant	Medium	Rare	status	Survey	Inquire
Mammals											
Order Chiroptera											
Family Pteropodidae											
1	ค้างคาวขอบหูขาวกลาง (*Cynopterus sphinx*)	-	LC	LC	100	/			-		/
2	ค้างคาวบัว (*Rosettus* sp.)	-	LC	LC	100	/			-		/
3	ค้างคาวเล็บกุด (*Eonycteris spelaea*)	PR	LC	LC	100	/			-		/
Family Emballonuridae											
4	ค้างคาวปีกถุงเคราดำ (*Taphozous melanopogon*)	PR	LC	LC	100	/			-		/
5	ค้างคาวปีกถุงใหญ่ (*Taphozous theobaldi*)	PR	LC	LC	100	/			-		/
Family Megadermatidae											
6	ค้างคาวแวมไพร์แปลงเล็ก (*Megaderma spasma*)	PR	LC	LC	100	/			-		/
Family Rhinolophidae											
7	ค้างคาวมงกุฎมลายู (*Rhinolophus malayanus*)	PR	LC	LC	100	/			-		/
8	ค้างคาวมงกุฎเล็ก (*Rhinolophus pusillus*)	PR	LC	LC	100	/			-		/
Family Hipposideridae											
9	ค้างคาวหน้ายักษ์เล็กสองสี (*Hipposideros bicolor*)	PR	LC	LC	100	/			-		/
10	ค้างคาวหน้ายักษ์เล็กจมูกปุ่ม (*Hipposideros halophyllus*)	PR	EN	VU	100	/			-		/
11	ค้างคาวหน้ายักษ์ทศกัณฐ์ (*Hipposideros armiger*)	PR	LC	LC	100	/			-		/

Table 3.2.1-2 (cons.)

No.	Orders, families, species of wildlife (Scientific name)	Legal status			Abundance (%)	Abundance Level			Seasonal status	source	
		Act	ONEP	IUCN		Abundant	Medium	Rare		Survey	Inquire
Family Hipposideridae											
12	ค้างคาวหน้ายักษ์หมอบุญส่ง (*Hipposideros lekaguli*)	PR	VU	NT	100	/			-		/
13	ค้างคาวหน้ายักษ์สามหลืบ (*Hipposideros larvatus*)	PR	LC	LC	100	/			-		/
Family Vespertilionidae											
14	ค้างคาวเพดานใหญ่ (*Scotophilus kuhlii*)	PR	LC	LC	100	/			-		/
Family Molossidae											
15	ค้างคาวปากย่น (*Tadarida teniotis*)	PR	LC	LC	100	/			-	/	
Order Rodentia											
Family Sciuridae											
16	กระรอกปลายหางดำ (*Callosciurus caniceps*)	-	LC	LC	60	/			-	/	
Order Primates											
Family Cercopithecidae											
17	ลิงแสม (*Macaca fascicularis*)	PR	LC	LC	80	/			-	/	
Order Carnivora											
Family Herpestidae											
18	พังพอนเล็ก (*Herpestes javanicus*)	PR	LC	LC	20			/	-	/	

Table 3.2.1-2 (cons.)

No.	Orders, families, species of wildlife (Scientific name)	Legal status			Abundance (%)	Abundance Level			Seasonal status	source	
		Act	ONEP	IUCN		Abundant	Medium	Rare		Survey	Inquire
Amphibians											
Order Anura											
Family Bufonidae											
1	คางคกบ้าน (*Duttaphrynus melanostictus*)	-	LC	LC	40		/		-	/	
Family Microhylidae											
2	อึ่งน้ำเต้า (*Microhyla ornata*)	-	LC	LC	100	/			-	/	
Family Dicroglossidae											
3	เขียดจะนา (*Occidozyga lima*)	-	LC	LC	60	/			-	/	
4	เขียดน้ำนอง (*Occidozyga martensii*)	-	LC	LC	80	/			-	/	
5	กบหนอง (*Fejervarya limnocharis*)	-	LC	LC	80	/			-	/	
Family Ranidae											
6	กบนา (*Hoplobatrachus rugulosus*)	-	LC	LC	40		/		-	/	
7	กบบัว/เขียดจิก (*Hylarana erythraea*)	-	LC	LC	80	/			-	/	
Reptiles											
Order Squamata											
Family Agamidae											
1	กิ้งก่ารั้ว/กิ้งก่าหัวแดง (*Calotes versicolor*)	PR	LC	-	100	/			-	/	
2	แย้เหนือ (*Leiolepis belliana*)	-	LC	LC	40		/		-	/	

Table 3.2.1-2 (cons.)

No.	Orders, families, species of wildlife (Scientific name)	Legal status			Abundance	Abundance Level			Seasonal	source	
		Act	ONEP	IUCN	(%)	Abundant	Medium	Rare	status	Survey	Inquire
Family Gekkonidae											
3	จิ้งจกบ้านหางหนาม (*Hemidactylus frenatus*)	-	LC	LC	40		/		-	/	
4	จิ้งจกบ้านหางแบน (*Hemidactylus platyurus*)	-	LC	-	40		/		-	/	
5	ตุ๊กแกบ้าน (*Gekko gecko*)	-	LC	LC	40		/		-	/	
Family Scincidae											
6	จิ้งเหลนบ้าน (*Mabuya multifasciata*)	-	LC	LC	100	/			-	/	
Birds											
Order Anseriformes											
Family Dendrocygnidae											
1	เป็ดแดง (*Dendrocygna javanica*)	PR	LC	LC	20			/	R	/	
Order Coraciiformes											
Family Coraciidae											
2	นกตะขาบทุ่ง (*Coracias benghalensis*)	PR	LC	LC	40		/		R	/	
Family Halcyonidae											
3	นกกะเต็นอกขาว (*Halcyon smyrnensis*)	PR	LC	LC	60	/			R	/	
Family Meropidae											
4	นกจาบคาเล็ก (*Merops orientalis*)	PR	LC	LC	60	/			R	/	
5	นกจาบคาหัวเขียว (*Merops philippinus*)	PR	LC	LC	20			/	N/R	/	

Table 3.2.1-2 (cons.)

No.	Orders, families, species of wildlife (Scientific name)	Legal status			Abundance (%)	Abundance Level			Seasonal status	source	
		Act	ONEP	IUCN		Abundant	Medium	Rare		Survey	Inquire
Order Cuculiformes											
Family Cuculidae											
6	นกอีวาบตั๊กแตน (*Cacomantis merulinus*)	PR	LC	LC	60	/			R	/	
7	นกกาเหว่า (*Eudynamys scolopaceus*)	PR	LC	LC	20			/	R	/	
Family Centropodidae											
8	นกกระปูดใหญ่ (*Centropus sinensis*)	PR	LC	LC	40		/		R	/	
Order Apodiformes											
Family Apodidae											
9	นกแอ่นตาล (*Cypsiurus balasiensis*)	PR	LC	LC	60	/			R	/	
Order Caprimulgiformes											
Family Eurostopodidae											
10	นกตบยุงหางยาว (*Caprimulgus macrurus*)	PR	LC	LC	40		/		R	/	
Order Columbiformes											
Family Columbidae											
11	นกพิราบป่า (*Columba livia*)	-	-	LC	100	/			R	/	
12	นกเขาใหญ่ (*Streptopelia chinensis*)	-	LC	LC	80	/			R	/	
13	นกเขาไฟ (*Streptopelia tranquebarica*)	PR	LC	LC	100	/			R	/	
14	นกเขาชวา (*Geopelia striata*)	-	LC	LC	100	/			R	/	

Table 3.2.1-2 (cons.)

No.	Orders, families, species of wildlife (Scientific name)	Legal status			Abundance (%)	Abundance Level			Seasonal status	source	
		Act	ONEP	IUCN		Abundant	Medium	Rare		Survey	Inquire
Order Charadriiformes											
Family Scolopacidae											
15	นกเด้าดิน (*Actitis hypoleucos*)	PR	LC	LC	20			/	N	/	
Family Jacanidae											
16	นกพริก (*Metopidius indicus*)	PR	LC	LC	20			/	R	/	
Family Recurvirostridae											
17	นกตีนเทียน (*Himantopus himantopus*)	PR	LC	LC	40		/		N/R	/	
Family Charadriidae											
18	นกกระแตแต้แว้ด (*Vanellus indicus*)	PR	LC	LC	80	/			R	/	
Order Podicepediformes											
Family Podicipedidae											
19	นกเป็ดผีเล็ก (*Tachybaptus ruficollis*)	PR	LC	LC	20			/	R	/	
Order Gruiformes											
Family Rallidae											
20	นกกวัก (*Amaurornis phoenicurus*)	PR	LC	LC	20			/	R	/	
Order Suliformes											
Family Phalacrocoracidae											
21	นกกาน้ำเล็ก (*Microcarbo niger*)	PR	LC	LC	20			/	R	/	

Table 3.2.1-2 (cons.)

No.	Orders, families, species of wildlife (Scientific name)	Legal status			Abundance (%)	Abundance Level			Seasonal status	source	
		Act	ONEP	IUCN		Abundant	Medium	Rare		Survey	Inquire
Order Ciconiiformes											
Family Ardeidae											
22	นกยางเปีย (*Egretta garzetta*)	PR	LC	LC	60	/			N/R	/	
23	นกยางโทนใหญ่ (*Ardea alba*)	PR	LC	LC	40		/		N/R	/	
24	นกยางควาย (*Bubulcus ibis*)	PR	LC	LC	40		/		N/R	/	
25	นกแขวก (*Nycticorax nycticorax*)	PR	LC	LC	20			/	N/R	/	
26	นกยางกรอกพันธุ์ชวา (*Ardeola speciosa*)	PR	LC	LC	40		/		N/R	/	
Family Ciconiidae											
27	นกปากห่าง (*Anastomus oscitans*)	PR	LC	LC	80	/			N/R	/	
Order Passeriformes											
Family Rhipiduridae											
28	นกอีแพรดแถบอกดำ (*Rhipidura javanica*)	PR	LC	LC	60	/			R	/	
Family Dicruridae											
29	นกแซงแซวหางปลา (*Dicrurus macrocercus*)	PR	LC	LC	40		/		N/R	/	
30	นกแซงแซวหางบ่วงใหญ่ (*Dicrurus paradiseus*)	PR	LC	LC	80	/			R	/	
Family Aegithinidae											
31	นกขมิ้นน้อยธรรมดา (*Aegithina tiphia*)	PR	LC	LC	100	/			R	/	
Family Muscicapidae											
32	นกจับแมลงอกส้มท้องขาว (*Cyornis tickelliae*)	PR	LC	LC	20			/	R	/	

<u>Table 3.2.1-2 (cons.)</u>

No.	Orders, families, species of wildlife (Scientific name)	Legal status			Abundance	Abundance Level			Seasonal	source	
		Act	ONEP	IUCN	(%)	Abundant	Medium	Rare	status	Survey	Inquire
33	นกกางเขนบ้าน (*Copsychus saularis*)	PR	LC	LC	80	/			R	/	
34	นกกางเขนดง (*Copsychus malabaricus*)	PR	LC	LC	40		/		R	/	
Family Sturnidae											
35	นกเอี้ยงสาลิกา (*Acridotheres tristis*)	PR	LC	LC	100	/			R	/	
36	นกเอี้ยงหงอน (*Acridotheres cinereus*)	PR	LC	LC	40		/		R	/	
Family Artamidae											
37	นกแอ่นพง (*Artamus fuscus*)	PR	LC	LC	100	/			R	/	
Family Hirundinidae											
38	นกนางแอ่นบ้าน (*Hirundo rustica*)	PR	LC	LC	20			/	N/R	/	
Family Pycnonotidae											
39	นกปรอดหัวสีเขม่า (*Pycnonotus aurigaster*)	PR	LC	LC	40		/		R	/	
40	นกปรอดสวน (*Pycnonotus blanfordi*)	PR	LC	LC	100	/			R	/	
Family Cisticolidae											
41	นกยอดข้าวหางแพนลาย (*Cisticola juncidis*)	PR	LC	LC	20			/	R	/	
Family Cisticolidae											
42	นกกระจิบหญ้าสีเรียบ (*Prinia inornata*)	PR	LC	LC	60	/			R	/	
43	นกกระจิบธรรมดา (*Orthotomus sutorius*)	PR	LC	LC	100	/			R	/	
Family Alaudidae											
44	นกจาบฝนปีกแดง (*Mirafra erythrocephala*)	PR	LC	LC	40		/		R	/	

Table 3.2.1-2 (cons.)

No.	Orders, families, species of wildlife (Scientific name)	Legal status			Abundance	Abundance Level			Seasonal	source	
		Act	ONEP	IUCN	(%)	Abundant	Medium	Rare	status	Survey	Inquire
Family Dicaeidae											
45	นกสีชมพูสวน (*Dicaeum cruentatum*)	PR	LC	LC	80	/			R	/	
Family Nectariniidae											
46	นกกินปลีคอสีน้ำตาล (*Anthreptes malacensis*)	PR	LC	LC	20			/	R	/	
47	นกกินปลีอกเหลือง (*Nectarinia jugularis*)	PR	LC	LC	100	/			R	/	
Family Passeridae											
48	นกกระจอกใหญ่ (*Passer domesticus*)	PR	-	LC	20			/	R	/	
49	นกกระจอกตาล (*Passer flaveolus*)	PR	LC	LC	20			/	R	/	
50	นกกระจอกบ้าน (*Passer montanus*)	-	LC	LC	80	/			R	/	
Family Ploceidae											
51	นกกระจาบทอง (*Ploceus hypoxanthus*)	PR	NT	NT	20			/	R	/	
Family Estrildidae											
52	นกกระติ๊ดตะโพกขาว (*Lonchura striata*)	PR	LC	LC	20			/	R	/	
53	นกกระติ๊ดขี้หมู (*Lonchura punctulata*)	PR	LC	LC	20			/	R	/	

Note : PR = Protected wildlife on The Wildlife Preservation and Protection Act, B.E. 2562, EN = Endangered species (ใกล้การสูญพันธ์),
VU = Vulnerable species (มีแนวโน้มใกล้สูญพันธุ์) NT = Near Threatened (ใกล้ถูกคุกคาม) LC = Least Concern (มีความเสี่ยงต่ำต่อการสูญพันธุ์),
R = Resident or Presumed resident (นกประจำถิ่นหรือคาดว่าเป็นนกประจำถิ่น)
N = Non breeding visitor (นกอพยพย้ายถิ่นในฤดูหนาว)

- Amphibians were found in 7 species from 6 genera, 4 families, 1 order, which were animals living in areas with moisture or water sources in agricultural areas. Amphibians are animals that sensitive to changes in the area. It also needs clean water sources for reproduction, therefore, animals are rarely found in changing areas such as agricultural areas. All amphibians in this study were found in Anura order, Bufonidae family, such as the toad (*Duttaphrynus melanostictus*), For Microhylidae family, Microhyla ornate was found. For Dicroglossidae family, *Occidozyga lima*, *Occidozyga martensii*, and *Fejervarya limnocharis* were found. For Ranidae family, *Hoplobatrachus rugulosus* and *Hylarana erythraea* were found.

- Reptiles were found in all 6 species from 5 genera, 3 families, 1 order. For reptiles which in the order of King Gila and Snake (Squamata), they lived in areas with diverse ecological conditions, agricultural areas, patches of forests and limestone mountains. Threfore, they could be found in the study area of the project. As for the reptiles in lizards and snakes (Squamata) order in the family of lizards (Agamidae), fenced lizards/red-lizards (*Calotes versicolor*) and northern lio (*Leiolepis belliana*) were found. For Gekkonidea family, *Hemidactylus frenatus*, *Hemidactylus platyurus* and House Gecko (*Gekko gecko*) were found. The Skink Family (Scincidae) include the House skink (*Mabuya multifasciata*) was found.

(B) Abundance Level

From the study, the abundance of animals in the project area were concluded (**Table 3.2.1-3**) and summarized as follows.

- There were 47 species of abundant animals, such as *Cynopterus sphinx, Tadarida teniotis, Callosciurus caniceps,* Macaque, *Microhyla ornate, Fejervarya limnocharis, Hylarana erythraea, Calotes versicolor, Mabuya multifasciata,* Fire Dove, *Vanellus indicus,Anastomus oscitans*, little canary, *Acridotheres tristis, Ashy woodswallow, Pycnonotus blanfordi, Orthotomus sutorius, Cinnyris jugularis,* etc.

- There were 18 species of medium abundance such as toad (*Hoplobatrachus rugulosus*), *Hoplobatrachus rugulosus*, *Leiolepis belliana*, *Gekko gecko*, *Coracias benghalensis*, *Centropus sinensis*, *Caprimulgus macrurus*, *Himantopus himantopus*, *Ardea alba*, Bubulcus ibis *Dicrurus macrocercus, Copsychus malabaricus*, Acridotheres grandis, *Pycnonotus aurigaster*, *Mirafra erythrocephala*, etc.

- There were 19 species of rare animals, such as *Herpestes javanicus*, *Dendrocygna javanica*, *Merops philippinus*, *Eudynamys scolopaceus*, *Actitis* *hypoleucos*, *Metopidius indicus*, *Tachybaptus ruficollis*, Amaurornis phoenicurus, *Microcarbo niger*, *Nycticorax nycticorax*, *Cyornis tickelliae*, *Hirundo rustica*, *Cisticola juncidis*, *Anthreptes malacensis*, *Passer domesticus*, *Ploceus hypoxanthus*, *Lonchura punctulata*, etc.

Table 3.2.1-3

Variety and Abundance of wildlife in study area

Category	Species	Family	Order	Abundance Level		
				rare	medium	abundant
Mammals	18	10	4	1	-	17
Amphibians	7	4	1	-	2	5
Reptiles	6	3	1	-	4	2
Birds	53	34	12	18	12	23
Total	**84**	**51**	**18**	**19**	**18**	**47**

(C) Wildlife status

There were 4 groups of wildlife found in the project area, a total of 84 species were classified according to the Wildlife Preservation and Protection Act, B.E. 2562, as seen in **Table 3.2.1-4.** There were 65 species of protected wildlife, 15 species of mammals, 1 species of reptiles and 49 species of birds. Their status were conservation with the consideration based on the decline in population due to threats by consideration criteria of International Union Conservation of Nature; IUCN (2019). For the study area, there were 82 species of animals registered in the state. In the area, 1 animal found to be vulnerable species (VU) which was *Hipposideros halophyllus*. Two species were near threatened (NT) were *Hipposideros lekaguli*. There were 79 species in the least concern (LC) such as, *Tadarida teniotis*, *Callosciurus canicep*, *Macaca fascicularis*, *Microhyla ornate*, *Fejervarya limnocharis*, *Leiolepis belliana*, *Mabuya multifasciata*, *Streptopelia tranquebarica*, *Aegithina tiphia*, *Artamus fuscus*, *Pycnonotus blanfordi*, *Orthotomus sutorius*, *Nectarinia jugularis*, etc. For the classification done according to the Office of Natural Resources and Environmental Policy and Planning, ONEP, B.E.2560, there were 82 registered animals. There was 1 endangered specie (EN) which was, *Hipposideros halophyllus*. One vulnerable species (VU) was *Hipposideros lekaguli* and 1 species on the near threatened (NT) was *Ploceus hypoxanthus*. There were 79 species on the least concern (LC) group such as *Rhinolophus pusillus*, *Macaca fascicularis*, *Herpestes javanicus*, *Occidozyga lima*, *Hoplobatrachus rugulosus*, *Calotes versicolor*, *Hemidactylus frenatus*, *Streptopelia chinensis*, *Himantopus himantopus*, *Amaurornis phoenicurus*, *Ardeola speciosa, Copsychus saularis, Prinia inornata, Passer montanus, Lonchura striata,* (**Figure 3.2.1-3**), etc.

Table 3.2.1-4

Conservation and legal status of wildlife in study area

Category	Conservation status (IUCN)				Wildlife status of the Wildlife Preservation and Protection Act, B.E. 2562 (species)
	EN	VU	NT	LC	
Mammals	-	1	1	16	15
Amphibians	-	-	-	7	-
Reptiles	-	-	-	4	1
Birds	-	-	1	52	49
Total	**-**	**1**	**2**	**79**	**65**

Note : EN = Endangered species (ใกล้การสูญพันธ์)
VU = Vulnerable species (มีแนวโน้มใกล้สูญพันธุ์)
NT = Near Threatened (ใกล้ถูกคุกคาม)
LC = Least Concern (มีความเสี่ยงต่ำต่อการสูญพันธุ์)

ค้างคาวหน้ายักษ์เล็กจมูกปุ่ม
(*Hipposideros halophyllus*)

กระรอกปลายหางดำ
(*Callosciurus caniceps*)

ลิงแสม
(*Macaca fascicularis*)

พังพอนเล็ก
(*Herpestes javanicus*)

กบหนอง
(*Fejervarya limnocharis*)

แย้เหนือ
(*Leiolepis belliana*)

Figure 3.2.1-3 Examples of wildlife found in study area

		
จิ้งเหลนบ้าน (*Mabuya multifasciata*)	นกเขาไฟ (*Streptopelia tranquebarica*)	เป็ดแดง (*Dendrocygna javanica*)
		
นกเขาชวา (*Geopelia striata*)	นกจาบคาหัวเขียว (*Merops philippinus*)	นกพริก (*Metopidius indicus*)
		
นกเขาใหญ่ (*Streptopelia chinensis*)	นกตีนเทียน (*Himantopus himantopus*)	นกกระแตแต้แว้ด (*Vanellus indicus*)
		
นกอีแพรดแถบอกดำ (*Rhipidura javanica*)	นกยางควาย (*Bubulcus ibis*)	นกแซงแซวหางปลา (*Dicrurus macrocercus*)

<u>Figure 3.2.1-3</u> (cons.)

		
นกยางกรอกพันธุ์ชวา (*Ardeola speciosa*)	นกขมิ้นน้อยธรรมดา (*Aegithina tiphia*)	นกปากห่าง (*Anastomus oscitans*)
		
นกแอ่นพง (*Artamus fuscus*)	นกปรอดสวน (*Pycnonotus blanfordi*)	นกกระจอกใหญ่ (*Passer domesticus*)
		
นกยอดข้าวหางแพนลาย (*Cisticola juncidis*)	นกกระจอกบ้าน (*Passer montanus*)	นกจาบฝนปีกแดง (*Mirafra erythrocephala*)
		
นกกระติ๊ดตะโพกขาว (*Lonchura striata*)	นกกินปลีคอสีน้ำตาล (*Anthreptes malacensis*)	นกกระติ๊ดขี้หมู (*Lonchura punctulata*)

Figure 3.2.1-3 (cons.)

3.2.2 Biological resources in water

The project collected water ecology samples in the Mae Klong River due to raw water being pumped for the consumption by collecting samples near the pumping and draining points of the project in both the dry season, on 18 February B.E.2562 and the rainy season on 18 July B.E.2562. Measurement parameters were consisting of phytoplankton, zooplankton, benthos, aquatic and aquatic plants. There were 3 stations for the measurement and sampling (**Figure 3.2.2-1**) as follows.

Details on analysis results as seen in **Table 3.2.2-1** to **Table 3.2.2-5** which could be summarized as belows.

(1) Phytoplankton

1) At Wat Bang Li (BW1)

Phytoplankton samples were collected on 18 February B.E.2562. There were 16 species of phytoplankton in Division Cyanophyta, 40 species in Division Chlorophyta and 22 species in Chromophyta, a total of 78 species with a volume of 7,315,000 units/m^3. The most common phytoplankton was Pefidinium sp. For a phytoplankton diversity index , it was 3.7089 with a phytoplankton consistency index of 0.2347.

The phytoplankton samples were collected on 18 July B.E. 2562. There were 12 species of phytoplankton in Division Cyanophyta, 32 species in Division Chlorophyta, and 29 species in Chromophyta, a total of 73 species, with 21,063,000 units/m^3. The most common phytoplankton was *Oscillatoria sp.* For a phytoplankton diversity index, it was 3.1304. For a phytoplankton consistency index, it was 0.7296.

2) At Wat Khok Mo (BW2)

The phytoplankton samples were conducted on 18 February B.E. 2562. There were 10 species of Division Cyanophyta, 39 species of Division Chlorophyta and 31 species of Division Chromophyta, a total of 80 species with a volume of 16,281,000 units/m^3. The most common phytoplankton was *Oscillatoria* sp. For a phytoplankton diversity index, it was 3.5831. For a phytoplankton consistency index, it was 0.2158.

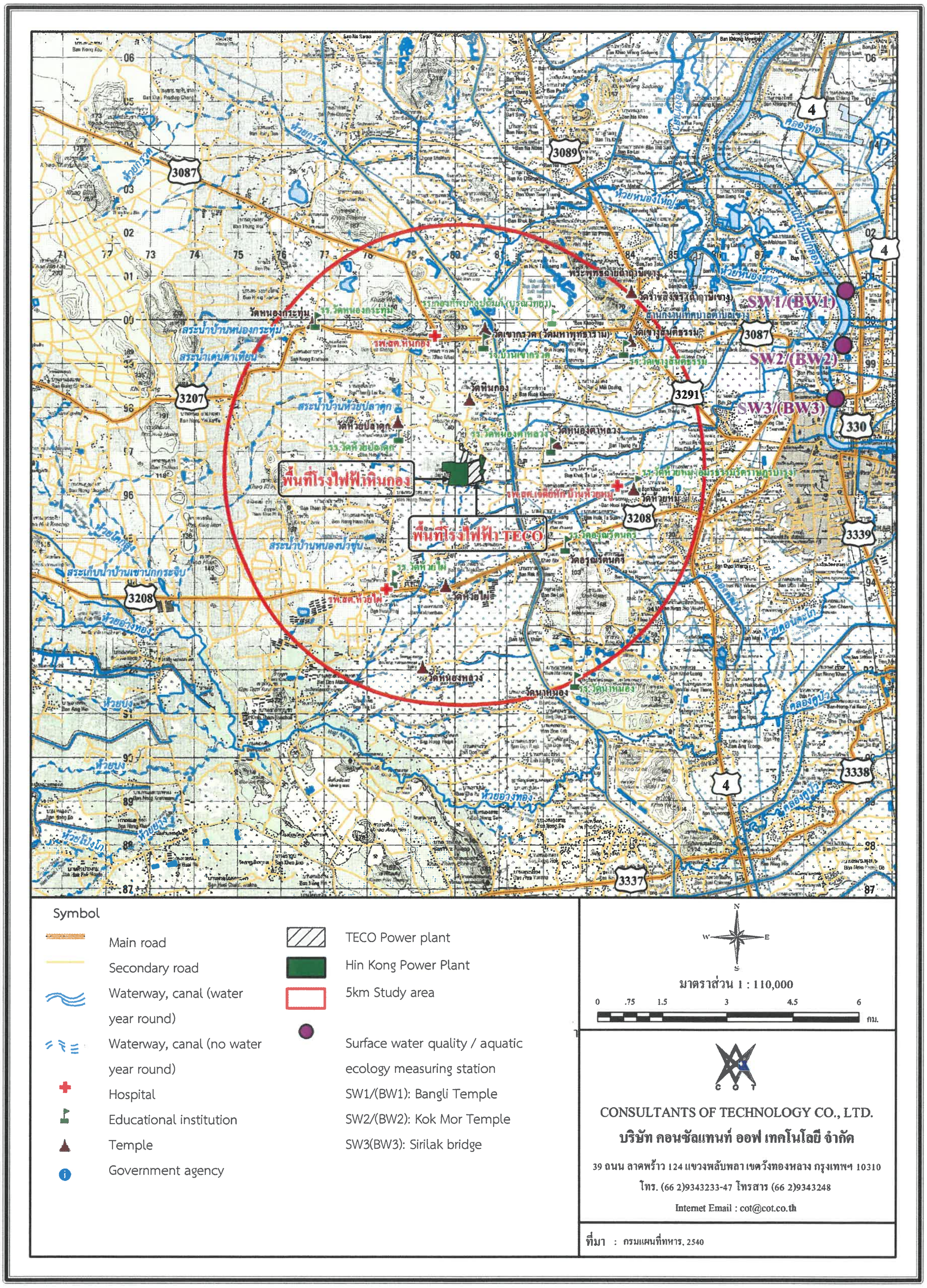


Figure 3.2.2-1 Stations for the measurement and sampling water ecology samples

The phytoplankton samples were conducted on 18 July B.E. 2562. There were 8 species of Division Cyanophyta, 34 species of Division Chlorophyta and 17 species of Division Chromophyta, a total of 59 species with a volume of 18,857,000 units/m^3. The most common phytoplankton was *Oscillatoria* sp. For a phytoplankton diversity index, it was 3.3001. For a phytoplankton consistency index, it was 0.8093.

3) At Sirilak Bridge (BW3)

The phytoplankton samples were collected on 18 February B.E. 2562. There were 9 species of Division Cyanophyta, 30 species of Division Chlorophyta, 33 species of Division Chromophyta, a total of 72 species with a volume of 11,799,000 units/m^3. The most common phytoplankton was *Peridinium* sp. For a phytoplankton diversity index, it was 3.3692. For a phytoplankton consistency index, it was 0.2069.

The phytoplankton samples were collected on 18 July B.E. 2562. There were 7 species of Division Cyanophyta, 27 species of Division Chlorophyta and 16 species of Division Chromophyta, a total of 50 with a volume of 21,573,000 units/m^3. The most common phytoplankton was *Synedra ulna*. For a phytoplankton diversity index, it was 3.1036. For a phytoplankton consistency index, it was 0.7933.

(2) Zooplankton

1) At Wat Bang Li (BW1)

The zooplankton samples were collected on 18 February, B.E. 2562. There were 2 species of Phylum Protozoa and 2 species of Phylum Rotifera for totally 4 species with a volume of 54,000 units/m^3. The most common zooplankton was *Polyarthra vulgaris*. For a phytoplankton diversity index, it was 1.2851. For a phytoplankton consistency index, it was 0.1179.

The zooplankton samples were collected on 18 July B.E. 2562. There were 2 species of Phylum Protozoa and on species of Phylum Rotifera for totally 3 species with the volume of 8,000 units/m^3. The most common zooplankton were *Difflugia acuminate* and *Trichocerca pusilla.* For a phytoplankton diversity index, it was 1.7329. For a phytoplankton consistency index, it was 0.9671.

2) At Wat Khok Mo (BW2)

The zooplankton samples were collected on 18 February, B.E. 2562. There were 3 specide of Phylum Protozoa and pne specie of Phylum Rotifera fo totally species with the volume of 121,000 units/m^3. The most common zooplankton was

Arcella sp. For a phytoplankton diversity index, it was 0.9487. For a phytoplankton consistency index, it was 0.0811.

The zooplankton samples were collected on 18 July, B.E.2562. There were 2 species of Phylum Protozoa and 3 species of Phylum Rotifer, for totally 5 species, with the volume of 65,000 units/m^3. The most common zooplankton were *Difflugia urceolata* and *Trichocerca pusilla*. For a phytoplankton diversity index, it was 1.5403. For a phytoplankton consistency index, it was 0.9570.

3) At Sirilak Bridge (BW3)

The zooplankton samples were collected on 18 February, B.E.2562 There were 3 species of Phylum Protozoa and 3 species of Phylum Rotifera for totally 6 species, with the volume of 63,000 units/m^3. The most common zooplankton was *Arcella vulgaris*. For a phytoplankton diversity index, it was 1.7479. For a phytoplankton consistency index, it was 0.1582.

The zooplankton samples was collected on 18 July, B.E. 2562. There were 2 species of Phylum Protozoa and 3 species of Phylum Rotifera and one specie of Phylum Arthropoda for toally 6 species, with the volume of 121,000 units/m^3. The most common zooplankton was *Arcella vulgaris.* For a phytoplankton diversity index, it was 1.7202. For a phytoplankton consistency index, it was 0.9601.

(3) Benthos

1) At Wat Bang Li (BW1)

Benthos samples were collected on 18 February, B.E.2562. There were 2 kinds of benthos which were, red worms and amphipods. The volume of bethos were 312 /sq.m. A phytoplankton diversity index was 0.6648.

Benthos samples were collected on 18 July, B.E. 2562. There were 4 kinds of benthos which were red worms, larvae of white-robed ascetic, amphipods and gastropods. The volume of bethos were 2,180 /sq.m. A phytoplankton diversity index was 0.3768.

2) At Wat Khok Mo (BW2)

Benthos samples were collected on 18 February, B.E.2562. There were 2 kinds of benthos which were red worms and amphipods. The volume of bethos were 386 /sq.m. A phytoplankton diversity index was 0.6457.

Bethos samples were collected on 18 July, B.E. 2562. There were 2 kind of benthos which were red worms and amphipods. The volume of bethos were 120/sq.m. A phytoplankton diversity index was 0.6932.

3) At Sirilak Bridge (BW3)

Bethos samples were collected on 18 February, B.E.2562. There were 4 kind of benthos which were freshwater earthworms, red worms, amphipods and clams. The volume of bethos were 165/sq.m. A phytoplankton diversity index was 1.1622.

Bethos samples were collected on 18 July, B.E.2562. There were 3 kinds of sepecies which were freshwater earthworms, red worms and amphibians. The volume of bethos were 357 /sq.m. A phytoplankton diversity index was 0.7933.

(4) Aquatic animal

1) At Wat Bang Li (BW1)

Aquatic animals were collected on 18 February, B.E.2562. There were 5 species of fish, totally 8 fish, consisting of nile tilapia (1 fish), Thai silver barb (1 fish), Tinfoil barb (2 fish), Hampala barb (2 fish) and Siamese glassfish (1 fish). The diversity index was 1.5596.

Aquatic animals were collected on 18 July, B.E.2562. There were 3 species of fish, totally 6 fish, consisting of, tinfoil barb (2 fish), Indian river barb (1 fish) and Siamese glassfish (3 fish). The diversity index was 1.0114.

2) At Wat Khok Mo (BW2)

Aquatic animals were collected on 18 February, B.E.2562. There were 5 species of fish, totally 5 fish, consisting of nile tilapia (1 fish), thai silver barb (1 fish), Tinfoil barb (2 fish), Hampala barb (2 fish) and *Hemibagrus filamentus* (1 fish). The diversity index was 1.6094

Aquatic animals were collected on 18 July B.E. 2562 There were 6 species of fish, totally 11 fish, consisting of Thai silver barb (1 fish), Tinfoil barb (2 fish), Indian river barb (2 fish), Siamese glassfish (1 fish) and Silver biddy (3 fish). The diversity index was 1.7202.

3) At Sirilak Bridge (BW3)

Aquatic animals were collected on 18 February, B.E.2562. There were 6 species of fish, totally 11 fish, consisting of *Nile tilapia* (1 fish), Thai silver barb (2 fish), *Hampala barb* (4 fish), *Whipfin mojarra* (1 fish) and *Hemibagrus filamentus* (2 fish). The diversity index was 1.6417.

Aquatic animals were collected on 18 July B.E. 2562 There were 5 species of fish, totally 5 fish, consisting of Thai silver barb (1 fish), Tinfoil barb (2 fish), Indian river barb (1 fish), Silver biddy (1 fish) and *Hemibagrus filamentus* (2 fish). The diversity index was 1.5498.

(5) Aquatic plants

1) At Wat Bang Li (BW1), total 9 of aquatic plants were found which were, morning glory, water hyacinth, Bon, Spreading Dayflower, Bulrus, *Ludwigia hyssopifoliareed*, Pong and Polygonum tomentosum Willd.

2) At Wat Khok Mo (BW2), total 8 of aquatic plants were found which were morning glory, water hyacinth, Bon, Creeping Daisy, Merremia bambusetorum, Kerr, Bulrusreed and Pong.

3) At Sirilak Bridge (BW3) total 6 of aquatic plants were found which were morning glory, water hyacinth, Bon, Bulrusreed and Pong.

Table 3.2.2-1
Analysis of phytoplankton at Mae Klong River

Phytoplankton	At Wat Bang Li (BW1)				Wat Khok Mo (BW2)				Sirilak Bridge (BW3)			
	1/2562		2/2562		1/2562		2/2562		1/2562		2/2562	
	species	units/m^3	species	units/m^3	species	units/m^3	species	units/m^3	species	units/m^3	species	units/m^3
Division Cyanophyta												
Class Cyanophyceae	16	1,703,000	12	6,268,000	10	4,148,000	8	4,223,000	9	3,132,000	7	5,146,000
Division Chlorophyta												
Class Chlorophyceae	33	2,396,000	27	6,558,000	26	3,985,000	31	8,590,000	22	1,953,000	26	7,349,000
Class Euglenophyceae	7	403,000	5	149,000	13	1,142,000	3	148,000	8	522,000	1	66,000
Division Chromophyta												
Class Bacillariophyceae	20	1,581,000	23	4,395,000	29	4,875,000	13	1,608,000	30	4,023,000	14	6,461,000
Class Chrysophyceae			2	30,000								
Class Dictyochophyceae									1	9,000		
Class Dinophyceae	2	1,232,000	4	3,663,000	2	2,131,000	4	4,288,000	2	2,160,000	2	2,551,000
species of Phytoplankton	**78**		**73**		**80**		**59**		**72**		**50**	
Volume of Phytoplankton	**7,315,000**		**21,063,000**		**16,281,000**		**18,857,000**		**11,799,000**		**21,573,000**	
The diversity index	**3.7089**		**3.1304**		**3.5831**		**3.3001**		**3.3692**		**3.1036**	
The Consistency index	**0.2347**		**0.7296**		**0.2158**		**0.8093**		**0.2069**		**0.7933**	

Source : Analysis by ALS Laboratory Group (Thailand) Co.,Ltd.

Note : 1st/2562 (dry season) 18 February B.E.2562 2nd/2562 (rainy season) 18 July B.E.2562

Table 3.2.2-2

Analysis of zooplankton at Mae Klong River

Zooplankton	At Wat Bang Li (BW1)				Wat Khok Mo (BW2)				Sirilak Bridge (BW3)			
	1/2562		2/2562		1/2562		2/2562		1/2562		2/2562	
	species	units/m^3	species	units/m^3	species	units/m^3	species	units/m^3	species	units/m^3	species	units/m^3
Phylum Protozoa												
Class Sarcodina	2	16,000	2	30,000	3	113,000	1	19,000	3	36,000	2	44,000
Class Ciliata							1	9,000				
Phylum Rotifera												
Class Monogononta	2	15,000	1	20,000	1	8,000	2	28,000	3	27,000	3	66,000
Class Digononta							1	9,000			1	22,000
Phylum Arthropoda												
Class Crustacea			3	30,000							1	11,000
species of zooplankton	4		6		4		5		6		6	
Volume of zooplankton	54,000		8,000		121,000		65,000		63,000		121,000	
The diversity index	1.2851		1.7329		0.9487		1.5403		1.7479		1.7202	
The Consistency index	0.1179		0.9671		0.0811		0.9570		0.1582		0.9601	

Source : Analysis by ALS Laboratory Group (Thailand) Co.,Ltd.

Note : 1st/2562 (dry season) 18 February B.E.2562 2nd/2562 (rainy season) 18 July B.E.2562

Table 3.2.2-3

Analysis of Benthos at Mae Klong River

Benthos	At Wat Bang Li (BW1)				Wat Khok Mo (BW2)				Sirilak Bridge (BW3)			
	1/2562		2/2562		1/2562		2/2562		1/2562		2/2562	
	species	units/m^3	species	units/m^3	species	units/m^3	species	units/m^3	species	units/m^3	species	units/m^3
Phylum Annelida												
Class Clitellata												
Lumbriculus sp. (ไส้เดือนน้ำจืด)	-	-	-	-	-	-	-	-	1	60	1	15
Phylum Arthropoda												
Class Insecta												
Chironomus sp. (หนอนแดง)	1	193	1	60	1	252	1	60	1	75	1	223
Choroterpes sp. (ตัวอ่อนแมลงชีปะขาว)	-	-	1	119	-	-	-	-	-	-	-	-
Class Malacostraca												
Gammarus sp. (แอมฟิพอด)	1	119	1	1,986	1	134	1	60	1	15	1	119
Phylum Mollusca												
Class Bivalvia												
Hyriopsis desowitzi (หอยกาบ)	-	-	-	-	-	-	-	-	1	15	-	-
Rivomarginella sp. (หอยฝาเดียวชนิดหนึ่ง)	-	-	1	15	-	-	-	-	-	-	-	-
species of benthos	**2**		**4**		**2**		**2**		**4**		**3**	
Volume of benthos	**312**		**2,180**		**386**		**120**		**165**		**357**	
The diversity index	**0.6648**		**0.3768**		**0.6457**		**0.6932**		**1.1622**		**0.7933**	

Source : Analysis by ALS Laboratory Group (Thailand) Co.,Ltd.

Note : 1st/2562 (dry season) 18 February B.E.2562 2nd/2562 (rainy season) 18 July B.E.2562

Table 3.2.2-4

Analysis of aquatic animal at Mae Klong River

Aaquatic animal	At Wat Bang Li (BW1)		Wat Khok Mo (BW2)		Sirilak Bridge (BW3)		Size range (cm.)		Total weight	
	1/2562	2/2562	1/2562	2/2562	1/2562	2/2562	1/2562	2/2562	1/2562	2/2562
	fish	fish	fish	fish	fish	fish				
Order Cichliformes										
Family Cichlidae										
Oreochromis niloticus (ปลานิล)	1	-	1	-	1	-	14.60-26.90	-	462.45	-
Order Cypriniformes										
Family Cyprinidae										
Barbonymus gonionotus (ปลาตะเพียนขาว)	1	-	1	1	2	1	11.20-43.10	17.00-31.10	1,445.55	557.94
Barbonymus schwanenfeldii (ปลากระแห)	2	2	1	2	1	2	9.80-15.00	7.40-10.20	174.21	41.63
Hampala macrolepidota (ปลากระสูบขีด)	2	-	1	-	4	-	12.00-15.50	-	202.03	-
Mystacoleucus marginatus (หนามหลัง)	-	1	-	2	-	1	-	7.50-11.50	-	43.57
Order Perciformes										
Family Ambassidae										
Parambassis siamensis (ปลาแป้นแก้ว)	2	3	-	1	-	-	4.50-4.90	4.40-4.80	3.24	8.23
Gerres oblongus (ปลาดอกหมาก)	-	-	-	3	-	1	-	4.49-6.00	-	9.94
Family Ambassidae										
Gerres filamentosus (ปลาดอกหมากกระโดง)	-	-	-	-	1	-	11.1	-	25.35	-

Table 3.2.2-4 (cons.)

Aaquatic animal	At Wat Bang Li (BW1)		Wat Khok Mo (BW2)		Sirilak Bridge (BW3)		Size range (cm.)		Total weight	
	1/2562	2/2562	1/2562	2/2562	1/2562	2/2562	1/2562	2/2562	1/2562	2/2562
	fish	fish	fish	fish	fish	fish				
Order Siluriformes										
Family Bagridae										
Hemibagrus spilopterus (ปลากดเหลือง)	-	-	-	2	2	2	23.00-26.00	17.90-24.10	345.86	401
species of aquatic animal	**5**	**3**	**5**	**6**	**6**	**5**	**4.50-43.10**	**4.40-31.10**	**2,658.69**	**1,062.37**
Volume of aquatic animal	**8**	**6**	**5**	**11**	**11**	**7**				
The diversity index	**1.5596**	**1.0114**	**1.6094**	**1.7202**	**1.6417**	**1.5498**				

Source : Analysis by ALS Laboratory Group (Thailand) Co.,Ltd.

Note : 1st/2562 (dry season) 18 February B.E.2562 2nd/2562 (rainy season) 18 July B.E.2562

Figure 3.2.2-5

Analysis of aquatic plants at Mae Klong River

Family	Scientific name	Thai name	Distribution of aquatic plants					
			At Wat Bang Li (BW1)		Wat Khok Mo (BW2)		Sirilak Bridge (BW3)	
			1/2562	2/2562	1/2562	2/2562	1/2562	2/2562
Floating plants								
Convolvulaceae	*Ipomoea aquatica*	ผักบุ้ง	+	-	+	+	+	+
Potamogetonaceae	*Eichhornia crassipes*	ผักตบชวา	+++	++	++	++	++	+++
Marginal plants								
Araceae	*Colocasia esculenta*	บอน	++	+	+	-	+	-
Commelinaceae	*Commelina diffusa*	ผักปลาบใบแคบ	+	+	-	-	-	-
Compositae	*Wedelia trilobata*	กระดุมทองเลื้อย	-	-	-	++	-	-
Convolvulaceae	*Merremia vitifolia*	จิ้งจ้อเหลือง	-	-	-	+	-	-
Cyperaceae	*Scirpus grossus*	กกสามเหลี่ยม	++	+	+	+	-	++
Onagraceae	*Ludwigia hyssopiolia*	เทียนนา	+	-	-	-	-	-
Poaceae	*Coix aquatica*	อ้อน้ำ	+	+	+	++	+	+
	Erianthus arundinaceus	พง	++	++	++	+++	+	++
Polygonaceae	*Polygonum tomentosum*	เอื้องเผ็ดม้า	+	-	-	-	-	-

Source : Analysis by ALS Laboratory Group (Thailand) Co.,Ltd.

Note : 1st/2562 (dry season) 18 February B.E.2562 2nd/2562 (rainy season) 18 July B.E.2562\

- Not found + less ++ moderate +++ very

3.3 Value of human use

3.3.1 Land utilization

(1) Comprehensive city plan and land use regulations

The project is located in Hin Kong Subdistrict, Mueang Ratchaburi District, Ratchaburi, under the city plan of Ratchaburi, as seen in **Figure 3.3.1-1.** The project land were a type of community and agriculture. It was stipulating the use of agricultural land or related to agriculture, residence, educational institutions, religious institutions, government institutions, public utilities and facilities, according to the announcement of the Ratchaburi Comprehensive Plan Enforcement, Ratchaburi Integrated Town Plan Announcement (Version 2) issued on 4 December, B.E.2558. Ratchaburi Unified Town Planning Announcement had expire on 29 May, B.E.2560. However, this town planning had specified type or factory type. The factory producing electricity from thermal energy (only operations that do not use coal and nuclear fuel for production) could operated on land, community and agriculture areas. Therefore, the project operation was not against the Ratchaburi Integrated Town Plan Announcement (2nd update) at all.

(2) Land utilization in the study area

The study of land utilization within the 5 km radius of the study area. The consulting company uses geographic information system together with the basic map scale 1: 70,000 of the Department of Land Development (B.E.2561) and the Department of Military Maps (B.E.2540) and from additional field survey data. It was found that land utilization within the study area could be divided into 6 types, mainly agricultural areas (**Figure 3.3.1-2**) with the following details.

1) Agricultural area

Land utilization for agriculture had the highest ratio of land utilization in the study area. It was found that, in every community, most of them were in the area of rice and vegetable farming, with a total area of 53.72 sq.km., or 56.39% of the total study area.

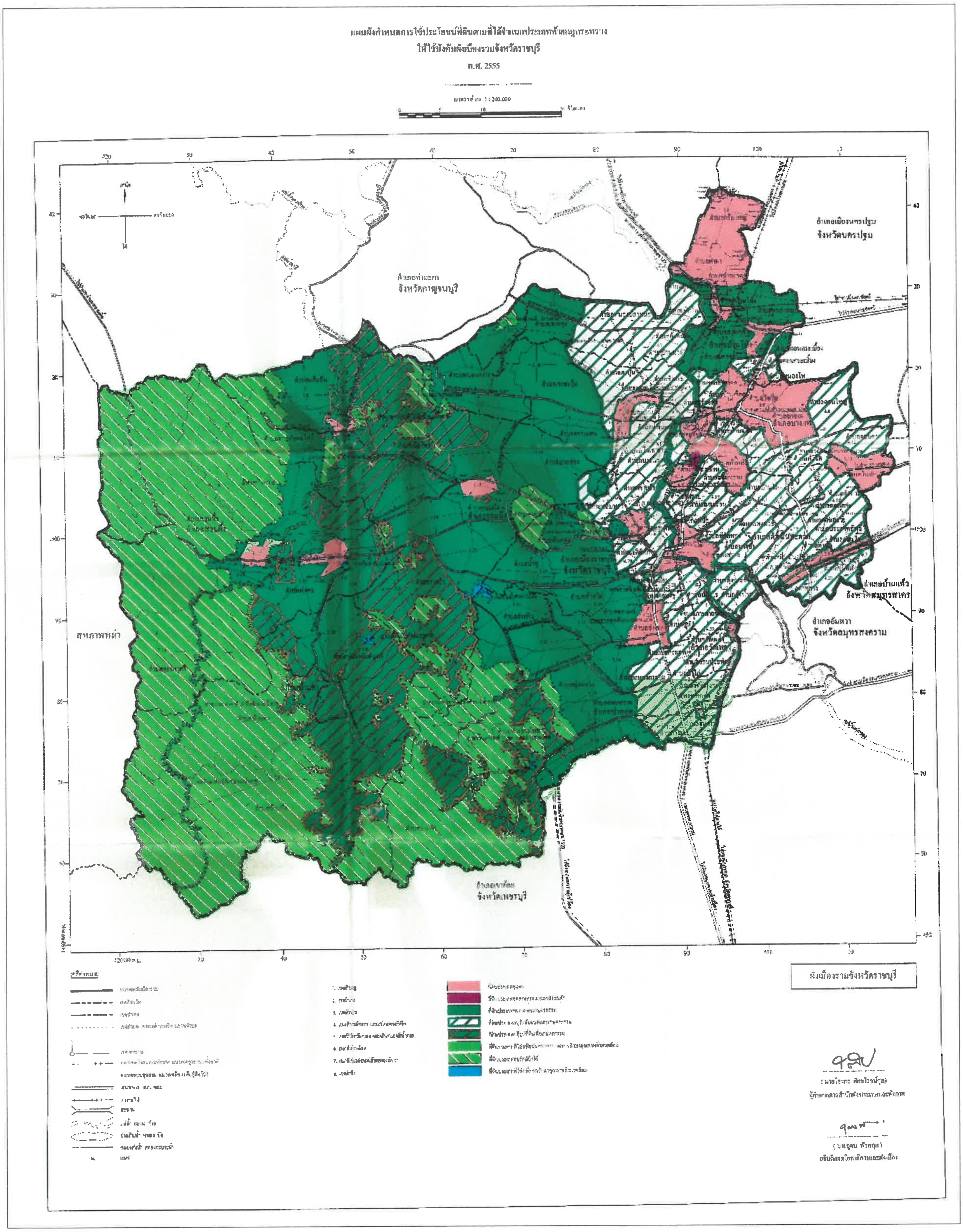


Figure 3.3.1-1 Project location according to the announcement of the Ratchaburi Comprehensive Plan Enforcement, Ratchaburi Integrated Town Plan Announcement B.E.. 2555

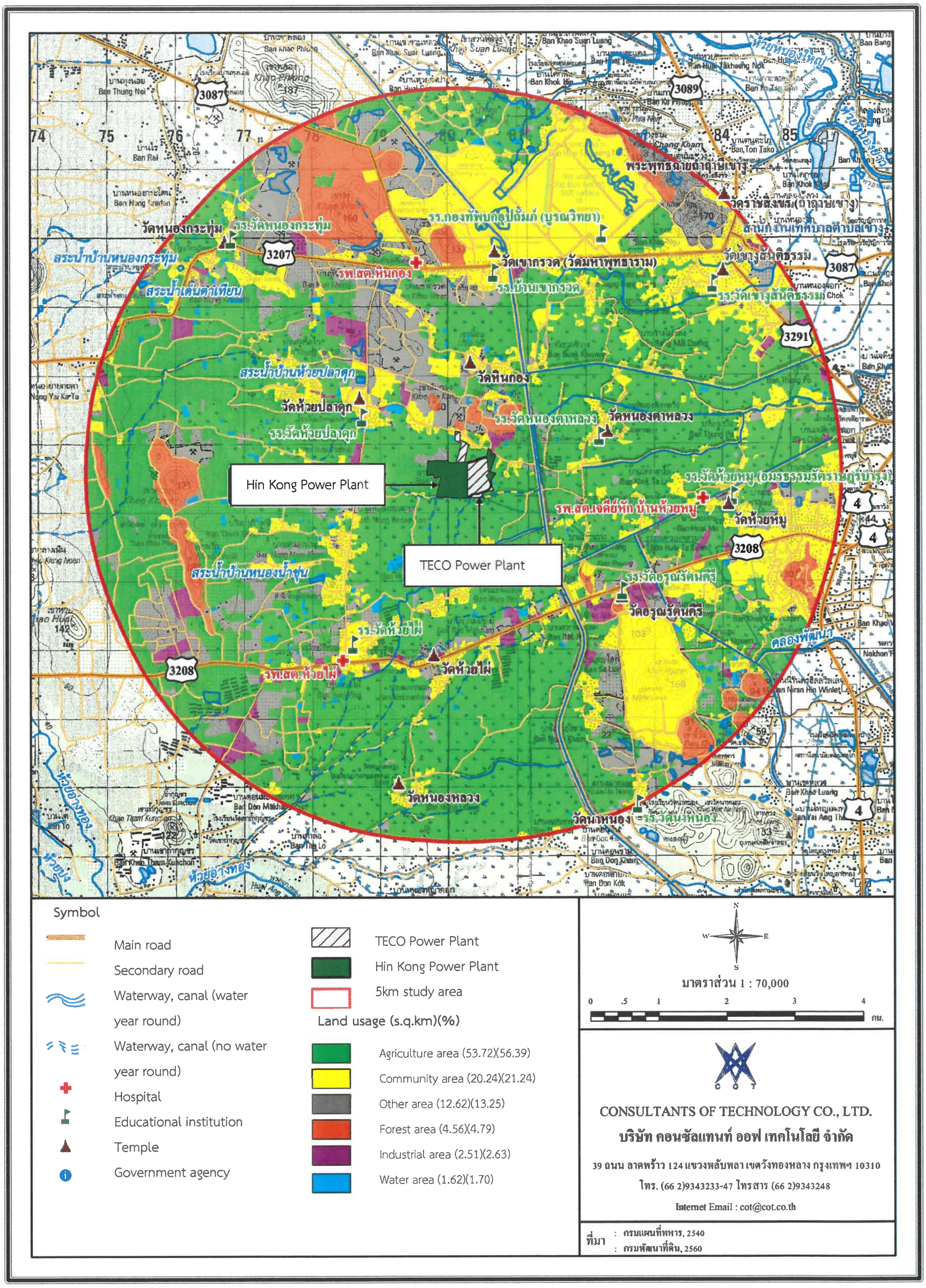


Figure 3.3.1-2 Land utilization in the study area

2) Community areas and buildings

Community and building areas, include government offices, temples and schools in the study area were scattered along the road and the characteristics of the house group. It was also distributed according to land plots under ownership near the arable land. Community and building areas had a total area of 20.24 sq.km., or 21.24% of the total study area.

3) Others

Other areas were unused with a total area of 12.62 sq.km., or 13.25% of the total study area.

4) Forest area

Within the study area in the 5 kilometers radius from the project location, the total forest area was 4.56 sq.km., or 4.79% of the total study area.

5) Industrial area

Within the study area in the 5kilometers radius from the project, with a total industrial area of 2.51 sq.km., or 2.63 % of the total study area.

6) Water area

Within the study area in the 5 kilometers radius from the project, there were water sources scattered in the area with a total water area of 1.62 sq.km, or 1.70% of the total study area.

In this regard, the consulting company added photos showing the current land utilization in the study area. It was based on photos from a drone on 30 July, B.E.2562, as shown in **Figure 3.3.1-3**. Most of the area were agricultural areas. The community closest to the project was the village area, Moo.5, Baan Nong Rak, Hin Kong Subdistrict, Mueang Ratchaburi District. This was on the north side of the project approximately 300 meters from the project.

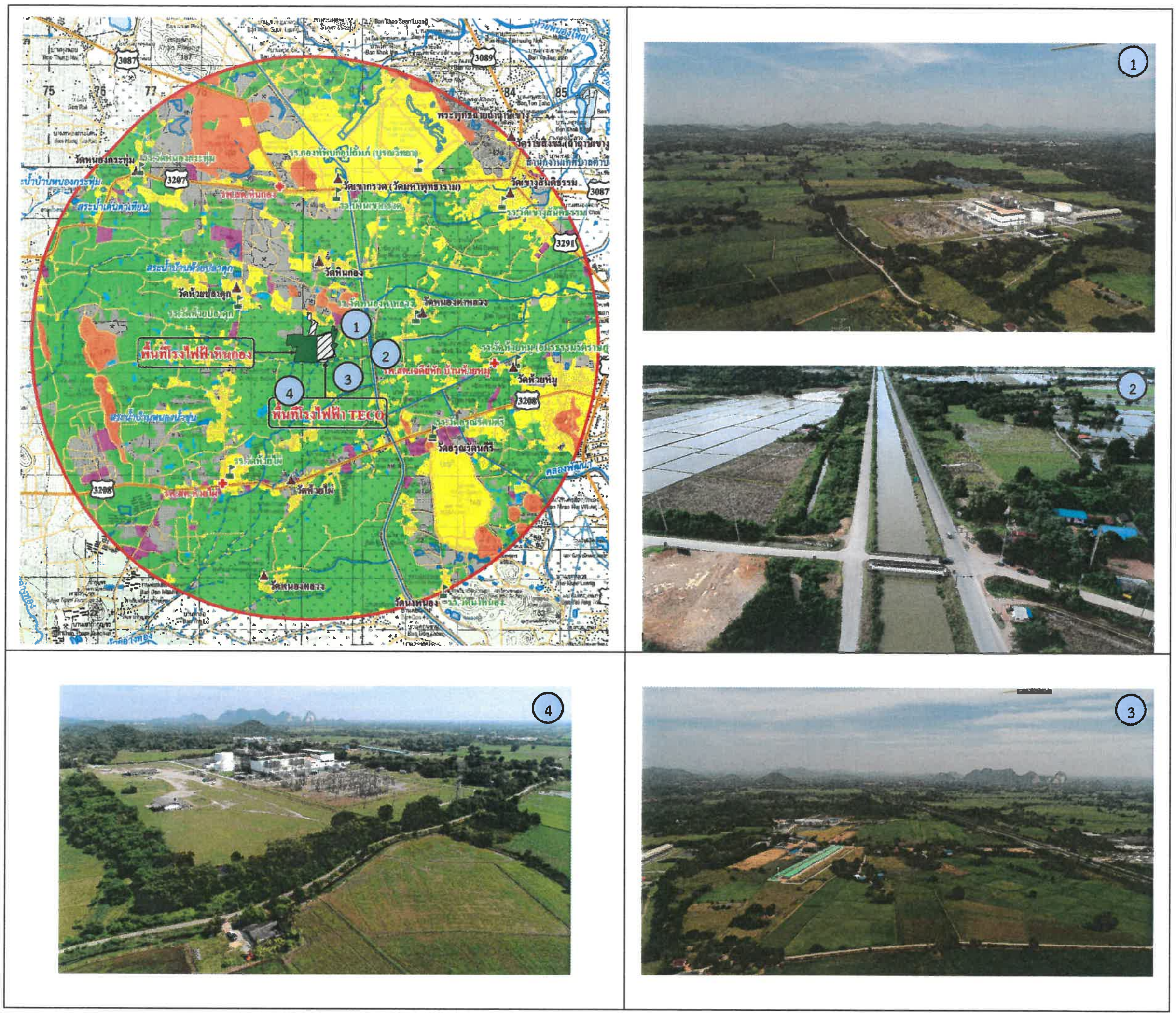


Figure 3.3.1-3 Photos showing the current land utilization in the study area from a drone on 30 July, B.E.2562

3.3.2 Water consumption

(1) Water sources for the consumption

Water for the household consumption of the community in the study area receiving water for the consumption from the Provincial Waterworks Authority, Ratchaburi branch. The natural water source was the Mae Klong River, which was the main river flowing through 3 districts, namely Ban Pong District, Photharam District and Mueang Ratchaburi District. Currently, a total of 23,137 water users. The water capacity is 18,000 m^3/day. The amount of produced water are 1,020,553 m^3/month. Amount of distributed water are 1,017,460 m^3/month. The amount of water disposed are 534,837 m^3/month (Source: Data Center Planning and Information Technology Division Provincial Waterworks Authority, Ratchaburi Branch as of June B.E. 2562).

(2) Groundwater source

There were a total of 1 ,4 2 3 artesian wells in the Ratchaburi area for various businesses consumption, such as agriculture and consumption (Source: Department of Groundwater Resources, as of July B.E. 2562) as follows:

1) 119 groundwater wells for agriculture
2) 1,304 groundwater wells for the consumption

(3) Water sources for irrigation

1) **Irrigation and maintenance project in Ratchaburi,** under the Royal Irrigation Department that was responsible for the delivery of irrigation water for agriculture and consumption, there were 7 agencies, with following details.

- Tha Maka irrigation and maintenance project was responsible for the area of Ban Pong, Photharam, Chom Bueng Districts and Mueang Ratchaburi District. Total water delivery areas (Benefit area) were 160,408 rais.

- Nakhon Pathom irrigation and maintenance project was responsible for Ban Pong District area. Total water delivery area (Benefit area) were 14,400 rais.

- Kamphaengsaen irrigation and maintenance project was responsible for Ban Pong District area. Total water delivery area (Benefit area) were 9,244 rais.

- Nakhon Chum irrigation and maintenance project was responsible for Ban Pong, Photharam, Bang Phae and Damnoen Saduak Districts. Total water delivery area (Benefit area) were 139,860 rais.

- The left side of Ratchaburi irrigation and maintenance project was responsible for Photharam, Damnoen Saduak, Ban Pong, and Mueang Ratchaburi Districts. Total water delivery area (Benefit area) were 75,453 rais.

- The right side of Ratchaburi irrigation and maintenance project was responsible for Wat Phleng, Pak Tho and Mueang Ratchaburi Districts. Total water delivery area (Benefit area) were 101,000 rais.

- Damneon Saduak irrigation and maintenance project was responsible for Damnoen Saduak District. Total water delivery area (Benefit area) were 19,360 rais.

- The study area was in the area of Tha Maka irrigation and maintenance project.

2) There were 5 medium-sized reservoirs, which were;

- Hui Mai Teng Reservior located in Mueang Ratchaburi District. It was the largest reservoir in Ratchabur. The amount of water capcity was 36.00 million m^3 with 17,922 rais of benefit areas.

- Chat Pa Wai Reservior located in Suan Phueng District. It had a capacity to hold water for 2.50 million m^3 with 1,117 households as benefit areas (the water consumption system).

- Huai Tha Khoi Reservoir located in Ban Kha District. It had a capacity to hold water for 23.40 million m^3 with beneficial areas of 3,500 rais.

- Pong Krating Reservoir located in Ban Kha District. It had a capacity to hold water for 0.23 million m^3 with beneficial areas of 420 households (the water consumption system).

- Huai Mahad Reservoir located in Ban Kha District. It had a capacity to hold water for 4.30 million m^3 with beneficial areas of 5,800 rais.

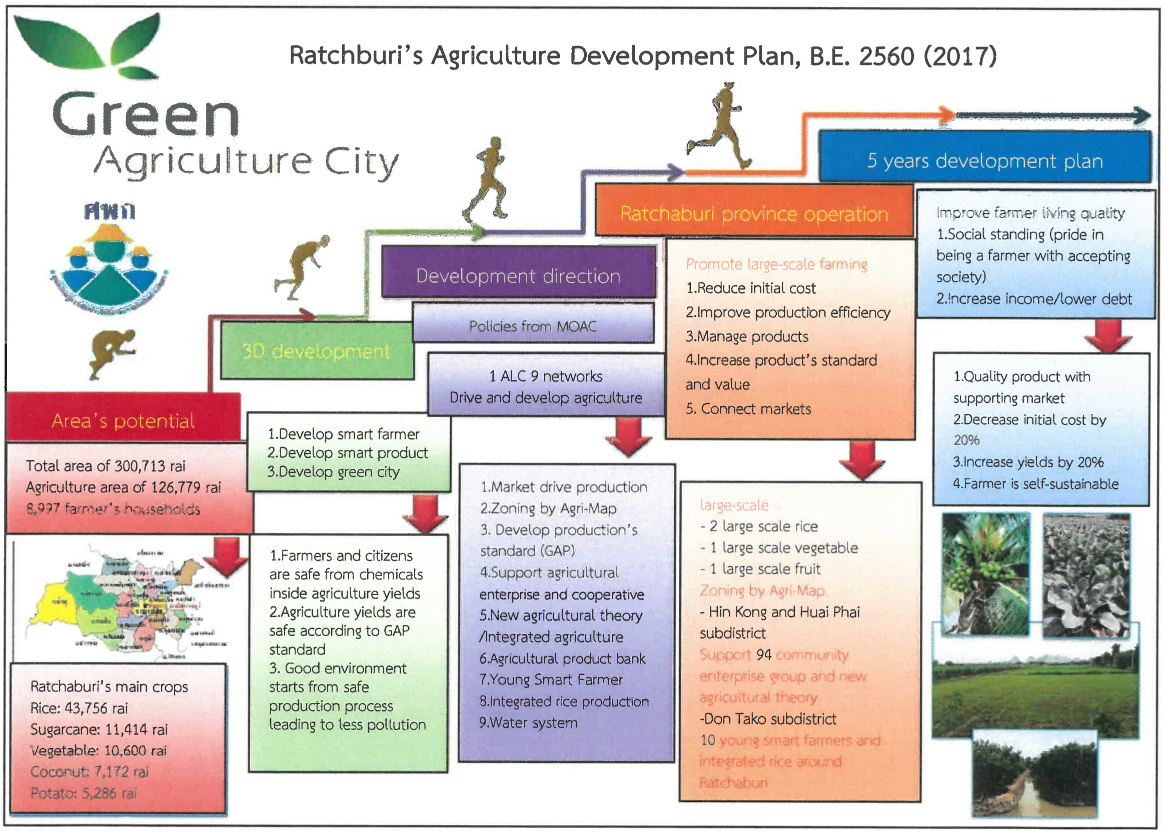
3) There were 64 small reservoirs (59 reserviors were under the supervision of Ratchaburi Irrigation Projects and 5 reserviors were under Regional Water Resources Offices 7). There were 20 irrigation dam and 13 electric pumping stations distributed in the area of Pak Tho, Chom Bueng, Suan Phueng and Ban Kha districts. The total amount of collected were 29.687 million m^3. The total benefit areas were approximately 88,000 rais.

For the summary of water consumption in various activities of Ratchaburi, it was totally 2,302.44 m^3/year as follows.

- For agriculture for 2,172.17 m^3/year
- For livestock for 34.13 m^3/year
- For consumption for 66.33 m^3/year
- For industry for 29.81 m^3/year

3.3.3 Agriculture, livestock and aquaculture

The consulting company collected basic agricultural information of the sub-district in the project study area from the Mueang Ratchaburi Agricultural Extension Office, Department of Agricultural Extension, Ministry of Agriculture and Cooperatives as details were in **Table 3.3.3-1**. It was found that in the study area of 6 sub-districts, there were 3,373 households with a holding area of 103,279 rais. There was a total agricultural area of 48,567 rais which had been classified as peddy fields, farming areas, vegetables, perennial plants, ornamental plants, fishery and livestock. Other areas were 55,230 rais. There were mportant economic crops, such as rice, sugarcane, vegetables, coconut, and cassava. Because rice is an important economic crop of the country, farmers in the study area preferred to grow rice twice a year, during the season and off-season. In addition, the Agricultural Learning Center (ALC) estbalished an agricultural development plan in Mueang Ratchaburi District as shown in **Figure 3.3.3-1**. This plan was to develop the main economic crops and the potential of the area according to the development goals within 5 years.



<u>sourec</u> : Muang ratchaburi agricultural extension office B.E..2562

<u>Figure 3.3.3-1</u> Agricultural development plan in Mueang Ratchaburi District B.E. 2560

Table 3.3.3-1

Basic agricultural information of the sub-district in the project's study area

No	Subdistrict	holding area (rai)	Farmers (households)	agriculture area (rai)														Total of agriculture area (rai)	Other (rai)
				paddy fields		farming areas		vegetables		perennial plants		ornamental plants		fishery		livestock			
				area	households	area	households	area	households	area	households	area	households	area	households	area	households		
1	Ko Plub Pla	11,391	682	5,346	477	245	10	50	8	396	100	14	5	175	41	847	278	7,073	4,318
2	Chedi Hak	22,380	347	6,143	299	-	-	9	5	17	8	3	1	18	1	63	144	6,253	16,127
3	Don Tako	10,212	230	1,800	108	20	1	140	61	42	14	4	3	10	9	83	78	2,099	8,113
4	Don Rae	7,845	565	5,500	320	-	-	1,080	295	325	39	-	-	68	20	39	53	7,012	1,351
5	Huai Phai	23,091	928	6,761	592	2,174	38	1,778	343	1,388	221	-	-	50	28	746	248	12,897	10,194
6	Hin Kong	28,360	621	5,381	355	6,220	255	115	40	269	51	-	-	20	13	1,228	344	13,233	15,127
total	**6 subdistrict**	**103,279**	**3,373**	**30,931**	**2,151**	**8,659**	**304**	**3,172**	**752**	**2,437**	**433**	**21**	**9**	**341**	**112**	**3,006**	**1,145**	**48,567**	**55,230**

Sourec : Muang ratchaburi agricultural extension office B.E..2562

3.3.4 Drainage and flood prevention

(1) Current drainage conditions around the power plant area

From the study of drainage conditions in the area around the current power plant, it has been done by using the river network data in the area, together with the initial inspection of the rainwater drainage canal on 10 July,B.E. 2562 and 26 August B.E.2562. The direction of the flow of the various rivers and irrigation canals in the area were shown in **Figure 3.3.4 –1**. Various rivers around the area the final power plant will finaly flow into the Mae Klong River.

From the investigation of the current drainage of the TECO power plant and the area to be developed into the Hin Kong power plant, it was found that currently water will be drained down to the canal on the north side of the power plant, as shown in **Figure 3.3.2-3.** Water would flew to the drainage canal on the side of the irrigation canal before flowing into the Mae Klong river.

Results of preliminary examination of the drainage capacity of the north side canal showed that, the condition was a concrete paved canal. The width of the canal botton was approximately 1 meter. The depth of the canal was approximately 6 meters. The depth was approximately 2.5 meters, as details shown in **Figure 3.3.4-2**.

In addition, the initial drainage capacity of the drainage canal on the south side was also examined. It was found that the drainage canal on the south side had a concrete pavement condition. The width of the canal bottom was approximately 1.25 meters. The width of the canal was about 4.4 meters. The depth was about 1.8 meters, as detail shown in **Figure 3.3.4-3**.

(2) Investigation of past flood areas of power plants

From the investigation of the flooding in the area of power plants and nearby areas by using the flood area data from the Bureau of Space and Geo-Information Technology Development (GISTDA), starting from GISTDA began collecting satellite image data of flood areas from B.E.2548 -2560, it was found that the power plant area and surrounding area only flooded for 1 year in 13 years as shown in the frequency of flooding of the power plant and nearby areas in **Figure 3.3.4-4.** The year that the flood occurred in the power plant area was B.E.2553. It was a short-term flood due to the heavy rainfall in the area as shown in **Figure 3.3.4-5.**

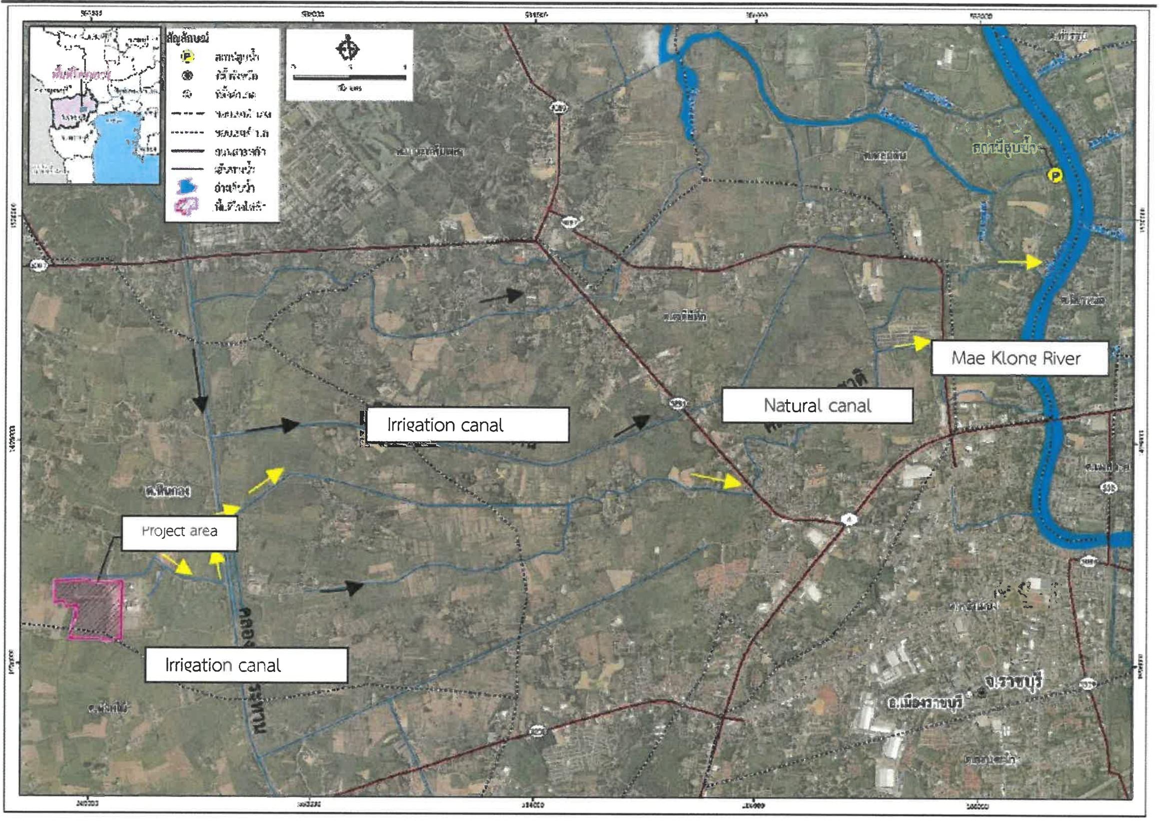


Figure 3.3.4 –1 The direction of the flow of the various rivers and irrigation canals in the area

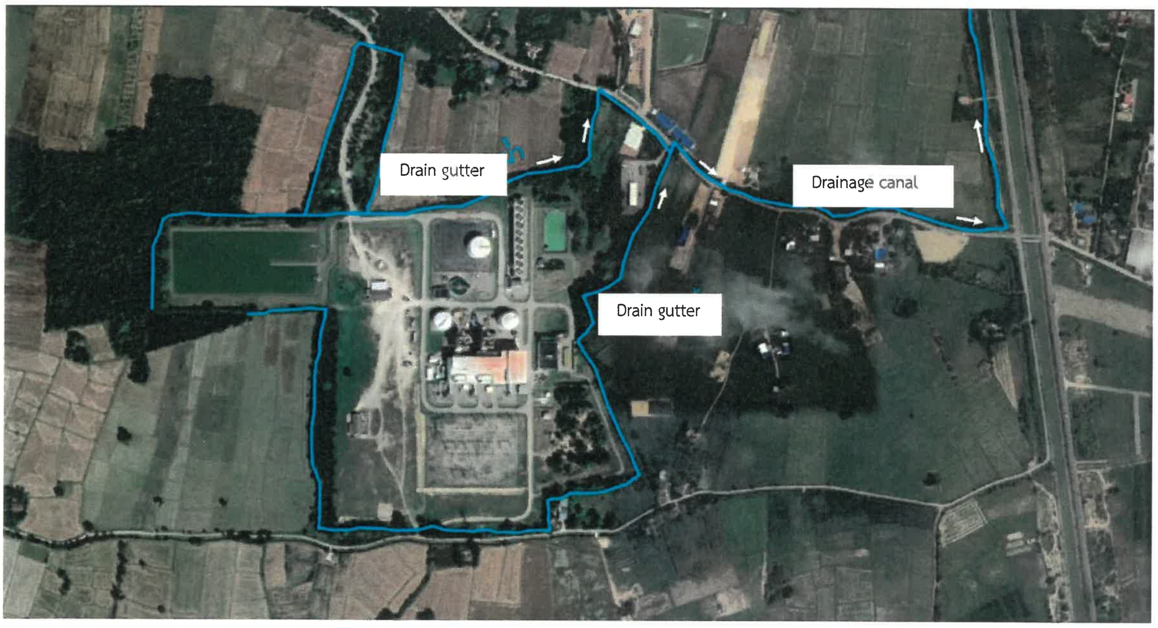


Figure 3.3.4-2 Current drainage of the TECO power plant and the area to be developed into the Hin Kong power plant

Figure 3.3.4-3 The drainage capacity of the north side canal

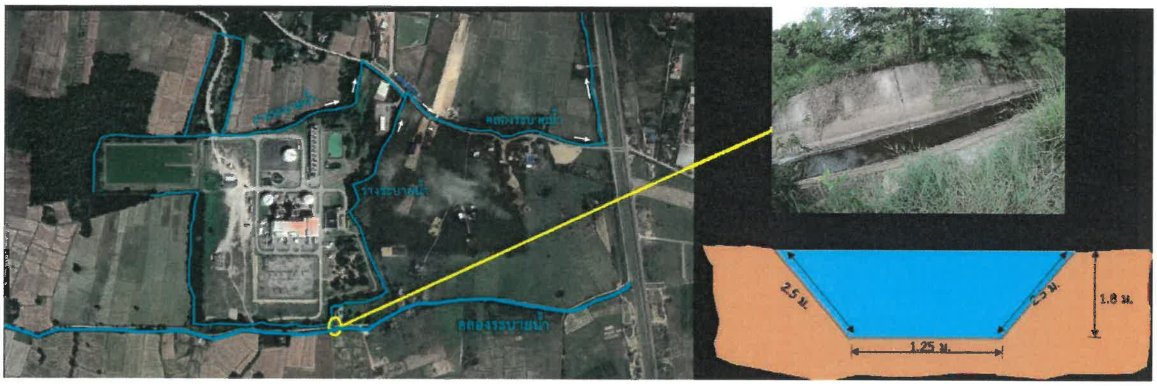
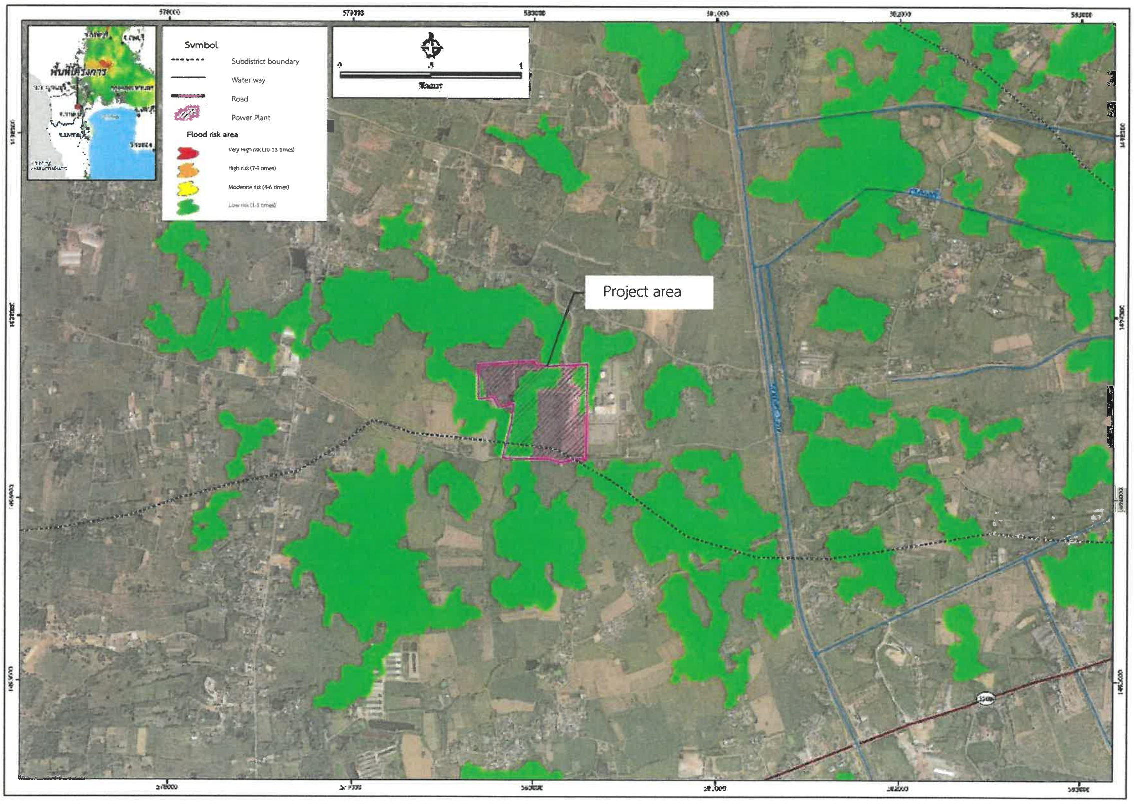


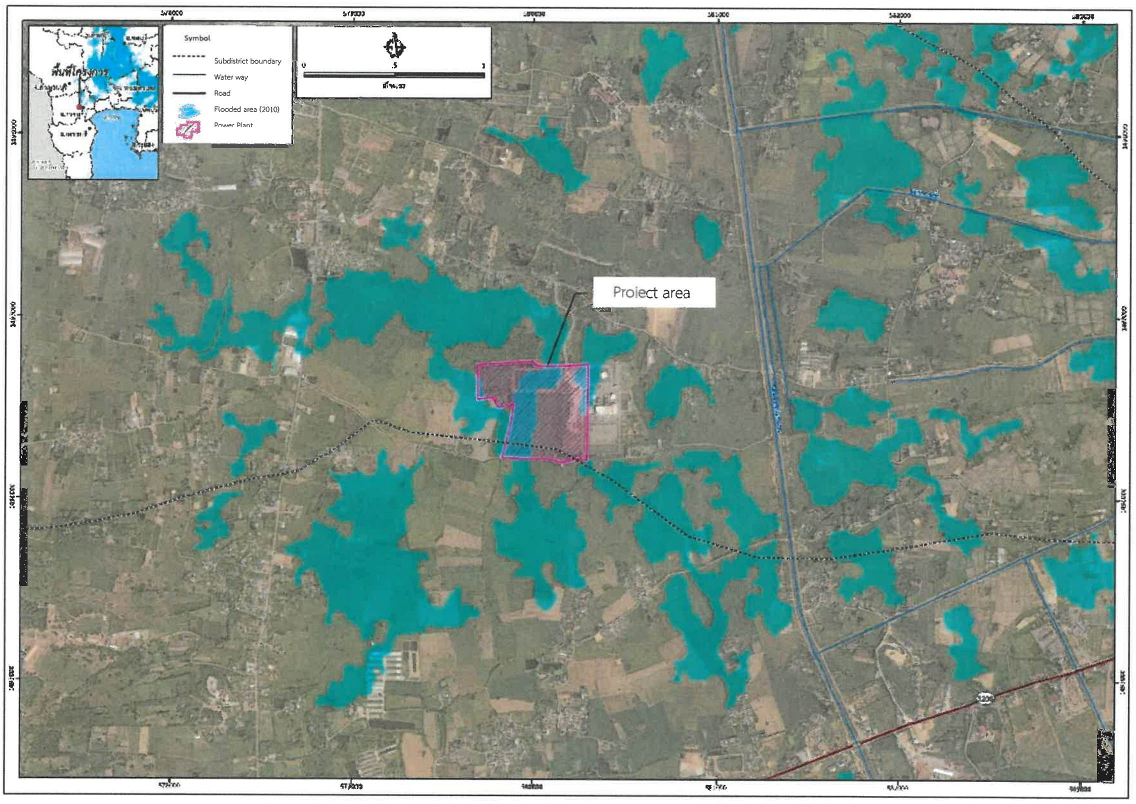
Figure 3.3.4-4 The drainage capacity of the south side canal



Source : Analysis of data from GISTDA during B.E.. 2548 – 2560

Figure 3.3.4-5 The flood frequency of the power plant and nearby areas

According to the data of the flooded areas in the power plant areas and surrounding areas in the past 13 years, it was found that the flood occurred in the power plant area only 1 year, B.E.2553, which had only a small amount of flooding as shown in **Figure 3.3.4-6**. Due to the amount of rain that falls in the area causing water waiting to be discharged from the area. This was not caused by overflowing of the irrigation canals and the nearby drainage canals. In B.E. B.E.2553, there were events that caused heavy rainfall in the area as follows.



Source : Analysis of data from GISTDA

Figure 3.3.4-6 Flooded areas B.E. 2553

Causes of flooding in B.E. 2553, in B.E. 2553 was a year with a lot of rain. The reason was because of the tropical storm "Con Son" moved into upper Vietnam on 17 July,B.E.2553, causing the north, northeast and the upper western regions, the upstream areas of the Mae Klong River Basin, had dense rain throughout the week.

Later on 25 August, B.E.2553, there was a tropical storm "Mindon Lay" weakening to became a depression. It had moved into Laos PDR, causing upper Thailand, in particularly, the north, northeast and upper West regions had heavy rains and floods in many areas.

After that, between 8 - 18 September, B.E.2553, a cloud covered the upper and the middle of Thailand causing in the north, central west, central and northeast regions. There was a continuous heavy rain from August for a long time, resulting in increased flooding in the said area.

During the end of September to the beginning of October, There was a low pressure cell covering the lower central region, lower western region and upper southern region. In addition, southwest monsoon prevails over the central, western and southern regions causing heavy rainfall in the area, resulting in heavy flooding in Kanchanaburi, Ratchaburi and Phetchaburi.

For power plant areas even it located in Ratchaburi. Due to it was on a high ground, therefore, it was not affected by the floods overflowing from the Mae Klong River due to heavy rainfall in the area. Then water was waiting to be discharged from the area when the water levels of various canals and Mae Klong River lower.

3.3.5 Electricity consumption

Ratchaburi has a procurement agency to distributing electric power to people in the residential region, business sector and agriculture expand the area covering all 10 districts, with a total of 255,031 household electrical users and 1,918 households undergoing electricity usage. There are 68 power plants in Ratchaburi, with 7,007 MW capacity as follows:

(1) Provincial Electricity Authority Zone 1 (Southern region), was supervised and be responsible for Ratchaburi, consisting of 9 districts such as Mueang Ratchaburi, Photharam, Damnoen Saduak, Pak Tho, Chom Bueng, Bang Phae, Suan Phueng, Ban Kha, and Wat Phleng districts with the Provincial Electricity Authority consisting of;

1) Ratchaburi Provincial Electricity Authority is the 260th branch that has the power office under the jurisdiction of the Provincial Electricity Authority which are, Pak Tho Branch and Provincial Electricity Authority Sub-branch of Wat Phleng District .There are 71,198 households using electricity and there are 438 households in the process of requesting electricity.

2) Chom Bueng Provincial Electricity Authority is 261st branch with the Electricity Authority under the jurisdiction, which is the Provincial Electricity Authority Suan Phueng Branch. There are 39,046 household electrical users and 1,349 households in the process of requesting electricity.

(2) Provincial Electricity Authority Region 3 (Central Region) in Nakhon Pathom supervised and be responsible for Ratchaburi province, consisting of 1 district, Ban Pong District. There is the 250th branch of Ban Pong Provincial Electricity Authority with offices under the jurisdiction which are, Nong Pla Mor Sub-Branch Provincial Electricity Authority, Krab Yai Sub-Branch Provincial Electricity Authority. There are 56,332 household electrical users and 32 households currently in the process of requesting electricity.

There are 11 electrical power stations of the Provincial Electricity Authority, which are, Ratchaburi Electricity Station 2 (Lan Kai), Ratchaburi Electricity Station 1, Ratchaburi Electricity Station 2, Ratchaburi Electricity Station 3, Chom Bueng Power Station, Photharam Electricity Station, Damnoen Saduak Power Station, Nikhom Ratchaburi Electricity Station (Temporary), Pak Tho Electricity Station, Ban Pong Station 2 and Nong Pla Mor Station (Lan Kai).

When considering electricity usage data classified by type of users done by district of Ratchaburi province in B.E. 2558 by referring to Ratchaburi Provincial Electricity Authority which could be summarized as in **Table 3.3.5-1**. It was found that there were total electricity users of 267,919 with the total electricity consumption of 2,510.63 million kilowatts/hour. It was divided into 529.31 million kilowatts/hour of residence. business and industry consumed 1,951.48 million kilowatts/hour. Government and public buildings consumed 13.54 million kilowatts/hour and others for 16.33 million kilowatts/hour.

Table 3.3.5-1

Electricity usage data classified by type of users done by district of Ratchaburi province in B.E. 2558

District	electricity users	Electricity distribution (Million kilowatt/hour)				
		Residence	business and industry consumed	Government and public buildings consumed	others	Total
Mueang ratchaburi	64,510	138.13	340.92	0.11	10.78	489.92
Chom Bueng	20,668	33.45	89.72	2.76	1.00	126.93
Suan Phueng	17,867	2.26	4.67	0.40	1.05	8.38
Damnoen Saduak	29,883	57.69	47.66	1.83	0.34	107.52
Ban Pong	55,283	153.94	527.00	8.19	-	689.13
Bang Phae	14,479	25.67	9.95	-	0.45	36.07
Photharam	41,012	75.52	785.14	-	2.30	862.96
Pak Tho	24,217	42.65	146.42	0.25	0.41	189.72
Total	**267,919**	**529.31**	**1,951.48**	**13.54**	**16.33**	**2,510.63**

Source : Provincial Electricity Authority Ratchburi, 2558

3.3.6 Solid waste management

(1) Ratchaburi

1) Community solid waste

From the collection of information on community solid waste management in Ratchaburi (monitoring and assessment reports of community wastewater collection and treatment systems and community waste disposal systemson the enhancement of the operational plan for environmental quality management at the provincial level B.E.2561: Regional Environment Office 8 (Ratchaburi), Ministry of Natural Resources and Environment), it was found that Ratchaburi had a total of 111 local government organizations, divided into 4 municipalities, 30 district municipalities and 77 sub-district administrative organizations, with 302,084.95 tons of community waste generated per year, or approximately 827.63 tons per day. There were 75 municipal waste collection services. There were 134,601.05 tons of community wastes/year or 368.77 tons /day, equivalent to 44.56% of the amount of community waste ccurring in the whole province. The amount of community waste with properly dispossal were 110,587.70 tons/year or 302.98 tons/day, equivalent to 36.61% of the amount of community waste occuring in the province. The amount of recycled waste were 144,080.10 tons/year, or approximately 394.74 tons/ day, representing 47.70% of the amount of community waste occuring throughout the province.

For local government organizations that do not provide waste collection services in the area, people in the area will manage in their own household waste by separating waste for sale or use such as raising animals, composting and disposing of community waste by burning in public places. In addition, the local government organization also has operations to promote and support the community to participate in the management of community waste, such as organizing training and educational activities/raising awareness of community waste management, community solid waste reduction and separation activities in households and communities, activities of managing community waste and recycled, etc.

From previous operations, it was found that Ratchaburi drove and promoted the development of local administrative organizations and communities to be ready, able to upgrade and develop as the potential prototype area for community waste management which were: 1) Krab Yai Sub-district Municipality, Ban Pong District, Ratchaburi, 2) Ban Bueng Subdistrict Administrative Organization, Ban Kha District, Ratchaburi, 3) Damnoen Saduak Subdistrict Municipality, Damnoen Saduak District, Ratchaburi, 4) Suan Phueng Subdistrict Administrative Organization, Suan Phueng District, Ratchaburi.

2) Community waste disposal sites

There are 14 municipal waste disposal sites in Ratchaburi, which are owned by 9 local administrative organizations. One site is own by local administrative organizations but is managed by a private sector. 4 private sites. There are 6 community solid waste disposal sites in the correct area, with the separation system, the sanitary landfill and control dump. The amount of community waste that is properly disposed are 302.98 tons/day, representing 82.16% of the amount of waste. There area still approximately 65.79 tons/day of leftover community waste, or as of 17.84% of the collected community waste that being dumped at the wrong community waste disposal site. With management methods such as dumping, landfill or occasional transportation small incinerator without pollution control system, there is still a accumulation of

22,860 tons of community waste in the community waste disposal site in Ratchaburi. The management of community waste disposal sites of most local administrative organizations are occasional improvements of landfill, approximately 1 -2 times/year, depending on the amount of community waste and the size of each area. Due to the limited budget and the local government organization does not have machines for plowing, improving or filling that often.

3) Hazardous waste from the community

From results of the study under the project to develop guidelines for the evaluation of waste products, electrical and electronic products of the Pollution Control Department, it was found that Ratchaburi had been estimated the amount of hazardous waste from the community that occurred in B.E.2 5 6 0 for approximately 6,193.14 tons/year. These values were estimated from the average hazardous waste rate of 7.12 kilograms/person/year. Most of them were waste from electrical and equipment (WEEE) approximately 4 ,0 2 5 .5 4 tons or about 6 5 %. Other hazardous waste from communities such as batteries, chemical containers, spray cans, etc., approximately 2,419.60 tons/year or about 35% percent.

(2) Study areas

Solid waste management in the study area was under the responsibility of the local government such as Huai Phai Subdistrict Administration Organization, Hin Kong Subdistrict Administration Organization, Chedi Hak Subdistrict Administration Organization, Ko Plub Pla Subdistrict Administration Organization, Don Tako Subdistrict Administration Organization, Don Rae Subdistrict and Khao Ngu Subdistrict Municipality. These local governments are responsible for collecting and transferring waste to the disposal areas in 3 locations, which are 1) Moo.1, Ang Hin Subdistrict, Mueang Ratchaburi District 2) Nong O Subdistrict, Ban Pong District and 3) Moo.6, Don Sai Subdistrict, Pak Tho District. However, Huai Phai, Chedi Hak and Don Tako Subdistrict Administration Organizations still have the problem of waste leftovers, unable to collect all waste for further disposal.

1) Huai Phai Subdistrict Administration Organization

Currently, there are 4 m^3 of compressed end-loaded garbage collection vehicle for 1 vehicle. Huai Phai Subdistrict Administrative Organization will be disposed waste in Moo.1 , Ang Hin Subdistrict, Mueang Ratchaburi District, Ratchaburi. The amount of waste that can be collected at present are 4.5 tons/day, and the waste is collected 1 trip/day. The waste will be collected 3 days/week. The remaining wastes are 9 tons/day. There are 4 waste collection staff and 9 villages of garbage collection services, which are Moo.1, Ban Khao Kwang, Moo.2, Ban Khao Tham Khunchorn Village, Moo.3, Ban Rak Makham, Moo.4, Ban Huai Phai, Moo.5, Ban Nakhon Ban, Moo.6, Ban Nong Luang, Moo.7, Ban Nong Din Daeng, Moo.8, Ban Rak Kham and Moo.9, Ban Nong Nam Khun (source : Huai Phai Subdistrict Administration Organization, B.E.2562).

2) Hin Kong Subdistrict Administration Organization

Currently, there are 6 m^3 of compressed end-loaded garbage collection vehicles. 1 car and 3 m^3 in amount of 1 vehicle. The waste collected by the Hin Kong Subdistrict Administrative Organization will be disposed of to Village No. 1, Ang Hin Sub-district, Mueang Ratchaburi District. Ratchaburi. The amount of waste that can be collected at present is 5 tons per day, and the waste is collected for 2 trips per day. The waste is collected 7 days a week without leftover waste. There are 5 waste collection staff and 11 villages for waste collection services, which are Moo.1, Ban Hin Kong, Moo.2, Ban Ruak Khwang, Moo.3, Ban Nong Ta Luang, Moo. 4, Ban Nong Sadao Lang, Moo. 5, Ban Nong Rak, Moo. 6, Ban Nong Sadao Bon, Moo. 7, Ban Huai Pladuk, Moo. 8, Ban Nong Yai Kata, Moo.9, Ban Thung Lai Kai, Moo.10, Ban Nong Krathum, Moo.11, Ban Thung Noi (Source: Hin Kong Subdistrict Administrative Organization, BE 2562).

3) Chedi Hak Subdistrict Administration Organization

Currently, there are 8 m^3 of compressed end-loaded garbage collection vehicles for 1 vehicle and 3 vehicles with 10 m^3 of such vehicles. There is 1 container typed vehicles of 12 m^3. For the collected waste, the Chedi Hak Subdistrict Organization will dispose waste at Moo.1, Ang Hin Sub-district, Muang District, Ratchaburi, Ratchaburi. At present, the amount of waste is 20 tons/day and the waste is collected 1 trip/day. The waste will be collected for 6 days per week. There are 3 tons of leftover waste per day. There are 19 waste collection staff and 13 villages for waste collection services which are Moo.2, Ban Nong Je, Moo.3, Ban That, Moo.4, Ban Aranyik, Moo.5, Ban Nong Chok, Moo.6, Ban Rang Mai Daeng, Moo.7, Ban Thung Por, Moo.8, Ban Thung Tan, Moo.9, Ban Huai Mu, Moo.10, Sa Sawat, Moo.11, Ban Chedi Hak, Moo.12, Ban Khao Mo, Moo.13, Ban Samakkhee, Moo.14, Ban Keha Chumchon (source: Chedi Hak Subdistrict Administration Organization, B.E.2562).

4) Ko Plub Pla Subdistrict Administration Organization

Currently, there are 4 m^3 of compressed end-loaded garbage collection vehicles for 1 vehicle. Ko Plub Pla Subdistrict Administrative Organization will be disposed collected waste to Moo.1, Ang Hin Subdistrict, Mueang Ratchaburi District, Ratchaburi. The amount of collected waste is 1.6 tons/day and waste collection each day for 1 trip/ day. Wastes will be collected for 5 days/week without waste leftover. There are 4 waste collection staff and 8 villages for waste collection service, which are Moo 6, Ban Huai Takhaeng Nai, Moo.7, Khao Khaod, Moo.8, Kho loi, Moo.9, Ban Na, Moo.10, Ban Chong Makam, Moo.11, Khao Suan Luang, Moo.12, Huai Champa, Moo.15 Nong Song Hong (Source: Ko Plub Pla Subdistrict Administration Organization, B.E.2562).

5) Don Tako Subdistrict Administration Organization

Currently, there are 3 vehiles of 12 m^3 of compressed end-loaded garbage trucks for waste collection. Don Tako Subdistrict Administration Organization will take collected waste to Nong O Sub-district, Ban Pong District, Ratchaburi. Currently, 15 tons of waste are collected daily for one trip/day, 7 days a week. The remaining wastes are 15 tons/day. There are 12 waste collection staff and 9 villages for waste collection service which are, Moo.2, Ban Khao Mo, Moo.3, Ban Don Tako, Moo.4, Ban Chaeng. Moo.5, Ban Mai, Moo.6, Ban Nakhon Ban, Moo.7, Ban Khao Loi-Khao Luang, Moo.8, Ban Khao Ngam-Thung Phiman, Moo.9, Ban Khao Kaen Chan and Moo.10, Ban Suan Dok Mai (Source: Don Tako Subdistrict Administration Organization, BE 2562).

6) Don Rae Subdistrict Administration Organization

Currently, there is 1 vehicle with 12 m^3 of compressed end-loaded garbage truck. Don Rae Subdistrict Administrative Organization will disposed collected waste to Moo.1, Ang Hin Subdistrict, Mueang District, Ratchaburi. Currently, 32.50 tons of waste are collected per month and waste will be collected one trip/day, for 5 day a week., without leftover waste. There are 4 waste collection staff and 10 villages for waste collection services, which are Moo.1, Ban Don Rae, Moo.2, Ban Na Nong, Moo.3, Ban Sara Lok, Moo.4, Ban Don Khad, Moo.5, Ban Don Kham, Moo.6, Ban Don Kok, Moo. 7, Ban Nong Sa, Moo.8, Ban Nong Pong, Moo.9, Ban Nong Matum, Moo.10, Ban Huai (source: Don Rae Subdistrict Administration Organization, B.E.2562).

7) Khao Ngu Subdistrict Municipality

Currently, there is 1 vehicle with 12 m^3 of compressed end-loaded garbage truck and 1 vehicle with 10m^3 of compressed end-loaded garbage truck. Khao Ngu Subdistrict Municipality. Village No. 6, Don Sai Subdistrict, Pak Tho District, Ratchaburi. The amount of waste that can be collected at present is 8-10 tons per day, waste is collected for 1-2 trips per day. The waste is collected 5 days per week without the amount of leftover waste. There are 5 solid waste collection staff and 9 service areas for the waste collection areas, which are, Moo.1,2,3,4,5,13,14, Ko Plub Pla Subdistrict and Moo.5,6, Chedi Hak Subdistrict (Source : Khao Ngu Subdistrict Municipality, BE 2562).

3.3.7 Disaster relief

Agencies that will responsible for the community in the study area and is ready to assist in the event of an emergency or disaster, consisting of;

(1) Huai Phai Subdistrict Administrative Organization

Currently, there are 4 firefighters, 45 civilian disaster prevention volunteer officers (CDV) , 1 firefighting truck with a capacity of 6,000 liters, 1 firefighting truck with a capacity of 10,000 liters, and 15 tanks of mobile chemical tanks for fire fighting. There will be a fire drills 1 time per year.

(2) Hin Kong Subdistrict Administrative Organization

Currently, there are 4 firefighters, 30 civilian disaster prevention volunteer officers (CDV), 1 firefighting truck with a capacity of 6,000 liters, 1 firefighting truck with a capacity of 12,000 liters, 1 inspection vehicle and 25 tanks of mobile chemical tanks for fire fighting. There will be a fire drills twice a year.

(3) Chedi Hak Subdistrict Administrative Organization

Currently, there are 6 firefighters, 10 civilian disaster prevention volunteer officers (CDV), 1 firefighting truck with a capacity of 6,000 liters, 1 firefighting truck with a capacity of 12,000 liters, and 20 tanks of mobile chemical tanks for fire fighting. There will be a fire drill once a year.

(4) Ko Plub Pla Subdistrict Administrative Organization

Currently, there are 15 civilian disaster prevention volunteer officers (CDV), 1 firefighting truck with a capacity of 6,000 liters and 5 tanks of mobile chemical tanks for fire fighting.

(5) Don Tako Subdistrict Administrative Organization

Currently, there are 5 firefighters, 1 firefighting truck with a capacity of 6,000 liters, 1 firefighting truck with a capacity of 12,000 liters. There will be a fire drill once a year.

(6) Don Rae Subdistrict Administrative Organization

Currently, there are 4 firefighters, 12 civilian disaster prevention volunteer officers (CDV), 1 firefighting truck with a capacity of 6,000 liters, 1 inspection vehicle and one tank for the fire fighting. There will be a fire drill once a year.

(7) Khao Ngu Subdistrict Municipality

Currently, there are 13 firefighters, 27 civilian disaster prevention volunteer officers (CDV), 1 firefighting truck with a capacity of 8,000 liters, 1 firefighting truck with a capacity of 12,000 liters 2 firefighting trucks with a capacity of 6,000 liters with 7 tanks for the fire fighting. There will be a fire drill once a year.

3.3.8 Transportation

(1) Vehicle transportation

Traveling to the project area can be done from 2 routes, by car and train, which can be summarized as follows.

For traveling from Bangkok to the project area by car, it can take Highway No. 338 (Borommaratchachonnani Road) entering Highway No.4 (Petchkasem Road) through Nakhon Pathom and entering Mueang Ratchaburi District with the distance of 120 kilometers. Then, turn right to Huai Phai intersection into the Highway No.3208 for approximately 6 kilometers. Then turn into rural road KorJor.4004(the road along the Irrigation canel). Then Turn left and cross the bridge over the irrigation canal into Nong Pla Duk Road for approximately 2 kilometers to reach the power plant location. The distance from Bangkok to the project area is approximately 129 kilometers. The journey takes about 2 hours. The asphaltic concrete surface is made up of 4 traffic lanes and 2 traffic lanes. In addition, major transportation networks around the project are National Highway No.3087, National highway No.3207, National highway No.3208 and National highway No.3291 which can also enter the project area, as seen in **Figure 3.3.8-1**.

1) National highway No.3087

National Highway No.3087, Ratchaburi-Kaem On which link between Mueang Ratchaburi District to Chom Bueng District. The total distance is approximately 60 kilometers. Currently, the asphaltic concrete road has 4 traffic lanes and 2 traffic lanes with a width of 3.5 meters and a width of 2.0 meters on each side of the pavement.

2) National highway No.3207

National Highway No.3207, Khao Kruat-Nong Chae Sao which link between Hin Kong Subdistrict to Nam Pu Subdistrict, Mueang Ratchaburi District with approximately 11.3 kilometers. Currently, the asphaltic concrete road has 2 traffic lanes.

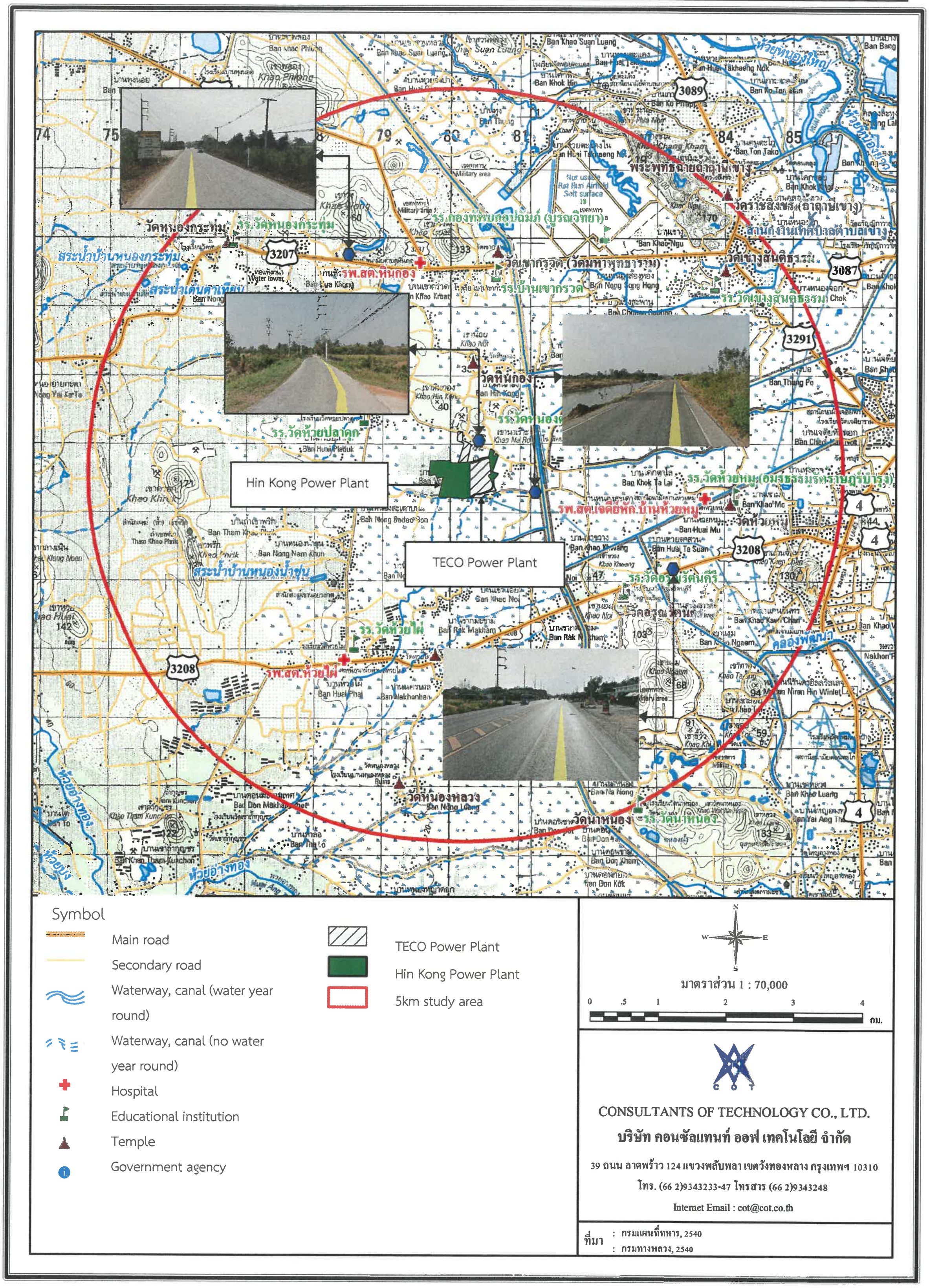


Figure 3.3.8-1 Major transportation networks around the project

3) National highway No.3208

National Highway No.3207, Khao Wang – Mueng Pha Pok Khang Khao which link between Mueang Ratchaburi District to Suan Phueng District, Ratchaburi with approximately 67 kilometers. Currently, the asphaltic concrete road has 2 traffic lanes.

4) National highway No.3291

National Highway No.3291, Chedi Hak-Boek Prai which link between Mueang Ratchaburi District to Ban Pong District, Ratchaburi with approximately 45 kilometers. Currently, the asphaltic concrete road has 2 traffic lanes.

5) Rural road KorJor.4004

Rural road KorJor.4004 has the beginning at Ban Than Subdistrict, Ban Lat District, Phetchaburi which link to rural road Rorbor.4044 as a road along the irrigation. Currently, the asphaltic concrete road has 2 traffic lanes with a width of 2.5 meters per traffic lanes, the pavement is 1.0 meter width. The road condition is generally in good condition.

6) Nong Pladuk Road

Nong Pladuk Road is a local road which link between Hin Kong Subdistrict to Huai Phai Subdistrict and nearby districts. Currently, there are 2 asphaltic concrete roads with a width of 2.5 meters/lane. The road condition is generally in good condition.

(2) Train transportation

For traveling to the project area by train, it can reach by the train at Bangkok Railway Station (Hua Lamphong) and Thonburi Station (Bangkok Noi) to Ratchaburi with a railroad crossing at Ban Pong District, Photharam District, Mueang Ratchaburi Districts and Pak Tho District. The service is available daily with approximately 2 hours and the distance is approximately 117 kilometers.

(3) Traffic volume

The consulting company collected the data from Average Annual Daily Traffic (AADT) done by the Department of Highway Safety in the year B.E.2557-2561 on National Highway No.3207 and No.3208. There are 12 different types of vehicles. The traffic volume of each type of vehicle is calculated into PCU units (Passenger Car Unit) using the weight of Passenger Car Equivalents (PCE) of each type of vehicles. It can be summarized as follows.

1) Average daily traffic volume (surveyed by the Department of Highways)

From the above information, it was found that the traffic volume on the National Highway No. 3207 in the area of Km 3 + 000 (Khao Kruat - Nong Chae Sao), including the inbound and outbound traffic from B.E.2557-2561 (**Table 3.3.8-1**), has an average traffic volume/day during of 4,458 5,048 6,198 7,076 and 7,844 vehicles/day, respectively. The volume of traffic on the National Highway No.3208 in the area of Km 3 + 000 (Khao Wang-Nampu), which includes inbound and outbound traffic from B.E. 2557-2561 (**Table 3.3.8-2**), average daily volume during the year is 15,035 16,799 15,195 12,793 and 15,285 cars/day, respectively. It can be summarized as follows.

(A) National highway No.3027

- **B.E. 2557,** the top 3 types of cars are small trucks (4 wheels) (27.70%), followed by motorcycles and tricycles (27.66%) and cars with no more than 7 passengers(21.22%), respectively.

- **B.E. 2558,** the top 3 types of cars are small trucks (4 wheels) (34.45%), followed by cars with no more than 7 passengers(25.55%) and motorcycles and tricycles (21.95%), respectively.

- **B.E. 2559,** the top 3 types of cars are small trucks (4 wheels) (34.04%), followed by cars with no more than 7 passengers(25.65%) and motorcycles and tricycles (20.89%), respectively.

- **B.E. 2560,** the top 3 types of cars are small trucks (4 wheels) (32.66%), followed by passenger cars with no more than 7 people (25.33%) and motorcycles and tricycles (20.94%), respectively.

- **B.E. 2561** the top 3 types of cars are small trucks (4 wheels) (31.43%), followed by passenger cars with no more than 7 people (28.19%) and motorcycles and tricycles (23.25%), respectively.

(B) National highway No.3028

- **B.E. 2557,** the top 3 types of cars are small trucks (4 wheels) (44.35%), followed by motorcycles and tricycles (17.38%) and passenger cars with no more than 7 people (17.21%), respectively.

Table 3.3.8-1

Average annual daily traffic and V/C ratio on the National Highway No. 3207 in the area of Km 3 + 000 (Khao Kruat - Nong Chae Sao) from B.E.2557-2561

No.	Vehicle - Type	PCU Factor	B.E. 2557			B.E. 2558			B.E. 2559			B.E. 2560			B.E. 2561		
			Vehicles /day	%	PCU/ day	Vehicles /day	%	PCU/ day	Vehicles /day	%	PCU/ day	Vehicles /day	%	PCU/ day	Vehicles /day	%	PCU/ day
1	Passenger Car, less than 7 persons	1	946	21.22	946	1,290	25.55	1,290	1,590	25.65	1,590	1,792	25.33	1,792	2,211	28.19	2,211
2	Passenger Car, more than 7 persons	1	460	10.32	460	507	10.04	507	716	11.55	716	866	12.24	866	956	12.19	956
3	Light Bus	1.5	32	0.72	48	44	0.87	66	49	0.79	74	11	0.16	17	20	0.25	30
4	Medium Bus	1.5	31	0.70	47	22	0.44	33	16	0.26	24	32	0.45	48	1	0.01	2
5	Heavy Bus	2.1	11	0.25	23	2	0.04	4	14	0.23	29	15	0.21	32	0	0.00	0
6	Light Truck (4 wheels)	1	1,235	27.70	1,235	1,739	34.45	1,739	2,110	34.04	2,110	2,311	32.66	2,311	2,465	31.43	2,465
7	Medium Truck (6 wheels)	2.1	177	3.97	372	112	2.22	235	193	3.11	405	210	2.97	441	186	2.37	391
8	Heavy Truck (10 wheels)	2.5	187	4.19	468	162	3.21	405	168	2.71	420	155	2.19	388	135	1.72	338
9	Full Trailer (More than 3 axles)	2.5	96	2.15	240	56	1.11	140	43	0.69	108	109	1.54	273	30	0.38	75
10	Semi Trailer (More than 3 axles)	2.5	50	1.12	125	6	0.12	15	4	0.06	10	93	1.31	233	16	0.20	40
12	Motorcycles and tricycles	0.333	1,233	27.66	411	1,108	21.95	369	1,295	20.89	431	1,482	20.94	494	1,824	23.25	607
Total			**4,458**	**100**	**4,373**	**5,048**	**100**	**4,803**	**6,198**	**100**	**5,917**	**7,076**	**100**	**6,892**	**7,844**	**100**	**7,114**
V/C Ratio			**0.06**			**0.07**			**0.09**			**0.10**			**0.11**		
Level of Service			A			A			A			A			A		

Source : Collected by Consultants of Technology Co., Ltd., 2562

Table 3.3.8-2

Average annual daily traffic and V/C ratio on the National Highway No. 3208 in the area of Km 3 + 000 (Khao Wang-Nampu) from B.E.2557-2561

No.	Vehicle - Type	PCU Factor	B.E. 2557			B.E. 2558			B.E. 2559			B.E. 2560			B.E. 2561		
			Vehicles /day	%	PCU/ day	Vehicles /day	%	PCU/ day	Vehicles /day	%	PCU/ day	Vehicles /day	%	PCU/ day	Vehicles /day	%	PCU/ day
1	Passenger Car, less than 7 persons	1	2,588	17.21	2,588	2,438	14.51	2,438	2,666	17.55	2,666	2,556	19.98	2,556	3,420	22.37	3,420
2	Passenger Car, more than 7 persons	1	1,168	7.77	1,168	2,386	14.20	2,386	1,805	11.88	1,805	1,438	11.24	1,438	1,444	9.45	1,444
3	Light Bus	1.5	40	0.27	60	65	0.39	98	65	0.43	98	42	0.33	63	61	0.40	92
4	Medium Bus	1.5	36	0.24	54	40	0.24	60	50	0.33	75	32	0.25	48	44	0.29	66
5	Heavy Bus	2.1	24	0.16	50	22	0.13	46	44	0.29	92	15	0.12	32	23	0.15	48
6	Light Truck (4 wheels)	1	6,668	44.35	6,668	7,130	42.44	7,130	6,274	41.29	6,274	4,514	35.28	4,514	4,978	32.57	4,978
7	Medium Truck (6 wheels)	2.1	649	4.32	1,363	613	3.65	1,287	716	4.71	1,504	520	4.06	1,092	678	4.44	1,424
8	Heavy Truck (10 wheels)	2.5	752	5.00	1,880	518	3.08	1,295	463	3.05	1,158	564	4.41	1,410	694	4.54	1,735
9	Full Trailer (More than 3 axles)	2.5	308	2.05	770	303	1.80	758	222	1.46	555	161	1.26	403	408	2.67	1,020
10	Semi Trailer (More than 3 axles)	2.5	189	1.26	473	229	1.36	573	125	0.82	313	108	0.84	270	212	1.39	530
12	Motorcycles and tricycles	0.333	2,613	17.38	870	3,055	18.19	1,017	2,765	18.20	921	2,843	22.22	947	3,323	21.74	1,107
Total			**15,035**	**100**	**15,944**	**16,799**	**100**	**17,087**	**15,195**	**100**	**15,459**	**12,793**	**100**	**12,772**	**15,285**	**100**	**15,863**
V/C Ratio			**0.25**			**0.26**			**0.24**			**0.20**			**0.25**		
Level of Service			A			A			A			A			A		

Source : Collected by Consultants of Technology Co., Ltd., 2562

- **B.E. 2558,** the top 3 types of cars are small trucks (4 wheels) (42.44%), followed by motorcycles and tricycles (18.19%) and passenger cars with no more than 7people (14.51%), respectively.

- **B.E. 2559,** the top 3 types of cars are small trucks (4 wheels) (41.29%), followed by motorcycles and tricycles (18.20%) and passenger cars with no more than 7people (17.55%), respectively.

- **B.E. 2560,** the top 3 types of cars are small trucks (4 wheels) (35.28%), followed by motorcycles and tricycles (22.22%) and passenger cars with no more than 7people (19.98%), respectively.

- **B.E. 2561,** the top 3 types of cars are small trucks (4 wheels) (32.57%), followed by passenger cars with no more than 7 people (22.37%) and motorcycles and tricycles (21.74%), respectively.

2) Average daily traffic volume (surveyed by the consulting company)

Traffic volume on Rural Roads No.Korjor 4004, a local road in front of the power plant, a local road in front of the Big Food Group Co.,Ltd., was measured twice a day, for 2 days. This measurement covered weekdays and holidays. The 1st time was on Friday 12 July,B.E.2562 and on Saturday 13 July, B.E.2562. The 2nd time was on Monday 28 October,B.E.2562 and on Sunday 27 October B.E.2562. The traffic volume can be summarized as follows.

(A) Rural road, No.Korjor.4004 (a road along the irrigation canal)

A) Friday 12 July,B.E.2562

From the traffic survey on rural road No.Korjor 4004 throughout the day on Friday 12 July B.E. 2562 (**Table 3.3.8-3**), results were below.

- For the morning rush hour (07.00-08.00 hrs.), there were 420 cars/hour. The most common ratio of cars was cars with no more than 7 passengers(39.05%), followed by motorcycles and motor tricycles (24.76%) and small trucks (4 wheels) (23.81%).
- For off the rush hours (12.00-13.00 hrs.), there were 396 cars/hour. The most common ratio of cars was small trucks (4 wheels) (33.33%),

followed by cars with no more than 7 passengers(31.82%) and motorcycles and motor tricycles (28.79%).

- For the evening rush hour (16.00-17.00 hrs.), there were 630 cars/hour. The most common ratio of cars was cars with no more than 7 passengers (39.05%), followed by motorcycles and motor tricycles (29.21%) and small trucks (4wheels) (26.03%).

B) Saturday 13 July, B.E.2562

From the traffic survey on rural road No.Korjor 4004 throughout the day on Saturday 13 July, B.E.2562 (**Table 3.3.8-3**), results were below.

- For the morning rush hour (07.00-08.00 hrs.), there were 468 cars/hour. The most common ratio of cars was motorcycles and motor tricycles (46.58%), followed by small trucks (4wheels) (26.50%) and cars with no more than 7 passengers (23.08%)

- For off the rush hours (12.00-13.00 hrs.), there were 292 cars/hour. The most common ratio of cars was cars with no more than 7 passengers (38.36%), followed by small trucks (4wheels) (34.25%) and motorcycles and motor tricycles (24.66%).

- For the evening rush hour (16.00-17.00 hrs.), there were 416 cars/hour. The most common ratio of cars was small trucks (4 wheels) (34.62%), followed by cars with no more than 7 passengers (31.73%) and motorcycles and motor tricycles (25.48%).

(B) Road in front of the power plant (Nong Pladuk Road)

A) Friday 12 July,B.E.2562

From the survey of traffic volume on the road in front of the power plant (Nong Pladuk Road) throughout the day on Friday 12 July B.E. 2562 (**Table 3.3.8-4**), results were below.

- For the morning rush hour (07.00-08.00 hrs.), there were 170 cars/hour. The most common ratio of cars was motorcycles and motor tricycles (41.18%), followed by cars with no more than 7 passengers (37.65%) and small trucks (4wheels) (15.29%).

- For off the rush hours (12.00-13.00 hrs.), there were 156 cars/hour. The most common ratio of cars was motorcycles and motor tricycles (60.26%), followed by cars with no more than 7 passengers (25.64%) and small trucks (4wheels) (12.82%).

- For the evening rush hour (16.00-17.00 hrs.), there were 184 cars/hour. The most common ratio of cars was motorcycles and motor tricycles (57.61%), followed by cars with no more than 7 passengers (31.52%) and small trucks (4wheels) (6.52%).

B) Saturday 13 July, B.E.2562

From the survey of traffic volume on the road in front of the power plant (Nong Pladuk Road) throughout the day on Saturday 13 July, B.E.2562 (**Table 3.3.8-4**), results were below.

- For the morning rush hour (07.00-08.00 hrs.), there were 244 cars/hour. The most common ratio of cars was motorcycles and motor tricycles (69.67%), followed by cars with no more than 7 passengers (17.21%) and small trucks (4wheels) (13.11%).

- For off the rush hours (12.00-13.00 hrs.), there were 112 cars/hour. The most common ratio of cars was motorcycles and motor tricycles (39.29%), followed by cars with no more than 7 passengers (35.71%) and small trucks (4wheels) (16.07%).

- For the evening rush hour (16.00-17.00 hrs.), there were 182 cars/hour. The most common ratio of cars was motorcycles and motor tricycles (50.55%), followed by cars with no more than 7 passengers (20.88%) and small trucks (4wheels) (20.88%).

(C) Road in front of Big Food Group Co.,Ltd. (Nong Pla Duk Road)

A) Sunday, 27 October B.E.2562

From the traffic volume survey in front of Big Food Group Co.,Ltd., (Nong Pladuk Road) throughout the day on Sunday 27 October, B.E. 2562 (**Table 3.3.8-5**), results were below.

- For the morning rush hour (07.00-08.00 hrs.), there were 204 cars/hour. The most common ratio of cars was small trucks (4 wheels) (45.59%), followed by motorcycles and motor tricycles (31.86%) cars with no more than 7 passengers (18.63%).

- For off the rush hours (12.00-13.00 hrs.), there were 308 cars/hour. The most common ratio of cars was small trucks (4 wheels) (48.05%), followed by no more than 7 passengers (26.30%) and motorcycles and motor tricycles (21.10%).

- For the evening rush hour (16.00-17.00 hrs.), there were 353 cars/hour. The most common ratio of cars was small trucks (4 wheels) (45.89%), followed by no more than 7 passengers (25.78%) and motorcycles and motor tricycles (23.80%).

B) Monday 28 October, B.E.2562

From the traffic volume survey in front of Big Food Group Co.,Ltd., (Nong Pladuk Road) throughout the day on Monday 28 October, B.E.2562 (**Table 3.3.8-5**), results were below.

- For the morning rush hour (07.00-08.00 hrs.), there were 357 cars/hour. The most common ratio of cars was small trucks (4 wheels) (35.57%), followed by motorcycles and motor tricycles (33.33%) and motorcycles and motor tricycles (26.89%).

- For off the rush hours (12.00-13.00 hrs.), there were 248 cars/hour. The most common ratio of cars was small trucks (4 wheels) (47.58%), followed by motorcycles and motor tricycles (22.98%) and motorcycles and motor tricycles (22.18%).

- For the evening rush hour (16.00-17.00 hrs.), there were 400 cars/hour. The most common ratio of cars was small trucks (4 wheels) (38.25%), followed by motorcycles and motor tricycles (28.25%) and motorcycles and motor tricycles (26.75%).

Table 3.3.8-3

Traffic volume on Rural Roads No.Korjor 4004 (a road along the irrigation canal) (Station 1)

Vehicle - Type	Weekdays (Friday 12 July,B.E.2562)						Holidays (Saturday 13 July, B.E.2562)					
	Morning rush hour		Off the rush hours		Evening rush hour		Morning rush hour		Off the rush hours		Evening rush hour	
	07.00-08.00 hrs.		12.00-13.00 hrs.		16.00-17.00 hrs.		07.00-08.00 hrs.		12.00-13.00 hrs.		16.00-17.00 hrs.	
	Cars/hour	%	Cars/hour	%	Cars/hour	%	Cars/hour	%	Cars/hour	%	Cars/hour	%
Passenger Car, less than 7 persons	164	39.05	126	31.82	246	39.05	108	23.08	112	38.36	132	31.73
Passenger Car, more than 7 persons	0	0.00	2	0.51	2	0.32	0	0.00	0	0.00	2	0.48
Light Bus	4	0.95	4	1.01	2	0.32	0	0.00	0	0.00	4	0.96
Medium Bus	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Heavy Bus	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Light Truck (4 wheels)	100	23.81	132	33.33	164	26.03	124	26.50	100	34.25	144	34.62
Medium Truck (6 wheels)	14	3.33	10	2.53	16	2.54	6	1.28	2	0.68	18	4.33
Heavy Truck (10 wheels)	20	4.76	2	0.51	8	1.27	2	0.43	0	0.00	2	0.48
Full Trailer (More than 3 axles)	2	0.48	2	0.51	4	0.63	8	1.71	4	1.37	4	0.96
Semi Trailer (More than 3 axles)	12	2.86	4	1.01	2	0.32	2	0.43	2	0.68	4	0.96
Motorcycles and tricycles	104	24.76	114	28.79	184	29.21	218	46.58	72	24.66	106	25.48
2 and 3 wheel bikes	0	0.00	0	0.00	2	0.32	0	0.00	0	0.00	0	0.00
Total	**420**	**100.00**	**396**	**100.00**	**630**	**100.00**	**468**	**100.00**	**292**	**100.00**	**416**	**100.00**

Table 3.3.8-4

Traffic volume on Road in front of the power plant (Nong Pladuk Road) (Station 2)

Vehicle - Type	Weekdays (Friday 12 July,B.E.2562)						Holidays (Saturday 13 July, B.E.2562)					
	Morning rush hour		Off the rush hours		Evening rush hour		Morning rush hour		Off the rush hours		Evening rush hour	
	07.00-08.00 hrs.		12.00-13.00 hrs.		16.00-17.00 hrs.		07.00-08.00 hrs.		12.00-13.00 hrs.		16.00-17.00 hrs.	
	Cars/hour	%	Cars/hour	%	Cars/hour	%	Cars/hour	%	Cars/hour	%	Cars/hour	%
Passenger Car, less than 7 persons	64	37.65	40	25.64	58	31.52	42	17.21	40	35.71	38	20.88
Passenger Car, more than 7 persons	0	0.00	0	0.00	0	0.00	0	0.00	2	1.79	4	2.20
Light Bus	8	4.71	0	0.00	4	2.17	0	0.00	2	1.79	0	0.00
Medium Bus	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Heavy Bus	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Light Truck (4 wheels)	26	15.29	20	12.82	12	6.52	32	13.11	18	16.07	38	20.88
Medium Truck (6 wheels)	0	0.00	2	1.28	0	0.00	0	0.00	2	1.79	8	4.40
Heavy Truck (10 wheels)	2	1.18	0	0.00	0	0.00	0	0.00	2	1.79	0	0.00
Full Trailer (More than 3 axles)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Semi Trailer (More than 3 axles)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Motorcycles and tricycles	70	41.18	94	60.26	106	57.61	170	69.67	44	39.29	92	50.55
2 and 3 wheel bikes	0	0.00	0	0.00	4	2.17	0	0.00	2	1.79	2	1.10
Total	**170**	**100.00**	**156**	**100.00**	**184**	**100.00**	**244**	**100.00**	**112**	**100.00**	**182**	**100.00**

Table 3.3.8-5

Traffic volume on Road in front of Big Food Group Co.,Ltd. (Nong Pla Duk Road) (Station 3)

Vehicle - Type	Weekdays (Friday 12 July,B.E.2562)						Holidays (Saturday 13 July, B.E.2562)					
	Morning rush hour		Off the rush hours		Evening rush hour		Morning rush hour		Off the rush hours		Evening rush hour	
	07.00-08.00 hrs.		12.00-13.00 hrs.		16.00-17.00 hrs.		07.00-08.00 hrs.		12.00-13.00 hrs.		16.00-17.00 hrs.	
	Cars/hour	%	Cars/hour	%	Cars/hour	%	Cars/hour	%	Cars/hour	%	Cars/hour	%
Passenger Car, less than 7 persons	38	18.63	81	26.30	91	25.78	96	26.89	55	22.18	113	28.25
Passenger Car, more than 7 persons	0	0.00	6	1.95	2	0.57	3	0.84	5	2.02	5	1.25
Light Bus	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Medium Bus	0	0.00	0	0.00	2	0.57	0	0.00	0	0.00	0	0.00
Heavy Bus	1	0.49	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Light Truck (4 wheels)	93	45.59	148	48.05	162	45.89	127	35.57	118	47.58	153	38.25
Medium Truck (6 wheels)	2	0.98	4	1.30	3	0.85	4	1.12	5	2.02	8	2.00
Heavy Truck (10 wheels)	2	0.98	4	1.30	5	1.42	6	1.68	2	0.81	6	1.50
Full Trailer (More than 3 axles)	3	1.47	0	0.00	1	0.28	0	0.00	2	0.81	2	0.50
Semi Trailer (More than 3 axles)	0	0.00	0	0.00	0	0.00	0	0.00	4	1.61	4	1.00
Motorcycles and tricycles	65	31.86	65	21.10	84	23.80	119	33.33	57	22.98	107	26.75
2 and 3 wheel bikes	0	0.00	0	0.00	3	0.85	2	0.56	0	0.00	2	0.50
Total	**204**	**100.00**	**308**	**100.00**	**353**	**100.00**	**357**	**100.00**	**248**	**100.00**	**400**	**100.00**

3.4 Quality of life value

3.4.1 General socio-economic conditions

The consulting company conducted a comprehensive socio-economic study at the provincial, district, and local levels by collecting secondary data from the relevant government agencies, in particularly, local government organizations in the study area, as well as conducted field and community socio-economic status surveys in the study area by using the questionnaire. This was carried out along with an opinion survey on the project from relevant government agencies as stakeholders. Surveying for comments from formal and informal community leaders was also taken into the consideration in the study to cover social and community conditions in the study area from various perspectives.

The project is located in the administrative district of Hin Kong Subdistrict Administrative Organization, Hin Kong Subdistrict, Mueang Ratchaburi District, Ratchaburi Province. The study area is 5 kilometers radius (details as seen in **Figure 3.4.1-1**) covering the area 1 District, Mueang Ratchaburi District where 6 sub-districts, 1 municipality, which are, Hin Kong Subdistrict, Huai Phai Subdistrict, Chedi Hak Subdistrict, Ko Plub Pla Subdistrict, Don Tako Subdistrict, Don Rae Subdistrict, and Khao Ngu Subdistrict Municipality are covered. The study area also covers 32 villages (details are seen in **Table 3.4.1-1**). The consulting company has searched the socio-economic conditions with following details.

(1) Socio-economic conditions at the provincial level

The study area is located in Ratchaburi province. The characteristic of socio-economic status at the provincial level can be briefly described as follows.

1) Ratchaburi Province

(A) Location and territory

Ratchaburi is located in the western central region with approximately 100 kilometers away from Bangkok. Ratchaburi has a total area of 5,196.465 sq.km., or approximately 3,247,789 rais, representing 11.27% of the western region (from 5 provinces). The border area is connected to the Republic of the Union of Myanmar with the Tenasserim hills as a border watershed. The length of this border is approximately 73 kilometers. Mae Klong River is the main river, with a length of approximately 67 kilometers flowing in the area (briefing of Ratchaburi, B.E.2562). In this regard, Ratchaburi has connected to surrounding areas as follows (**Figure 3.4.1-2**).

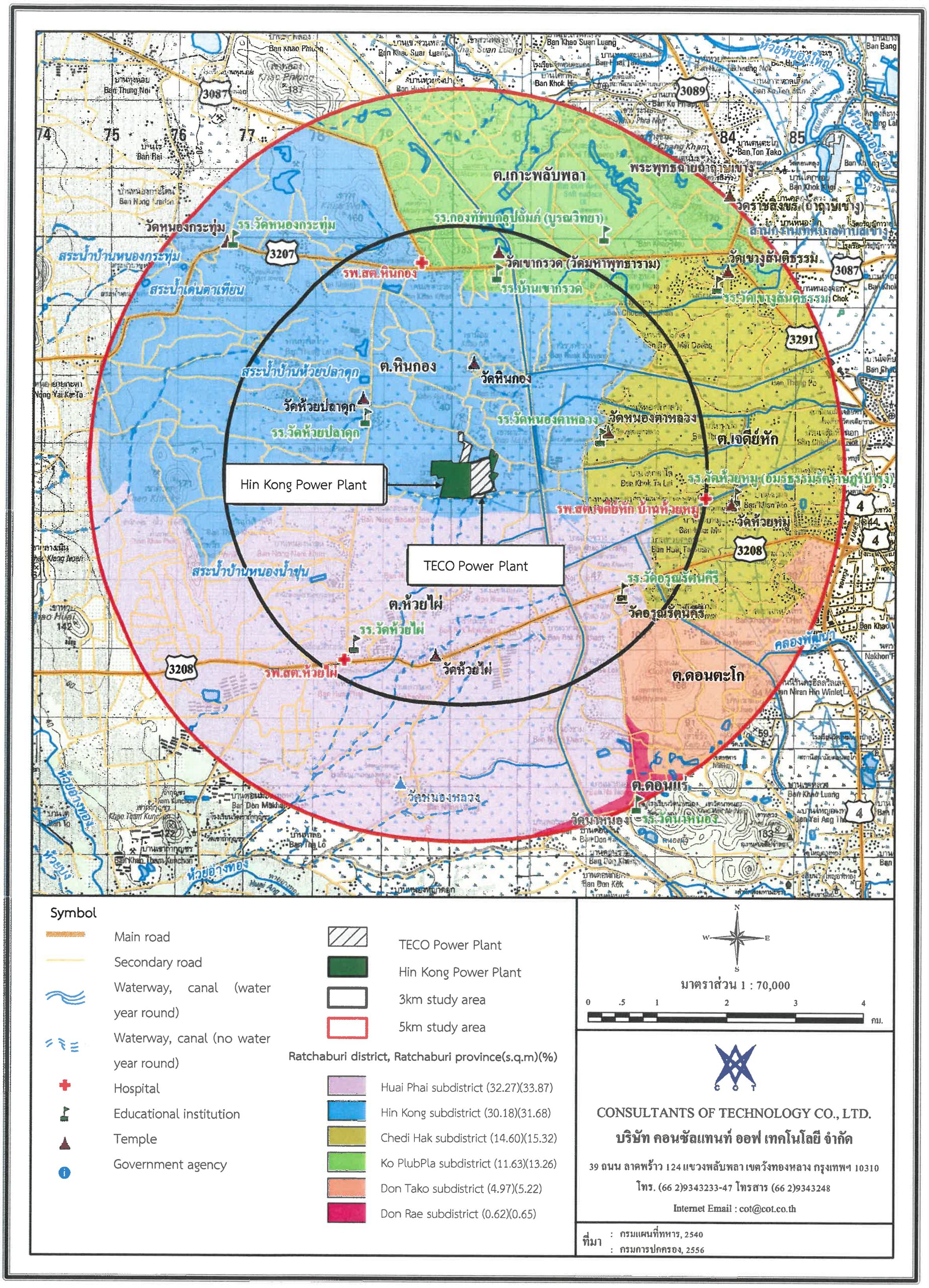


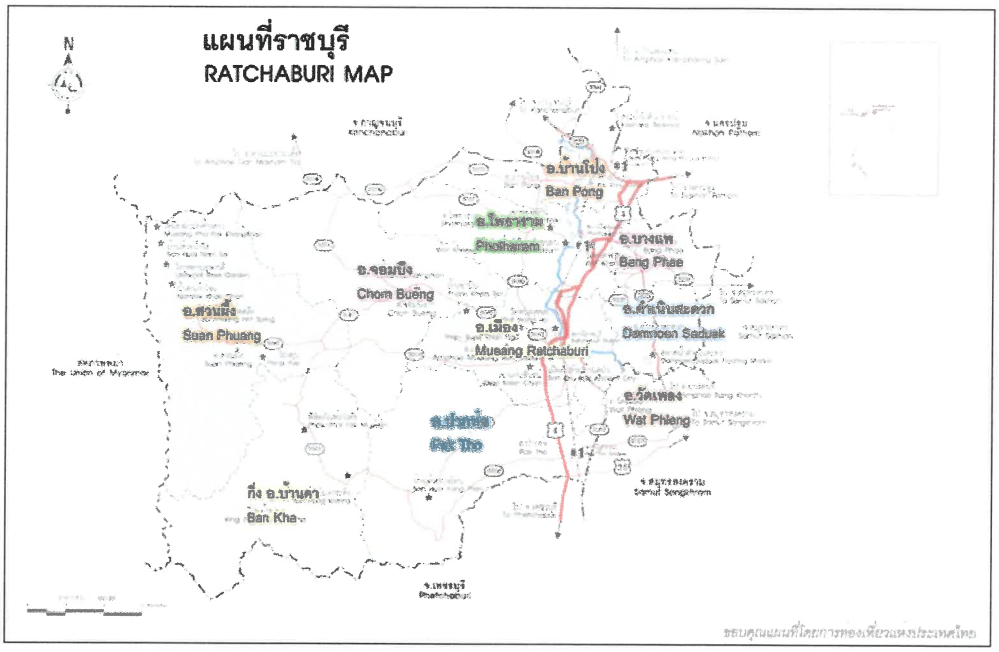
Figure 3.4.1-1 Study area

Table 3.4.1-1

Village communities in the study area, radius 5 kilometers from the project location

District	Local government organization	village	
		Radius 0-3 kilometers	Radius 3-5 kilometers
Mueang Ratchaburi	Hin Kong SAO	Moo. 1 Ban Hin Kong Moo. 2 Ban Ruakkwang Moo. 3 Ban Nong Ta Luang Moo. 4 Ban Nong Sadao Lang Moo. 5 Ban Nongrak Moo. 6 Ban Nong Sadao Bon Moo. 7 Ban Huay Pladuk Moo. 9 Ban Thung Lai Kai Bon	Moo. 8 Nong Yai Ka Ta Moo. 10 Ban Nong Krathum
	Huai Phai SAO	Moo. 1 Ban Khao Khwang Moo. 3 Ban Rak makham Moo. 4 Ban Huay Phai Moo. 5 Ban Nakon Barn Moo. 7 Ban Nong Din Daeng Moo. 9 Ban Nong Nam Khun	Moo. 6 Ban Nong Luang Moo. 8 Ban Nong Kham
	Chedi Hak SAO	Moo. 6 Ban Rang Mai Daeng Moo. 9 Ban Huay Mu	Moo. 7 Ban Thung Po Bon Moo. 8 Ban Thung Tan Moo. 10 Ban Sa Sawat Moo. 12 Ban Khao Mo
	Ko Plub Pla SAO	Moo. 15 Ban Nong Song Hong	Moo. 6 Ban Huai Thien Nai Moo. 7 Ban Thung Po Bon
	Don Tako SAO		Moo. 8 Ban Khao Ngam - Ban Klang Thung Moo. 9 Ban Khao Kaen Chan
	Don Rae SAO		Moo. 2 Ban Na Nong
	Khao Ngu Sub-district Municipality		Ban Ton Mamuay Pattana Community Sompoom Pattana Community
1 District	**7** SAO	**17 village**	**15 village**

Source : Consultants of Technology Co.,LTD, B.E.2562



<u>Figure 3.4.1-2</u> Ratchaburi Territory Map

North	connects to	Kanchanaburi
South	connects to	Phetchaburi
East	connects to	Nakhon Pathom, Samut Sakhon and Samut Songkhram
West	connects to	Republic of the Union of Myanmar

(B) History of the city and communities

Ratchaburi, with a more auspicious name means "King city", is an old city in Thailand. From the study and review of historians and archaeologists, they found that areas of the Mae Klong River Basin has been inhabited by many generations and has flourished since the past. From evidence of ancient sites and antiques, it was believed that people settled in this area since the Middle Stone Age, as well as discovering the ancient city of Dvaravati period in Khu Bua Subdistrict, Mueang Ratchaburi District. King Buddha Yot Fa Chulalok the Great, the first king of the Chakri Dynasty used to hold the royal position of Ratchaburi during the late Ayutthaya period. In the late Ayutthaya and early Rattanakosin periods, historical evidences showed that Ratchaburi was an important outpost city and was used many time as a battle arena, especially during the period of King Buddha Yot Fa Chulalok the Great. The king had raised many troops to stand for war with Burma. The most important time was the Ninth Army War. Later in B.E.2360, during the reign of King Phra Buddha Lertlah Napalai, the King was graciously pleased to build a new city wall on the left bank of the Mae Klong River until the present time. In the year of B.E.2437, in the reign of King Chulalongkorn, he changed the regional government by including various cities closing to each other and established them as a canton and Ratchaburi, Kanchanaburi, Samut Songkhram Phetchaburi Pranburi, Prachuap Khiri Khan city were included as a total of 6 cities. He established this area as Ratchaburi canton with a city commander in Ratchaburi, on the right bank of the Mae Klong River (at the present, it is the old Ratchaburi City Hall). Later on, B.E.2440, it was moved the city commander of Ratchaburi from the left bank, back to the same location as Ratchaburi City Hall on the right bank of the Mae Klong River until B.E.2476. When all canton were abolished, Ratchaburi was therefore canceled and maintained as Ratchaburi province until now.

(C) Government

Ratchaburi is divided administrative divisions into 10 districts, 104 sub-districts, 975 villages, 34 municipalities (3 municipalities, 31 sub-district municipalities) 1 provincial administrative organization and 77 sub-district administrative organization. Details as seen in **Table 3.4.1-2**.

Table 3.4.1-2
The division of the provincial administrative area and area in each district of Ratchaburi Province

No.	District	Sub-district	Village	Area (sqkm.)	Number of Municipal	Number of SAO
1.	Mueang Ratchaburi	22	187	430.298	5	17
2.	Ban Pong	15	183	366.559	6	11
3.	Photharam	19	156	417.009	9	11
4.	Damnoen Saduak	13	105	210.271	5	8
5.	Pak Tho	12	85	757.835	2	10
6.	Chom Bueng	6	89	772.054	2	6
7.	Bang Phae	7	65	172.597	2	4
8.	Wat Pleng	3	28	37.892	1	3
9.	Suan Phueng	4	37	1,005.080	2	4
10.	Ban Kha	3	40	1,026.87	0	3
Total		**104**	**975**	**5,196.462**	**34**	**77**

Source: Office of Registration Administration, Department of Provincial Administration, B.E2562

(D) Characteristics of Ratchaburi population

a) Number and size of the population

For B.E. 2562, Ratchaburi had a total population of 873,101 persons, dividing into 425,677 males and 447,424 females (Source: Department of Provincial Administration, Ministry of Interior, B.E.2562) with a population density of 168.02 people/sq.km. The rate of population growth in B.E. 2562 was decreased by 0.05 % from B.E.2561, details were shown in **Table 3.4.1-3**. Population trend during the past 10 years (B.E.2553-2562) has continuously increased population, as seen in **Figure 3.4.1-3.**

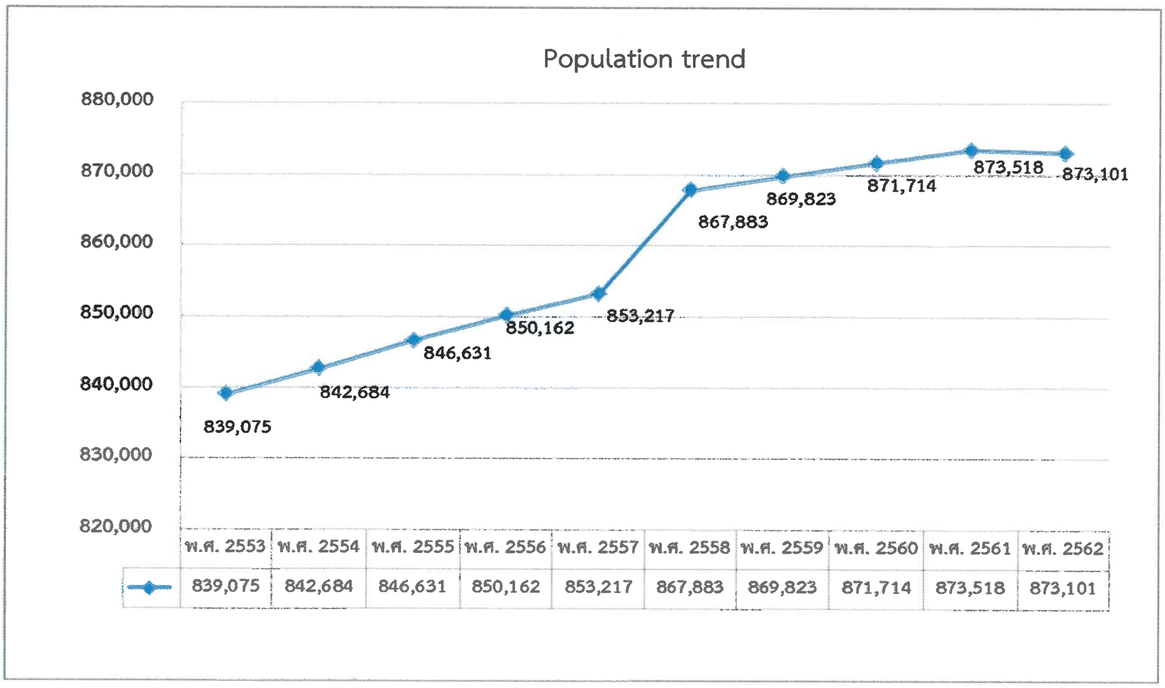


Figure 3.4.1-3 Population trend

b) Number of households

The trend of household numbers will continually increase every year. In B.E.2553, there were 268,900 houses. In B.E.2562, household numbers increased to 319,619 houses (referred to **Table 3.4.1-3**). Household numbers in B.E.2562 was increasing by 18.86% from B.E.2553.

Table 3.4.1-3

Ratchaburi population statistics during B.E.2553-2562

category	B.E.2553	B.E.2554	B.E.2555	B.E.2556	B.E.2557	B.E.2558	B.E.2559	B.E.2560	B.E.2561	B.E.2562
Number of population from registration (person)	839,075	842,684	846,631	850,162	853,217	867,883	869,823	871,714	873,518	873,101
- male	409,599	411,063	412,906	414,568	415,725	423,298	424,280	425,159	426,132	425,677
- female	429,476	431,621	433,725	435,594	437,492	444,585	445,543	446,555	447,386	447,424
Population density (person per km^2)	161.47	162.16	162.92	163.60	164.19	167.01	167.39	167.75	168.10	168.02
Population increase rate (percentage)	-	0.43	0.47	0.42	0.36	1.72	0.22	0.22	0.21	-0.05
Number of births (people)[1/]	10,359	11,024	10,958	10,490	10,756	10,072	9,739	9,699	8,933	8,077
Birth rate per 1,000 people	12.35	13.08	12.94	12.34	12.61	11.61	11.20	11.13	10.23	9.25
Number of deaths (people)[1/]	6,066	6,145	6,186	6,438	6,480	6,840	7,046	6,671	6,925	7,314
Mortality per 1,000 people	7.23	7.29	7.31	7.57	7.59	7.88	8.10	7.65	7.93	8.38
Natural increase rate of Population per 100 people	0.51	0.58	0.56	0.48	0.50	0.37	0.31	0.35	0.23	0.09
Number of people moving in (person)[1/]	42,233	43,792	41,771	38,888	36,989	35,168	36,385	34,980	37,256	36,185
Number of people moving out (person)[1/]	39,118	44,536	37,903	39,772	38,760	36,638	36,792	36,511	37,793	37,214
Number of houses (houses)	268,900	275,331	281,758	287,882	293,877	299,569	304,876	309,377	314,365	319,619
Rate of change (percentage)	-	2.39	2.33	2.17	2.08	1.94	1.77	1.48	1.61	1.67

Note : [1/] The number of births, deaths, moving in, and out may not correlate with the population in the next year. Since there may be a registration, that is, the name has not been registered / sold out from the registration system.

Source : Department of Provincial Administration, Ministry of Interior, B.E.2562, searching in January B.E.2563

c) Population structure

The population structure was divided by age. In B.E. 2562, a ratio of males to females of newborn population were 106, labor population was 98 and elderly was 74, respectively. With a gender ratio of the entire population equal to 94. It indicated that in the childhood population, there were more male population than females. While growing up, there was a tendency that the female population continuously increases. This was consistent with studies of Pramote Prasartkun and Pattama Vapattanawong (B.E.2551)[1], indicating that Thai population at birth would had slightly more males than females. The gender ratio at birth was 105, considering as a normal gender ratio. When growing up, the mortality rate of the male population was higher than the female population of all age groups. Important biological factors made women less at risk of death than men. For the same reason, this may be one of the causes that could change the sex ratio. In addition, as time goes by, the male ratio of the entire population decreases. Beside of the difference between genders as the male mortality rate was greater than females, the migration due to the migration behavior of males could be the cause as males has the tendency to migrate over long distances. For the sex ratio of children (ages 0-14 years) and labor age (ages 15-59 years), their ratios was increase .The elderly (aged 60 years and older) had a reduced sex ratio. Details were shown in **Table 3.4.1-4.** When considering the population pyramid, it showed that the pyramid of the labor age population had the highest proportion, as seen in **Figure 3.4.1-4.**

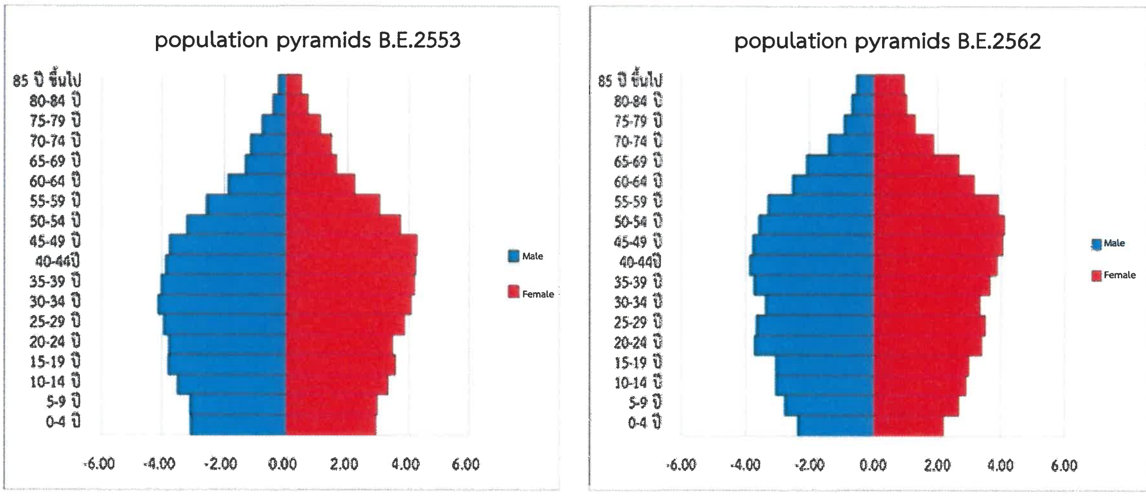


Figure 3.4.1-4 **Comparative population pyramids B.E.2553 and B.E.2562**

Table 3.4.1-4

Comparison of population structure and population proportion classified by sex and age of Ratchaburi in B.E.2553 and B.E.2562

B.E.	B.E.2553						B.E.2562					
Age group	Population (people)			Proportion by gender (percent)		Sex ratio by age group[1/]	Population (people)			Proportion by gender (percent)		Sex ratio by age group[1/]
	Male	Female	sum	Male	Female		Male	Female	sum	Male	Female	
0-4 yrs.	25,294	24,042	49,336	3.08	2.92		19,880	18,221	38,101	2.37	2.17	
5-9 yrs.	25,504	24,334	49,838	3.10	2.96	105	23,416	22,397	45,813	2.79	2.66	106
10-14 yrs.	28,829	27,298	56,127	3.51	3.32		25,760	24,348	50,108	3.06	2.90	
15-19 yrs.	31,264	29,417	60,681	3.80	3.58		25,681	25,035	50,716	3.06	2.98	
20-24 yrs.	31,108	28,555	59,663	3.78	3.47		31,340	28,561	59,901	3.73	3.40	
25-29 yrs.	32,378	31,822	64,200	3.94	3.87		30,734	29,444	60,178	3.66	3.50	
30-34 yrs.	33,967	33,544	67,511	4.13	4.08		28,489	28,103	56,592	3.39	3.34	
35-39 yrs.	33,116	34,365	67,481	4.03	4.18	96	31,372	30,785	62,157	3.73	3.66	98
40-44 yrs.	31,952	34,862	66,814	3.89	4.24		32,616	32,728	65,344	3.88	3.89	
45-49 yrs.	30,866	35,078	65,944	3.76	4.27		31,701	34,074	65,775	3.77	4.05	
50-54 yrs.	26,383	30,796	57,179	3.21	3.75		30,217	34,566	64,783	3.59	4.11	
55-59 yrs.	21,137	25,127	46,264	2.57	3.06		27,861	32,928	60,789	3.31	3.92	
60-64 yrs.	15,322	18,439	33,761	1.86	2.24		21,332	26,410	47,742	2.54	3.14	
65-69 yrs.	10,840	13,487	24,327	1.32	1.64		17,655	22,446	40,101	2.10	2.67	
70-74 yrs.	9,375	12,167	21,542	1.14	1.48	75	11,797	15,767	27,564	1.40	1.88	74
75-79 yrs.	6,270	9,127	15,397	0.76	1.11		7,633	10,765	18,398	0.91	1.28	
80-84 yrs.	3,500	5,976	9,476	0.43	0.73		5,582	8,591	14,173	0.66	1.02	
85 yrs. Up	2,198	4,225	6,423	0.27	0.51		4,310	8,035	12,345	0.51	0.96	
Total	**399,303**	**422,661**	**821,964**	**48.58**	**51.42**		**407,376**	**433,204**	**840,580**	**48.46**	**51.54**	
Sex ratio of population[2/]				94			Sex ratio of population[2/]			94		

Due to information from the Department of Provincial Administration The Interior Ministry has separated the population by age. Only people with Thai nationality and As for the population of non-citizens And whose name is in the house registration Those whose names are in the central house register And and those in the process of moving do not have the following age population classification

Population according to the status of the person	B.E.2553			B.E.2562		
	Male	Female	sum	Male	Female	sum
People of Thai nationality and whose name is on the house registration	399,303	422,661	**821,964**	407,376	433,204	**840,580**
Those who are not of Thai nationality and whose name is on the house registration	4,984	3,799	**8,783**	12,287	10,602	**22,889**
Those whose names are in the central house register[3/]	3,784	1,953	**5,737**	4,015	2,333	**6,348**
Those who are in the process of moving[4/]	1,523	1,057	**2,580**	1,999	1,283	**3,282**
Person of Thai nationality and whose name is on the household registration of the lunar year	5	6	11	0	2	2
Total population	**409,599**	**429,476**	**839,075**	**425,677**	**447,424**	**873,101**

Note : [1/]Sex ratio means Number of Male per Female 100 people

[2/]Sex ratio is calculated by Consultants of Technology Co.,LTD

[3/]Those whose names are in the central house register (Registration which the Director of the Central Registrar prescribes to be made for List people who may not have names in the household registration.)

[4/]Those who are in the process of moving (People who have moved but have not moved in)

Source : Department of Provincial Administration, Ministry of Interior, B.E.2562, searching in January B.E.2563

When considering the dependency ratio or the burden ratio classified by age group of the Bureau of Registration Administration, Department of Provincial Administration, Ministry of Interior, the population structure at each age was shown in **Table 3.4.1-5** and **Figure 3.4.1-5**. It showed that in B.E.2562, population of children (ages 0-14) had a ratio of 15.94%. The labor population between 15-59 years old, had a ratio of 64.98%. This was decrease from 10 years ago (B.E.2553) for 13.70% and 1.71%, respectively. The elderly age (age of 60 years and over) had a ratio of 19.07%, which was increase for 44.53% from 10 years ago (B.E.2553). The total dependency ratio in B.E.2562 was 53.89, increasing from the past 10 years (B.E.2553). Therefore, meaning that 100 people in labor age had to carry the burden for raising 25 children and 30 elderlies.

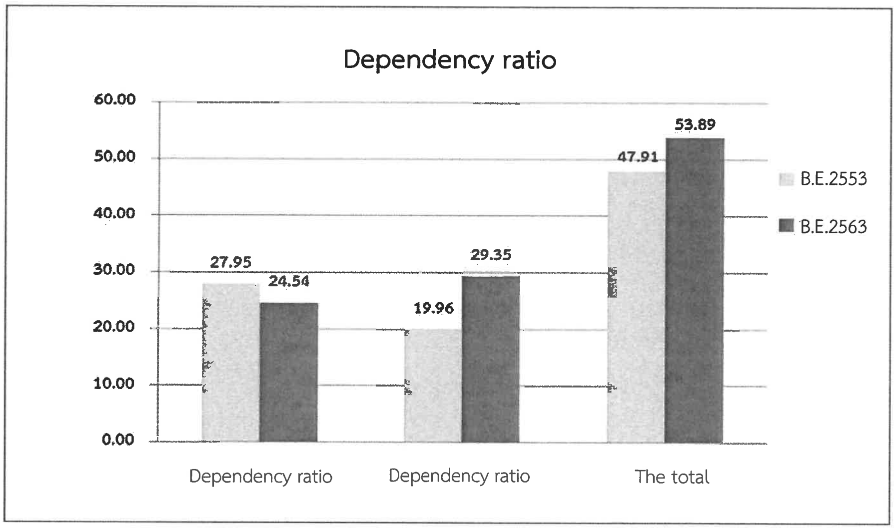


Figure 3.4.1-5 **Dependency ratio on labor age B.E.2553 and B.E. 2563**

d) Population change

According to the statistics of the registration office, Department of Provincial Administration, the statistics showed the statistic of birth, death, move in, move out (refer to **Table 3.4.1-3**). In B.E.2562, there were 8,077 births. Birth rate per 1,000 population was equal to 9.25. There were 7,314 death with the mortality rate per 1,000 population equal to 8.38. The natural growth rate of the population per 100 population were equal to 0.09. Over the last 10 years (B.E.2553-2562), the birth rate was continually greater than the death rate every year. For the migration, there were 36,185 people moving in and 37,214 people were moving out.

Table 3.4.1-5
Comparison of age structure and dependency ratio of population in Ratchburi in B.E.2553 and B.E.2562

Population characteristics	B.E.2553		B.E.2562		Change	
	people	Percentage	people	Percentage	people	Percentage
1. People who have Thai nationality and have their name on the house registration						
1.1 Male	399,303	48.58	407,376	48.46	8,073	2.02
1.2 Female	422,661	51.42	433,204	51.54	10,543	2.49
Total	**821,964**	**100.00**	**840,580**	**100.00**	**18,616**	**2.26**
Those who are not of Thai nationality and whose name is on the house registration	8,783	1.05	22,889	2.62	14,106	160.61
Those whose names are in the central house register	5,737	0.68	6,348	0.73	611	10.65
Those who are in the process of moving	2,580	0.31	3,282	0.38	702	27.21
Person of Thai nationality and whose name is on the household registration of the lunar year	11	0.00	2	0.00	-9	-81.82
Total	**839,075**	**100.00**	**873,101**	**100.00**	**34,026**	**4.06**
2. Population by age						
2.1 Childhood (0-14 yrs.)	155,301	18.89	134,022	15.94	-21,279	-13.70
2.2 Labor age (15-59 yrs.)	555,737	67.61	546,235	64.98	-9,502	-1.71
2.3 Old age (60 yrs. up)	110,926	13.50	160,323	19.07	49,397	44.53
Total	**821,964**	**100.00**	**840,580**	**100.00**	**18,616**	**2.26**
Those who are not of Thai nationality and whose name is on the house registration	8,783	1.05	22,889	2.62	14,106	160.61
Those whose names are in the central house register	5,737	0.68	6,348	0.73	611	10.65
Those who are in the process of moving	2,580	0.31	3,282	0.38	702	27.21
Person of Thai nationality and whose name is on the household registration of the lunar year	11	0.00	2	0.00	-9	-81.82
Total	**839,075**	**100.00**	**873,101**	**100.00**	**34,026**	**4.06**
3. Dependency ratio						
3.1 Childhood	155,301	27.95	134,022	24.54	-21,279	-3.41
3.2 Old age	110,926	19.96	160,323	29.35	49,397	9.39
Total dependence	**266,227**	**47.91**	**294,345**	**53.89**	**28,118**	**5.98**

Source : Department of Provincial Administration, Ministry of Interior, B.E.2562, searching in January B.E.2563

e) Population forecasting

From the population numbers of Ratchaburi since B.E.2553-2562, they showed the different trends of the population change. Meaning that Ratchaburi population tended to continuously increase as refer to **figure 3.4.1-3**, but non-registered population numbers had unstable increase and decreased trend. That is to say, the trend was continuously increased since B.E.2553 and then decreased in B.E.2557. After that, the trend was continuously increased before decreasing again in B.E.2561. The consulting company compared the 3 forecasting methods (4 sub-methods), (1) Complex Extrapolation Methods divided into 1) Simple Linear Regression and 2) Polynomial Curve (2) Ratio Extrapolation Methods, (3) Cohort – Survival Model Based on Mean Square Error : MSE

Forecasting method	Forecasting error measurement	R^2
(1) Complex Extrapolation Methods		
1) Simple Linear Regression	11,871,373.52 (1)	0.9299
2) Polynomial Curve	26,788,592.10 (2)	0.9526
(2) Ratio Extrapolation Methods	98,266,705.70 (3)	0.8336
(3) Cohort –Survival Model	937,352,573.50 (4)	0.9917

From the table, it showed that, complex extrapolation methods gave the lowest error of prediction values. When considering of R^2, **equal to 0.9299**. Haaland[1/](1989) and Hu[2/](1999) said that the equation with reliability should had an R^2 greater than 0.75. Thus, **the project selected the simple linear regression** for population prediction from household registration. **Polynomial Curve was selected** in predicting the non-registered population for 5 years, 10 years, 15 years and 20 years, respectively. The total forecasting values were shown in **Figure 3.4.1-6** and Appendix 3

(E) Provincial economic and social conditions

Ratchaburi is the center of the region, with trades of agricultural products and agricultural processed products as the main economic structure. It has a center of vegetable and fruit markets in the region. It is one of the largest agricultural markets in Thailand. Moreover, it has local markets along with livestock and feed mills. These are many in Pak Tho and Photharam districts. There are also other industries such as the electricity and natural gas industry, automotive industry, sugar industry, pulp and

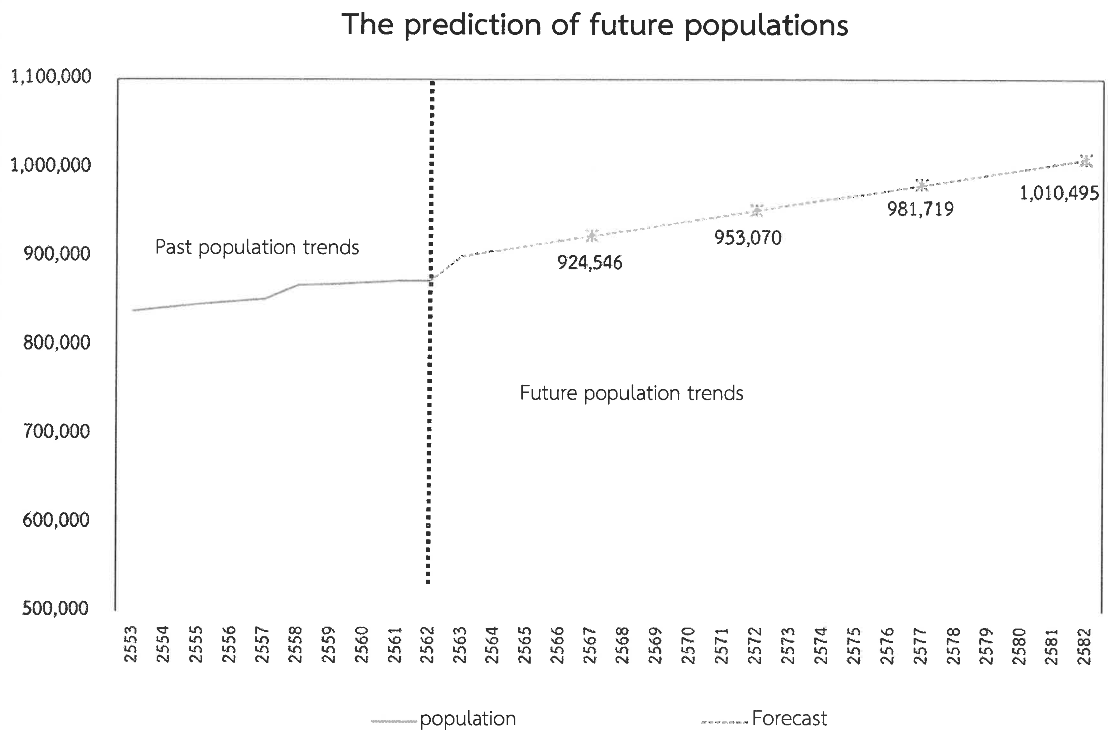


Figure 3.4.1-6 **The prediction of future populations of Ratchaburi**

paper industry and textile industry, etc. Ratchaburi is one of 14 provinces with large industrial estates in Thailand. The major commercial centers are distributed in the large urban areas such as Mueang Ratchaburi District and Ban Pong District, etc. These areas are the location of the regional centers and branch offices of many leading companies. It is also a province that has a continuously economic growth for every year, an average of 5-6 % per year, leading to the continuous investments in areas such as shopping centers, residences, companies, stores etc.

A) Gross domestic product

Gross domestic product of Ratchaburi, at the annual price in B.E.2560, was 172,591 million THB which had been decrease from B.E.2559 for 1.19%. It was divided into agricultural sector for 25,477 million THB and non-agricultural sector for 147,114 million THB. The top 3 of non-agricultural sector were an Industrial sector for 41,476 million THB, then electricity, gas, steam and air conditioning sectors for 38,403 million THB. Finally, wholesale, retail trade, repair of motor vehicles, motorcycles sectors for 15,982 million THB, respectively. They were shown in **Table 3.4.1-6** (source: Office of the National Economic and Social Development Council, B.E.2560)

B) **Agriculture**

Ratchaburi has a total area of 3,247,789 rais, which is an approximately agricultural area of 1,248,275 rais, or 38.43% of the province. There are 59,328 household registered farmers (source: Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, B.E.2561) with following details.

- **Plant production:** there are many types of valued economic crops as the area has the potential and suitability to produce plants. In addition, there are large industrial factories for supporting agricultural products sufficiently. Ratchaburi is also a center for agricultural processing industry and a center for governance, economy and transportation in the region. The statistical data on the agricultural production in B.E.2557-2561 is shown in **Table 3.4.1-7**. It was found that in B.E.2561 having the most sugarcane from the factory with agricultural products of 1,950,850 tons, followed by factorial cassava for 252,406 tons and pineapples for 179,765 tons, respectively. There were agricultural products that has a reduction tend, such as rice and sugarcane from the factory. Main factors that affected the quantity of agricultural products were the fluctuated prices of agricultural products each year. As a result, farmers had to change the type of cultivation according to the price of the crop in that year. Weather fluctuation was one the main factors as well as drought and floods that may affect the amount of products. From the above factors, the trend of agricultural products is unstable.

- **Livestock production**, in B.E.2562, there were 23,182 livestock farmers. Among these, there were 122,025 cows, 371 buffalos, 1,978,063 pigs, 11,751,574 chickens, 308,278 ducks, 18,406 goats and 967 sheep (source : Information and Communication Technology Center, Department of Livestock Development, B.E2562). For past statistics of each type of livestock numbers since B.E.2558-2562 were shown in **Table 3.4.1-8.** It was found that when compare the change rate of pigs and sheep between B.E.2562 and B.E.2561, the trend was increased for 3.48% and 20.57%, respectively. For the trend of cows, buffalos, chickens, ducks and goats were decreased for 6.96%, 20.90%, 11.34 %, 22.67% and 11.10%, respectively. Livestock numbers of each year tended to change unstably in each type of livestock. Factors that contributed to changes in the amount of each type of livestock were local demand for the consumption, population numbers, prices, the production capacity and export to foreign markets which fluctuated in each year. The weather fluctuation also affected growth as well as drought and floods that affected to animal feed production factors, including the epidemic problem.

Table 3.4.1-6

Gross domestic product of Ratchaburi, at the annual price in B.E.2560

category	Year (B.E.)									
	2551	2552	2553	2554	2555	2556	2557	2558	2559	2560
Agricultural	**19,387**	**20,851**	**19,221**	**20,492**	**22,747**	**24,632**	**25,388**	**24,680**	**27,702**	**25,477**
Agriculture, forestry and fishing	19,387	20,851	19,221	20,492	22,747	24,632	25,388	24,680	27,702	25,477
Non-agricultural	**94,427**	**101,619**	**114,253**	**118,729**	**122,813**	**119,958**	**129,372**	**138,032**	**146,940**	**147,114**
Mining and quarrying	1,543	1,602	1,629	1,759	1,922	1,817	1,683	2,067	2,315	2,497
Manufacturing	25,032	27,948	36,995	44,422	37,710	36,570	40,859	40,075	38,611	41,476
Electricity, gas, steam and air conditioning supply	29,328	30,082	32,641	27,513	32,648	31,047	31,885	37,810	42,027	38,403
Water supply; sewerage, waste management and remediation activities	498	562	554	594	577	744	854	947	959	869
Construction	2,517	2,931	2,774	2,798	3,694	3,514	4,899	5,145	5,759	5,510
Wholesale and retail trade and repair of motor vehicles	8,167	9,619	10,245	10,186	11,123	11,487	12,833	14,703	15,627	15,982
Transportation and storage	7,655	8,722	8,282	8,220	7,485	6,191	7,999	8,664	10,606	9,838
Accommodation and food service activities	254	297	333	361	366	426	474	582	733	999
Information and communication	643	597	613	695	700	660	746	801	674	664
Financial and insurance activities	3,119	3,207	3,275	3,554	4,019	4,458	4,997	5,509	6,155	6,278
Real estate activities	3,018	2,877	3,016	3,160	3,154	3,207	2,753	2,334	3,332	3,598
Professional, scientific and technical activities	16	15	14	21	13	17	18	22	26	31
Administrative and support service activities	268	273	281	280	249	262	283	318	326	356
Public administration and defence; compulsory social security	5,208	5,238	5,704	6,248	8,668	8,846	7,637	7,701	8,084	8,396
Education	4,292	4,512	4,685	5,523	6,584	6,657	7,187	6,900	7,001	7,163
Human health activities	2,234	2,488	2,456	2,531	2,735	2,940	3,151	3,281	3,457	3,716
Arts, entertainment and recreation	85	81	111	129	205	232	246	249	336	402
Other service activities	550	570	644	736	960	884	868	927	910	933
Gross provincial product (GPP)	**113,814**	**122,471**	**133,474**	**139,221**	**145,560**	**144,590**	**154,760**	**162,712**	**174,642**	**172,591**

Source: The Office of National Economic and Social Development Board, B.E. 2560, searching in March B.E 2563

Table 3.5.1-7

The statistical data on the agricultural production in B.E.2557-2561

Economic crops	Year (B.E.)								
	2557	2558		2559		2560		2561	
	Output quantity (tons)	Output quantity (tons)	Rate of change compared to B.E.2557 (Percentage)	Output quantity (tons)	Rate of change compared to B.E.2558 (Percentage)	Output quantity (tons)	Rate of change compared to B.E.2559 (Percentage)	Output quantity (tons)	Rate of change compared to B.E.2560 (Percentage)
Rice paddies	260,561	156,324	-40.00	170,125	8.83	165,076	-2.97	160,749	-2.62
Off-season rice	187,128	18,105	-90.32	7,821	-56.80	9,510	21.60	127,461	1240.28
Sugar cane	1,751,920	1,486,802	-15.13	1,558,619	4.83	2,176,731	39.66	1,950,850	-10.38
pineapple	120,186	104,544	-13.01	130,746	25.06	155,288	18.77	179,765	15.76
Cassava plant	268,009	182,701	-31.83	242,929	32.97	247,793	2.00	252,406	1.86

Source : Office of Agricultural Economics, B.E.2561, searching in March. B.E.2563

Table 3.4.1-8

The past statistics of each type of livestock numbers since B.E.2557-2562

Economic animal	Year (B.E.)								
	2558	2559		2560		2561		2562	
	Amount (number)	Amount (number)	Rate of change compared to B.E.2558 (Percentage)	Amount (number)	Rate of change compared to B.E.2559 (Percentage)	Amount (number)	Rate of change compared to B.E.2560 (Percentage)	Amount (number)	Rate of change compared to B.E.2561 (Percentage)
cow	144,401	118,891	82.33	144,401	21.46	131,154	-9.17	122,025	-6.96
buffalo	483	363	75.16	483	33.06	469	-2.90	371	-20.90
Pig	1,755,325	1,760,101	100.27	1,755,325	-0.27	1,911,625	8.90	1,978,063	3.48
chicken	11,699,532	14,753,651	126.10	11,699,532	-20.70	13,255,025	13.30	11,751,547	-11.34
duck	678,542	424,052	62.49	678,542	60.01	398,675	-41.25	308,278	-22.67
goat	18,305	18,449	100.79	17,594	-4.63	20,704	17.68	18,406	-11.10
sheep	710	703	99.01	748	6.40	802	7.22	967	20.57

Source : Information and Communication Technology Center, Department of Livestock Development, B.E2562, searching in March B.E. 2563

- **Fishery** : in B.E.2561, Ratchaburi has 3,022 households for fishery with areas of 24,346 rais. Important freshwater animals are catfish, carp, tilapia, shrimp and snakehead fish, etc. In B.E.2560, there were the most beautiful fish in the amount of 18,576 tons, then there were white shrimps for 2,860 tons and tilapia for 1,066.23 tons, respectively (source: Ratchaburi Fishery Office, B.E.2561), as seen in **Table 3.4.1-9**.

Table 3.4.1-9

Number of products classified by aquatic animals B.E.2561

No.	category	Quantity (tons)
1	Catfish	765.43
2	carp	449.04
3	Tilapia	1,066.23
4	Lobster	32.56
5	White Vannamei Shrimp	2,860
6	Beautiful fish	18,576
7	Snakehead fish	126
Total		**23,875.26**

Source : Ratchaburi Fisheries Office, B.E.2561, searching in January B.E.2563

C) Industry

Numbers of industrial factories in Ratchaburi in B.E.2560 as Ratchaburi had the high investment in industrial, there were a total of 1,762 industrial factories with a capital investment of 115,522 million THB with a total of 70,776 workers (divided into 42,700 men and 28,076 women). There were 381 other industries (sports equipment, cosmetics and toys, etc.), followed by 227 food factories and 168 non-metal factories. Details were shown in **Table 3.4.1-10** (source: Ratchaburi Provincial Industrial Office, B.E.2560).

D) Mining

Ratchaburi areas have a Permain stone. The name of Ratchaburi is used as the name of a stone group in the geological layer of Thailand. The Ratchaburi stone group is the name used to refer to the Permian stone group that spread to the west. The distinctive feature of the carbonate stone group, especially limestone, emerges as long mountains on plain lands that looks like a wall and clearly visible along Petchkasem route from Mueang Ratchaburi District toward Khao Yoi district Phetchaburi. These mountains are Khao Ngu, Khao Prathap Chang, Khao Bin, Khoa Kula, Khoa Phrik, etc. Most mountains are consisted of limestone and dolomite. Historical data of produced mineral content classified by mineral type since B.E.2556 -2560 were shown in **Table 3.4.1-11.** It showed that, in B.E.2560, the total amount of produced minerals were 4,873,408.60 tons which increasing from B.E.2559 for 23.76% (source: Department of Primary Industries and Mines, Ministry of Industry, B.E.2560). There are 28 mining plots which are 5 Feldspar mines locating in Ban Bueng Sub-district, Ban Kha District, 15 limestone industrial mining for the construction industry locating in Thung Luang and Ang Hin Subdistricts, Pak Tho District, Rang Bua and Chom Bueng Subdistricts, Chom Bueng District, and Khao Changum Subdistrict, Photharam District. There are 8 ornamental stone minings, Granite type locating in Tha Khoei Subdistrict, Suan Phueng District, Nong Phan Chan Subdistrict, Ban Kha District and Khao Khlung Subdistrict, Ban Pong District.

E) Commerce

Ratchaburi is the regional center of the western region that has agricultural business. Therefore, the economic structure depends mainly on an agriculture. For historical data of the registration of a juristic person of Ratchaburi in B.E.2557-2561, it was shown in **Table3.4.1-12.** It showed that, in B.E.2561, there were totally 4,349 registered entities. When comparing the rate of change, the number of limited companies and registered ordinary partnership were increase by 11.52% and 100%, respectively. For the limited partnership, it was decreased for 3.14% when comparing to the data in B.E.2560.

F) Finance and banking

In B.E.2561, there were 82 commercial banks in Ratchaburi, with the deposits of 85,807 million THB and with 37,283 million THB of loans from commercial banks. For previous statistics data in B.E.2557-2561, it was shown in **Table 3.4.1-13**. It was found that the trend of the change on the office, the amount of deposits and loans tend to increase by 2.50%, 3.98% and 7.61%, respectively. In B.E.2560, numbers of offices tended to decrease slightly due to the behavior of financial service users had changed quite a lot. Users were increasingly turning to online transactions and online banking and the transaction at the branch had decreased. Therefore, the bank had opened a new type of automatic branch, in order to meet customers demands and more comprehensive financial transactions. The amount of deposits was likely to increase from the previous year, possibly due to economic growth and the adjustment of the bank strategy by launching new savings products to compete between commercial banks and sources of more savings to maintain the base. Therefore, the financial situation grew accordingly.

Table 3.4.1-10

Numbers of industrial factories in Ratchaburi in B.E. 2556 – 2560

Industry type	B.E.2556	B.E.2557		B.E.2558		B.E.2559		B.E.2560	
	Number (places)	Number (places)	Rate of change compared to B.E.2556 (Percentage)	Number (places)	Rate of change compared to B.E.2557 (Percentage)	Number (places)	Rate of change compared to B.E.2558 (Percentage)	Number (places)	Rate of change compared to B.E.2559 (Percentage)
Agriculture industry	108	118	9.26	121	2.54	121	0.00	121	0
Food industry	173	210	21.39	216	2.86	211	-2.31	227	7.58
Beverage industry	6	11	83.33	12	9.09	12	0.00	13	8.33
Textile industry	61	68	11.48	69	1.47	70	1.45	69	-1.43
Costume industry	11	13	18.18	13	0.00	11	-15.38	11	0.00
Leather industry	2	2	0.00	2	0.00	2	0.00	2	0.00
Wood industry and wood products	97	136	40.21	137	0.74	132	-3.65	134	1.52
furniture industry	23	28	21.74	29	3.57	27	-6.90	24	-11.11
paper products	18	23	27.78	24	4.35	22	-8.33	21	-4.55
Printing industry	4	3	-25.00	3	0.00	3	0.00	3	0.00
Chemical industry	42	61	45.24	60	-1.64	59	-1.67	62	5.08
Petrochemical and product industries	12	16	33.33	16	0.00	17	6.25	16	-5.88
Rubber industry	16	20	25.00	19	-5.00	19	0.00	19	0.00
Plastic industry	39	54	38.46	54	0.00	52	-3.70	57	9.62
Non-metallic industry	155	176	13.55	172	-2.27	168	-2.33	168	0.00
Metal industry	12	12	0.00	12	0.00	12	0.00	13	8.33
Metal products industry	109	119	9.17	116	-2.52	114	-1.72	122	7.02
Machinery industry	82	90	9.76	90	0.00	89	-1.11	87	-2.25
Electric industry	17	21	23.53	20	-4.76	20	0.00	19	-5.00
Transport industry	160	194	21.25	197	1.55	191	-3.05	193	1.05
Other industries (sports equipment Cosmetics and toys, etc.	211	366	73.46	337	-7.92	328	-2.67	381	16.16
Total	**1,358**	**1,741**	**28.20**	**1,719**	**-1.26**	**1,680**	**-2.27**	**1,762**	**4.88**

source: Ratchaburi Provincial Industrial Office, B.E.2560, searching in March B.E.2563

Table 3.4.1-11

Historical data of produced mineral content classified by mineral type since B.E.2556 -2560

Unit: tons

category	Year (B.E.)								
	2556	2557		2558		2559		2560	
	amount	amount	Rate of change compared to B.E.2556 (Percentage)	amount	Rate of change compared to B.E.2557 (Percentage)	amount	Rate of change compared to B.E.2558 (Percentage)	amount	Rate of change compared to B.E.2559 (Percentage)
- Feldspar (sodium - clump)	108,700.00	92,402.00	-14.99	126,017.00	36.38	135,464.00	7.50	188,596.00	39.22
Limestone (industrial stone, construction type)	4,342,807.50	4,213,401.40	-2.98	4,874,536.40	15.69	3,755,388.40	-22.96	4,679,812.60	24.62
- phosphate	4,342,807.50	4,213,401.40	-2.98	-	-	47,000.00	-	-	-
- Sandstone (industrial stone)	-	-	-	-	-	-	-	5000.00	-
The amount of mineral produced	**8,794,315.00**	**8,519,204.80**	**-3.13**	**5,000,553.40**	**-41.30**	**3,937,852.40**	**-21.25**	**4,873,408.60**	**23.76**

Note : - There is no information published at that year.

Source : Department of Primary Industries and Mines, Ministry of Industry, B.E.2560, searching in March B.E.2563

Table3.4.1-12

Historical data of the registration of a juristic person of Ratchaburi in B.E.2557-2561

Detail	Year (B.E.)									
	2557		2558		2559		2560		2561	
	Number (places)	Rate of change compared to B.E.2554 (Percentage)	Number (places)	Rate of change compared to B.E.2557 (Percentage)	Number (places)	Rate of change compared to B.E.2558 (Percentage)	Number (places)	Rate of change compared to B.E.2559 (Percentage)	Number (places)	Rate of change compared to B.E.2560 (Percentage)
Limited company	1,786	7.72	2,004	12.21	2,167	8.13	2,517	16.15	2,807	11.52
Limited partnership	1,481	-11.63	1,600	8.04	1,533	-4.19	1,590	3.72	1,540	-3.14
Ordinary Partnership	3	-57.14	3	0.00	1	-66.67	1	0.00	2	100.00
Total	**3,270**	**-2.13**	**3,607**	**10.31**	**3,701**	**2.61**	**4,108**	**11.00**	**4,349**	**5.87**

Source: National Statistical Office, B.E.2561, searching in March B.E.2563

Table 3.4.1-13

Commercial bank deposits and loans in B.E.2557-2561

category	Year (B.E.)								
	B.E.2557	B.E.2558		B.E.2559		B.E.2560		B.E.2561	
	amount	amount	Rate of change compared to B.E.2557 (Percentage)	amount	Rate of change compared to B.E.2558 (Percentage)	amount	Rate of change compared to B.E.2559 (Percentage)	amount	Rate of change compared to B.E.2560 (Percentage)
Office (places)	82	83	1.22	82	-1.20	80	-2.44	82	2.50
Deposit (million baht)	75,153	78,381	4.30	81,689	4.22	82,523	1.02	85,807	3.98
Loans (million baht)	48,357	51,266	6.02	33,538	-34.58	34,648	3.31	37,283	7.61

Source : Bank of Thailand, B.E.2561, searching in March B.E.2563

G) Labors in Ratchaburi

The labor situation in Ratchaburi in B.E.2562 showed that the population aged 15 years and over was 668,476 persona with a total of 459,655 persons were in the labor force. Among this group, it was classified as 453,819 employed, 5,217 unemployed and 619 persons waiting for the season. There were 213,699 persons who were out of the labor force. The data was shown in **Table 3.4.1-14.**

At present, the minimum wage is at the rate of 315 baht/day, according to the Announcement of the Wage Committee on the minimum wage rates (No. 10), effectived from January 1st , B.E. 2563 onwards.

Table 3.4.1-14

The labor situation in Ratchaburi in B.E.2562

Labor status	Numbers (person)
Population aged 15 years and over	668,476
Labor force	459,655
- Employed person	453,819
- Unemployed person	5,217
- Those waiting for the season	619
Out of labor force	213,699
Unemployment rate	**1.13**

Note : Unemployment rate = $\frac{\text{Unemployed x 100}}{\text{Labor force}}$

Source: Ratchaburi Provincial Labor Office, B.E. 2562, searching in January B.E.2563

H) The education

Ratchaburi has allocated schools and educational institutions for sufficient and thorough out the public demand as follows.

- **Vocational and higher education** totally 14 following places;

* There are 7 educational institutions under the Office of Vocational Education Commission, which are, Ratchaburi Technical College, Ratchaburi Polytechnic College Ratchaburi Technical College 2, Banpong Industrial And Community Education College, Photharam Technical College Ratchaburi Agricultural and Technology College and Paktho Industrial And Community Education College.

* There are 5 educational institutions under The Offices of the Private Education Commission, which are, Ratchaburi Business Administration School Darunaratchaburi Vocational College, Daruna Polytechnic Technological College, Ban Pong Business Administration-Technology School and Don Bosco Technical School Banpong.

* There were 2 public higher education institutions, which are, Muban Chom Bueng Rajabhat University and King Mongkut's University of Technology Thonburi, Ratchaburi Campus.

- **Educational institutions classified by educational system and affiliated** as below.

* Central Regional Institute for Non-Formal and Informal Education within 16 provinces are consisting of Kanchanaburi, Ratchaburi, Chai Nat, Sing Buri, Lopburi, Saraburi, Ang Thong, Phra Nakhon Si Ayutthaya, Pathum Thani, Suphanburi, Nakhon Pathom, Nonthaburi, Samut Sakhon, Samut Songkhram, Phetchaburi and Prachuap Khiri Khan (source: Central Regional Institute for Non-Formal and Informal Education, B.E.2562).

* There are 10 institutes for Non-Formal and Informal Education in the district level and 104 of such institutes in the sub-district level (source : Office of the Non-Formal and Informal Education Ratchaburi, B.E.2562).

* Ratchaburi Primary Educational Service Area Office 1 is responsible for primary schools locating in 6 districts, which are, Mueang Ratchaburi District, Pak Tho District, Chom Bueng District, Suan Phueng District, Ban Kha District, and Wat Phleng District (source : Ratchaburi Primary Educational Service Area Office 1, B.E.2562)

* Ratchaburi Primary Educational Service Area Office 2 is responsible for primary schools locating in 4 districts, which are, Ban Pong District Photharam District Damnoen Saduak District And Bang Phae District (source: Ratchaburi Primary Educational Service Area Office 2, B.E.2562).

* **The** Secondary Educational Service Area Office 8 is responsible for 26 secondary schools in Ratchaburi. There are 779 classrooms, 29,600 students and 1,599 teachers (source: **The** Secondary Educational Service Area Office 8, B.E.2562)

I) Religion and culture

- **Religion:** majority of Ratchaburi population are Buddhist. In B.E.2561, there were 438 temples 100 residences for monks, 19 Christian churches and 4 mosques. There were 5,223 monks and 311 novices (source: Ratchaburi Provincial Office of Buddhism, B.E.2561). The statistic data of temples, abbey, Christian churches mosques, monks and novices of Ratchaburi during B.E.2557-2561 were shown in **Table 3.4.1-15.** It was found that the tendency of changes in numbers of temples, abbey, churches, and mosques is stable. On the other hand, numbers of monks and novices were unstable, due to the ordination has been Thai tradition since ancient times. Thai men when they are ordained, they must ordain once in a lifetime to study the teachings of the Lord Buddha and inherit the age of Buddhism. It is a great charity for himself, his parents and relatives. Therefore, numbers of monks and novices can change at any time.

- **Culture:** Ratchaburi consists of 8 ethnics, which are, local Thai Ratchaburi, Chinese Ratchaburi, Khmer Ratchaburi, Karen Ratchaburi, Mon Ratchaburi, Schong (Song) Ratchaburi, Tai-Yuan Ratchaburi and Lao Wiang Ratchaburi. Each ethic has its own valuable unique and cultural identity. Ratchaburi is chosen as one of the 12 cities under the concept of "12 must-see cities" on the topic of public relations "Ratchaburi Art Community". Ratchaburi has important tourist attractions and tourist sites that are popular with tourists and more tourists come to visit every year. Ratchaburi is also outstanding in the city of contemporary art that can be developed as a product linked to various tourism (source: Ratchaburi briefing, B.E.2562), such as;

* Pottery with dragon pattern that are currently being developed into modern ceramic products with exotic beauty and practical for use.
* Hand-woven and coiled cloth products with distinctive patterns of Ban Khu Bua and Ban Don Rae, Mueang Ratchaburi District.
* Nang Yai Wat Khanon, Photharam District, it is an artwork that combines a variety of arts, including the pattern of the large leather painting, the art of performing dancing arts in conjunction with the music of the gamelan.
* Famous fabric doll production and distribution, Photharam District.

J) Safety of life and property

Ratchaburi is located in the central region in the west as a border province with an area adjacent to the Republic of the Union of Myanmar. The boundary of the border has the characteristic of high mountains and forest areas, such as Tenasserim Hills as a watershed border with a length of 73 kilometers. This border is in Suan Phueng and

Table 3.4.1-15

The statistic data of temples, abbey, Christian churches mosques, monks and novices of Ratchaburi during B.E.2557-2561

category	Year (B.E.)								
	B.E.2557	B.E.2558		B.E.2559		B.E.2560		B.E.2561	
	amount	amount	Rate of change compared to B.E.2557 (Percentage)	amount	Rate of change compared to B.E.2558 (Percentage)	amount	Rate of change compared to B.E.2559 (Percentage)	amount	Rate of change compared to B.E.2560 (Percentage)
Temple (place)	377	379	0.53	378	-0.26	431	14.02	438	1.62
Monk residence (place)	43	43	0.00	50	16.28	96	92.00	100	4.17
Christian church (place)	-	19	-	19	-	19	-	19	-
Mosque (place)	3	5	66.67	4	-20.00	4	0.00	4	0.00
Monk (number of)	5,277	4,951	-6.18	5,452	10.12	5,223	-4.20	5,223	0.00
Novice (mumber of)	235	376	60.00	1,003	166.76	311	-68.99	311	0.00

Source: Ratchaburi Provincial Office of Buddhism, B.E.256, searching in March B.E.2563

Ban Kha Districts. Ratchaburi has 13 channels along the border, which are, Tako Bon, Huay Kota, Tako Bhidthong, Huai Khok Moo, Tako Lang, Pong Hang, Huay Sood, Purakam, Khao Krachom, Krasung, Huai Mi, Ja Aeo and Bo Wi. There are 5 channels that vehicles can traveled by, which are, Tako Bon Tako Bhidthong, Tako Bhidthong, Khao Krachom, and Huai Khok Moo. From the above mention, it has been resulting in safety and security impacts on life and property from drug problems and illegal migrant workers due to bad economic conditions and the poverty of the neighboring countries. The interesting statistics of criminal cases in Ratchaburi during B.E.2557-2561 as seen in **Table 3.4.1-16.** It was found that, cases of violence against life, body and sex, and interesting cases tend to decrease by 29.5% and 25.6%, respectively. However, violence cases against property was increase by 13.8%, possibly, due to alt of changes of social conditions from the past, causing more stress and resulting in more violent behavior.

For the traffic accident problem resulting in the loss of life and property causing by many reasons, accident numbers were decreasing every year since B.E.2558 to B.E.2561. Numbers of deaths and injuries in B.E.2561 were decreased B.E.2560 for 9.77%, due to the strict enforcement of traffic regulations and the development of automotive technology, so that, cars were more efficiency in safety compared to the past as seen in **Table 3.4.1-17**.

K) Public utility

- **Electricity:** Ratchaburi has a procurement agency to distribute electric power to public in the residential areas, business sectors and agricultural area. It has expanded the area covering all 10 districts. In B.E.2561, there were totally 300,404 electricity consumers with the increased trend for 2.01% comparing to B.E.2560 (source: National Statistical Office, B.E.2561). It was increasing due to the raising of household consumption, increasing of demand for resources and increasing of the real estate development, resulting in more electricity consumers. For the statistic of electricity consumers since B.E.2557-2561, as seen in **Table 3.4.1-18**.

- **Waterworks:** Ratchaburi has 4 regional waterworks servicing, consisting of Provincial Waterworks Authority Ratchaburi, Provincial Waterworks Authority Ban Pong, Provincial Waterworks Authority Pak Tho, and Provincial Waterworks Authority Suan Phueng. These 4 regional waterworks cover 9 districts, excluding Ban Ka District where the regional waterworks servicing has not established yet. The statistics of water consumption since B.E.2557- B.E.2561 can be seen in **Table 3.4.1-19.** It was found that, in B.E.2561, there was an increasing rate of tap water consumers, actual amount of produced water and the amount of water sold by 3.07%, 11.85% and 0.08% respectively when

Table 3.4.1-16

Interesting statistics of criminal cases in Ratchaburi during B.E.2557-2561

Criminal case		Year (B.E.)				
		2557	2558	2559	2560	2561
Criminal and shocking cases	Number of cases	54	44	-	-	-
	Rate of change (percentage)	-10.0	-18.5	-	-	-
Cases of violence against life, body and sex,	Number of cases	414	501	502	390	275
	Rate of change (percentage)	17.3	21.0	0.2	-22.3	-29.5
Violence cases against property	Number of cases	617	676	678	796	906
	Rate of change (percentage)	7.5	9.6	0.3	17.4	13.8
Interesting case	Number of cases	395	497	497	82	61
	Rate of change (percentage)	-9.6	25.8	0.0	-83.5	-25.6

Note : - No information published at that yea

Source: Royal Thai Police, B.E.2561, searching in March B.E.2563

Table 3.4.1-17

Statistics of road traffic accidents and causes Of Ratchaburi in B.E.2557-2561

Road traffic accidents	Year (B.E.)				
	2557	2558	2559	2560	2561
Number of accidents[1/]	**1,139**	**1,980**	**1,942**	**1,418**	**1,039**
Rate of change (percentage)	-	73.84	-1.92	-26.98	-26.73
Number of people dead and injured[1/] (ราย)	**200**	**183**	**202**	**174**	**157**
Rate of change (percentage)	-	-8.50	10.38	-13.86	-9.77
- dead	122	107	110	83	72
- Injured	78	76	92	91	85
Cause of acciden[2/]					
- Drunk	3	4	-	-	-
- Not wearing a helmet	9	6	-	-	-
- Does not give the parking / turn / slow signal	34	71	-	-	-
- Refusing to have the right car	39	57	-	-	-
- Driving outside the lane	1	1	-	-	-
- Doze off	7	9	-	-	-
- Driving faster than the law	272	247	-	-	-
- Drive the car in front	193	357	-	-	-
- Driving in a tight way	81	143	-	-	-
- Drive the wrong lane	17	19	-	-	-
- Driving violates the mark / signal	7	9	-	-	-
- Driving across the dividing line	10	20	-	-	-
- Illegal overtaking	2	10	-	-	-
- Not skilled at driving	25	30	-	-	-
- Slow down / stop the car suddenly	4	4	-	-	-
- The car is broken, no sign / signal is shown	-	3	-	-	-
- Using the wrong light signal	3	2	-	-	-
- Violating the stop sign while exiting a joint / intersection	-	2	-	-	-
- Not driving in the far left lane	4	7	-	-	-
- Other	56	82	-	-	-

Note : - There is no accident event information published at that year.

Source : [1/] Royal Thai Police, B.E.2561 searching in March B.E.2563

[2/] National Statistical Office, B.E.2558 searching in March B.E.2563

Table 3.4.1-18

The statistic of electricity consumers since B.E.2557-2561

category	Year (B.E.)								
	2557	2558		2559		2560		2561	
	amount (Person)	amount (Person)	Rate of change compared to B.E.2557 (Percentage)	amount (Person)	Rate of change compared to B.E.2558 (Percentage)	amount (Person)	Rate of change compared to B.E.2559 (Percentage)	amount (Person)	Rate of change compared to B.E.2560 (Percentage)
Power users (person)	273,834	280,814	2.55	287,828	2.50	294,479	2.31	300,404	2.01
Electric power sold and used (KW / hour)									
Living house	526,271,320	561,453,777	6.69	604,725,779	7.71	617,942,512	2.19	630,177,495	**1.98**
Small establishments	234,706,713	254,108,390	8.27	258,898,639	1.89	262,580,351	0.00	264,820,047	**0.00**
Medium establishments	470,913,189	488,634,814	3.76	504,162,770	3.18	511,952,812	0.00	520,393,968	**0.00**
Large establishments	1,222,073,054	1,173,730,379	-3.96	1,049,676,734	-10.57	1,112,444,492	5.98	1,083,274,897	**-2.62**
Other 1/	27,903,327	29,062,521	4.15	30,409,598	4.64	30,791,840	1.26	36,350,033	**18.05**
Total	**2,481,867,603**	**2,506,989,881**	**1.01**	**2,447,873,520**	**-2.36**	**2,535,712,007**	**3.59**	**2,535,016,440**	**-0.03**

Note: 1/ The other groups consist of the consumer Specific business Non-profit organization Water pumping for agriculture Temporary electricity and free fire

Source : National Statistical Office, B.E.2561 searching in March B.E.2563

Table 3.4.1-19

The statistics of water consumption since B.E.2557- 2561

category	Year (B.E.)								
	B.E.2557	B.E.2558		B.E.2559		B.E.2560		B.E.2561	
	amount	amount	Rate of change compared to B.E.2557 (Percentage)	amount	Rate of change compared to B.E.2558 (Percentage)	amount	Rate of change compared to B.E.2559 (Percentage)	amount	Rate of change compared to B.E.2560 (Percentage)
Water user (person)	45,303	47,221	4.23	49,451	4.72	50,905	2.94	52,470	3.07
Actual water production (Cubic meter)	16,337,769	16,670,214	2.03	18,384,398	10.28	21,203,352	15.33	23,716,826	11.85
Sale Water content (Cubic meter)	11,741,931	12,594,818	7.26	13,448,531	6.78	13,523,347	0.56	13,534,388	0.08

Source : National Statistical Office, B.E.2561 searching in March B.E.2563

compared to the data of B.E.2560. The trend of water consumption is increasing every year. This might be due to economic expansion resulting in communities separating from large families to smaller families.

- **Technology and communication,** in B.E.2561, there were 213,164 computer users, 447,868 internet users and 644,547 mobile phone users. This situation occurs because, at the present, people can use the internet through mobile phone. It was convenient to use, resulting in the increasing rate of mobile phones and the internet users. The statistics on number of population using the service since B.E.2557- B.E.2561 can be seen in **Table3.4.1-20.**

(F) Summary of general social-economic conditions of Ratchaburi

Ratchaburi is located in the western central region and approximately 100 kilometers away from Bangkok. Ratchaburi has an area of 5,196.465 sq.m., or approximately 3,247,789 rais, representing 11.27% of the western region (in 5 provinces). The border area is adjacent to the Republic of the Union of Myanmar, having the Tenasserim Mountains as a border watershed with the length of approximately 73 kilometers. Ratchaburi has Mae Klong River as the main river with a length of approximately 67 kilometers flowing in the area. There are approximately 1,248,275 rais of agricultural area or 38.43% of the total area. The highest volume of agricultural product is sugar cane factory for 1,950,850 tons, followed by cassava for 252,406 tons and pineapples for 179,765 tons, respectively. Most of the production structure is food industry. Ratchaburi is also the regional center of the western region that has agricultural business with a center for fruit and vegetable markets in parallel with raising livestock. As for the current minimum wage in Ratchaburi, at present, the rate is 315 THB /day. Ratchaburi is therefore a center for the agricultural and livestock processing industry of the country.

Table3.4.1-20

The statistics of usages of communication techonolgy and service since B.E.2557- 2561

Type of technology and communication	Year (B.E.)								
	2557	2558		2559		2560		2561	
	amount	amount	Rate of change compared to B.E.2557 (Percentage)	จำนวน	Rate of change compared to B.E.2558 (Percentage)	amount	Rate of change compared to B.E.2559 (Percentage)	amount	Rate of change compared to B.E.2560 (Percentage)
Available phone numbers [1/]									
TOT Public Company Limited	56,552	56,296	-0.45	56,250	-0.08	-	-	-	-
Concession company	39,519	39,519	0.00	39,519	0.00	-	-	-	-
Telephone number with tenants									
TOT Public Company Limited	35,113	32,362	-7.83	30,344	-6.24	-	-	-	-
Business	4,614	4,602	-0.26	4,624	0.48	-	-	-	-
Residence	25,169	22,433	-10.87	20,440	-8.88	-	-	-	-
Government agency	2,206	2,201	-0.23	2,199	-0.09	-	-	-	-
Public phone [2/]	2,297	2,297	0.00	2,254	-1.87	-	-	-	-
Unable to specify type	1	3	200.00	1	-66.67	-	-	-	-
Concession company	16,211	14,153	-12.70	11,224	-20.70	-	-	-	-
Computers / Internet / Mobile phones									
Using a computer (person)	247,349	258,614	4.55	223,322	-13.65	208,801	-6.50	213,164	2.09
Internet use (person)	240,150	318,461	32.61	352,803	10.78	387,498	9.83	447,868	15.58
Having a Mobile phone (person)	557,075	589,759	5.87	613,874	4.09	635,344	3.50	644,547	1.45

Note : - Not publishing information at that year

1/ With public and fixed telephone numbers

2/ Show only information that TOT Public Company Limited operates by itself, excluding those that TOT Public Company Limited rented cabinets / machines. And which give rights to the Communications Authority of Thailand (CAT)

Source : National Statistical Office, B.E.2561 searching in March B.E.2563

(2) Socio-economic status at the district level

The study area of the project covers the area of Mueang Ratchaburi District. The social-economic condition at the district level can be briefly described as follows.

1) Mueang Ratchaburi District

(A) Location and government

Mueang Ratchaburi District is located in the middle toward the east of Ratchaburi with an area of 268,637 sq.m., or 430.30 rais. The border connects to the neighboring districts as follows.

North	connects to	Photharam and Bang Phae Districts
East	connects to	Damnoen Saduak and Bang Khonthi Districts Samut Songkhram
South	connects to	Wat Phleng and Pak Tho Districts
West	connects to	Chom Bueng and Pak Tho Districts

(B) History and settlements

Mueang Ratchaburi District Mueang Ratchaburi District was formerly known as Ratchaburi canton, which was a part of the "Dvaravati" Kingdom of Laos. Both the name of Ratchaburi appeared to have taken the name of Thailand in India to be the name given to the city. Sri Thammasokraj, King of Central Indian was the builder in B.E.210 as the colonization city of the kingdom. It was located in Ban Rai Subdistrict (Formerly known as U-Reua Sub-district). After King U-Thong (the governor of U Thong) built a new Ratchaburi city at Wat Mahathat, locating to the north of the town hall (old one) on the right bank of the Mae Klong River. Later on, in B.E.2360 (Ratanakosin Era. 36), during the reign of King Phra Buddha Lertlah Napalai Of Rattanakosin, The King ordered to move the city of Ratchaburi to located on the left bank of the Mae Klong River. Moreover, in B.E.2440 (Ratanakosin Era. 116), it began to organize local government, therefore, Ratchaburi was moved city to be located at the Town Hall of Ratchaburi (former Town Hall). During that time, the local government was divide into 5 districts. Later on, around Mueang Ratchaburi District office had some improvement to become a shopping center. Mueang Ratchaburi District office was then moved out and built at the District Road (adjacent to Ratchaburi City Hall) Since B.E.2517 until the present.

(C) Government

The government of Mueang Ratchaburi District is divided into 2 parts, which are 2 2 provincial administrations, 1 8 7 villages, and the local government (1 municipality, 4 district Municipalities and 17 sub-district administrative organizations as seen in **Table 3.4.1-21.**

Table 3.4.1-21

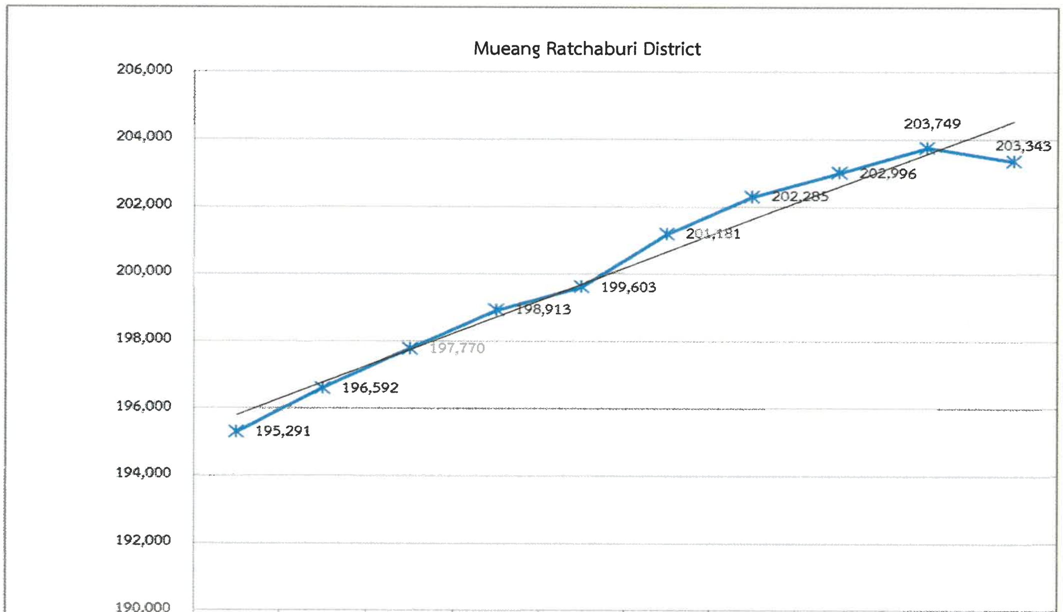
Administrative area of Mueang Ratchaburi District Ratchaburi

Rule provincial	Local government	
	Municipality	Subdistrict Administrative Organization (SAO)
- Na meaung	- Ratchaburi Municipality	
- Chedi Hak	- Khao Ngu Sub-district municipality	- Chedi Hak SAO
- Don Tako		- Don Tako SAO
- Nong Klang Na		- Nong Klang Na SAO
- Huay Phai		- Huay Phai SAO
- Khung nam won		- Khung nam won SAO
- Khung krathin		- Khung krathin SAO
- Ang Thong	- Huai Chin Si Sub-district Municipality	
- Khok mor	- Lak Muang Subdistrict Municipality	
- Sajm reion		- Sajm reion SAO
- Pikulthong		- Pikulthong SAO
- Namphu		- Namphu SAO
- Don Rae		- Don Rae SAO
- Hin kong		- Hin kong SAO
- Khao raeng		- Khao raeng SAO
- Koh pubpla		- Koh pubpla SAO
- Lum Din	- Lum Din Sub-district Municipality	
- Bangpa		- Bangpa SAO
- Pongsawai		
- Khu Bua		- Khu Bua SAO
- Tharab		- Tharab SAO
- Banrai		- Banrai SAO

(D) Size and population

A) Population numbers

Population data in Mueang Ratchaburi District according to the civil registration of Department of Provincial Administration, Ministry of Interior in B.E.2562 showed that, there were 203,343 population. They are divided into 99,770 males and 103,573 females, with a population density of 472.56 persons/sq.km. The birth rate/1,000 persons is 20.87. The death rate/1,000 persons is 12.86. Natural growth rate/100 persons is 0.80%. There are 11,101 persons moving in with 13,932 persons that moving out. Household numbers had increased from 65,514 units in B.E.2553, to 78,445 units in B.E.2562. The rate of change was increasing by 19.74%, as seen in **Table 3.4.1-22**. For population trends during B.E.2553-2562 were shown in **Figure 3.4.1-7.**



	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562
Population	195,291	196,592	197,770	198,913	199,603	201,181	202,285	202,996	203,749	203,343

Figure 3.4.1-7 Population trends during B.E.2553-2562

B) Forecasting populations of Mueang Ratchaburi District

From data ta of population numbers living in Mueang Ratchaburi District since B.E.2553-2562 (source: Department of Provincial Administration, Ministry of Interior, retrieved in April B.E.2563) (Table5.1-17), it showed the continuously increase trend.

Table 3.4.1-22

Population statistics in Mueang Ratchaburi District B.E.2553-2562

List	Year (B.E.)									
	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562
Number of population from registration (person)	195,291	196,592	197,770	198,913	199,603	201,181	202,285	202,996	203,749	203,343
- male	96,296	97,091	97,624	98,100	98,090	98,779	99,468	99,775	100,285	99,770
- female	98,995	99,501	100,146	100,813	101,513	102,402	102,817	103,221	103,464	103,573
Population density (person per square kilometer)	453.85	456.87	459.61	462.27	463.87	229.56	470.10	471.75	473.50	472.56
Population increase rate (percentage)	-	0.67	0.60	0.58	0.35	0.79	0.55	0.35	0.37	-0.20
Number of births (people)	4,737	5,131	5,229	5,161	5,270	4,982	5,010	4,986	4,569	4,243
Birth rate per 1,000 people	24.26	26.10	26.44	25.95	26.40	24.76	24.77	24.56	22.42	20.87
Number of deaths (people)	1,393	1,411	1,362	2,121	2,449	2,673	2,707	2,432	2,552	2,616
Mortality per 1,000 people	7.13	7.18	6.89	10.66	12.27	13.29	13.38	11.98	12.53	12.86
The rate of natural increase of the population per 100 people.	1.71	1.89	1.96	1.53	1.41	1.15	1.14	1.26	0.99	0.80
Number of people moving in (person)[1/]	12,204	12,744	12,587	11,774	11,123	10,889	11,656	10,790	12,347	11,101
Number of people moving out (person)[1/]	11,853	11,964	12,282	14,510	14,453	13,583	13,840	13,608	14,717	13,932
Number of houses (houses)	65,514	67,120	68,959	70,368	71,915	73,406	74,814	75,860	77,118	78,445
Rate of change (percentage)	-	2.45	2.74	2.04	2.20	2.07	1.92	1.40	1.66	1.72

Note : [1/] The number of births, deaths, moving in, and out may not correlate with the population in the next year. Because there may be a fall

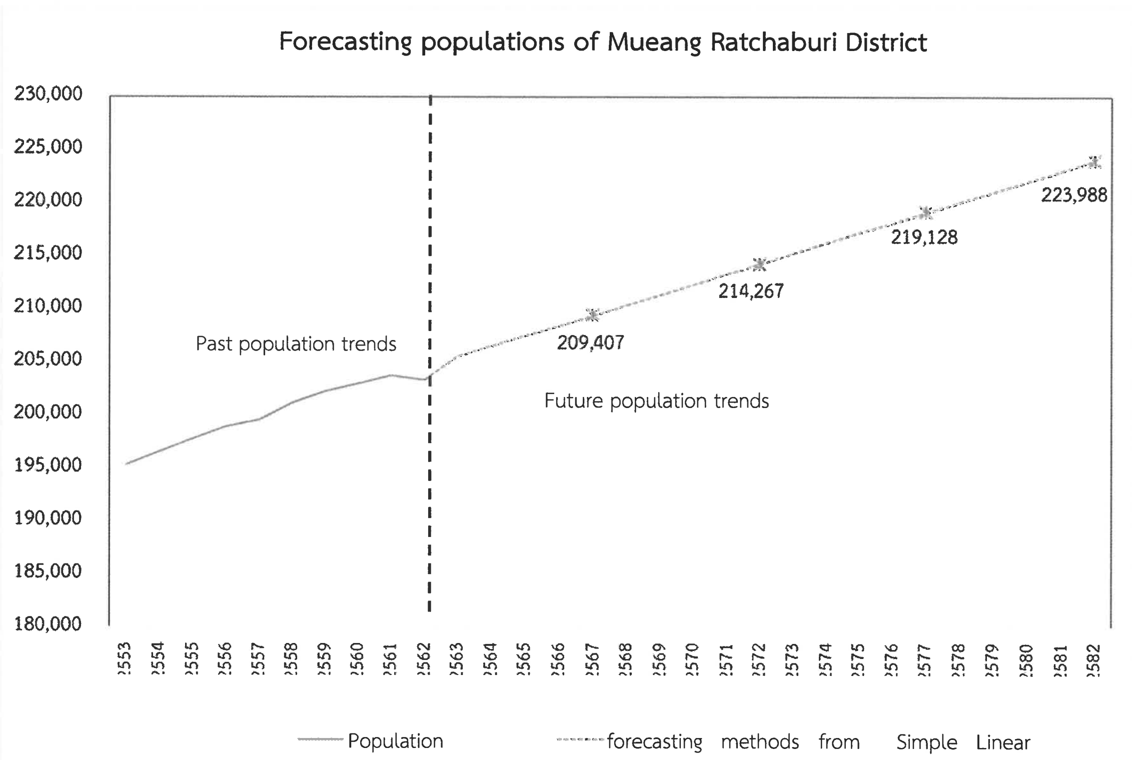
Meaning no name is registered / sold out from the registration system

Source : Department of Provincial Administration, B.E.2562 searching in January B.E.2563

Thus, the suitable forecasting methods for the predictions are (1) Complex Extrapolation Methods (2) Ratio Extrapolation Methods. The method providing the lowest error value would be considers. This will consider from Mean Square Error (MSE) with following details in **Appendix 3-1**

Forecasting method	Forecasting Mean Square Error (MSE)	R^2
(1) Complex Extrapolation Methods		
1) Simple Linear Regression	267,162.97 (1)	0.9832
(2) Ratio Extrapolation Methods	633,655.90 (2)	0.9609

From the table, it showed that, <u>Complex Extrapolation Methods</u> gave the lowest error of prediction values. When considering of **R^2 equal to 0.9832,** in which Haaland[1/](1989) and Hu[2/](1999) said that the equation with reliability should had an R^2 greater than 0.75. Thus, the ratio extrapolation method was used for the forecasting of population for the next 5years, 10years, 15years and 20years, respectively. The total forecasting values were shown in **Figure 3.4.1-8.**



<u>Figure 3.4.1-8</u> Predeicted future populations of Mueang Ratchaburi District

(E) Socio-economic conditions

The mainly topography is river plains (Mae Klong river). On the north side is mountainous and undulating, large plains and farming on both sides of the Mae Klong River. There is an irrigation system for the Khlong Khoi canal. For more than 50% of the area are agricultural areas as a large paddy field such as Thung Don Rae - Huai Phai, Thung Khao Raeng - Nong Klang Na, Thung Khu Bua-Don Tako, and Thung Tha Rap - Pikul Thong. There are fruit orchards along both banks of the Mae Klong River in parallel to the south of Samut Songkhram. Mueang Ratchaburi District has a diverse population because houses were built together in clusters with a long cultured government for many generations. Most of population are Thai-Chinese and Thai-Yuan people, as well as other races such as Laos, Mon and Khmer. For the industry, there are 421 licensed and operated industrial plants.

For the education, there are 3 vocational schools, 77 secondary schools, 84 elementary schools. There are public health services dividing into 6 public and private hospitals and 26 health promotion hospitals. For religion and culture, there are 96 temples, 6 abbeys, 3 Christian churches and 1 mosque.

(3) Socio-economic conditions in the study area

The study area covers 6 sub-districts, 1 municipality, including Hin Kong Sub-district, Huai Phai Subdistrict, Chedi Hak Subdistrict, Ko Plub Pla Subdistrict, Don Tako Subdistrict, Don Rae Subdistrict, and Khao Ngu Subdistrict in Mueang Ratchaburi District, Ratchaburi. Social-economic conditions in the study area can be explained as follows.

1) Hin Kong Subdistrict Administration Organization (Project location)

(A) Location and territory

It has approximately 2,212 sq.km., or approximately 1,382,500 rais with the territory adjacent to the nearby area as follows.

North	connects to	Pak Chong Subdistrict, Chom Bueng District
South	connects to	Huai Phai Subdistrict, Mueang Ratchaburi District
East	connects to	Ko Plub Pla and Chedi Hak Subdistricts, Mueang Ratchaburi District
West	connects to	Chom Bueng and Namphueng Subdistrict, Mueang Ratchaburi District

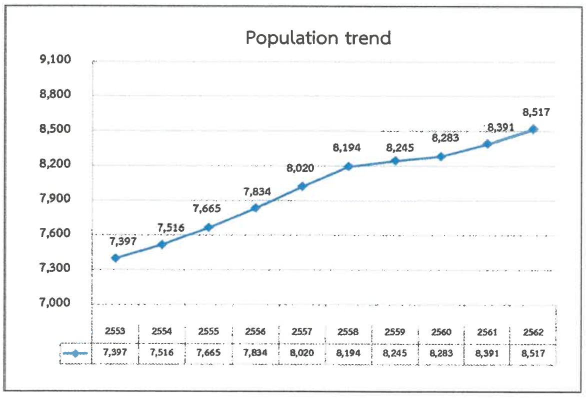
Hin Kong SAO divides the administrative area into 11 villages which are Moo. 1, Ban Hin Kong, Moo. 2, Ban Ruak Khwang, Moo.3, Ban Nong Ta Luang, Moo. 4, Ban Nong Sadao Lang, Moo. 5, Ban Nong Rak, Moo. 6, Ban Nong Sadao Bon, Moo. 7, Ban Huai Pladuk, Moo. 8, Ban Nong Yai Kata, Moo. 9, Ban Thung Lai Kai, Moo.10, Ban Nong Krathum and Moo.11, Ban Thung Noi.

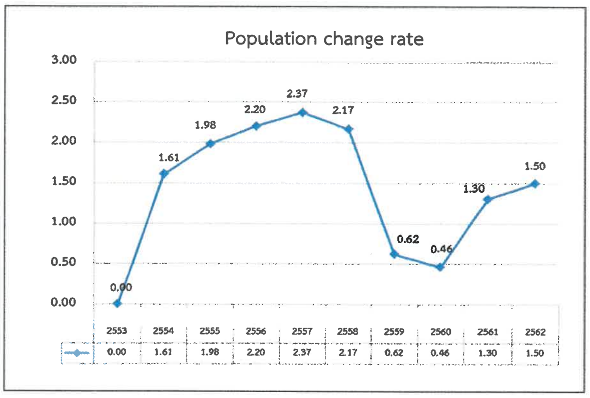
For the villages in the study area, there are 10 villages, which are Moo.1, Ban Hin Kong, Moo.2, Ban Ruak Khwang, Moo.3, Ban Nong Ta Luang, Moo. 4, Ban Nong Sadao Lang, Moo.5, Ban Nong Rak, Moo. 6, Bang Nong Sadao Bon, Moo.7, Ban Huay Pladuk, Moo.8, Ban Nong Yai Kata, Moo.9, Ban Thung Lai Kai and Moo.10, Ban Nong Krathum.

(B) Demographic information

A) Population numbers

From population data according to the population registration of Department of Provincial Administration, the Ministry of Interior, it was found that in B.E.2562, there were total of 8,517 populations which divided into 4,132 men and 4,385 women with 3,024 households. Details were shown in **Table 3.4.1-23.** For the population trend in the past 10 years (B.E. 2553 - 2562), it showed the increased population trend. When using the rate of change of population to create a graph, the population density can be calculated as 696.97 persons/sq.km. Details as shown **Figure 3.4.1-9.** No number of birth but the number of deaths was 40. The calculation of the natural growth rate of the population per 100 people, with a negative value of 4.00. There were 403 population of moving in and there were 207 population moving out, as shown in **Figure 3.4.1-10.**





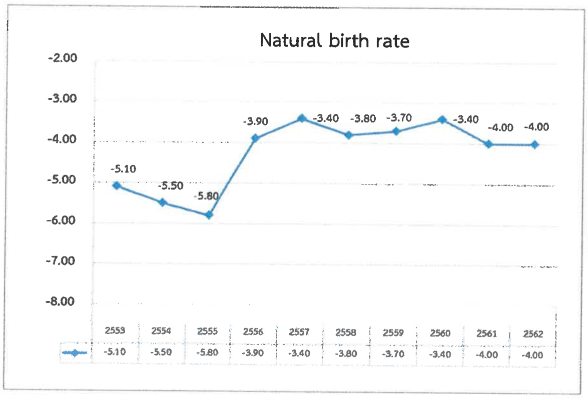
<u>Figure 3.4.1-9</u> **Population trend and change rate in B.E.2553-2562**

Table 3.4.1-23
Hin Kong Population Statistics B.E.2553-2562

List	Year (B.E.)									
	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562
Number of population from registration (person)	7,397	7,516	7,665	7,834	8,020	8,194	8,245	8,283	8,391	8,517
- male	3,611	3,661	3,725	3,814	3,898	3,993	4,023	4,041	4,079	4,132
- female	3,786	3,855	3,940	4,020	4,122	4,201	4,222	4,242	4,312	4,385
Population increase rate (percentage)	-	1.61	1.98	2.20	2.37	2.17	0.62	0.46	1.30	1.50
Population density (person per square kilometer)	605.32	615.06	627.25	641.08	656.30	670.54	674.71	677.82	686.66	696.97
Change in population density	-	1.61	1.98	2.20	2.37	2.17	0.62	0.46	1.30	1.50
Number of births (people)	0	0	0	0	0	0	0	0	0	0
Birth rate per 1,000 people	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number of deaths (people)	51	55	58	39	34	38	37	34	40	40
Mortality per 1,000 people	6.89	7.32	7.57	4.98	4.24	4.64	4.49	4.10	4.77	4.70
The rate of natural increase of the population per 100 people	-5.10	-5.50	-5.80	-3.90	-3.40	-3.80	-3.70	-3.40	-4.00	-4.00
Number of people moving in (person)[1/]	453	415	500	442	477	437	405	347	421	403
Move-in rate (percent)	-	-8.39	20.48	-11.60	7.92	-8.39	-7.32	-14.32	21.33	-4.28
Number of people moving out (person)[1/]	233	237	297	214	226	217	300	242	252	207
Moving-out rate (percent)	-	1.72	25.32	-27.95	5.61	-3.98	38.25	-19.33	4.13	-17.86
Net migration per 100 population	2.97	2.37	2.65	2.91	3.13	2.68	1.27	1.27	2.01	2.30
Number of houses (houses)	2,262	2,340	2,448	2,535	2,613	2,717	2,774	2,836	2,938	3,024
House number change rate (percentage)	-	3.45	4.62	3.55	3.08	3.98	2.10	2.24	3.60	2.93

Note : [1/] The number of births, deaths, moving in, and out may not correlate with the population in the next year. Because there may be a fall
Meaning no name is registered / sold out from the registration system

Source : Department of Provincial Administration, B.E.2562 searching in January B.E.2563



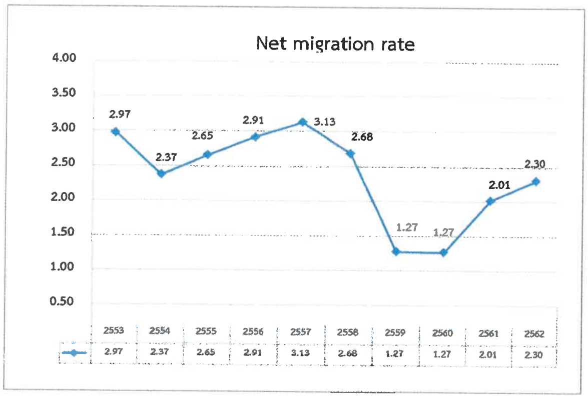


Figure 3.4.1-10 Natural birth rate and net migration rate B.E.2553-2562

(C) Economic and social conditions

The area has the character as a long line from the east to the west. The west side has a steeper slope than the east side. The eastern area will have agricultural area and dense population. Most population in the area are engaged in agriculture, such as farming, fruit and vegetable farming, animal husbandry such as pigs, fish and cattle farming. In addition, there are household industries such as weaving. Importance places of the district are Wat Hin Kong, Nong Ta Luang Temple, Huay Pladuk Temple, Nong Krathum Temple, and Wat Thung Noi.

2) Chedi Hak Subdistrict Administrative Organization

(A) Location and territory

Chedi Hak SAO had areas of 19.85 sq.km., or approximately 12,406.25 rais. It has the territory adjacent to nearby areas as follows.

North	connects to	Lum Din and Ko Plub Pla Subdistricts
South	connects to	Don Tako and Huai Phai Subdistricts
East	connects to	Na Mueang Subdistrict
West	connects to	Hin Kong Subdistrict

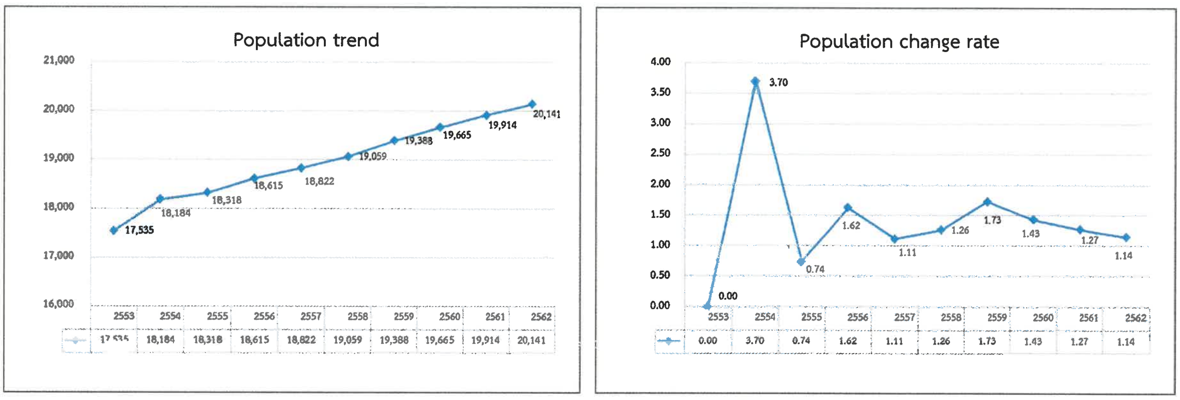
The administrative area is divided into 13 villages, which are: Moo. 2, Ban Nong Je, Moo.3, Ban Chedi Hak, Moo. 4, Ban Nong Chok, Moo.5, Ban Nong Chok, Moo. 6, Ban Rang Mai Daeng, Moo.7, Ban Thung Por, Moo.8, Ban Thung Tan, Moo.9, Ban Huai Mu, Moo.10, Baan Sa Sawat, Moo.11, Ban Chedi Nak, Moo.12, Ban Khao Mo, Moo.13, Samukkee, and Moo. 14, Kay Ha.

There are 6 villages locating in the study area, which are, Moo. 6, Ban Rang Mai Daeng, Moo.7, Ban Thung Por, Moo.8, Ban Thung Tan, Moo.9, Ban Huai Mu, Moo.10, Ban Sa Sawat and Moo.12, Ban Khao Mo.

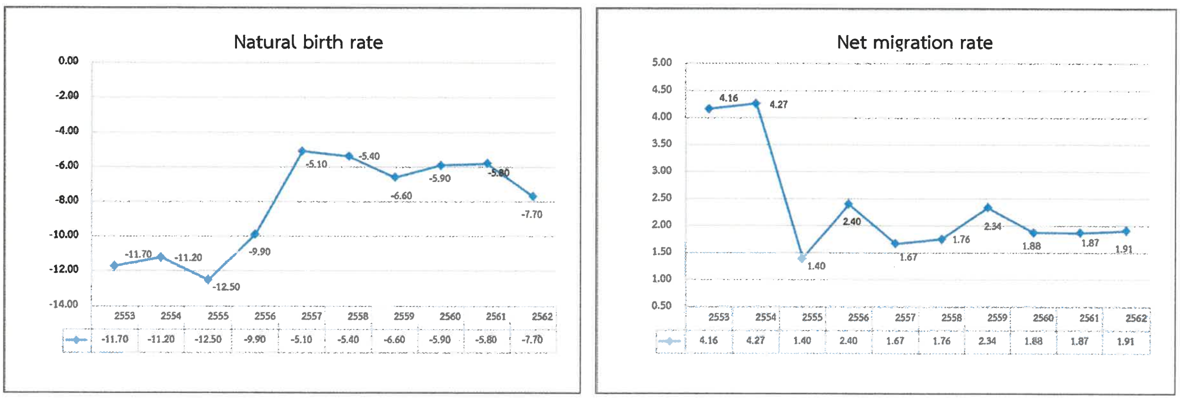
(B) Demographic information

A) Population numbers

From population data according to the population registration of Department of Provincial Administration, the Ministry of Interior, it was found that in B.E.2562, there were total of 20,141 populations which divided into 9,456 men and 10,685 women with 9,002 households. Details were shown in **Table 3.4.1-24.** For the population trend in the past 10 years (B.E. 2553 - 2562), it showed the increased population trend. When using the rate of change of population to create a graph, details as seen in **Figure 3.4.1-11**, the population density can be calculated as 1,014.66 persons/sq.km. No number of birth but the number of deaths were 77. The calculation of the natural growth rate of the population/ 100 people was equal to -7.70. This was because the number of deaths was greater than the number of birth. Therefore, it caused the natural increase rate of the population/ 100 people to be a negative value. There were 1,279 population of moving in and 894 population were moving out, as shown in **Figure 3.4.1-12.**



<u>Figure 3.4.1-11</u> Population trend and change rate in B.E.2553-2562



<u>Figure 3.4.1-12</u> Natural birth rate and net migration rate B.E.2553-2562

Table 3.4.1-24

Chedi Hak Population Statistics B.E.2553-2562

List	Year (B.E.)									
	2553	**2554**	**2555**	**2556**	**2557**	**2558**	**2559**	**2560**	**2561**	**2562**
Number of population from registration (person)	17,535	18,184	18,318	18,615	18,822	19,059	19,388	19,665	19,914	20,141
- male	8,308	8,661	8,718	8,825	8,930	9,006	9,175	9,302	9,395	9,456
- female	9,227	9,523	9,600	9,790	9,892	10,053	10,213	10,363	10,519	10,685
Population increase rate (percentage)	-	3.70	0.74	1.62	1.11	1.26	1.73	1.43	1.27	1.14
Population density (person per square kilometer)	883.38	916.07	922.82	937.78	948.21	960.15	976.73	990.68	1,003.22	1,014.66
Change in population density	-	3.70	0.74	1.62	1.11	1.26	1.73	1.43	1.27	1.14
Number of births (people)	3	1	0	0	0	0	0	0	0	0
Birth rate per 1,000 people	0.17	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number of deaths (people)	120	113	125	99	51	54	66	59	58	77
Mortality per 1,000 people	6.84	6.21	6.82	5.32	2.71	2.83	3.40	3.00	2.91	3.82
The rate of natural increase of the population per 100	-11.70	-11.20	-12.50	-9.90	-5.10	-5.40	-6.60	-5.90	-5.80	-7.70
Number of people moving in (person)[1/]	1,625	1,685	1,351	1,322	1,185	1,171	1,238	1,208	1,239	1,279
Move-in rate (percent)	-	3.69	-19.82	-2.15	-10.36	-1.18	5.72	-2.42	2.57	3.23
Number of people moving out (person)[1/]	895	909	1,095	875	871	836	784	839	866	894
Moving-out rate (percent)	-	1.56	20.46	-20.09	-0.46	-4.02	-6.22	7.02	3.22	3.23
Net migration per 100 population	4.16	4.27	1.40	2.40	1.67	1.76	2.34	1.88	1.87	1.91
Number of houses (houses)	7,496	7,735	7,911	8,081	8,229	8,407	8,552	8,703	8,846	9,002
House number change rate (percentage)	-	3.19	2.28	2.15	1.83	2.16	1.72	1.77	1.64	1.76

Note : [1/] The number of births, deaths, moving in, and out may not correlate with the population in the next year. Because there may be a fall

Meaning no name is registered / sold out from the registration system

Source : Department of Provincial Administration, B.E.2562 searching in January B.E.2563

(C) Economic and social conditions

The topographical features of this area is plains. The majority of the population are farmers. Next is employment and trading. For the education, there are 3 child development centers, 3 elementary schools. Moreover, it provides the reading zone in the village for the newspaper, community learning center, information center and the western institute of skill development, etc. For the religion, there are 5 temples in the area, such as Wat Chetiyaram, Wat Aranyikawat, Wat Thung Tan, Wat Huai Mu and Mogul Shrine. For public health services, there are Chedi Hak health promotion hospital and Ban Huai health promotion hospital.

3) Don Rae Subdistrict Administrative Organization

(A) Location and territory

Don Rae SAO locating in Moo.1, Don Rae Subdistrict with the total areas of 22.6 sq.km., or approximately 14,125 rais. Its territory adjacent to the nearby areas as follows.

North	connects to	Huai Phai Subdistrict, Mueang Ratchaburi District
South	connects to	Thung Luang Subdistrict, Pak Tho District
East	connects to	Ang Thong Subdistrict, Mueang Ratchaburi District
West	connects to	Huai Phai Subdistrict, Mueang Ratchaburi District and Thung Luang Subdistrict, Pak Tho District

The administrative areas are divided into 10 villages which are, Moo.1, Ban Don Rae, Moo.2, Ban Na Nong, Moo.3, Ban Nong Kham, Moo.4, Don Chad, Moo.5, Ban Don Tan, Moo.6, Baan Don Kok, Moo.7, Ban Nong Sar, Moo.8, Ban Nong Prong, Moo.9 Nong Matum and Moo.10, Ban Huai

There is 1 village locating in the study which is Moo.2, Ban Na Nong.

(B) Demographic information

A) Population numbers

From population data according to the population registration of Department of Provincial Administration, the Ministry of Interior, it was found that in B.E.2562, there were total of 4,355 populations which divided into 2,122 men and 2,233 women with 1,485 households. Details were shown in **Table 3.4.1-25.** For the population trend in the past 10 years (B.E. 2553 - 2562), it showed the increased population trend. When using the rate of change of population to create a graph, it can be seen in **Figure 3.4.1-13.** The population density can be calculated as 192.70 persons/sq.km. No number of birth but the number of deaths were 24. The calculation of the natural growth rate of the population per 100 people, showed a negative value of -2.40. This was because the number of deaths was greater than the number of birth. Therefore, it caused the natural increase rate of the population/ 100 people to be a negative value. There were 135 population who moving in and there were 88 population who moving out, as shown in **Figure 3.4.1-14**.

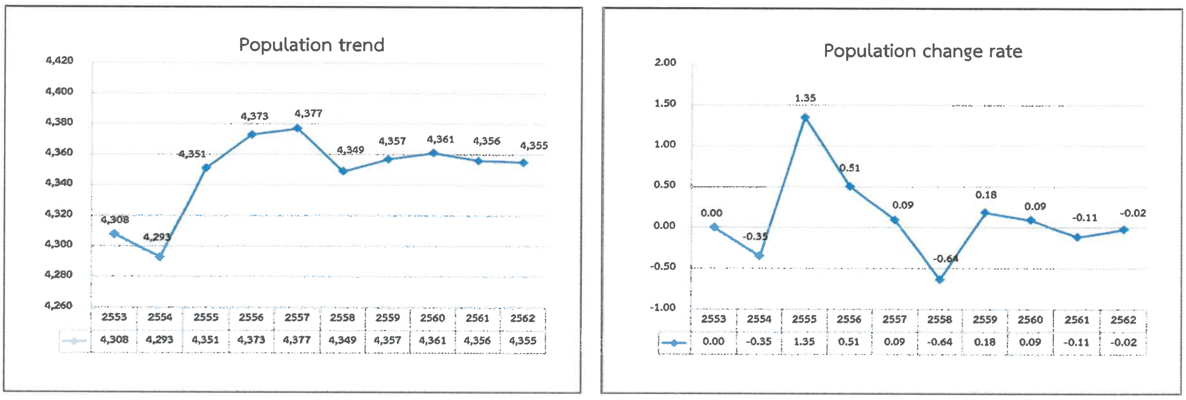


Figure 3.4.1-13 Population trend and change rate in B.E.2553-2562

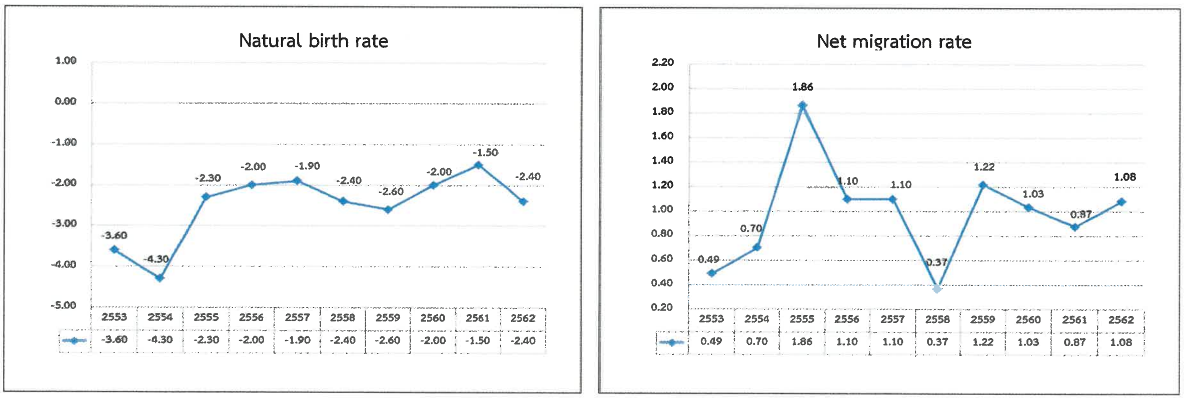


Figure 3.4.1-14 Natural birth rate and net migration rate B.E.2553-2562

(C) Economic and social conditions

For topography, most areas are lowland areas which surrounding by mountains and 2 small creeks, Thap Tai and Nong Thong Creeks. Some areas have irrigation canals and some areas are military restricted areas. Living condition is a rural area, with peddy fields along the way. For an economic condition in the sub-district, most of the people are

Table 3.4.1-25

Don Rae Population Statistics B.E.2553-2562

List	Year (B.E.)									
	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562
Number of population from registration (person)	4,308	4,293	4,351	4,373	4,377	4,349	4,357	4,361	4,356	4,355
- male	2,102	2,086	2,109	2,124	2,125	2,107	2,111	2,116	2,121	2,122
- female	2,206	2,207	2,242	2,249	2,252	2,242	2,246	2,245	2,235	2,233
Population increase rate (percentage)	-	-0.35	1.35	0.51	0.09	-0.64	0.18	0.09	-0.11	-0.02
Population density (person per square kilometer)	190.62	189.96	192.52	193.50	193.67	192.43	192.79	192.96	192.74	192.70
Change in population density	-	-0.35	1.35	0.51	0.09	-0.64	0.18	0.09	-0.11	-0.02
Number of births (people)	0	0	0	0	0	0	0	0	0	0
Birth rate per 1,000 people	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number of deaths (people)	36	43	23	20	19	24	26	20	15	24
Mortality per 1,000 people	8.36	10.02	5.29	4.57	4.34	5.52	5.97	4.59	3.44	5.51
The rate of natural increase of the population per 100 people	-3.60	-4.30	-2.30	-2.00	-1.90	-2.40	-2.60	-2.00	-1.50	-2.40
Number of people moving in (person)[1/]	149	161	208	149	149	116	145	145	145	135
Move-in rate (percent)	-	8.05	29.19	-28.37	0.00	-22.15	25.00	0.00	0.00	-6.90
Number of people moving out (person)[1/]	128	131	127	101	101	100	92	100	107	88
Moving-out rate (percent)	-	2.34	-3.05	-20.47	0.00	-0.99	-8.00	8.70	7.00	-17.76
Net migration per 100 population	0.49	0.70	1.86	1.10	1.10	0.37	1.22	1.03	0.87	1.08
Number of houses (houses)	1,300	1,323	1,358	1,378	1,393	1,402	1,420	1,430	1,471	1,485
House number change rate (percentage)	-	1.77	2.65	1.47	1.09	0.65	1.28	0.70	2.87	0.95

Note : [1/] The number of births, deaths, moving in, and out may not correlate with the population in the next year. Because there may be a fall

Meaning no name is registered / sold out from the registration system

Source : Department of Provincial Administration, B.E.2562 searching in January B.E.2563

engaged in agriculture, such as farming and livestock, etc. In addition, they are engaged in general employment, small shops, officials, private business. Overall, people will pursue many careers simultaneously. There are some businesses in the area such as petrol stations, mills, car repair shops, pig farms and community shops, etc.

For the social condition, there are primary schools, which are, Wat Na Nong School, Wat Thung Ya Kom Bang School and the Child Development Center of Don Rae SAO. For public health services, there is a Don Rae Health Promoting Hospital. In addition, there are groups of Don Rae SAO health volunteers and the elderly care volunteers who look after the members in the community. For religious, there are 2 temples in the area which are, Wat Na Nong and Wat Thung Ya Kom Bang.

4) Don Tako Subdistrict Administration Organization

(A) Location and territory

Don Tako SAO is locating in the southwest of Mueang Ratchaburi District with approximately 2.8 kilometers away from the district. There is Petchkasem Road Locating in the area of Moo. 4 with approximately areas of 20.4 sq.km, or approximately 12,750 rais. Its territory adjacent to the nearby area as follows.

North	connects to	Chedi Hak Subdistrict, Mueang Ratchaburi District
South	connects to	Khu Bua Subdistrict, Mueang Ratchaburi District
East	connects to	Ban Rai Subdistrict, Mueang Ratchaburi District
West	connects to	Don Rae and Huai Phai Subdistricts, Mueang Ratchaburi District

Don Tako SAO has divided the administrative area into 9 villages which are Moo. 2, Ban Khao Mo, Moo.3, Ban Don Tako, Moo.4, Ban Chaeng, Moo.5, Ban Mai, Moo.6, Ban Nakhon Ban, Moo.7, Ban Kha Loi - Khao Luang, Moo.8, Ban Khao Ngam - Thung Phiman, Moo.9, Ban Khao Khen Chan and Moo.10, Baan Suan Dok Mai.

There are 2 villages locating in the study area, which are, Moo.8, Ban Khao Ngam - Thung Phiman, Moo.9, Ban Khao Khen Chan.

(B) Demographic information

A) Population numbers

From population data according to the population registration of Department of Provincial Administration, The Ministry of Interior, it was found that in B.E.2562, there were total of 15,599 populations which divided into 7,398 men and 8,201 women, with a total of 7,575 households, as shown in **Table 3.4.1-26**. For the population trend during the past 10 years (B.E.2553-2562), the population is likely to increase. When using the rate of change of population to create a graph, details shown in **Figure3.4.1-15**, the density of the population was equal to 764.66 persons/sq.km. No number of birth but there were 54 deaths. The natural growth rate per 100 people was equal to -5.40. This was because the number of deaths was greater than the number of birth, therefore, the natural increase rate of the population was a negative value. There were 1,092 people moving in and 900 people moving out, details are shown in **Figure3.4.1-16**.

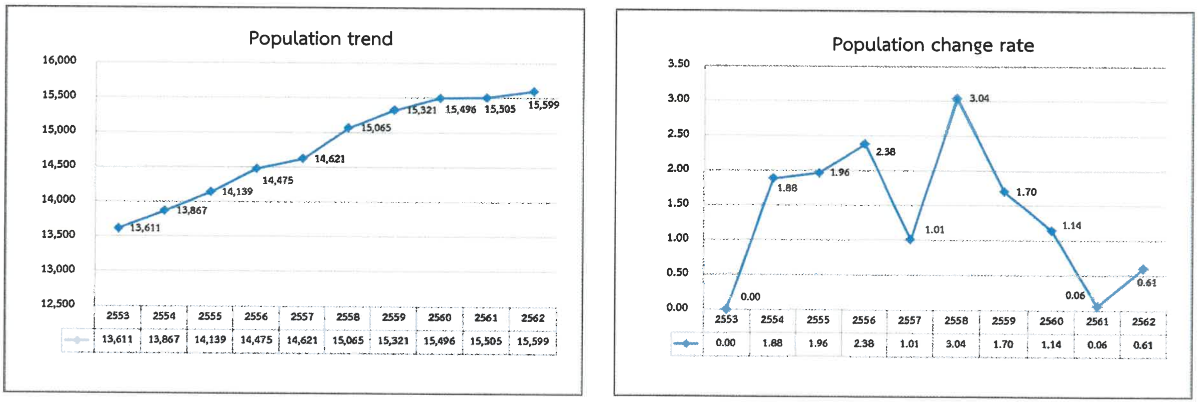


Figure 3.4.1-15 Population trend and change rate in B.E.2553-2562

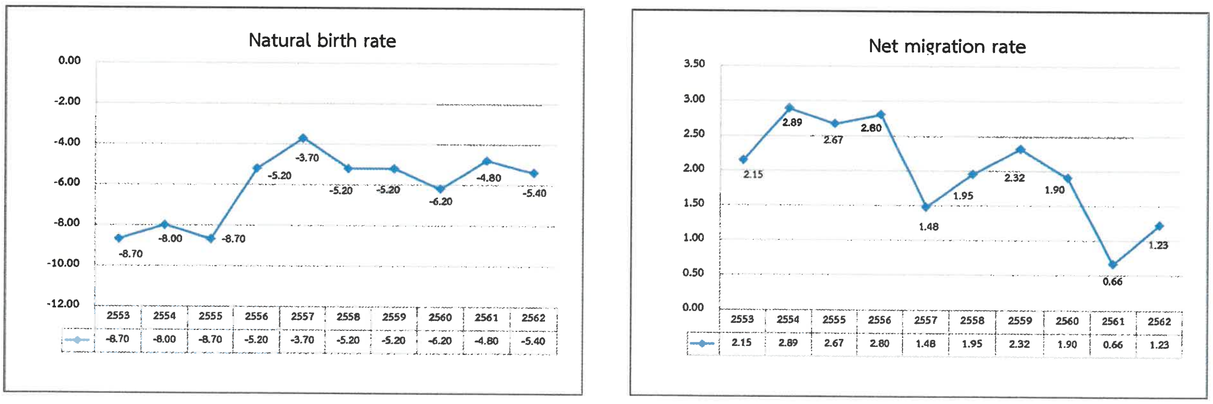


Figure 3.4.1-16 Natural birth rate and net migration rate B.E.2553-2562

Table 3.4.1-26

Don Tako Population Statistics B.E.2553-2562

List	Year (B.E.)									
	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562
Number of population from registration (person)	13,611	13,867	14,139	14,475	14,621	15,065	15,321	15,496	15,505	15,599
- male	6,461	6,620	6,738	6,935	6,981	7,200	7,328	7,393	7,383	7,398
- female	7,150	7,247	7,401	7,540	7,640	7,865	7,993	8,103	8,122	8,201
Population increase rate (percentage)	-	1.88	1.96	2.38	1.01	3.04	1.70	1.14	0.06	0.61
Population density (person per square kilometer)	667.21	679.75	693.09	709.56	716.72	738.48	751.03	759.61	760.05	764.66
Change in population density	-	1.88	1.96	2.38	1.01	3.04	1.70	1.14	0.06	0.61
Number of births (people)	0	0	0	0	0	0	0	0	0	0
Birth rate per 1,000 people	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number of deaths (people)	87	80	87	52	37	52	52	62	48	54
Mortality per 1,000 people	6.39	5.77	6.15	3.59	2.53	3.45	3.39	4.00	3.10	3.46
The rate of natural increase of the population per 100	-8.70	-8.00	-8.70	-5.20	-3.70	-5.20	-5.20	-6.20	-4.80	-5.40
Number of people moving in (person)[1/]	1,119	1,306	1,111	1,234	1,083	1,154	1,179	1,111	1,084	1,092
Move-in rate (percent)	-	16.71	-14.93	11.07	-12.24	6.56	2.17	-5.77	-2.43	0.74
Number of people moving out (person)[1/]	827	905	733	828	867	860	824	816	981	900
Moving-out rate (percent)	-	9.43	-19.01	12.96	4.71	-0.81	-4.19	-0.97	20.22	-8.26
Net migration per 100 population	2.15	2.89	2.67	2.80	1.48	1.95	2.32	1.90	0.66	1.23
Number of houses (houses)	5,954	6,203	6,509	6,736	6,911	7,085	7,235	7,334	7,453	7,575
House number change rate (percentage)	-	4.18	4.93	3.49	2.60	2.52	2.12	1.37	1.62	1.64

Note : [1/] The number of births, deaths, moving in, and out may not correlate with the population in the next year. Because there may be a fall

Meaning no name is registered / sold out from the registration system

Source : Department of Provincial Administration, B.E.2562 searching in January B.E.2563

(C) Economic and social conditions

The topographical feature of this areas is upland with a mountain in the west. The eastern part is a lowland plain with the irrigation area. Some parts of the sub-district are urban areas with crowded population. Most people are engaged in agriculture, such as vegetable and fruit farming. Followed by animal husbandry such as pig, fish and cattle. For the industry, there are brass making and pottery. The Commercial business unit has 1 3 factories, including loincloth factories, ice mills, lathes and ceramic pottery factories, etc. There are also 7 hotels and apartments.

For the social condition, there are educational institutions such as Rajabhat University Chom Bueng Village, The Demonstration School of Muban Chom Bueng Rajabhat University, Daruna Ratchaburi Witaed Suksa School, Wat Mai Nakhon School, Wat Don Chaeng School, Wat Don Tako School, Child Development Center of Don Tako SAO and the non-formal and informal education center. In addition, there were a village reading zone for the newspaper, village broadcasting tower, radio station of traffic community, Niran Sin Village Community Radio Station, and the national radio stations. Within the area, there are parks, sports grounds and boxing stadiums for the service. For the religion and religious organization, there are Wat Don Tako, Wat Don Chaeng, Wat Mai Nakhon Ban, Wat Khao Loi, Mamba In Khoi Rot mosque, Taihwa Dharma **retreat** Center locating in Moo.7. There is a health promotion hospital, locating in Moo.5.

5) Ko Plup pla Subdistrict Administration Organization

(A) Location and territory

Ko Plub Pla SAO is located in the northeast of Ratchaburi along the Highway No. 3291 for approximately 11 kilometers. Ko Plub Pla SAO is located in Moo.6 with approximately 12.42 sq.km., or approximately 7,762.50 rais. Its territory connects to the nearby area as follows.

North	connects to	Khao Raeng Subistrict, Mueang Ratchaburi District
South	connects to	Chedi Hak Subdistrict, Mueang Ratchaburi District
East	connects to	Nong Klang Na and Lum Din Subdistricts Mueang Ratchaburi District
West	connects to	Hin Kong Subdistrict, Mueang Ratchaburi District and Pak Chong Subdistrict, Chom Bueng District

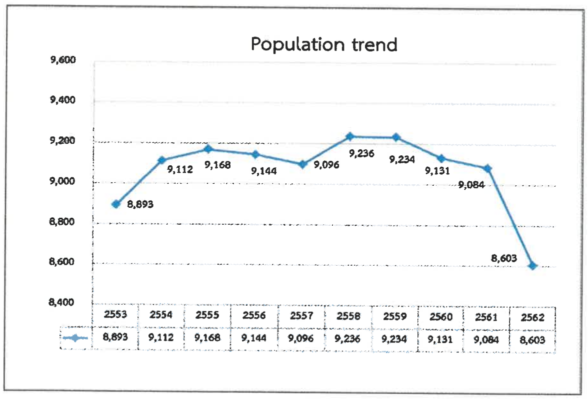
Ko Plub Pla SAO has divides the administrative area into 8 villages which are, Moo.6, Ban Huai Ta Kaeng, Moo.7, Ban Thung Por Bon, Moo.8, Ban Koh Loi, Moo.9, Ban Na, Moo.10, Ban Chong Mak Klam, Moo.11, Ban Khao Suan Luang, Moo.12, Ban Huai Champa, Moo.15, Ban Nong Song Hong.

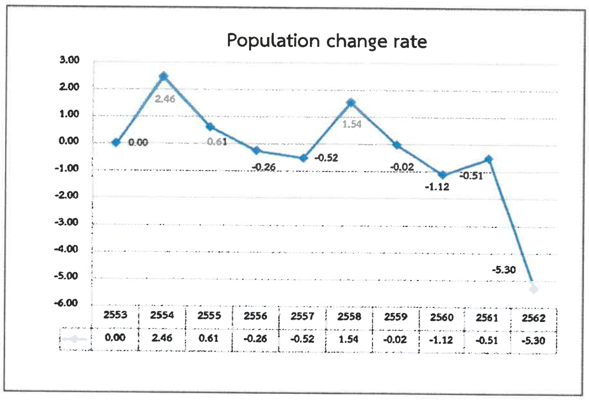
There are 3 villages locating in the study area, which are, Moo.6, Ban Huai Ta Kaeng, Moo.7, Ban Thung Por Bon and Moo.15, Ban Nong Song Hong.

(B) Demographic data

A) Population

From population data according to the population registration of Department of Provincial Administration, the Ministry of Interior, it was found that in B.E.2562, there were total of 8,603 populations which divided into 5,365 men and 3,238 women with 3,284 households, as details shown in **Table 3.4.1-27.** For the population trend in the past 10 years (B.E. 2553 - 2562), it showed the unstable population trend. When using the rate of change of population to create a graph, details were shown in **Figure 3.4.1-17.** The population density can be calculated as 692.67 persons/sq.km No number of birth but the number of deaths was 33. The calculation of the natural growth rate of the population per 100 people was equal to-3.30. This was because the number of deaths was greater than the number of birth. Therefore, it caused the natural increase rate of the population/ 100 people to be a negative value. There were 899 population of moving in and there were 1,270 population of moving out as details shown in **Figure 3.4.1-18.**





<u>Figure 3.4.1-17</u> **Population trend and change rate in B.E.2553-2562**

Table 3.4.1-27

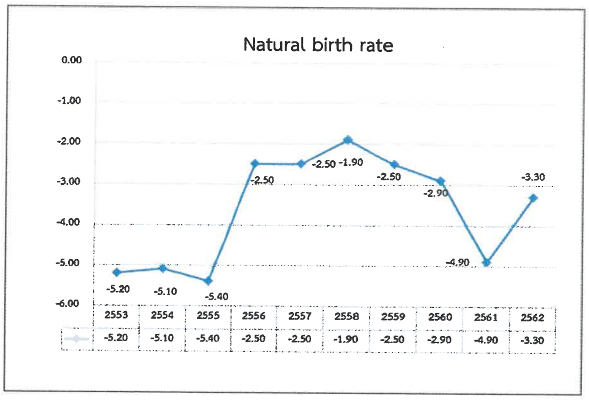
Ko Plup pla Population Statistics B.E.2553-2562

List	Year (B.E.)									
	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562
Number of population from registration (person)	8,893	9,112	9,168	9,144	9,096	9,236	9,234	9,131	9,084	8,603
- male	5,387	5,639	5,732	5,717	5,709	5,867	5,872	5,814	5,803	5,365
- female	3,506	3,473	3,436	3,427	3,387	3,369	3,362	3,317	3,281	3,238
Population increase rate (percentage)	-	2.46	0.61	-0.26	-0.52	1.54	-0.02	-1.12	-0.51	-5.30
Population density (person per square kilometer)	716.02	733.66	738.16	736.23	732.37	743.64	743.48	735.19	731.40	692.67
Change in population density	-	2.46	0.61	-0.26	-0.52	1.54	-0.02	-1.12	-0.51	-5.30
Number of births (people)	0	0	0	0	0	0	0	0	0	0
Birth rate per 1,000 people	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number of deaths (people)	52	51	54	25	25	19	25	29	49	33
Mortality per 1,000 people	5.85	5.60	5.89	2.73	2.75	2.06	2.71	3.18	5.39	3.84
The rate of natural increase of the population per 100 people	-5.20	-5.10	-5.40	-2.50	-2.50	-1.90	-2.50	-2.90	-4.90	-3.30
Number of people moving in (person)[1/]	1,119	1,292	1,327	1,223	1,398	1,389	1,465	1,307	1,515	899
Move-in rate (percent)	-	15.46	2.71	-7.84	14.31	-0.64	5.47	-10.78	15.91	-40.66
Number of people moving out (person)[1/]	1,075	1,059	1,131	1,221	1,392	1,207	1,444	1,377	1,538	1,270
Moving-out rate (percent)	-	-1.49	6.80	7.96	14.00	-13.29	19.64	-4.64	11.69	-17.43
Net migration per 100 population	0.49	2.56	2.14	0.02	0.07	1.97	0.23	-0.77	-0.25	-4.31
Number of houses (houses)	2,900	2,945	2,982	3,022	3,055	3,087	3,127	3,173	3,237	3,284
House number change rate (percentage)	-	1.55	1.26	1.34	1.09	1.05	1.30	1.47	2.02	1.45

Note : [1/] The number of births, deaths, moving in, and out may not correlate with the population in the next year. Because there may be a fall

Meaning no name is registered / sold out from the registration system

Source : Department of Provincial Administration, B.E.2562 searching in January B.E.2563



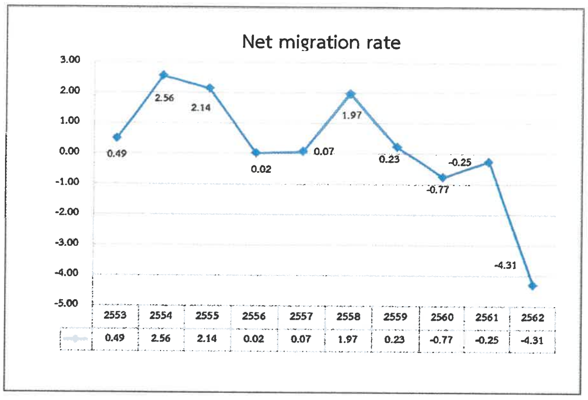


Figure 3.4.1-18 Natural birth rate and net migration rate B.E.2553-2562

(C) Economic and social conditions

The topography is generally a lowland on the east, suitable for cultivation. In the west, there are Khao Plong, Khao Suan Luang, Khao Ling, Khao Kruat and Khao Phaya Prab. There is Hua Tha Kang creek flowing through the village. Most population in the area are engaged in agriculture and livestock. Important economic crops are rice, sugarcane, fruit and vegetables. For industrial areas, there are rice mills, lime plants and gas stations.

For the social condition, 3 schools locating in the area, which are, Wat Koh Loi School, Wat Huai Tha Kang School and Wat Khao Kruat School. There are religious institutions such as Wat Koh Loi, Wat Huay Tha Keang, Wat Khao Kruat, and Tham Khao Suan Luang Abbey. There are 2 Health Promoting Hospitals, which are, Ko Plub Pla Health Promoting Hospital and Koh Loi Health Promoting Hospital.

6) Huai Phai Subdistrict Administration Organization

(A) Location and territory

Huai Phai SAO has approximately 36.85 sq.km., or approximately 23,031.25 rais. Its territory connects to the nearby area as follows.

North	connects to	Hin Kong Subdistrict, Mueang Ratchaburi District
South	connects to	Don Rae Subdistrict, Mueang Ratchaburi District Ang Hin Subdistrict, Mueang Pak Tho District
East	connects to	Nong Chedi Hak and Don Tako Subdistricts, Mueang Ratchaburi District
West	connects to	Hin Nam Phu Subdistrict, Mueang Ratchaburi District

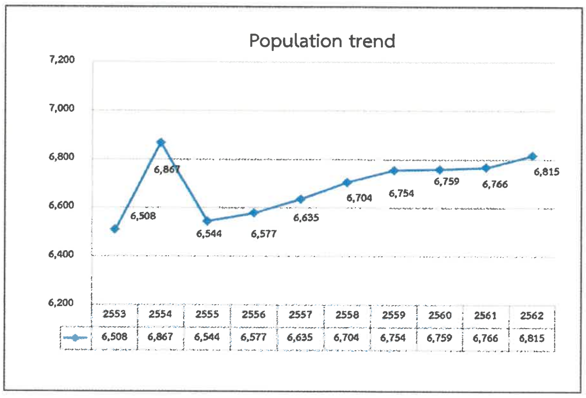
Huai Phai SAO has divides the administrative area into 9 villages which are Moo.1, Ban Khao Kwang, Moo.2, Ban Tham Kunchorn, Moo. 3, Ban Rak Makham, Moo. 4, Ban Huai Phai, Moo.5, Ban Nakhon Ban, Moo.6, Ban Nong Luang, Moo.7, Ban Nong Din Daeng, Moo.8, Ban Nong Kham and Moo.9, Ban Nong Nam Kun.

There are 8 villages locating in the study area, which are, Moo.1, Ban Khao Kwang, Moo. 3, Ban Rak Makham, Moo. 4, Ban Huai Phai, Moo.5, Ban Nakhon Ban, Moo.6, Ban Nong Luang, Moo.7, Ban Nong Din Daeng, Moo.8, Ban Nong Kham and Moo.9, Ban Nong Nam Kun.

(B) Demographic data

A) Population numbers

From population data according to the population registration of Department of Provincial Administration, the Ministry of Interior, it was found that in B.E.2562, there were total of 6,815 populations which divided into 3,331 men and 3,484 women with 2,641 households as details shown in **Table 3.4.1-28.** For the population trend in the past 10 years (B.E. 2553 - 2562). it showed the unstable population trend. When using the rate of change of population to create a graph, detail were shown in **Figure3.4.1-19.** The population density can be calculated as 184.94 persons/sq.km. No number of birth but there were 35 deaths. The calculation of the natural growth rate of the population/ 100 people was equal to -3.50. This was because the number of deaths was greater than the number of birth. Therefore, it caused the natural increase rate of the population/ 100 people to be a negative value. There were 272 persons moving in and 177 persons moving out, as details shown in **Figure3.4.1-20.**



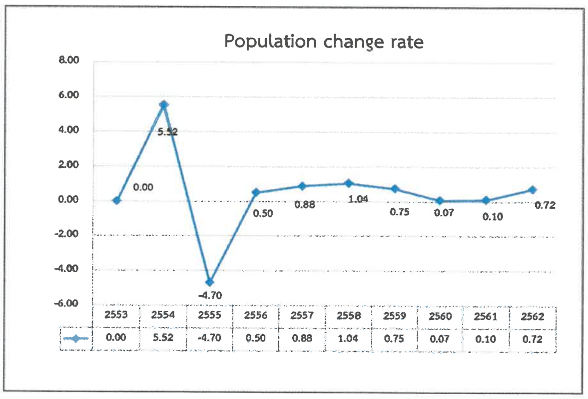


Figure 3.4.1-19 Population trend and change rate in B.E.2553-2562

Table 3.4.1-28

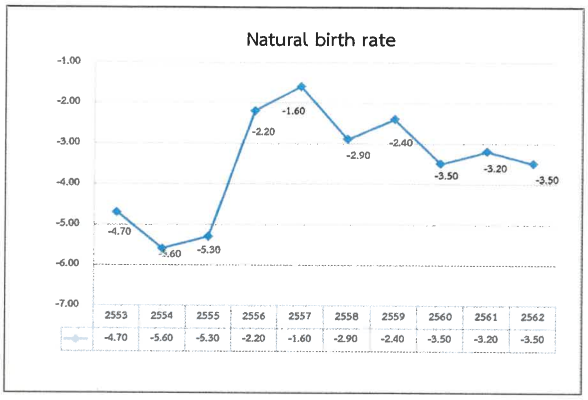
Huai Phai Population Statistics B.E.2553-2562

List	Year (B.E.)									
	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562
Number of population from registration (person)	6,508	6,533	6,544	6,577	6,635	6,704	6,754	6,759	6,766	6,815
- male	3,187	3,205	3,208	3,226	3,244	3,272	3,293	3,310	3,306	3,331
- female	3,321	3,328	3,336	3,351	3,391	3,432	3,461	3,449	3,460	3,484
Population increase rate (percentage)	-	0.38	0.17	0.50	0.88	1.04	0.75	0.07	0.10	0.72
Population density (person per square kilometer)	176.61	177.29	177.58	178.48	180.05	181.93	183.28	183.42	183.61	184.94
Change in population density	-	0.38	0.17	0.50	0.88	1.04	0.75	0.07	0.10	0.72
Number of births (people)	0	0	0	0	0	0	0	1	0	0
Birth rate per 1,000 people	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00
Number of deaths (people)	47	56	53	22	16	29	24	36	32	35
Mortality per 1,000 people	7.22	8.57	8.10	3.34	2.41	4.33	3.55	5.33	4.73	5.14
The rate of natural increase of the population per 100 people	-4.70	-5.60	-5.30	-2.20	-1.60	-2.90	-2.40	-3.50	-3.20	-3.50
Number of people moving in (person)[1/]	245	250	261	254	260	235	248	227	258	272
Move-in rate (percent)	-	2.04	4.40	-2.68	2.36	-9.62	5.53	-8.47	13.66	5.43
Number of people moving out (person)[1/]	165	165	203	188	171	142	149	159	180	177
Moving-out rate (percent)	-	0.00	23.03	-7.39	-9.04	-16.96	4.93	6.71	13.21	-1.67
Net migration per 100 population	1.23	1.30	0.89	1.00	1.34	1.39	1.47	1.01	1.15	1.39
Number of houses (houses)	2,060	2,127	2,174	2,245	2,312	2,375	2,436	2,498	2,562	2,641
House number change rate (percentage)	-	3.25	2.21	3.27	2.98	2.72	2.57	2.55	2.56	3.08

Note : [1/] The number of births, deaths, moving in, and out may not correlate with the population in the next year. Because there may be a fall

Meaning no name is registered / sold out from the registration system

Source : Department of Provincial Administration, B.E.2562 searching in January B.E.2563



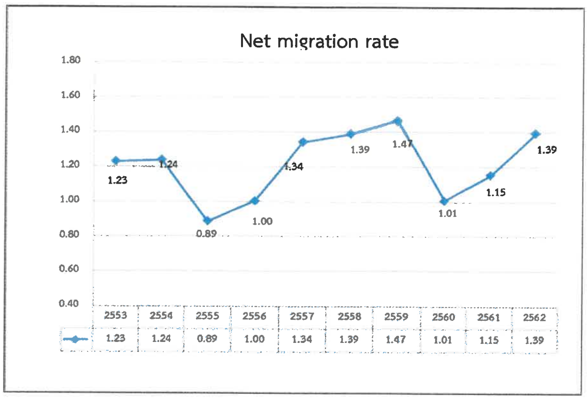


Figure 3.4.1-20 Natural birth rate and net migration rate B.E.2553-2562

(B) Government

Mueang Ratchaburi District is divided the government into 2 parts, which are, 22 provincial administrations, 187 villages, and local government (1 municipality, 4 subdistrict municipalities and 17 sub-district administrative organizations), as refer to **Table 3.4.1-21**.

(C) Economic and social conditions

The area condition is the slope with approximately 1 – 5% from the west to the east. The west area is the high slope area with growing crops and fruit trees. The east side is a lowland area. There are rice fields and vegetable farming in the eastern part of the area lined along the road and spread out. Three is a creek flowing through every village. The majority of people are farmers, with growing vegetables and handicrafts are the second career for extra incomes. The electricity and water supply, as the utility system in the household, are installed in every village.

7) Khao Ngu Subdistrict Municipality

(A) Location and territory

Khao Ngu Subdistrict Municipality is located on the northwest, away from Mueang Ratchaburi District Office approximately 10 kilometers, along the Highway No.3291, Khao Ngu - Chedi Hak Road. It has areas of 8 sq.km., or approximately 5,000 rais. Its territory connects to the nearby area as follows.

North	connects to	Ko Plub Pla Subdistrict, Mueang Ratchaburi District
South	connects to	Chedi Hak Subdistrict, Mueang Ratchaburi District
East	connects to	Chedi Hak Subdistrict, Mueang Ratchaburi District
West	connects to	Chedi Hak Subdistrict, Mueang Ratchaburi District

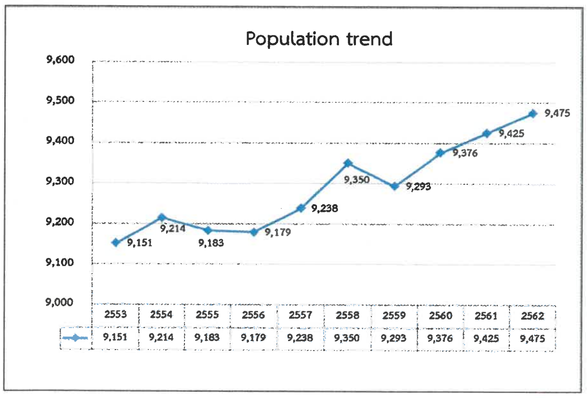
Khao Ngu Subdistrict Municipality has administrative districts covering parts of Ko Plub Pla Subdistrict, which are Moo.1, Moo.2, Moo.3, Moo.4, Moo.5, Moo.13 and Moo.1 4 and parts of Chedi Hak Subdistrict, which are Moo. 5 and Moo.6 , Chedi Hak Subdistrict. The total numbers of villages in the municipality are 8 villages with 9 communities, which are, Ruam Chai Pattana Community, Ban Ton Mamuang Pattana Community, Kho Phlapphla Pattana Community, Ban Huai Tha Kang Community, Ban Khok Hin Community, Ban Nai Pattana Community, Neung Samakkhi Community, Ban Ton Tako Community and Sompoom Pattana Community.

There are 2 villages locating in the study area which are Ban Ton Mamuang Pattana Community and Sompoom Pattana Community.

(B) Demographic data

A) Population

From population data according to the population registration of Department of Provincial Administration, the Ministry of Interior, it was found that in B.E.2562, there were total of 9,475 populations which divided into 4,591 men and 4,884 women with 2,692 households, as details shown in **Table3.4.1-29.** For the population trend in the past 10 years (B.E. 2553 - 2562), it showed the unstable population trend. When using the rate of change of population to create a graph, details were shown in **Figure3.4.1-21**. The population density can be calculated as 1,184.38 persons/sq.km. No number of birth but the number of deaths was 32. The calculation of the natural growth rate of the population/ 100 people was equal to -3.20. This was because the number of deaths was greater than the number of birth. Therefore, it caused the natural increase rate of the population/ 100 people to be a negative value. There were 421 persons moving in and 307 persons moving out, as details shown in **Figure3.4.1-22.**



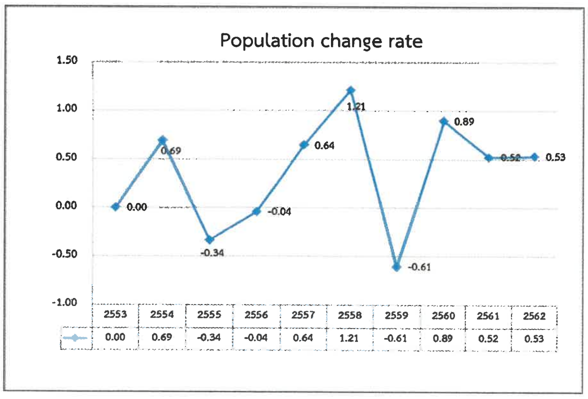


Figure 3.4.1-21 Population trend and change rate in B.E.2553-2562

Table 3.4.1-29

Khao Ngu Population Statistics B.E.2553-2562

List	Year (B.E.)									
	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562
Number of population from registration (person)	9,151	9,214	9,183	9,179	9,238	9,350	9,293	9,376	9,425	9,475
- male	4,497	4,513	4,508	4,487	4,524	4,547	4,522	4,549	4,550	4,591
- female	4,654	4,701	4,675	4,692	4,714	4,803	4,771	4,827	4,875	4,884
Population increase rate (percentage)	-	0.69	-0.34	-0.04	0.64	1.21	-0.61	0.89	0.52	0.53
Population density (person per square kilometer)	1,143.88	1,151.75	1,147.88	1,147.38	1,154.75	1,168.75	1,161.63	1,172.00	1,178.13	1,184.38
Change in population density	-	0.69	-0.34	-0.04	0.64	1.21	-0.61	0.89	0.52	0.53
Number of births (people)	0	0	0	0	0	0	0	0	0	0
Birth rate per 1,000 people	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number of deaths (people)	55	60	78	38	23	27	35	44	32	32
Mortality per 1,000 people	6.01	6.51	8.49	4.14	2.49	2.89	3.77	4.69	3.40	3.38
The rate of natural increase of the population per 100 people	-5.50	-6.00	-7.80	-3.80	-2.30	-2.70	-3.50	-4.40	-3.20	-3.20
Number of people moving in (person)[1/]	444	485	426	421	401	418	368	424	468	421
Move-in rate (percent)	-	9.23	-12.16	-1.17	-4.75	4.24	-11.96	15.22	10.38	-10.04
Number of people moving out (person)[1/]	399	350	340	360	282	271	302	257	240	307
Moving-out rate (percent)	-	-12.28	-2.86	5.88	-21.67	-3.90	11.44	-14.90	-6.61	27.92
Net migration per 100 population	0.49	1.47	0.94	0.66	1.29	1.57	0.71	1.78	2.42	1.20
Number of houses (houses)	2,202	2,247	2,302	2,340	2,381	2,410	2,504	2,554	2,641	2,692
House number change rate (percentage)	-	2.04	2.45	1.65	1.75	1.22	3.90	2.00	3.41	1.93

Note : [1/] The number of births, deaths, moving in, and out may not correlate with the population in the next year. Because there may be a fall

Meaning no name is registered / sold out from the registration system

Source : Department of Provincial Administration, B.E.2562 searching in January B.E.2563

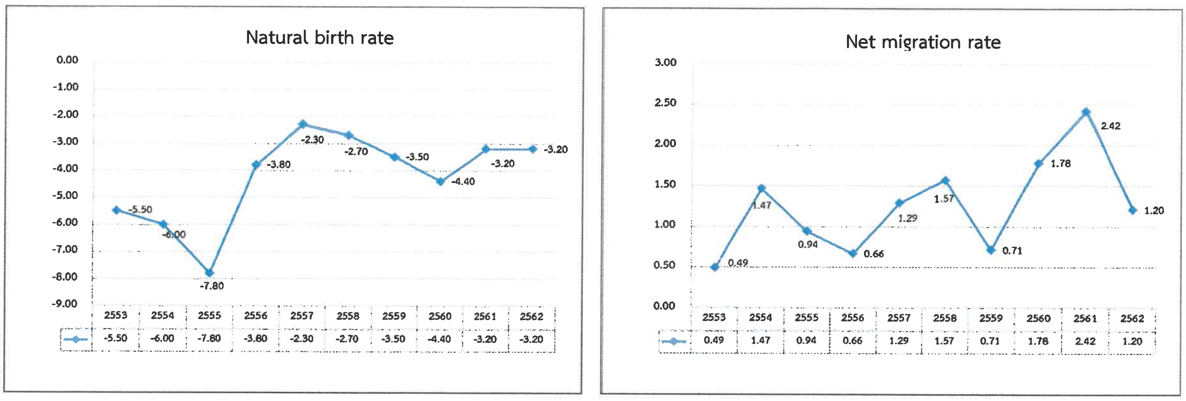


Figure 3.4.1-22 **Natural birth rate and net migration rate B.E.2553-2562**

(C) Economic and social conditions

The majority of the population are farmers and general contractors. Most areas have rice fields, followed by farming, gardening. Most farmers are likely to raise animals such as cows, pigs, chickens and ducks. There are 1 large fuel service place, 220 community shops for distributing consumer goods on a daily basis with 15 licensed industrial facilities. There are schools under the Office of Educational Service Area, which are, Wat Don Talung School, Wat Khao Ngu Santitham School, Khao Ngu Kindergarten and Khao Ngu Child Development Center. The majority of the population are Buddhists. There are 4 temples which are Wat Rajasangkhon, Wat Khao Ngu, Wat Don Talung and Wat Huai Tha Kang. There are 3 health centers, which are Ko Plub Pla Subdistrict Health Center, Huai Ta Kang Health Center and municipality health service center. These health centers are responsible for the health service of the people in the municipality and nearby sub-districts.

3.4.2. Survey of public opinion and stakeholder

The consulting company conducted a survey of public opinion in the study area, as the main stakeholder group that may be affected by the project. Survey results were used for the social impact assessment, in particularly, opinions of the community on various aspects, in order to consider alternatives in formulating appropriate prevention and measures that complied with issues and concerns. In addition, a survey of community leaders and representatives of government agencies as project stakeholder groups was conducted to provide a comprehensive and truly meaningful study.

(1) The study area, number of samples and sampling

The consulting company determined the area to conduct the public opinion survey within a radius of 5 kilometers from the project location, covering an area of 7 local administrative organizations, including Hin Kong Subdistrict Administration Organization, Huai Phai Subdistrict Administration Organization, Chedi Hak Subdistrict Administrative Organization, Ko Plub PlaSubdistrict Administration Organization, Don Tako Subdistrict Administration Organization, Don Rae Sub-district Administration Organization and Khao Ngu Subdistrict Municipality, which consisting of 32 villages as shown in **Figure 3.4.2-1**. Besides conducting surveys of community leaders and household representatives, EIA study had also been considered among other additional stakeholders related to the project operations. All stakeholder groups of the project were be summarized in **Figure 3.4.2-2.**

1) Related government agencies

Relevant government agencies are indirect stakeholders in the project. With the power in policy and local development, the consulting company identified sample groups from representatives of government agencies as stakeholders, in accordance with the powers and duties of each group of agencies responsible for problems by focusing on government policies and related programs. The consulting company sent a request form for questionnaires to 2 samples in each agencies per survey. The survey was conducted during 27 June-30 July B.E.2562. Summary of positions of respondents from each department as in **Table 3.4.2-1**, which were divided into 5 following groups.

(A) Environmental and regulatory agency group

The consulting company conducted the survey from representatives of 6 agencies with the responsibility of environment and regulatory. The consulting company received questionnaire responses back from 2 agencies, 3 samples, consisting of,

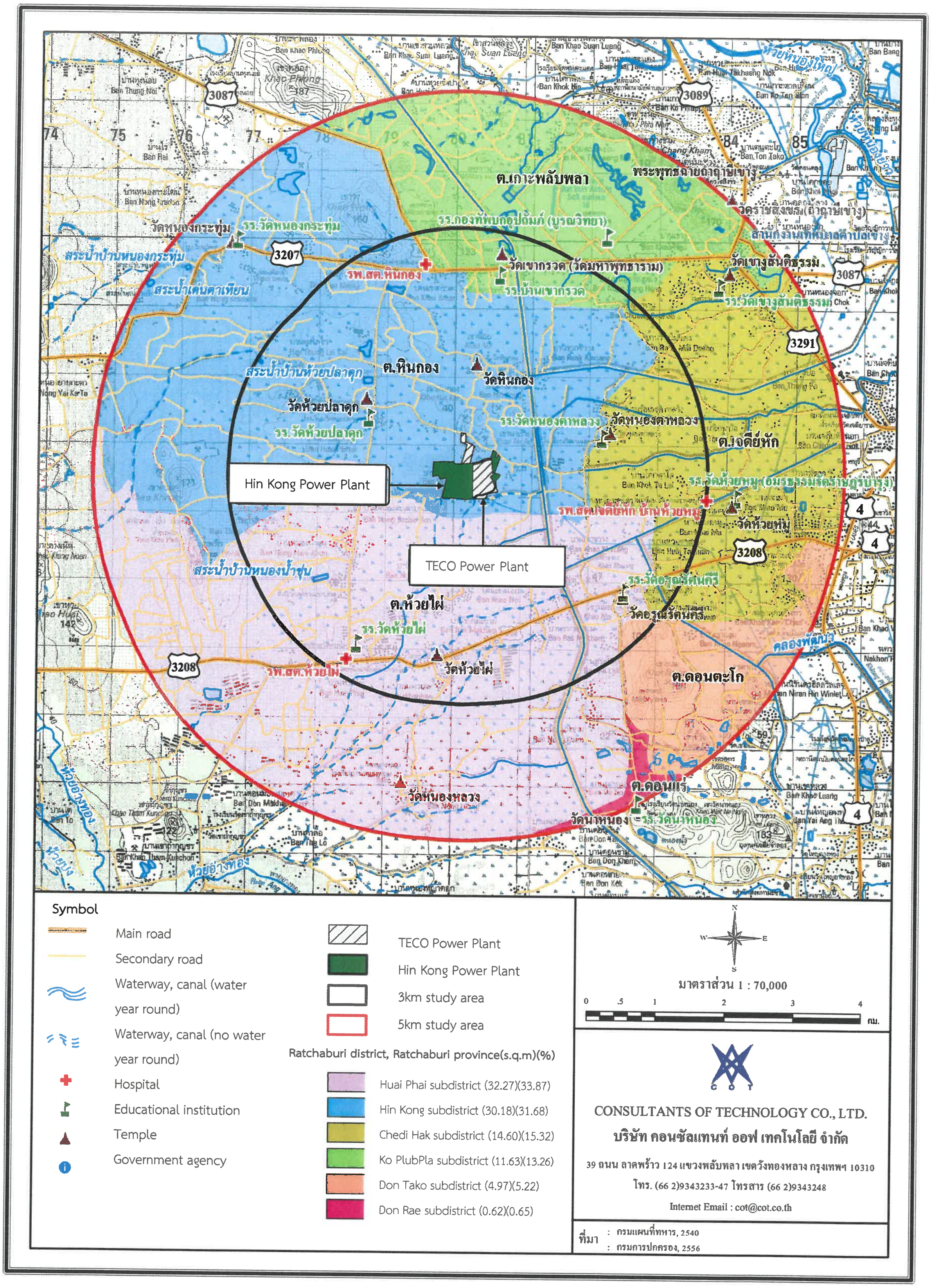


Figure 3.4.2-1 Study area

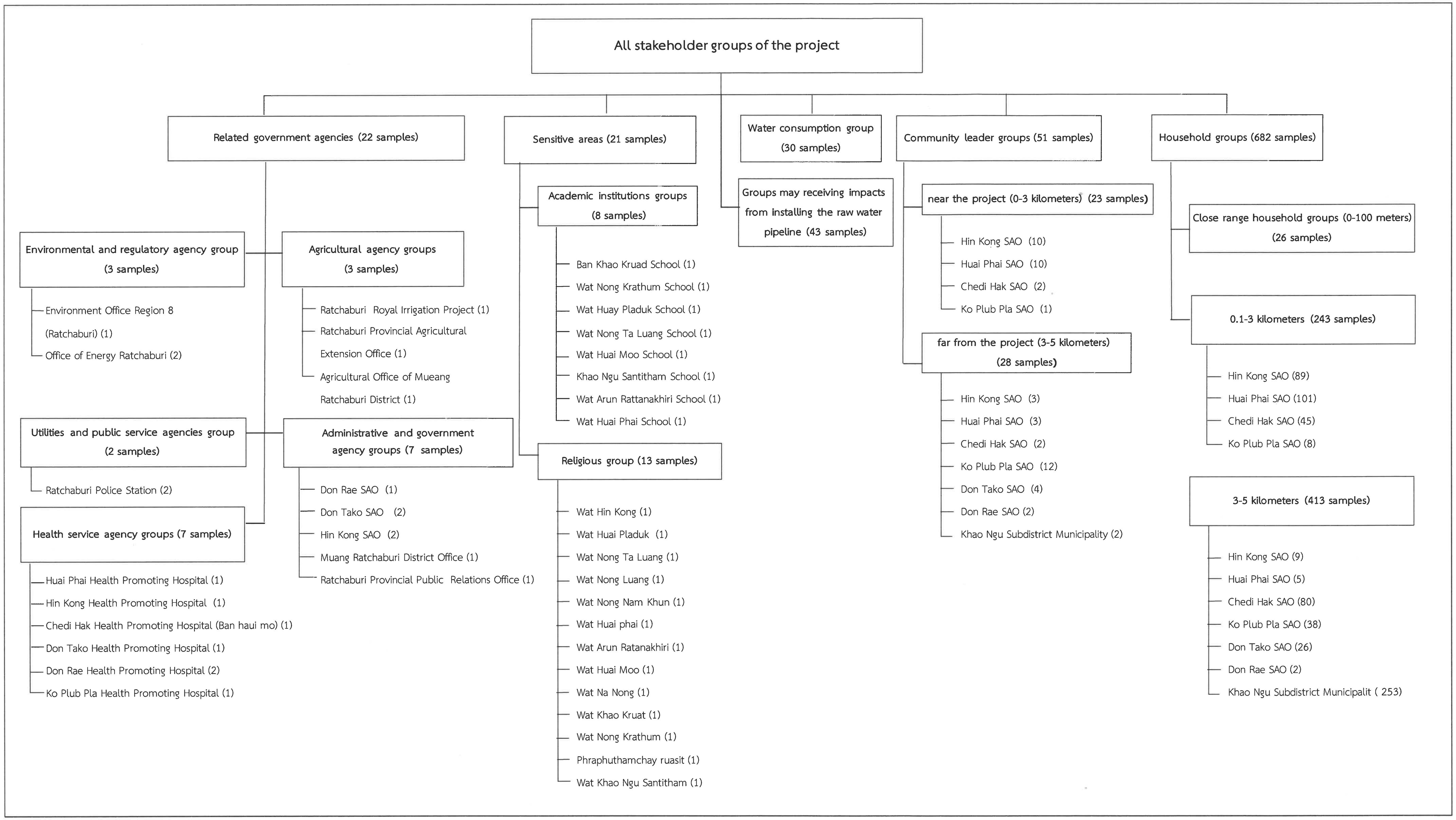


Figure 3.4.2-2 Chart of summary of number of samples that were collected questionnaires

Table 3.4.2-1

Summary of positions of respondents from each department

Instittition	position	Duration of holding a position in the area
1. Environmental and regulatory agency group		
1) Environment Office Region 8 (Ratchaburi)	- Director of Environmental Quality Control	12 yrs.
2) Office of Energy Ratchaburi	- Energy professional	28 yrs.
3) Office of Energy Ratchaburi	- Staff working according to the project	-
sum	3 samples	
2. Utilities and public service agencies group		
1) Ratchaburi Police Station	- Inspector	2 yrs.
2) Ratchaburi Police Station	- Inspector	2 yrs.
sum	2 samples	
3. Agricultural agency groups		
1) Ratchaburi Royal Irrigation Projec	- Head of Department and Maintenance	2 yrs.
2) Ratchaburi Provincial Agricultural Extension Office	- Agricultural Scientist	2 yrs.
3) Agricultural Office of Mueang Ratchaburi District	- Agricultural Scientist	4 yrs.
sum	3 samples	
4. Health service agency groups		
1) Chedi Hak Health Promoting Hospital (Ban haui mo)	Public Health Technologist	26 yrs.
2) Hin Kong Health Promoting Hospital	Professional Nurse	18 yrs.
3) Don Tako Health Promoting Hospital	Public Health Technologist	25 yrs.
4) Don Rae Health Promoting Hospital	Professional Nurse	22 yrs.
5) Don Rae Health Promoting Hospital	Health official	7 yrs.
6) Ko Plub Pla Health Promoting Hospital	Director	15 yrs.
7) Huai Phai Health Promoting Hospita	Director	2 yrs.
sum	7 samples	
5. Administrative and government agency groups		
1) Don Rae SAO	- Principal of Don Rae SAO	18 yrs.
2) Don Tako SAO	- Permanent Secretary SAO.	5 yrs.
3) Don Tako SAO	- Principal of Don Tako SAO	7 yrs.
4) Hin Kong SAO	- Principal of Hin Kong SAO	22 yrs.
5) Mueang Ratchaburi District	- Deputy District Chief	4 yrs.
6) Hin Kong SAO	- Associate principal of Hin Kong SAO	7 yrs.
7) Ratchaburi Provincial Public Relation Office	- Public Relations Assistant	5 yrs.
sum	7 samples	
Total	22 samples	

Source : Consultants Of Technology Co.,LTD B.E.2563

(B) Utilities and public service agencies group

The consulting company conducted the survey from representatives of 6 agencies with the responsibility of utilities and public services. The consulting company received questionnaire responses back from 2 agencies, 3 samples, consisting of,

(C) Agricultural agency groups

The consulting company conducted the survey from representatives of 6 agencies with the responsibility of agriculture. The consulting company received questionnaire responses back from 3 agencies, 3 samples, consisting of,

(D) Health service agency groups

The consulting company conducted the survey from representatives of 10 agencies with the responsibility of health services. The consulting company received questionnaire responses back from 6 agencies for 7 samples, consisting of,

(E) Administrative and government agency groups

The consulting company conducted the survey from representatives of 7 agencies with the responsibility of administrative and government. The consulting company received questionnaire responses back from 4 agencies for 6 samples, consisting of,

2) Sensitive areas

There were 21 sensitive areas to impacts from the project activities, such as, academic institutions, hospitals, religious and historic sites, as details shown in **Table 3.4.2-2**. Interviews were conducted using purposive sampling. The sample size used in the survey was 100%. A total of 21 samples were conducted on 27 June - 30 July B.E. 2562 by interviewing the school director/ temple abbot or persons assigned to express opinions as following details.

(A) Academic institutions groups

The consulting company conducted the survey from representatives of 9 agencies. There are 8 agencies providing questionnaire data, for 8 samples, consisting of.

From the interviewing, it was found that 1 school did not provide comment, which was Kong Thabbok Upatham School.

Table 3.4.2-2
Summary of positions of respondents from each department of sensitive receptor group

Instititionn	position	a position in the area
1. Academic institutions groups		
1) Wat Huay Pladuk School	- Academic Teacher	2 yrs.
2) Ban Khao Kruad School	- Director	1 yrs.
3) Wat Huai Moo School	- Director	13 yrs.
4) Wat Nong Ta Luang Schoo	- Director	1 yrs.
5) Wat Nong Krathum School	- Director	7 yrs.
6) Wat Arun Rattanakhiri School	- Director	1 yrs.
7) Khao Ngu Santitham School	- Director	1 yrs.
8) Wat Huai Phai School	- Director	13 yrs.
sum	8 samples	
2. Religious group		
1) Wat Huai Moo	- secretary	2 yrs.
2) Wat Huai Pladuk	- abbot	1 yrs.
3) Wat Nong Ta Luang	- monk	13 yrs.
4) Wat Hin Kong	- abbot	1 yrs.
5) Wat Arun Ratanakhiri	- District Secretary	7 yrs.
6) Wat Na Nong	- abbot	18 yrs.
7) Wat Khao Ngu Santitham	- abbot	5 yrs.
8) Phraphuthamchay ruasi	- abbot	7 yrs.
9) Wat Nong Luang	- monk	22 yrs.
10) Wat Nong Krathum	- abbot	4 yrs.
11) Wat Nong Nam Khun	- abbot	7 yrs.
12) Wat Huai phai	- abbot	23 yrs.
13) Wat Khao Kruat	- nun	30 yrs.
sum	13 samples	
Total	**21 samples**	

Source : Consultants Of Technolog y Co.,LTD B.E.2563

(B) Religious group

The consulting company conducted the survey within the 5 kilometers of radius of 13 religious representatives. The consulting company received questionnaire responses back from 13 samples which consisting of.

3) Water consumption group

The consulting company conducted a survey of representatives from households consuming water resources. Areas, such as Lum Din Sub-district, was the downstream area from the pumping area and was an agricultural area. By using Accidental sampling, it was done during 26-28 October, B.E. 2562 by surveying 30 water consumers with details as seen in **Figure 3.4.2-3.**

4) Groups may receiving impacts from installing the raw water pipeline

The consulting company conducted a survey of representatives from households that may be affected by the construction of water pipes. By surveying those affected by the delivery of raw water within 0-50 meters from the center of the pipe line using aerial photograph maps for the survey of such households. The survey was done during 26-28 October, B.E. 2562. It surveyed every household leader who convenient for providing information on the day of the survey. The consulting company then conducted a survey of 43 samples, with details as seen in **Figure 3.4.2-4.**

5) Community leader groups

This study divided community leaders into 2 groups according to their roles, responsibilities and respect in society. The consulting company had surveyed opinions of community leaders by asking for courtesy to answer questionnaires for 3 samples per community during 27 September - 30 November, B.E. 2562. Summary of positions of respondents in each community, as seen in **Table 3.4.2-3** with following details.

(A) Community leaders living near the project (0-3 kilometers)

Community leaders living near the project were communities locating within 0-3 kilometers from the project location. There were 17 villages for the survey and questionnaire responses were back from 23 samples, which were;

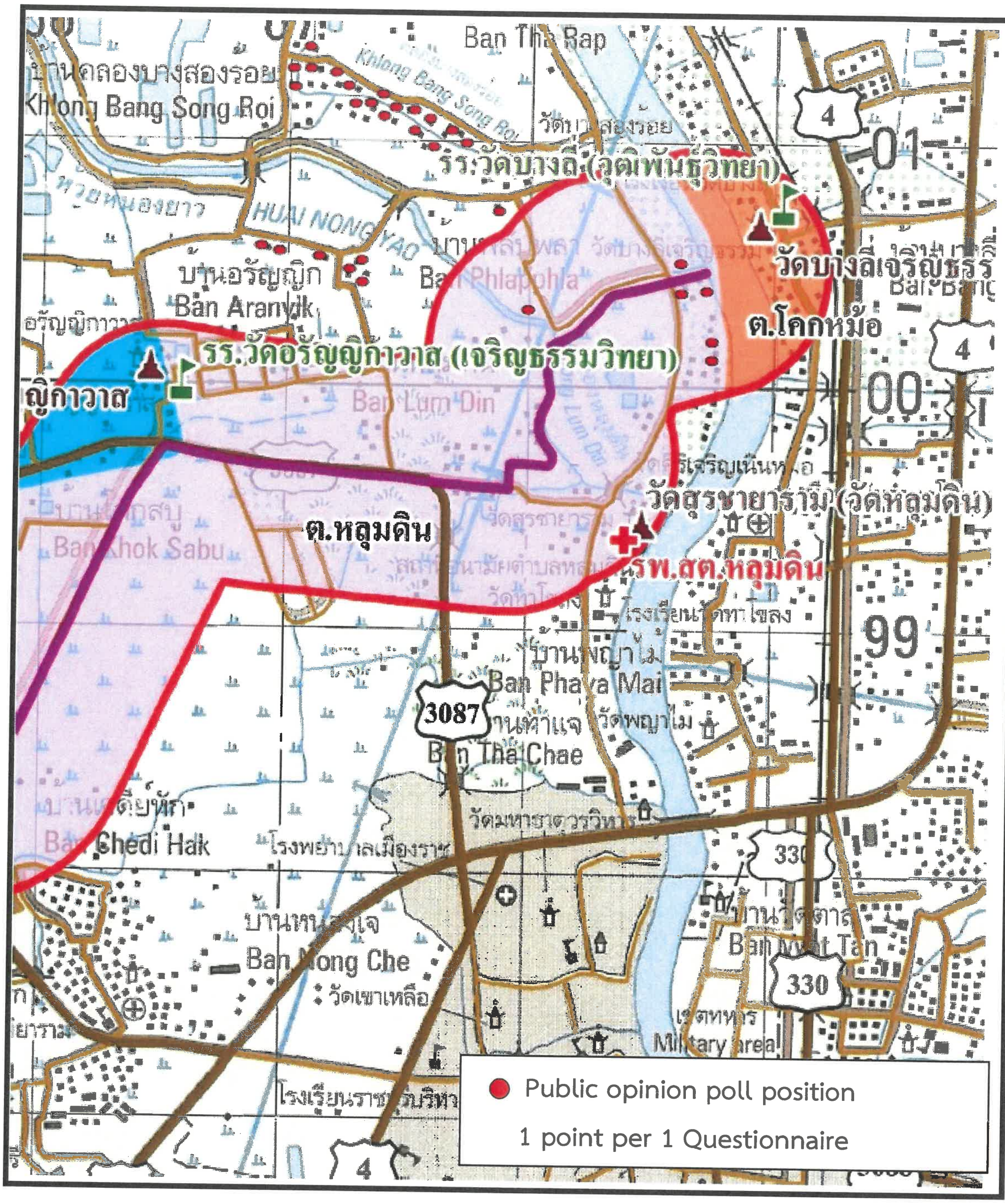


Figure 3.4.2-3 Location of water user group query

A) **Hin Kong SAO** for 8 villages: Moo.1, Ban Hin Kong, Moo. 2, Ban Ruakkwang, Moo.3, Ban Nong Ta Luang, Moo.4, Ban Nong Sadao Lang, Moo. 5, Ban Nong Rak, Moo.6, Ban Nong Sadao Bon, Moo.7, Ban Huai Pladuk and Moo.9, Ban Thung Lai Kai Bon.

B) **Huai Phai SAO** for 6 villages: Moo.1, Ban Khao Kwang, Moo.3, Ban Rak Makham, Moo.4, Ban Huai Phai, Moo.5, Ban Nakhon Ban, Moo.7, Ban Nong Din Daeng and Moo.9, Ban Nong Nam Khun.

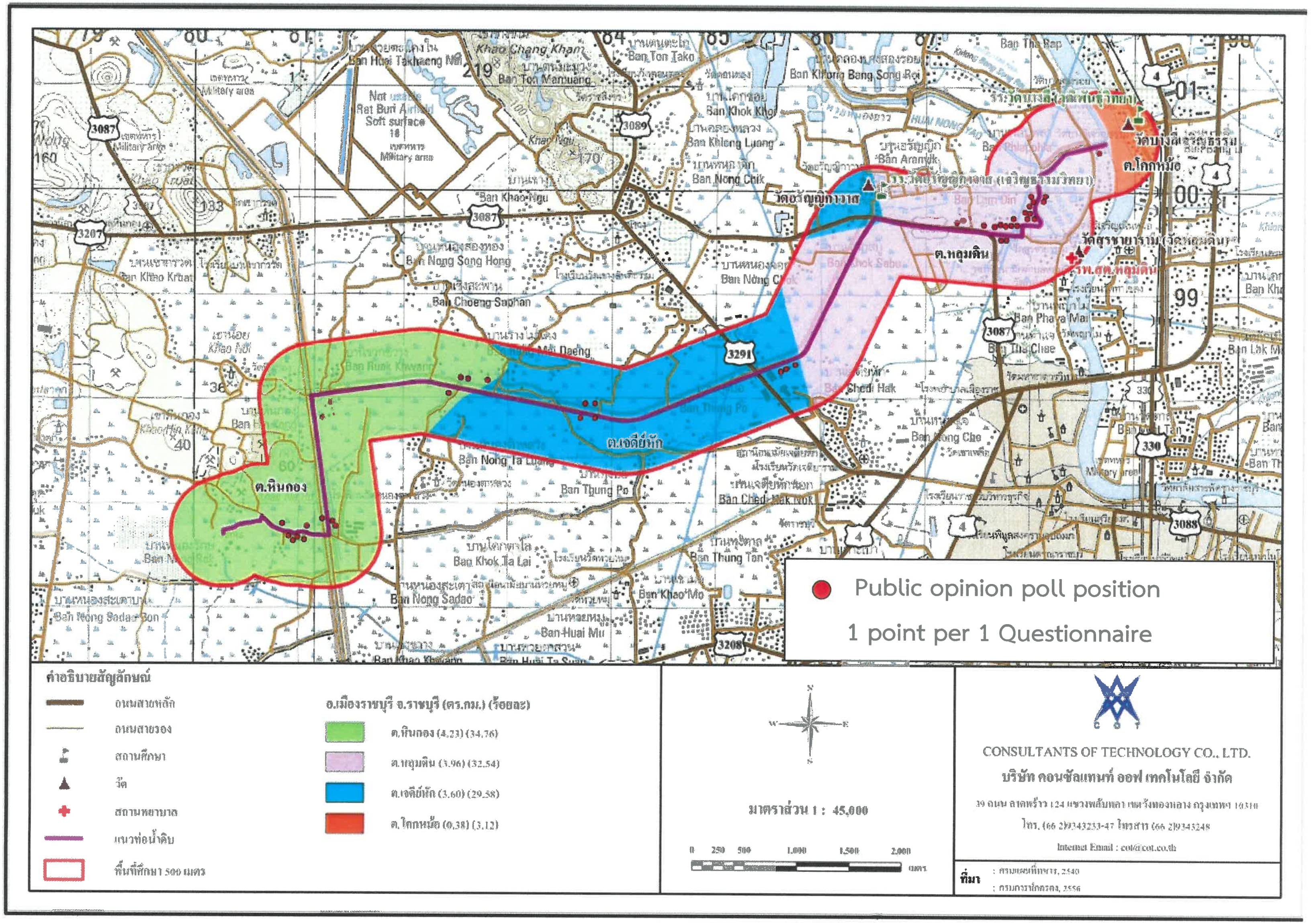


Figure 3.4.2-4 The location of the questionnaire for Groups may receive impacts from installing the raw water pipeline

Table 3.4.2-3

Summary of positions of respondents in each community

community	position	Duration of tenure (years)
Hin Kong SAO		
Moo.1, Ban Hin Kong	1. Village Headman	22
Moo. 2, Ban Ruakkwang	2. Village Headman	21
	3. Assistant Village Headman	8
Moo.3, Ban Nong Ta Luang	4. Village Headman	4
Moo.4, Ban Nong Sadao Lang	5. Village Headman	3
Moo. 5, Ban Nong Rak	6. Village Headman	8
Moo.6, Ban Nong Sadao Bon	7. Village Headman	4
Moo.7, Ban Huai Pladuk	8. Village Headman	3
	9. Assistant Village Headman	5
Moo.8, Ban Nong Yai Kata	10. Village Headman	2
Moo.9, Ban Thung Lai Kai Bon	11. Village Headman	5
Moo.10, Ban Nong Krathum	12. Village Headman	12
	13. Assistant Village Headman	6
Huai Phai SAO		
Moo.1, Ban Khao Kwang	1. Assistant Village Headman	8
Moo.3, Ban Rak Makham	2. Village Headman	6
	3. Assistant Village Headman	9
	4. Assistant Village Headman	1
Moo.4, Ban Huai Phai	5. Assistant Village Headman	3
Moo.5, Ban Nakhon Ban	6. Village Headman	12
	7. Assistant Village Headman	7
	8. Assistant Village Headman	9
Moo.6, Ban Nong Luang	9. Village Headman	6
	10. Assistant Village Headman	10
Moo.7, Ban Nong Din Daeng	11. Village Headman	3
Moo.8, Ban Nong Kham	12. Village Headman	3
Moo.9, Ban Nong Nam Khun	13. Village Headman	3
Chedi Hak SAO		
Moo.6, Ban Rang Mai Daeng	1. Village Headman	12

Table 3.4.2-3 (cons.)

community	position	Duration of tenure (years)
Moo.7, Ban Nong Thung Po Bon	2. Village Headman	16
Moo.8 Ban Thung Tan	3. Village Headman	6
	4. Assistant Village Headman	9
	5. Assistant Village Headman	2
Moo.9, Ban Huai Mu	6. Village Headman	4
Moo.10, Ban Sa Sawat	7. Village Headman	3
	8. Assistant Village Headman	4
	9. Assistant Village Headman	7
Moo.12, Ban Khao Mo	10. Village Headman	4
	11. Assistant Village Headman	8
	12. Assistant Village Headman	9
Ko Plub Pla SAO		
Moo.6, Ban Huai Tha Kang Nai	1. Village Headman	12
Moo.7, Ban Thung Po Bon	2. Village Headman	13
Moo.15 Ban Nong Song Hong	3. Village Headman	4
Don Tako SAO		
Moo.7, Ban Khao Loi - Khao Luang	1. Village Headman	3
	2. Assistant Village Headman	2
Moo.8, Ban Khao Ngam - Klang Thung	3. Village Headman	4
	4. Assistant Village Headman	10
	5. Assistant Village Headman	6
Moo.9, Ban Khao Kaeng Chan	6. Village Headman	8
Don Rae SAO		
Moo.2, Ban Na Nong	1. Village Headman	2
Moo. 3, Ban Nong Kam	2. Village Headman	24
Khao Ngu Subdistrict Municipality		
Somphum Phatthana Community	1. Chairman of community	8
Ton Mamuang Phattana Community	2. Chairman of community	6
Total	51 samples	

Source : Consultants Of Technology Co.,LTD B.E.2563

C) **Chedi Hak SAO** for 2 villages: Moo.6, Ban Rang Mai Daeng and Moo.9, Ban Huai Mu.

D) **Ko Plub PlaSAO** for 1 village: Moo.15 Ban Nong Song Hong.

(B) **Community leaders living far from the project (3-5 kilometers)**

Community leaders living far from the project were communities locating within 3-5 kilometers from the project location.

A) **Khao Ngu Subdistrict Municipality:** 2 community leaders from Khao Ngu Subdistrict Municipality, which were, Somphum Phatthana Community and Ton Mamuang Phattana Community. Questionnaire responses were back from 2 samples.

B) **Subdistrict Administration Organization**: for the total of 15 village, there were community leaders responded to questionnaires for totally 26 samples, including.

- **Hin Kong SAO** for 2 villages: Moo.8, Ban Nong Yai Kata and Moo.10, Ban Nong Krathum;
- **Huai Phai SAO** for 2 villages: Moo.6, Ban Nong Luang and Moo.8, Ban Nong Kham;
- **Chedi Hak SAO** for 4 villages: Moo.7, Ban Nong Thung Po Bon, Moo.8 Ban Thung Tan, Moo.10, Ban Sa Sawat and Moo.12, Ban Khao Mo;
- **Don Tako SAO** for 3 villages: Moo.7, Ban Khao Loi - Khao Luang, Moo.8, Ban Khao Ngam - Klang Thung, Moo.9, Ban Khao Kaeng Chan;
- **Ko Plub Pla SAO** for 2 villages: Moo.6, Ban Huai Tha Kang Nai and Moo.7, Ban Thung Po Bon;
- **Don Rae SAO** for 2 villages: Moo.2, Ban Na Nong and Moo. 3, Ban Nong Kam.

6) **Household groups**

People living target areas of public participant were main stakeholders from the project development. Thus, such target groups were very necessary for a survey since they lived together with the project throughout the project life. The survey of the household groups around the project, in order to cover all target groups in the sub-district administrative organization and the municipality in the study area, the consulting company, therefore, divided the survey into 3 groups by surveying representatives of 32 villages between 27-28 July B.E. 2562. The survey was consisting of household groups close to the project, household groups in the sub-district administrative organization and household groups in the municipality with following methods.

(A) Identification of the sample size

A) Household groups locating close to the project

Household groups living close to the project with the radius of 0 to 100 meters, considered from aerial images, together with the field survey on 26-28 October B.E. 2562, there were total of 26 households assigning to conduct a survey. Purposive Sampling was used as a method to survey. There were interviewing household leaders for 100%. Positions of survey data were shown in **Figure 3.4.2-5**.

B) Household groups

For the survey of the household population in the area around the project and the survey to cover all target groups in the subdistrict administrative organizations and municipalities In the study area, the consulting company then divided the survey groups into 2 groups, which were the target group in the sub-district administrative organization area and the target group in the municipality area. The sample size of the population was calculated by using the formula of Taro Yamane (1973: 725, Yamane, Taro. Statistics: An Introductory Analysis. 3rd ed. Tokyo: Harper International Edition, 1973) as follows.

The determination of sample size used in the study was calculated using the formula of Taro Yamane (1973: 725, Yamane, Taro. Statistics: An Introductory Analysis. 3rd ed. Tokyo: Harper International Edition, 1973), as seen in **Table 3.4.2-4** and **Table 3.4.2-5** with the following equation.

When	n	was	sample size that must be studied
	N	was	total of households
	e	was	acceptable error (in this case, e = 0.05)

In the public opinion survey, it was divided into groups within the municipality and groups within the sub-district administrative organization area because both groups have different economic and social characteristics. The details of the sample size calculation were as follows.

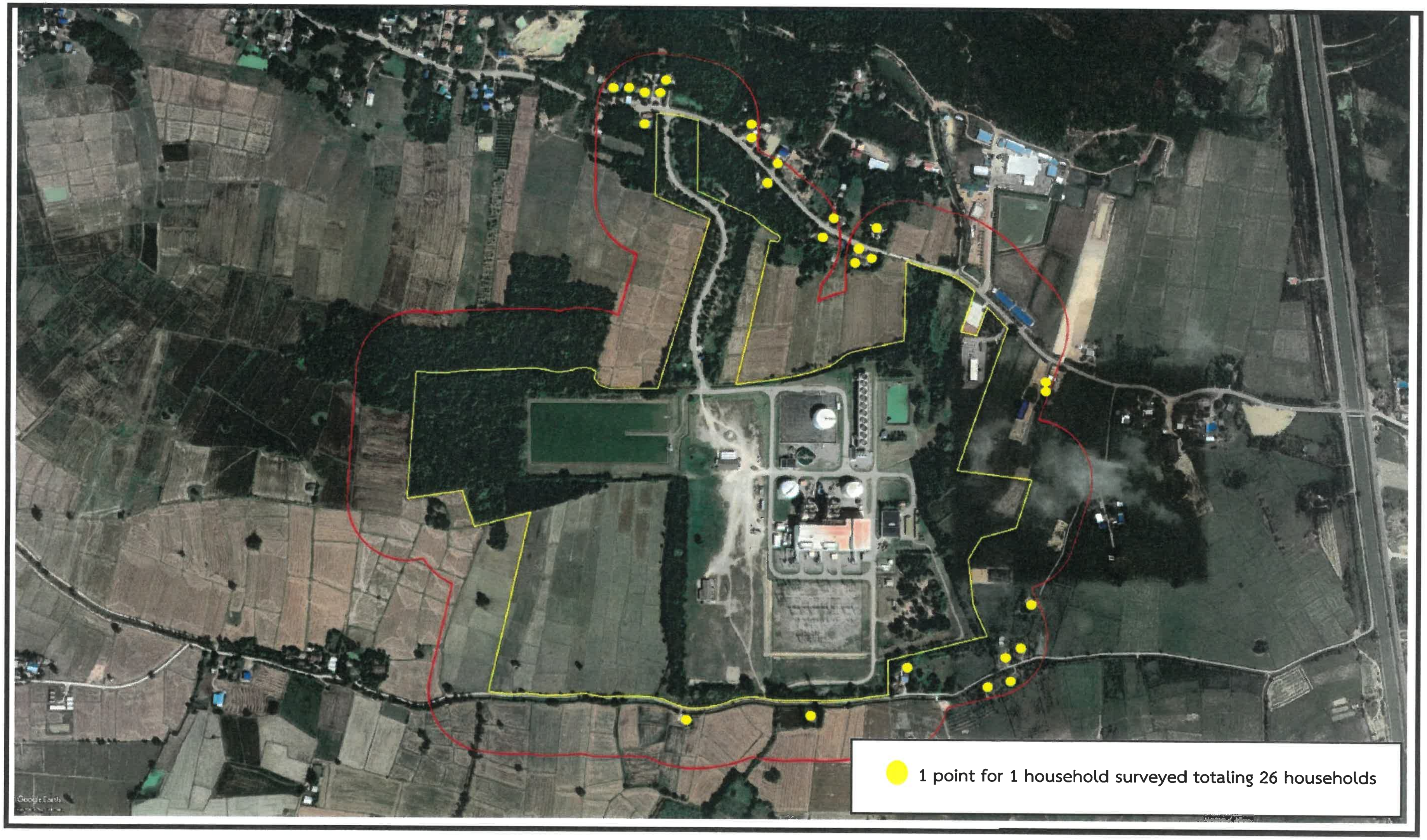


Figure3.4.2-5 Positions of survey data of Household groups living close to the project with the radius of 0 to 100 meters

Groups in the municipality district, substituting the values in equation (1)

Groups in the sub-district administrative organization area, substituting the values in equation (1)

Therefore, the sample size of households in the municipality group used in this study were not less than 252 samples and not less than 388 samples for the subdistrict administrative organization group.

From the calculation of the total number of samples, the consulting company had given importance to the communities in the radius close to the project area (0.1-3 kilometers). According to the number of calculated samples, the consulting company determined the ratio of the sample numbers in the community near the project area to the communities that are far away from the area equal to 60:40 as follows.

Sample numbers in communities near the project area (radius of 0.1-3 kilometers) per community in the project area was equal to 233: 155.

When received all the sample sizes, there were used to determine the sample size of each community in ratio to the number of households In order to have a uniform distribution of sampling and an equal opportunity for selection in each community. Numbers were substituted the value in Equation (2)

By n_1 = numbers of households in the community
n = total samples
N = total households
A = number of samples in the community

For example, Ban Hin Kong (n1 = 398) substituted the value in equation (2)

When determining the sample size of each community in ratio to the number of households of each community and made the decimal rounded point, resulting in the number of samples in communities near the project area (radius 0.1-3 kilometers) per community far from the project area was equal to 243: 160.

In summary, from the sample size calculation of households used in this study, in the municipality group, there were total of 252 samples and at least 388 samples in the subdistrict administrative organization group. After specifying sample size ratio in equation 2, when rounding up decimals in every community, the sample size of the sub-district municipality group was 253 and the sample size of the sub-district administrative organization group was 403 samples. It was divided into a group of 0-3 kilometers in the amount of 243 samples and a group in the area of 3-5 kilometers in the amount of 160 samples. Lists of communities surveying and number of samples in subdistrict administrative organizations and sub-district municipalities were shown in **Table3.4.2-4** and **Table3.4.2-5**, respectively.

The consulting company had set eligibility criteria for respondents to show their representatives by specifying the characteristics of household samples (Respondents). The interviewee must be the head of the household or the host. If the host was not present, spouse or resident who is related to a relative able to provide information at the household level must be interviewed. The study required a survey of 1 household per sample.

Table 3.4.2-4

Lists of communities surveying and number of samples in SAO

No.	Village/Community's name	numbers of households	Samples		
			calculation	Desired	Explored
The communities in the radius close to the project area (0-3 kilometers)					
Hin Kong SAO					
1	Moo.1, Ban Hin Kong	398	19.73	20	20
2	Moo. 2, Ban Ruakkwang	78	3.87	4	4
3	Moo.3, Ban Nong Ta Luang	165	8.18	9	9
4	Moo.4, Ban Nong Sadao Lang	135	6.69	7	7
5	Moo. 5, Ban Nong Rak	124	6.15	7	7
6	Moo.6, Ban Nong Sadao Bon	102	5.06	6	6
7	Moo.7, Ban Huai Pladuk	238	11.80	12	12
8	Moo.9, Ban Thung Lai Kai Bon	469	23.26	24	24
Huai Phai SAO					
9	Moo.1, Ban Khao Kwang	244	12.10	13	13
10	Moo.3, Ban Rak Makham	386	19.14	20	20
11	Moo.4, Ban Huai Phai	612	30.35	31	31
12	Moo.5, Ban Nakhon Ban	169	8.38	9	9

Table 3.4.2-4 (cons.)

No.	Village/Community's name	numbers of households	Samples		
			calculation	Desired	Explored
13	Moo.7, Ban Nong Din Daeng	256	12.69	13	13
14	Moo.9, Ban Nong Nam Khun	287	14.23	15	15
Chedi Hak SAO					
15	Moo.6, Ban Rang Mai Daeng	350	17.35	18	18
16	Moo.9, Ban Huai Mu	535	26.53	27	27
Ko Plub Pla SAO					
17	Moo.15 Ban Nong Song Hong	151	7.49	8	8
Total (0-3 kilometers)		**4,699**	**233.00**	**243**	**243**
The communities in the radius close to the project area (3-5 kilometers)					
Hin Kong SAO					
18	Moo.8, Ban Nong Yai Kata	124	2.36	3	3
19	Moo.10, Ban Nong Krathum	303	5.76	6	6
Huai Phai SAO					
20	Moo.6, Ban Nong Luang	133	2.53	3	3
21	Moo.8, Ban Nong Kham	97	1.84	2	2
Chedi Hak SAO					
22	Moo.7, Ban Nong Thung Po Bon	187	3.55	4	4
23	Moo.8 Ban Thung Tan	1175	22.32	23	23
24	Moo.10, Ban Sa Sawat	1832	34.80	35	35
25	Moo.12, Ban Khao Mo	939	17.84	18	18
Ko Plub Pla SAO					
26	Moo.6, Ban Huai Tha Kang Nai	82	1.56	2	2
27	Moo.7,Ban Khao Kruat	1882	35.75	36	36
Don Tako SAO					
28	Moo.8, Ban Khao Ngam - Klang Thung	348	6.61	7	7
29	Moo.9, Ban Khao Kaeng Chan	975	18.52	19	19
Don Rae SAO					
30	Moo.2, Ban Na Nong	83	1.58	2	2
Total (3-5 kilometers)		**8,160**	**155**	**160**	**160**
Total		**12,859**	**388.00**	**403**	**403**

Source : Consultants Of Technology Co.,LTD B.E.2563

Table 3.4.2-5

Lists of communities surveying and number of samples in municipality

No.	Village/Community's name	numbers of households	Samples		
			calculation	Desired	Explored
The communities in the radius close to the project area (3-5 kilometers)					
Khao Ngu Subdistrict Municipality					
1.	Ton Mamuang Phattana Community	278	103.33	104	104
2.	Somphum Phatthana Community	400	148.67	149	149
Total		**678**	**252.00**	**253**	**253**
Total subdistrict municipality		**678**	**252.00**	**253**	**253**

Source : Consultants Of Technology Co.,LTD B.E.2563

(B) Sampling method

For questionnaire sampling of this study, the consulting firm used sampling details as follows.

A) Close range household groups (0-100 meters radius)

The survey had set to be conducted on every household. The Interview was done by Purposive Sampling, for a total of 26 households with the head of the household or spouse who had the power at the home and make decisions. Households were selected by considering of data from aerial photography, the project radius border and the field survey on 20-21 July B.E.2562.

B) Sampling of households in the study area with the radius of 0.1-5 kilometers

The consulting company had set the area for the study with the multistage random sampling as follows.

Step 1: the consulting company had selected the sample area covering the study area of 0.1-5 kilometers and had divided it into 2 groups.

Step 2: the consulting company had calculated the sample size from total population in the study area, in order to obtain a sufficient sample size to be able to represent the household population. Therefore, the determination of the statistical confidence value of the sample selection at 95% (tolerance value 0.05) was done by using

Yamane's formula (1967) [1/]. From the calculation of the total sample mentioned above, the consulting company had given the importance to communities locating near the project area (0.1-3 kilometers). Therefore, from the calculated sample numbers, the consulting company determined the ratio of sample numbers in the nearby communities (0.1-3 kilometers) and the project area to distant communities (3-5 kilometers), was equal to 60:40. These numbers were taking into account for determining the sample size of each community in proportion to the number of households, in order to facilitate a thoroughly distribution of sampling and an equal opportunity of selection in each community.

Step 3: when getting the sample size in each community, the consultant team collected household level data using the systematic random sampling, meaning that when knowing the number of households and the number of samples needed in each community, the transportation route map was used for the travel planning and considered the total number of distributed households. Then randomly sampling households in the study area as needed by distributing appropriately, regularly, and being a sample of real households in the study area. It was started with the first randomly selected household unit as a random start, while the next units were omitted according to the random interval. Activities were proceeded to complete the required number of samples, with the interviewee as the head of the household or the host. When the host was not present, interviewing a spouse or permanent resident with a relative older than 18 years that could provide information at the household level was done. It required to survey 1 sample per household.

For the location of questionnaire sampling in households, it was shown in **Figure 3.4.2-6** and the atmosphere for collecting questionnaires was shown in **Figure 3.4.2-7**.

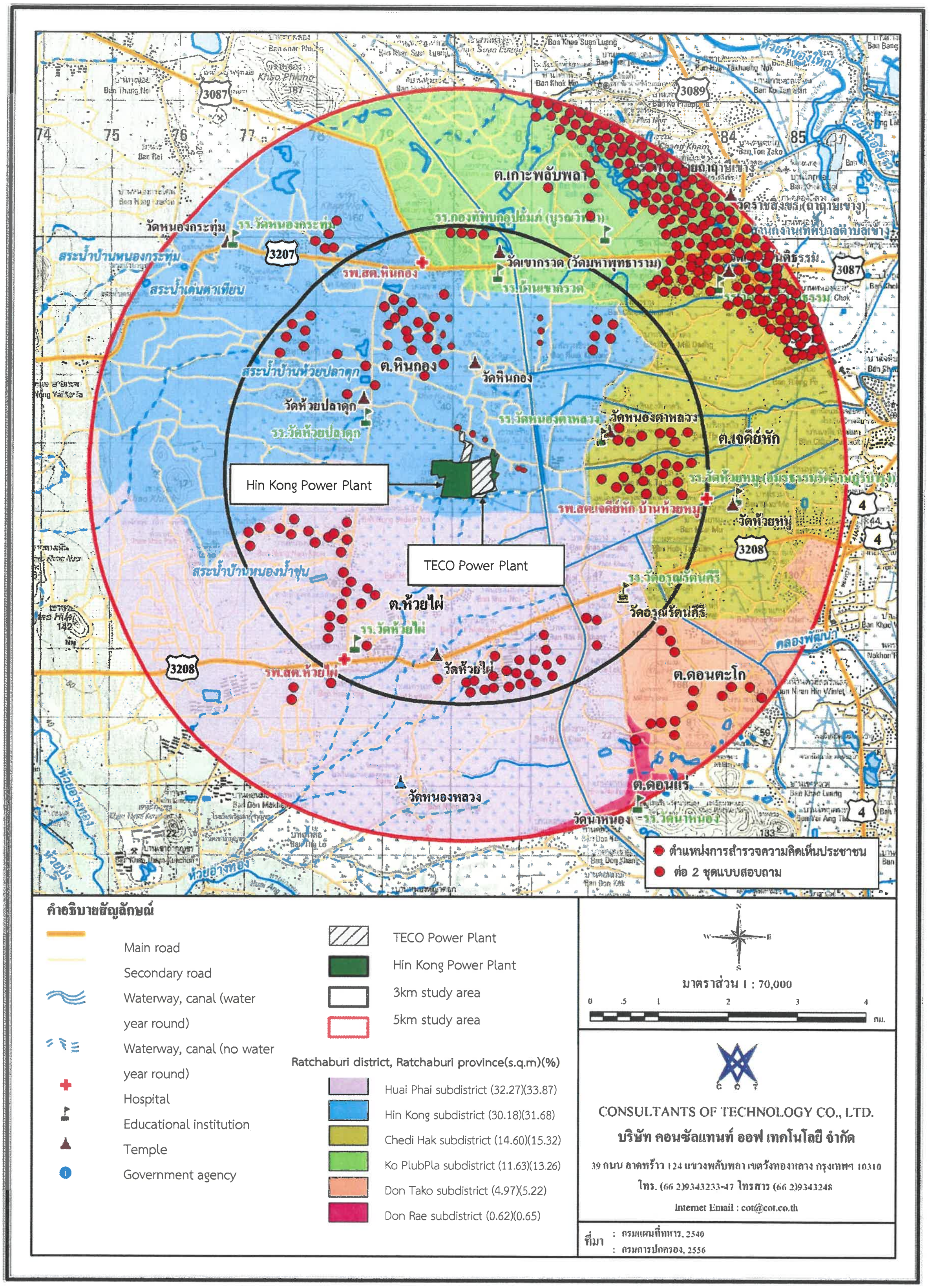


Figure 3.4.2-6 The location of questionnaire sampling in households during 27-29 July B.E.2562

Figure 3.4.2-7 Picture of the survey of the household population during 27-29 July B.E.2562

(2) The essence of the questionnaire in each group

1) **Related government agencies**

The related government agencies were consisting of (1) environmental and regulatory agencies (2) public utilities and services groups (3) agricultural sector groups (4) Health service agencies and (5) administrative and government agencies. The structure of the questionnaire consisted of general information, previous operation and policies in the department, environmental impacts, comments and suggestions for the project.

2) **Sensitive area groups**

Sensitive areas were consisting of (1) educational institutions and (2) religious groups which were affected groups. The structure of the questionnaire consisted of general information, previous operation of industrial plants in the area, environmental impact, comments and suggestions for the project.

3) **Water consumer groups,** the structure of the questionnaire consisted of general information, data on water consumption in the area, current living conditions, problems receiving from the project, comments and suggestions for the project.

4) **Groups affecting by the raw water pipeline installation,** the structure of the questionnaire consisted of general socio-economic information, family health, current environmental and health impacts, environmental impact, comments and suggestions for the project.

5) **Community leader groups,** the structure of the questionnaire consisted of general information of community leaders who had been interviewed, demographic information, employment rate, acknowledgment in the general news in the community, sufficiency of public health facilities, public utility, environmental impact, comments and suggestions for the project.

6) **Close range household groups (0 -100 meters form the project location),** the structure of the questionnaire consisted of general socio-economic information, family health, current environmental and health impacts, environmental impact, comments and suggestions for the project.

7) Household groups, the structure of the questionnaire consisted of general socio-economic information, family health, current environmental and health impacts, environmental impact, comments and suggestions for the project.

(3) Data analysis

Once the questionnaire had been completely collected, Eligibility checking was done in every questionnaire. They were coded and recorded in computer software for data analysis, in order to explain results in percentages, means and statistics and to accompany notes. Information obtained from open-ended questions were compiled and classified messages in categories. Then data analysis was done and content was presented in a descriptive manner. The following criteria were used for the interpretation of results.

1) Interpretation using percentage

This method was done by finding the frequency (number) in each answer and then translating those frequencies into percentages. Data used in this analysis were closed-end questionnaires with multiple choices, such as;

(A) General information of the respondents, consisting of gender, age, education level and religion

(B) Data on quality of life consisted of social aspects such as, information on household structure. For economic aspects, such as occupation, income, savings and debt. Basic public utilities and environmental health such as water consumption, electricity consumption, waste management, and community waste water management. For social and public health services and communicating and acknowledging information and opinions on the project, they included knowing of the project owner, impacts from the project, project Information acknowledgment, advantages or benefits from the projects, confidence in project management systems and the confidence of supervised government agencies, etc.

2) Interpretation of estimation scale data

For questions aimed for opinions, the questions were in the scale form and use the Interval Scale to find the average score by assigning scores instead of weight for each range of opinion levels and then calculated the average. After that, the mean value was compared with the interpretation criteria. The meanings of interpretation criteria were as follows:

(A) Environmental impact had the assessment criteria as follows;

Very	for	3	scores
Moderate	for	2	scores
Low	for	1	scores

Interpretation of average scores could be interpreted as follows;

Average scores	1.00 – 1.50	low level
Average scores	1.51 – 2.50	moderate level
Average scores	2.51 – 3.00	very level

(B) The severity of the current impact compared to the previous period had the assessment criteria as follows;

More	for	3	scores
Same	for	2	scores
Less	for	1	scores

Interpretation of average scores could be interpreted as follows;

Average scores	1.00 – 1.50	low level
Average scores	1.51 – 2.50	moderate level
Average scores	2.51 – 3.00	very level

(C) Confidence level in projects and departments had the assessment criteria as follows;

Very unbelievable	for	1	scores
No confident	for	2	scores
Not sure	for	3	scores
Confidence	for	4	scores
Strongly confidence	for	5	scores

Interpretation of average scores could be interpreted as follows

Average scores	1.00 – 1.50	Very unbelievable
Average scores	1.51 – 2.50	No confident
Average scores	2.51 – 3.50	Not sure
Average scores	3.51 – 4.50	Confidence
Average scores	4.51 – 5.00	Strongly confidence

(D) Participation level had the assessment criteria as follows.

Lowest	for	1	scores
Low	for	2	scores

Moderate	for	3	scores
very	for	4	scores
Highest	for	5	scores

Interpretation of average scores could be interpreted as follows

Average scores	1.00 – 1.50	Lowest
Average scores	1.51 – 2.50	Low
Average scores	2.51 – 3.50	Moderate
Average scores	3.51 – 4.50	very
Average scores	4.51 – 5.00	Highest

For the reason to select the absolute criteria and exact limits (Source: Wan Detphichai. (B.E.2535). Research and evaluation manual for educational and behavioral science programs. Pattani: Montri Service.) for interpreting the estimation scale data because in the case of interpretation using the arithmetic mean, these criteria were based on the principle that the range or range of scores at all levels must be equaled. When determining weight, level of strongly confidence, confidence, not sure, no confident and very unbelievable level as 5, 4, 3, 2 and 1, respectively, the range was 5-1 = 4. The average of each interval was 4/5 = 0.8 with the interpretation criteria as follows.

Mean level	**Meaning**
4.21 - 5.00	Strongly confidence
3.41 - 4.20	Confidence
2.61 - 3.40	Not sure
1.81 - 2.60	No confident
1.00 - 1.80	Very unbelievable

If calculating for the average from the data obtained was an integer, then there was no problem. But if the value was a decimal number, then it had to be rounded to an integer, such as 1.65 rounding into 2, as the value closer to 2 than 1 without controversy. When using the criteria that all levels had the same distance spacing, it may cause conflicts with the rounding principle mentioned above, for example; when calculating the average value as 1.80, it was interpreted according to the criteria to be in a very unbelievable level. However, when rounded it to an integer, it was 2 , which corresponds to the level of no confident. This was causing conflicts and arguments. To reconcile these conditions, the weight of each level must be integrated with the principle of rounding the decimal into an integer, with the following interpretation criteria:

Mean level	Meaning
4.50 - 5.00	Strongly confidence
3.50 - 4.49	Confidence
2.50 - 3.49	Not sure
1.50 - 2.49	No confident
1.00 - 1.49	Very unbelievable

In this type of criteria, the highest and lowest scores would be less than other levels. The highest score range and the lowest scores were about 0.5 in each range, but in other level, it was about 1. Therefore, the average score of 1.80 would fell into the level of no confidence, corresponding to the rounding principle. However, even it was associated with the general rounding principle, if the average score was 4.50, 3.50, 2.50 and 1.50, there were the same problem points. For example, 4.50 was rounded to 5 at a high level, despite 4.50 had an equal distance from 5 and 4. Therefore, the most appropriate interpretation criteria covering all the arguments was developing from these two concepts as follows.

Mean level	Meaning
4.51 - 5.00	Strongly confidence
3.51 - 4.50	Confidence
2.51 - 3.50	Not sure
1.51 - 2.50	No confident
1.00 - 1.50	Very unbelievable

Information obtained from open-ended questions were classified messages in categories. Data analysis was done and presented with percentage form with the descriptive manner.

(3) Survey results

Results of the survey of the six stakeholder groups consisting of 1) government agencies, such as environmental and regulatory groups, agricultural groups, health service agency groups, utilities and public service organizations groups and administrative and government agencies, 2) sensitive areas such as, educational institutions, health promotion hospitals and religious places, 3) community leader groups, 4) household groups, 5) water consumer groups, and 6) groups affecting form the pipeline installation. Details of the survey of stakeholders groups were as follows.

1) **Related government agency groups**

From the survey of 5 groups of government agencies, namely, agricultural groups, environmental and regulatory groups, health service agency groups, utilities and public service organizations groups and administrative and government agencies, total number of respondents were 22 examples with survey results as seen in **Appendix 3-3 Table 1** and could be summarized as follows.

(A) General information

All respondents had their ages between 51-60 years (42.9 %), followed by 41-50 years (39.3%). Among these were graduated with bachelor degree (60.7%), followed by master degree (35.7%). They had a duration of holding positions in the area for 6-10 years (32.1%), followed by 0-5 years (25.0%) and over 20 years (17.9%).

A) <u>Environmental and Regulatory agency Groups</u>

For inquiring about the past 5 years operation and policies in their department. Issues of natural resources and major environmental problem of the area were the waste water and dust problem (equal to 27.3%), followed by odor (18.2%).

All samples indicated that the operation of existing factories in the area affecting the community. The occurred impacts were odor, wastewater and dust (equal to 33.3%) due to the management deficiencies, sewage discharge from factories and the production process of the factories. The duration of the impact was in the evening, most of them indicating that the effect was moderate (= 1.75, S.D. = 0.500).

When inquiring about various complaints, it was found that most of the samples received complaints (66.7%) with regard to wastewater and dust (50.0%). The solutions when receiving complaints were the investigation for the facts with relevant agencies, collecting environmental samples when it was necessary, in order to prove evidence, coordinating and following up on the solutions, vesting the area to supervise/inquire for public opinions, coordinating with regulatory agencies, reporting the situation to the supervisor and monitoring with advises, etc.

For policies of the environment and regulatory agencies were following practices: 1) participating in the consideration of the permit in the case of the large factory had the public objection, 2) allowing industrial plants to comply with the law and learn how to live with the community, 3) Providing knowledge as industrial factories to the environment, 4) collaborating with relevant agencies, such as the environment, industry. 5) following up on problems as according to the roles and responsibilities of the department. 6) acknowledging problems, specify solutions to the community, factories, and 7) joint operating with the community leading to mutual acceptance.

B) Utilities and public service agency groups

Most samples were aware of the project (85.7%) and viewed that this project had advantages and benefits to the area (71.4%). They looked at the growth of overall economy in the area and the project created jobs and income for the community in the area (equal 30.0%). The followed by having a power plant development fund (20.0%), there were concerns if there was a project establishment (71.4%) they would concerned about fuels used in production (50.0%) and polluted air / dust (25.0%). The cause of concern was self-prediction (57.1%) and from the information disseminated through public relations (28.6%).

C) Agricultural agency groups

Sample groups stated that types of important economic crops in the area that they were responsible for were, rice, cassava, corn, rubber and fruits such as longan, coconut, etc.

The major agricultural problems of the area were water shortage in irrigated areas, agricultural product prices fell, lack of agricultural labor and the high cost of production. For impacts on the overall agriculture in the area, most of causes were water impacts, wastewater, which had a moderate level of overall impact ($\bar{x}$= 2.00, S.D. = 0.000). When there was a complaint, the sample group resolved the problem by visiting the location of the complaint, investigating the cause of the problem and notifying relevant departments to take action to resolve cases. In violation of the law, there was a notice. For the environmental policy of the agency relating to agriculture, any activity or operation done by the agency must not affect farmers, the environment and others.

D) Health service agency groups

From the interview of sample groups on the past year, it was found that most of the people came to receive treatment for the disease such as respiratory diseases, gastrointestinal diseases, musculoskeletal diseases, skin diseases (20.0% equal), including eye and eye component diseases (11.4%). The number of patients compared to the previous year showed an increase rate (57.1 %), followed by the stable (28.6%). When compared to the previous 3 years, the trend of local diseases had changed (71.4 %). The nature of the changes were more illness with non-communicable diseases, increased respiratory diseases, increased dermatitis and rash, decreased communicable diseases (dengue fever) and increased non-communicable diseases (20.0% equal).

As for the planning to support the trend of disease occurrence in the area of responsibility, it was found that there was the implementation of the plan as collecting health information, clinic of NCD Plus, set up a mobile medical unit at the sub-district level to control the disease in the area. The health program was planned once a year, with surveillance for diseases and health hazards, covering service areas for patients with the coordination with local administrative organizations, local government agencies and village health volunteers, local government agencies supported the budget and manpower to control the disease. There was an opening of Family Doctor Clinic, and a clear strategy and action plan in line with disease problems. Tambon Health Promotion Hospital had established the action plan to promote and control health for all age groups, to request additional health officials due to numbers of staff was insufficient to provide services. There was a continuous surveillance for communicable diseases, non-communicable diseases and other health problems. Work plan evaluation was done to improve the plan for solving the problem, etc.

Regarding the plan to support the non-registered population, it was found that the plan for migrant budget was to have the village health volunteers surveyed, analyzed the data and gave recommendations on the treatment right. The treatment right was divided into 2 groups, 1. Thai people informed of access to services according to the channels and 2. For the non-registered population groups, advised on diseases and the right to access the service would be done, with plans to support disease surveillance in foreign groups, having the village health volunteers surveyed the non-registered population, providing essential services such as vaccines for children aged 0 -5 to control non-communicable diseases, such as dengue fever, basic vaccination. Moreover, the formulation of a plan to promote health of foreign workers, control non-communicable diseases such as blood pressure, diabetes etc., were already established.

For issues of resources and providing health services to people in the area, the most common problem were insufficiency of public health personnel to provide services (36.4%), followed by confined spaces which insufficient to provide services, in case of many activities (27.3%) and insufficient medical supplies and equipment to provide services (18.2%).

E) Administrative groups

From the survey on issues of natural resources and the environment, sensitive issues, or major problem in the area, there were found as following issues, wastewater from pig farms (9.1%), loud noise caused by noisy machines (18.2%), the weather from emission by industrial plants (9.1%), factory lighting (9.1%), foul smell from pig farms (9.1%), floods from factories located close to natural water (18.2%), heat from industrial machines (9.1%) and traffic (9.1%). For the question, did past industrial operations in the area cause impacts to the community? Most of them stated that it affected the communities in the area (85.7%). Those impacts were noise (42.9%), followed by people who are nearby are affected, problems of complaints in the area, and the weather problems (14.3% equal) causing by machines used for the production (33.3%), the smell of pig farming, gas leaks and noise from the power plant (16.7% equal). For the period of impact, it was the evening (33.3%), followed by the morning, during 19.00-21.00 hrs. and the period with heavy rain (16.7% equal). The overall level of impact was moderate (50.0%), then followed by low level (33.3%) ($\bar{x}$ = 1.83, S.D. = 0.753).

When the survey on the complaint in the department, the sample stated that they used to complaints (57.1%). The reported problems were noise from the power plant (57.1%), followed by floods, wastewater in public canals and dust (14.3%) due to power plants, destruction of explosive materials, and pig farming.

In the case of receiving a complaint, samples had methods of operation by arranging staff to investigate the facts, notifying relevant agencies, using canal dredging trucks, establishing regulations for waste and waste disposal, send documents to the company for correction and participation in the examination, creating a green space project, using pump, using the backhoe for dredging the canal, enforcing according to duties, establishing environmental conservation projects, such as garbage collection on public roads and notifying the factory for information.

The policy related to environmental measures from industrial development in the area was to inspect the operations of businesses causing impacts. There was a policy to manage the environment according to the government policy for the peaceful community.

(B) Comments and suggestions for the project

A) Acknowledgment of the project

Regarding to receiving information about the project, most of respondents were informed about the project (82.1%) by the project public relations (30.6%), followed by a public hearing meeting on the drafted project proposal, project details, and scope of study and evaluation of project alternatives (27.8%).

B) Benefits or advantages and concerns from the project

When inquiring about benefits or advantages for the community, Respondents stated that there were benefits or advantages to the community (71.4%) and no benefits to the community (14.3 %). The expected benefits were job creation, income generation for local communities (21.9%), followed by local authorities receiving tax for local maintenance. Moreover, there was a development fund around the power plant and a new power plants using modern technology (17.2% equal). However, if projects occurred, they were worried (78.6%) with concerns about air pollution / dust (15.4%), followed by concerns on noise and fuels used in production (12.3% equal). They also concerned about the conflict of people in the community (10.8%).

C) Confidence in the project and the organization

For the confidence in operations and environmental management of the project, respondents commented that they were unsure (53.6%) with an average of confidence level in the unsure (= 3.12, S.D. = 0.726). For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, respondents stated that they were unsure (43.3%) with the average confidence level in the unsure (= 3.26, S.D. = 0.764).

D) Patterns of public relations and information sharing to the community

For patterns of public relations and information sharing to the community, they would like to be informed through a village chief/village headman/ community leaders/village broadcasting tower (46.9%), followed by holding a meeting (31.3%).

Other suggestions that would benefit the factory and the environmental protection and quality of life of the surrounding people were summarized as follows.

Environment and safety

- A concrete mechanism for the participation in the monitoring and examination of environmental impacts
- Avoiding to destroy of nature as much as possible
- Demands for environmental measures for the power plant project
- Concerns on the physical and biological environment impacts
- Demands for measures to solve the problem of noise pollution
- Demands for the measurement of the air quality in each area
- The plant must grow a lot of trees to reduce global warming
- Demands for dredging of canals during the rainy season to reduce flooding problems

Society and public participation

- Improve the landscape and arrange a sport field
- Demands for the clarification to the people to know the process of production, environmental impact and other impacts
- A meeting shall be conducted with the people around the project area for the impact notification
- Direct help the community without working through funds due to the fund was not transparent
- Evaluate and plan appropriate activities
- Direct help the community without working through the power development fund

Health

- Collect information about illness
- Negative impact on health from dust problems, fuel combustion and the temperature rising
- Support the budget for the development of Tambon Health Promotion Hospital (Service location)
- Support manpower (nurses, staff under the workforce framework, Thai Traditional medicine)
- Assess health impacts and environmental health monitoring
- Arrange for a health examination for the community at least twice a year.

2) Academic institutions

(A) General information

In educational institutions groups, there were 8 respondents, the survey results shown in **Appendix 3-3 Table 2**. The age of respondents were between 41-45 years (37.5%), followed by the age between 31-40 years and 51-60 years (25.0% equal). Most respondents graduated with master's degree (75.0%) and Bachelor degree (25.0%), with the position of being directors (87.5%) and teachers (12.5%).

(B) Environment and social information in the area

Respondents had identified important issues in the area which were parental poverty problems (25.0%), environmental problems, such as odor from the pig farm, odor from industrial plants, and odor from chicken processing factories (12.5% equal). Social problems were drug and crime problems. When inquiring about previous operations of the industrial plants whether it affecting communities in the area or not, it was found that most of them stated that they were not affected (87.5%) and affected (12.5%). They had indicated impacts such as, odor from industrial plants with a moderate impact (= 2.00, S.D. = 0.000). All schools stated that they had never received complaints from local people regarding environmental problems.

(C) Comments and suggestions for the project

A) Acknowledgment of the project

Regarding to receiving news about the project, most respondents were not informed (62.5%) and aware about the project (37.5%) from the community leaders (33.3%), followed by the public relations of the project and holding public hearing on the project proposal draft (25.0% equal).

B) Benefits or advantages and concerns from the project

When inquiring about benefits or advantages for the community, most respondents stated that it had benefits or advantages to the community (87.5%) and did not benefit the community (12.5%). The benefits were the overall economic growth of the area (27.3%), followed by creating jobs, income for the local community (22.7%). However, if the project occurred, most of them feel anxious (62.5%) with concerns about air pollution/dust (45.5%), followed by concerns about fuels used in production (27.3%). The cause of anxiety is mainly from self-estimation (71.4%).

C) Confidence in the project and the organization

For the confidence in operations and environmental management of the project, most respondents had the high confidence (50.0%), followed by the most confidence and unsure (25.0% equal) with the average confidence level at a medium level ($\overline{X}$ = 4.00, SD = 0.756). For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, respondents stated that they were very confident (62.5%), followed by the most confidence (25.0%) with a medium level of confidence ($\overline{X}$ = 4.00, SD = 0.926).

D) Patterns of public relations and information sharing to the community

For forms of public relations and providing information to the community, respondents would like to be informed through village chief/village headman/community leaders/village broadcasting tower (40.0%), followed by holding a meeting (26.7%).

Other suggestions that would benefit the factory and the environmental protection and quality of life of the surrounding people were summarized as follows.

Environment and safety

- Demand for trees plantation around the project.

Society and public participation

- Demand for the support on educational opportunities

Health

- Demand for organizing activities of the health promotion which engagen the population of the community.

3) Religious institution

(A) General information

From interviews with religious groups, there were 13 respondents, the survey results were shown in **Appendix 3-3 Table 3**. Respondents were older than 60 years (38.5%), followed by aged between 51-60 years (23.1%), aged between 31-40 years and 41-50 years (15.4% equal). For the education, most of them had primary education (46.2 %), followed by junior high school, diploma / theologian level and master degree level (15.4% equal). In terms of religious positions, it was found that, there were abbots (61.5%), followed by monk and the secretary of the archbishop/assistant abbot (15.4% equal). Most of them held these positions for more than 20 years (46.2%), followed by 0-5 years (30.8%) and 6-10 years (15.4%).

(B) Environment information in the area

The sample group had identified important environmental problems in the area which were, noise from the power plant (40.0%), followed by the problem of dust, odor and wastewater from the chicken processing factory (20.0%). For the operation of the existing factories in the area in the past, it was found that it did not cause any impact (76.9%) and caused impacts (23.1%). The impacts were a problem of dust (50.0%), followed by odor/fly and the noise level (25.0% equal) generating from alum factory, industrial factory, power plants and chicken processing plants (25.0% equal).

When inquiring about past complaints, all samples stated that they had never received complaints about environmental issues. In the case of a complaint, a community leader would be notified.

(C) Comments and suggestions for the project

A) Acknowledgment of the project

Acknowledgment of the project, most of respondents were informed about the project (92.3%), by the public relations project (42.9%), followed by a public hearing meeting on the draft proposal, project details, scope of study and evaluation of project alternatives and from community leaders (equal 19.0%).

B) Benefits or advantages and concerns from the project

Respondents expected that the operation of the Hin Kong Power Plant Project had benefits to the community (92.3 %). The expected benefits were the overall economic growth of the area (37.5%), followed by creating jobs and income for the local community (25.0%) and the power plant development fund (16.7%). However, if there was a project, most respondents had no feeling of anxiety (69.2%) and feel anxiety (30.8%) with the same concerns about noise and air pollution / dust (28.6% equal), respectively. The following with traffic jams, concerns on the fuel used in production and the increase in health impacts (14.3 % equal). Causes of anxiety were from the self-estimation (80.0%) and from the operations of nearby factories (20.0%).

C) Confidence in the project and the organization

For the confidence in operations and environmental management of the project, respondents were unsure (38.5 %), followed by strong confidence and confidence (23.1% equal). The average confidence level was uncertain ($\overline{X}$ = 3.54, SD = 1.050). For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, respondents stated that they were unsure (46.2 %), followed by the confidence (23.1 %) with an average of confidence level of uncertain ($\overline{X}$ = 3.38, SD = 0.961).

D) Patterns of public relations and information sharing to the community

For patterns of public relations and information sharing to the community, they would like to be informed through village chief/village headman/ community leaders/village broadcasting tower (45.0 %), and others (PR from staff, meeting in villages, in community events, such as making merit in the middle of the house) (25.0%) and held a meeting the project detail explanation (20.0 %).

Other suggestions that would benefit the factory and the environmental protection and quality of life of the surrounding people were summarized as follows.

Environment and safety

- Demand for publicizing about the production process and potential hazards
- Demand for preventions on pollution and safety in the community.

Society and public participation

- Temple should be used as a place for holding meetings
- Suggestion for allowing villagers to visit the factory and supporting activities in the community
- Allowing people in the community to work, pay less electricity bills, support community activities.

Health

- Providing the health check up in the community

4) Water consumption group

Thee consulting company conducted a survey on water consumption groups during 27-29 October, B.E. 2562, the results from the group which was not living near the water source, pumping area, but it was a group in the downstream area which may receiving impacts by the water consumption from the Mae Klong River were summarized in **Appendix 3-3 Table 4,** with following details.

(A) General socio-economic conditions of the interviewee

A total of 30 respondents, most of them (60.0%) were female, being family heads (46.7%) and older than 60 years (43.3%), followed by the age between 51-60 year (20.0%). They completed primary education (56.7%), followed by high school (13.3%) and junior high school and high vocational certificates/vocational education (10.0% equal). Most of the respondents were living in the Ratchaburi at birth (80.0%). Some of them had moved from more than 20 years (66.7%) because of following up with their family / marriage.

For household economic conditions in the area for the primary family occupation at present, respondents engaged in the general employment (43.3 %), followed by personal trades/business (20.0%) and farmers and company/factory employees (13.3 %), respectively. It was found that, most respondents did not have a secondary occupation (73.3%), followed by a career/ personal business (13.3%). For household financial status, saving and loans, sufficient financial status was found (50.0%), followed by insufficient saving (40.0%) and insufficient (10.0%), respectively. In case of insufficient income, most respondents would have a loan (66.7%).

(B) The water consumption in agricultural activities or other activities

From interviews with people who may be affected by the Mae Klong River, it was found that most of interviewees consumed water for agriculture (83.3%), stating that the month with the highest amount of water was around August – November. Water was used for agriculture (86.4%), or other activities such as village waterworks and consumption, etc. (9.1%). Most of interviewees had no problems with water consumption (84.0%).

In terms of receiving impacts by the water consumption from other industrial plants in the area, most of interviewees (88.0%) were not affected. Some were receiving impacts (12.0%) from odor, turbidity of water and sediment. These impacts came from a liquor factory in the area. When inquiring about concerns on water consumption of the project, all respondents said there was no concern about the impact on water consumption of the project.

C) Comments on the project

For comments and suggestions for the project, respondents stated that they did not know about the project (83.3%) because they were far away. Some of them awared of the project (16.7%) known from community leaders (50.0%), followed by relatives/siblings (37.5%) and/neighbors (12.5%). In terms of benefits or advantages of the project, respondents (36.7%) agreed that the project was useful. They said that jobs were created, as well as income for the local community (33.3%). The overall economy of the area were grown and create stability for the local electricity system (19.0% equal).

For concerns about water consumption, it was found that the majority of interviewees were not worried (73.3%). In the worry groups, they stated the concern on insufficient water (25.0%), followed by sewage problems (12.5%). All such worries came from their own predictions.

Regarding the confidence in entrepreneurs to manage environment within the project, It was found that interviewees were unsure (46.7%), followed by confidence (23.3%) ($\overline{x}$ = 3.08, sd = 0.830), the confidence in the operators was uncertain. For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, respondents stated that they were unsure (46.7%), followed by confidence (23.3%) ($\overline{x}$ = 3.00, sd = 0.913) with the confidence level uncertain.

Forms of public relations/appropriate information providing to the community, most respondents indicated to receiving new through village chiefs/village headmen/community leaders/broadcasting tower (51.6%), followed by organizing meetings (25.8%).

Concerns or suggestions regarding the project operations could be summarized as follows:

Environment aspect

- The project operation had impacts on the environment
- The project must cause no impact on the water consumption of the community.

Water consumption of the community

- Concerns on wastewater and odor

5) Groups that may be affected by the raw water pipeline installation

(A) General information

Those groups that may be affected by the raw water pipeline installation were totally 43 respondents. The results were shown in **Appendix 3-3 Table 5** with following details.

The majority of the respondents were female (51.2%) and males (48.8%). They were family heads (62.8%), followed by residents (30.2%) with the age of older than 60 years (% 32.6), followed by age between 41-50 years (27.9%) and aged between 51-60 years (23.3%). Most of them had finished primary education (48.8%), followed by vocational education/High vocational certificate (16.3%). They were living in Ratchaburi since their birth (93.0%) and foreigners (7.0%) by moving in the area for more than 20 years. The reason they moved was to follow their family/marriage.

(B) General socio-economic conditions

Respondents were farmers and general contractors (30.2%), followed by personal/business (23.3%). For the second occupation, respondents indicated that there were no secondary occupations (48.8%), followed by farmers (18.6%), trades/private businesses and general employment (16.3% equal). In terms of financial status, most of them had sufficient but no saving (51.2%), followed by sufficient for saving (37.2%) and insufficient (11.6%). Those who stated that insufficient spending had solutions by reducing expenses (60.0 %) and loans (40.0%).

(C) Water consumption in the area

Respondents used water from natural sources for agricultural activities (48.8%), using water from irrigation canals (57.4 %), village waterworks and the canal (4.8% equal). The month with the highest water from irrigation canals was August (19.0%), water had been used for agriculture (95.2%), using water by pumping/pumping method (19.0%). Most of them said that, there was no problem with water consumption from irrigation canals (61.9%) and problems with water consumption from irrigation canals (38.1%). Problems with water consumption were wastewater (62.5%), insufficient water, releasing water for a period of time, and rubbish in the water (12.5%), which these problems had not been solved (62.5%). The solution was to notify the Subdistrict Administration Organization, waiting for government assistance, waiting for seasonal rains (12.5% equal). For the impact level of industrial activities in the area on water consumption, It was at a medium level (50.0%), followed by a high impact (37.5%).

For impacts of industrial plants on water consumption, respondents stated that, industrial factory operations in nearby areas had no effect on water consumption in the past (61.9%) and stated that in the past, industrial factory operations in nearby areas caused impact on the water consumption (38.1%). The impacts were sewage and odor (62.5%), followed by black water (25.0%) due to industrial factories (75.0%). All respondents said they were not worried about the drainage of the project.

(D) Comments and suggestions for the project

A) Acknowledgment of the project

For acknowledgment of the project information, respondents were informed about the project (55.8%), by community leaders (68.0%), followed by relatives/siblings (12.0 %).

B) Benefits or advantages and concerns from the project

When inquiring about benefits or advantage for the community, respondents indicated that there was no benefit or advantage to the community (81.4%), and benefits to the community (18.6%) due to the overall economy growth of the area (33.3%), creating jobs, generating income for the local community (25.0%). However, if the project occurred, respondents said that they felt anxiety (46.5%) with concerns about air pollution/dust (16.9%), followed by noise (14.3%), fuel used for the production and worry about water consumption (11.7% equal). The cause of anxiety came from self-estimation (95.0%).

C) Confidence in the project and the organization

For the confidence in operations and environmental management of the project, respondents were unsure (41.9%), followed by confidence (20.9 %) with average confidence in the level of unsure ($\overline{X}$ = 3.05, SD = 1.117). For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, respondents stated that they were unsure (53.5%), followed by confidence (16.3%) with an average of confidence level of uncertain ($\overline{X}$ = 3.00, S.D. = 1.025).

D) Patterns of public relations and information sharing to the community

For patterns of public relations and information sharing to the community, respondents would like to be informed through village chief/village headman/ community leaders/village broadcasting tower (62.8%) and held a meeting (27.9%).

E) Concerns about the environmental impact of raw water pipeline construction

Respondents Identified their suffering/annoying by environmental impact problems (88.4%) which were summarized as **Table 3.4.2-6**, dust, pollution / soot, noise, vibration, subsidence soil, obstructing the waterway, flooding problems, garbage from the construction worker accommodation, construction wastewater, problems of the entrance-exit barriers, traffic/congestion, accidents from transportation of construction equipment, annoyance from construction workers, damage to public utilities, damaged houses and buildings, sluggish business/trade, incomes from occupations, damaged pipelines causing water leakage affecting water consumption in the area.

From environmental impact problems, It was found that most impacts were dust (84.2%), followed by noise (81.6%) and entrance-exit barriers (78.9%).

Other suggestions that would benefit the factory and the environmental protection and quality of life of the surrounding people were summarized as follows.

Table 3.4.2-6

Environmental impact problems to Groups that may be affected by the raw water pipeline installation

Construction phase	Number (percent)	Effect		Impact level To Annoyance	
		negative	positive	$\overline{X}$ (S.D.)	results
dust	32 (84.2)	0.0	100.0	2.38 (0.609)	moderate
pollution / soot	25 (65.8)	0.0	100.0	2.36 (0.638)	moderate
noise	31 (81.6)	0.0	100.0	2.35 (0.661)	moderate
vibration	22 (57.9)	0.0	100.0	2.09 (0.750)	moderate
subsidence soil	17 (44.7)	0.0	100.0	1.94 (0.899)	moderate
Obstructing the waterway, flooding problems	15 (39.5)	6.7	93.3	2.33 (0.617)	moderate
garbage from the construction worker accommodation	19 (50.0)	0.0	100.0	1.89 (0.737)	moderate
construction wastewater	14 (36.8)	0.0	100.0	2.21 (0.893)	moderate
problems of the entrance-exit barriers	30 (78.9)	0.0	100.0	2.40 (0.675)	moderate
traffic/congestion	13 (34.2)	7.7	92.3	2.38 0.870	moderate
accidents from transportation of construction equipment	10 (26.3)	0.0	100.0	1.90 (0.738)	moderate
annoyance from construction workers	16 (42.1)	6.3	93.8	1.75 (0.683)	moderate

Table 3.4.2-6 (cons.)

Construction phase	Number (percent)	Effect		Impact level To Annoyance	
		negative	positive	$\overline{X}$ (S.D.)	results
damage to public utilities	8 (21.1)	12.5	87.5	1.75 (0.463)	moderate
damaged houses and buildings	6 (15.8)	0.0	100.0	2.00 (0.000)	moderate
sluggish business/trade	3 (7.9)	33.3	66.7	2.33 (0.577)	moderate
incomes from occupations	6 (15.8)	0.0	100.0	2.00 (0.632)	moderate
damaged pipelines causing water leakage	12 (31.6)	0.0	100.0	2.58 (0.515)	high
affecting water consumption in the area	10 (26.3)	0.0	100.0	2.50 (0.527)	moderate

Note : 1/ Interpretation of average scores of the level of impact on annoyance

Average scores 1.00 - 1.50 means low annoyance level

Average scores 11.51 – 2.50 means moderate annoyance level

Average scores 12.51 – 3.00 means high annoyance level

Source : Consultants Of Technology Co.,LTD, B.E.2563

Environment and safety

- Emission of power plants to the community

Society and public participation

- Demand for CSR activity for the community development

6) Community leader groups

From a survey of community leaders, there were total of 51 respondents, divided into 2 samples of the municipality area and 49 sample of administrative subdistrict administrative organizations. Results of the survey were summarized as **Appendix 3-3 Table 6** as following details.

(A) Community leaders living bear the project area

A) Community leaders in the subdistrict administrative organization in the area of radius of 0-3 kilometers

- **General information**

Most respondents were male (87.0%), aged between 51-60 years (60.9%). They completed junior high school education (65.2%). They held the position for 6 -10 years (52.2%), followed by 0-5 years (39.1%). Most respondents were original people in the area (95.7%).

* **General socio-economic conditions**

Most respondents were farmers (8 7 .0 %), general contractor (13.0%). For the secondary careers in the community, it was found that there were trading/personal businesses (47.8), followed by no secondary occupations (39.1%) and general employment (13.0%). The employment in the area indicated that there was employment in the area (82.6%), most employee were local people (73.7%). Activities for employment were agriculture (63.2%), with an average wage of 301-500 THB (68.4%). For the industrial employment most respondents said that there were employments (82.6%) with local workers (73.7%). The most hiring activity was a chicken processing factory (52.2%), followed by working in industrial plants in the area (21.7%) and working in a power plant (8.7%) with an average employment rate of 301- 500 บาท (%73.7%),

For the agriculture in the community, most respondents stated that people working on agricultural areas twice a year (82.6%), using chemicals (91.3%). They indicated that chemicals were used for weeding/mulching (69.2%) and for pest control (30.8%).

Regarding to information awareness in households, most respondents were informed by neighbors and community leaders (77.8%), followed by government officials (18.5%) and by telephone, broadcasting tower, news, and social media (3.7%).

* **Public health services and public utility systems**

For health information, most respondents stated that public health services such as district health promotion hospitals or hospitals were sufficient (87.0%) and were insufficient (13.0 %). For the insufficiency, the cause was due to taking a long time (84.6%).

Most respondents stated that there was no problem with electricity usage in the community (87.0%). For problems, all indicated that it was caused by a power failure/power ran out. For drinking water sources, most respondents indicated that they bought bottled water/buckets (68.0%), followed by tap water (32.0%). For the drinking water quality, most respondents stated that drinking water was not a problem (91.3%), bad water quality (8.7%) which was unclean water (50.0 %). All mentioned problem were unresolved. All respondents specified sufficient amount of water throughout the year. For the water sources in the community, they used village water supply (76.0%). For the problem of using water sources, respondents said that there was no problem (82.6%). Some of the problems were turbidity, red sediment, rust, some parts were black and smelly (25.0% equal). For solutions, most of them remained unsolved (75.0%), some were solved by informing the relevant departments (25.0%). However, I was found that the amount of water was sufficient throughout the year (95.7%).

Regarding water sources used for agriculture, it was found that respondents who engaged in agriculture (61.8%) stated that there was no problem, some respondents indicated that there was a problem (38.2 %), due to the dry canal and no rain. For the solutions, it was waiting for rain or pumping water from irrigation canals (50.0% equal). However, most respondents specified that there was still sufficient water for agriculture (95.7%). Most water sources for agriculture came from the river (69.6%), followed by the digging pond (8.7%). For the most water problem for agriculture, respondents indicated that there was no problem (95.0%). For those who said there was a problem, indicating that the problem was caused by lack of water for the agriculture and not enough water. The solution were pumping water in their ponds, waiting for rain. When asking whether the amount of water in agriculture was sufficient or not, it was found to be sufficient (85.0%).

Most of the waste management was disposed by incineration (50.0%), followed by waiting for the waste collecting vehicles of the responsible department (41.7%). For wastewater/efflux management in the community, there was pumped into public drains (62.5%), followed by watering trees (29.2%).

The nature of the transportation routes in the community, most respondents indicated that it was a concrete road (73.9%), followed by the asphalt road (17.4%). For the transportation problems, there were not many problems (78.3%). Problems would be a road damage (30.8%) and traffic jams (7.7 %).

* **Current environmental and health impacts**

Information on environmental impact and opinions of factories in the area. Samples indicated that the community was currently suffering or affected (65.2 %). some said they were not affected (34.8 %). For impacts, most of them stated that there was a problem of odor (73.3%) and noise (26.7%). Causes were came from the chicken processing plant (68.8%) and the power plant (12.5%). Samples stated that they had received a complaint. (60.9%). The most complaint was the odor (42.9%), followed by noise (35.7%) and the color and odor of water for consumption that could not be used (14.3%). Most of the solutions were reporting to the factory that caused the impact (85.7%), followed by reporting to the relevant authorities for washing the pond that supplied water to household and coordinating to the affiliation (7.1% equal).

- **Comments and suggestions for the project**

* **Acknowledgment of the project**

Regarding to receiving information about the project, most of respondents were informed about the project (95.7%). They were informed from the public relation of the project (41.0%), followed by the public hearing meeting on the drafted project proposal, project details, study scope and evaluation of project alternatives (35.9%), and from community leaders (23.1%).

* **Benefits or advantages and concerns from the project**

When inquiring about benefits or advantages for the community, Respondents stated that there were benefits or advantages to the community (87.0%). The expected benefits were the power plant development fund (52.9%), followed by job creation, income generation for local communities (17.6%) local authorities receiving tax for local maintenance (11.8%). However, if projects occurred, they were worried (73.9%) fuels used in production and air pollution dust (25.0% equal), followed by concerns on the water consumption (16.7%) and wastewater noise and increasing of health impacts (8.3 % equal) The cause of concerns came from self-estimation (42.9%), followed by the operations of nearby factories (28.6%), from neighbors, and from the information disseminated through the public relations media (14.3% equal).

* **Confidence in the project and the organization**

For the confidence in operations and environmental management of the project, respondents commented that they were highly confident (52.2%), followed by unsure (21.7%) and confidence (13.0%), with an average of confidence level in the confidence ($\overline{X}$ = 4.24, S.D. = 0.995). For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, respondents stated that they were no confidence (56.5%), followed by unsure (17.4%) and followed by confidence (13.0%) with the average confidence level in no confidence ($\overline{X}$ = 2.50, S.D. = 0.761).

* **Patterns of public relations and information sharing to the community**

For patterns of public relations and information sharing to the community, it was a meeting (60.7%), followed by village chiefs/village headmen/community leaders/village broadcasting tower (28.6%).

Other suggestions that would benefit the factory and the environmental protection and quality of life of the surrounding people were summarized as follows.

Environment and safety

- Increasing planting activities to reduce heat

Society and public participation

- Supporting communities around power plants
- Supporting scholarships, budget for village development
- Granting special privileges for electricity usage/electricity discount

Health

- Supporting medical tools for the health center, promoting physical exercise in the sub-district
- Providing a health check up in the area
- Providing a budget to promote physical activity

(B) Community leaders living far from the project areas (within a distance of 3-5 kilometers)

A) Community leaders in the municipality area

- **General information**

There were 2 male respondent with their ages between 51-60 years. Both of them were village headmen whose graduated from junior high school and holding this position for 6-10 years. They were also native people.

- **General socio-economic conditions**

The sample group indicated that the main occupation of people in the community was trading, personal business and there was a secondary career in trading/personal business. There was an employment in the area with the employment in the industrial sector which the priority went to a local. Income were in the range of 301-500 THB. The type of activity that was employed was to work in a chicken processing factory.

Agricultural activity in the community was carried out once a year with the use of chemicals. For receiving general news and information in the community, they knew from neighbors and community leaders (50.0%), followed by newspapers and television (25.0%). For the sufficiency of public health facilities, samples indicated that there was sufficient. In addition, there was no public utility problems, such as electricity and drinking water or water consumption. Drinking water sources came from purchasing of bottled waters/buckets. For water sources in the community, it was obtained from the village water supply. There was no problems in both drinking water and water for the consumption. In terms of water for agriculture, it was found that it had a problem on water quality without describing the problem. The amount of water for agriculture was sufficient. The water source came from the river / canal.

Waste disposal in the community used the method of incineration as the principle of waste disposal. For the community wastewater, it was disposed into public drains. For the transportation routes within the community, they was a concrete road without any transportation problems in the community.

- **Current environmental and health impacts**

Community leaders said that there was an environmental impact and had received a complaint on odor and overflowing bins causing odor. These occurred from the chicken processing plant. There were complaints on environmental impacts from people in the area with odor from the chicken processing plant and overflowing bins causing odor. The solution was done by notifying the responsible department.

- **Comments and suggestions for the project**

* **Acknowledgment of the project**

Regarding to receiving information about the project, most of respondents were informed about the project from community leaders, public relations project and public hearing meetings (33.3% equal). All of them said that the project had benefits and advantages to the community such as the overall economy growth, creating jobs, creating income for the local communities, local authorities received taxes for local maintenance (33.3% equal). There were no concerns about the project establishment.

* **Confidence in the project and the organization**

For the confidence in operations and environmental management of the project, respondents commented that they were unsure ($\overline{X}$ = 4.24, S.D. = 0.995). For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, all respondents stated that they were unsure ($\overline{X}$ = 2.50, S.D. = 0.761).

* **Patterns of public relations and information sharing to the community**

For patterns of public relations and information sharing to the community, they would like to be informed through village chief/village headman/ community leader/village broadcasting tower and hold a meeting to explain the project details (50.0% equal).

Other suggestions that would benefit the factory and the environmental protection and quality of life of the surrounding people were summarized as follows.

Environment and safety

- Concerns on changing weather conditions;
- Pollution management that may affect the community Environment;
- Proving a good care on health/environment of the people in the community;
- Proving forest planting activities for better air quality, good waste management of factories;
- Increasing planting activities to reduce heat;
- Concerns on noise, disturbing villagers in the community;

Society and public participation

- Demand for promoting important day activities in communities and villages;
- Demand for special privileges on electricity usage/electricity discount;
- Demand for supporting scholarships, budgets for village development.

Health

- Supporting medical devices for the health center, promoting physical exercise in the sub-district;
- Providing a health check up in the area;
- Promoting exercise.

B) Community leaders in the sub-district administrative organization area

- **General information**

Most respondents were male (69.2%), with their aged between 51-60 years (57.7%), graduated from junior high school education (34.6%), with the duration of holding this position for 6 -10 years (46.2%). Most respondents were native (65.4%) and had relocated (34.6%). Relocated people mostly came from the West (55.6%). The reason was because they followed their families/marriage and for occupation (33.3%). The duration of moving was more than 20 years (55.6%), followed by 0-5 years (22.2%).

- **General socio-economic conditions**

Sample groups stated that the majority of the people in the community are farmers (46.2%), general employment (23.1%) and government officers (15.4%). For the secondary/supplementary careers in the community, there were trading/personal business (42.3%), followed by general employment (26.9%). Employment in the sample area indicated that there was employment in the area (80.8%) with hiring the local people as a priority (66.7%). Activities for employment were general contractors and employed by agriculture (42.9% equal). The average wage rate was 301-500 THB (66.7 %). For employment in the industrial sector, there were employment (84.6%), with local people in the area (63.6%). Activities for employment were working in a chicken processing factory (25.9%), followed by working in batteries, cement plants, and industrial plants in the area and a power plant (11.1% equal). The average wage was 301-500 THB (72.7%).

Agricultural information of people in the community, most of them did the agriculture twice a year (57.7%), followed by once a year (26.9%) and using chemicals (76.9%) for weeding/mulching (63.3%) and pest control (36.7%).

For the awareness of general information in the household, they received information from the neighbors and community leaders (40.7%), followed by broadcasting tower, social media (24.1%) and government officials reporting information (16.7%).

- **Public health services and public utility systems**

For the sufficiency of public health services such as district health promotion hospitals, hospitals, the sample group indicated that it was sufficient (96.2%). In case of insufficient, it was because of the long waiting time (85.7%) and the increase of population resulting in delayed service (14.3%).

Regarding the problems related to electricity usage in the community, most respondents stated that they had no problems (69.2%) and had problems (30.8%) caused by power failure/power outage (88.9%) and expensive electricity bills (11.1%). For drinking water sources in the community, it was found that community bought bottled drinking water/buckets (55.2%), followed by tap water (34.5%). Quality of drinking water, respondents indicated that drinking water had a good quality.

For drinking water sources in the community, it was found that they bought bottled water/bucket (55.2%), all respondents specified good water quality and there was no problem (91.3%) and there was a sufficient water supply (96.2%). For the water consumption in the community, most of them used the village water supply (59.3%), followed by the provincial water supply (33.3%). Water quality was good (92.3%). Most respondents specified that there was sufficient amount of water throughout the year (96.2%). For water sources used for agriculture, it was found no problems (83.3%) and had problems (16.7%). Amount of water was sufficient for agriculture (83.3%). Water sources for agriculture came from river/canal (69.2%).

For the community waste management, there were put in the waste bins waiting for the waste collecting vehicles of the responsible department to collect (67.9%), followed by burning (25.0%). For wastewater/waste management in the community, there were done by disposal into public drains (67.9%), followed by dumping into water sources and canals, left in the open/let them flew along the ground and watering the plants (10.7% equal).

For the transportation routes within the community, there were a concrete road (57.7%), followed by paved roads (34.6%). For the problems of transportation in the community, there was no problem (50.0%), followed by damaged roads (30.8%) and frequent accidents (11.0%).

- **Current environmental and health impacts**

For information on environmental impact and comments of factories in the area, respondents equally indicated that it had impacts and not impact (50.0% equal). For those affected, there were odor (61.5%), followed by insufficient waste management (15.4%) due to the chicken processing factories (46.2%). complaints were received (53.8%) and never received (46.2%). For issues of complaints, there were overflowing garbage causing odor and wastewater, flooding water to the community area (22.2%equal). Problems were reported to the responsible department or factory (78.6%).

- **Comments and suggestions for the project**

* **Acknowledgment of the project**

Regarding to receiving information about the project, most of respondents were informed about the project by a public hearing meeting on the drafted project proposal, project details, scope of study and evaluation of project alternatives (35.8%), community leaders (26.4%) and PR of the project (24.5%).

* **Benefits or advantages and concerns from the project**

When inquiring about benefits or advantages for the community, Respondents stated that there were benefits or advantages to the community (92.3%). The expected benefits were the power plant development fund (40.0%), followed by local authorities receiving tax for local maintenance (17.5%), and the overall economy growth of the area (15.0%). However, if projects occurred, they were worried (50.0%) with concerns about air pollution/dust and increasing of health impacts (16.7% equal), increasing of foreign workers (13.3%). The cause of concerns was from the information published on public relations media (33.3%), followed by the predictions by themselves (27.8%) and from neighbors (22.2%).

* **Confidence in the project and the organization**

For the confidence in operations and environmental management of the project, respondents commented that they were the highest confidence (38.5%), followed by unsure (30.8%) with an average of confidence level in high level ($\overline{X}$ = 3.81, S.D. = 1.167). For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, respondents stated that they were no confidence (38.5%), followed by unsure (23.1%) with an average of confidence level in inconclusive ($\overline{X}$ = 2.96, S.D. = 1.136).

* **Patterns of public relations and information sharing to the community**

For patterns of public relations and information sharing to the community, they would like to be informed through a village chief/village headman/ community leaders/village broadcasting tower (40.5%), followed by holding a meeting (35.7%) and others (broadcasting tower, internet, leaflets) (16.7%).

Other suggestions that would benefit the factory and the environmental protection and quality of life of the surrounding people were summarized as follows.

Environment and safety

- Concern on the change of the weather;
- Pollution management that may affect the community environment;
- Provide a good care of the health/environment of the people in the Community;
- Provide a good forest planting activities, good waste management of Factories;
- Increase planting activities to reduce heat;
- Concern on noise disturbing the villagers in the community;
- Provide knowledge on electricity usage, details on facts based on the living of people in nearby areas;
- Demand to reduce electricity bills, providing a community broadcasting tower to be informed when the power plant was built.

Society and public participation

- Promote important day activities in communities and villages;
- Co-host in a funeral in the community, providing petrol fees;
- Increase more activities to the public sector, people in Ratchaburi should use free electricity;
- Demand for the project to publicize the project details to the community, need help or activities in the community;
- Provide public relations media, new modern technology, and funds for various electricity bills;
- Do not agree with the project, Do not want to come to the community;
- Funds were very difficult to use, not related to the demand;

- Support sufficient scholarships, increasing budgets for the village development;
- Promote activities in the village such as important days of the Community;
- Demand for the power plant to provide more welfares, to support for education/scholarships for those who met the criteria, provide special privileges on electricity usage / discount for the people in the area;
- Distribute the electricity fund to every village;
- Promote important day activities in communities and villages;
- Co-host in a funeral in the community, providing petrol fees.

Health

- Request a budget for medical supplies to the Tambon Health; Promotion Hospital and requesting budget for village health volunteers in the community such as blood pressure tools, and other tests;
- Provide a public health check in the area at least once a year;
- Research and test on weather that will affect the environment and health;
- Promote exercise in the sub-district;
- Provide a health check up to the community once a year.

7) **Household representative groups**

From a survey of household representative groups, there were total of 682 samples, which were divided into 26 close-ranged household representatives (radius 0-100 meters) (survey results were show in **Appendix 3-3 Table 7**). Household representatives in the area near the project (radius 0.1-3 kilometers), in administrative organization area for 243 samples. Representatives of households in remote areas (radius 3-5 kilometers), there were 160 sub-district administrative organization and 253 sub-district municipal districts (survey results were shown in **Appendix 3-3 Table 8**) and described as follows.

(A) Representatives of close ranged households to the project (radius 0 - 100 meters)

A) **General information**

According to the interview, 26 people were male and female (50.0% equal), they were the head of the family (61.5%) with aged between 51-60 years and over 60 years (30.8% equal). They graduated from primary school (73.1%) and most of them were original people in the area (88.5%) and were foreigners (11.5%). All relocated people came to the area by following their families/marriage. They moved from the West, East and Northeast (33.3%). The duration of relocation were 0-5 years (66.7%) and over 20 years (33.3%).

B) **General socio-economic conditions**

The most respondents were general contractors (46.2%), followed by trading/personal businesses (26.9%). Most of them did not have a secondary occupation (96.2%). In terms of financial status, it was sufficient to spend but no saving (42.3%), followed by sufficient saving (38.5%) and insufficient (19.2%). Given that insufficient financial expenditures, there were resolved by loans.

For receiving general information in the household, most of them were informed by neighbors and community leaders (75.0%), followed by television (18.8%). Most of the people lived in groups and taken into account of advantage of the majority (57.7%). Household members went to the temple and perform religious activities every important religious days (92.3%) with amulets as an anchor (48.1%). The current community problems, respondents said that there were problems (65.4%). It was drug problems (37.9%), followed by high cost of living (27.6%), crime/gambling/burglary and unemployment problems (17.2% equal).

C) Public health services and public utility / utilities systems

For health information, sample groups indicated that in the past year, there were sick members (42.3%) with influenza (66.7%), followed by allergies high blood pressures and diabetic (16.7% equal). There were patients with congenital diseases (38.5%), 1 member was sick with chronic illness (90.0%). Most of them had diabetes, high blood pressure (72.7%), followed by allergy (18.2%). Patients mostly attended government hospitals (76.9%), Tambon health promotion hospitals (19.2%) and bought their own medicine (3.8%).

For water consumption in the household, most respondents stated that they used drinking water from bottled water/buckets (96.2%) and tap water (3.8%). All respondents indicated that drinking water had a good quality and had sufficient water. Water sources in the community came from village water supply (89.3%), followed by provincial water supply (10.7%). Respondents stated that there was a problem in water consumption and without problems (50.0% equal). Regarding the problem, there was a problem of turbidity (84.6%). The solution was done by solving sedimentation problem (66.7%). In terms of the amount of drinking water and water for the consumption, all respondents said that there was sufficient amount of water. For water used in the agriculture, sample groups were engaged in agriculture (7.7%), by using rainwater and water from rivers and canals for agriculture (equal to 50.0%). No water problems were found in agriculture.

For the solid waste management, it was done by putting in the tank, waiting for the garbage collection truck of the responsible department to collect (96.2%) and incineration (3.8%). For the wastewater/efflux management in the community, it was dumped in clear area/left to flow along the area (85.2%).

D) Current environmental and health impacts

According to an interview with 26 households, all of them stated that they suffered from environmental problems which were summarized in **Table 3.4.2-7.**

From environmental impact problems, it was found that most respondents affected by noise (23.1%), followed by dust (11.5%) and wastewater (7.7%). Affected people did not notify to any department (80.8%), followed by notifying community leaders (11.5%) and sub-district/municipality and the factory owners (3.8% equal). However, there were unsolved problems (83.3%) and already resolved problems (16.7%).

Table 3.4.2-7

Environmental impact problems to Representatives of close ranged households to the project

Impact / Sources	Numbers (%)	The most affected time period	Annoyance impact level		Current impact severity compared to the past	
			$\overline{X}$ (S.D.)	Interpretation[1/]	$\overline{X}$ (S.D.)	Interpretation [2/]
Noise (from the power plant)	6 (23.1)	Sometimes	2.17 (0.753)	Moderate	1.67 (0.516)	Constant
Dust (traffic)	3 (11.5)	Sometimes	1.67 (1.155)	Moderate	2.00 (1.000)	Constant
Wastewater (community / industrial factories)	2 (7.7)	All year round	2.00 (1.414)	Low	2.50 (0.707)	Constant
Odor (industrial factories)	1 (3.8)	All year round	3.00 (0.000)	High	3.00 (0.000)	Increase

Note: [1/] Interpretation of average scores of the level of impact on annoyance

Average scores 1.00 - 1.50 means low annoyance level
Average scores 1.51 – 2.50 means moderate annoyance level
Average scores 2.51 – 3.00 means high annoyance level

[2/] Interpretation of t average scores on the severity level of the current impact compared to the past

Average scores 1.00 – 1.50 means low level of severity
Average scores 1.51 – 2.50 means constant level of severity
Average scores 2.51 – 3.00 means increase level of severity

Source : Consultants Of Technology Co.,LTD, B.E.2563

E) **Comments and suggestions for the project**

- **Acknowledgment of the project**

Regarding to receiving information about the project, most of respondents were informed about the project (88.5%) by friends/ neighbors (34.5%)ม then followed by community leaders and from a public hearing meeting on the drafted project proposal, project details, scope of study and evaluation of project alternatives (20.7% equal).

- **Benefits or advantages and concerns from the project**

When inquiring about benefits or advantages for the community, Respondents stated that there were benefits or advantages to the community (96.2%) due to job creation, income generation for local communities (30.6%), followed by the growth of overall economy in the area (22.6%) and local authorities receiving tax for local maintenance (17.7%). However, if projects occurred, most of them were worried (57.7%) with concerns about noise (42.9%), air pollution/dust and odor (14.3 % equal). Causes of concerns came from self-prediction (70.6%), followed by neighbors (23.5%).

- **Confidence in the project and the organization**

For the confidence in operations and environmental management of the project, respondents commented that they were confidence (42.3%) followed by the unsure (38.5%) with an average of confidence level in moderate ($\overline{X}$ = 3.40, S.D. = 0.764). For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, respondents stated that they confidence (46. %2), followed by the unsure (38.5%), with an average of confidence level in moderate ($\overline{X}$ = 3.44, S.D. = 0.821).

- **Patterns of public relations and information sharing to the community**

For patterns of public relations and information sharing to the community, they would like to be informed through a village chief/village headman/ community leaders/village broadcasting tower (57.7%) and followed by holding a meeting (38.5%).

Other suggestions that would benefit the factory and the environmental protection and quality of life of the surrounding people were summarized as follows.

Environment and safety

- Air pollution/pollutions
- Environmental control measures

Society and public participation

- Prevent villagers from the suffer or problems
- Provide sports events within the community/fitness/park
- Support the development of the community such as improving the water and electricity for better evelopment
- Promote careers and recruit people area for the employment.

Health

- Demand for a health checkup/a mobile medical unit

(B) Representatives of households living near the project area (radius of 0.1-3 kilometers)

A) Sub-district Administrative Organization (radius of 0.1-3 kilometers)

- **General information**

From the interview, most respondents were female (59.7%) and males (40.3%) as the head of the family (50.6%), followed by spouses (30.5%) with the age between 51-60 years (31.3%). They completed a primary education (59.7%), followed by junior high school education (14.8%). Most respondents were original people in the area (90.1%) and foreigners (9.9%). In the case of relocating, there were from the central region (29.2%) and the western region (20.8%). Most of them relocated for more than 20 years (45.8%), followed by 11-15 years (25.0%). The reason for relocating were to following family/marriage (66.7%), to pursuing a career and finding new residences (16.7% equal).

- **General socio-economic conditions**

The sample group stated that they were general labors (43.2%), followed by private businesses/trades (29.6%) and farmers (17.3%). As for secondary occupations, most of them had no secondary occupations (66.3%), followed by general employment (17.7%) and engaged in trades/personal businesses (9.5 %). For the financial status, most respondents said that there were sufficient financial status without saving (39.9%), followed by sufficient with saving (32.9 %) and insufficient

(27.2%). In the case of insufficiency, solutions were reducing expenses (45.5 %) and loans (37.9 %).

Regarding to general information in households, most respondents were informed by neighbors and community leaders (59.1%), followed by television (27.9%) and radio (7.0%). For the lifestyle of people in the community, they lived as relative types and taken public benefits into account (40.3%), followed by people living as a group and taken public benefits into account (35.8%). The household members entered temples / mosques / churches and carry out religious activities every time on important dates (70.8%). They had amulets and talismans as an anchor (49.3%), followed by offering to gods/Phra Phum Shrine/shrines (31.8%). Regarding the current community problems, there are problems within the community (41.2%), as drug problems (54.8%), followed by crime/gambling/burglary (20.5%) and unemployment (11.6 %)

- **Public health services and public utility systems**

For health information, the sample group stated that in the past year, there were members with illness (38.7%), with influenza (43.4%), followed by high blood pressure, diabetes (32.1%). There were household members with chronic illnesses or communicable diseases. The sample group indicated that family members have chronic illnesses (33.6%), with the ratio of 1 patient per household (73.8%). Most of them were suffering from high blood pressure/ diabetes (64.3%), followed by arteriosclerosis (8.2%) and heart diseases (7.1%). When the illness occurred, patients were admitted to government hospitals (84.3%), followed by Tambon health promotion hospitals (8.7%) and buy their own medication (3.9%).

Regarding drinking water, the sample group stated that they were buying bottled water /buckets (84.5%), followed by tap water (10.3%). For the quality of drinking water, most respondents indicated that drinking water had a good quality (95.5 %). In the cases specified that water was bad (4.5%), the problem came from turbidity/insufficient water and wastewater without solutions. In terms of the sufficiency of water, most of them indicated that the amount of water was sufficient (99.1%). For water sources in the community, indicating a good water quality without problems (76.1%). For whose indicating that water was bad (24.0%), problems came from turbidity with rust sediment (75.9%) and odor (6.9%). These were unsolved problem (68.2%). In cases of resolved problems, they had been done by allowing sedimentation (22.7%) and using filter cloth (4.5%). For water sufficiency, it was found that, the amount of water was sufficient (96.3%).

Regarding water sources for agriculture, respondents engaged with the agricultural sector used (21.8%) river/canal water (34.0%), rainwater and dredged ponds (15.1% equal). Respondents said that without a water problem (83.0%), with a problem (17.0%). With water problems, they were insufficient water (44.4%), lack of water (33.3%), and lack of rainfall (22.2%). Most of these problem were unsolved (55.6%). In the report with resolved cases, they asked the government to help, waited for rain, saved water and called the water truck to deliver water.

Most of the solid waste management was disposed by putting in the waste bins, waiting for the waste collecting vehicles of the responsible department to collect (98.8%). In terms of wastewater/efflux of the community, there were done by dumping in the open area/let flew along the ground (47.7%), followed by dumping in the public drain (20.6%) and watering the trees (19.8%).

- **Current environmental and health impacts**

From the interview of 243 household groups, whose suffering/ annoying from the environmental impact problem (65.8%) results were summarized in **Table 3.4.2-8**.

From environmental impact problems, it was found that the most impact were dust (37.4%), followed by noise (32.9%) and soot (21.4%). The affected people did not notify any department (65.0%), followed by notification to the Subdistrict Administration Organization / municipality (18.8 %) and community leaders (16.3 %). The problem had not been resolved (47.1 %), had been resolved (44.1%) and some parts had been resolved but not yet completed (8.8 %).

Regarding the accidents that occur frequently in the community, there were rarely accidents (55.6%). With accidents, the most frequency were accident in cars/motorcycles (42.4%), followed by fire (2.1%).

Table 3.4.2-8
Environmental impact problems to Sub-district Administrative Organization (radius of 0.1-3 kilometers)

Impact / Sources	Numbers (%)	The most affected time period	Annoyance impact level		Current impact severity compared to the past	
			$\overline{X}$ (S.D.)	Interpretation[1/]	$\overline{X}$ (S.D.)	Interpretation[2/]
Dust (traffic)	91 (37.4)	Sometimes	1.75 (0.569)	Moderate	1.73 (0.579)	Constant
Noise (unidentified source)	80 (32.9)	Sometimes	1.73 (0.656)	Moderate	1.81 (0.530)	Constant
Wastewater (unidentified source)	29 (11.9)	All year round	1.55 (0.632)	Moderate	1.55 (0.632)	Constant
Odor (unidentified source)	33 (13.6)	Sometimes	1.55 (0.617)	Moderate	1.58 (0.561)	Constant
Soot (unidentified source)	52 (21.4)	Sometimes	1.71 (0.667)	Moderate	1.67 (0.617)	Constant

Note: [1/] Interpretation of average scores of the level of impact on annoyance

Average scores 1.00 - 1.50 means low annoyance level
Average scores 1.51 – 2.50 means moderate annoyance level
Average scores 2.51 – 3.00 means high annoyance level

[2/] Interpretation of t average scores on the severity level of the current impact compared to the past

Average scores 1.00 – 1.50 means low level of severity
Average scores 1.51 – 2.50 means constant level of severity
Average scores 2.51 – 3.00 means increase level of severity

Source : Consultants Of Technology Co.,LTD, B.E.2563

- **Comments and suggestions for the project**

* **Acknowledgment of the project**

Regarding to receiving information about the project, most of respondents were informed about the project (60.5%) by community leaders (35.9%), followed by friends/neighbors (31.3%) and by the PR of the project (19.4%).

* **Benefits or advantages and concerns from the project**

When inquiring about benefits or advantages for the community, Respondents stated that there were benefits or advantages to the community (71.6%), due to job creation, income generation for local communities (33.2%), followed by the overall growth of local economy (23.5%)and local authorities receiving tax for local maintenance (13.8%). However, if projects occurred, they were worried (42.8%) with concerns about air pollution / dust (24.3%), followed by concerns on noise (20.6%) and odor (17.0%). Causes of concerns came from self-prediction (62.2%) and from operations of nearby factories (17.6%).

* **Confidence in the project and the organization**

For the confidence in operations and environmental management of the project, respondents commented that they were unsure (40.3%), followed by the confidence (30.5%) and no confidence (14.0%) with an average of confidence level in the unsure ($\overline{X}$ = 3.17, S.D. = 0.874). For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, respondents stated that they were unsure (36.2%), followed by the confidence (33.3%) and no confidence (14.4%) with an average of confidence level in the unsure ($\overline{X}$ = 3.16, S.D. = 0.883).

* **Patterns of public relations and information sharing to the community**

For patterns of public relations and information sharing to the community, they would like to be informed through a village chief/village headman/ community leaders/village broadcasting tower (60.9%), followed by holding a meeting (29.4%).

Other suggestions that would benefit the factory and the environmental protection and quality of life of the surrounding people were summarized as follows.

Environment and safety

- Concern on impacts affecting the people in the neighborhoods;
- Demand for looking after the environment as best as possible;
- Demand for climate protection measures in the community;
- Demand for safety system during the construction phase;
- Demand for measures on the wastewater management;
- Concerns about noise.

Environment and safety

- Demand the project to participate in the community by holding important religious events and providing scholarships to schools in the community;
- Improving roads/electricity in the service area, follow the agreement, distributing the fund to the community;
- Promote community activities such as religious days
- Reduce electricity bills;
- Support youths such as sports, scholarships
- Provide PR on benefits of the project to the community;
- Hire more local people to work in the area.

Health

- Demand for a school for the elderly;
- Demand for a public park;
- Demand for a health checkup for the community once a year.

(C) Representative of households living far away from the project area (a radius of 3-5 kilometers)

A) Household representatives in the municipality area

- **General information**

A total of 253 samples were female (55.3%) with the status of family leader (44.3%), aged between 41-50 years (29.6%). They graduated with primary education (39.5%). Most of them were original people in the area (82.6%) and were foreigners (17.4%), relocating for 6-10 years (29.5%). They relocated because of following family/marriage (50.0%).

- **General socio-economic conditions**

Respondents had private business (36.0%), followed by general employment (32.8%) and official/state enterprise employees (18.2%). Regarding to the secondary occupation, there was no secondary occupation (68.8%), followed by general employment as a secondary occupation (16.6%). There were sufficient with saving for the financial status (54.9%), followed by insufficient (23.3%) and sufficient without saving (23.3%). For insufficient group, reduce expenses (49.2 %) was done as the solution.

For receiving general information in the household, most respondents receiving information from neighbors and community leaders (53.0%), followed by television (23.9%) and radio (13.8%), respectively. The community was living as a group and taken public benefits into account (33.6%). Household members attended temples and performed religious activities every time on important days (68.4%). There were amulets and talismans as an anchor (53.5%). In the current community problems (37.2%), there are the crime/gambling/burglary (28.9%), followed by the drug (24.8%) and high cost of living (20.8%). Accidents in the community were car or motorcycle accidents (71.1%).

- **Public health services and public utility systems**

For health information, the sample group stated that in the past year, there were members with illness (42.3%), with influenza (47.8%), followed by high blood pressure/diabetes (31.%), allergy and gastrointestinal diseases (4.3% equal).

The sample group indicated that family members have chronic illnesses (27.7%) with high blood pressure/ diabetes (74.0%), followed by heart disease, kidney disease (5.2% equal). When the illness occurred, patients were admitted to government hospitals (78.4%), followed by bought their own medication (12.5%) and used services from private hospital/clinic (8.2%).

Regarding drinking water, the sample group stated that they were buying bottled water /buckets (79.9%), followed by tap water (20.1%). For the quality of drinking water, most respondents indicated that drinking water had a good quality (94.9%) In the cases specifying that water was bad, the problem came from sediment. In terms of the sufficiency of drinking water, most of them indicated that the amount of drinking water was sufficient (99.6%). For water sources in the community, they used the provincial water supply (61.8%), followed by the village water supply (36.2%). Majority said that there was a good quality of water supply (92.1%), the rest were bad quality (7.9%) which came from turbidity with rust sediment. It was found that, the amount of water was sufficient (99.2%). For water with turbidity and sediment, the solution was the filtering by bringing the cloth to the tap.

For water for agriculture, there were a sample of 9 farmers, most of them used water in the river/canal (88.9%). All indicated that there was no water problem for agriculture.

Most of the solid waste management was disposed by putting in the waste bins, waiting for the waste collecting vehicles of the responsible department to collect (92.0%), followed by incinerating (6.8%) and dumping in the area/piling up in open areas (1.2%). In terms of wastewater/efflux of the community, there were done by draining into the public drainage (63.2%), followed by dumping in the open area/let flew along the ground (24.5%), respectively.

- **Current environmental and health impacts**

From the interview of 253 household groups, they were 61.7% suffering/ annoying from the environmental impact problem which could be summarized in **Table 3.4.2-9.**

Table 3.4.2-9

Environmental impact problems to Household representatives in the municipality area

Impact / Sources	Numbers (%)	The most affected time period	Annoyance impact level		Current impact severity compared to the past	
			$\overline{X}$ (S.D.)	Interpretation[1/]	$\overline{X}$ (S.D.)	Interpretation [2/]
Noise (traffic)	85 (33.6)	Sometimes	1.86 (0.515)	Moderate	1.86 (0.467)	Constant
Dust (traffic)	77 (30.4)	Sometimes	1.75 (0.517)	Moderate	1.81 (0.399)	Constant
Soot (unidentified source)	24 (9.5)	Sometimes	1.63 (0.576)	Moderate	1.67 (0.565)	Constant
stink (unidentified source)	18 (7.1)	Sometimes	1.44 (0.511)	Moderate	1.50 (0.514)	Constant
Waste water (unidentified source)	12 (4.7)	All year round	1.17 (0.389)	Moderate	1.58 (0.515)	Constant

Note: [1/] Interpretation of average scores of the level of impact on annoyance

Average scores 1.00 - 1.50 means low annoyance level

Average scores 1.51 – 2.50 means moderate annoyance level

Average scores 2.51 – 3.00 means high annoyance level

[2/] Interpretation of t average scores on the severity level of the current impact compared to the past

Average scores 1.00 – 1.50 means low level of severity

Average scores 1.51 – 2.50 means constant level of severity

Average scores 2.51 – 3.00 means increase level of severity

Source : Consultants Of Technology Co.,LTD, B.E.2563

From environmental impact problems, it was found that the most respondents affected by noise (33.6%), followed by dust (30.4%) and soot (9.5 %), respectively. Affected people did not notify the agency (77.6%), followed by informing the Subdistrict Administrative Organization/municipality (17.3%) and community leaders (4.5%) respectively. The problem had been resolved (72.1%) and unresolved (27.9%).

- **Comments and suggestions for the project**

* **Acknowledgment of the project**

Regarding to receiving information about the project, most of respondents were informed about the project (66.8%) by friends/neighbors (35.6%), followed by PR of the project (33.5%) and community leaders (20.1%)

* **Acknowledgment of the project**

When inquiring about benefits or advantages for the community, Respondents stated that there were benefits or advantages to the community (86.6%), due to were job creation, income generation for local communities (30.6%) followed by local authorities receiving tax for local maintenance (18.8%), the growth of the overall local economic (16.8%) and the power plant had the new technology replacing the old one (14.4%). However, if projects occurred, they were worried (29.6%) with concerns on noise (26.8%), followed by air pollution / dust (23.2%) and odor (21.0%). The cause of concerns came from self-prediction (64.0%).

* **Confidence in the project and the organization**

For the confidence in operations and environmental management of the project, respondents commented that they were confidence (41.1%), followed by unsure (37.5%) and no confidence (11.1%) with an average of confidence level in the unsure ($\overline{X}$ = 3.32, S.D. = 0.885). For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, respondents stated that they were confidence (37.9%), unsure (36.8%) and no confidence (13.4%) and highly no confidence (7.9%) with the average confidence level in the unsure ($\overline{X}$ = 3.14, S.D. = 0.962).

* **Patterns of public relations and information sharing to the community**

For patterns of public relations and information sharing to the community, they would like to be informed through a village chief/village headman/ community leaders/village broadcasting tower (53.8%), followed by holding a meeting (38.3%) and posting on the village board (5.7%).

Other suggestions that would benefit the factory and the environmental protection and quality of life of the surrounding people were summarized as follows.

Environment and safety

- Provide environmental control measures to check the weather in the community once in every 3 months;
- When the power plant opens, the project must take care of the environment as best as possible;
- Demand for control measures with a regular air pollution monitor;
- Demand for a well control of the operation system;
- Demand for the implementation of the specified measures;
- Demand for a safety system during construction phase;
- Demand for maintaining the environment in the community as good as before;
- Concern on noise.

Society and public participation

- Demand for the project to participate in the community by holding important religious events and providing scholarships to schools in the community;
- Improve roads/electricity in the service area, following the agreement and distributing the fund to the community;
- Demand for sports events for anti-drug in the community;
- Support sports for youth;
- Hire more local people for works;
- Demand for a public park in the community.

Health

- Demand for a health check up for the community once a year;
- Take a good care of the environment, do not cause problems for the community and the health of people in the community;
- Provide additonal medical units for annual health checkup.

B) Household representatives in the sub-district administrative organization area

- **General information**

From the interview of 1 60 samples, most respondents were female (62.5%) as a resident (48.8%) and head of the family (36.3%) with the age of 51-60 year (25.6%), followed by 41-50 years (21.3%). They were mostly graduated from primary education (36.9%), followed by uneducated (24.4%) and bachelor degree (11.9%). Most respondents were original people in the area (81.9%) and foreigners (18.1%). In the case of relocating, there were from the west region (51.7%), followed by the central region (17.2%). Most of them relocated for more than 20 year (86.2%). The reason for relocating were to following family/marriage (79.3%).

- **General socio-economic conditions**

The sample group stated that they were general labors (29.4%), followed by private businesses/trades (26.9%) and unidentified careers (21. 3%). As for secondary occupations, most of them had no secondary occupations (75.0%), followed by trades/personal businesses and general labors (11.3% equal). For the financial status, most respondents said that there were sufficient financial status without saving (46.3%), followed by sufficient with saving (31.9%). In the case of insufficiency, solutions were reducing expenses (40.0%) and loans (34.3%).

Regarding to general information in households, most respondents were informed by neighbors and community leaders (41.2% equal). For the lifestyle of people in the community, they lived as relative types and taken public benefits into account (51.3%), followed by living and holding personal interests (17.5%). The household members entered temples for religious activities every time on important dates (69.4%). They had amulets and talismans as an anchor (33.9%), followed by offering to gods/Phra Phum Shrine/shrines (31.0%). Regarding the current community problems, there are problems within the community (18.1%) as drug problems (39.5%) and then followed by unemployment problem (28.9%).

- **Public health services and public utility systems**

For health information, the sample group stated that in the past year, there were members with illness (17.5%) with high blood pressure, diabetes (38.5%), followed by influenza (15.4%) and bedridden (11.5%). There were family members with chronic illness (23.8%) with high blood pressure/diabetes (71.4%), blood lipids and bedridden (8.6% equal). When the illness occurred, patients were admitted to government hospitals (74.6%), followed by bought their own medication (16.0%) and use a service from health promotion hospitals (5.3%).

Regarding drinking water, the sample group stated that they were buying bottled water /buckets (76.8%), followed by tap water (21.4%). For the quality of drinking water, most respondents indicated that drinking water had a good quality (97.5%). In the cases specified that water was bad (25.0%) the problem came from dust. The solution was buying the water filter (25.0%). For water sources in the community, they used the village water supply (51.2%), then provincial water supply. (41.5%). Most respondents indicated a good water quality (95.6%). For the bad quality (4.4%), it came from turbidity, sediment, rust and odor. the amount of water was sufficient (97.5%). Regarding water sources for agriculture, most respondents engaged with the agricultural sector (10.0%) with unidentified water source (50.0%), followed by using water from river/canal (37.5%) and rainwater (12.5%). There was no problem on water for agriculture (87.5%). In the report, the problem was identified as insufficient was for agriculture.

Most of the solid waste management was disposed by putting in the waste bins, waiting for the waste collecting vehicles of the responsible department to collect (91.4%), followed by incinerating (3.7%). In terms of wastewater/efflux of the community, there were managed by dumping in the public drain (42.5%) and watering the trees (23.1%).

- **Current environmental and health impacts**

From the interview of 160 household groups, whose suffering/ annoying from the environmental impact problem (45.6%), results were summarized in **Table 3.4.2-10**.

From environmental impact problems, the most affected problems were dust (18.8%), followed by soot (13.1%), odor and noise (12.5%). The affected people did not notify to any department (67.6%), followed by informing community leaders (21.6%). Such problems had been resolved (44.0%), followed by resolved (36.0%) and had not been resolved (20.0%).

Table 3.4.2-10
Environmental impact problems to Household representatives in the Sub-district Administrative Organization area

Impact / Sources	Numbers (%)	The most affected time period	Annoyance impact level		Current impact severity compared to the past	
			$\overline{X}$ (S.D.)	Interpretation[1/]	$\overline{X}$ (S.D.)	Interpretation [2/]
Dust (unidentified source)	30 (18.8)	Sometimes	1.87 (0.571)	Moderate	1.90 (0.481)	Constant
Stink (unidentified source)	20 (12.5)	Sometimes	1.90 (0.641)	Moderate	1.95 (0.510)	Constant
Soot (unidentified source)	21 (13.1)	Sometimes	1.76 (0.625)	Moderate	1.81 (0.512)	Constant
Noise (unidentified source)	20 (12.5)	Sometimes	1.90 (0.641)	Moderate	1.95 (0.510)	Constant
Waste water (unidentified source)	12 (7.5)	Sometimes	1.92 (0.793)	Moderate	1.75 (0.754)	Constant

Note: [1/] Interpretation of average scores of the level of impact on annoyance

Average scores 1.00 - 1.50 means low annoyance level

Average scores 1.51 – 2.50 means moderate annoyance level

Average scores 2.51 – 3.00 means high annoyance level

[2/] Interpretation of t average scores on the severity level of the current impact compared to the past

Average scores 1.00 – 1.50 means low level of severity

Average scores 1.51 – 2.50 means constant level of severity

Average scores 2.51 – 3.00 means increase level of severity

Source : Consultants Of Technology Co.,LTD, B.E.2563

- **Comments and suggestions for the project**

* **Acknowledgment of the project**

Regarding to receiving information about the project, most of respondents were informed about the project (37.5%) by community leaders (44.9%), followed by friends/neighbors (26.9%) and public relations (11.5%).

* **Benefit or advantages and concerns from the project**

When inquiring about benefits or advantages for the community, Respondents stated that there were equally benefits and no benefits to the community (50.0%). For the benefits, there was a development fund around the power plant (36.7%), building the security for local electricity systems (19.3%) and creating jobs and income for the local community (18.3%). However, if projects occurred, they were worried (23.1%) with concerns about air pollution / dust (37.0%), followed by concerns on noise, water consumption and increasing of health problems (11.1% equal). The cause of concerns came from self-prediction (59.5%), followed by neighbors and from operations of nearby factories (14.3% equal).

* **Confidence in the project and the organization**

For the confidence in operations and environmental management of the project, respondents commented that they were unsure (50.6%) and no comment (23.1%) due to insufficient information. An average of confidence level in the unsure ($\overline{X}$ = 2.85, S.D. = 0.800). For their confidence in agencies regulating the project for not causing any impacts to the environment, society and health, respondents stated that they were unsure as well (41.9%) and no comment (25.6%), with the average confidence level in the unsure ($\overline{X}$ = 2.89, S.D. = 0.842). The reason for no comment was due to insufficient information.

* **Patterns of public relations and information sharing to the community**

For patterns of public relations and information sharing to the community, the community would like to be informed through village chief/village headman/community leaders/village broadcasting tower (6 0 .3 %), followed by holding a meeting (18.5%).

Other suggestions that benefit the project, the environmental protection and quality of life of the surrounding people can be summarized as follows.

Environment and safety

- Concern that it will affect nearby villagers Demand to look after the environment as best as possible
- Concern on dust and polluted air
- Do not want to affect the environment
- Concern on noise

Society and public participation

- Demand to publicize the benefits of the project to the community
- Demand to provide equal treatment to nearby communities, no differences

Health

- Demand for establishing a school for the elderly
- Demand for a community park
- Health checkup should be provided for people in the community once a year.
- Concern on respiratory diseases such as allergies, lung diseases
- Demand for supporting the public health

Results of the survey of household representative groups can be summarized as follows. It was found that communities near the study area (0-3 km of radius) and remote areas (3-5 km. of radius) had not much difference in the way of living, and the recently environmental impact. For the project information, there was a concern on environmental issues, including the confidence if the project was established.

3.4.3 Public health

The consulting company collected the secondary data from public health agencies in the study area, such as the readiness in health services, personnel, and public health situations. The secondary data from various government agencies were also included with the following study details.

(1) Public health resource information

1) Public health centers

From the data of Ratchaburi Provincial Health Office (**Table 3.4.3-1**), it was found that health facilities in Ratchaburi were divided into 2 types which were public health centers under the Ministry of Public Health and private health facilities, a total of 442 with the following details.

Table 3.4.3-1
Public health centers in Ratchaburi

category	Unit (places)
Public health centers under the Ministry of Public Health	
1. Hospitals	
- center hospital	1
- general hospitals	3
- community hospitals	7
2. health promotion hospitals	158
Private health facilities	
1. Admitted patients	6
2. Non admitted patients (clinics)	267
Total	**442**

Source: Ratchaburi Provincial Health Office 22 May B.E.2562

(A) Public health centers under the Ministry of Public Health

Public health center under the Ministry of Public Health were divided into 2 categories, hospitals and sub-district health promotion hospitals. There were divided into 1 center hospital, 3 general hospitals, 7 community hospitals and 158 health promotion hospitals.

(B) Private health facilities

Private health facilities were divided into 2 categories, 6 places of admitted patients and 267 places of non admitted patients (clinics).

For the study area of the project in Mueang Ratchaburi District, there were a public health service units (**Figure 3.4.3-1**) in the following areas.

- Center hospital ; Ratchaburi Hospital.
- Community hospitals ; Health Promotion Hospital Health Center 4 Ratchaburi.
- Private hospital ; Promtpath hospital, Bankok hospital (Muangraj), Phaet pradit hospital.
- Eorce Panurangsi Hospital Under the Ministry of Defense
- Health promotion hospitals ; Huai Phai Health Promoting Hospital, Hin Kong Health Promoting Hospital, Chedi Hak Health Promoting Hospital, Ko Plub Pla Health Promoting Hospital, Don Tako Health Promoting Hospital, Don Rae Health Promoting Hospital.

2) Medical and public health personnel

From the compilation of data from B.E.2561 on the Health Resources Information Report of the Strategy and Planning Division Office of the Permanent Secretary, it showed the ratio of medical and public health personnel to the population of Ratchaburi compared between Health service network area 5 (covering 8 provinces, such as, Kanchanaburi, Nakhon Pathom, Prachuap Khiri Khan, Phetchaburi, Ratchaburi, Samut Songkhram, Samut Sakhon and Suphan Buri) and the whole country as seen in **Table 3.4.3-2.** When comparing the ratio of medical and public health personnel of Ratchaburi to the ratio of service personnel in Health service network area 5 and nationwide personnel, it was found that medical and public health personnel of Ratchaburi had less work load than the area of health service network 5.

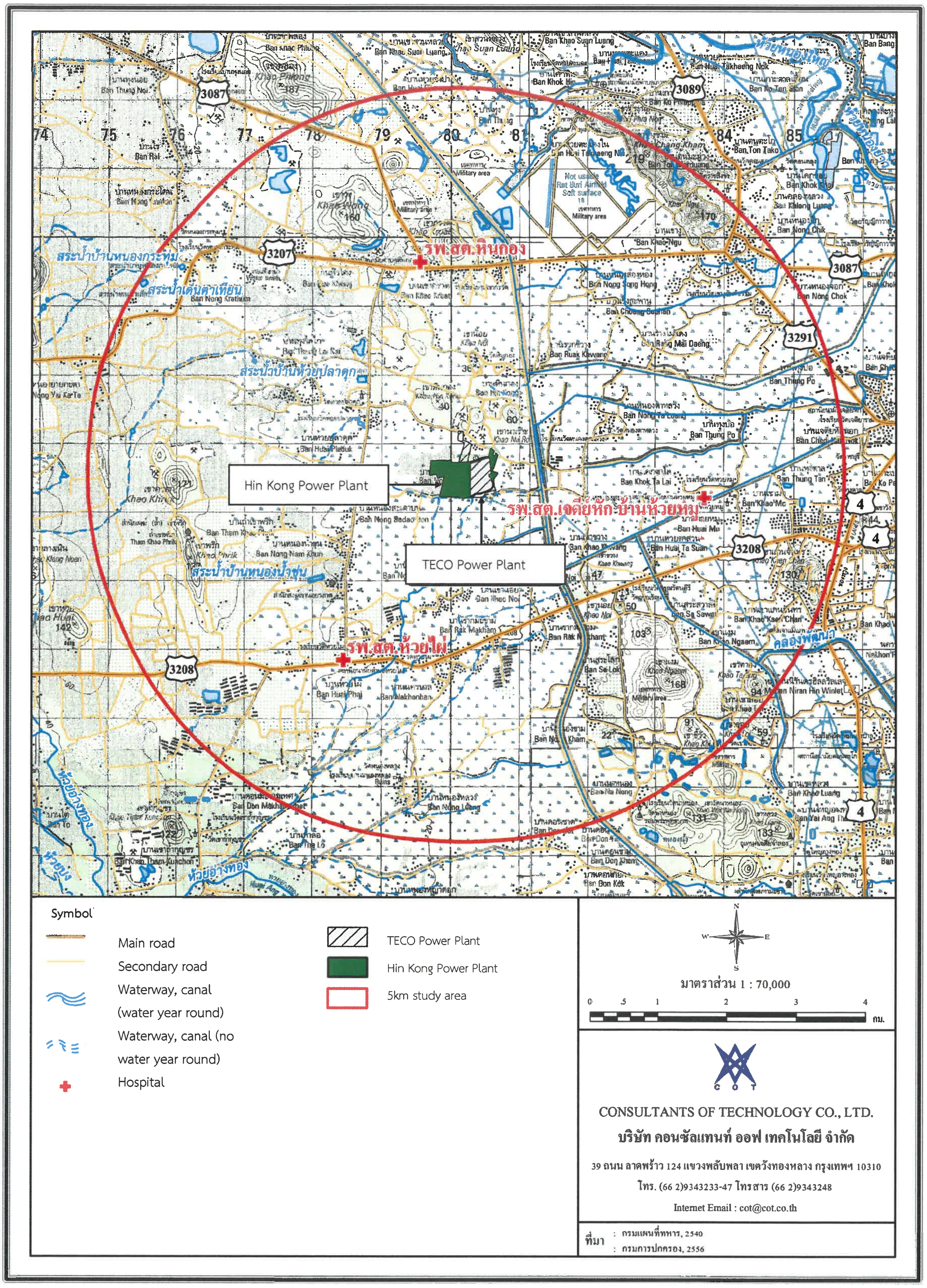


Figure 3.4.3-1 Public health service units in study area

Table 3.4.3-2

The ratio of medical and public health personnel to all of population

category	Public health personnel		
	Ratchaburi	Health service network area 5	nationwide personnel
physicians	1:1,913	1:2,019	1: 1,764
dentists	1:8,227	1: 8,574	1: 8,472
pharmacists	1: 4,984	1: 5,016	1: 4,569
registered nurses	1:392	1: 437	1: 395

Note : Health service network area 5 (covering 8 provinces, such as, Kanchanaburi, Nakhon Pathom, Prachuap Khiri Khan, Phetchaburi, Ratchaburi, Samut Songkhram, Samut Sakhon and Suphan Buri)

Source: The Health Resources Information Report of the Strategy and Planning Division Office of the Permanent Secretary 12 May B.E.2562

When taking the actual work force of medical and public health personnel such as, physicians, dentists, pharmacists and registered nurses, in Ratchaburi to compare with the criteria of the number of medical personnel that should be obtained from the survey according to the Geographic Information System (GIS) of the Office of the Permanent Secretary, Ministry of Public Health, as seen in **Table 3.4.3-3**, the study found that Ratchaburi Hospital Center was shortage of dentists.

In the study area from data collection and searching in the Geographic Information System (GIS), Office of the Permanent Secretary, Ministry of Public Health on 11 October, B.E. 2562, it was found that the rate of medical personnel in health facilities were as the following detials.

1) Ratchaburi Provincial Health Office

Number of medical and public health personnel at Ratchaburi Provincial Health Office was in the following power rates. Physicians 2 position, dentists 5 position, pharmacists 8 position, registered nurses 1 position, Public Health Technical Officer 32 position, Public Health Officer 5 position.

2) Ratchaburi Hospital

Ratchaburi Hospital is a hospital center with a total of 885 beds to support patients. There are 138,135 people in the service area, with the following personnel and staff rates. Physicians 158 position, dentists 17 position, pharmacists 41 position, registered nurses 602 position, Public Health Technical Officer 10 position, Public Health Officer 7 position.

3) Health Promoting Hospitals

(A) Huai Phai Health Promoting Hospital

Huai Phai Health Promotion Hospital in Mueang Ratchaburi District had 4,162 people in the service area, with personnel and staff rates as follows. Registered nurses 2 position, Public Health Technical Officer 2 position.

(B) Hin Kong Health Promoting Hospital

Hin Kong Health Promoting Hospital in Mueang Ratchaburi District had 8,157 people in the service area, with personnel and staff rates as follows. Registered nurses 1 position, Public Health Technical Officer 1 position.

(C) Chedi Hak Health Promoting Hospital

Chedi Hak Health Promoting Hospital in Mueang Ratchaburi District had 9,262 people in the service area, with personnel and staff rates as follows. Dental Assistant 1 position, registered nurses 4 position, Public Health Technical Officer 1 position, Public Health Officer 1 position.

(D) Ko Plub Pla Health Promoting Hospital

Ko Plub Pla Health Promoting Hospital in Mueang Ratchaburi District had 10,014 people in the service area, with personnel and staff rates as follows. Registered nurses 1 position, Public Health Technical Officer 2 position.

(E) Don Tako Health Promoting Hospital

Don Tako Health Promoting Hospital in Mueang Ratchaburi District had 3,455 people in the service area, with personnel and staff rates as follows. Registered nurses 3 position, Public Health Technical Officer 1 position, Public Health Officer 1 position.

Table 3.4.3-3

Public health personnel of Government service centers in Ratchaburi

Agency	physicians			dentists			pharmacists			registered nurses		
	Should	Have	lower/ Over	Should	Have	lower/ Over	Should	Have	lower/ Over	Should	Have	lower/ Over
Ratchaburi Provincial Health Office (scholarship)	0	15	+15	0	4	+4	0	10	+10	0	33	+33
Ratchaburi Provincial Health office (board)	0	0	0	-	-	-	-	-	-	-	-	-
Bang Phae community hospitals	5	8	+3	4	4	0	3	3	0	45	57	+12
Ban Kha community hospitals	0	1	+1	0	2	+2	0	2	+2	0	1	+1
Pak Tho community hospitals	7	7	0	5	4	-1	5	4	-1	68	66	-2
Chom Bueng community hospitals	14	9	-5	6	6	0	5	6	+1	82	58	-24
Suan Phueng community hospitals	7	7	0	6	8	+2	5	4	-1	74	51	-23
Photharam general hospitals	33	32	-1	16	11	-5	15	14	-1	219	245	+26
Ban Pong general hospitals	34	40	+6	20	12	-8	18	18	0	265	301	+36
Jed samian community hospitals	3	2	-1	2	3	+1	2	3	+1	17	46	+29
Ratchburi center hospital*	89	158	+69	31	17	-14	31	41	+10	656	602	-54
Wat phaleng community hospitals	3	3	0	2	3	+1	2	3	+1	12	44	+32
Damnoen Saduak general hospitals	23	27	+4	11	10	-1	11	13	+2	153	180	+27
Total	**218**	**309**	**+22**	**103**	**84**	**-19**	**97**	**121**	**+24**	**1,591**	**1,684**	**+93**

Note: * data collection and searching in the Geographic Information System (GIS), Office of the Permanent Secretary, Ministry of Public Health

Source : Office of the Permanent Secretary, Ministry of Public Health on 11 October, B.E. 2562 and Hospital in the study area

(F) Don Rae Health Promoting Hospital

Don Rae Health Promoting Hospital in Mueang Ratchaburi District had 2,065 people in the service area, with personnel and staff rates as follows. Registered nurses 1 position, Public Health Technical Officer 1 position, Public Health Officer 1 position.

From the personnel allocation information in Health Promotion Hospitals according to the government organization structure under the Office of the Permanent Secretary, which had classified health promotion hospitals into 3 sizes, consisting of small health promotion hospitals (responsible for a population of less than 3,000 people), medium-sized Health Promoting Hospital (responsible for the population of 3,001-8,000 people) and large-scale health promotion hospitals (responsible for a population of more than 8,001 people).

When considering the size of health promotion hospitals in the study area, it was found that the area had 3 large-sized health promotion hospitals, 2 medium-sized and 1 small-sized health promotion hospitals. Most of health promotion hospitals have the lower workload of personnel in the hospital,for example, academic public health staff/public health officers and dental public health officials as shown in **Table 3.4.3-4.**

Table 3.4.3-4

The ratio of medical and public health personnel to the population in study area

Health Promoting Hospital	personnel	Number of people	Ratio per population[1/]	criteria[2/]	results
Huai Phai Health Promoting Hospital	registered nurses	2	1 : 2,081	1 : 2,500	Pass
	Public Health Technical Officer / Public Health Officer	2	1 : 2,081	1 : 1,250	No Pass
	Dental Assistant	-	-	-	-
Hin Kong Health Promoting Hospital	registered nurses	1	1 : 8,157	1 : 2,500	No Pass
	Public Health Technical Officer / Public Health Officer	1	1 : 8,157	1 : 1,250	No Pass
	Dental Assistant	-	-	-	-
Chedi Hak Health Promoting Hospital	registered nurses	4	1 : 2,316	1 : 2,500	No Pass
	Public Health	2	1 : 4,631	1 : 1,250	Pass

Table 3.5.4-4 (cons.)

Health Promoting Hospital	personnel	Number of people	Ratio per population[1/]	criteria[2/]	results
	Technical Officer / Public Health Officer				
	Dental Assistant	1	1 : 9,262	1 : 8,000	No Pass
Ko Plub Pla Health Promoting Hospital	registered nurses	1	1 : 10,014	1 : 2,500	No Pass
	Public Health Technical Officer / Public Health Officer	2	1 : 5,007	1 : 1,250	No Pass
	Dental Assistant	-	-	-	-
Don Tako Health Promoting Hospital	registered nurses	3	1 : 1,151	1 : 2,500	Pass
	Public Health Technical Officer / Public Health Officer	2	1 : 1,727	1 : 1,250	No Pass
	Dental Assistant	-	-	-	-
Don Rae Health Promoting Hospital	registered nurses	1	1 : 2,065	1 : 2,500	Pass
	Public Health Technical Officer / Public Health Officer	2	1 : 1,032	1 : 1,250	Pass
	Dental Assistant	-	-	-	-

Note : [1/] calculated from people in the service area
[2/] Population Based/Service Based Office of the Permanent Secretary, Ministry of Public Health

Source : Health Promoting Hospital in study area B.E. 2562

(2) Health status information

Vital statistics

Ratchaburi vital statistics during B.E.2557-2561 were shown in **Table 3.4.3-5**. It showed that the birth rate tends was decrease. The birth rates of males and females were similar. The mortality rate during B.E.2559-2561 was likely to be stable. Males had a higher ratio of mortality than females, as shown in **Figure 3.4.3-2**.

Table 3.4.3-5

Ratchaburi vital statistics during B.E.2557-2561

category	Number of people									
	B.E.2557		B.E.2558		B.E.2559		B.E.2560		B.E.2561	
	Birth	Death	Birth	Death	Birth	Death	Birth	Death	Birth	Death
males	5,446	3,607	5,154	3,772	5,060	3,934	5,136	3,681	4,710	3,770
females	5,310	2,873	4,918	3,068	4,679	3,112	4,563	2,990	4,223	3,155
Total	**10,756**	**6,480**	**10,072**	**6,840**	**9,739**	**7,046**	**9,699**	**6,671**	**8,933**	**6,925**

Source : Registration statistics system Office of Registration Administration, Department of Provincial Administration Ministry of Interior, (http://stat.bora.dopa.go.th/stat/statnew/statTDD) seach 15 October B.E.2562

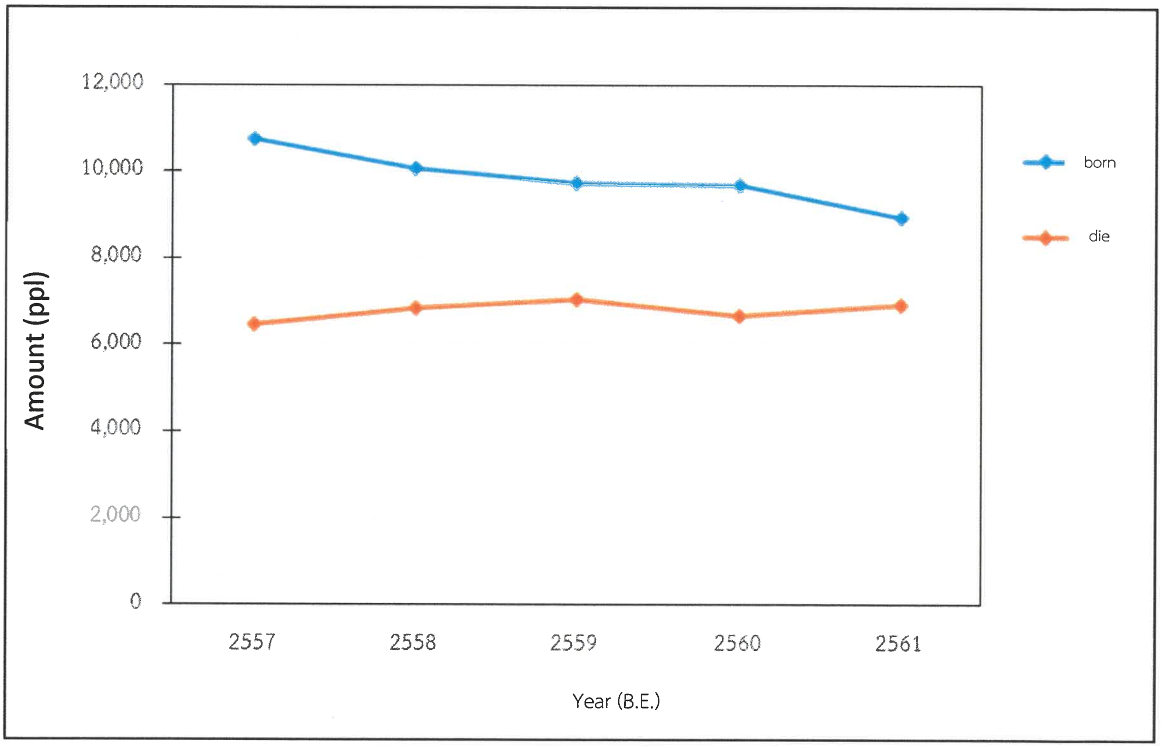


Figure 3.4.3-2 Graph of the birth and death rate tends B.E.2557-2561 in Ratchburi

(3) Statistics of public morbidity classified by disease, 21 disease groups (RorNgo. 504) from public health facilities

The consulting company collected data on illness condition statistics of people in the study area, classified by 21 disease groups (RorNgo.504) of outpatients that receive services from public health facilities in 6 study areas. It was consisted of Huai Phai Health Promoting Hospital, Hin Kong Health Promoting Hospital, Chedi Hak Health Promoting Hospital, Ko Plub Pla Health Promoting Hospital, Don Tako Health Promoting

Hospital, Don Rae Health Promoting Hospital for information. Details of illness in study areas were described as follows.

1) **Huai Phai Health Promotion Hospital**

From the collection of statistics of illness from Huai Phai Health Promotion Hospital, Ratchaburi classified by the cause of the disease, 21 disease groups (Ror.Ngo. 504) during B.E.2558-2562 (**Table 3.4.3-6**), it was found that in B.E.2558, the top 5 diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 1,153 times, as of 34.16%, followed by respiratory diseases for 982 times, as of 29.10%. Then digestive system diseases including oral diseases for 440 times, as of 13.04%, circulatory system diseases, for 223 times, as of 6.61% and diseases of musculoskeletal syestem and connective tissuefor 202 times, as of 5.99% of outpatients.

In B.E.2559, the top 5 outpatient diseases were respiratory diseases for 927 times, as of 31.98%, followed by systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 854 times, as of 29.46%, digestive system diseases including oral diseases for 546 times, as of 18.83%, diseases of eye and admexa for 189 times, as of 6.52% and diseases of musculoskeletal syestem and connective tissuefor 147 times, as of 5.07% of outpatients.

In B.E.2560, the top 5 outpatient diseases were respiratory diseases for 1,032 times, as of 31.63%, followed by digestive system diseases including oral diseases for 956 times, as of 29.30%, then diseases of the skin and subcutaneous tissue for 277 times, as of 8.49%, systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 238 times, as of 7.29% and diseases of eye and admexafor 235 times, as of 7.20% of outpatients.

In B.E.2561, the top 5 outpatient diseases were digestive system diseases including oral diseases for 1,066 times, as of 31.28%, followed by respiratory diseases for 997 times, as of 29.25%, then diseases of the skin and subcutaneous tissue for 306 times, as of 8.98%, diseases of musculoskeletal syestem and connective tissuefor 259 times, as of 7.60% and diseases of eye and admexafor 257 times, as of 7.54% of outpatients.

In B.E. 2562, the most likely outpatient disease was respiratory diseases, followed by digestive system diseases including oral diseases.

Table 3.4.3-6

Data on illness condition statistics of people in the study area, classified by 21 disease groups (RorNgo.504) Huai Phai Health Promotion Hospital during B.E.2558-2562

Disease group	Cause	B.E.2558		B.E.2559		B.E.2560		B.E.2561		B.E. 2562*	
		amount		amount		amount		amount		amount	
		Times	%	Times	%	Times	%	Times	%	Times	%
1.	Certain infectious and parsitic diseases	32	0.95	7	0.24	26	0.80	29	0.85	4	0.23
2.	Neoplasms	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
3.	Diseases of the blood and blood forming organs	0	0.00	0	0.00	1	0.03	0	0.00	0	0.00
4.	Endocrine, nutritional and metabolic diseases	54	1.60	3	0.10	14	0.43	21	0.62	14	0.82
5.	Mental and behavioural disorders	0	0.00	0	0.00	0	0.00	1	0.03	0	0.00
6.	Diseases of the nervous system	21	0.62	6	0.21	13	0.40	25	0.73	13	0.76
7.	Diseases of the eye and adnexa	171	5.07	189	6.52	235	7.20	257	7.54	135	7.87
8.	Diseases of the ear and mastoid process	2	0.06	12	0.41	89	2.73	123	3.61	68	3.97
9.	Diseases of the circulatory system	223	6.61	73	2.52	59	1.81	49	1.44	21	1.22
10.	Diseases of the respiratory system	982	29.10	927	31.98	1,032	31.63	997	29.25	517	30.15
11.	Diseases of the digestive system	440	13.04	546	18.83	956	29.30	1,066	31.28	478	27.87
12.	Diseases of the skin and subcutaneous tissue	24	0.71	55	1.90	277	8.49	306	8.98	161	9.39
13.	Diseases of the musculoskeletal system and connective tissue	202	5.99	147	5.07	183	5.61	259	7.60	155	9.04
14.	Diseases of the genitourinary system	18	0.53	20	0.69	30	0.92	11	0.32	6	0.35
15.	Complication of preganancy, childbirth and the puerperium	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
16.	Certain conditions originating in the perinatal period	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
17.	Congenital malformations, deformations and chromosomal abnormalities	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
18.	Symptoms,signs and abonormality clinical and laboratory findings, not elsewhere classified	1,153	34.16	854	29.46	238	7.29	177	5.19	104	6.06
19.	Poisoning, toxic effect, and their sequelae	0	0.00	0	0.00	0	0.00	1	0.03	0	0.00
20	Transport accidents and their sequelae	4	0.12	7	0.24	10	0.31	6	0.18	6	0.35
21.	Other external causes of morbidity and morbidity and mortality	49	1.45	53	1.83	100	3.06	80	2.35	33	1.92
	Total	**3,375**	**100**	**2,899**	**100**	**3,263**	**100**	**3,408**	**100**	**1,715**	**100**

Source : Huai Phai Health Promotion Hospital, B.E.2562

Note : * During 1 January – 31 July B.E.2562

2) Hin Kong Health Promotion Hospital

From the collection of statistics of illness from of Hin Kong Health Promotion Hospital, Ratchaburi classified by the cause of the disease, 21 disease groups (Ror.Ngo.504) during B.E.2558-2562 (**Table 3.4.3-7**), it was found that during B.E. 2558-2562, the top 5 diseases of outpatients were respiratory diseases for 9,811 times, as of 34.81%, followed by systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 6,125 times, as of 21.73%, digestive system diseases including oral diseases for 3,620 times, as of 12.85%, diseases of musculoskeletal syestem and connective tissuefor 2,377 times, as of 8.43% and diseases of the skin and subcutaneous tissue for 1,325 times, as of 4.70% of outpatients.

Table 3.4.3-7

Data on illness condition statistics of people in the study area,

classified by 21 disease groups (RorNgo.504)

Hin Kong Health Promotion Hospital during B.E.2558-2562

Disease group	Cause	B.E.2558 2562	
		amount	
		Times	%
1.	Certain infectious and parsitic diseases	339	1.20
2.	Neoplasms	4	0.01
3.	Diseases of the blood and blood forming organs	2	0.01
4.	Endocrine, nutritional and metabolic diseases	591	2.10
5.	Mental and behavioural disorders	156	0.55
6.	Diseases of the nervous system	258	0.92
7.	Diseases of the eye and adnexa	1,182	4.19
8.	Diseases of the ear and mastoid process	324	1.15
9.	Diseases of the circulatory system	986	3.50
10.	Diseases of the respiratory system	9,811	34.81
11.	Diseases of the digestive system	3,620	12.85
12.	Diseases of the skin and subcutaneous tissue	1,325	4.70
13.	Diseases of the musculoskeletal system and connective tis	2,377	8.43
14.	Diseases of the genitourinary system	212	0.75
15.	Complication of preganancy, childbirth and the puerperium	2	0.01
16.	Certain conditions originating in the perinatal period	0	0.00
17.	Congenital malformations, deformations and chromosomal abnormalities	5	0.02
18.	Symptoms,signs and abonormality clinical and laboratory findings, not elsewhere classified	6,125	21.73
19.	Poisoning, toxic effect, and their sequelae	3	0.01
20	Transport accidents and their sequelae	90	0.32
21.	Other external causes of morbidity and morbidity and mort	770	2.73
Total		**28,182**	**100**

sourc : Hin Kong Health Promotion Hospital, B.E.2562

Note : * During 1 January B.E.2558– 20 June B.E.2562

3) Chedi Hak Health Promotion Hospital

From the collection of statistics of illness from Chedi Hak Health Promotion Hospital, Ratchaburi classified by the cause of the disease, 21 disease groups (Ror.Ngo.504) during B.E.2558-2562 (**Table 3.4.3-8**) it was found that in B.E.2558, the top 5 diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 1,467 times, as of 53.48 %, followed by digestive system diseases including oral diseases for 952 times, as of 34.71%, respiratory diseases for 135 times, as of 4.92%, other external causes of morbidity and mortalityfor 44 times, as of 1.60% and diseases of eye and admexa for 38 times, as of 1.39% of outpatients.

Table 3.4.3-8

Data on illness condition statistics of people in the study area, classified by 21 disease groups (RorNgo.504) Chedi Hak Health Promotion Hospital during B.E.2558-2562

Disease group	Cause	B.E.2558		B.E.2559		B.E.2560		B.E.2561		B.E. 2562*	
		amount		amount		amount		amount		amount	
		Times	%	Times	%	Times	%	Times	%	Times	%
1.	Certain infectious and parsitic diseases	19	0.69	14	0.48	24	0.72	16	0.68	10	0.38
2.	Neoplasms	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
3.	Diseases of the blood and blood forming organs	0	0.00	0	0.00	1	0.03	0	0.00	0	0.00
4.	Endocrine, nutritional and metabolic diseases	1	0.04	3	0.10	7	0.21	330	14.04	1,152	43.34
5.	Mental and behavioural disorders	0	0.00	1	0.03	3	0.09	2	0.09	5	0.19
6.	Diseases of the nervous system	0	0.00	4	0.14	96	2.89	10	0.43	99	3.72
7.	Diseases of the eye and adnexa	38	1.39	43	1.48	63	1.90	62	2.64	102	3.84
8.	Diseases of the ear and mastoid process	1	0.04	8	0.28	41	1.23	28	1.19	8	0.30
9.	Diseases of the circulatory system	2	0.07	7	0.24	10	0.30	115	4.89	69	2.60
10.	Diseases of the respiratory system	135	4.92	271	9.33	423	12.73	368	15.65	282	10.61
11.	Diseases of the digestive system	952	34.71	752	25.90	1,384	41.66	311	13.23	216	8.13
12.	Diseases of the skin and subcutaneous tissue	20	0.73	74	2.55	153	4.61	129	5.49	159	5.98
13.	Diseases of the musculoskeletal system and connective tis	34	1.24	171	5.89	233	7.01	155	6.59	163	6.13
14.	Diseases of the genitourinary system	4	0.15	4	0.14	12	0.36	14	0.60	7	0.26
15.	Complication of preganancy, childbirth and the puerperium	0	0.00	10	0.34	25	0.75	7	0.30	2	0.08
16.	Certain conditions originating in the perinatal period	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
17.	Congenital malformations, deformations and chromosomal abnormalities	8	0.29	2	0.07	4	0.12	0	0.00	0	0.00
18.	Symptoms,signs and abonormality clinical and laboratory findings, not elsewhere classified	1,467	53.48	1,471	50.65	759	22.85	737	31.35	327	12.30
19.	Poisoning, toxic effect, and their sequelae	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
20	Transport accidents and their sequelae	18	0.66	24	0.83	14	0.42	20	0.85	15	0.56
21.	Other external causes of morbidity and morbidity and mort	44	1.60	45	1.55	70	2.11	47	2.00	42	1.58
	Total	**2,743**	**100**	**2,904**	**100**	**3,322**	**100**	**2,351**	**100**	**2,658**	**100**

sourc : Chedi Hak Health Promotion Hospital, B.E.2562

Note : * During 1 January – 31 July B.E.2562

In B.E.2559, the top 5diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 1,471 times, as of 50.65%, followed by digestive system diseases including oral diseases for 752 times, as of 25.90%, respiratory diseases for 271 times, as of 9.33%, diseases of musculoskeletal syestem and connective tissuefor 171 times, as of 5.89% and diseases of the skin and subcutaneous tissue for 74 times, as of 2.55% of outpatients.

In B.E.2560, the top 5diseases of outpatients were digestive system diseases including oral diseases for 1,384 times, as of 41.66 %, followed by systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for7 5 9 times, as of 22.85%, respiratory diseases for 423 times, as of 12.73%, diseases of musculoskeletal syestem and connective tissuefor 233 times, as of 7.01 % and diseases of the skin and subcutaneous tissue for 153 times, as of 4.61 % of outpatients.

In B.E.2561, the top 5diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 737 times, as of 31.35 %, followed by respiratory diseases for 368 times, as of 15.65%, endocrine, nutritional and metabolic diseases for 330 times, as of ละ 14.04%, digestive system diseases including oral diseases for 3 1 1 times, as of 1 3 .2 3 % and diseases of musculoskeletal syestem and connective tissuefor 1 5 5 times, as of 6 .5 9 % of outpatients.

In B.E.2 5 6 2 , the most likely outpatient disease was endocrine, nutritional and metabolic diseases, followed by systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified.

4) Ko Plub Pla Health Promotion Hospital

From the collection of statistics of illness from Ko Plub Pla Health Promotion Hospital, Ratchaburi classified by the cause of the disease, 21 disease groups (Ror.Ngo. 504) during B.E.2558-2562 (**Table 3.4.3-9**) it was found that in B.E.2558, the top 5diseases of outpatients were respiratory diseases for 1,186 times, as of 28.61 %, followed by digestive system diseases including oral diseases for 7 7 1 times, as of 18.60%, systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 7 1 7 times, as of 1 7 .3 0 %, diseases of musculoskeletal syestem and connective tissue for 498 times, as of 12.01% and diseases of the skin and subcutaneous tissue for 400 times, as of 9.65% of outpatients.

Table 3.4.3-9

Data on illness condition statistics of people in the study area, classified by 21 disease groups (RorNgo.504) Ko Plub Pla Health Promotion Hospital during B.E.2558-2562

Disease group	Cause	B.E.2558		B.E.2559		B.E.2560		B.E.2561		B.E. 2562*	
		amount		amount		amount		amount		amount	
		Times	%	Times	%	Times	%	Times	%	Times	%
1.	Certain infectious and parsitic diseases	14	0.34	20	0.51	8	0.24	22	0.90	4	0.33
2.	Neoplasms	5	0.12	0	0.00	0	0.00	0	0.00	0	0.00
3.	Diseases of the blood and blood forming organs	11	0.27	0	0.00	0	0.00	0	0.00	5	0.42
4.	Endocrine, nutritional and metabolic diseases	68	1.64	17	0.44	10	0.30	13	0.53	8	0.67
5.	Mental and behavioural disorders	112	2.70	83	2.13	31	0.93	23	0.94	11	0.92
6.	Diseases of the nervous system	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
7.	Diseases of the eye and adnexa	264	6.37	300	7.70	299	8.99	246	10.09	70	5.85
8.	Diseases of the ear and mastoid process	2	0.05	1	0.03	0	0.00	0	0.00	2	0.17
9.	Diseases of the circulatory system	27	0.65	11	0.28	4	0.12	1	0.04	3	0.25
10.	Diseases of the respiratory system	1,186	28.61	1,094	28.09	830	24.95	723	29.64	296	24.75
11.	Diseases of the digestive system	771	18.60	1,041	26.73	640	19.24	534	21.89	271	22.66
12.	Diseases of the skin and subcutaneous tissue	400	9.65	335	8.60	334	10.04	252	10.33	125	10.45
13.	Diseases of the musculoskeletal system and connective tis	498	12.01	408	10.47	395	11.87	318	13.04	138	11.54
14.	Diseases of the genitourinary system	24	0.58	6	0.15	9	0.27	18	0.74	6	0.50
15.	Complication of preganancy, childbirth and the puerperium	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
16.	Certain conditions originating in the perinatal period	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
17.	Congenital malformations, deformations and chromosomal abnormalities	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
18.	Symptoms,signs and abonormality clinical and laboratory findings, not elsewhere classified	717	17.30	555	14.25	753	22.63	275	11.28	250	20.90
19.	Poisoning, toxic effect, and their sequelae	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
20	Transport accidents and their sequelae	12	0.29	4	0.10	0	0.00	2	0.08	3	0.25
21.	Other external causes of morbidity and morbidity and mort	34	0.82	20	0.51	14	0.42	12	0.49	4	0.33
	Total	**4,145**	**100**	**3,895**	**100**	**3,327**	**100**	**2,439**	**100**	**1,196**	**100**

sourc : Ko Plub Pla_Health Promotion Hospital, B.E.2562

Note : * During 1 January – 31 July B.E.2562

In B.E.2559, the top 5diseases of outpatients were respiratory diseases for 1,094 times, as of 28.09%, followed by digestive system diseases including oral diseases for 1,041 times, as of 26.73%, systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 555 times, as of 14.25 %, diseases of musculoskeletal syestem and connective tissuefor 408times, as of 10.47% and diseases of the skin and subcutaneous tissue for 335 times, as of 8.60% of outpatients.

In B.E.2560, the top 5diseases of outpatients were respiratory diseases for 830 times, as of 24.95 %, followed by systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 753 times, as of 22.63%, digestive system diseases including oral diseases for 640 times, as of 19.24 %, diseases of musculoskeletal syestem and connective tissuefor 395 times, as of 11.87 % and diseases of the skin and subcutaneous tissue for 334 times, as of 10.04% of outpatients.

In B.E.2561, the top 5 diseases of outpatients were respiratory diseases for 723 times, as of 29.64 %, followed by digestive system diseases including oral diseases for 534 times, as of 21.89 %, diseases of musculoskeletal syestem and connective tissuefor 318 times, as of 13.04%, systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 275 times, as of 11.28% and diseases of the skin and subcutaneous tissue for 252 times, as of 10.33 % of outpatients.

In B.E. 2562, the most likely outpatient disease was respiratory diseases and followed by digestive system diseases including oral diseases.

5) Don Tako Health Promotion Hospital

From the collection of statistics of illness from Don Tako Subdistrict Health Promotion Hospital, Ratchaburi classified by the cause of the disease, 21 disease groups (Ror.Ngo. 504) during B.E.2558-2562 (**Table 3.4.3-10**), it was found that in B.E.2558, the top 5 diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 2,262 252 times, as of 73.73%, followed by respiratory diseases for 235 times, as of 7.66%, diseases of the genitourianry system for 204 times, as of 6.65%, diseases of musculoskeletal syestem and connective tissue for 69 times, as of 2.25% and digestive system diseases including oral diseases for 67 times, as of 2.18 % of outpatients.

In B.E. 2559, the top 5 diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 1,111 times, as of 54.57 %, followed by respiratory diseases for 375 times, as of 18.42%, digestive system diseases including oral diseases for 168 times, as of 8.25%, diseases of the skin and subcutaneous tissue for 116 times, as of 5.70% and diseases of musculoskeletal syestem and connective tissue 56 times, as of 2.75 % of outpatients.

In B.E.2560, the top 5 diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 1,089 times, as of 41.80%, followed by respiratory diseases for 515 times, as of 19.77 %, digestive system diseases including oral diseases for 474 times, as of 18.20%, diseases of the skin and subcutaneous tissue for 133 times, as of 5.11% and diseases of musculoskeletal syestem and connective tissue for 123 times, as of 4.72% of outpatients.

Table 3.4.3-10

Data on illness condition statistics of people in the study area, classified by 21 disease groups (RorNgo.504) Don Tako Health Promotion Hospital during B.E.2558-2562

Disease group	Cause	B.E.2558		B.E.2559		B.E.2560		B.E.2561		B.E. 2562*	
		amount		amount		amount		amount		amount	
		Times	%	Times	%	Times	%	Times	%	Times	%
1.	Certain infectious and parsitic diseases	10	0.33	15	0.74	22	0.84	14	0.73	8	0.85
2.	Neoplasms	0	0.00	0	0.00	6	0.23	12	0.63	9	0.96
3.	Diseases of the blood and blood forming organs	0	0.00	0	0.00	0	0.00	2	0.10	0	0.00
4.	Endocrine, nutritional and metabolic diseases	4	0.13	4	0.20	5	0.19	13	0.68	14	1.50
5.	Mental and behavioural disorders	32	1.04	16	0.79	12	0.46	31	1.62	27	2.88
6.	Diseases of the nervous system	9	0.29	5	0.25	5	0.19	7	0.37	0	0.00
7.	Diseases of the eye and adnexa	26	0.85	30	1.47	73	2.80	104	5.45	33	3.53
8.	Diseases of the ear and mastoid process	0	0.00	2	0.10	2	0.08	3	0.16	1	0.11
9.	Diseases of the circulatory system	97	3.16	53	2.60	58	2.23	39	2.04	55	5.88
10.	Diseases of the respiratory system	235	7.66	375	18.42	515	19.77	246	12.89	214	22.86
11.	Diseases of the digestive system	67	2.18	168	8.25	474	18.20	223	11.69	161	17.20
12.	Diseases of the skin and subcutaneous tissue	51	1.66	116	5.70	133	5.11	177	9.28	125	13.35
13.	Diseases of the musculoskeletal system and connective tis	69	2.25	56	2.75	123	4.72	114	5.97	61	6.52
14.	Diseases of the genitourinary system	204	6.65	43	2.11	27	1.04	49	2.57	25	2.67
15.	Complication of preganancy, childbirth and the puerperium	0	0.00	6	0.29	0	0.00	0	0.00	0	0.00
16.	Certain conditions originating in the perinatal period	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
17.	Congenital malformations, deformations and chromosomal abnormalities	1	0.03	1	0.05	2	0.08	2	0.10	0	0.00
18.	Symptoms,signs and abonormality clinical and laboratory findings, not elsewhere classified	2,262	73.73	1,111	54.57	1,089	41.80	840	44.03	150	16.03
19.	Poisoning, toxic effect, and their sequelae	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
20	Transport accidents and their sequelae	0	0.00	5	0.25	13	0.50	4	0.21	10	1.07
21.	Other external causes of morbidity and morbidity and mort	1	0.03	30	1.47	46	1.77	28	1.47	43	4.59
Total		**3,068**	**100**	**2,036**	**100**	**2,605**	**100**	**1,908**	**100**	**936**	**100**

sourc : Don Tako Health Promotion Hospital, B.E.2562

Note : * During 1 January – 31 July B.E.2562

In B.E.2561, the top 5 diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 840 times, as of 44.03%, followed by respiratory diseases for 246 times, as of 12.89 %, digestive system diseases including oral diseases for 223 times, as of 11.69 %, diseases of the skin and subcutaneous tissue for 177 times, as of 9.28% and diseases of musculoskeletal syestem and connective tissue for 114 times, as of 5.97% of outpatients.

In B.E.2 5 6 2 , the most likely outpatient disease was respiratory diseases and then followed by digestive system diseases including oral diseases.

6) Don Rae Health Promotion Hospital

From the collection of statistics of illness from Don Rae Health Promotion Hospital, Ratchaburi classified by the cause of the disease, 21 disease groups (Ror.Ngo. 504) during B.E.2558-2562 (**Table 3.4.3-11**), it was found that in B.E.2558, the top 5 diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 2,304 times, as of 57.60%, followed by respiratory diseases for 765 times, as of 19.13%, diseases of the skin and subcutaneous tissue for 229 times, as of 5.73%, digestive system diseases including oral diseases for 180 times, as of 4.50% and diseases of musculoskeletal syestem and connective tissue for 115 times, as of 2.88% of outpatients.

In B.E.2559, the top 5 diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 2,300 times, as of 55.05%, followed by respiratory diseases for 828 times, as of 19.82%, diseases of the skin and subcutaneous tissue for 235 times, as of 5.62%, digestive system diseases including oral diseases for 173 times, as of 4.14% and diseases of musculoskeletal syestem and connective tissue for 154 times, as of 3.69% of outpatients.

In B.E.2560, the top 5 diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 1,274 times, as of 47.01%, followed by respiratory diseases for 618 times, as of 22.80%, digestive system diseases including oral diseases for 241 times, as of 8.89 %, diseases of the skin and subcutaneous tissue for 165 times, as of 6.09 % and diseases of musculoskeletal syestem and connective tissue for 103 times, as of 3.80% of outpatients.

In B.E.2561, the top 5 diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for 870 times, as of 34.04%, followed by respiratory diseases for 593 times, as of 23.20 %, digestive system diseases including oral diseases for 429 times, as of 16.78 %, diseases of the skin and subcutaneous tissue for 214 times, as of 8.37% and diseases of musculoskeletal syestem and connective tissue for 104 times, as of 4.07% of outpatients.

In B.E.2562, the top 5 diseases of outpatients were systoms, signs and abnormal clinical and laboratory findings, not elsewhere classified for, followed by respiratory diseases.

Table 3.4.3-11
Data on illness condition statistics of people in the study area, classified by 21 disease groups (RorNgo.504) Don Rae Health Promotion Hospital during B.E.2558-2562

Disease group	Cause	B.E.2558		B.E.2559		B.E.2560		B.E.2561		B.E. 2562*	
		amount		amount		amount		amount		amount	
		Times	%	Times	%	Times	%	Times	%	Times	%
1.	Certain infectious and parsitic diseases	80	2.00	101	2.42	69	2.55	89	3.48	23	1.53
2.	Neoplasms	1	0.03	0	0.00	1	0.04	0	0.00	0	0.00
3.	Diseases of the blood and blood forming organs	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4.	Endocrine, nutritional and metabolic diseases	30	0.75	20	0.48	23	0.85	8	0.31	5	0.33
5.	Mental and behavioural disorders	4	0.10	7	0.17	4	0.15	1	0.04	5	0.33
6.	Diseases of the nervous system	14	0.35	15	0.36	11	0.41	15	0.59	10	0.67
7.	Diseases of the eye and adnexa	106	2.65	147	3.52	85	3.14	97	3.79	80	5.34
8.	Diseases of the ear and mastoid process	2	0.05	5	0.12	4	0.15	0	0.00	2	0.13
9.	Diseases of the circulatory system	96	2.40	125	2.99	88	3.25	97	3.79	87	5.80
10.	Diseases of the respiratory system	765	19.13	828	19.82	618	22.80	593	23.20	390	26.02
11.	Diseases of the digestive system	180	4.50	173	4.14	241	8.89	429	16.78	240	16.01
12.	Diseases of the skin and subcutaneous tissue	229	5.73	235	5.62	165	6.09	214	8.37	130	8.67
13.	Diseases of the musculoskeletal system and connective tis	115	2.88	154	3.69	103	3.80	104	4.07	109	7.27
14.	Diseases of the genitourinary system	23	0.58	37	0.89	4	0.15	7	0.27	5	0.33
15.	Complication of preganancy, childbirth and the puerperium	0	0.00	1	0.02	0	0.00	0	0.00	0	0.00
16.	Certain conditions originating in the perinatal period	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
17.	Congenital malformations, deformations and chromosomal abnormalities	3	0.08	3	0.07	0	0.00	0	0.00	0	0.00
18.	Symptoms,signs and abonormality clinical and laboratory findings, not elsewhere classified	2,304	57.60	2,300	55.05	1,274	47.01	870	34.04	395	26.35
19.	Poisoning, toxic effect, and their sequelae	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
20	Transport accidents and their sequelae	12	0.30	14	0.34	9	0.33	9	0.35	3	0.20
21.	Other external causes of morbidity and morbidity and mort	36	0.90	13	0.31	11	0.41	23	0.90	15	1.00
Total		**4,000**	**100**	**4,178**	**100**	**2,710**	**100**	**2,556**	**100**	**1,499**	**100**

sourc : Don Rae Health Promotion Hospital, B.E.2562

Note : * During 1 October B.E.2557 – 14 August B.E.2562

(3) Health status summary

From the statistics of patients in the area of responsibility of the Health Promotion Hospital in the study area, it was found that during B.E.2558-2562, had an unstable trends of patient statistics. Top diseases were respiratory and circulatory system diseases which could occurred to every genders and ages. Respiratory diseases caused by various factors such as, virus, bacteria, etc. Respiratory diseases mostly found during the rainy season and winter, or, especially, during the climate change. Infected population could occurred at any age. Therefore, numbers of patients with respiratory diseases were numerous in every area. For circulatory system diseases meaning that any disease with any pathology to the vascular system throughout the body, such as blood pressure, heart, etc. The disease could occurred for many reasons, such as hereditary eating habits, etc. Therefore, there were high numbers of patients with circulatory system diseases.

3.4.4 Safety in life and property

The consulting company collected basic information on safety in life and property from crime data and traffic accident statistics during B.E.2559-2561 done by the Provincial Police Region 7 and the Royal Thai Police, responsible for the project area and nearby areas. Details were described in **Table 3.4.4-1**, which could be summarized as follows.

Table 3.4.4-1

Crime data and traffic accident statistics during B.E.2559-2561

by the Provincial Police Region 7

Fault type	Criminal cases								
	B.E.2559			B.E. 2560			B.E.2561		
	Notified (cases)	catch		Notified (cases)	catch		Notified (cases)	catch	
		cases	person		cases	person		cases	person
offences affecting life, body and sexuality	1,889	1,514	2,101	2,236	1,881	2,451	2,061	1,878	2,318
offences relateing property	5,666	3,514	4,869	5,737	3,843	4,751	5,738	4,345	5,326
Fix offences	1,089	600	939	1,800	938	1,149	1,776	912	1,136
offences that the state was the victim	26,236	-	29,309	40,974	-	45,654	46,817	-	51,464
Total	34,880	5,628	37,218	50,747	6,662	54,005	56,392	7,135	60,244

Source : The Provincial Police Region 7, B.E.2562

In B.E.2559, the top 3 cases were criminal offences that the state was the victim, offences relateing property, offences affecting life, body and sexuality which accounted for 26,236 5,666 and 1,889 cases, respectively. In B.E.2560, top 3 reported cases were offences that the state was the victim, offences relateing property, offences affecting life Body and sexuality which ccounted for 40,974 5,737 and 2,236 cases respectively, In B.E.2561, top 3 reported cases were offences that the state was the victim, offences relating property, offences affecting life Body and sex, which accounted for 46,817 5,738 and 2,061 cases, respectively. From the data showing the offences that state was the victim had increased notification.

Based on basic information on the safety in life and property, the statistical data on such crime cases showed that numbers of offences that state was the victim was the highest case. Most of them were drug cases, followed by gambling, firearms and explosives and offences relating to immigration laws etc.

As for the statistics of traffic accidents in the area of responsibility of the Ratchaburi Police Station from B.E.2559-2561, it was found that a total of 139, 110 and 50 traffic accidents occurred, mainly due to driving faster than the law, driving and cutting across in the close range, carelessly driving and violate traffic signs, etc. Damages of traffic accidents were described in **Table 3.4.4-2.**

Table 3.4.4-2

The statistics of traffic accidents of Ratchaburi

Detail	B.E. 2559	B.E. 2560	B.E. 2561	Total
Damage to person	139	110	50	299
Died	111	83	37	231
Seriously injured	19	18	9	46
Minor injuries	9	9	4	22
suspect	630	297	75	1,002
arrest	626	296	74	996
Escape	4	1	1	6
Unaware	0	0	0	0

Source : Information system of police statio Royal Thai Police, B.E.2562

3.4.5 Aesthetics and tourism

Ratchaburi is an old town since ancient times. It was one of cities in the Suvarnabhumi region. Nakhon Pathom was a metropolis called "Dvaravati". The legend said that Nakhon Pathom was the main city used in the dissemination of Buddhism. Ratchaburi town had relocated the city for many times. Until in B.E.2440, it had been moved and settled up on the current city hall. The Royal Monument of Phra Buddha Yod Fah Chulalongkorn the Great is an interesting tourist destination in Mueang District. It is located at the foot of Kaeng Chan Mountain, Petchkasem Road, which is a place of public worship. The province also renovated this area into a recreation area. In addition, Mueang Ratchaburi District has many important historical sites, such as the City Pillar

Shrine, Wat Phra Si Rattana Mahathat Worawihan, Ratchaburi National Museum and others which are beautiful and have a fascinating history. In addition, the important place in Ratchaburi is Damnoen Saduak floating market which has been operated for over 100 years. The important festival and tradition is the eating wrapped rice traditions or Ang Mee Thong as a tribute ceremony in the ninth month. In the ceremony, there will be a boiling rice which glutinous rice will be used and wrapped in a cone and then boiled and cooked as a snack in the past. There is also an outstanding culture, saying that, Ratchaburi consists of 8 ethnic populations which are native Thai, Thai-Chinese, Thai-Khmer, Thai-Karen, Thai-Mon, Ratchaburi thaisongdam, Thai-Yuan and Thai-Laos Vieng Ratchaburi. Each ethnic group has their own unique and valuable cultural identities which associate with domestic tourism marketing action plan of the Ministry of Tourism and Sports, B.E.2558, under the topic of “Year of Thai Way Tourism”, in order to diversify tourism from the big province to alternative provinces which have the potential to accommodate tourists. Ratchaburi was chosen to be 1 in 12 cities under the concept of "12 forbidden cities that cannot miss" under the theme for public relations "Ratchaburi Community of Art", which will help stimulate and expand the tourism economy of Ratchaburi this year and in the future.

Nowadays, Ratchaburi is still outstanding in the matter of "City of contemporary art" as seen from various travel products, such as the dragon pottery, which is currently being developed into a modern ceramic product as uniquely beautifully and can really use it. Hand-woven and cloth with unique patterns of Ban Khu Bua and Ban Don Rae in Mueang Ratchaburi District. Nang Yai Wat Khanon Photharam District, a work of art that combines a variety of art, including the pattern of large leather painting. The dance performance together with music of the Pi Paat and the source of production and distribution of famous cloth dolls of Photharam District.

For Mueang Ratchaburi District, there are various interesting tourist attractions as follows.

(1) Rattanakosin 1 is the first and only pottey factory that opened for tourists, students, and those interested in visiting every step of making a dragon pottery, earthenware jars and pottery, from the patterned glaze, coating and kilns that are unique to Ratchaburi. There are also modern ceramics, porcelain and souvenirs from artisans which is unique and a variety of molding works from small to large pieces for both wholesale and retail. They are suitable for souvenirs as the longer they have been, more valuable they will be. These souvenirs receive guaranteed with the Otop Outstanding Export Award 2006 and the Best Export Award of Thailand. In addition, this place is also suitable for a car stop to take some photos as a souvenir with the symbol of Ratchaburi, Dragon pottery, and a service from "C Coffee Kitchen", a coffee shop and good atmosphere food for tourists.

Rattanakosin 1 is located on Petchkasem Road, KM.98, the southern side. It opens daily from 8.00 – 17.00 hrs., everyday. For inquiries, please call (032) 334664, (032) 334689-90.


(2) **Ratchaburi City Pillar Shrine** is considered very sacred where people always come to worship. The people of Ratchaburi have worshiped this place since the ancestor era. Ratchaburi City Pillar is known as the Shrine of the City Pillar Shrine. It was first established in the reign of King Rama 2. Ratchaburi in ancient times had been built and moved to many places in the area not far from each other. Land area in which Ratchaburi is currently located from evidence of ancient artifacts and ancient sites that have been discovered leding to the believe that there werw people settling here since the Middle Ages, approximately 10,000 years ago. However, the evidence on the building, a house in that city had clearly shown evidence in the Dvaravati period. After discovering archaeological sites in the Dvaravati period at Khu Bua Subdistrict, Mueang Ratchaburi District. It is believed that this Khu Bua Subdistrict used to be the location of the old Ratchaburi city. During the Lopburi period, Ratchaburi had moved to the area of Wat Mahathat with Wat Mahathat or Wat Mahathat as the city axis. it located on the bank of the Mae Klong River on the west side (right side). Outside the city, there was Wat Aranyik. The area of Ratchaburi in Lop Buri period was in the Chedi Hak Subdistrict and Lum Din Subdistrict. Part of the mound, east side of city wall was reclamated as a road that passed to Khao Ngu, Ratchaburi, which had the center at Wat Mahathat as evidence has been established for hundreds of years. It is considered as one of the longest located cities in Thailand. Lasted until the Rattanakosin period, during the reign of King Rama II, His Highness thought that the location of the city on the west bank or the right bank of the Mae Klong River was a strategic disadvantage, so that Burma was always invading. Threfore, the King please and ordered to move the city to the east or the left bank of the Mae Klong river, in order to make the enemy more difficult to reach the city and provide a way to escape. This relocation of the city has set auspicious

ceremony to bury the city pillar as well at Panurangsee Camp, Phongsawai Subdistrict, Mueang Ratchaburi District, Ratchaburi.

Ratchaburi City Pillar Shrine located at Panurangsei Camp, Phongsawai Subdistrict, Mueang Ratchaburi District, Ratchaburi Province. Opening hours are 6.00 - 20.00 hrs.



(3) **Wat Nong Hoi** is the temple that built in B.E. 2416, located in Khao Raeng Subdistrict, Mueang District, Ratchaburi Province, approximately 12 kilometers from the city. It is the location of the Avalokitesvara Bodhisattva Kuan Yin Temple, with a height of 16 meters and a width of 9 meters. General people called it as "Khao Kuan Im Wat Nong Hoi". which is located on the top of Kao Raeng and the other side of the hilltop (Big Buddha Mountain) enshrines the Buddha Rattanakosin Mahamuni (Luang Pho Yai). This is a temple that has many believers come to pay respect to monks. Nowadays, Nong Hoi Temple is well-known to the general people both in the province and other provinces. It is rumored that this place is very sacred, people will receive what they wish for. People always come to worshipe, in particularly, on festival days or holidays. This place is opened from 7.00 -18.00 hrs.



(4) **Ta Lat Thai-Yuan, Wat Na Nong** open every Saturday - Sunday at approximately 10.00 am onwards. For the travel: from Khao Kaen Chan Intersection (Huai Phai Intersection), Muang District, Ratchaburi. Then drive towards the sign to Suan Phueng for approximately 3.4 km past Ratchaburi Mitr Phol Stadium then drive a bit forward, a sign to the market will appear. Turn left and drive for another 3 km to reach Ta Lat Thai-Yuan, Wat Nong Nong.



(5) Khao Ngu Stone Park located approximately 8 kilometers from Ratchaburi. Ko Plub Pla Subdistrict, Mueang District, Ratchaburi originally an important eruption and rock source of Thailand since the early Rattanakosin period because it is a good cement quality. Later on, both the government and the public were aware of the deterioration of the terrain and scenery. In addition, Khao Ngu is also an ancient religious place. Therefore, there was a cancellation of the concession for the eruption and rock formation in this area. After canceling the concession, Khao Ngu turned into an abandoned and dilapidated mine. Ratchaburi has developed Khao Ngu into a public park and archaeological tourist attraction, built a large stone Buddha statue at the cliff area created by shooting lasers down a rocky cliff. Within this rocky mountain park, there are many archaeological sites, many caves on the mountain with Hermit Cave, Jarlid Cave and Chinese-Cham Cave. Each cave is not far away from each other, people have to walk up the stairs to climb quite high. Surrounding areas have monkeys living around. Carved Buddha images or many carved stone Buddha images in cave walls were found in these caves. These statues were Buddha from the Dvaravati period.



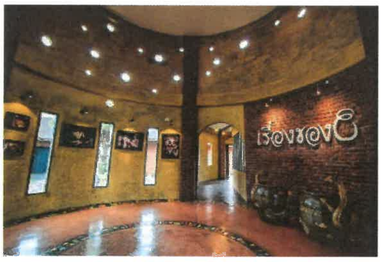
(6) Wat Khao Noi Thiam Sawan located at Ang Thong Subdistrict, Mueang District, Ratchaburi over Khao Luang, follow on Petchkasem Road for approximately 10 kilometers away from the province. The old temple built of laterite, following the Lop Buri art in the Chao Phraya River Basin. It is assumed that it was built from the Khmer era in the Suvarnabhumi Peninsula which consistent with the names of 6 cities in the central region that is influenced by Cambodia. Ratchaburi is one of those places, as it appears that Chaya Rajapuri (Ratchaburi) and Samphukah Patana which assumed that It is an ancient town, Kosai Narai. Ratchaburi, itself is evidence of the Khmer art that spread into the central region. In addition, it is believed that the temple hall was built according to the Khmer motto, as temple was built on a cliff, like Phra Viharn Temple, to worship the gods of the Brahmins. The celebration of the new temple hall on the New Year's Day which was the 5th month (Thai New Year). Inside the temple hall is the enshrined of 2 Buddha statues placing against each other. Buddha statues were made from laterite. Buddha statues were facing east. The villagers called Luang Por Khao Noi and believed to be sacred and respected until now. The top of the temple has a replica of the Buddha footprint. People can see the view of Ratchaburi city from above.The temple is open to visit Daily from 08.00 - 17.00 hrs.



(7) Khu Bua Community Way of Life open every Friday, Saturday and Sunday during 09.00 – 20.00 hrs. There are native performances of natives for free !! Show time is during 17.00-19.00 hrs., at Wat Khong Klang Suwannakhiri, Mueang District, Ratchaburi.



(8) Story of Ong, Ong Mang Kron is a product of Ratchaburi for more than 60 years with the unique red soil and attention to every production process. It is considered a local wisdom that is difficult to imitate. "The Story of Ong" is a new tourist attraction, a conservation of local arts and culture in order to truly reflect the way of life of the people of Ratchaburi. With a commitment to inheriting art, culture and the process of Ong Mang Kron of Ratchaburi in the traditional format from the past to the present in both the artistic and cultural progress and the continuous development of the provincial identity to raise awareness of preservation and preserve the traditional knowledge and wisdom of the people of Ratchaburi. In addition, it is maintaining the legendary charm and popular forever, creating pride in being a descendant of "Mueang Ong Mang Korn" and spread culture to many countries. Moreover, it is presenting the traditional charm of jar factory with the aura of the jar city and the origin of Ong Mang Kron on an area over 6 rai, next to the Rueang Sin 3 factory at the 108 milestone on the inbound road from Phetchaburi to Ratchaburi. It is open the legend of Ong Mang Korn, an over 100 years of civilization, through a 3D animation. People can study the history of the jar from ancient times to the present. While also visiting the exquisite production process since molding, decorative pattern and simulated atmosphere inside the stove using to burn jar for a long time, which is difficult to find nowadays. The tourist museum for The story of Ong is located at 66 Moo 6, Petchkasem Road, Don Tako Subdistrict, Mueang District, Ratchaburi. It has a service hours during 9.30 - 17.30 hrs., for every day.



(9) **Tao Hong Tai** is the oldest pottery factory in Mueang Ratchaburi. This factory has been started since B.E.2476 by Mr.Song Hong Sae Tia. He found the soil source in Ratchaburi, then he invited friends to establsidh a factory to produce jars of fish sauce, water jar without pattern, plant pot as the first factory in the province. Later on, it has been continuously developed until the present day. With the 3rd generation, Mr.Wasinburee (Tiew) Supanichvoraparch, he has realized the survival of the factory at that time. It was highly competitive with over 20 factories causing overflowed of pottery in the market. In addition, the era has changed and people had less demand for pottery to collect water. Therefore, he has developed ceramics into creative, contemporary and practical works of art, not just only brown green colors as before. There are more than 600 colors with new styles always occur. This factory located at 234/1, Moo.2, Chedi Hak Subdistrict Road, Mueang District, Ratchaburi. It is open daily from 08.00 - 17.00 hrs.



(10) Khao Bin Cave is a beautiful natural attraction in the national forest reserve area. Inside the cave is full of beautiful stalactites and stalagmites. In B.E.2530, the Tourism Authority of Thailand has assigned the Office of Academic Services to design the lighting of Khao Bin Cave, in order to emphasize the beauty of the cave. This cave located in Moo.11, Hin Kong Subdistrict, Mueang District, Ratchaburi on Ratchaburi-Chom Bueng Road, approximately 20 kilometers away from the city with the daily service hours for 8.00 - 16.00 hrs.



(11) Wat Mahathat Worawihan is the third class of royal temple as the Worawihan type. It was built since the reign of Jayavarman VII of Khmer, from the 18th century. It is located almost in the heart of Ratchaburi on the west side of the Mae Klong River, formerly known as "Wat Na Phra That". "Wat Phra Si Rattana Mahathat" has a 12-meter laterite pagoda with murals on walls of Phra Prang. It is a temple that enshrines the Buddha’s relics. The temple located on Ban Dai It, Khlong Kra Saeng Canal, Soi 2, Khao Ngu Road, Na Mueang Subdistrict, Mueang Ratchaburi District, Ratchabur. The opening time for viewing: 07.00-18.00 hrs. (Daily).



(12) Ratchaburi National Museum located on Woradech Road, Na Muang Subdistrict near the clock tower on the Mae Klong river. The museum building used to be the city hall before. It was built in the reign of King Rama VI on B.E.2465 and established as a National Museum in B.E.2526 with continuously restored. Until in B.E.2534, Her Royal Highness Princess Maha Chakri Sirindhorn was the inaugural president to officially open the museum. Those who interested can visit the museum which is exhibited about Ratchaburi in history, archeology, ethnology, geology, folk art tools for catching fish, cultural well-being of various ethnic groups in Ratchaburi, such as Laos, Karen and Tai-Yuan, as well as various tourist attractions in the province, outstanding antiques. Aside from the royal sword of Ratchaburi, there is Bodhisattva Avalokitesvara with shining radius as Khmer art style art. This statute is one of the 5 statutes excavated in Thailand, which is the most complete and beautiful. The place open daily from 09.00-16.00 hrs. and closed on Mondays, Tuesdays and public holidays. Thai admission fee is 20 THB (children enter for free) and the foreigners fee is 100 THB. For more information, please call 0 3232 1513, Fax. 0 3232 7235.

(13) Ban Khu Bua Miscellaneous/Museam located in Wat Khlong Suwankhiri, Khu Bua Subdistrict, Mueang District, Ratchaburi. Ban Khu Bua Miscellaneous is a local museum of the community with the initiative of many community organizations in the area. Its construction was completed in B.E.2550 with the cooperation of Wat Khlong Suwankhiri, Khu Bua Subdistrict Development Foundation and the Fabric Art Heritage Center of Ratchaburi, Ratchaburi Tai-Yuan Club. The budget was supported by Ratchaburi Provincial Administrative Organization for the benefit of the public, in terms of inheritance of Tai-Yuan culture. At the present, there is only language spoken and weaving left for Tai-Yuan culture, which is a cultural heritage of Tai-Yuan women dressing only. This museam open to visit daily from 09.00 - 16.00 hrs. It will be closed every Tuesday.



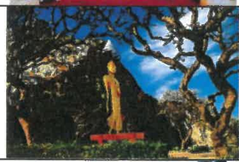
(14) Khao Kaen Chan, formerly known as Khao Chan Daeng, located on Petchkasem Road, approximately 2 kilometers away from the province with a height of 141 meters. There are roads leading up to the hill top. At the top of the temple is a Buddha statue of Niro Khanthrai Chaiwat Chaturathit, or what the locals call "Phra Si Mum Mueang". It is one of the 4 statues that His Majesty the King has graciously built and bestowed in four different cities, which are, Ratchaburi, Lampang, Saraburi and Phatthalung. At the top of the hill, people can see the view of Ratchaburi city. On the hillside area, it is the location of the Phra Phutthayotfa Chulalok, King Rama 1 statue which people of Ratchaburi united to build on the occasion of the celebration of Rattanakosin 200 and use as the Chakri Memorial Park. Open: 07.00-18.00 hrs. (Every day.



Beside from interesting tourist attractions, Ratchaburi also organizes festivals and activities every month, as seen in following details.

Month	Activities	
January	Worship and gilding of Luang Pho Kaen Chan at Wat Chong Lom, Mueang Ratchaburi District	
	Organic Shrimp Day, inherit the tradition and good products in Bang Phae District at the area of Bang Phae District Office	
February	Ratchaburi Chinatown Event at the Rat- Pracha Dam Area, Mueang Ratchaburi District	

Month	Activities	
	Go back in time event of the 119 years old market of Chet Samian at the 119 year old market, Chet Samian Subdistrict, Photharam District	
March	Ratchaburi Tourism Fair of Mueang Ong at Ratchaburi City Hall	
	Festival of sweet grapes and Damnoen Saduak products at the courtyard and pier of Wat Rat Charoen Tham, Damnoen Saduak District	
April	Big Shadow Pay Festival Wat Khanon at Wat Khanon, Photharam District	
	Traditional Thai Songkran Festival, in front of the National Museum, Mueang Ratchaburi District	
	Lao Wiang Songkran Festival at Wat Ban Sing, Photharam District	
	Mango and Pak Tho product Fair, in front of Pak Tho District Office	
	Cultural event of "Eng Kon Fuon Kan" at Song Dam Chinese Culture Center, Ban Hua Khao Chin, Pak Tho District	
April	Flower festival parade after Songkran festival and good products of Chet Samian at Wat Subdistrict at Chet Samian, Photharam District	
	Worship Event of the City Pillar Shrine at Panurangi Camp, Mueang Ratchaburi District	
May	Pineapple Festival and good product of Ban Kha District, in front of Ban Kha District Office	
July	A memorial ceremony for the royal traveling at Wat Rat Charoen Tham and Klong Lat Ladphee, Damnoen Saduak District	

Month	Activities	
August	The tradition of tied arms and eat the rice wrap at Ban Bo Wi community stadium, Suan Phueng District	
September	Ban Pong Vegetarian Festival at Buan Hok Tao Vegetarain House, Ban Pong District	
October	Worship of Buddha Image Project at Khao Ngu Hermit Cave, in front of Khao Ngu Hermit Cave, Mueang Ratchaburi District	
	Traditional long boat racing event, in front of Wat Yai Nakhon Chum	
November	Loi Krathong Festival at Mae Klong River bank, Mueang Ratchaburi District	
	Mountain climbing for Chomphon Cave event at Muban Chom Bueng University, Chom Bueng District	
December	Honoring the King Rama 5 and inheriting good traditions of Chom Bueng District, around Chom Bueng District Office	
	Thai Tanaosri Traditonal Festival at Suan Phueng District Office	
December	So in Art So in Love Event at The Scenery Vintage Farm, Suan Phueng District	
	Season of Lovesong Event at Veneto SuanPhueng Floating Market, Suan Phueng District	

Source : Ratchaburi Provincial Tourism and Sports Office, B.E. 2562

Note : The date and time of the event may not be the same every year. Depending on the availability of the event in various fields

For the study area in the radius 5 kilometers from the project location, important cultural or historical tourist spots were found, such as the Buddha image, Khao Ngu Hermit Cave, which located at Moo.2, Ban Khao Ngu, Ko Plub Pla Subdistrict, Mueang Ratchaburi District. Khao Ngu is a limestone mountain that is a valuable archaeological site and a sanctuary that provide one of the oldest artifacts in Ratchaburi, which is Buddha Large Stone Carvings. General villagers call it Buddha projecting Khao Ngu Hermit Cave . For the general characteristics, there are 2.50 meters of Buddha stone carvings. The left hand is placed on the thigh. The right hand is raised up to make Pang Jitaka. His face is quite square, occupying the robe obliquely attached to him. Thre are 12 inscriptions between the two feet which is the signature of the Buddha image engraved. It can be read as Bun Wara ritsi-Sri Smati Gupta. The alphabet is the Sanskrit Palawan script using in Southern India during the B.E.1,000-1,100 which matches with the Dvaravati period. In addition, there is a replica of the Buddha's footprint enshrined on a hilltop approximately 130 meters height.

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Chapter 4

Public participation

Chapter 4
Public participation

4.1 Guidelines and Principles

The public participation process is another important process that make the people in the study area aware of the expected positive and negative impacts on the community as well as have opportunities to express their opinions, suggestions and concerns for the project.

Hin Kong Power Co., Ltd., realizes the preparation of the public participation process since the society is very active in the environment. If people continually receive incorrect and incomplete information, it can lead to misunderstandings and concerns for the project. Therefore, public relations of the company had been provided to introduce the project and explain details of the project, operation plan, environmental impact prevention and measures and environmental impact monitoring for both during the construction and operation periods, with honesty and transparency of information. Information obtained from all processes of public participation will be taken into account and consider as approaches and measures to prevent possible impacts on the community. This will help reduce concerns of the people in the surrounding communities in all aspects.

4.2 Objectives of public participation

(1) To clarify and disseminate project details to the target group, in particular, the group may receive direct impacts by both positive and negative effects, including other relevant target groups which may receive indirect impacts.

(2) To listen to public opinions on the project operation.

(3) To use information obtained from operations and opinion survey to study, develop project plan, evaluate the environmental impacts resulting from the project, establish prevention and measures, in order to increase benefits that are feasible in practice in accordance with demands of the public.

4.3 Scope of operation

The scope of the project operation was in accordance with the Announcement of the Office of Natural Resources and Environmental Policy and Planning on guidelines for public participation in the process of preparing the environmental impact assessment report. This guideline required the preparation of the community by providing information to the public before the public hearing meeting. The public hearing process must be done at least 2 time (**Figure4.3-1**) as follows:

Operation steps for public participation	Operation results
Public Relations	**Community Preparation** (Operation during April B.E. 2562 (2019)) Prepare by meeting with the government agencies and the community to establish relationships
Draft project's proposal, project details, and study scope and assess project's choices Invite and schedule meeting notice at least 15 days before hand → 29 April – 3 May B.E.. 2562(2019) PP 1 21 – 25 May B.E. 2562(2019) (all 7 stages) publicise meeting's result within 15 days → 2 – 4 June B.E. 2562(2019)	**1st public hearing meeting** Stage 1: Tuesday, 21 May B.E. 2562(2019) during 08.30 - 12.00 at meeting room of Hin Kong Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi province Stage 2: Wednesday, 22 May B.E. 2562(2019) during 08.30 - 12.00 at meeting room of Ko Plub Pla Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi province Stage 3: Wednesday, 22 May B.E. 2562(2019) during 18.00 - 21.00 at SML pavillion Moo 3 of Chedi Hak Subdistrict, Ratchaburi district, Ratchaburi province Stage 4: Thursday, 23 May B.E. 2562(2019) during 14.00 – 16.30 at multipurpose pavillion of Na Nong Temple in Don Rae Subdistrict, Ratchaburi district, Ratchaburi province Stage 5: Friday, 24 May B.E. 2562(2019) during 08.30 – 12.00 at Learing Center of Khao Ngu subdistrict Municipality in Ratchaburi district, Ratchaburi province Stage 6 : Friday, 24 May B.E. 2562(2019) during 13.30 – 16.00 at meeting room of Huai Phai Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi province Stage 7 : Saturday, 25 May B.E. 2562(2019) during 08.30 – 12.00 at SML pavillion in Don Tako Subdistrict, Ratchaburi district, Ratchaburi province **Total participants = 774 ppl** **(not including project owners and consultant company)**
Opinion survey → 27 April – 30 November B.E. 2562(2019) Draft report and measures	**Survey** (1) Related agencies 28 samples (2) Sensitive receptor 21 samples (2) Water users group 30 samples (3) Potential affected group from pipeline installation 33 samples (4) community leader (34 communities) 51 samples (5) Household representative 682 samples
Invite and schedule meeting notice at least 15 days before hand → 7-9 October B.E.. 2562(2019) PP 2 24 – 30 October B.E. 2562(2019) (all 7 stages) publicise meeting's result within 15 days → 12 – 14 November B.E.. 2562(2019) Draft report Office of Natural Resources and Environmental Policy and Planning	**2nd public hearing meeting** Stage 1 : Hin Kong Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi province Stage 2 : Thursday, 24 October B.E. 2562 during 18.00-21.00 at SML pavilion Moo 3 in Chedi Hak subdistrict, Ratchaburi district, Ratchaburi province Stage 3 : Friday, 24 October B.E. 2562 during 08..30 – 12.00 at multipurpose pavillion of Na Nong Temple in Don Rae Subdistrict, Ratchaburi district, Ratchaburi province Stage 4 : Friday, 25 October B.E. 2562 during 13.30 – 16.00 at meeting room of Huai Phai Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi province Stage 5 : Tuesday, 29 October B.E. 2562 during 08.30 - 12.00 at meeting room of Ko Plub Pla Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi province Stage 6 Tuesday, 29 October B.E. 2562 during 13.30 – 16.00 at multipurpose pavillion of Don Tako Subdistrict Administrative Organization, Ratchaburi district, Ratchaburi province Stage 7 : Wednesday, 30 October B.E. 2562 during 08.30 – 12.00 at meeting room in Learing Center of Khao Ngu subdistrict Municipality in Ratchaburi district, Ratchaburi province **Total participants = 1,028 ppl** **(not including project owners and consultant company)**
	Proceed to consideration process

Figure 4.3-1 Steps / procedure of public participation in the process of drafting environmental impact assessment report by the Office of Natural Resources and Environmental Policy and Planning(ONEP)

The 1st public hearing, held during the project start by listening to opinions on the project proposal, project details, study scope and evaluation of project options. An objective of this meeting was to provide information to the public and related agencies on an upcoming project and directly and indirectly potential impacts, including the scope of the study and evaluation of project options. Recommendations obtained from the hearing were used in the study and preparing the complete report.

The 2nd public hearing held during the preparation of drafted reports and environmental impact prevention and measures, including environmental impact monitoring. An objective of this meeting was to ensure people confidence in the report and the measures. The suggestions obtained from the hearing will be used to improve the report and measures and must be included as parts of the report.

The comparison of project participation activities according to the Announcement of the Office of Natural Resources and Environmental Policy and Planning on guidelines for public participation in the process of EIA report, dated 8 February, B.E.2562(2019) as seen in **Table 4.3-1**.

Table 4.3-1

Comparison of procedures for participation of the project according to the Announcement of the Office of Natural Resources and Environmental Policy and Planning, on guidelines for public participation in the process of preparing the EIA report

Public participation in the process of preparing the EIA report	Project participation activities
(1) Person responsible for preparing the report must enter the project area for preparation process before the hearing with the objective of;	**(1) Preparation of the community** Publicize the project to government agencies and local community leaders, in order to distribute the preliminary project details (operation during April B.E.2562).
1) Prepare the community by giving public information on project details and the rules for hearing of the project by focusing on communication in a format that can be easily understood by the public, such as preparing an info graphic, short video clips,	

Table 4.3-1 (Cont)

Public participation in the process of preparing the EIA report	Project participation activities
brochures, publicity banners, etc. Therefore, public can obtain complete and sufficient information for expressing comments and opinions.	
2) Stakeholder analysis will be done to define the pattern of the suitable stakeholder engagement.	
3) Discuss the appropriate date, time, place and hearing format with the company.	
(2) The responsible person for preparing the EIA report must organize the public hearing at least 2 times.	(2) Public hearing meeting
1) The 1st public hearing is held for opinions on the project proposal draft, project details, study scope and evaluation of project options. The objective of the hearing is to provide information to the public and related agencies on details of upcoming projects and their direct and indirect impacts, including the scope of study and evaluation of project options. Moreover, comments and suggestions from the hearing will be used in the study and the preparation of the complete report.	1) The 1st public hearing was a meeting to listen to opinions on the project proposal, project details, study scope which held on 21 - 25 May, B.E.2562(2019) (totally 7 stages).
2) The 2nd public hearing is held for comments on the preparation of drafted environmental impact	2) The 2nd public hearing is held for comments on the preparation of drafted environmental impact

Table 4.3-1 (Cont)

Public participation in the process of preparing the EIA report	Project participation activities
prevention and measures and environmental impact monitoring. The objective is to give the public confidence in the report and the measure. Comments and suggestions from the hearing will be used to improve the report and the measure and must be included as part of the report. For large and complex projects, a widely public hearing may be required. Other appropriate participatory techniques may be considered.	prevention and measures and environmental impact monitoring on 24 – 30 October, B.E.2562(2019) (totally 7 stages). In this regard, opinions from the public hearing was taken into account as parts of the report. In addition, an opinion survey was conducted to government agencies, community leaders and household representatives which was hold from 27 April- 30 November B.E.2562(2019).
In providing project information to stakeholders, responsible persons for preparing the report must provide relevant documents in a public place. It may also be distributed on the website for the public to access relevant documents quickly and easily.	Publicize project information by placing dissemination at government agencies and the website of the consulting company as follows. - Before the 1st meeting on 29 April - 3 May, B.E.2562(2019). - Summary of the 1st meeting conducting on 2-4 April, B.E.2562(2019). - Before the 2nd meeting on October 7-9, B.E.2562(2019). - Summary of the 2nd meeting on 12-14 November, B.E.2563(2020).

4.4 Stakeholder groups

For stakeholder analysis, the consulting company had consulted with community leaders and local government agencies during the public relations/ clarification of project information and discuss the process of participation. It was conducted between 18 - 21 February, B.E.2562(2019). The study area was preliminary identified within a radius of 5 kilometers from the project area. It covered areas where expecting to received directly and indirectly impacts which consisting of 10 villages of Hin Kong Sub district Administrative Organization, 8 villages of Huai Phai Sub district Administrative Organization, 6 villages of Chedi Hak Sub district Administrative Organization, 3 villages of Koh Phlapphla Sub district Administrative Organization, 3 villages of Don Tako Sub district Administrative Organization, 2 villages of Don Rae Sub district Administrative Organization, 2 villages of Khao Ngu Sub district Municipality as shown in **Figure4.4-1**. In addition, the project had invited communities outside the community in the study area within radius of 5 kilometers to participate in drafted reports and environmental impact prevention and measures and environmental impact monitoring of the project. Stakeholder groups were classified into 7 groups according to the Announcement of the Office of Natural Resources and Environmental Policy and Planning on guidelines for public participation in preparing the environmental impact assessment report, dated 8 January, B.E.2562, as shown in **Table 4.4-1.**

Table 4.4-1

Stakeholder group

Stakeholder group	Subgroup	Detail
Group 1: people who may be affected	People	0-3 km. in radius from the project location **1.1 Hin Kong SAO** 1) Moo 1 Ban Hin Kong 8 2) Moo 2 Ban Ruak Khwang 3) Moo 3 Ban Nong Ta Luang 4) Moo 4 Ban Nong Sadao Lang 5) Moo 5 Ban Nong Rak 6) Moo 6 Ban Nong Sadao Bon 7) Moo 7 Ban Huai Pla Duk 8) Moo 9 Ban Thung Lai Kai **1.2 Huai Phai SAO** 1) Moo 1 Ban Khao Khwang

Table 4.4-1 (continue)

Stakeholder group	Subgroup	Detail
		2) Moo 3 Ban Rak Makham 3) Moo 4 Ban Huai Phai 4) Moo 5 Ban Nakhonban 5) Moo 7 Ban Nong Din Daeng 6) Moo 9 Ban Nong Nam Khun **1.3 Chedi Hak SAO** 1) Moo 6 Ban Rang Mai Daeng 2) Moo 9 Ban Huai Mu **1.4 Ko Plub Pla SAO** 1) Moo 15 Ban Nong Song Hong **3-5 km. in radius from the project location** **1.5 Hin Kong SAO** 1) Moo 8 Ban Nong Yai Kata 2) Moo 10 Ban Nong Krathum **1.6 Huai Phai SAO** 1) Moo 6 Ban Nong Luang 2) Moo 8 Ban Nongkham **1.7 Chedi Hak SAO** 1) Moo 7 Ban Thung Po Bon 2) Moo 8 Ban Thung Tan 3) Moo 10 Ban Sa Sawat 4) Moo 12 Ban Khao Mo **1.8 Ko Plub Pla SAO** 1) Moo 6 Ban Huai Takhaeng Nai 2) Moo 7 Ban Thung Po Bon **1.9 Don Tako SAO** 1) Moo 8 Ban Khao Ngaem - Ban Klang Thung 2) Moo 9 Ban Khao Kaen Chan **1.10 Don Rae SAO** 1) Moo 2 Ban Na Nong 2) Moo 3 Ban Nongkam **1.11 Khaongu Municipality Office** 1) Ban Ton Mamuang Pattana 2) Somphum Pattana

Table 4.4-1 (continue)

Stakeholder group	Subgroup	Detail
Group 2: the agency responsible for preparing the environmental impact assessment report	- Project owner	- Hin Kong Power Company Limited
	- Environmental consulting company	- Consultants of Technology Company Limited
Group 3: agencies considering environmental impact assessment reports / licensing agencies	- EIA approval agency	- Office of Natural Resources and Environmental Policy and Planning (ONEP)
Group 4: government agencies at different levels	- Central level	- Pollution Control Department (PCD)
	- Regional level	- Regional Environment office 8th (Ratchaburi) - Regional Irrigation Office 13 - Office of the Energy Regulatory Commission Area 10 (Ratchaburi) - Office of the National Water Resources Region 2
	- Provincial level	- Ratchaburi Provincial Office - Ratchaburi Provincial Office of Natural Resources and Environment - Ratchaburi Provincial Energy Office - Ratchaburi Provincial Public Health Office - Ratchaburi Provincial Industry Office
		- Ratchaburi Office of Pubic Work and Town & Country Planning - Ratchaburi Hospital - Ratchaburi Provincial Agricultural Extension Office - Ratchaburi Provincial Security Administration Division - Ratchaburi Provincial Disaster Prevention and Mitigation Office - Ratchaburi Provincial Public Rations Department

Table 4.4-1 (continue)

Stakeholder group	Subgroup	Detail
		- Engineering Equipment Battalion 11 (Baruchat Camp) - Ratchaburi Irrigation Program - Ratchaburi Provincial Electricity Authority
	- District level	- Muang Ratchaburi District Office - Muang Ratchaburi District Health Office - Muang Ratchaburi Agricultural Extension Office - Muang Ratchaburi Police Station
	- Subdistrict level	- Hin Kong SAO - Huai Phai SAO - Chedi Hak SAO - Ko Plub Pla SAO - Don Tako SAO - Don Rae SAO - Khaongu Municipality Office - Huai Phai Tambon Health Promoting Hospital - Hin Kong Tambon Health Promoting Hospital - Chedi Hak Tambon Health Promoting Hospital - Don Tako Tambon Health Promoting Hospital - Don Rae Tambon Health Promoting Hospital - Ko Plab Pla Tambon Health Promoting Hospital - Khaongu Tambon Health Promoting Hospital
Group 5: environmental NGOs, NGOs, educational institute, and religious places	NGOs	- Thai Community Development Volunteer Leader Association - Rabbit in The Moon Foundation - Volunteer Network Association

Table 4.4-1 (continue)

Stakeholder group	Subgroup	Detail
	educational institute	- Ban Khao Kruat School - Wat Nong Krathum School - Kong Thabbok Upatham School - Wat Khao Ngu Santitham School - Wat Huai Pla Duk School - Wat Nong Talong School - Wat Arun Rattanakhiri School - Huai Phai School - Wat Haui Moo School
	religious institute	- Wat Khao Kruat - Wat Hin Kong - Wat Huai Pla Duk - Wat Nong Krathum - Wat Khao Ngu Santitham - Wat Nong Talong - Wat Haui Moo - Wat Nong Nam Khun - Wat Arun Rattanakhiri - Wat Huai Phai - Wat Nong Luang
Group 6: mass media	mass media	- Ratchaburi Journalist Association - Ratchaburi Public Relations Journalist Association - Ratchaburi News Association
Group 7: public who is interested in the project	public	-

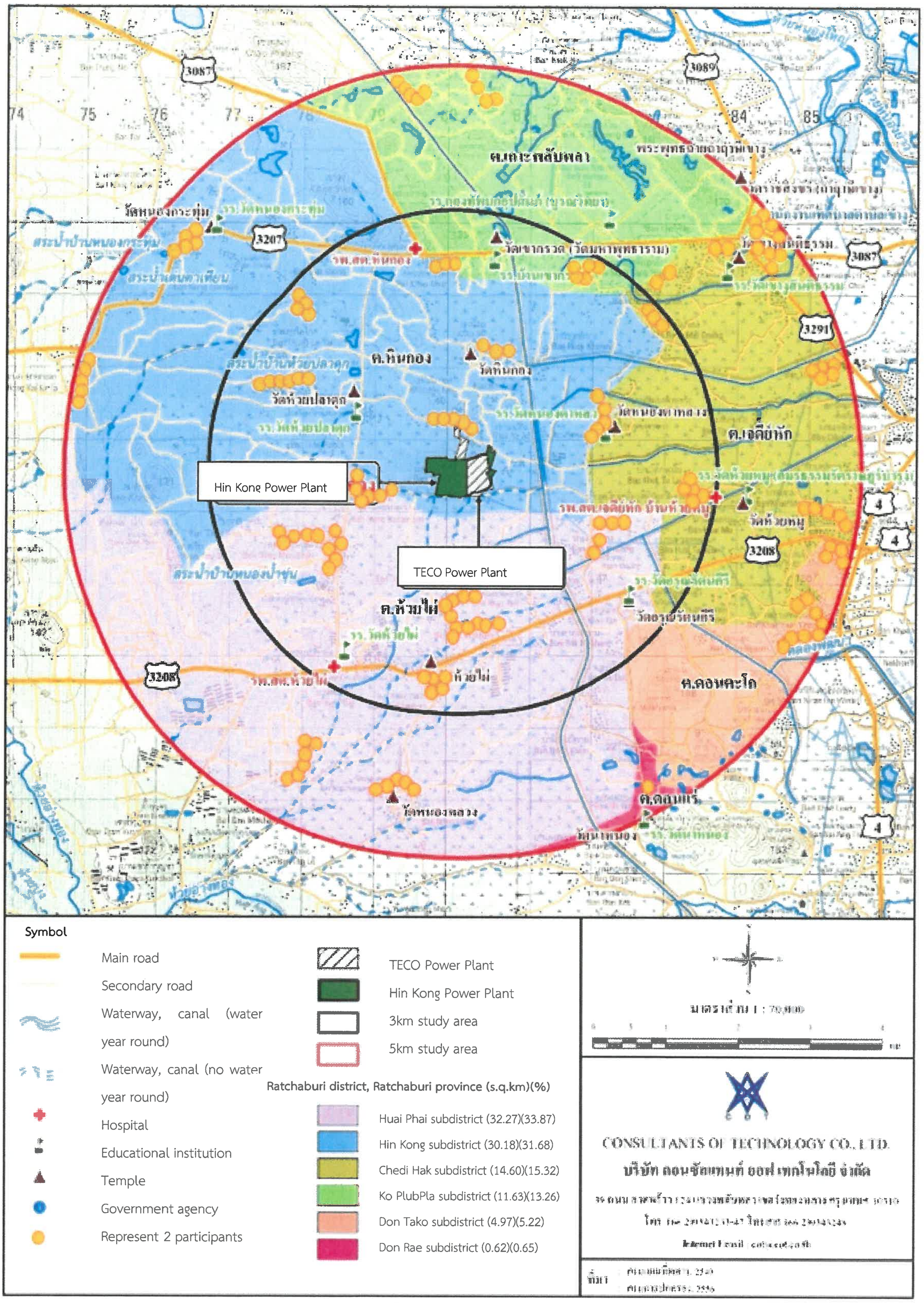


Figure 4.4-1 Location of the project and the surrounding communities

4.5 Operations on the public participation

4.5.1 Public relations/clarification of project information and discuss the process of participation

Visited to public relations the project to government agencies and community leaders by presenting brochures to promote the project and details of the preliminary project development. Suggestions/comments related to the public participation on February 18-21, B.E.2562, for the draft project proposal, project details, study scope and project alternative assessment were taken into account (**Figure4 .5 .1 -1**). Details of suggestions / concerns from agencies were summarized in **Table 4.5.1-1** (example of the project brochure as seen in **Appendix 4-1**, example of a copy of the letter requesting a visit to promote the project as seen in **Appendix 4-2**).

Former senators of Ratchaburi province

Representative from Ministry of Natural Resources and Environment of Ratchaburi province

Representative from Hin Kong Subdistrict Administrative organization (SAO)

Representative from Don Tako Subdistrict Administrative organization (SAO)

Representative from Khao Ngu Subdistrict Administration

Community leaders from Chedi Hak subdistrict

Figure 4.5.1-1 Public relations/clarification of project information and discuss the process of participation

Table 4.5.1-1
Summary of recommendations from public relations on project details and discussing on guidelines for organizing the 1st public hearing

Recommendations	Recommenders	Date/Time of visits
(1) Project details		
- The project should be prepared to clarify on Ratchaburi already has many power plants, why is the produced electricity sent to the South, not just distribution within Ratchaburi?	- Former Senator of Ratchaburi (Mr.Napintorn Srisunpang)	- Wednesday, 24 April B.E. 2562 - at 09.00
- The project should clarify that "Why does Ratchaburi, where many power plants are located, have frequent electricity failures?	- Chief Executive of Don Tako - Chief Administrator of Don Tako - Deputy Chief Administrator of Don Tako	- Firday, 26 April B.E. 2562 - at 13.30
	- Chief Executive of Don Rae	- Friday, 26 April B.E. 2562 - At 10.30
	- Assistant Headman, Moo.9 of Koh Phlapphla Sub district (representative of the village chief of Koh Phlapphla)	- Thursday, 25 April B.E. 2562 - at 10.30
- The project should present positive/negative impacts and environmental management of the project, in case of increasing the production capacity (focus on presenting a new environmental management system) to change public attitudes/images regarding environmental management.	- Chief Administrator of Chedi Hak	- Wednesday, 24 April B.E. 2562 - at15.00
- Besides cogeneration energy, does the project have an idea of using other energy sources, and are there any studies on alternative energy?	- Deputy Mayor of Khao Ngu Sub district	- Thursday, 25 April B.E. 2562 - at 09.00
	- Deputy Chief Administrator of Koh Phlapphla SAO - Chief of the Office of Koh Phlapphla SAO	- Thursday, 25 April B.E. 2562 - at 10.30

Table 4.5.1-1 (Conts)

Recommendations	Recommenders	Date/Time of visits
- Should explain the doubling of production capacity whether it is against urban planning law or not?	- Chief Executive of Don Tako - Chief Administrator of Don Tako - Deputy Chief Administrator of Don Tako	- Friday, 26 April B.E. 2562 - at 13.30
- Should explain the increase heat because people in the area worry about the heat that may affect the temperature in Ratchaburi.	- Former Senator of Ratchaburi (Mr.Napintorn Srisunpang)	- Wednesday, 24 April B.E. 2562 - at 09.00
	- Chief Administrator of Huai Phai SAO	- Friday, 26 April B.E. 2562 - at 09.00
	- Deputy Chief Administrator of Koh Phlapphla SAO - Chief of the Office of Koh Phlapphla SAO - Assistant Headman of Moo.9 of Koh Phlapphla Sub district (representative of village chief of Koh Phlapphla Sub district)	- Thursday, 25 April B.E. 2562 - at 10.30
	- Village chief of Chedi Hak Sub district - Headman of Moo.2, Moo.7, Moo. 13 of Chedi Hak Sub district	- Friday, 26 April B.E. 2562 - at 15.00
- Will the project reduce dust impacts or not?	- Former Senator of Ratchaburi (Mr.Napintorn Srisunpang)	- Wednesday, 24 April B.E. 2562 - at 09.00
- The project should provide a noise monitoring since people in the area have been affected, especially, in the Hin Kong area.	- Deputy District Chief of Mueang Ratchaburi District	- Wednesday, 24 April B.E. 2562 - at 10.30
- Should explain the noise from the production process in the event of a recent emergency.	- Chief Administrator of Huai Phai SAO	- Friday, 26 April B.E. 2562 - at 09.00
- Does the project operation affect the declining agricultural crops of the villagers? - Present to the public on environmental impacts, especially in agriculture.	- Former Senator of Ratchaburi (Mr.Napintorn Srisunpang)	- Wednesday, 24 April B.E. 2562 - At 09.00
	- Deputy Chief Administrator of Koh Phlapphla SAO - Chief of the Office of Koh Phlapphla SAO	- Thursday, 25 April B.E. 2562 - at 10.30

Table 4.5.1-1 (Conts)

Recommendations	Recommenders	Date/Time of visits
- The project should set guidelines / measures to compensate those affected by the project operation.	- Former Senator of Ratchaburi (Mr.Napintorn Srisunpang)	- Wednesday, 24 April B.E. 2562 - at 09.00
- The project should focus on giving people access and benefiting from the power development fund. "How to provide benefits to every household be?" - The project should present on the accountability and return benefits to the community.	- Deputy Chief Administrator of Koh Phlapphla SAO	- Thursday, 25 April B.E. 2562 - at 10.30
	- Chief Administrator of Huai Phai SAO	- Friday, 26 April B.E. 2562 - at 09.00
	- Chief of the Office of Koh Phlapphla SAO	- Thursday, 25 April B.E. 2562 - at 10.30
	- Assistant Headman of Moo.9 Koh Phlapphla Sub district (representative of village chief of Koh Phlapphla Sub district)	- Saturday, 27 April B.E. 2562 - at 09.00.
- Should clarify about the budget allocation from the power development fund to the people in the important / surrounding areas. - It should also describe the increasing process which increasing the power development fund, as this is something that people in the area pay attention to. - Should clearly explain the power development fund, especially the important area that is often understood to have a greater share than others.	- Energy Specialist, Senior Professor Level, Ratchaburi Provincial Energy Office	- Thursday, 25 April B.E. 2562 - at 13.30
	- Deputy District Chief of Mueang Ratchaburi District	- Wednesday, 24 April B.E. 2562 - at 10.30
	- Chief Administrator of Chedi Hak	- Wednesday, 24 April B.E. 2562 - at 15.00
	- Deputy Mayor of Khao Ngu Sub district	- Thursday, 25 April B.E. 2562 - at 09.00
- Should clarify or revise the power development fund regulations whether who should propose for the budget from the fund between the local government organization and administrative. - For the budget allocation of power development fund, there should be a separate budget and the	- Chief Executive of Don Tako - Chief Administrator of Don Tako - Deputy Chief Administrator of Don Tako	- Friday, 26 April B.E. 2562 - At 13.30
	- Chief Executive of Don Rae SAO	- Friday, 26 April B.E. 2562 - at 10.30

Table 4.5.1-1 (Conts)

Recommendations	Recommenders	Date/Time of visits
local authority shall manage by itself in the form of a local committee.		
- Should prepare an answer that "What will the people get" when increasing production capacity, such as reducing electricity bills?	- Village chief of Chedi Hak Sub district - Headmen of Moo.2, Moo.7, Moo.13 of Chedi Hak Sub district	- Friday, 26 April B.E. 2562 - at 15.00
- Should support the local government organization on the power development fund for disaster prevention and mitigation in the area, especially, Khao Ngu Sub-district Municipality that has never received a budget from the power development fund. On the other hand, when an emergency occurred in the municipality, Khao Ngu Sub-district Municipality must be responsible for suppressing such events.	- Deputy Mayor of Khao Ngu Sub district	- Thursday, 25 April B.E. 2562 - at 09.00
- The project should focus on employment of local people as a priority.	- Chief Administrator of Huai Phai SAO	- Friday, 26 April B.E. 2562 - at 09.00
- The project should adjust the landscape and add more green zones in the project.	- Chief Administrator of Huai Phai SAO	- Friday, 26 April B.E. 2562 - at 09.00
(2) Organizing the public participation process		
- For a public hearing meeting, the project should separately organized for each district / area. Therefore, people in the area can fully participate and easily control the meeting process.	- Energy Specialist, Senior Professor Level, Ratchaburi Provincial Energy Office	- Thursday, 25 April B.E. 2562 - at 13.30
- The project should conduct public relations in all villages. Requesting to add more public relations to Moo.7 and Moo.8, since it is also an area in the radius of the project.	- Chief Executive of Don Tako - Chief Administrator of Don Tako - Deputy Chief Administrator of Don Tako	- Friday, 26 April B.E. 2562 - at 13.30

Table 4.5.1-1 (Conts)

Recommendations	Recommenders	Date/Time of visits
- Should provide opportunities for the public sector to participate in environmental quality measurement, starting from the selection of the company for the measurement, study plan and monitoring the environment. - Should meet and build understanding with local leaders. To enable local leaders to understand with local NGOs, especially in Hin Kong Sub district. - Should clarify and build understanding with the people in the area, in addition to the radius of 3 kilometers (according to the former EIA), on details of the project operation. - Should continuously focus on building understanding with people in the area, in order to reduce anxiety and build confidence. - Should build understanding with the Mae Klong River Basin Conservation Group and people of Hin Kong area, in order to create mutual understanding. - The project should focus on public relations and build understanding with the village headman of Hin Kong Sub district.	- Former Senator of Ratchaburi (Mr.Napintorn Srisunpang)	- Wednesday, 24 April B.E. 2562 - at 09.00
	- District Chief of Ratchaburi District - Deputy District Chief of Muang Ratchaburi District	- Wednesday, 24 April B.E. 2562 - at 10.30
	- Deputy Chief Administrator of Koh Phlapphla - Chief of the Office of Koh Phlapphla	- Thursday, 25 April B.E. 2562 - at 10.30
	- Chief Administrator of Huai Phai SAO	- Friday, 26 April B.E. 2562 - at 09.00
	- Chief Executive of Don Rae	- Friday, 26 April B.E. 2562 - at10.30
	- Village chief of Don Tako Sub district	- Friday, 26 April B.E. 2562 - at 13.30
- Projects should support travel expenses for participants (citizens 500 baht / community leaders 1,000 baht).	- Deputy Chief Executive of Hin Kong SAO	- Thursday, 25 April B.E. 2562 - at 15.00

4.5.2 Organizing a public hearing meeting on the draft project proposal, project details, study scope and project alternative assessment (PP1)

Before the 1st public hearing meeting, the consulting company met with government agencies and community leaders in the area on February 18-21, B.E.2562 to discuss the date, time and place of the meeting. Details were shown in **Table 4.5.2-1.**

Table 4.5.2-1

Summary of consultation on the date, time and place of the public participation meeting

Areas, date, time and place of the meeting	Recommenders
- **Stage 1 Hin Kong SAO** On Tuesday, 21 May, B.E.2562, during 08.30 - 12.00 hrs, at the meeting room of Hin Kong SAO (as a government office and government agencies were informed)	- Deputy Chief Executive of Hin Kong SAO - Village chief of Hin Kong Sub district
Stage 2 Huai Phai SAO On Tuesday, 21 May, B.E.2562, during 08.30 - 12.00 hrs, at the meeting room of Huai Phai SAO (it was a center point and able to accommodate a large number of people).	- Chief Administrator of Huai Phai SAO - Village chief of Huay Phai Sub district
- **Stage 3 Koh Phlapphla SAO** On Wednesday, 22 May, B.E.2562, during 08.30 – 12.00 hrs., at the multipurpose pavilion of Koh Phlapphla SAO (the location was convenient/ center point).	- Deputy Chief Administrator of Koh Phlapphla SAO - Chief of the Office of Koh Phlapphla SAO - Assistant Headman of Moo.9, Koh Phlapphla Sub district (representative of a village headman of Koh Phlapphla Sub district)
- **Stage 4 Chedi Hak SAO** On Wednesday, 22 May, B.E.2562, during 18.00 - 21.00 hrs, at SML pavilion of Moo.3, Chedi Hak Sub district (the location was convenient/ center point and should arranged the meeting	- Chief Administrator of Chedi Hak SAO - Village headman of Chedi Hak Sub district

Table 4.5.2-1 (conts)

Areas, date, time and place of the meeting	Recommenders
in the evening for people in the area were convenient during this time).	- Headman of Moo.2, Moo.7, Moo.13 of Chedi Hak Sub district
- **Stage 5 Don Rae SAO** On Thursday, 23 May, B.E.2562 during 14.00 - 16.30 hrs, at the multipurpose pavilion of Wat Na Nong, Don Rae Sub district (because it was convenient, comfortable and could accommodate large numbers of people).	- Chief Executive of Don Rae SAO - Village chief of Don Rae Sub district
- **Stage 6 Khao Ngu Sub district Municipality** On Friday 24 May, B.E.2562 during 08.30 - 12.00 hrs, at the community learning center of Khao Ngu Sub district Municipality (due to the wide space and could accommodate a large number of people).	- Deputy Mayor of Khao Ngu Sub district Municipality
- **Stage 7 Don Tako SAO** On Saturday 25 May, B.E.2562 during 08.30 - 12.00 hrs, at the SML pavilion of Moo.8, Don Tako Sub district (due to most people in the area were convenient on holidays and a meeting place located near the affected group).	- Chief Executive of Don Tako SAO - Chief Administrator of Don Tako SAO - Deputy Chief Administrator of Don Tako SAO - Village chief of Don Tako Sub district

4.5.2.1 Invitation and dissemination of the schedule of the 1st public hearing meeting

(1) Delivering the invitation letter to stakeholders directly along with brochures to promote the project, meeting schedule and meeting acceptance. It was done during 29 April - 3 May, B.E.2562 (example of a copy of the 1st meeting invitation as seen in **Appendix 4-3**).

(2) Installing signs to publicize the meeting in important areas of the community and government agencies where such signs could be easily seen by the public. This was done during 29 April - 3 May, B.E.2562, as shown as **Figure 4.5.2.1-1**.

(3) Notification of the meeting schedule along with publishing documents for the project through the website of Consultants of Technology Co., Ltd., www.cot.co.th, which as seen as **Figure4.5.2.1-2.**

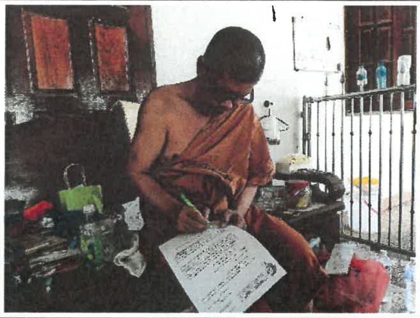
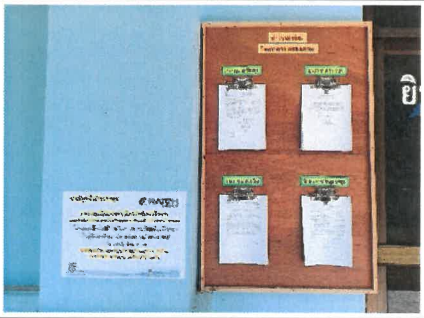
	
	
To a direct stakeholder	
	
Hin Kong SAO	Don Rae SAO
	
Wat Arun Rattanakhiri School	Khaongu Tambon Health Promoting Hospital

Figure 4.5.2.1-1 Publication of the 1st public hearing schedule in the communities

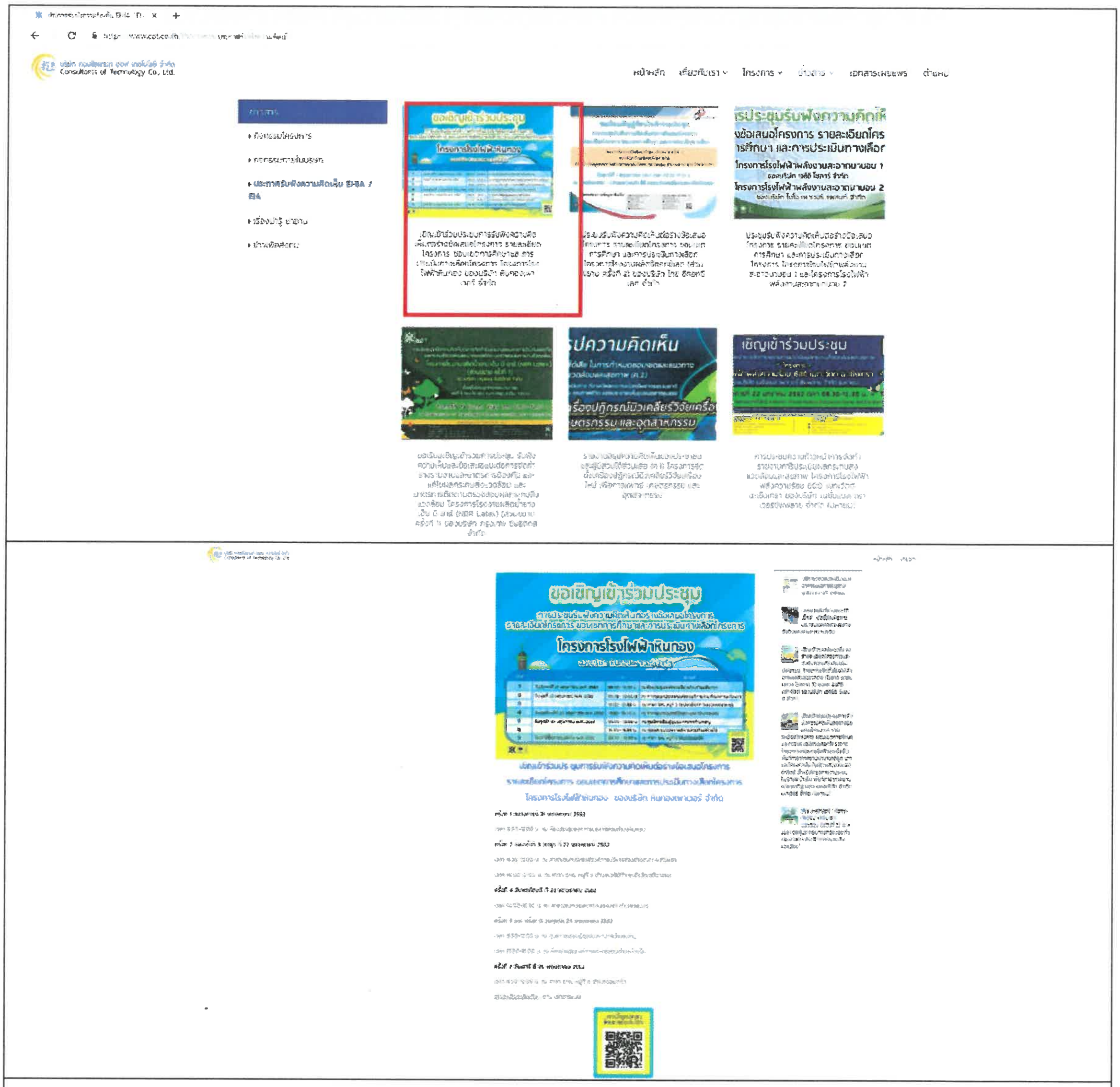


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Figure 4.5.2.1-2 Online publication of the 1st public hearing schedule and documents

4.5.2.2 Process of the 1st public hearing meeting

The project had organized the 1st public hearing meeting during 21 - 25 May, B.E.2562, for totally 7 stages. There were 774 participants (project owners and consulting company were excluded), as seen in **Table 4.5.2.2-1**. Participants were classified their position as seen in **Table 4.5.2.2-2**. The atmosphere of the first public hearing meeting as shown in **Figure4.5.2.2-2**. Concerns and important recommendations for the project as seen in **Table 4.5.2.2-3** and **Table 4.5.2.2-4** (supporting documents for the 1st meeting, as seen in **Appendix 4-4,** copy of the registration for the 1st meeting was shown in **Appendix 4-5** and an evaluation form after the 1st meeting as shown in **Appendix 4-6).**

Table 4.5.2.2-1
Details on the opinions of the 1st public meeting

Date-month-year	Time	Location	Number of participant (people)
Tuesday, 21 May B.E. 2562	08.30-12.00	Meeting room of Hin Kong Subdistrict Administrative Organization, Ratchaburi district, Ratchaburi province	159
Wednesday, 22 May B.E. 2562	08.30-12.00	Meeting room of PlubPla Subdistrict Administrative Organization, Ratchaburi district, Ratchaburi province	88
	18.00 - 21.00	SML pavilion Moo 3, Chedi Hak subdistrict, Ratchaburi district, Ratchaburi province	113
Thursday, 23 May B.E. 2562	14.00 - 16.30	Wat Na Nong Multipurpose pavilion, Don Rae subdistrict, Ratchaburi district, Ratchaburi province	74
Friday, 24 May B.E. 2562	08.30–12.00	Learning center of Khao Ngu subdistrict, Ratchaburi district, Ratchaburi province	117
	13.30–16.00	Meeting room of Huai Phai Subdistrict Administrative Organization, Ratchaburi district, Ratchaburi province	111
Saturday, 25 May B.E. 2562	08.30-12.00	SML pavilion Moo 8, Don Tako subdistrict, Rat Ratchaburi district, Ratchaburi province	112
Total Participants			**774**

Remark : Not including consultant company and the project staffs

Table 4.5.2.2-2

Details on 1st public hearing on project's objective, details, study scope, and choices assessment of the Hin Kong Power Plant Project of Hin Kong Power Co.,Ltd

Participants	Rank	Amount (ppl)
1 Affected party *Hin Kong Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi Province*		
- Moo 1 Ban Hin Kong 8	- Village Headman	1
	- Assisstant Village Headman	2
	- Subdistrict Administrative Organization Council member	1
	- Resident	1
- Moo 2 Ban Ruakkwang	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	2
	- Residnet	2
- Moo 3 Ban Nong Taluang	- Village Headman	1
	- Assistant Village Headman	2
	- Village Committee	1
	- Subdistrict Administrative Organization Council member	2
	- Subdistrict Headman	1
	- Resident	3
- Moo 4 Ban Nong Sadao Lang	- Village Headman	1
	- Assistant Village Headman	1
	- Subdistrict Administrative Organization Council member	2
	- Resident	10
- Moo 5 Ban Nong Ruk	- Village Headman	1
	- Assistant Village Headman	2
	- Village Committee	1
	- Subdistrict Administrative Organization Council member	2
	- Resident	4

Table 4.5.2.2-2(cont)

Participants	Rank	Amount (ppl)
- Moo 6 Ban Nong Sadao Bon	- Village Headman	1
	- Assistant Village Headman	2
	- Village Committee	1
	- Subdistrict Administrative Organization Council member	2
	- Public Health volunteer	2
	- Resident	4
- Moo 7 Ban Huai Pladuk	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	1
	- Resident	8
- Moo 8 Ban Nong Yai Ga Ta	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	2
	- Resident	6
- Moo9 Ban Thung Lai Gai	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Headman	1
	- Subdistrict Administrative Organization Council member	1
	- Village Committee	1
	- Resident	9
- Moo 10 Ban Nong Kra Thum	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	2
	- Village Committee	2
	- Resident	3
Huai Phai Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi Province		
- Moo1 Ban Khao Kwang	- Village Headman	1
	- Assistant Village Headman	1

Table 4.5.2.2-2(cont)

Participants	Rank	Amount (ppl)
	- Subdistrict Administrative Organization Council member	1
	- Public Health volunteer	2
	- Village Committee	1
	- Resident	4
- Moo 3 Ban Lak Makarm	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	3
	- Public Health volunteer	2
	- Resident	3
- Moo 4 Ban Huai Phai	- Village Headman	1
	- Subdistrict Administrative Organization Council member	2
	- Village Committee	3
	- Subdistrict doctor	1
	- Public Health volunteer	1
	- Resident	2
- Moo 5 Ban Nakron Barng	- Village Headman	1
	- Assistant Village Headman	2
	- Village Committee	2
	- Subdistrict Administrative Organization Council member	1
	- President of Women Majority	1
	- Public Health volunteer	2
- Moo 6 Ban Nong Luang	- Village Headman	1
	- Assistant Village Headman	1
	- Village Committee	3
	- Public Health volunteer	1
	- Resident	3
- Moo 7 Ban Nong Din Dang	- Village Headman	1
	- Subdistrict Administrative Organization Council member	2
	- Public Health volunteer	1

Table 4.5.2.2-2(cont)

Participants	Rank	Amount (ppl)
	- Resident	5
- Moo 8 Ban Nong Karm	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	2
	- Public Health volunteer	1
	- President of Women Majority	2
	- Village Committee	3
- Moo 9 Ban Nong Nam Kun	- Village Headman	1
	- Assistant Village Headman	2
	- Village Committee	3
	- Subdistrict Administrative Organization Council member	1
	- Resident	3
Chedi Hak Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi Province		
- Moo 6 Ban Rang Mai Dang	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	2
- Moo 7 Ban Thung Por Bon	- Village Headman	1
	- Assistant Village Headman	2
	- Village Committee	3
	- Resident	4
- Moo 8 Ban Thung Tarn	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	1
	- Village Committee	3
	- Resident	2
Moo 9 Ban Huai Moo	- Assistant Village Headman	1
	- Vice-president of the housewives group	1
	- Housewives group's secretary	1

Table 4.5.2.2-2(cont)

Participants	Rank	Amount (ppl)
- Moo 10 Ban Sra Swat	- Subdistrict Administrative Organization Council member	2
	- Resident	5
	- Village Headman	1
	- Village Committee	1
	- Subdistrict doctor	1
- Moo 12 Ban Khao Mor	- Village Headman	1
	- Assistant Village Headman	1
	- Resident	2
Plub Pla Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi Province		
- Moo 6 Ban Huai Ta Kang Nai	- Assistant Village Headman	1
	- Public Health volunteer	1
	- Village Committee	1
	- Resident	8
- Moo 7 Ban Toom Por Bon	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	1
	- Public Health volunteer	2
	- Resident	2
- Moo 15 Ban Nong Song Hong	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	1
	- Village Committee	3
	- Resident	2
Don Tako Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi Province		
- Moo 8 Ban Khao Ngam- Ban Glang Thung	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	1

Table 4.5.2.2-2(cont)

Participants	Rank	Amount (ppl)
	- President of Women's Majority	1
	- Public Health volunteer	1
	- Resident	6
- Moo 9 Ban Khao Gan Jao	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	2
	- Public Health volunteer	2
	- Village Committee	3
Don Rae Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi Province		
- Moo 2 Ban Na Nong	- Village Headman	1
	- Resident	1
Khao Ngu Subdistrict Municipal of Ratchaburi district, Ratchaburi Province		
- Ban Ton Mamuang Pattana Community	- Village Headman	1
	- Assistant Village Headman	2
	- Subdistrict Administrative Organization Council member	1
	- Resident	6
- Sompoon Pattana Community	- Community's Chariman	1
	- Community Committee	2
	- Public Health volunteer	2
	- Resident	4
	Total	**296**
2 Agency responsible for writing Environmental Impact Assessment report		
- Hin Kon Power co.,Ltd		6
- Consultants of Techonology Co.,Ltd		7
	Total	**13**
3 Agency responsible for assessing the Environmental Impact Assessment report		
	Total	**0**

Table 4.5.2.2-2(cont)

Participants	Rank	Amount (ppl)
4 Government agencies at different levels		
4.1 Regional Agency		
- Energy Regulatory Commission zone 10	- Department director	1
	- Specialist	1
	- Academic staff*	1
	- engineer*	1
	- Assisstant Director*	1
- Regional Environment Office 8	- Director of Environmental Quality Control	1
- Office of Regional Irrigation 13	- Irrigation engineer	1
4.2 Provincial Agency		
- Ratchaburi Office	- Provincial Office Chief	1
- Provincial Inernal Secutiry Operations Command	- Deputy Director	1
	- Head of News department	1
- Ratchaburi Office of Disaster Prevention and Mitigation	- Policy and Specialized Plan Analyst	1
- Ratchaburi Ministry of Energy	- Energy Specialist Scholar*	1
- Ratchaburi Office of Natural Resources and Environmental Policy and Planning	- Director Representative	1
	- Project Staff	1
- Ratchaburi Office of Public Work and Town & Country Planning	- City Planner	1
4.3 District Agency		
- Mueng Ratchaburi District	- District Chief	1
	- Deputy District Chief*	3
4.4 Local Authorities		
- Hin Kong Subdistrict Administrative Organization	- Deputy Chairman of the Subdistrict Administrative Organization	1
	- Deputy Permanent Secretary of the Subdistrict Administrative Organization	2
	- Permanent Secretary of the Subdistrict Administrative Organization	1

Table 4.5.2.2-2(cont)

Participants	Rank	Amount (ppl)
	- Secretary of the Chairman of the Subdistrict Administrative Organization	1
	- Educational Department Director	1
	- Head of General Administration	1
	- Head of Educational Administration	1
	- Educational Academician	2
	- Community Developer	1
	- Legal officer	1
	- Financial Academician	1
	- Administrative Officer	1
	- Electrician Staff	1
	- Genral Staff	5
	- Genral employee	4
	- Not specified	1
- Kor PlubPla Subdistrict Administrative Organization	- Permanent Secretary Head	1
	- Administrative Officer	1
	- Administrative Officer Helper	1
- Chedi Hak Subdistrict Administrative Organization	- Director of Public Health	1
	- Policy and Planning Analyst	1
- Don Rae Subdistrict Administrative Organization	- Chairman of Subdistrict Administrative Organization - Deputy Permanent Secretary of Subdistrict Administrative Organization	1
- Khao Ngu Subdistrict Municipality	- Head of Public Health Service	1
	- Administrative Straff	1
- Huai Phai Subdistrict Administrative Organization	- Deputy Chairman of Subdistrict Administrative Organization	2
	- Secretary of Chairman of Subdistrict Administrative Organization	1

<u>Table 4.5.2.2-2(cont)</u>

Participants	Rank	Amount (ppl)
- Don Tako Subdistrict Administrative Organization	- Permanent Secretary of Subdistrict Administrative Organization	1
	- Chairman of Subdistrict Administrative Organization	1
	- Deputy Permanent Secretary of Subdistrict Administrative Organization	1
- Hin Kong Health Promoting Hospital	- Director	1
- Kor PlubPla Health Promoting Hospital	- Director	1
	- Public Heatlh Officer	1
- Khao Ngu Health Promoting Hospital	- Public Heatlh Officer	1
- Chedi Hak Health Promoting Hospital	- Director	1
- Don Rae Health Promoting Hospital	- Director	1
- Huai Phai Health Promoting Hospital	- Director	1
	Total	**66**
5 Independent Organization/Private Organization/Education Institution/Religious Institution		
- Wat Nong Grathum School	- Director	1
- Wat Nong Ta Luang School	- Director	1
	- Not specified	1
- Wat Huai Moo School	- Teacher	1
- Wat Khao Ngu Suntitum School	- Director	1
- Wat Arun Rattana Siri School	- Director	1
- Wat Huai Phai School	- Teacher	1
- Wat Nong Grathum	- Abbot Assistant	1
- Hin Kong Temple	- Not specified	1
- Thailand Department Volunteer Network Association	- Association's President*	1
	- member*	4
	Total	**14**

Table 4.5.2.2-2(cont)

Participants	Rank	Amount (ppl)
6 Mass Media/ Public		
- Mass Media Association	- News reporter	1
- Siamrath	- News reporter *	3
- Thairath	- News reporter	1
- Thairath newspaper	- News reporter	2
- Tourism Social Press Association	- Association President	1
	- News reporter	2
- Thai Radio and Television Channel 3	- News reporter	1
- Newspaper, 7	- Editor	1
	- News reporter	1
- MONO 29	- News reporter	1
- Luk Muang Newspaper	- Association President	1
- Ratchaburi Economic Reporter Association	- Vice president	1
- Kao Sod Newspaper	- News reporter	1
	Total	**17**
7 Interested Citizens		
- Moo 11 Ban Thung Noi, Hin Kong Subdistrict		12
- Moo 2 Ban Khao Tum Kun Chorn, Huai Phai Subdistrict		11
- Moo 2 Ban Nong Jae, Chedi Hak Subdistrict		9
- Moo 3 Ban Chedi Hak, Chedi Hak Subdistrict		14
- Moo 4 Ban Aran Yik , Chedi Hak Subdistrict		8
- Moo 5 Ban Nong Jork , Chedi Hak Subdistrict		7
- Moo 11 Ban Chedi Hak Nork , Chedi Hak Subdistrict		13
- Moo 13 Ban Samakki , Chedi Hak Subdistrict		9
- Moo 14 Ban Garn Keha , Chedi Hak Subdistrict		2
- Moo 8 Ban Kor Loi , Kor Plub Pla Subdistrict		2
- Moo 9 Ban Na , Kor Plub Pla Subdistrict		11
- Moo 10 Ban Chong Ma Glum , Kor Plub Pla Subdistrict		10
- Moo 11 Ban Khao Suan Luang , Kor Plub Pla Subdistrict		11

Table 4.5.2.2-2(cont)

Participants	Rank	Amount (ppl)
- Moo 12 Ban Huai Ja Pa , Kor Plub Pla Subdistrict		2
- Moo 2 Ban Khao Mor , Don Tako Subdistrict		11
- Moo 3 Ban Don Tako , Don Tako Subdistrict		12
- Moo 4 Ban Don Jang , Don Tako Subdistrict		10
- Moo 5 Ban Mhai , Don Tako Subdistrict		14
- Moo 6 Ban Nakorn Barn , Don Tako Subdistrict		10
- Moo 7 Ban Khao Loi- Khao Luang , Don Tako Subdistrict		11
- Moo 10 Ban Suan Dork Mai , Don Tako Subdistrict		11
- Moo 1 Ban Don Rae , Don Rae Subdistrict		2
- Moo 3 Ban Nong Kham , Don Rae Subdistrict		6
- Moo 4 Ban Don Sak , Don Rae Subdistrict		5
- Moo 5 Ban Don Tan , Don Rae Subdistrict		7
- Moo 6 Ban Don Kork , Don Rae Subdistrict		8
- Moo 7 Ban Nong Sra , Don Rae Subdistrict		1
- Moo 8 Ban Nong Prong , Don Rae Subdistrict		6
- Moo 9 Ban Nong Ma Toom , Don Rae Subdistrict		6
- Moo 10 Ban Huai , Don Rae Subdistrict		9
- Ruamjai Pattana Community, Khao Ngu Subdistrict Municipality		11
- Kor PlubPla Pattana Community, Khao Ngu Subdistrict Municipality		11
- Ban Huai Ta Kang Community, Khao Ngu Subdistrict Municipality		13
- Ban Kok Hin Community, Khao Ngu Subdistrict Municipality		10
- Ban Nai Pattana Community, Khao Ngu Subdistrict Municipality		16
- Nueng Sarm Pattana Community, Khao Ngu Subdistrict Municipality		7
- Ban Tako Community, Khao Ngu Subdistrict Municipality		10
- General interested citizens		8
	Total	341
	Total[1/]	734

Source : Gathered by Consultants of Technology Co.,Ltd, B.E. 2563

Remark : 1/ Total number of participants (not including project owners and consultant company)

* Participate in more than one stage

Stage 1 Hin Kong Subdistrict Administrative Organization's area

Atmosphere during registration

Atmosphere during registration

Mr. Ronapop Wiangsima
Ratchaburi District Chief
Is the president for this meeting

Consultant company presenting project's details

Participants offering opinions / suggestions

Participants offering opinions / suggestions

Figure 4.5.2.2-1 The 1st Public Hearing

Stage 2 Kor PlubPla Subdistrict Administrative Organization's area	
	
Atmosphere during registration	Atmosphere during registration
	
Colonel Pongsawat Pachanatip, Deputy Director of Ratchaburi Internal Security Operation Command, acts as president to start off the meeting	Consultant company presenting project's details
	
	
Participants offering opinions / suggestions	Participants offering opinions / suggestions

Figure 4.5.2.2-1(cont) The 1st Public Hearing

Stage 3 Chedi Hak Subdistrict Administrative Organization's area	
	
Atmosphere during registration	Atmosphere during registration
	
Ms. Tuptim Sinsoontorn, representative from Ratchaburi Office of Natural Resources and Environment, acts as the president to start off the meeting	Consultant company presenting project's details
	
Overall atmosphere	
	
Participants offering opinions / suggestions	Participants offering opinions / suggestions

Figure 4.5.2.2-1(cont) The 1st Public Hearing

Stage 4 Don Rae Subdistrict Administrative Organization's area	
	
Atmosphere during registration	Atmosphere during registration
	
Consultant company presenting project's details	Overall atmosphere
	
	
Participants offering opinions / suggestions	Participants offering opinions / suggestions

Figure 4.5.2.2-1(cont) The 1st Public Hearing

<u>Stage 5 Khao Ngu Subdistrict Municipality area</u>

Atmosphere during registration

Atmosphere during registration

Mr. Chaichart Chaipimon, Head of Ratchaburi Office, acts as president to start off the meeting

Consultant company presenting project's details

Participants offering opinions / suggestions

Participants offering opinions / suggestions

<u>Figure 4.5.2.2-1(cont)</u> The 1st Public Hearing

Stage 6 Huai Phai Subdistrict Administrative Organization	
	
Mr. Chaichart Chaipimon, Head of Ratchaburi Office, acts as president to start off the meeting	Consultant company presenting project's details
	
Overall atmosphere	
	
	
Participants offering opinions / suggestions	Participants offering opinions / suggestions

Figure 4.5.2.2-1(cont) The 1st Public Hearing

Stage 7 Don Tago Subdistrict Administrative Organization's area	
	
Atmosphere during registration	Atmosphere during registration
	
Mr. Krirk Munkong, representative from Ratchaburi Office of Energy, acts as president to start off the meeting	Consultant company presenting project's details
	
	
Participants offering opinions / suggestions	Participants offering opinions / suggestions

Figure 4.5.2.2-1(cont) The 1st Public Hearing

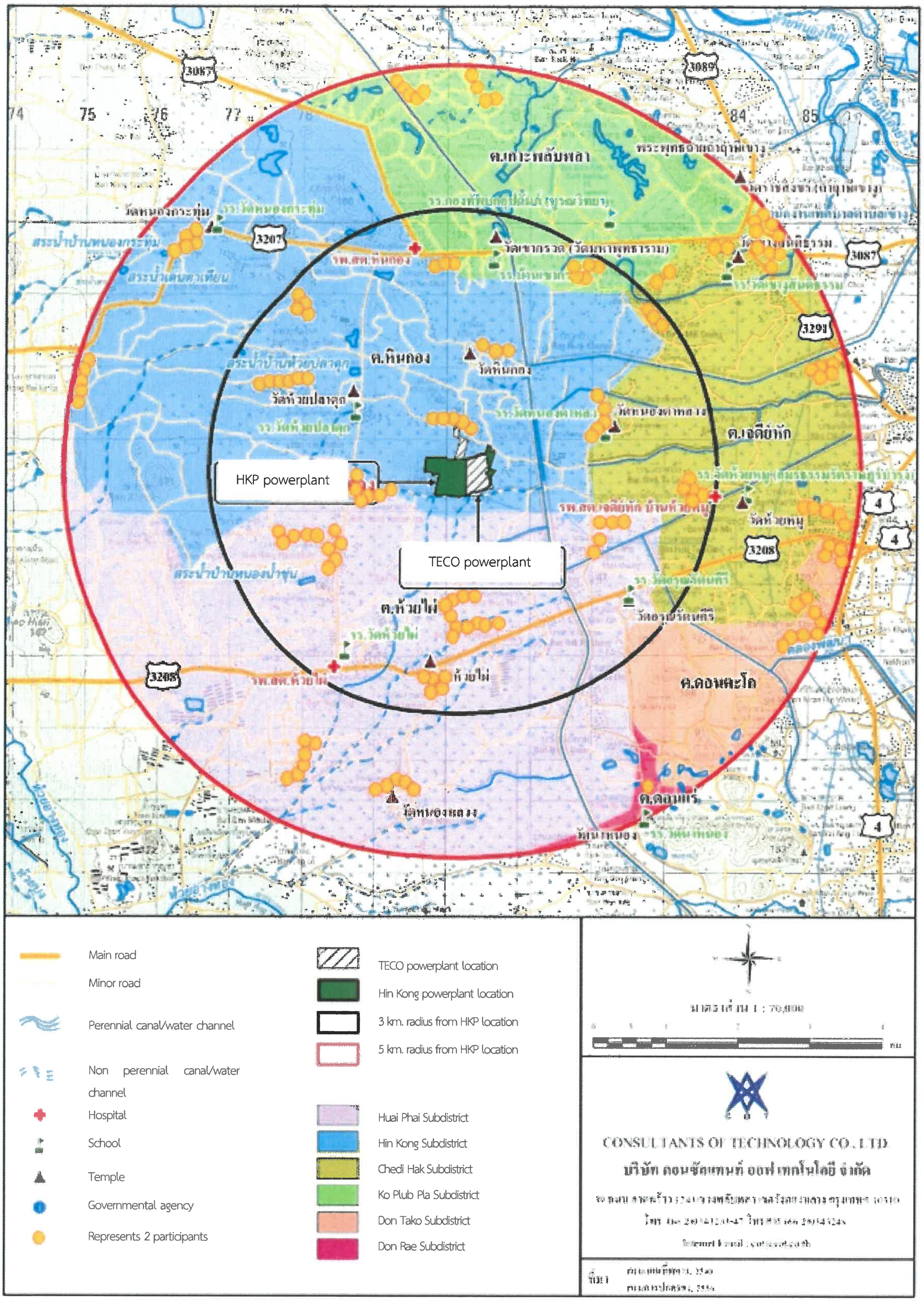


Figure 4.5.2.2-2 Distribution of participants of PP1 in each area

Table 4.5.2.2-3

Summarization of worries from the 1st public hearing categorized by stages

Consideration point	Opinion from each area						
	0-3 km radius			3-5 km radius			
	Hin Kong SAO	Huai Phai SAO	Chedi Hak SAO	Kor Plub Pla SAO	Don Tako SAO	Don Rae SAO	Khao Ngu SAO
1. Project details							
1.1 Location and project's importance		✓		✓		✓	
1.2 Technology		✓		✓		✓	
1.3 Impacts and past/previous operations	✓	✓					✓
1.4 Trust in project	✓	✓	✓		✓		
2. Environmental aspect							
2.1 dust particles		✓		✓		✓	
2.2 disturbance noise	✓	✓					
2.3 heat	✓	✓		✓	✓		✓
2.4 smog/ smoke	✓						
3.Public Health		✓			✓		✓
4. Safety		✓					
5. Sludge,waste, and trashes		✓			✓		
6. Water treatment and management					✓		
7. Economic aspect/social and human relation	✓	✓		✓	✓		✓

Table 4.5.2.2-3(cont)

Consideration point	Opinion from each area						
	0-3 km radius			3-5 km radius			
	Hin Kong SAO	Huai Phai SAO	Chedi Hak SAO	Kor Plub Pla SAO	Don Tako SAO	Don Rae SAO	Khao Ngu SAO
8.Fund for development	✓			✓	✓		✓
9. Others such as social problem and various utilities	✓	✓	✓		✓	✓	
10. Environmental impact assessment study		✓			✓		✓

Table 4.5.2.2-4

Summary of concerns and suggestions from the 1st public hearing.

Questions / Suggestions	Clarifications
(1) Project details	
1) Location and necessity of the project	
- Was this a new construction power plant or renovated one? **(Community leader : Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, media representative)**	- It was a new construction in the area of the current TECO power plant **(Environmental expert: Consultant of Technology Co.,Ltd).**
- Why did you have to build a power plant in Ratchaburi ? **(Community leader : Moo.12, Ban Huay Champa, Koh Phlapphla Sub district. Community leader: Moo.10, Ban Chong Maklam, Koh Phlapphla Sub district, Government agency: representative of Muang Ratchaburi District, Government: representative of Don Rae SAO, media representative, question sheet: Huai Phai Sub district).**	- The reason for the establishment of the power plant at Ratchaburi was because the electricity capacity of 5,581 MW of the western region in the next 4-5 years will be lost from the system. Thing that needs to be done in advance is to plan ahead to accommodate the lost capacity. For the establishment of a power plant, it must take into account the suitability of the area, for example, why coal power plant must be built next to the sea? Because a lot of water is required for cooling. Why do we have to build a gas power plant in Ratchaburi? Due to the original gas transmission line which, if the construction occurred in new areas, the investment in these matters will reflect as electricity bills. Therefore, in order to reduce these costs, it will indirectly reduce the burden of the people. **(Environmental expert: Consultant of Technology Co.,Ltd).**
- Where was electricity produced form the plant sent to? **(Community leader : Moo.12 Ban Huay Champa, Koh Phlapphla Sub district, Government agency: representative of Don Rae SAO,**	- <u>Additional clarification</u> The project implemented the operation in accordance with the Power Development Plan of Thailand, B.E. 2561-2580 by the Ministry of Energy, in order to replace the power generation capacity that will be

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
government agency: representative of Huai Phai Sub District Health Promoting Hospital).	depleted from the TECO plant on the TECO area. The said area was ready and suitable for the transmission system, fuel and raw water systems. **(Environmental expert: Consultant of Technology Co.,Ltd).**
- Was there any expansion of the project area? **(Community leader : Moo.6,Ban Nong Luang, Huai Phai Sub district, media representative)**	- The project uses the same space. There was no additions or extensions in any way. **(Environmental expert: Consultant of Technology Co.,Ltd).**
2) Technology	
- Concerns on impacts during construction as it had been affected by the previous power plant, therefore the old power plant should be improved and installed new machines instead. **(Community leader : Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district)**	- Due to the efficiency of the original power plant was an older model 20 years ago, if compared to the car, it was an old car. When the project build a new power plant, it will be built on the existing vacant space within the TECO power plant. For flood issues, the project accepts issues, so that it can be improved without repeated impacts. **(Environmental expert: Consultant of Technology Co.,Ltd).** - The reason that the project does not renovate from the old power plant is because the old power plant had been working for a long time. When the production is operated, many pollutants are generated and the production efficiency is low. In the future, all old power plants will be removed. No more re-use the old power plant. Old ones would be replaced with new ones.
- Concerns on using coal as fuel **(Media representative)**	- The fuel using in the project is natural gas, which is a liquid fuel with injectors to deliver gas. It cannot be used in conjunction with solid fuel as such coal, due to machines are

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
	different as to compared with cars that use diesel and gasoline, etc. **(Environmental expert: Consultant of Technology Co.,Ltd).**
- Does the project replace with new gas pipelines or not? If so, where are additional pipelines placed? **(Government agency: representative of Don Rae SAO)**	- The project will have a new gas pipeline which an environmental assessment report must be prepared. There will be a public hearing meeting on the part of the gas pipe as well, due to existing pipeline are not suitable for future use. **(Environmental expert: Consultant of Technology Co.,Ltd).**
- Which country does the project use technology from? **(Government agency: representative of Huai Phai SAO)**	- Machines using in the project are currently in negotiations with two options: from Japan or Germany. It is the latest technology and has a high efficiency in eliminating pollution. For the management during the operation phase, staff from the Electricity Generating Authority of Thailand (EGAT) will control the production operation. **(Project Leader: Hin Kong Power Co.,Ltd.)**
3) Impacts and previous operation	
- The previous operation of the project have affected the environment, such as worsen air quality, dust, oil stains, hot weather and noise. These can be caused by many factors. People in the area are concerned about taking care of the communities around the project based on their experience. **(Community leader : Moo.11 Ban Thung Noi, Hin Kong Sub district, public: Moo.6, Ban Nong Sadao Bon, Hin Kong Sub district, community leader: Moo.4, Koh**	- There are both positive and negative aspects of development activities at this time. Negative or bad things occurring in the past or issues in concerns should be raised and help in planning. In the past, the project establishment process can be easily performed and obtained permission. However, at present, the Environmental Impact Assessment report (EIA) must be done with measures to take care of the community. The project must follow established measures as laws that the project must comply with. Failure to do so,

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
Phlapphla Sub district, government agency: representative of Wat Huay Phai School)	the project then have to pay a fine. The government has tried to set regulations to control operators to operate according to the law. **(Environmental expert: Consultants of Technology Co., Ltd.)** - Building trust in the community, not just when new projects entering the community, project therefore went to meet with the community. However, in the future, there must be a project staff visiting communities as suggested, to build more trust in the community. At least, this meeting is a way to listen to the problem and to improve new projects in the future. **(Project Leader: Hin Kong Power Co.,Ltd.)**
- Concerns about the problem of draining water and flood problems. **(Community leader : Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district)**	- The project would improve to avoid repeated impacts. **(Project Leader: Hin Kong Power Co.,Ltd.)**
4) Confidence in the project	
- The project had invited government agencies to monitor the emission rate releasing to the outside or not. **(Question sheet: Chedi Hak Sub district)**	- The rate of pollution emissions that the project emits to the outside when measuring by an automatic detector, it cannot edit numbers. The emission rate was set as a condition in the EIA report and in the license which is considered as a law that must be followed. If the violation occurred, it was illegal. For the inspection, it will be done by the audit agency as the central agency or the legal registered consulting company to perform the measurement as hiring by the project. If the public had no confidence in the agency performing the measurement, a joint committee would be involved for

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
	further monitoring the environmental impact. **(Environmental expert: Consultants of Technology Co., Ltd.)**
- For environmental quality measurement results of the agency that the project hired, was the measurement result biased? **(Public : Moo.9, Ban Huay Moo, Chedi Hak Sub district)**	- The organization that had been assigned to monitor and inspect the environmental impact must properly register. The same protocol applies to the consulting company that providing EIA report to the project. Despite being hired, the consulting company must prepare a report by using only truthful information. If false information occurred, when people make complaints, the consulting company will be forfeited the work permit immediately. If the public was unsure, they could participate in the monitoring process. **(Environmental expert: Consultants of Technology Co., Ltd.)** - The representative of the Provincial Environmental Resources Office explained that in preparing the impact assessment report or EIA, the authorized agency is the Office of Natural Resources and Environmental Policy and Planning or ONEP, which has an expert committee to review the report done by the consulting company. The report will be reviewed by an expert team in various fields, both from government agencies and educational institutions. The committee would make recommendations to the project for further study and improve the report, in order to complete and correct such report. From the past experience, it was found that the EIA report was not considered just once. **(Environmentalist, Practitioner Level :**

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
	Office of Natural Resources and Environment)
- Publicizing results of air quality measurements to the community through various channels. **(Community leader : Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, government agency : representative of the Internal Security Operations Command, of Ratchaburi, government agency :representative of Huai Phai SAO, representative of media)**	- The consulting company accepted issues for further study and will further clarify in the 2nd meeting.
- In the past, villagers were able to consume rainwater. When the power plant was established in the area, villagers were not be able to consume rainwater. **(Community leader : Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, community leader: Moo.12, Ban Huay Champa, Koh Phlapphla Sub district)**	- Regarding the quality of rainwater, the consultant company would like to study the said concern and clarify at the 2nd meeting. **(Environmental expert: Consultants of Technology Co., Ltd.)**
(2) Environment	
1) Noise	
- After installation of silencer, the community still have impacts. **(Public : Moo.6, Ban Nong Sadao on Hin Kong Sub district, community leader, Moo.8, Ban Nong Kham, Huai Phai Sub district, government agency : representative of Huai Phai SAO)**	- The way to design machines, equipment, devices with different pressures, in case of pressure build up the pressure must be ventilated with a safety valve device. While the pressure occurs, a safety valve will work and noise occurs. Without a silencer, the noise will be very loud. How much the silencer could reduce the noise level depends on the silencer design. However, it is able to minimize the impact of the noise for a shorter duration. TECO power

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
	plants had been designed for more than 20 years. The design being inconsistent with the living conditions of the community today. In this regard, the new project in the future will be consistent with the living conditions of the community and use more modern technology. This will be able to reduce the noise impact to people in the area. Beside control and prevention, if there was an emergency, the project would have a fast moving unit to notifying the community, in order to reduce anxiety. **(Environmental expert: Consultants of Technology Co., Ltd.)**
- Concerned about the noise impact to the community **(Community leader : Moo.3, Ban Rak Makham, Huay Phai Sub district)**	- The noise will be measured while the machine is working. The project can operate when the noise level is in the standard level without causing any impacts. If the noise level exceeded the standard, the project would not be allowed to operate. - During the past, there was a loud noise in the project area because a gas ventilation system. But for this project, a new pipeline will be constructed in the existing route line, for more efficientvy. **(Environmental expert: Consultants of Technology Co., Ltd)**
2) Heat	
- Concerned on the heat impact from the production system of the project. In this regard, is there any heat control in the system? **(Community leader :Moo.8, Ban Nong Yai Kata, Hin Kong Sub district, community leader: Moo.1,**	- The consultant company would like to study the said concern and clarify in the 2nd meeting. **(Environmental expert: Consultants of Technology Co., Ltd)**

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
Ban Nong Krathum, Hin Kong Sub district, community leader: Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, community leader:Moo.4, Koh Phlapphla Sub district,government agency: representative of Don Tako SAO, government agency: representative of the Royal Rainmaking Project, Ratchaburi)	
3) Soot/smoke	
- People living nearby the project found soot stains. Is there any solution? **(community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**	- For soot stains found on the roof of households, it may be caused by combustion of a type of fuel which the project could not determine. However, the project has to prove for the cause. But the nature of the power plant production does not generate soot or oil vapor due to it is the natural gas-fired project. Even small particles were found in very small amounts. However, at present, there is an increase in community activities from the past such as transportation, burning of fields, etc. If soot stains occurred again, the project would prove for the cause together with the community. **(Environmental expert: Consultants of Technology Co., Ltd)**
- Measurement of PM 2.5 dust had no information reporting to villagers. This caused villagers to not know the current weather information. **(Community leader : Moo.15, Ban Nong Song Hong, Hin Kong Sub district)**	- The consultant company would like to study the said concern and clarify in the 2nd meeting. **(Environmental expert: Consultants of Technology Co., Ltd)**

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
- Should install a dust measurement station in every district at least 1 station per Sub district. **(Community leader: inspector of Don Rae Sub district, media representative)**	- Air quality monitoring was done by a random sampling from the station for every 6 months in each area. For the installation of a permanent air quality monitoring station, the project will consider the impacts and affected areas. The most impacted point is assigned to represent the area in the environmental impact assessment. **(Environmental expert: Consultants of Technology Co., Ltd)**
- In case of incomplete combustion, will it cause dust or not? And does dust affect the community or not? **(Government agency: representative of Huai Phai SAO)**	- Dust will not occur because the project uses natural gas and has a filter to help absorb dust. The consulting company accepts the issue for further study and will be clarified at the 2nd meeting. **(Environmental expert: Consultants of Technology Co., Ltd)**
(3) Project water management	
- How does the project manage rain and wastewater contaminated with chemicals? - **(Community leader : Moo.10, Ban Suan Dok Mai, Don Tako Sub district)**	- Most of chemicals using in the project are chemicals for improving the quality of the water to be suitable for the consumption, prevent slag in the water pipes, steam boilers and cooling systems, etc. Such chemicals are transported to the project by trucks. It will then be stored inside the chemical storage building and working area. Therefore, the chemicals will not contaminate with the rainwater. Various types of chemicals are stored according to their properties to ensure the safety of the reaction between sensitive chemicals, in particularly, flammable materials which must clearly store in the separate area. - For making rainwater ponds, it is usually done to prevent flooding in the surrounding area. In case of rain water

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
	contaminating with lubricant, it will be sent to the wastewater treatment system of the project before releasing to the holding pond. **(Environmental expert: Consultants of Technology Co., Ltd)**
- Guidelines for water management from the Mae Klong River **(Government agency: office of Public Works and Town Planning Ratchaburi)**	- The consultant company would like to study the said concern and clarify in the 2nd meeting. **(Environmental expert: Consultants of Technology Co., Ltd)**
(4) Public health	
- Concerned about the health impacts of people in the community. **(Community leader: Don Tako Sub district)**	- The project has studied health impacts both short-term and long-term effects. The information will be presented again at the 2nd meeting.
- Will the chemicals used by the project have any impact on public health? **(Government agency: representative of Huai Phai SAO, government agency: Representative of Huay Phai School)**	- Most chemicals using in the project are chemicals for improving the quality of the water to be suitable for the consumption, preventing slag in the water pipes, steam boilers and cooling systems, etc. Such chemicals are transported to the project by trucks. It will then be stored inside the chemical storage building and working area. Therefore, there is no impact to the public. **(Environmental expert: Consultants of Technology Co., Ltd)**
- How does nitrogen oxides contaminated in the air affecting health? **(Government agency: representative of Huai Phai SAO)**	- Nitrogen oxide gas has a weak acid effect. When inhaling with moisture, it causes respiratory irritation. The project therefore has to control air pollution values at stacks and community areas. The value of nitrogen oxide gas in the community area must meet the standard of the Pollution Control Department. **(Environmental expert: Consultants of Technology Co., Ltd)**

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
- Project supported the budget for the village health volunteers for public health care. **(Community leader : Don Tako Sub district)**	- The health impact was divided into 2 parts: impact on increasing the burden of health care for local medical personnel and the air impact on the health of the community. However, the project had measures to prevent such impacts. The consulting company will bring results of studies and prevention measures to clarify at the 2nd meeting. **(Environmental expert: Consultants of Technology Co., Ltd)** - Measures to support general public health services of the project are the support of medical equipment, budget for staff. However, the consulting company will take the measure into account and present to the public in the 2nd meeting. **(Project Leader: Hin Kong Power Co.,Ltd.)**
(5) Safety	
- If there was a leak and chemical transportation, what would be the preventive measures of the project? **(Government agency: representative of Huai Phai SAO)**	- The project has followed the Storage of Chemicals and Hazardous Substances Act. The project selects the transporter with Type 4 of the transport permit. However, details will be presented and clarified at the 2nd meeting. **(Environmental expert: Consultants of Technology Co., Ltd)**
(6) Waste and solid waste	
- How will the project manage waste, solid waste and various sewage both during construction and demolish of the project? **(Community leader : Moo.10, Ban Suan Dok Mai, Don Tako Sub district)**	- The project will collect waste and keep it in the waste collection building before sending it to the industrial waste disposal agency licensed by the Department of Industrial Works for further disposal. **(Environmental expert: Consultants of Technology Co., Ltd)**
(7) Economic/social and public relations	
- From the presentation, it was found that the project had a solution to the	- This meeting is not organizing for the approval of the project. It is a meeting to

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
problem. But in the past, when the accident occurred, the project could not resolve any problems. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**	listen to comments of the people in the area. It will be found that since the registration process, the registration form had a letter indicating that the registration was not an approval/ permission of the project. But it was for the registration to attend the meeting only. Therefore, the project would like all participants to share their opinions, in order to bring the problems occurring in the past to be further modified. This stage would like everyone to express their opinions and reflect problems of the existing power plant to improve the new project, so that, the power plant can coexist with the community. **(Environmental expert: Consultants of Technology Co., Ltd)**
- The issues that must be resolved should be taken from this hearing forum to define a measure and must communicate with people for their understanding. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, government agency : representative of the Environment Agency Region 8, government agency: representative of Muang Ratchaburi)**	- The meeting is a participation process that emphasizes the exchange of ideas. As early informed at the beginning that joining the meeting was to establishing a problem and seek for a solution together. One thing was that there was no confidence in the existing power plant operation, resulting in a mistrust of new projects in the future. Normally, for the consideration of the EIA report, the Office of Natural Resources and Environmental Policy and Planning (ONEP) requires the consulting company to analyze existing problems, what problems are there? Is there any chance that the same problem will happen again? And how to prevent and mitigate such impacts, including establishing measures for the project to be implemented. Comments from everyone appear in the report as the

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
	starting point showing needs of villagers. Therefore, we would like everyone to use the forum for sharing comments on the project for further improvement and correction. **(Environmental expert: Consultants of Technology Co., Ltd)**
- The project should support activities of the community such as education, utilities and careers with people in the community. The project should arrange a fire truck to help the community in case of emergency. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, community leader: Moo.8, Ban Nong Yai Kata, Hin Kong Sub district, community leader: Moo.8, Ban Khao Ngam - Baan Klang Thung, Don Tako Sub district, government agency : representative of Don Rae SAO, government agency : representative of Don Tako SAO)**	- For the community and social work of the project, its concept is divided into 2 parts which are; - Part 1, the development fund around the power plant in accordance with the law. The project must allocate the fund into 2 phases: the construction and the operation phases. - Part 2, the project provides a public relation budget for activities with the community. In the operation, needs of the community are mainly considered. **(Project Leader: Hin Kong Power Co.,Ltd.)**
- In the past, the surrounding communities lacked care and attention from the project. **(Public: Khao Ngu Sub-district Municipality)**	- This meeting is a meeting to listen to comments and problems that arise with the community for further improvement. In the next meeting, the project would like the public to participate in order to present the progress of some concrete actions. **(Environmental expert: Consultants of Technology Co., Ltd)**
- Can you stop building a power plant? If created, what would be the policy to look after the community? **(Community leader : Moo.3, Ban Nong Kham, Don Rae Sub district, question sheet: Huai Phai Sub**	- The consulting company would like to bring said issues back for the discussion, due to it is a duty of the project owner to taking care of the community. Anyway, it will be presented and clarified in the 2nd meeting.

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
district)	**(Environmental expert: Consultants of Technology Co., Ltd)**
- If unable to reduce electricity bills for people, then there should be a fund to support activities in the community. **(Government agency: Hin Kong SAO, community leader: Moo.9 Ban Thung Lai Kai, Hin Kong Sub district, government agency: representative of Don Tako SAO)**	- For the community and social work of the project, its concept is divided into 2 parts which are; - Part 1, the development fund around the power plant in accordance with the law. The project must allocate the fund into 2 phases: the construction and the operation phases. - Part 2, the project provides a public relation budget for activities with the community. In the operation, needs of the community are mainly considered. **(Project Leader: Hin Kong Power Co.,Ltd.)**
(8) Power Development Fund around the power plant	
- Regulations for the use of power development funds of the power plant that were not conducive to needs of various projects of the people of the area. **(Community leader : Moo.11, Ban Thung Noi, Hin Kong Sub district, community leader: Moo.8, Ban Nong Yai Kata, Hin Kong Sub district, public : Moo.14, Ban Karn KeaHa, Chedi Hak Sub district, community leader: Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, community leader : Moo.12, Ban Huai Cha Pa, Koh Phlapphla Sub district, community leader: Moo.3, Ban Nong Kham, Don Rae Sub district, community leader: Moo.4, Koh Phlapphla Sub district, public : Moo.5,**	- In many areas, there were a lot of issues regarding development funds around power plants. Therefore, it was the origin of the community and social work of the project. Its concept was divided into 2 parts which were; - Part 1, the development fund around the power plant in accordance with the law. The project must allocate the fund into 2 phases: the construction and the operation phases. - Part 2, the project provides a public relation budget for activities with the community. In the operation, needs of the community are mainly considered. **(Project Leader: Hin Kong Power Co.,Ltd.)**

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
Ban Mai, Don Tako Sub district, government agency : Hin Kong SAO, government agency: representative of Don Tako SAO)	
- Koh Phlapphla Sub district was divided into 2 departments, namely Khao Ngu Subdistrict Municipality and Koh Phlapphla SAO. In the past, the project has only supported the Koh Phlapphla SAO. **(Community leader : Moo.1, Koh Phlapphla Sub district)**	<u>Additional clarification</u> - For the power development fund operations around power plants, the project is just allocate money to the fund. There will be a community development fund committee around the power plant who was appointed by the Energy Regulatory Commission (ERC), to manage the fund. This committee comprises of qualified persons as a representative of the government sector, representative of the public sector and representatives of the power plant. However, the project operation is divided into 2 parts, which are; - Part 1, the development fund around the power plant in accordance with the law. The project must allocate the fund into 2 phases: the construction and the operation phases. - Part 2, the project provides a public relation budget for activities with the community. In the operation, needs of the community are mainly considered **(Project Leader: Hin Kong Power Co., Ltd.)**
- During the construction phase, will the project allocate the budget to the power development fund? **(Government agency: representative of Don Rae SAO)**	- The project must allocate the budget into the power development fund around the power plant since the construction starts with an average of approximately 50,000 baht / MW / year. **(Project Leader: Hin Kong Power Co.,Ltd.)**

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
- What does the community development committee in the area surrounding the power plant appoint to do? Because this committee had never been invited to a Sub district meeting.	- The consulting company has recorded the issue and will send this issue to the Energy Regulatory Commission (Central unit) for their awareness, due to the power plant only has the duty to allocate budget to the fund. **(Environmental expert: Consultants of Technology Co., Ltd)**
- Allocation of the power development fund budget for each Sub district should be done per capita basis and increased according to the population. **(Community leader : Moo.1, Koh Phlapphla Sub district, government agency : representative of Don Tako SAO)**	- The consulting company has recorded the issue and will send this issue to the Energy Regulatory Commission (Central unit) for their awareness, due to the power plant only has the duty to allocate budget to the fund. **(Environmental expert: Consultants of Technology Co., Ltd)**
- What are the procedures of the Power Plant Development Fund for the compensation to affected persons? **(Government agency: representative of Don Tako SAO)**	- If the power plant violated the law causing impacts to public, the project would be directly responsible for mitigating such impact. Letter to the governor or related agencies must be sent, in order to continue to perform remedies to impacts. **(Environmental expert: Consultants of Technology Co., Ltd)**
(9) Environmental impact study	
- The radius of the impact study must be a newly define radius or not? **(Community leader : inspector of Don Rae Sub district)**	- For the determination of the study scope, the consulting company has determined from the boundary of the existing TECO power plants, including a new power plant. It covers a 5-kilometer radius. For the study of discrete receptor area using for determining the trends of air pollution from projects that may affect the public health, it had been defined for 20x20 kilometers from the project boundary. For the impact on water consumption and water quality, the study will be done using

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
	the Mae Klong River network, a water source and receiving drainage from the project drainage, including transportation network related to the operation of the project as well. **(Environmental expert: Consultants of Technology Co., Ltd)**
- The meeting only invited village chief and headman. Volunteers, village / community committee, women and housewives should be invited as well. **(Public: Khao Ngu Sub-district Municipality)**	- The consulting company will continue to improve the meeting. However, in conducting an impact study, the consulting company will conduct a survey by questionnaire with the government agency, leader group and people in the area again. **(Environmental expert: Consultants of Technology Co., Ltd)**
- Provide air quality and groundwater measurements prior to construction. **(Community leader : Moo.8, Ban Nong Kham, Huay Phai Sub district)**	- The project has already measured air, noise, soil, groundwater and Mae Klong River quality by measuring on both seasons. Results of such measurements will be presented in the 2nd meeting. **(Environmental expert: Consultants of Technology Co., Ltd)**
- Increase the public relations of the project to be thorough and comprehensive. **(Government agency: representative of Huai Phai SAO, government agency: representative of Don Tako SAO)**	- The consulting company has channels to publicize news and receive opinions such as telephone/fax, e-mail and Facebook. The project will continue public relations activity by posting on public relations boards of the local government organization. **(Environmental expert: Consultants of Technology Co., Ltd)**
- Allow people to send their letters of comments by mail. **(Government agency: representative of Don Tako SAO)**	- The consulting company received comment for further improvement. However, after the meeting, there are also various channels shown in the meeting documents. Thus, everyone can express

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
	further opinions. Besides organizing a public hearing meeting, the consulting company will also conduct a survey by using questionnaires from government agencies, leader groups and people in the area to present in the report as well. **(Environmental expert: Consultants of Technology Co., Ltd)**
- The meeting minutes should be publicized, so that, people in the area who did not attend the meeting would be informed. **(Government agency: representative of Don Tako SAO)**	- The consulting company acknowledged this issue and will proceed. - **Additional clarification** - Fifteen days after the meeting, the consulting company will collect issues in a hearing meeting and summarize the meetings for various agencies and post in the community area for the public to be informed. **(Environmental expert: Consultants of Technology Co., Ltd)**
- A meeting place should locates at the center of the Sub district **(Government agency: representative of Don Tako SAO)**	- The consulting company will take this issue for further improvement. **(Environmental expert: Consultants of Technology Co., Ltd)**
(10) Others	
- The project should study the law of town planning and using of fuel into the area, in particularly, coal. **(Government agency : Office of Public Works and Town Planning, Ratchaburi)**	- The project has examined the town planning. Since the project is located in the existing area, however, an inspection letter will be submitted to the Office of Public Works and Town Planning to receive the certification. For the fuel of the Hin Kong power plant, liquid and gas fuels can only be used due to the power plant uses a fuel injection method. Therefore, there is absolutely no use of coal fuel. **(Environmental expert: Consultants of Technology Co., Ltd)**

Table 4.5.2.2-4 (Cont)

Questions / Suggestions	Clarifications
- The power plant was located in the community area but why is the cost of electricity increasing which affecting workers? **(Community leader : Moo.1, Koh Phlapphla Sub district)**	- When the weather is hot, more electricity is used resulting in increasing of the electricity cost which in consistence with the amount of electricity used. **(Environmental expert: Consultants of Technology Co., Ltd)**
- Reduction of FT or electricity bills for communities nearby the project **(Community leader: Moo.3, Ban Rak Makham, Huay Phai Sub district, public : Moo.5, Ban Mai, Don Tako Sub district)**	- The consulting company had recorded them as data. **(Environmental expert: Consultants of Technology Co., Ltd.)**
- The problem of frequent power outages and some households had no electricity. **(Government agency: representative of Don Tako SAO)**	- The consulting company had recorded them as data. **(Environmental expert: Consultants of Technology Co., Ltd.)**
- Inquiring about the cost of organizing the meeting. **(Government agency: representative of Don Tako SAO)**	- Meeting expenses were only the cost of traveling to the meeting due to some people may have a problem and have travel expenses. Execution of all expenses done the consulting company. The local government organization was not involved in such expenses. **(Environmental expert: Consultants of Technology Co., Ltd.)**
- The community would like to visit the project area, would it be possible or not? **(Community leader : Moo.10, Ban Nong Krathum, Hin Kong Sub district, community leader: Moo.10, Ban Suan Dok Mai, Don Tako Sub district)**	- If the community was interested in studying and visiting the project, it can be done by grouping within the community and then notifying the project on what kind of the study they want to study. **(Project Leader: Hin Kong Power Co.,Ltd.)**

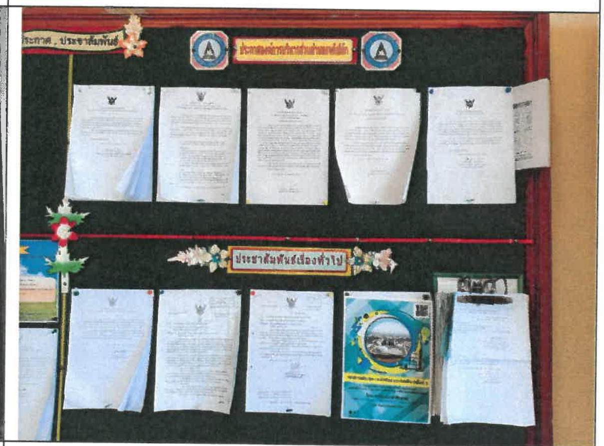
4.5.2.3 Dissemination and summary of the 1st public hearing meeting

The project sent a summary of the 1st public hearing meeting on the draft proposal, project details, study scope and evaluation of project alternative by sending a letter with a summary of the meeting to government agencies and community leaders in the study area for further dissemination (the summary report of the 1 st public hearing meeting presented in **Appendix 4-7**, example of a copy of the letter to send summary results of the 1 st public hearing meeting as shown in **Appendix 4 -8**). The project disseminated the summary of meeting on the environmental impacts within the community during June 2 - 4, B.E.2562, as shown in **Figure4.5.2.3-1**.

Ratchaburi Office of Energy

Hin Kong SAO

Khao Ngu subdistrict municipality



Chedi Hak SAO

Figure 4.5.2.3-1 Picture samples of 1st public hearing annoucements

4.5.3 The public hearing on the drafted reports, environmental impact prevention and measures and environmental impact monitoring (PP2)

4.5.3.1 Invitation and dissemination of the schedule of the 2nd public hearing meeting

Public relations for the meeting had chosen a variety of media channels to keep stakeholders and interested parties informed on the meeting schedule and detailed project information. There were totally 3 channels had been used as follows.

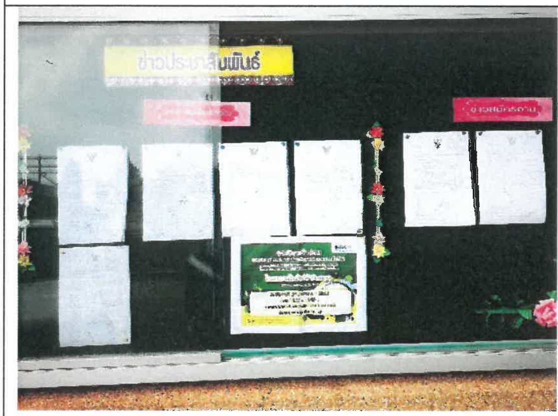
(1) Delivering the meeting invitation letter to the stakeholders along with the meeting schedule and meeting acceptance form during 7-9 October, B.E. 2019 (example of a copy of the 2nd meeting invitation letter as seen in **Appendix 4-9**).

(2) Installing signs to publicize the meeting and project guidance documents on Important areas of communities/government agencies that can be easily seen, such as local government organizations and the headman office, etc. It was done between October 7-9, B.E.2562, as shown in **Figure4.5.3.1-1.**

(3) Notification of the meeting schedule and disseminate project documents through www.cot.co.th, as seen as **Figure4.5.3.1-2.**

Hin Kong SAO

Chedi Hak SAO



Don Tako SAO

Village's pavilion Moo 6 Ban Nong Sadao Bon, Hin Kong Subdistrict

Figure 4.5.3.1-1 Picture sample of 2nd public hearing announcement at important/noticeable places of the community / government agency

Figure 4.5.3.1-2 Public relation on the 2nd public hearing meeing and the publish of project's recommendation document on the company's website (www.cot.co.th)

4.5.3.2 Process of organizing the 2nd public hearing meeting

The project organized the 2nd hearing meeting during 24-30 October, B.E. 2562, a total of 7 stages with a total of 1,028 participants (project owner and consulting company were excluded). It was summarized as **Table 4.5.3.2-1.** Position of stakeholders were classified as seen in **Table 4.5.3.2-2.** The atmosphere of the 1st hearing meeting was shown as **Figure4.5.3.2-1.** For the distribution of the participants in each area, it was shown in **Figure 4.5.3.2-2.** Issues, concerns and important recommendations to the project were shown in **Table 4.5.3.2-3** and **Table 4.5.3.2-4** (supporting documents for the 2nd meeting as seen in **Appendix 4-10**, a copy of registration form for the 2nd meeting as seen in **Appendix 4-11** and a copy of evaluation form after the 2nd meeting as seen in **Appendix 4-12).**

Table 4.5.3.2-1
Details on the 2nd public hearing meeting

Date-month-year	Time	Location	Number of participants (people)
Thursday, 24 October B.E.. 2562	08.30-12.00	Meeting room of Hin Kong Subdistrict Administrative Organization, Ratchaburi district, Ratchaburi province	201
	18.00-21.00	SML pavilion Moo 3, Chedi Hak subdistrict, Ratchaburi district, Ratchaburi province	187
Friday, 25 October B.E.. 2562	08.30-12.00	Wat Na Nong Multipurpose pavilion, Don Rae subdistrict, Ratchaburi district, Ratchaburi province	133
	13.30–16.00	Meeting room of Huai Phai Subdistrict Administrative Organization, Ratchaburi district, Ratchaburi province	126
Tuesday, 29 October B.E.. 2562	08.30–12.00.	Meeting room of PlubPla Subdistrict Administrative Organization, Ratchaburi district, Ratchaburi province	119
	13.30–16.00	Multipurpose building of Don Tako Subdistrict Administrative Organization, Ratchaburi district, Ratchaburi province	133
Wednesday, 30 October B.E.. 2562	08.30-12.00	Learning center of Khao Ngu subdistrict, Ratchaburi district, Ratchaburi province	129
Total			**1,028**

Remark : Excluding consulting companies and project staff

Table 4.5.3.2-2

Summarization of the 2nd public hearing meeting on environmental impact assessment report and environmental impact prevention and mitigation measures by Hin Kong Power Plant Project of Hin Kong Co.,Ltd

Participants	Rank	Amount (ppl)
1. Affected party		
Hin Kong Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi Province		
- Moo 1 Ban Hin Kong 8	- Village Headman	1
	- Assisstant Village Headman	2
	- Resident	8
- Moo 2 Ban Luak Kwang	- Village Headman	1
	- Assisstant Village Headman	1
	- Public Health Volunteer	3
	- Resident	5
- Moo 3 Ban Nong Ta Luang	- Village Headman	1
	- Assisstant Village Headman	2
	- Resident	6
- Moo 4 Ban Nong Sadao Lang	- Village Headman	1
	- Assisstant Village Headman	2
	- SAO member	1
	- Resident	4
- Moo 5 Ban Nong Rak	- Assisstant Village Headman	2
	- SAO member	1
	- Resident	8
- Moo 6 Ban Nong Sadao Bon	- Village Headman	1
	- Assisstant Village Headman	2
	- SAO member	2
	- Public Health Volunteer	1
	- Resident	11

Table 4.5.3.2-2(cont)

Participants	Rank	Amount (ppl)
- Moo 7 Ban Huai Pladuk	- Village Headman	1
	- Assisstant Village Headman	1
	- Resident	8
- Moo 8 Ban Nong Yai Ka Ta	- Village Headman	1
	- Assisstant Village Headman	1
	- Resident	9
- Moo 9 Ban Thung Lai Gai	- Village Headman	1
	- Assisstant Village Headman	1
	- Village Committee	1
	- Resident	13
- Moo 10 Ban Nong Grathum	- Village Headman	1
	- Assisstant Village Headman	2
	- Village Committee	2
	- Resident	4
Huai Phai Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi Province		
- Moo 1 Ban Khao Kwang	- Village Headman	1
	- Assisstant Village Headman	2
	- Public Health Volunteer	3
	- Village Committee	1
	- Resident	5
- Moo 3 Ban Rark Ma Karm	- Village Headman	1
	- Assisstant Village Headman	2
	- SAO member	1
	- Village Committee	1
	- Resident	7
- Moo 4 Ban Huai Phai	- Village Headman	1
	- Assisstant Village Headman	1
	- Village Committee	9

Table 4.5.3.2-2(cont)

Participants	Rank	Amount (ppl)
- Moo 5 Ban Nakorn Barn	- Village Headman	1
	- Assisstant Village Headman	2
	- SAO member	2
	- Resident	6
- Moo 6 Ban Nong Luang	- Village Headman	1
	- Assisstant Village Headman	1
	- Village Committee	2
	- Resident	5
- Moo 7 Ban Nong Din Dang	- Village Headman	1
	- Public Health Volunteer	4
	- Resident	5
- Moo 8 Ban Nong Karm	- Village Headman	1
	- Assisstant Village Headman	1
	- President of Public Health Service	1
	- President of Women Majority	1
	- Resident	8
- Moo 9 Ban Nong Nam Kun	- Village Headman	1
	- Assisstant Village Headman	2
	- SAO member	1
	- Public Health Volunteer	3
	- Village Committee	1
	- Resident	2
Chedi Hak Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi Province		
- Moo 6 Ban Larng Mai Dang	- Village Headman	1
	- Assisstant Village Headman	2
	- Village Committee	6
- Moo 7 Ban Thung Por Bon	- Village Headman	1
	- Assisstant Village Headman	1
	- Village Committee	6

Table 4.5.3.2-2(cont)

Participants	Rank	Amount (ppl)
- Moo 8 Ban Thung Tarn	- Village Headman	1
	- Assisstant Village Headman	1
	- Village Committee	7
- Moo 9 Ban Huai Moo	- President of Public Health Service	1
	- President of Housewives group	1
	- Village Committee	1
	- Resident	8
- Moo 10 Ban Sra Swat	- Village Headman	1
	- Assisstant Village Headman	1
	- Village Committee	2
	- Resident	7
- Moo 12 Ban Khao Mor	- Village Headman	1
	- Assisstant Village Headman	2
	- SAO member	1
	- Public Health Volunteer	4
	- Resident	3
Kor Plub Pla Subdistrict Administrative Organization of Ratchaburi district, Ratchaburi Province		
- Moo 6 Ban Huai Takang Nai	- Village Headman	1
	- Assisstant Village Headman	2
	- Women Majority	6
	- Village Committee	1
- Moo 7 Ban Thung Por Bon	- Village Headman	1
	- Assisstant Village Headman	1
	- Public Health Volunteer	4
	- Village Committee	2
	- Resident	3
- Moo 15 Ban Nong Song Hong	- Village Headman	1
	- Assisstant Village Headman	1
	- Resident	8

Table 4.5.3.2-2(cont)

Participants	Rank	Amount (ppl)
Don Tako Subdistrict Administrative Organization		
- Moo 8 Ban Khao Ngam-Ban Glarng Thung	- Village Headman	1
	- Assisstant Village Headman	2
	- Village Committee	1
	- Resident	6
- Moo 9 Ban Khao Gan Jan	- Village Headman	1
	- Assisstant Village Headman	1
	- Public Health Volunteer	1
	- Resident	8
Don Rae Subdistrict Administrative Organization		
- Moo 2 Ban Na Nong	- Village Headman	1
	- Assisstant Village Headman	1
	- Public Health Volunteer	1
	- Resident	9
Khao Ngu Subdistrict Municipality		
- Ban Ton Ma Muang Pattana Community	- Village Headman	1
	- Public Health Volunteer	1
	- Resident	8
- Som Poom Pattana Community	- Community President	1
	- Community Committee	3
	- Resident	5
	Total	**341**
2. Agencies resposinsible for writing Environmental Impact Assessment Report		
- Hin Kong Power Co.,Ltd		4
- Consultants of Techonology Co.,Ltd		6
	Total	**10**

Table 4.5.3.2-2(cont)

Participants	Rank	Amount (ppl)
3. Agency responsible for assessing the Environmental Impact Assessment report		-
	Total	0
4. Government agencies at different levels		
4.1 Regional Agency		
- National Water Resources Office	- Secretary of Ma Klong River Basin Committee	1
	- Policy and Plaanning Analyst	1
	- Project Coordinator	1
- Environment Office Section 8	- Director of Environment Quality Control	1
- Ratchaburi Energy Regulatory Commission 10	- Academic Staff	2
4.2 Provincial agency		
- Ratchaburi Internal Security Operations Commands	- Deputy Chief	1
	- Operating staff	1
- Ratchaburi Ministry of Energy	- Special Energy Technical Officer	1
	- Energy Technical Officer	1
	- Head of Security Coordination Department	1
	- Security Coordination Department	1
- Ratchaburi Irrigation Project	- Industrial Engineer	1
- Ratchaburi Industry Office	- Ratchaburi Industry	1
- Ratchaburi Office of Public Work and Town& Country Planning	- Town Planner	1

Table 4.5.3.2-2(cont)

Participants	Rank	Amount (ppl)
4.3 District Agency		
- Ratchaburi Police Station	- Defense and Supression Deputy Inspector	2
	- Defense and Supression Squad Leader	3
- Ratchaburi District	- Deputy District Chief	2
	- Officer	1
4.4 Local authoriy		
- Hin Kong SAO	- President of SAO	1
- Chedi Hak SAO	- Public Health Director	1
- Don Rae SAO	- SAO Deputy Permanent Secretary	1
- Huai Phai SAO	- SAO Permanent Secretary	1
- Huai Phai Health Promoting Hospital	- Director	1
- Plub Pla Health Promoting Hospital	- SAO Deputy Permanent Secretary	1
	- Permanent Secretary Chielf	1
	- Social Welfare Director	1
	- Treasury Director	1
	- Engineering Director	1
	- Policy and Plan Analyst	1
	- Civil Engineer	1
	- Assisstant Civil Engineer	1
	- Assisstant Community Development Officer	1
	- Administrative Officer	1
- Khao Ngu Subdistrict Municipality	- Procurement Officer	1
	- Treasury Officer	1
	- Procurement Assisstant	1
	- Administrative Officer	1
	- Head of Health Service	1
	- Assisstant Administrative Officer	1
	Total	**44**

Table 4.5.3.2-2(cont)

Participants	Rank	Amount (ppl)
5. Independent organization/private organization/Educational Institution/ Religious Institution		
- Thailand Development Volunteer Network Association	- President	1
	- Member	6
- Wat Nong Gra Thum School	- Teacher	1
- Wat Arun Rattana Siri School	- Director	1
- Wat Huai Phai School	- Director	1
- Mahidol University	- Professor	1
	Total	**11**
6. Mass media / public		
- Mass Media and Public Relation Association of Ratchaburi	- Association President	1
	- Vice President	1
	- News reporter	2
- Royal Thai Army Radio and Television Ch 5	- News reporter	1
	- Not specified	1
- Ratchaburi News Newspaper	- News reporter	1
	- Not specified	1
- Royal Thai Army Radio and Television Ch 7	- News reporter	1
- Radio Thailand in Ratchaburi	- Journalist	2
- Online TV AEC NEWS	- Not specified	1
- TC.NEWS	- Not specified	1
- MD TV News	- Not specified	1
- Kao Sod Newspaper	- Not specified	1
- Pim Mati Chon Newspaper	- News reporter	1
- Ratchaburi Time Newspaper	- News reporter	1
- Wikror Kao Newspaper	- News reporter	1

Table 4.5.3.2-2(cont)

Participants	Rank	Amount (ppl)
- Siamrat Newspaper	- News reporter	1
- PBS Television Station	- News reporter	1
- Thai News Agency	- News reporter	1
- Luk Mueng Newspaper	- Director	1
- Kra Sae Kao Newspaper	- Mass Media	1
- Kao Park 7 Newspaper	- Mass Media	1
- Hot News Newspaper	- Editor	1
- Mueng Ong News	- News reporter	1
- PM TV	- News reporter	1
- Siam News	- News reporter	1
- Ratchaburi News Association	- News reporter	1
- 24 News	- News reporter	1
- FM.99 Radio Station	- Not specified	1
- Not specified		2
	Total	**33**
7. Interested Citizens		
- Moo 11 Nan Thung Noi, Hin Kong Subdistrict		13
- Moo 2 Bam Khao Tum Gun Chorn, Huai Phai Subdistrict		12
- Moo 2 Ban Nong Jay, Chedi Hak Subdistrict		11
- Moo 3 Ban Chedi Hak, Chedi Hak Subdistrict		21
- Moo 4 Ban Arun Yik, Chedi Hak Subdistrict		10
- Moo 5 Ban Nong Jork, Chedi Hak Subdistrict		10
- Moo 11 Ban Chedi Hak Nork, Chedi Hak Subdistrict		17
- Moo 13 Ban Samakki, Chedi Hak Subdistrict		10
- Moo 14 Ban Garn Keha, Chedi Hak Subdistrict		13
- Moo 8 Ban Kor Loi, Kor PlubPla Subdistrict		3
- Moo 9 Ban Na, Kor PlubPla Subdistrict		3
- Moo 10 Ban Chong Ma Glum, Kor PlubPla Subdistrict		14

Table 4.5.3.2-2(cont)

Participants	Rank	Amount (ppl)
- Moo 11 Ban Khao Suan Luang, Kor PlubPla Subdistrict		8
- Moo 12 Ban Huai Jum, Pa Kor PlubPla Subdistrict		8
- Moo 2 Ban Khao Mor, Don Tako Subdistrict		10
- Moo 3 Ban Don Tako, Don Tako Subdistrict		11
- Moo 4 Ban Don Jang, Don Tako Subdistrict		17
- Moo 5 Ban Mai, Don Tako Subdistrict		13
- Moo 6 Ban Nakorn Barn, Don Tako Subdistrict		9
- Moo 7 Ban Khao Loi- Khao Luang, Don Tako Subdistrict		13
- Moo 10 Ban Suan Dork Mai, Don Tako Subdistrict		13
- Moo 1 Ban Don Rae, Don Rae Subdistrict		12
- Moo 3 Ban Nong Karm, Don Rae Subdistrict		14
- Moo 4 Ban Don Sak, Don Rae Subdistrict		8
- Moo 5 Ban Don Tan, Don Rae Subdistrict		10
- Moo 6 Ban Dorn Kork, Don Rae Subdistrict		10
- Moo 7 Ban Nong Sra, Don Rae Subdistrict		10
- Moo 8 Ban Nong Prong, Don Rae Subdistrict		10
- Moo 9 Ban Nong Matoom, Don Rae Subdistrict		10
- Moo 10 Ban Huai, Don Rae Subdistrict		9
- Ruan Jai Pattana Community, Khao Ngu Subdistrict Municipaility		11
- Ban Huai Takang Community, Khao Ngu Subdistrict Municipaility		16
- Ban Kok Hin Community, Khao Ngu Subdistrict Municipaility		10
- Ban Nai Pattana Community, Khao Ngu Subdistrict Municipaility		10
- Nueng Sarm Pattana Community, Khao Ngu Subdistrict Municipaility		11

Table 4.5.3.2-2(cont)

Participants	Rank	Amount (ppl)
- Ban Tako Community, Khao Ngu Subdistrict Municipaility - Genreral interested citizens		10 17
	Total	**417**
Total 1/		**871**

Remark : 1/ Total number of participants (not including project owners and consultant company)

* Participate in more than one stage

Source : Gathered by Consultants of Technology Co.,Ltd, B.E. 2563

Stage 1 Hin Kong Subdistrict Administrative Organization area

Atmosphere during registration

Mr. Prakorb Wongmaniruong, Deputy Governer of Ratchaburi Province, starts off the meeting

Presenting Information

Participants offering and exchanging ideas and suggestions

Figure 4.5.3.2-1 the 2nd public hearing

Stage 2 Chedi Hak Subdistrict Administrative Organization area


Atmosphere during registration

Mr. Amun Fungsung, Ratchaburi Industry, starts the meeting

Atmoshphere during Presentation


Overall atmosphere

Figure 4.5.3.2-1 (cont) the 2nd public hearing

Stage 3 Don Rae Subdistrict Administrative Organization area


Atmosphere during registration

Mr. Krrik Munkong, Energy Speicalist from Ratchaburi Office of Energy, starts off the meeting

Atmoshphere during Presentation


Participants offering and exchanging ideas and suggestions

Figure 4.5.3.2-1 (cont) the 2nd public hearing

Stage 4 Huai Phai Subdistrict Administrative Organization area

Atmosphere during registration

Atmoshphere during Presentation

Participants offering and exchanging ideas and suggestions

<u>Figure 4.5.3.2-1 (cont)</u> the 2nd public hearing

Stage 5 Kor Plub Pla Subdistrict Administrative Organization area	
	
Atmosphere during registration	
	
Mr. Krasaim Wattanahiranchelem, Energy Specialist from Ratchaburi Office of Energy, starts off the meeting	Atmoshphere during Presentation
	
Participants offering and exchanging ideas and suggestions	

<u>Figure 4.5.3.2-1 (cont)</u> the 2nd public hearing

Stage 6 Don Tako Subdistrict Administrative Organization area

Atmosphere during registration

Mr. Krrik Munkong, Energy Speicalist from Ratchaburi Office of Energy, starts off the meeting

Atmoshphere during Presentation

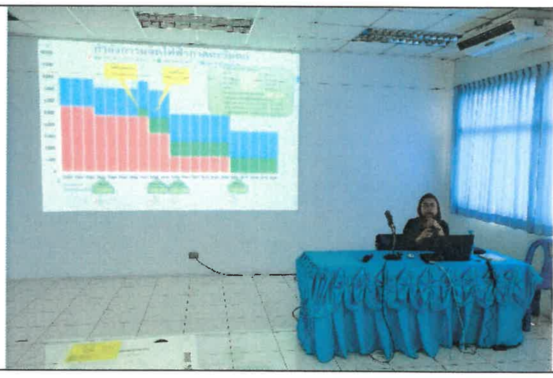
Participants offering and exchanging ideas and suggestions

Figure 4.5.3.2-1 (cont) the 2nd public hearing

Stage 7 Khao Ngu Subdistrict Municipality


Atmosphere during registration

Mr. Sunchai Waikagun, Vice Mayor of Khao Ngu District, starts off the meeting



Atmoshphere during Presentation


Participants offering and exchanging ideas and suggestions

Figure 4.5.3.2-1 (cont) the 2nd public hearing

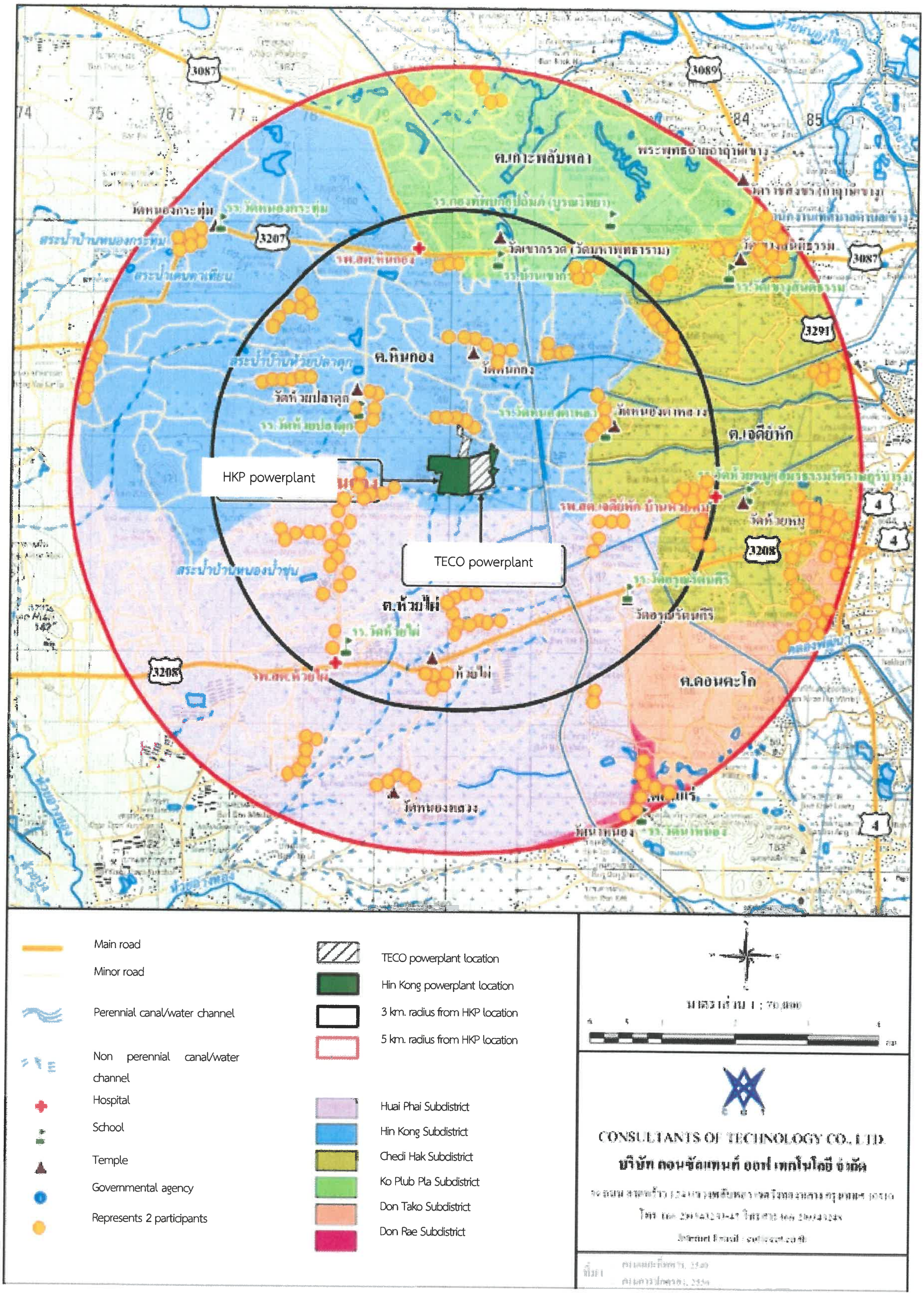


Figure 4.5.3.2-2 Distribution of the participants of PP2 in each area

Table 4.5.3.2-3

Summarization of consideration points, ideas, suggestions, and worries from the 2nd public hearing, categorized by stages

Consideration point, ideas, suggestions, and worries	Opinion from each area						
	0-3 km radius of the project			3-5 km radius of the project			
	Hin Kong SAO	Chedi Hak SAO	Huai Phai SAO	Don Rae SAO	Kor Plub Pla SAO	Don Tako SAO	Khao Ngu SM
(1) Project details	✓		✓			✓	✓
(2) Water drainage and flood prevention	✓			✓		✓	
(3) Trade	✓			✓			
(4) Air quality and heat	✓	✓				✓	
(5) Disturbance noise	✓						✓
(6) Waste water							
(7) Citizens' participation	✓						
(8) Social and public relation							
- Support education, religion, and cultures	✓	✓	✓		✓	✓	✓
- support and help the community	✓	✓	✓				
(9) Safety	✓	✓					
(10) Fund for the powerplant		✓	✓	✓	✓		✓
(11) Others such as social problem and various utilities					✓		

Table 4.5.3.2-4

Summary of issues, concerns and suggestions from the 2nd Public Hearing Meeting

Comments / suggestions / concerns	Clarification
(1) Project details	
- Gas turbine generators, steam turbine generators and HRSG locating near the community area, which may affect neighboring communities. **(Public : Moo.6, Ban Nong Sadao Bon, Hin Kong Sub district)**	- The project has been designed to reduce noise at sources such as buildings covered the noise source, noise reduction equipment and control the noise level at the fence not more than 70 dB (A) as required by law. The area connecting to the community has considered to have soundproof lines to reduce the impact. However, after the project has established measures, the project will monitor the noise levels from 2 stations nearby the area, twice a year for 7 consecutive days. Summary will be done and informed the community.
- Is the power plant a new project or is it an operation of the re-contract and has to have a public hearing? - Where will the generated electricity be distributed? - How much is the original electricity capacity? And how much more will be produced? **(Question sheet: Huai Phai Sub district)**	- Hin Kong Power Plant Project is a new power plant to replace and strengthen in the future electricity following the Tri Energy or TECO power plant that generates 700 megawatts of electricity, which the power generation contract is expiring in B.E. 2563. The area of the TECO power plant is ready and suitable for power transmission system. There is an amount of electricity supplied to the grid system of the Electricity Generating Authority (EGAT) in accordance with the power purchase agreement at 1,400 megawatts, which falls under the category of thermal power plant projects with a power generation capacity of 10 megawatts or more. This category must provide an environmental impact assessment report, according to the Announcement of the Ministry of Natural Resources and Environment.

Table 4.5.3.2-4 (cont)

Comments / suggestions / concerns	Clarification
	- The project has no intention for the general hearing. The meeting today is held to listening opinions from people, according to the Announcement of the Office of Natural Resources and Environmental Policy and Planning. Moreover, this is the 2nd meeting to present study results and draft environmental impact prevention and measures, including environmental impact monitoring, as well as to listen to suggestions and concerns from all sectors, in order to improve and complete the report. **(Environmental expert: Consultants of Technology Co., Ltd.)**
- In case of the main fuel and reserve fuel run out, what kind of fuel will be used instead? **(Public : Moo.10, Ban Suandokmai Don Tako Sub district)**	- Current related agencies plan to import natural gas from foreign countries in other forms such as liquids transported by shipment, before converting to gas and delivering to the desired area through pipelines, in order to meet the fuel demand of different sectors. However, in the absence of fuel to generate electricity, the project will stop operating. **(Environmental expert: Consultants of Technology Co., Ltd.)**
(2) Drainage and flood prevention	
- Concern about the problem of flooding in community areas. - Propose to define measures for prevention management and the compensation in case of flooding in affected communities and agricultural areas. **(Public : Moo.6, Ban Nong Sadao Bon, Hin Kong Sub district, community leaders: Moo.11, Ban Thung Noi, Hin Kong Sub district, Moo.10, Ban Suandokmai, Don Tako**	- For the current drainage of the area around the power plant, it was found that the direction of the river flows was from west to east and flowed into the Mae Klong River. From examining the current drainage of the TECO Power Plant and the Hin Kong Power Plant development area, it was found that the area drained water into the canal on the north of the power plant. The north drainage ditch will drain the water from the rain falling in the catchment area to prevent the impact of local drainage. The project has designed a

Table 4.5.3.2-4 (cont)

Comments / suggestions / concerns	Clarification
Sub district)	rainwater drainage system in the project area to collect into 2 rainwater retention ponds and manage the drainage without changing the flow rate of the drainage canal and within the capacity that the canal can support. - However, at present during the rainy season, the surrounding area is affected by flooding. If the surrounding communities were in trouble, the project would willing to support and assistance by coordinating with local authorities to discuss the mitigation of further problems, such as providing water pumps, etc. **(Project leader: Hin Kong Power Co.,Ltd.)**
- Can treated water be used by farmers or not? **(Public : Don Rae Sub district)**	- The amount of treated water of the project is not much. At present, Tri Energy Power Plant has drained the water to Mae Klong River. The project has planned to drain treated water into the Mae Klong River as well. **(Project leader: Hin Kong Power Co.,Ltd.)**
(3) Transportation	
- Transportation during the construction should consider selecting the route that passes the least community area, in order to prevent traffic congestion and accidents. **(Community leader : Moo.11, Ban Thung Noi, Hin Kong Sub district, community leader : Moo.5, Ban Don Tan, Don Rae Sub district)**	- The consulting company assessed the impact on both the construction and the operation phases. For the construction phase, the transportation of large machines has to be coordinated with the traffic police to plan the transportation and facilitate the transportation to minimize the impact on the public and avoid the transportation during rush hours, in order to reduce the traffic congestion. Controlling of vehicle speed limit was required within construction areas and areas passing through dense communities. During the operation phase, the transportation will consist of vehicles transporting chemicals and employee. The

Table 4.5.3.2-4 (cont)

Comments / suggestions / concerns	Clarification
	chemical transportation of the project will be coordinated with the distributed company before importing into the project, in order to prepare and reduce the risk of unnecessarily waiting for unloading in the project area. **(Environmental expert: Consultants of Technology Co., Ltd.)** - The project coordination center is located in Huai Phai Roundabout. In the event that the community received impacts or coordinated in supporting activities, the community can contact the Project Coordination Center or contact via the contact numbers at the end of the meeting document. **(Project leader: Hin Kong Power Co.,Ltd.)**
(4) Air quality and heat	
- At present, the area already has various pollution problems, the operation of the project may cause additional problems. Thus, measures or approaches to prevent the consequences should be established. **(Community leader : Moo.11 , Ban Thung Noi, Hin Kong Sub district, public : Moo.5, Ban Nong Chok, Chedi Hak Sub district)**	- For the air quality from the presentation, the project collected air quality samples before the project establishment to check the condition and to assess the post-air quality impact from the project operation. For the impact assessment, the consulting company combined current air quality measurement results with the power plant emission forecast in the future. It was found that assessment results were in the standard and safe for health. However, when a power plant established, the project will monitor the air quality in the community. Once results were done, a summary report would be prepared and posted to the community or the SAO for further acknowledgment. **(Environmental expert: Consultants of Technology Co., Ltd.)**
- Does diesel fuel using in the project cause oil stains to fall on the roof of houses or agricultural areas or not?	- Project selects the combined cycle power plant technology with natural gas as the main fuel. Diesel will be used as a backup

Table 4.5.3.2-4 (cont)

Comments / suggestions / concerns	Clarification
(Community leader : Moo.11 , Ban Thung Noi, Hin Kong Sub district)	fuel in an emergency case (In the event that there is no natural gas supply). The reserved fuel will be lasted for 3 days only. Diesel is obtained from a domestic oil distribution company and transported to the project area by truck. Diesel will be stored in a reserve tank in the project area. **(Environmental expert: Consultants of Technology Co., Ltd.)**
- The operation of the project may cause the weather to change and causing impacts on agricultural crops and may cause various diseases accordingly. **(Public : Moo. 4, Ban Don Chaeng, Moo.10, Ban Suandokmai ,Don Tako Sub district)**	- From the study of the heat level of existing the power plant in Ratchaburi, it was found that the heat level was no difference between the area of the power plant and the nearby area. - However, studies have shown that agricultural production depends on various factors such as water, air, light. In this study, the criteria of World Health Organization (WHO) was used for the comparison, study results were in the low level and was not harmful to plants. **(Environmental expert: Consultants of Technology Co., Ltd.)**
- Concern about the impact on quality of life, in terms of health, environment and agriculture. **(Community leader : Moo.6, Ban Don Kok, Don Rae Sub district)**	- The study of environmental impact is the forecasting of the impact by using model and academic principles to find appropriate prevention measures. When the project operated, there will be continuous environmental quality measurements. Results would be summarized and disseminated to the community. **(Environmental expert: Consultants of Technology Co., Ltd.)**
(5) Noise	
- Can the installation of sound barrier reduce the impact? **(Community leader: Moo.11, Bang Thung Noi, Hin**	- The project has assigned the contractor to use construction equipment at high noise levels only during the time 08.00-17.00 hrs.

Table 4.5.3.2-4 (cont)

Comments / suggestions / concerns	Clarification
Kong Sub district)	For construction areas near the community that may be affected, a barrier with steel sheet or other materials that have the ability to reduce noise and remove easily would be installed in the construction area and around noisy devices. If construction activities cause more noise than usual, the project will informed the surrounding communities at least 7 days in advance. - In addition, during the construction the project has established measures to monitor noise levels in 2 stations which locating near the project for a period of 7 consecutive days. Results will be summarized and informed the community. **(Environmental expert: Consultants of Technology Co., Ltd.)**
- Previous operation of Tri Energy Power Plant caused noise impact. What was the cause? **(Public: Khao Ngu Sub-district Municipality)**	- The occurred noise was the noise from the natural gas distribution station. The Tri Energy Power Plant has coordinated and informed the relevant departments for corrective actions. **(Project leader: Hin Kong Power Co.,Ltd.)**
(6) Public participation	
- Arranging a public hearing meeting, are there any indicators? And what percentage of participants will require for the representation of the population? **(Community leader: Moo.11, Bang Thung Noi, Hin Kong Sub district)**	- In the public hearing meeting, there were unlimited number of participants and allows interested people to freely join the meeting and express their opinions on the project. **(Environmental expert: Consultants of Technology Co., Ltd.)**
(7) Social and public relations	
- Propose to assign staff to take care of the defenseless people or organizing a care center for the defenseless. - Comprehensive and thoroughly Support and promote the quality of life of people	- The consulting company is aware of the importance of the environment, in order to achieve sustainable development and good relations with the communities nearby in the project area and create a balance between

Table 4.5.3.2-4 (cont)

Comments / suggestions / concerns	Clarification
both in the field of public health and education. **(Community leader: Moo.11, Bang Thung Noi, Hin Kong Sub district, public : Moo.5, Ban Nong Chok, Chedi Hak Sub district, public : Moo.10, Ban Suandokmai ,Don Tako Sub district, question sheet : Huai Phai Sub district, government agency: representative of Khao Ngu Sub district Municipality)**	business and society by promoting participation in society. However, for determining the activities, the project will discuss and plan with the community for the implementation of social and community activities. - The project has allocated funds to support various activities of the community which are not related to the contributions to the Power Development Fund as follows: For the community development, the project will be implemented in coordination with the community. (1) Supporting the community by considering the needs of the community as each area has different needs. (2) The project should allow the community to write a proposal asking for the support **(Project leader: Hin Kong Power Co., Ltd.)**
- Propose to increase the role of the committee to publicize various information of the project to the public. **(Government agency: representative of Ratchaburi Provincial Energy Office)**	- Project will take this issue for the consideration.
- Arrange the staff to coordinate and receive complaints. **(Government agency: Representative of Ratchaburi Provincial Energy Office, community leader: Moo. 3, Ban Nong Kham, Don Rae Sub district)**	- Community relations staff was assigned to coordinate various aspects and the project coordination center is located at Huai Phai Roundabout. In the event that the community is affected or coordinated in supporting activities, communities can contact the project coordination center through the contact numbers at the end of the meeting document. **(Project leader: Hin Kong Power Co.,Ltd.)**

Table 4.5.3.2-4 (cont)

Comments / suggestions / concerns	Clarification
- Consider hiring local people as a priority and provide a guidance education for the youth in the area. **(Government agency: representative of Khao Ngu Sub district Municipality)**	- Project will take this issue for the consideration. **(Project leader: Hin Kong Power Co.,Ltd.)**
- Publicize results of air quality measurements in the area to the public. **(Government agency: representative of Khao Ngu Sub district Municipality)**	- The project provides a display of emission monitoring result (CEMS) in front of the project area. **(Project leader: Hin Kong Power Co.,Ltd.)**
- Ask about the budget to support the area. **(Question Sheet: Huai Phai Sub district)**	- The project is aware the problem of accessing the community power development fund, therefore, the project created a budget to address the limited problem of funds. It can be used this part of the budget for the initial rescue. For the ratio of the budget presented by the project, it was just a sample. In the meantime, there must be a meeting to discuss the budget and needs of the community. **(Project leader: Hin Kong Power Co.,Ltd.)**
(8) Safety	
- Which kind of chemical agents does the project used? And what kind of effect? **(Community leader : Moo.11, Ban Thung Noi, Hin Kong Sub district)**	- Most chemicals using in the project are chemicals for the water quality improvement for further consumption. They are similar to chemicals used in the production of tap water. These chemical are also used to prevent scale build-up in pipes, boilers, steam boilers and cooling systems. - For the chemical transportation into the project, it is transported by trucks. Chemicals will then be stored in the chemical storage area and the work area. Properties of chemicals are mostly corrosive to direct contact. The project placed different types of chemicals in accordance with their

Table 4.5.3.2-4 (cont)

Comments / suggestions / concerns	Clarification
	properties for the safety from the reaction between sensitive chemicals. **(Environmental expert: Consultants of Technology Co., Ltd.)**
(9) Power Development Fund	
- Propose to establish a committee of the power development funds covering every village. This committee should involve in various processes including publicizing the power plant activities to the community. **(Government agency: representative of Khao Ngu Sub district Municipality)**	- The operation of the Power Development Fund is supervised by the Energy Regulatory Commission. The project only has the duty to allocate budget to the fund according to the law. **(Project leader: Hin Kong Power Co.,Ltd.)**
- For the increased electricity production, will the Power Plant Development Fund increase as well? **(Community leader : Moo.11, Ban Khao Suan Luang, Koh Phlapphla Sub district, community leader: Khao Ngu Sub-district Municipality, question Sheet: Huai Phai Sub district)**	- Power Plant Development Fund will increase by ratio of the electricity production. **(Project leader: Hin Kong Power Co.,Ltd.)**
- In the past, communities often encountered problems of spending budget from the power development fund.	- Take this issue into account to coordinate and notify relevant departments for their awareness. **(Environment expert: Consultants of Technology Co., Ltd.)**
(10) Others	
- The route between Moo.8 and Moo.10 of Hin Kong Sub district has no light. Then, the project should support the light installation. **(Community leader: Moo.8, Ban Yai Nong Kata, Hin Kong Sub district)**	- The light installation at the route between Moo.8 and Moo.10 has been approved by the relevant authorities. In detail, community leaders will coordinate information from relevant agencies to monitor the progress of the action. **(Village chief of Hin Kong Sub district)**
- Currently, the area has a power outage problem, resulting in a malfunction of electrical appliances.	- Take this issue into account to coordinate and notify relevant departments. **(Project leader: Hin Kong Power Co.,Ltd.)**

Table 4.5.3.2-4 (cont)

Comments / suggestions / concerns	Clarification
(Community leader: Moo.8, Ban Yai Nong Kata, Hin Kong Sub district)	
- Several power plants have been located in Ratchaburi. Is there any way to reduce electricity bills for people in the area or not? **(Question sheet: Chedi Hak Sub district, media)**	- Coordinate to notify relevant departments for the acknowledgment. - Currently, the Ministry of Energy is studying the suitability of the budget that will be used to help the electricity bill and determining the area of the people that will be entitled. From the past, in every public hearing meeting, people proposed that there should be a discount on electricity bills in the area of the power plant is located. **(Project leader: Hin Kong Power Co.,Ltd.)**
- Which areas will the produced electricity from the project be sent for the usage? **(Community leader : Moo.3, Ban Nong Kham, Don Rae Sub district, community leader: Moo.11, Ban Khao Suan Luang, Koh Phlapphla Sub district, community leader: member of Khao Ngu Sub district Council)**	- The generated electricity will be sent to the high-voltage transmission lines of the Electricity Generating Authority of Thailand (EGAT) and PEA will deliver electricity to various areas for the consumption. - Currently, the Ministry of Energy is studying the feasibility of electricity bill assistance and determining the area of the people that will be entitled. **(Environmental expert: Consultants of Technology Co., Ltd.**
- At the present, the area has frequent fire problems, most of which are caused by short circuit. However, what are the prevention measures? **(Public : Moo.14, Ban Karn KeaHa, Chedi Hak Sub district)**	- When the power plant generating electricity, it will be sold to the Electricity Generating Authority (EGAT) system. In terms of delivering electricity to the people, Provincial Electricity Authority will be a responsible agency. The power outage or power fall are caused by many reasons such as in the rainy season, there may be broken branches that cut the power line or trucks break the electric wire, etc. However, the project will be coordinated to notify the relevant departments for acknowledgment. **(Environmental expert: Consultants of Technology Co., Ltd.)**

Table 4.5.3.2-4 (cont)

Comments / suggestions / concerns	Clarification
- Inquiring about the route of laying the natural gas pipeline to the power plant project. **(Public : Moo.6, Ban Nong Sadao Bon, Hin Kong Sub district)**	- Natural gas pipeline as the main fuel of the project, currently in the process of studying and preparing an environmental impact assessment report. Routes of the gas pipeline are in the process of considering for suitable alternatives. However, various details will be presented at the 2nd public hearing meeting of the natural gas pipeline project. **(Environmental expert: Consultants of Technology Co., Ltd.)**
- The operation of natural gas pipeline installation should mainly consider hiring local workers and select tools or construction materials in the area. In the event that communities are affected, urgent action should be taken. **(Community leader : Moo.11, Ban Khao Suan Luang, Koh Phlapphla Sub district)**	- Natural gas pipeline as the main fuel of the project, currently in the process of studying and preparing an environmental impact assessment report. Routes of the gas pipeline are in the process of considering for suitable alternatives. However, various details will be presented at the 2nd public hearing meeting of the natural gas pipeline project. **(Environmental expert: Consultants of Technology Co., Ltd.)**
(11) Suggestions	
- Requesting for the cooperation in improving the electricity pole, in order to reduce the power outages during the rain. - Having representatives from the university to represent the community in environmental monitoring.	

4.5.3.3 Dissemination and summary of the 2nd public hearing meeting

The project sent a summary of the public hearing meeting on the drafted report, environmental impact prevention and measures and environmental impact monitoring by sending a letter with the summary of the draft report review meeting to government agencies and community leaders in the study area for further dissemination (the summary report of the 2nd public hearing meeting presented in **Appendix 4-13**, example of a copy of the letter to send the summary of results of the 2nd public hearing meeting as shown in **Appendix 4-14**). It was done during 21-23 July, B.E.2562 (example of photos sending a summary of the meeting as shown in **Figure 4.5.3.3-1**).

Figure 4.5.3.3-1 Examples of the 2nd Public Hearing Result Dissemination

4.6 The conclusion

From the study of environmental impact according to the academic scope, the project realizes values of the public participation in the operation of the project. The project followed the process of public participation since the public relations process, arranging a meeting to clarify project details, participate in the comments, presenting information, arguments, or additional suggestions on the EIA issue, especially, concerns from the community to the project to be extra careful. This was enable the community to understand and had more confident in the project operation from public participation for a period of time. For study results and public opinion, the project and the consulting company had taken them into account in conducting studies in various parts of this report, including revising measures to be consistent and appropriate with suggestions and comments that could be practical as stakeholders had already commented in Chapter 7 of this report. Concerns and suggestion were summarized and taken into account for the formulation of environmental impact prevention and mitigation measures and environmental impact monitoring as shown in the **Table 4.6-1** and **Table 4.6-2.**

Table 4.6-1

Summary of questions/suggestions, clarification and consideration of environmental impact prevention and measures and environmental impact monitoring.

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
(1) Project details					
- This new power plant is a renovate one or new construction. Where is the produced electricity sent for the consumption? **(Community leader: Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, media representative, community leader: Moo.12, Ban Huay Champa, Koh Phlapphla Sub district, government agency: representative of Don Rae SAO, government agency: representative of Health Promotion Hospital of Huay Phai Sub district)**	Group 1 Group 4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** It is a new construction in the area of the current TECO power plant. Additional clarification - The project operates according to the Power Development Plan of Thailand B.E.2561-2580 by the Ministry of Energy, to replace the power generation capacity that will be depleted from the TECO plant. The TECO area is ready and suitable for the transmission system, fuel and raw water systems.	(1) Strictly follow the environmental impact prevention and mitigation measures and environmental quality monitoring program in the form of an environmental action plan as proposed in the EIA report of Hin Kong Power Plant Project of Hin Kong Power Company Limited, locates at Hin Kong Subdistrict, Mueang Ratchaburi District, Ratchaburi Province. The Project shall use the measures as a guideline for the supervision, control, and monitoring of the organization, the people, and related organizations. (2) Hin Kong Power Company Limited shall embed details of measures in the environmental action plan as essential conditions in the contract for the contracting company to be strictly implemented in order to achieve effectiveness in practice. (3) Hin Kong Power Company Limited shall maintain the cooling system to be in good working condition on a regular basis and is safe for workers and people in the vicinity area. (4) Hin Kong Power Company Limited is required to engage a third party to inspect the implementation of environmental impact prevention and correction measures and environmental impact monitoring program of the Project. The report on the implementation of environmental impact prevention and correction measures and
- Is the power plant project undertaking a new construction or is it an operation to renew the contract? Does it need a public hearing? - Where will the electricity generated by the project be distributed? - How much is the original electricity capacity? And how much more will be produced? **(Question sheet: Huai Phai Sub district)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - Hin Kong Power Plant Project is a new power plant to replace and strengthen in the future electricity following the Tri Energy or TECO power plant that generates 700 megawatts of electricity, which the power generation contract is expiring in B.E.2563. The area of the TECO power plant is ready and suitable for power transmission system. There is an amount of electricity supplied to the grid system of the Electricity Generating Authority (EGAT) in accordance with the power purchase agreement at 1,400 megawatts, which falls under the category of thermal power plant projects with a power generation capacity of 10 megawatts or more. This category	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
				must provide an environmental impact assessment report, according to the Announcement of the Ministry of Natural Resources and Environment. - The project has no intention for the public hearing. The meeting today is held to listening opinions from people, according to the Announcement of the Office of Natural Resources and Environmental Policy and Planning. Moreover, this is the 2nd meeting to present study results and draft environmental impact prevention and measures, including environmental impact monitoring, as well as to listen to suggestions and concerns from all sectors, in order to improve and complete the report.	environmental impact monitoring program shall be submitted to licensing agencies, namely the Energy Regulatory Commission Office, the Department of Industrial Works, Ratchaburi Province, and electronic systems of the Office of Natural Resources and Environmental Policy and Planning. In this regard, the preparation of the report on the results of the measures implementation and the frequency of submission of the report shall be in accordance with the notification on criteria and methods for preparing a report on the results of the measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare after receiving permission to operate the project or business B.E. 2561 (2018) and related laws. (5) In cases where the environmental quality monitoring results have shown environmental problems including in the case of complaints from the community caused by the Project implementation, Hin Kong Power Company Limited shall improve and correct such problems as soon as possible. The Project shall notify the Energy Regulatory Commission, Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning to acknowledge soon in order to coordinate and cooperate in solving such problems. (6) If Hin Kong Power Company Limited requires to
- Why did you have to build a power plant in Ratchaburi? **(Community leader: Moo.12, Ban Huay Champa, Koh Phlapphla Sub district, Community leader: Moo.10, Ban Chong Maklam, Koh Phlapphla Sub district, government agency: representative of Muang Ratchaburi District, government agency: representative of Don Rae SAO, media representative, question Sheet: Huai Phai Sub district)**	Group 1,4,6		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The reason for the establishment of the power plant at Ratchaburi was because the electricity capacity of 5,581 MW of the western region in the next 4-5 years will be lost from the system. Thing that needs to be done in advance is to plan ahead to accommodate the lost capacity. For the establishment of a power plant, it must take into account the suitability of the area, for example, why coal power plant must be built next to the sea? Because a lot of water is required for cooling. Why do we have to build a gas power plant in Ratchaburi? Due to the original gas transmission line which, if the construction occurred in new areas, the investment in these matters will reflect as electricity bills. Therefore, in order to reduce these costs, it will indirectly reduce the burden of the people.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
- Concern about impacts during construction because it had occurred by the original power plant. Therefore, the project should improve the old power plant and install new machines instead. **(Community leader: Moo.1 5 Ban Nong Song Hong, Koh Phlapphla Sub district)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - Due to the efficiency of the original power plant as an older model for 20 years ago. If compared with the car, it was an old car. When the project will build a new power plant, it will be built on the existing vacant space within the TECO power plant. For the issue of flooding, the project takes issues so that it can be improved without repeated impacts. - The reason that the project does not renovate from the old power plant is because the old power plant has been working for a long time. When production is operated, many pollutants are generated and the production efficiency is low. In the future, all old power plants will be removed. No more re-use from the old plant. Old things will only have new ones to replace.	change the Project details or environmental impacts prevent and mitigation measures or environmental impact monitoring program from those presented in the environmental impact assessment report which has been approved by the expert committee, it is the duty of agencies that have the authority to consider or approve as follows: (a) In the case that changing of the Project details or environmental impacts prevention and mitigation measures or environmental impacts monitoring program does not affect the essence of the environmental impact assessment in the EIA report and it is a measure that is more beneficial to the environment or equivalent to the measures specified in the EIA report that has been considered and approved by the expert committee, the competent authority shall approve or accept the notification of such amendment to be in accordance with the rules and conditions stipulated in that regulation. The Project shall prepare a copy of the improved environmental impact prevention and mitigation measures or environmental impact monitoring program that has been notified and send it to the Office of Natural Resources and Environmental
- Concerns about using coal as fuel **(Media representative)**	Group 6		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The fuel using in the project is natural gas, which is a liquid fuel using injectors to deliver gas. It cannot be used in conjunction with solid fuel coal because machines are different. This is compared to cars using diesel and gasoline, etc.	
- In case of the main fuel and reserve fuel run out, which kind of fuel will be used instead? **(Public : Moo.1 0 Ban Suandokmai, Don Tako Sub district)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - Related agencies currently plan to import natural gas from foreign countries in other forms such as liquids transporting by shipping, before converting to gas and delivering to the desired area via pipelines to meet the fuel demand of different sectors. However, in the absence of fuel to generate electricity, the project will stop operating.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
- Will the project be replaced with new pipelines? If so, where is additional pipelines are placed? **(government agency: representative of Don Rae SAO)**	Group 4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2[nd] meeting.	**Clarification in PP1** - For the gas pipelines, the project will have a new gas pipeline. It must also prepare an environmental assessment report. There will be a public hearing meeting on the part of the gas pipeline again. This is because the existing pipes are not suitable for future use.	Policy and Planning for acknowledgment. (b) If the authority agency considers that revising the Project details or measures may affect the essence of the EIA report approved by the expert committee, the authorized agency shall submit the revision report on the Project details or environmental impacts preventional and mitigation measures or measures to environmental impact monitoring program to the Office of Natural Resources and Environmental Policy and Planning to propose to the expert committee. When the Project has changed details or improved the measures according to the expert committee comments, the authorized agency shall acknowledge the results of the changes to the Office of Natural Resources and Environmental Policy and Planning. (7) When the Project's operation is in the steady-state and the emission of an air pollutant is lower than the values set in the measures, the Project shall use that as a control level and notify the Office of Natural Resources and Environmental Policy and Planning as soon as possible. (8) Hin Kong Power Company Limited is required to obtain permission to use the area for pipeline installation from the landlord and the licensing agency before starting the construction of the Project.
- Which country does the project use technology from? **(government agency: representative of Huai Phai SAO)**	Group 4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2[nd] meeting.	**Clarification in PP1** - Machines using in the project are currently in negotiations with two options: from Japan or Germany. It is the latest technology and has a high efficiency in eliminating pollution. For the management during the operation phase, staff from the Electricity Generating Authority of Thailand (EGAT) will control the production operation.	
- Require the project to measure air and groundwater qualities prior to construction. **(Community leader: Moo.8 , Ban Nong Kham, Huay Phai Sub district)***	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2[nd] meeting.	**Clarification in PP1** - The project has already measured for air, noise, soil, groundwater and Mae Klong River quality. The measurement was done in both seasons, the results of the measurements will be presented at the 2[nd] meeting.	
- Gas turbine generators, steam turbine machine and steam generators locating near the community area, which may affect neighboring communities. **(Public : Moo.6, Ban Nong Sadao Bon, Hin Kong Sub district)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - The project has been designed to reduce noise at sources such as buildings covered the noise source, noise reduction equipment and control the volume at the edge of the fence not more than 70 dB (A) as required by law. The area connecting to the community has considered to have soundproofing lines to reduce the impact. However, after the project has established measures, the project will	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
				monitor the noise levels from 2 stations nearby the area, twice a year for 7 consecutive days. Summary will be done and inform the community.	
(2) Air quality					
- The previous operation of the project have affected the environment, such as worsened weather, dust, oil stains, hot weather and noise, which can be caused by many factors. People in the area are concerned about taking care of the communities around the project based on their experience. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, public : Moo.6 Ban Nong Sadao Bon, Hin Kong Sub district, Community leader: Moo.4 , Koh Phlapphla Sub district, government agency: representative of Wat Huay Phai School)**	Group 1,4,5		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - There are both positive and negative aspects of development activities at this time. Negative or bad things occurring in the past or issues in concerns should be raised and help plan. In the past, the project establishment process can be easily performed and obtained permission. However, at present, the Environmental Impact Assessment report (EIA) must be done with measures to take care of the community. The project must follow established measures as laws that the project must comply with. Failure to do so, the project then have to pay a fine. The government has tried to set regulations to control operators to operate according to the law. - Building trust in the community, not just when new projects entering the community, project therefore went to meet with the community. However, in the future, there must be a project staff visiting communities as suggested, to build more trust in the community. At least, this meeting is a way to listen to the problem and to improve new projects in the future.	**During Construciton:** (1) Spray water around the Project construction area and the road to the entrance-exit at least twice a day (morning and afternoon), consider additional spray when the weather is dry and windy to prevent dust from spreading into the atmosphere and affecting adjacent communities (2) Use canvas to cover the trucks or construction materials that may be diffuse, such as soil, cement, etc. during transportation (3) Clean truck wheels before leaving the construction area onto public roads to prevent dirt from creating contamination (4) Limited truck speed within the construction area of the Project not more than 20 kilometers per hour to reduce the dispersion of dust (5) Check the condition and maintain the vehicle/engine/machinery used in construction regularly according to the period specified in the engine/machinery maintenance manual to control the pollution emission to meet the design criteria (6) Stop the engine/machine every time it is idle (7) Do not burn materials or solid waste in the construction area (8) Control the contractor to clean up debris in the construction and adjacent areas which may be
- Should install a dust measurement station in every Sub district, at least 1 station per Sub district. **(Community leader: inspector of Don Rae Sub**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no	**Clarification in PP1** - Air quality monitoring was done by a random inspection station for every 6 months in each area. For the installation of a permanent air quality	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
district, media representative)			questions in this part at the 2nd meeting.	monitoring station, the project will consider the impacts and affected areas. The most impacted point is assigned to represent the area in the environmental impact assessment.	washed down by rainwater down the drainage gutters such as debris, sand attached to truck wheels, plastic bags, paper waste, etc. **Operation Period:** 1) The project must control the air pollutants emission not to exceed those specified in the environmental impact assessment report at dry conditions, temperature of 25 °C, pressure of 1 atmosphere and excess oxygen volume of 7% as follows: In case of using natural gas as fuel **Full load operation** - Nitrogen dioxide not exceed 59 ppm at 7% O_2 and not exceed 59.00 grams per second per stack - Sulfur dioxide not exceed 10 ppm at 7% O_2 and not exceed 13.90 grams per second per stack - Total suspended particulate not exceed 20 milligrams per m^3 and not exceed 9.70 grams per second per stack **Minimum generation load operation** - Nitrogen dioxide not exceed 59 ppm at 7% O_2 and not exceed 6.70 grams per second per stack - Sulfur dioxide not exceed 10 ppm at 7% O_2 and not exceed 8.60 grams per second per stack - Total suspended particulate not exceed 20 milligrams per m^3 and not exceed6.10 grams per second per stack In case of using diesel as fuel **Full load operation** - Nitrogen dioxide not exceed 99 ppm at 7% O_2 and not exceed 81.40 grams per second per stack - Sulfur dioxide not exceed 20 ppm at 7% O_2 and
- Did project invite government agencies to monitor the emission rate that releasing to outside or not? **(Question sheet : Chedi Hak Sub district)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The rate of pollution emissions that the project emits to the outside when measuring by an automatic detector, it cannot edit numbers. The emission rate was set as a condition in the EIA report and in the license which is considered as a law that must be followed. If the violation occurred, it was illegal. For the inspection, it will be done by the audit agency as the central agency or the legal registered consulting company to perform the measurement as hiring by the project. If the public had no confidence in the agency performing the measurement, a joint committee would be involved for further monitoring the environmental impact.	
- For environmental quality measurement results of the agency that the project hired, was the measurement result biased? **(Public : Moo.9 , Ban Huay Moo, Chedi Hak Sub district)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The organization that had been assigned to monitor and inspect the environmental impact must properly register. The same protocol applies to the consulting company that providing EIA report to the project. Despite being hired, the consulting company must prepare a report by using only truthful information. If false information occurred, when people make complaints, the consulting company will be forfeited the work permit immediately. If the public was unsure, they could participate in the investigation. - The representative of the Provincial Environmental Resources Office explained that in preparing the	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
				impact assessment report or EIA, the authorized agency is the Office of Natural Resources and Environmental Policy and Planning or ONEP, which has an expert committee to review the report done by the consulting company. The report will be reviewed by an expert team in various fields, both from government agencies and educational institutions. The committee would make recommendations to the project for further study and improve the report, in order to complete and correct such report. From the past experience, it was found that the EIA report was not considered just once.	not exceed 22.90 grams per second per stack - Total suspended particulate not exceed 35 milligrams per m^3 and not exceed 14.0 grams per second per stack **Minimum generation load operation** - Nitrogen dioxide not exceed 99 ppm at 7% O_2 and not exceed 67.8 grams per second per stack - Sulfur dioxide not exceed 20 ppm at 7% O_2 and not exceed 19.10 grams per second per stack - Total suspended particulate not exceed 35 milligrams per m^3 and not exceed 11.70 grams per second per stack 2) Provide a continuous emission monitoring system (CEMs) at 2 HRSG stacks to monitor gas velocity, temperature, excess oxygen, nitrogen oxide (NO_x), sulfur dioxide (SO_2), and total suspended particulate (TSP) and install a display monitor to show contents of nitrogen oxide (NO_x), sulfur dioxide (SO_2), and total suspended particulate (TSP) in front of the power plant throughout the operation period 3) Set alarm configurations from CEMs based on nitrogen oxides (NO_x) control values, which are set to 59 ppm, set two alarm levels: high and very high level, actions upon hearing the warning alarm are as follows: - In the event of a high alarm set at 85% of the controlled emission rate, the operator in the control room monitors the operation of the power generating unit and the discharge control device of that unit along with urgent maintenance or correction of detected malfunctions - In the event of a high high alarm set at 95% of the controlled emission rate, the operator in the
- Measurement of PM 2.5 dust had no information reporting to villagers. This caused villagers to not know the current weather information. **(Community leader: Moo.1 5 , Ban Nong Song Hong, Koh Phlapphla Sub district)***	**Group 1**		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The consulting company would like to bring the above issues for further study and the information would be presented at the 2nd meeting.	
- People living nearby the project found oil soot stain deposits. Is there any solution? **(Community leader: Moo.1 1, Ban Thung Noi, Hin Kong Sub district)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - For soot stains found on the roof of households, it may be caused by combustion of a type of fuel which the project could not determine. However, the project has to prove for the cause. But the nature of the power plant production does not generate soot or oil vapor due to it is the natural gas-fired project. Even small particles were found in very small amounts. However, at present, there is an increase in community activities from the past such as transportation, burning of fields, etc. If soot stains occurred again, the project would prove for the cause together with the community.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
- Does diesel fuel used by the project would cause oil stains to fall on the roof of houses or agricultural areas or not? **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - Project selects the combined cycle power plant technology with natural gas as the main fuel. Diesel will be used as a backup fuel, in an emergency case (in the event that there is no natural gas supply). The reserved fuel will be lasted for 3 days only. Diesel is obtained from a domestic oil distribution company and transported to the project area by truck. Diesel will be stored in a reserve tank in the project area.	control room will reduce the excess air volume to return to normal. If still unable to fix, the Project will consider reducing production or stop producing electricity to improve the operation of the system to be able to work normally first before resume the production again. 4) In case of using natural gas as fuel, control emission of nitrogen oxides (NO_x) by using the dry low NO_x (DLN) control system and in the case of using diesel as fuel, control the emission of nitrogen oxides (NO_x) by using the water injection control system 5) Air pollution management a) Set a guideline for the concentration of air pollutants (NOx) monitored from the CEMs not to exceed the alarm levels (excluding start up and shutdown) as follows: - Check the relevant production process, e.g. tendency of the pollutant concentrations readings from CEMs, examine whether the measured concentrations are wrong, etc. - Check the relevant equipment such as the CEMs system, if the fault is caused by the measuring device or caused by CEMs fails/error, find the cause and solution. If it cannot be fixed by the staffs, call CEMs service provider to fix it, etc - Inspected the production process and maintenance areas, if it is found that the control value is still over, reduce the
- If the incomplete combustion occurs, will it cause dust or not? And does dust affect the community or not? **(Government Agency : representative of Huai Phai SAO)***	Group 4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - Dust will not occur because the project uses natural gas and has a filter to help absorb dust. However, the consulting company accepts the issue for further study and will clarify at the 2nd meeting.	
- In the past, villagers were able to consume rainwater. But when there was a power plant in the area, villagers were not be able to consume rainwater. **(Community leader: Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, community leader: Moo.12, Ban Huay Champa, Koh Phlapphla Sub district)***	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - Regarding the quality of rainwater, the consultant company would like to study the said concern and clarify at the 2nd meeting.	
- At present, the area already has various pollution problems, the operation of the project may cause additional problems. Thus, measures or approaches to prevent the consequences should be established. **(Community leader: Moo.11, Ban Thung Noi,**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - For the air quality from the presentation, the project collected air quality samples before the project establishment to check the condition and to know whether what does the post-air quality impact assessment look like? For the impact assessment, the	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
Hin Kong Sub district, public : Moo.5 , Ban Nong Chok, Chedi Hak Sub district)				consulting company combined current air quality measurement results with the power plant emission forecast in the future. It was found that assessment results were in the standard and safe for health. However, when a power plant established, the project will monitor the air quality in the community. Once results were done, a summary report would be prepared and posted to the community or the SAO for further acknowledgment.	production capacity. - Record the cause of the problem and duration of each b) Provide an air pollution control system controller according to the relevant regulations of the Ministry of Industry to control the operation of the treatment system effectively c) Continuous check air quality monitoring instruments (CEMs) annually throughout the project life span d) Provide a plan for inspection and maintenance of the air pollution emission system to work effectively in a normal condition regarding to the design criteria
- The operation of the project may cause the weather to change and causing impacts on agricultural crops and may cause various diseases accordingly. (Public : Moo. 4 , Ban Don Chaeng, Moo.1 0 , Ban Suandokmai, Don Tako Sub district)		Group 1	Increased Since it was a continuous question from the clarification in meeting.	Clarification in PP2 - From the study of the heat level of existing the power plant in Ratchaburi, it was found that the heat level was no difference between the area of the power plant and the surrounding areas. - However, studies have shown that agricultural production depends on various factors such as water, air, light. In this study, the criteria of World Health Organization (WHO) was used for the comparison, study results were in the low level and was not harmful to plants.	
- Concerned about the impact on quality of life, in terms of health, environment and agriculture. (Community leader: Moo.6 , Ban Don Kok, Don Rae Sub district)		Group 1	Increased Since it was a continuous question from the clarification in meeting.	Clarification in PP2 - The study of environmental impact is the forecasting of the impact by using model and academic principles to find appropriate prevention measures. When the operation is open, there will be continuous environmental quality measurements. Results would be summarized and disseminated to the community.	
(3) Noise					
After installation of silencer, the community still have impacts.	Group 1,4		Decreased Since the consulting company	Clarification in PP1 - The way to design machines, equipment, devices	Construction Duration 1) No noise-inducing construction activities during the

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
(Public : Moo.6, Ban Nong Sadao Bon, Hin Kong Sub district, community leader: Moo.8 , Ban Nong Kham, Huay Phai Sub district, government agency: representative of Huai Phai SAO)			had presented the information, therefore there were no questions in this part at the 2nd meeting.	with different pressures, in case of pressure build up the pressure must be ventilated with a safety valve device. While the pressure occurs, a safety valve will work and noise occurs. Without a silencer, the noise will be very loud. How much the silencer could reduce the noise level depends on the silencer design. However, it is able to minimize the impact of the noise for a shorter duration. TECO power plants had been designed for more than 20 years. The design being inconsistent with the living conditions of the community today. In this regard, the new project in the future will be consistent with the living conditions of the community and use more modern technology. This will be able to reduce the noise impact to people in the area. Beside control and prevention, if there was an emergency, the project would have a fast moving unit to notifying the community, in order to reduce anxiety.	period of 17.00 - 07.00 o'clock of the next day in order to reduce the impact on the community during the period or if there is a need for activities that cause noise, the Project must notify people in the community and the households surrounding the power plant at least seven days in advance **2)** Install a temporary soundproof wall around the house behind the power plant (Southside of the Project) by using steel material, 18 ga, with a height of 5 meters **3)** Choose construction equipment and machinery that has low noise levels and always perform maintenance checks to reduce the noise level **4)** Provide noise protection equipment such as earplugs or earmuffs to construction workers in the areas where the noise level is higher than 85 dB(A) **5)** Install signboards or symbols to wear personal protective equipment in the areas with high noise levels according to the hazardous area classification by the safety officer **6)** Publicize construction plans and noise control measures to people in the community and the households surrounding the power plant **7)** Provide the Project's staffs to visit the area to inquire of the communities and households surrounding the power plant about the noise impact from the Project's construction activities periodically throughout the construction period in order to find ways to mitigate such impacts **8)** Continuously coordinate with communities and households surrounding the power plant to build
- Previous operation of Tri Energy Power Plant caused noise impact. What was the cause? **(Public: Khao Ngu Sub-district Municipality)**		Group 1		**Clarification in PP2** - The occurred noise was the noise from the natural gas distribution station. The Tri Energy Power Plant has coordinated and informed the relevant departments for corrective actions.	
- Concerned about the noise impact on the community. **(Community leader: Moo.3, Ban Rak Makham, Huay Phai Sub district)**	**Group 1**		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The noise will be measured while the machine is working. The project can operate when the noise level is in the standard level without causing any impacts. If the noise level exceeded the standard, the project would not be allowed to operate. - During the past, there was a loud noise in the project	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
				area because a gas drain system. But for this project, there will be a new pipeline in the same line, in order to work more efficiently.	good relationships and find solutions to problems together as well as coordinating with community leaders and related agencies to provide assistance, support, and problem-solving for people affected by the operation of the Project. In the case that there is an impact that is directly caused by the operation of the Project, the project shall compensate for any damages as appropriate. **Operation Period** 1) Install a device to reduce the noise level at a machine that generates noise such as installing silencer at HRSG 2) Perform regular checks and audits the performance of the silencer 3) Provide signs or symbols to indicate such areas where the noise exceeds 85 dB(A) 4) Provide personal protective equipment such as ear muffs or earplugs for employees working in areas with noise levels higher than 85 dB(A) 5) Specify high noise level areas, provide signs or symbols to indicate such areas where the noise exceeds 85 dB(A) and people who will work in the area must wear noise protective equipment such as earplugs or earmuffs 6) Manage to prevent employees from being exposed to noise levels for a long time, such as setting the length of work to reduce the time that employees are exposed to noise, staff switching/working day switching in noisy areas, etc. 7) Prepare noise contour around the Project area at least once within the first year of operation and revise every 3 years
Can the installation of sound barrier reduce the impact? **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**		**Group 1**	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - The project has assigned the contractor to use construction equipment at high noise levels only during the time 08.00-17.00 hrs. For construction areas near the community that may be affected, a barrier with steel sheet or other materials that have the ability to reduce noise and remove easily would be installed in the construction area and around noisy devices. If construction activities cause more noise than usual, the project will informed the surrounding communities at least 7 days in advance. - In addition, during the construction the project has established measures to monitor noise levels in 2 stations which locating near the project for a period of 7 consecutive days. Results will be summarized and informed the community.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
(4) Water for consumption					
Guidelines for water management from the Mae Klong River. **(government agency: Office of Public Works and Town Planning, Ratchaburi)***	Group 4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The consulting company would like to bring the above issues for further study and the information would be clarified at the 2nd meeting.	**Construction Period** 1) Require a contractor to supply sufficient water for construction activities 2) Require a contractor to provide clean, hygienic, and sufficient drinking water for construction workers **Operation Period** 1) Provide a raw water reservoir with a capacity of 92,838 m^3 to reserve water for use within the Project (reservation valid for at least 3 days)
(5) Water quality and wastewater management					
- How does the project manage rainwater and wastewater contaminated with chemicals? **(Community leader: Moo.1 0 , Ban Suandokmai, Don Tako Sub district)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - Most of chemicals using in the project are chemicals for improving the quality of the water to be suitable for the consumption, prevent slag in the water pipes, steam boilers and cooling systems, etc. Such chemicals are transported to the project by trucks. It will then be stored inside the chemical storage building and working area. Therefore, chemicals will not contaminate with the rainwater. Various types of chemicals are stored according to their properties to ensure the safety of the reaction between sensitive chemicals, in particularly, flammable materials which must clearly store in the separate area. - For making rainwater ponds, it is usually done to prevent flooding in the surrounding area. In case of rain water contaminating with lubricant, it will be sent to the wastewater treatment system of the project before releasing to the holding pond.	**Construction Period** 1) Provide adequate toilets that equipped with sewage storage tanks for the construction workers as required by law before contacting the authorized agencies to get rid of them 2) Require the contractor to clean up the sediment and construction debris such as cement, concrete, etc. that have fallen in the area to prevent the leaching of rainwater into the surrounding drainage gutters 3) Store construction materials in an appropriate area without obstructing the drainage and provide workers to regularly clean the drainage gutter to prevent clogging 4) Make sure the workers do not litter down the drainage gutter to prevent clogging 5) In vehicle maintenance and all kinds of machines must be performed in a specified area or on a hard surface and has a leakproof material to prevent leaks

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
					into the outside water source **Operation Period** **Cooling tower management** **1)** Before discharging wastewater from the power plant, it will be stored in reservoirs. Reservoir No. 1 has the capacity to hold water for at least one day. Reservoir pond No. 2 will have the capacity to hold water for at least 1 day as well. In order to prevent leakage, each reservoir will be lined with HDPE or concrete. In normal operation, the second reservoir is kept dry for an emergency reservoir. **2)** Install online monitoring systems to check the temperature, pH, and electrical conductivity (to determine total dissolved solids) in the area of the cooling tower basin and sewerage of the Project. Wastewater must meet the standard before discharging into the Mae Klong River. **Waste water management** **1)** Provide an oil separator to separate oil and grease from wastewater that is contaminated with oil **2)** Provide adequate sanitary toilets for employees as required by law as well as providing a ready-made wastewater treatment system or a septic tank to treat wastewater from consumption of employees **3)** Control the characteristics of the effluent according to the Notification of the Ministry of Industry B.E. 2560 (2017) on Effluent Standard

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
(6) Waste management					
- How did the project manage waste, solid waste and various sewage both during construction and demolish of the project? **(Community leader: Moo.1 0, Ban Suandokmai, Don Tako Sub district)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The project will collect waste and keep it in the waste collection building before sending it to the industrial waste disposal agency licensed by the Department of Industrial Works for further disposal.	**Construction Period** 1) Separate the wastes from construction and wastes from workers. Provide adequate waste containers with lids to collect waste generated within the Project area before transport to the storage point (at least once a day) before coordinating with the waste disposer who is authorized by law to dispose of in a sanitary manner. 2) Collect and separate wastes so that some can be recycled, reused, or resell. 3) Do not burn trashes in the project's area 4) Make sure the contractor instruct the workers to not throw trashes into the water drainage system **Operation Period** 1) Provide adequate waste containers with lids to collect waste generated within the Project area before transport to the storage point before coordinating with the waste disposer who is authorized by law to dispose of in a sanitary manner. 2) Waste from production shall be strictly managed in accordance with the Ministry of Industry Notification B.E. 2548 (2005), on the Disposal of Waste and Unused Materials or other relevant laws. The waste generated from the Project must be sent to a waste disposer that has been approved by the government agency. 3) Waste from the RO water production unit such as Multimedia Filter, Cartridge Filter, and RO membrane will be sent to a waste disposer that has been approved by the government agency. 4) General and office waste shall be managed properly,
- Can treated water draining into the creek branches be used by farmers or not? **(Public : Don Rae Sub district)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - The amount of treated water of the project is not much. At present, Tri Energy Power Plant has drained the water to Mae Klong. The project has planned to drain treated water into the Mae Klong River as before.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
					such as recyclable waste shall be sold to the purchaser who has been licensed by the government agency to reduce the amount of waste that must be disposed of 5) Record type and amount of the waste. Then record the location where the wastes are sent to 6) Set up temporary waste storage for wastes that are yet to be sent to the contracted agency. 7) Inform and ask for permit from the Ministry of Industry in transporting wastes out of the area in accordance with the law.
(7) Transportation					
- Transportation during the construction should consider selecting the route that passes the least community area, in order to prevent traffic jams and accidents. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, community leader: Moo.5, Ban Don Tan, Don Rae Sub district)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	Clarification in PP2 - The consulting company assessed the impact on both the construction and the operation phases. For the construction phase, the transportation of large machines has to be coordinated with the traffic police to plan the transportation and facilitate the transportation to minimize the impact on the public and avoid the transportation during rush hours, in order to reduce the traffic jam. Controlling of vehicle speed limit was required within construction areas and areas passing through dense communities. During the operation phase, the transportation will consist of vehicles transporting chemicals and employee. The chemical transportation of the project will be coordinated with the distributed company before importing into the project, in order to prepare and reduce the risk of unnecessarily waiting for unloading in the project area.	Construction Period 1) Manage transportation and traffic direction in the project's area. Set up officers to oversee the entrance and exit of the construction site. 2) In the case of transportation of large machines, coordinate with the traffic police to plan transportation, and facilitate transportation to minimize impacts on the traffic. 3) In community area, the speed of the vehicle in the construction shall be limited to not more than 20 kilometers per hour by notifying the contractor and putting up a speed limit sign in the construction area. 4) Inspect the engine conditions of construction trucks and transport vehicles in accordance with the vehicle maintenance manual throughout the life span and check for readiness and safety before use. 5) Control the weight of the transport truck /

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts, prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
				- The project opened the project coordination center locating in Huai Phai Roundabout. In the event that the community received impacts or coordinated in supporting activities, the community can contact the Project Coordination Center or contact via contact numbers at the end of the meeting document.	vehicle in accordance with the law 6) The contractor company is required to train and control the drivers to strictly comply with the traffic rules 7) Manage the traffic systems in the construction area accordingly, during rush hours (7.00-8.00 o'clock and 16.00-17.00 o'clock) the Project must provide staff to assist in facilitating and organizing traffic around the entrance-exit area of the Project. 8) The Project shall request contractors to plan the use of transportation routes for construction machinery/equipment by avoiding the transport routes that pass through the community as much as possible and to use the speed not exceeding the strict legal limit. 9) Put name and contact information onto the transport vehicles and construction materials as a way to receive complaints. Set up officer to manage traffic on the entrance and exit of transportation vehicles and avoid areas with traffic to minimize impacts on the community Operation Period General Measures 1) Provide training and educate drivers about the transportation procedure, action in case of emergency, and other relevant regulations as well as requiring drivers to strictly abide by traffic rules 2) Limit the speed of the vehicle within the Project area not to exceed 20 kilometers/hour and install speed control signs and use speed as of

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
					law when passing through community areas 3) Avoid using commuter routes that pass through communities in the morning and evening which is the rush hour (7.00-8.00 o'clock and 16.00-17.00 o'clock) to reduce the impact from the transportation that may occur **Safety measures in the transportation of chemicals** Transportation of hazardous substances to be safe for the community, property, and the environment the transportation operator must comply with the safety procedure and relevant laws and standards, such as the Hazardous Substance Transportation Manual of the Pollution Control Department, September 2011, Hazardous Substance Management Manual, July 2013, the Notification of the Department of Industrial Works on Hazardous Substances Storage Handbook B.E. 2550 (2007), and the Notification of the Department of Industrial Works on Transportation of Hazardous Substances B.E. 2558 (2015). For instance: - Request a transport license - Provide labels and signs on chemical transportation vehicles in accordance with the requirements of the Department of Land Transport - Arrange and transfer chemicals correctly and safely - Prepare chemical safety data sheet (SDS) about the hazard characteristics according to the properties of that substance both Thai and English - Provide personal protective equipment and equipment for chemical transportation vehicles - Provide training for drivers to have knowledge

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
					and understanding of the hazards of chemicals and to have the skills to drive vehicle safety as well as being able to fix basic problems when there is an emergency
(8) Drainage and flood prevention					
- Concerns about draining and flooding problems. **(Community leader: Moo.1 5, Ban Nong Song Hong, Hin Kong Sub district)**	**Group 1**	Group 1	**Increased** Since the consulting company presented the information but the participants still had concerns. In this regard, the consulting company clarified and established additional measures.	**Clarification in PP1 and PP2** - The project will improve measures to avoid repeated impacts.	**Construction Period** 1) In case of sediment and construction debris such as cement and concrete flows into the rain gutter, the contractor shall dredge sediment and debris immediately 2) Construct a temporary drainage channel and a sedimentation pond to collect sediment from rainwater into the sediment pond before draining or using water in the area 3) Control construction workers not to throw waste into the gutter to prevent clogging 4) Clean the waterway regularly 5) Check for clogging conditions and perform temporary drainage channel every month 6) Do not to throw waste into the gutter or nearby water sources **Operation Period** 1) Provide a rain gutter around the building or production units to handle the uncontaminated rainwater before sending into the Project's rain gutter 2) Check the drainage system in the Project area to be in good condition at all times so that there are no obstacles in the water flow and if it is found to be damaged, fix immediately 3) Provide a rain retention pond with a total
- Concern about the problem of flooding in community areas. - Propose to define measures for prevention management and the compensation in case of flooding in affected communities and agricultural areas. **(Public : Moo.6, Ban Nong Sadao Bon, Hin Kong Sub district, community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, Moo.10, Ban Suandokmai, Don Tako Sub district)**	Group 1	Group 1		**Clarification in PP1 and PP2** - For the current drainage of the area around the power plant, it was found that the direction of the river flows was from west to east and flowed into the Mae Klong River. From examining the current drainage of the TECO Power Plant and the Hin Kong Power Plant development area, it was found that the area drained water into the canal on the north of the power plant. The north drainage ditch will drain the water from the rain falling in the catchment area to prevent the impact of local drainage. The project has designed a rainwater drainage system in the project area to collect into 2 rainwater retention ponds and manage the drainage without changing the flow rate of the drainage canal and within the capacity that the canal can support. - However, at present during the rainy season, the surrounding area is affected by flooding. If the surrounding communities were in trouble, the project would willing to support and assistance by coordinating with local authorities to discuss the mitigation of further problems, such as providing water pumps, etc.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter 1/ By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
					capacity of at least 14,875 m^3 (excluding freeboard) to control the drainage rate from the area 4) Set up oil-water separator to separate oil out of the oil-contaminated waste water 5) Clean waterways during the dry season every year to maintain the drainage efficiency of the Project area
(9) Occupational health and safety					
- If there was a leak and chemical transportation, what would be the prevention measures in the project? **(Government agency: representative of Huai Phai SAO)**	Group 4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The project has followed the Storage of Chemicals and Hazardous Substances Act. The project selects the transporter with Type 4 of the transport permit. However, details will be presented and clarified at the 2nd meeting.	**Construction Period** 1) The Projects must clearly state an agreement on occupational health and safety measures with the construction company in the contract of employment. It must include methods to protect the safety and health of the employees working in the Project. 2) Clearly and strictly define the working area boundary and work permits 3) Have work permit control system (especially for works related to heat, electricity, and confined space) 4) The safety officer of the Project with knowledge of occupational health and safety as required by law shall coordinate with the safety staff of the contractor company to supervise and monitor the working safety conditions of the employees. 5) Provide training for employees prior to work on occupational health and safety along with accidents prevention 6) Provide warning signs in the construction area, dangerous area, and areas requiring personal

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
					protective equipment 7) Provide protective equipment such as dust masks, ear muffs and/or earplugs, helmets, gloves, and safety shoes as appropriate to the nature of work performed and strictly control the use of personal protective equipment.
- Which kind of chemical agents does the project used? And what kind of effect? **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - Most chemicals using in the project are chemicals for the water quality improvement for further consumption. They are similar to chemicals used in the production of tap water. These chemical are also used to prevent scale build-up in pipes, boilers, steam boilers and cooling systems. - For the chemical transportation into the project, it is transported by trucks. Chemicals will then be stored in the chemical storage area and the work area. Properties of chemicals are mostly corrosive to direct contact. The project placed different types of chemicals in accordance with their properties for the safety from the reaction between sensitive chemicals.	
(10) Health					
- Concerned about the health impact to the community. **(Community leader: Don Tako Sub district)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The project has studied health problems for both short-term and long-term impacts and the information will be presented at the 2nd meeting.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
- Will the chemicals used by the project have any impact on public health? **(Government agency: representative of Huai Phai SAO, government agency: representative of Huay Phai School)**	Group 4,5		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - Most chemicals using in the project are chemicals for improving the quality of the water to be suitable for the consumption, preventing slag in the water pipes, steam boilers and cooling systems, etc. Such chemicals are transported to the project by trucks. It will then be stored inside the chemical storage building and working area. Therefore, there is no impact to the public.	
- How does nitrogen oxides contaminated in the air affecting health? **(Government agency: representative of Huai Phai SAO)**	Group 4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - Nitrogen oxide gas has a weak acid effect. When inhaling with moisture, it causes respiratory irritation. The project therefore has to control air pollution values at stacks and community areas. The value of nitrogen oxide gas in the community area must meet the standard of the Pollution Control Department.	
(11) Socio-economic					
Publicize results of air quality measurements in the area to the public through various channels **(Community leader: Moo.1 5, Ban Nong Song Hong, Koh Phlapphla Sub district, government agency: representative of the Internal Security Operations Command of Ratchaburi, government agency: representative of Huai Phai SAO, Media representative)**	Group 1,4,6		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The consulting company would like to bring the above issues for further study and additional clarification will be presented at the 2nd meeting.	1) **Pre-construction period** **(a) Provide appropriate support to activities within the community to build good relationships with communities such as:** (b) Establish an environmental inspectorate which will complete the appointment before construction, details are as follows:
- Air quality measurement results should be publicized through various channels. **(Government agency: representative of Khao Ngu Sub district Municipality)**	Group 4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The project provides a display of air quality measurement result in front of the project area.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
- The presentation showed that the project has measures to the problems. But in the past, when the accident occurred, the problem could not be resolved. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - This meeting is not organizing for the approval of the project. It is a meeting to listen to comments of the people in the area. It will be found that since the registration process, the registration form had a letter indicating that the registration was not an approval / permission of the project. But it was for the registration to attend the meeting only. Therefore, the project would like all participants to share their opinions, in order to bring the problems occurring in the past to be further modified. This stage would like everyone to express their opinions and reflect problems of the original power plant to improve the new project, so that, the power plant can coexist with the community.	**3) Operation period** (a) Consider hiring qualified local workers who meet the project criteria as first priority to help local people get jobs and to foster a positive attitude towards the community by disclosing information on vacant positions to the community (b) Public relations to create understanding with the community and to reduce anxiety as follows: - Public relations to create more knowledge and understanding about the Project by creating a network to work with the community especially information on effective power production and pollution control efficiency as well as action plans related to environmental impacts - Prepare a document presenting details of the power plant and pollution prevention system in a readable manner to create a good image for the power plant - Coordinate with community leaders to organize groups of villagers to visit the power plant from time to time to build understanding and good relationship with the community - Coordinate and attend meetings with key local agencies or organizations to clarify the results of operations to resolve impacts and to disclose new policies and guidelines to be implemented (c) Support the community in activities that help to build up the confidence of the community, such as:
- The issues that must be resolved should be taken from this hearing forum to define a measure and must communicate with people for their understanding. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, government agency: representative of Regional Environment Office 8, government agency: representative of Muang Ratchaburi District)**	Group 1,4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The meeting is a participation process that emphasizes the exchange of ideas. As early informed at the beginning that joining the meeting was to establishing a problem and seek for a solution together. One thing was that there was no confidence in the original power plant operation, resulting in a mistrust of new projects in the future. Normally, for the consideration of the EIA report, the Office of Natural Resources and Environmental Policy and Planning (ONEP) requires the consulting company to analyze old problems, what problems are there? Is there any chance that the same problem will happen again? And how to prevent and mitigate such impacts, including establishing measures for the project to be implemented. Comments from	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
				everyone appear in the report as the starting point showing needs of villagers. Therefore, we would like everyone to use the forum for sharing comments on the project for further improvement and correction.	- Disaster relief training program, first aid training program, information exchange (methods and channels) between the power plant and the people
-The project should support activities of the community such as education, utilities and careers. The project should arrange a fire truck to help the community in case of emergency. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, Community leader: Moo.8, Ban Nong Yai Kata, Hin Kong Sub district, community leader: Moo.8, Ban Khao Ngam - Baan Klang Thung, Don Tako Sub district, government agency: representative of Don Rae SAO, government agency: representative of Don Tako SAO)**	Group 1,4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - For the community and social work of the project, its concept is divided into 2 parts which are; - Part 1, the development fund around the power plant in accordance with the law. The project must allocate the fund into 2 phases: the construction and the operation phases. - Part 2, the project provides a public relation budget for activities with the community. In the operation, needs of the community are mainly considered.	- Organize a tree-planting project to increase green areas in the community and adjacent areas to reduces the anxiety about the heat (d) In the event that damage is found to be caused by the operation of the Project, the company will set up a compensation committee for further consideration of appropriate compensation guideline (e) Emergency preparedness and operation in the case of emergency shall be prepared with a 24-hour emergency receiving system. The Project shall provide a list of telephone numbers of local authorities that need to coordinate in the event of an emergency such as municipalities/SAO, local police stations, disaster mitigation authority, hospital, etc.
- Project supported the budget for the village health volunteers for public health care. **(Community leader: Don Tako Sub district)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The health impact was divided into 2 parts: impact on increasing the burden of health care for local healthcare workers and the air impact on the health of the community. However, the project had measures to prevent such impacts. The consulting company will bring results of studies and prevention measures to clarify at the 2nd meeting. - Measures to support general public health services of the project are the support of medical equipment, budget for staff. However, the consulting company will take the measure into account and present to the public in the 2nd meeting.	
- In the past, the surrounding communities lacked care and attention from the project.	Group 1		**Decreased** Since the consulting company	**Clarification in PP1** - This meeting is a meeting to listen to comments and	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
(Public: Khao Ngu Sub-district Municipality)			had presented the information, therefore there were no questions in this part at the 2nd meeting.	problems that arise with the community for further improvement. In the next meeting, the project would like the public to participate in order to present the progress of some concrete actions.	
- The meeting only invited village chief and headman. Volunteers, village / community committee, women and housewives should be invited as well. **(Public: Khao Ngu Sub-district Municipality)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The consulting company will continue to improve the meeting. However, in conducting an impact study, the consulting company will conduct a survey by questionnaire with the government agency, leader group and people in the area again.	
- Is there an indication for the meeting for the public hearing? And what percentage of participants have to be accounted for the population in the area? **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - In the public hearing meeting, there were unlimited number of participants and allows interested people to freely join the meeting and express their opinions on the project.	
- Increase the public relations of the project to be thorough and comprehensive. **(Government agency: representative of Huai Phai SAO, government agency: representative of Don Tako SAO)**	Group 4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The consulting company has channels to publicize news and receive opinions such as telephone/fax, e-mail and Facebook. The project will continue public relations to the public by posting on public relations boards of the local government organization.	
- Comments from a reply letter by mail should be added. The meeting minutes should be posted and distributed, so that, people in the area who did not attend the meeting can be informed. **(government agency: representative of Don Tako SAO)**	Group 4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The consulting company received comment for further improvement. However, after the meeting, there are also various channels shown in the meeting documents. Thus, everyone can express further opinions. Besides organizing a public hearing meeting, the consulting company will also visit areas to collect questionnaires from government agencies, leader groups and people in the area for the preparation of	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
				the report as well. Additional clarification - Fifteen days after the meeting, the consulting company will collect issues in a hearing meeting and summarize the meetings for various agencies and post in the community area for the public to be informed.	
- There shall be a meeting place at the center of the district. (Government agency: representative of Don Tako SAO)	Group 4		Decreased Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	Clarification in PP1 - The consulting company will take this issue for further improvement.	
- Propose to assign staff to take care of the defenseless people or organize a care center for the defenseless. - Thoroughly and comprehensive support and promote the quality of life of people both in the field of public health and education. (Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, Moo.11, Ban Thung Noi, Hin Kong Sub district, public : Moo.5, Ban Nong Chok, Chedi Hak Sub district, public : Moo.10,Ban Suandokmai, Don Tako Sub district, question Sheet: Huai Phai Sub district, government agency: representative of Khao Ngu Sub district Municipality)		Group 1,4	Increased Since it was a continuous question from the clarification in meeting.	Clarification in PP2 - The consulting company is aware of the importance of the environment, in order to achieve sustainable development and good relations with the communities nearby in the project area and create a balance between business and society by promoting participation in society. However, for determining the activities, the project will discuss and plan with the community for the implementation of social and community activities. - The project has allocated funds to support various activities of the community which are not related to the contributions to the Power Development Fund as follows: For the community development, the project will be implemented in coordination with the community. (1) Supporting the community by considering the needs of the community as each area has	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
				different needs. (2) The project should allow the community to write a proposal asking for the support.	
- Propose to increase the role of the tripartite committee, to provide more public relations of various information of the project to the public **(Government agency: representative of the Ratchaburi Provincial Energy Office)**		Group 4	**Increased** - Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - The project will take it into account for the consideration.	
- Arrange the staff to coordinate complaints. **(Government agency: representative of the Ratchaburi Provincial Energy Office, community leader: Moo. 3, Ban Nong Kham, Don Rae Sub district)**		Group 4	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - Community relations staff was assigned to coordinate various aspects and located around Huai Phai Roundabout. In the event that the community is affected or coordinated in supporting activities, communities can contact the project coordination center through the contact numbers at the end of the meeting document.	
Consider hiring local people as a priority and provide a guidance education for the youth in the area. **(Government agency: representative of Khao Ngu Sub district Municipality)**		Group 4	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - The project will take it into account for the consideration.	
- Ask about the budget to support the area. **(Question Sheet: Huai Phai Sub district)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - The project is awared the problem of accessing the community power development fund, therefore, the project created a budget to address the limited problem of funds. It can be used this part of the budget for the initial rescue. For the ratio of the budget presented by the project, it was just a model. In the meantime, there must be a meeting to discuss the budget and needs of the community.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
(12) Heat monitoring from the power plant					
- Concerned on the heat impact from the production system of the project. In this regard, is there any heat control in the system? **(Community leader: Moo.8, Ban Nong Yai Kata, Hin Kong Sub district, Community leader: Moo.10, Ban Nong Krathum, Hin Kong Sub district, community leader: Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, community leader: Moo.4, Koh Phlapphla Sub district, government agency: representative of Don Tako SAO, government agency: representative of the Royal Rainmaking Project, Ratchaburi)**	Group 1,4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The consulting company accepted issues for further study and will further present the information in the 2nd meeting.	1) Pre-construction and construction periods Indicator : Satellite images showing temperature data provided by Geo-Informatics and Space Technology Development Agency (Public Organization) or GISTDA or agencies/companies that can perform the study and analysis of satellite imagery by presenting surface temperature with satellites Monitoring area : Cover the Project construction area and air quality monitoring stations of the Project Duration/frequency : Three times prior to the commissioning to cover all seasons, summer season (mid-February to around mid-May), rainy season (mid-May To around mid-October), and winter season (mid-October to around mid-February), the Meteorological Department, www.tmd.go.th.
(13) Development fund for the community around the power plant					
- Regulations for the use of development funds of the power plant that were not conducive to needs of various projects of the people of the area. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, Community leader: Moo.8, Ban Nong Yai Kata, Hin Kong Sub district, public : Moo.14, Ban Karn KeaHa, Chedi Hak Sub district, community leader:**	Group 1,4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - In many areas, there were a lot of issues regarding development funds around power plants. Therefore, it was the origin of the community and social work of the project. Its concept was divided into 2 parts which were; - Part 1, the development fund around the power plant in accordance with the law. The project must allocate the fund into 2 phases:	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, community leader: Moo.12, Ban Huay Champa, Koh Phlapphla Sub district, community leader: Moo.3, Ban Nong Kham, Don Rae Sub district, community leader: Moo.4, Koh Phlapphla Sub district, public : Moo.5 Ban Mai, Don Tako Sub district, government agency: Hin Kong SAO, government agency: representative of Don Tako SAO)				the construction and the operation phases. - Part 2, the project provides a public relation budget for activities with the community. In the operation, needs of the community are mainly considered.	
- In the past, communities often encountered problems of spending budget from the power plant development fund		Group 1,4	**Increased** Since it was a continuous question from the clarification in meeting.	Clarification in PP2 - The project would coordinate to notify relevant departments for their awareness.	
- Koh Phlapphla Sub district was divided into 2 departments, namely Khao Ngu Sub district Municipality and Koh Phlapphla SAO. In the past, the budget only supported the Koh Phlapphla SAO. **(Community leader: Moo.11, Ban Khao Suan Luang, Koh Phlapphla Sub district)**	Group 1		**Decreases** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	Clarification in PP1 Additional clarification - For the fund operations around power plants, the project is just a person who allocate money to the fund. There will be a community development fund committee around the power plant who was appointed by the Energy Regulatory Commission (Office of the ERC), to manage the fund. This committee comprises of qualified persons as a representative of the government sector, representative of the public sector and representatives of the power plant. - However, the project operation is divided into 2 parts, which are; - Part 1, the development fund around the power plant in accordance with the law. The project must allocate the fund into 2 phases:	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
				the construction and the operation phases. - Part 2, the project provides a public relation budget for activities with the community. In the operation, needs of the community are mainly considered.	
- During the construction phase, will there be any payment to the development fund around the power plant? **(Government agency : representative of Don Rae SAO)**	Group 4		**Decreases** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The project must allocate the budget into the development fund around the power plant since the construction starts with an average of approximately 50,000 baht / MW / year.	
- For the increased electricity production, will the Power Plant Development Fund increase as well? **(Community leader: Moo.11, Ban Khao Suan Luang, Koh Phlapphla Sub district, community leader: Khao Ngu Sub-district Municipality, question sheet: Huay Phai Sub district)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - Power Plant Development Fund will increase by ratio of the electricity production.	
- What does the community development committee in the area surrounding the power plant appoint to do? Because this committee had never been invited to a Sub district meeting. **(Community leader: Khao Ngu Sub-district Municipality, question sheet: Huay Phai Sub district)**	Group 1		**Decreases** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The consulting company has recorded the issue and will send this issue to the Energy Regulatory Commission (Central unit) for their awareness, due to the power plant only has the duty to allocate budget to the fund.	
- Allocation of budgets for the development fund around the power plants in each Sub district should be charged on a per capita basis and increased according to population.	Group 1,4		**Decreases** Since the consulting company had presented the information, therefore there were no	**Clarification in PP1** - The consulting company has recorded the issue and will send this issue to the Energy Regulatory Commission (Central unit) for their awareness, due to the power plant	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
(Community leader: Moo.1 Koh Phlapphla Sub district, government agency: representative of Don Tako SAO)			questions in this part at the 2nd meeting.	only has the duty to allocate budget to the fund.	
- What are the procedures of the Power Plant Development Fund for the compensation to affected persons? **(Government agency : representative of Don Tako SAO)**	Group 4		**Decreases** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - If the power plant violated the law causing impacts to public, the project would be directly responsible for mitigating such impact. Letter to the governor or related agencies must be sent, in order to continue to perform remedies to impacts.	
Propose to establish a committee of community development funds covering every village. This committee should involve in various processes including publicizing the power plant activities to the community. **(Government agency: representative of Khao Ngu Sub district Municipality)**		Group 4	**Increased** - Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - The operation of the Power Development Fund is supervised by the Energy Regulatory Commission. The project only has the duty to allocate budget to the fund according to the law.	
(14) others					
- Can you stop building a power plant? If created, what would be the policy to look after the community? **(Community leader: Moo.3 , Ban Nong Kham Don Rae Sub district, Question sheet: Huai Phai Sub district)**	Group 1		**Decreases** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The consulting company would like to bring said issues back for the discussion, due to it is a duty of the project owner to taking care of the community. Anyway, it will be presented and clarified in the 2nd meeting.	
- If unable to reduce electricity bills for people. There should be a fund to support activities in the community.	Group 1,4		**Decreases** Since the consulting company had presented the information,	**Clarification in PP1** - For the community and social work of the project, its concept is divided into 2 parts which are;	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
(Government agency: Hin Kong SAO, community leader: Moo.9, Ban Thung Lai Kai, Hin Kong Sub district, government agency: representative of Don Tako SAO)			therefore there were no questions in this part at the 2nd meeting.	- Part 1, the development fund around the power plant in accordance with the law. The project must allocate the fund into 2 phases: the construction and the operation phases. - Part 2, the project provides a public relation budget for activities with the community. In the operation, needs of the community are mainly considered.	
- The radius of the impact study must be a newly define radius or not? **(Community leader: inspector of Don Rae Sub district)**	Group 1		**Decreases** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - For the determination of the study scope, the consulting company has determined from the boundary of the existing TECO power plants, including a new power plant. It covers a 5-kilometer radius for the study of discrete receptor area using for determining the trends of air pollution from projects that may affect the public health. The study area had been defined for 20x20 kilometers from the project boundary. For the impact on water consumption and water quality, the study will be done using the Mae Klong River network, which is a water source and supports the project drainage. It covers the transportation network related to the operation of the project as well.	
- The project should study the law of town planning and the introduction of fuel into the area, in particularly, coal. **(Government agency: Office of Public Works and Town Planning, Ratchaburi)**	Group 1,4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The project has examined the city plan. Since the project is located in the same area, however, an inspection letter will be submitted to the Office of Public Works and Town Planning to receive the certification. For the fuel of the Hin Kong power plant, liquid and gas fuels can only be used due to the power plant uses a fuel injection method. Therefore, there is absolutely no use of coal fuel.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
- The power plant was located in the community area but why is the cost of electricity increasing which affecting workers? **(Community leader: Moo.1 , Koh Phlapphla Sub district)**	Group 1		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - When the weather is hot, more electricity is used resulting in increasing of the electricity cost which in consistence with the amount of electricity used.	
- Reduction of FT or electricity bills for communities nearby the project. **(Community leader: Moo.3, Ban Rak Makham, Huay Phai Sub district,public : Moo.5, Ban Mai, Don Tako Sub district)**	Group 4		**Decreased** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The consulting company had recorded it as data.	
- The problem of frequent power outages and some households live without electricity. **(Government agency: representative of Don Tako SAO)**	Group 1		**Decreases** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - The consulting company had recorded it as data.	
- Inquiring about the cost of organizing the meeting. **(Government agency : representative of Don Tako SAO)**	Group 4		**Decreases** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - Meeting expenses were only the cost of traveling to the meeting due to some people may have a problem and have travel expenses. Execution of all expenses done the consulting company. The local government organization was not involved in such expenses.	
- The community would like to visit the project area, would it be possible or not? **(Community leader: Moo.10, Ban Nong Krathum, Hin Kong Sub district, community leader: Moo.10, Ban Suandokmai, Don Tako Sub district)**	Group 4		**Decreases** Since the consulting company had presented the information, therefore there were no questions in this part at the 2nd meeting.	**Clarification in PP1** - If the community was interested in studying and visiting the project, it can be done by grouping within the community and then notifying the project on what kind of the study they want to study.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders PP1	PP2	The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
- The route between Moo.8 and Moo.10 of Hin Kong Sub district has no light and it is also a lonely path. Then, the project should support the light installation. **(Community leader: Moo.8 , Ban Nong Yai Kata, Hin Kong Sub district)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** The route between Moo.8 and Moo.10 has been approved by the relevant authorities. In detail, community leaders will coordinate information from relevant agencies to monitor the progress of the action.	
- Currently, the area has a power drop problem, resulting in a malfunction of electrical appliances **(Community leader: Moo.8, Ban Nong Yai Kata, Hin Kong Sub district)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - Take this issue into account to coordinate and notify relevant departments.	
- Ratchaburi has several power plants which is considered a sacrifice. Is there any way to reduce electricity bills for people in the area or not? **(Question sheet: Chedi Hak Sub district, media)**		Group 1.6	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - Will coordinate to notify relevant departments for the acknowledgment. - Currently, the Ministry of Energy is studying the suitability of the budget that will be used to help the electricity bill and determining the area of the people that will be entitled. From the past, in every public hearing meeting, people proposed that there should be a discount on electricity bills in the area of the power plant is located.	
- Which areas will the produced electricity from the project be sent for the usage? **(Community leader: Moo.3, Ban Nong Kham, Don Rae Sub district, community leader: Moo.11, Ban Khao Suan Luang, Koh Phlapphla Sub district, community leader: council Member of Khao Ngu Sub-district Municipality)**		Group 1	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - The generated electricity will be sent to the high-voltage transmission lines of the Electricity Generating Authority of Thailand (EGAT) and PEA will deliver electricity to various areas for the consumption. - Currently, the Ministry of Energy is studying the feasibility of electricity bill assistance and determining the area of the people that will be entitled.	

Table 4.6-1 (Cont)

Questions/suggestions	Commenter[1/] By Group of Stakeholders		The trend of Comments	Clarification in the meeting	Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program
	PP1	PP2			
- At the present, the area has frequent fire problems, most of which are caused by short circuit. However, what are the prevention measures? **(Public : Moo.14, Ban Karn KeaHa, Chedi Hak Sub district)**		Group 1	Increased Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - When the power plant generating electricity, it will be sold to the Electricity Generating Authority (EGAT) system. In terms of delivering electricity to the people, Provincial Electricity Authority will be a responsible agency. The power outage or power fall are caused by many reasons such as in the rainy season, there may be broken branches that cut the power line or trucks break the electric wire, etc. However, the project will be coordinated to notify the relevant departments for acknowledgment.	
- Inquiring about the route of laying the natural gas pipeline to the power plant project. **(Public : Moo.6, Ban Nong Sadao Bon, Hin Kong Sub district)**		**Group 1**	**Increased** Since it was a continuous question from the clarification in meeting.	**Clarification in PP2** - Natural gas pipeline as the main fuel of the project, currently in the process of studying and preparing an environmental impact assessment report. Routes of the gas pipeline are in the process of considering for suitable alternatives. However, various details will be presented at the 2nd public hearing meeting of the natural gas pipeline project.	
- The operation of natural gas pipeline installation should mainly consider hiring local workers and select tools or construction materials in the area. In the event that communities are affected, urgent action should be taken. **(Community leader: Moo.11, Ban Khao Suan Luang, Koh Phlapphla Sub district)**		Group 1	Increased Since it was a continuous question from the clarification in meeting.	- **Clarification in PP2** Natural gas pipeline as the main fuel of the project, currently in the process of studying and preparing an environmental impact assessment report. Routes of the gas pipeline are in the process of considering for suitable alternatives. However, various details will be presented at the 2nd public hearing meeting of the natural gas pipeline project.	-

Remark: * Questions to be clarified in the next meeting (1) clarified in PP1 (2) clarified in PP2
Group 1 means those who may be affected Group 2 means the agency responsible for preparing the environmental impact assessment report
Group 3 means agencies considering environmental impact assessment reports / licensing agencies Group 4 means government agencies at different levels
Group 5 means environmental NGOs, NGOs, educational institutes and religious places Group 6 means mass media Group 7 means general public who is interested in the project

Table 4.6-2

Results comparison of public opinions on the project operation.

Issues, questions / concerns		Stakeholder			Compare differences on question issues PP1 & PP2		
The 1st public hearing meeting	The 2nd public hearing meeting	Community leader	national	Government/NGO / mass media	Increase	Same	Decrease
(1) Project details							
- This new power plant is a renovate one or new construction, and which areas the produced electricity will be sent to use? **(Community leader: Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, Media representative, Community leader: Moo.12, Ban Huay Champa, Koh Phlapphla Sub district, government agency: representative of Don Rae SAO, government agency: representative of Health Promotion Hospital, Huay Phai Sub district)**	- Is the power plant a new construction or is it an operation to renew the contract and has to have a public hearing? - Where will the generated electricity be distributed? - How much is the original electricity capacity? And how much had it increased? **(Question Sheet: Huai Phai Sub district)**	✓		✓		✓	
- Why did you have to build a power plant in Ratchaburi? **(Community leader: Moo.12, Ban Huay Champa, Koh Phlapphla Sub district, Community leader: Moo.10, Ban Chong Maklam, Koh Phlapphla Sub district, government agency: representative of Muang Ratchaburi, government agency: representative of Don Rae SAO, Media representative, question sheet: Huai Phai Sub district)**	-	✓		✓		✓	
- Concerns about impact during construction because it had been affected from the original power plant. Therefore, the project should improve the old power plant and install new machines instead. **(Community leader: Moo.15, Ban Nong Song Hong, Koh Phlapphla, Sub district)**	-	✓					✓
- Concerns about using coal as fuel **(Media representative)**	- In case of run out of the main fuel and reserved fuel, which fuel will be used instead? **(Public: Moo.10 Ban Suandokmai, Don Tako Sub district)**		✓	✓		✓	
- Will the project be replaced with a new gas pipe? If yes, where an additional pipe will be located? **(Government agency: representative of Don Rae SAO)**	-			✓			✓
- Which country does the project use technology from? **(Government agency: representative of Huai Phai SAO)**	-			✓			✓
- Air quality and groundwater measurement should be monitored prior to the construction. **(Community leader: Moo.8, Ban Nong Kham, Huay Phai Sub district)**	-	✓					✓

Table 4.6-2 (Cont)

Issues, questions / concerns		Stakeholder			Compare differences on question issues PP1 & PP2		
The 1st public hearing meeting	The 2nd public hearing meeting	Community leader	national	Government/NGO / mass media	Increase	Same	Decrease
- Gas turbine generators, steam turbine machine and steam generators locating near the community area, may affect neighboring communities. **(Public : Moo.6 Ban Nong Sadao Bon, Hin Kong Sub district)**	-		✓				✓
(2) Air quality							
- The previous operation of the project have impacts to the environment, such as worsen weather, dust, oil stains, hot weather and noise, causing by many factors. People in the area were concerned about taking care of the communities around the project based on their experience. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, Public : Moo.6, Ban Nong Sadao Bon, Hin Kong Sub district, community leader: Moo.4, Koh Phlapphla Sub district, government agency: representative of Wat Huay Phai School)**	-	✓		✓			✓
- Should install a dust measurement station in every Sub district at least 1 station per Sub district. **(Community leader: inspector of Don Rae Sub district, Media representative)**	-	✓					✓
- Did project invite government agencies to monitor the emission rate that releasing to outside or not? **(Question sheet: Chedi Hak Sub district)**	-		✓				✓
- For environmental quality measurement results of the agency that the project hired, was the measurement result biased? **(People : Moo.9, Ban Huay Moo, Chedi Hak Sub district)**	-		✓				✓
- Result of PM 2.5 measurement did not report to villagers. Therefore, villagers do not know the current weather information. **(Community leader: Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district)**	-	✓					
- People living nearby the project found oil soot deposits. Is there any solution? **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**	- Does diesel fuel used by the project would cause oil stains to fall on the roof of houses or agricultural areas or not? **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**	✓				✓	
- In case of incomplete combustion, would it cause dust or not? Does dust affect the community or not? **(Government agency : representative of Huai Phai SAO)**	-			✓			✓

Table 4.6-2 (Cont)

Issues, questions / concerns		Stakeholder			Compare differences on question issues PP1 & PP2		
The 1st public hearing meeting	The 2nd public hearing meeting	Community leader	national	Government/NGO / mass media	Increase	Same	Decrease
- In the past, villagers were able to consume rainwater. But when there was a power plant in the area, villagers were not be able to consume rainwater. **(Community leader: Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, Community leader: Moo.12, Ban Huay Champa, Koh Phlapphla Sub district)**	-	✓					✓
-	- At present, the area already has various Agricultural crops problems, the project operation may cause additional problems. Therefore, measures or approaches to prevent the consequences should be established. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, public: Moo.5, Ban Nong Chok, Chedi Hak Sub district)**	✓	✓		✓		
-	- Implementation of the project may cause climate change, impacts on agricultural crops and may cause various diseases accordingly. **(Public : Moo. 4 Ban Don Chaeng, Moo.10, Ban Suandokmai, Don Tako Sub district)**	✓			✓		
-	- Concerned on the impact on quality of life, in terms of health, environment and agriculture. **(Community leader: Moo.6, Ban Don Kok, Don Rae Sub district)**	✓			✓		
(3) Nosie							
- After installation of silencers, the community still have impacts. **(Public: Moo.6, Ban Nong Sadao Bon, Hin Kong Sub district, Community leader: Moo.8, Ban Nong Kham, Huay Phai Sub district, government agency: representative of Huai Phai SAO)**	- With the operation of Tri Energy Power Plant, it has been very noisy. What is the cause? **(Public: Khao Ngu Sub-district Municipality)**	✓	✓	✓		✓	
- Concerned on the noise impact on the community **(Community leader: Moo.3, Ban Rak Makham, Huay Phai Sub district)**	- For installation of sound barriers, could it reduce the impact? **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**	✓				✓	

Table 4.6-2 (Cont)

Issues, questions / concerns		Stakeholder			Compare differences on question issues PP1 & PP2		
The 1st public hearing meeting	The 2nd public hearing meeting	Community leader	national	Government/NGO / mass media	Increase	Same	Decrease
(4) Water consumption							
- Guidelines for water management from the Mae Klong River. **(Government agency: Office of Public Works and Town Planning, Ratchaburi)**	-			✓			✓
(5) Water quality and wastewater management							
- How does the project manage rain and wastewater contaminated with chemicals? - **(Community leader: Moo.10, Ban Suandokmai, Don Tako Sub district)**	-	✓					✓
(6) Waste management							
- How does the project manage solid waste and various sewage both during construction and demolish phases? **(Community leader: Moo.10, Ban Suandokmai Don Tako Sub district)**	-	✓					✓
-	- Treated water draining into the creek branches, can farmers use it or not? **(Public : Don Rae Sub district)**		✓		✓		
(7) Transportation							
-	- Transportation during the construction should consider selecting the route that passes the least community area, in order to prevent traffic jams and accidents. **(Community leader: Moo.11 Ban Thung Noi, Hin Kong Sub district, community leader: Moo.5 Ban Don Tan, Don Rae Sub district)**	✓			✓		
(8) Drainage and flood prevention							
- Concerns on the problem of draining water and flood. **(Community leader: Moo.15, Ban Nong Song Hong, Hin Kong Sub district)**	- Concerns on the waterlogging in the community area - Propose to define measures for the prevention management and the compensation in case of flooding in communities and agricultural areas. **(Public : Moo.6, Ban Nong Sadao Bon, Hin Kong Sub district, Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, Moo.10, Ban Suandokmai, Don Tako Sub district)**	✓	✓			✓	

Table 4.6-2 (Cont)

Issues, questions / concerns		Stakeholder			Compare differences on question issues PP1 & PP2		
The 1st public hearing meeting	The 2nd public hearing meeting	Community leader	national	Government/NGO / mass media	Increase	Same	Decrease
(9) Occupational health and safety							
- If there was a leak and chemical transportation, what would be the prevention measures in the project? **(Government agency: representative of Huai Phai SAO)**	- Which chemical agents does the project use? And what kind of impacts do they cause? **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**	✓		✓		✓	
(10) Health							
- Concerned on the health impacts of people in the community **(Community leader: Don Tako Sub district)**	-	✓					✓
- Will the chemicals used by the project have any impact on public health? **(Government agency : representative of Huai Phai SAO, government agency: representative of Huay Phai School)**	-			✓			✓
- How does nitrogen oxides contaminated in the air affecting health? **(Government agency: representative of Huai Phai SAO)**	-			✓			✓
(11) Socio-economic							
- Air quality measurement results should be publicized through various channels. **(Community leader: Moo.1 5, Ban Nong Song Hong, Koh Phlapphla Sub district, government agency : representative of the Internal Security Operations Command of Ratchaburi, government agency: representative of Huai Phai SAO, Media representative)**	- Publicize results of air quality measurements in the area to the public. **(Government agency: representative of Khao Ngu Sub district Municipality)**	✓		✓		✓	
- The presentation showed that the project has measures to the problems. But in the past, when the accident occurred, the problem could not be resolved. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**	-	✓					✓
- Issues that need to be resolved should be taken from this hearing meeting, in order to define a measure and build people in the area for the understanding of the project. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, government agency: representative of the Environment Agency Region 8, government agency : representative of Muang Ratchaburi District)**	-	✓		✓			✓
-The project should support activities of the community such as education, utilities and careers. The project should arrange a fire truck to help the community in case of emergency.	-	✓		✓			✓

Table 4.6-2 (Cont)

Issues, questions / concerns		Stakeholder			Compare differences on question issues PP1 & PP2		
The 1st public hearing meeting	The 2nd public hearing meeting	Community leader	national	Government/NGO / mass media	Increase	Same	Decrease
(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, community leader: Moo.8, Ban Nong Yai Kata, Hin Kong Sub district, community leader: Moo.8, Ban Khao Ngam - Baan Klang Thung, Don Tako Sub district, government agency: representative of Don Rae SAO, government agency: representative of Don Tako SAO)							
- The project supports the budget for the village health volunteers for public health care. **(Community leader: Don Tako Sub district Sub district)**	-	✓		✓			✓
- In the past, the surrounding communities lacked care and attention from the project. **(Public: Khao Ngu Sub-district Municipality)**	-		✓				✓
- Only village chief and headman were invited into the meeting. Village health volunteers, village/community committee, women and housewives groups should be invited as well. **(Public: Khao Ngu Sub-district Municipality)**	-		✓				✓
-	- Is there an indication for the meeting for the public hearing? And what percentage of participants have to be accounted for the population in the area? **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district)**		✓		✓		
- Increase public relations of the project to be thoroughly and comprehensive. **(Government agency: representative of Huai Phai SAO, government agency : representative of Don Tako SAO)**	-			✓			✓
- Comments from a reply letter by mail should be added. The meeting minutes should be posted and distributed, so that, people in the area who did not attend the meeting can be informed. **(Government agency: representative of Don Tako SAO)**	-			✓			✓
- There shall be a meeting place at the center of the district. **(Government agency: representative of Don Tako SAO)**	-						✓
-	- Propose to assign staff to take care of the defenseless people or organize a care center for the defenseless.	✓		✓	✓		

Table 4.6-2 (Cont)

Issues, questions / concerns		Stakeholder			Compare differences on question issues PP1 & PP2		
The 1st public hearing meeting	The 2nd public hearing meeting	Community leader	national	Government/NGO / mass media	Increase	Same	Decrease
	- Thoroughly and comprehensive support and promote the quality of life of people both in the field of public health and education. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, public: Moo.11, Ban Thung Noi, Hin Kong Sub district, Moo.5, Ban Nong Chok, Chedi Hak Sub district, Moo.10, Ban Suandokmai , question sheet: Huai Phai Sub district, government agency: representative of Khao Ngu Sub district Municipality)**						
-	- Propose to increase the role of the tripartite committee, to provide more public relations of various information of the project to the public **(Government agency : representative of the Ratchaburi Provincial Energy Office)**			✓	✓		
-	- Provide staff to coordinate complaints **(Government agency: representative of the Ratchaburi Provincial Energy Office, community leader: Moo.3, Ban Nong Kham Don Rae Sub district)**	✓		✓	✓		
-	- Consider employment of local labors as a priority and provide education guidance for youth in the area. **(Government agency: representative of Khao Ngu Sub district Municipality)**			✓	✓		
-	- Ask for budget allocating for the support of the area. **(Question Sheet: Huai Phai Sub district)**		✓		✓		
(12) Heat monitoring from the power plant							
- Concern on heat impacts from the project production system. In this regard, is there any heat control in the system? **(Community leader: Moo.8, Ban Nong Yai Kata Hin Kong Sub district, community leader: Moo.10, Ban Nong Krathum, Hin Kong Sub district, community leader: Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, community leader: Moo.4, Koh Phlapphla Sub district, government agency: representative of Don Tako SAO, government agency : representative of the Royal Rainmaking Project, Ratchaburi)**	-	✓		✓			✓

Table 4.6-2 (Cont)

Issues, questions / concerns		Stakeholder			Compare differences on question issues PP1 & PP2		
The 1st public hearing meeting	The 2nd public hearing meeting	Community leader	national	Government/NGO / mass media	Increase	Same	Decrease
(13) The development fund for the community around the power plant							
- Regulations for requesting the funds from the power plant development are not conducive to needs of various projects of the people of the area. **(Community leader: Moo.11, Ban Thung Noi, Hin Kong Sub district, community leader: Moo.8, Ban Nong Yai Kata Hin Kong Sub district, public : Moo.14, Ban Karn KeaHa, Chedi Hak Sub district, community leader: Moo.15, Ban Nong Song Hong, Koh Phlapphla Sub district, Community leader: Moo.12, Ban Huay Champa, Koh Phlapphla Sub district, community leader: Moo.3, Ban Nong Kham, Don Rae Sub district, Community leader: Moo.4 , Koh Phlapphla Sub district, public : Moo.5, Ban Mai, Don Tako Sub district, government agency: Hin Kong SAO, Government agency: representative of Don Tako SAO)**	- Previously, communities often encountered problems of spending budget from the power plant development fund.	✓	✓	✓		✓	
- Koh Phlapphla Sub district has divided into 2 departments which are, Khao Ngu Sub-district Municipality and Koh Phlapphla SAO. Previously, the project only support the budget to Koh Phlapphla SAO. **(Community leader: Moo.1, Koh Phlapphla Sub district)**	-	✓			✓		
- - During the construction phase, will there be payment to the power plant development fund? **(Government agency : representative of Don Rae SAO)**	- For an increased electricity production, will the Power Development Fund increase as well? **(Community leader: Moo.11, Ban Khao Suan Luang, Koh Phlapphla Sub district, community leader: Khao Ngu Sub-district Municipality, question sheet: Huay Phai Sub district)**	✓		✓	✓		
- What is the role of the community development committee in the area surrounding the power plant? Since this committee had never be invited to any Sub district meeting. **(Community leader: Khao Ngu Sub-district Municipality, question sheet: Huay Phai Sub district)**	-	✓			✓		
- Allocation of budgets for the development fund around the power plants in each Sub district should be charged on a per capita basis and increased according to population. **(Community leader: Moo.1, Koh Phlapphla Sub district, government agency: representative of Don Tako SAO)**	-	✓		✓	✓		

Table 4.6-2 (Cont)

Issues, questions / concerns		Stakeholder			Compare differences on question issues PP1 & PP2		
The 1st public hearing meeting	The 2nd public hearing meeting	Community leader	national	Government/NGO / mass media	Increase	Same	Decrease
- What are procedures for the compensation of affected persons from the Power Plant Development Fund? **(Government agency: representative of Don Tako SAO)**	- Propose to assign a committee of community development funds covering every village. These committee shall participate in various processes including public relations of power plant activities to the community for information. **(Government agency: representative of Khao Ngu Sub district Municipality)**			✓		✓	
(14) Others							
- Can you stop build a power plant? If no, what is the policy to look after the community? **(Community leader: Moo.3, Ban Nong Kham Don Rae Sub district, Question Sheet: Huai Phai Sub district)**	-						✓
- If unable to reduce electricity bills for people. There should be a fund to support activities in the community. **(Government agency: Hin Kong SAO, community leader: Moo.9, Ban Thung Lai Kai, Hin Kong Sub district, government agency: representative of Don Tako SAO)**	-	✓		✓			✓
- The radius of the impact study must be a newly define radius or not? **(Community leader: inspector of Don Rae Sub district)**	-	✓					✓
- The project should study the law of town planning and the introduction of fuel into the area, especially, coal **(Government agency: Office of Public Works and Town Planning, Ratchaburi)**	-			✓			✓
- The power plant is located in the community area but why is the cost of electricity increasing which affecting the occupation of workers? **(Community leader: Moo.1, Koh Phlapphla Sub district)**	- Ratchaburi has several power plants which is considered a sacrifice area. Is there a way to reduce electricity bills for people in the area or not? **(Question sheet: Chedi Hak Sub district, media)**	✓	✓	✓		✓	
- Reduction of FT or electricity bills for communities nearby the project. **(Community leader: Moo.3, Ban Rak Makham, Huay Phai Sub district, public : Moo.5, Ban Mai, Don Tako Sub district)**	-	✓	✓				✓
- The problem of frequent power outages and some households live without electricity. **(Government agency: representative of Don Tako SAO)**	- Currently, the area has a power drop problem, resulting in a malfunction of electrical appliances **(Community leader: Moo.8, Ban Yai Nong Kata, Hin Kong Sub district)**	✓		✓		✓	

Table 4.6-2 (Cont)

Issues, questions / concerns		Stakeholder			Compare differences on question issues PP1 & PP2		
The 1st public hearing meeting	The 2nd public hearing meeting	Community leader	national	Government/NGO / mass media	Increase	Same	Decrease
- Inquire about the cost of organizing the meeting **(Government agency: representative of Don Tako SAO)**				✓			✓
- The community would like to visit the project area, would it be possible or not? **(Community leader: Moo.1 0 , Ban Nong Krathum, Hin Kong Sub district, community leader: Moo.10, Ban Suandokmai, Don Tako Sub district)**	-	✓					✓
-	- The route between Moo.8 and Moo.10 , Hin Kong Sub district had insufficient light. It is also a lonely path. Therefore, the community ask the project to support the installation of lighting. **(Community leader: Moo.8 , Ban Nong Yai Kata, Hin Kong Sub district)**	✓				✓	
-	- Nowadays, the area has frequent fire problems, most of which are caused by short circuit. However, what are the prevention measures? **(Public : Moo.14, Ban Karn KeaHa, Chedi Hak Sub district)**		✓		✓		
-	- Inquire about the route of laying the natural gas pipeline to the power plant project. **(Public : Moo.6 Ban Nong Sadao Bon, Hin Kong Sub district)**		✓		✓		
-	- The operation of natural gas pipelines should mainly consider hiring local workers as a priority. The project should also select tools or construction materials in the area. In case that impacts occurred to communities, urgent action should be taken. **(Community leader: Moo.11 Ban Khao Suan Luang, Koh Phlapphla Sub district)**	✓			✓		

<u>Remark:</u> Increased refers to issues of questions that were not present in the PP1 meeting, but appeared in the PP2 meeting.
Same refers to the same question presents in both PP1 and PP2 meetings
Decreased refers to the issues raised in PP1 meetings, but not in PP2 meetings.
PP1 refers to the first public participation meeting on project proposals, details, study scope and evaluation of project options.
PP2 refers to the second public participation meeting on the drafted report, environmental impact prevention and measures and environmental impact monitoring.

Chapter 5

Environmental impact assessment

Chapter 5
Environmental Impact Assessment

5.1 Introduction

Environmental impact assessment is the estimation of the magnitude of impact that arises from the Project of Hin Kong Power Plant of Hin Kong Power Company Limited. The environmental impact assessment covers four aspects during the construction and operation periods i.e. physical resources, biological resources, human use values, and quality of life values.

Data of existing environmental conditions of the study area used in the assessment are presented in **Chapter 3** while the Project details are expressed in **Chapter 2**. Moreover, the Project has collected comments and suggestions of the people in the area during the public participation activities, details are shown in **Chapter 4**, and were considered in the assessment. The results were used in the setting of suitable environmental impact prevention and mitigation measures and the environmental impact monitoring program.

5.2 Criteria for environmental impact assessment and environmental impact classification

The Consultant has assessed the impact on 3 main factors: 1) environmental impact, 2) social impact, and 3) health impact as shown in **Chapter 5**. For the health impact study, the study was focused on the key issue that has significant changes in environmental or social factors and health determinants, which are further illustrated in **Chapter 6**. The assessment framework is shown in **Figure 5.2-1**.

(1) Criteria used in the assessment

Environmental impact is the change in condition or value of environmental resources in both size and direction from the original state. The environmental impact explanation must be performed systematically by using a technically recognized technique for classifying impacts and predicts the severity or magnitude of the effects as close to reality as possible. The environmental impact arising from the Project development can be classified as follows:

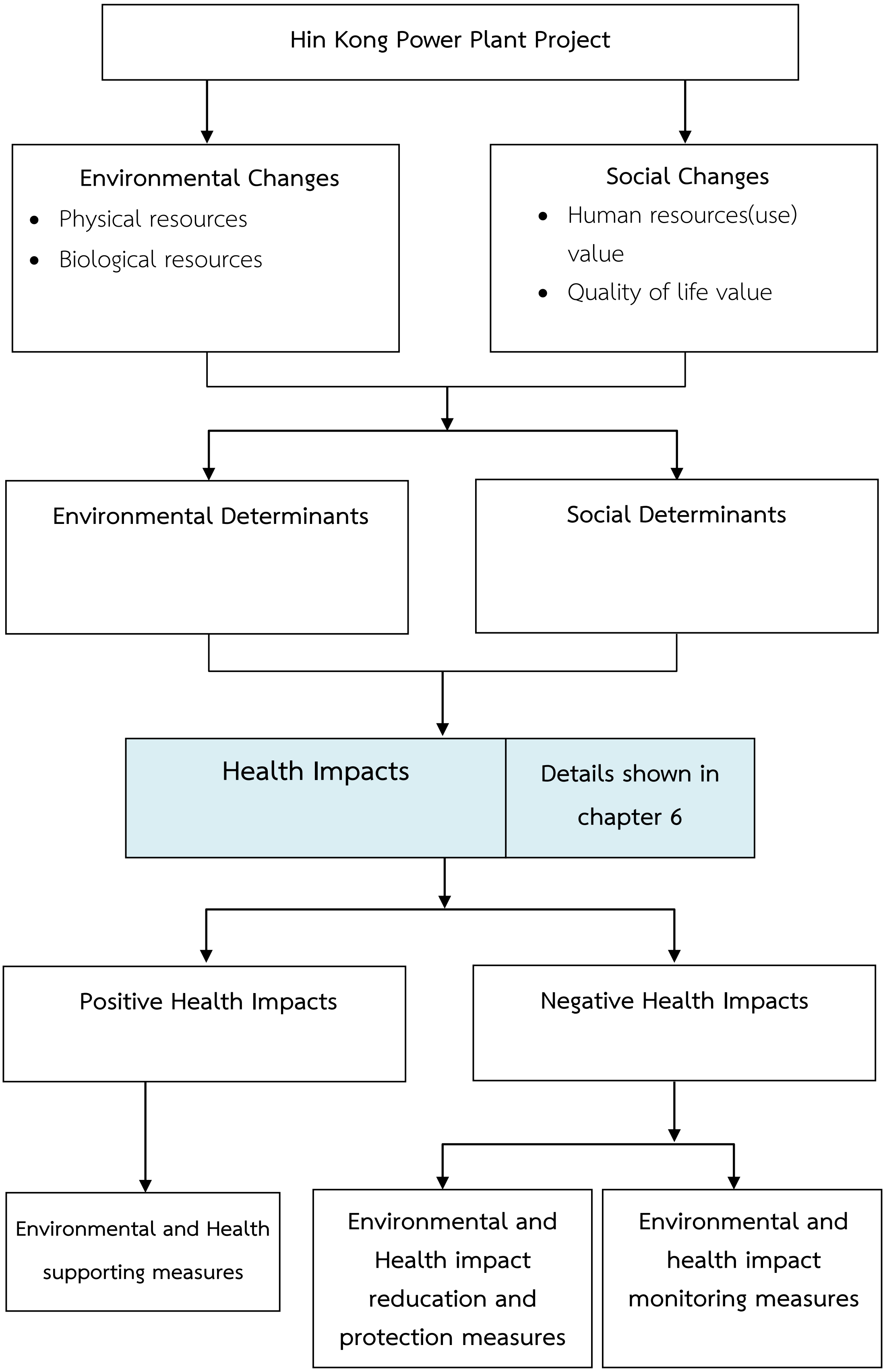


Figure 5.2-1 Conceptial framework of environmental, social, and health impact assessment

1) Identification of origin and impacts

The study considered the Project's operational activities on the impact or change in the condition of resources and the current environmental quality in aspects i.e., physical resources, biological resources, human use values, and quality of life values, with regard to the capacity to withstand the effects of the current environment.

2) Impact assessment

It is an assessment of the nature or severity of the impact that is expected to occur which can use both qualitative and quantitative methods in describing the effects of various impacts, include the following:

(a) Nature of impacts i.e., positive-nagative, direct-indirect, and cumulative impact,
(b) Magnitude of impacts i.e., high, medium, and low,
(c) Extent i.e., spatial scope, dispersion, and radius of impact
(d) Duration i.e., short term and long terma,
(e) Reversibility
(f) Likelihood of impacts

3) Assessing the level of significance of impact

Appropriate methods and criteria must be selected for the assessment of the significance of the impact. The Consultant selected the scaling method in coupling with a matrix to assess the significance of the impact.

Significance	=	Characteristics	x	Importance

(a) Assessing of characteristics or severity of impacts

a) The assessment of characteristics or severity of impacts considers magnitude, extent, and duration of impacts by employing the criteria shown in **Table 5.2-1**.

Table 5.2-1

The Assessment and Scoring of Environmental Impact's Severity and Characteristics

Level	Definition	Score
Magnitude[1/]		
High	- Above criteria or standard limits set by law - Causes structural changed of the environmental conditions or the ecosystems	3
Medium	- Is at a level approaching the criteria or standard set by law (still within the criteria or standard) There is a change in some factors of the environment or the ecosystems, - but no structural changes	2
Low	- Still within the criteria or standard set by law - Causes little changed	1
Extent[1/]		
High	- Widely spread - National/international level	3
Medium	- Out of the Project area but still in the limited area	2
Low	- Within the Project area	1
Duration[1/]		
High (long term)	- The impact persisted after the Project is closed - Long periods (e.g., more than 15 years) or permanent (irreversible)	3
Medium	- The impact is on the Project operation period - Moderate periods (e.g., 5 - 15 years) or reversible over time	2
Low (short term)	- The impact is shorter than the operation period - Short period (e.g., 0-5 years) or quickly reversible	1
The score of characteristic or severity of the impact = (magnitude x extent x duration)		

Remark: [1/] Consider as appropriate for each issue

Source : adapted from Nigel (2003), Sippe (1999) and United Nations University (2007)

b) Compare the characteristics and severity score with the criteria and the score ranges as shown in **Table 5.2-2**.

Table 5.2-2

The Assessment and Scoring of Impact's Severity and Characteristics

Multiplication result of characteristic or severity of impact[1/]	**Level**	**Definition**	**Score**
9-27	High	High impacts and can cause a consequential impact that requires strict preventive and mitigation measures	3
4-8	Medium	Moderate impacts or can cause changes in a moderate level	2
1-3	Low	Low impacts or can cause changes at a low level	1

Remark: 1 /Multiplication results from **Table 5.2-1**

(b) Assessing of importance of impact

The importance of impact was considered from the degraded value of resources and the environment or loss of opportunity to use resources, scoring criteria are shown in **Table 5.2-3**.

Table 5.2-3

The Asessement and Scoring of Impact's Importance

Level	**Definition**	**Score**
High	- Disturbing the pristine areas which have conservation value - Destroying rare or endangered species - It is an area of national/international importance	3
Medium	- Disturbing areas with potential for conservation value or as a resource - It is an area of local/regional importance	2
Low	- Disturbing degraded areas or general areas with little conservative value - It is an area with common ecological characteristics	1

(c) Assessing the level of significance of the impact

a) The significance of impact was assessed using the matrix as shown in **Table 5.2-4** by considering the results of the assessment of the characteristic or severity of the impact and the significance of the impact. It consists of two steps: step 1) assessing of characteristic or severity of the impact and step 2) assessing of importance of the impact.

b) The results of the assessment of the significance of the impact will lead to an analysis of the need for defining environmental impacts prevention and mitigation measures as shown in **Table 5.2-5**.

Table 5.2-4

Assessing the Importance of Environmental Impact using Matrix

Order of importance of environmental impacts		Characteristic and severity		
		Low	Medium	High
		1	2	3
Importance	low (1)	low (1)	low (2)	medium (3)
	medium (2)	medium (2)	medium (4)	high (6)
	high (3)	medium (3)	high (6)	high (9)

Table 5.2-5

Definitions of Order of Importance of Environmental Impacts

Level of importance	Score	Definition
High	6-9	Has a high level of impact and can cause consequential impacts which cannot be prevented and mitigated with any measures or it is difficult or not worthwhile
Medium	3-4	Create changes that can affect the value of resources, nature, and the environment, prevention and mitigation measures and monitoring are additionally required from normal measures
Low	1-2	Create change without reducing the value of natural resources and the environment, the impacts can be easily prevented and mitigated with common operations or measures

For the Hin Kong Power Plant Project of Hin Kong Power Company Limited, the design standards and operating patterns as well as environmental management are set by considering environmental impacts and safety of all stakeholders as detailed in **Chapter 2**. Any action, however, will inevitably have an impact on the environment. The magnitude of environmental impact depends on the existing environmental conditions and the current problems of the area. Therefore, the forecast and assessment of the impact from this Project, the Consultant, therefore, analyzes the impacts that may arise from the project activities in conjunction with the current environmental conditions of the study area (**Chapter 3**). The assessment covers four aspects i.e., physical resources, biological resources, human use values, and quality of life values. Comments, suggestions, and concerns of the local residents received from the public participation activities were carried out in parallel in the process of study as detailed in **Chapter 4**. The Consultant has taken into account the assessment issues completely and answered the concerns of the public to lead to the formulation of appropriate environmental impacts prevention and mitigation measures as well as environmental impact monitoring program.

(2) Issues to be carried out for the detailed health impact assessment

The Consultant determined the issues that were used to assess the health impact of the Project in detail by considering the results of the environmental and social impact assessment of the Project. The criteria for the selection of significant impacts were two levels, medium, and high levels, to assess the health effects in more detail that is presented in **Chapter 6**.

Issues that were used for health impact assessment are as follows:

Level of importance	Score	Definition
High	6-9	Has a high level of impact and can cause consequential impacts which cannot be prevented and mitigated with any measures or it is difficult or not worthwhile
Medium	3-4	Create changes that can affect the value of resources, nature, and the environment, prevention and mitigation measures and monitoring are additionally required from normal measures

5.3 Guidelines for environmental impact assessment

5.3.1 Impact on physical resources

5.3.1.1 Impact on topography, geology, and soil resources

(1) Impact on topography

The topography of Ratchaburi Province can be divided into 4 types: high mountain areas, plateau area, lowland area, and lowland plains. The area where the Project is located, arranged in the plain area. In the construction of the Project, it is necessary to adjust, fill, and level the land area to suit the construction activity. The Project will fill the soil approximately 0.5 meter high from the original ground level in order to be equal to the current TECO power plant level. Soil filling of the Project uses the soil balance principle within the Project area by bringing soil from the excavated area to be used for filling in normal areas. These soils will be used to cover the entire Project area.

During the operation period of the Project, there are no activities that cause changes in the topography in the Project area. Since the adjustment and preparation of the site have been done and completed only during the construction period, hence, the operation of the Project does not cause any impact on the topography.

Therefore, the impact on topography during both construction and operation periods is at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	3	(3) = 1	1	1	low

(2) Impact on geology and earthquake

Geological features of Ratchaburi Province consist of high mountains in the west of the area and mountains and hills with descending heights in the middle. It consists of solid rocks that are approximately 570 to 66.4 million years old, approximately 40% of the area. The rest 60% are flat areas, including foothills and flood plains that cover the east and the north of the province. The rocks found in Ratchaburi Province are composed of sedimentary, metamorphic, and igneous rocks. Considering the activities of the Project during the construction period found that there is no activity to alter the shale in the area. Therefore, there is no significant impact on the geological structure level. Therefore, the impact is expected to occur at a low level.

For the impact on the earthquake, it was found that the Project area is located at Hin Kong Subdistrict, Mueang Ratchaburi District, Ratchaburi Province. It is an area where no active fault is found. The closest fault to the Project is the Three Pagoda Fault, the fault began to appear in Burma to the Thai border at the Three Pagoda Pass. The total length is approximately 200 kilometers and is approximately 15 kilometers from the Project. From the Thailand earthquake disaster map data according to the Thailand Earthquake Disaster Map, October 2013 issue of the Department of Mineral Resources, it was found that the Project is located in a relatively high-risk area (V), magnitude 5 mercury or earthquake magnitude 4.0-4.9. With this magnitude, people can be noticed, panic, crockery falls, windows crumble, and unstable items can be collapsed. However, the buildings of the Project have been designed to comply with the Building Control Act B.E. 2522 (1979).

Therefore, the impact on earthquakes during both construction and operation periods is at a low level.

<table>
<tr><th rowspan="2">Conclusion</th><th>Size</th><th>Scope</th><th>Duration</th><th>Severity</th><th>Importance</th><th colspan="2">Order of Importance</th></tr>
<tr><td>1</td><td>1</td><td>3</td><td>(3) = 1</td><td>1</td><td>1</td><td>low</td></tr>
</table>

(3) Impact on soil resources

1) Construction period

The Project area is located on Khao Yoi and Pak Tho soil series (Kyo & Pth). These series of soils have characteristics and properties of slightly poor to poor drainage levels. They are deep soils while the topsoil is loam or sandy loam. The colors vary from brownish gray to brown or reddish-brown. It is a slightly acidic soil (pH 6.0-6.5). The lower soil is sandy loam or loamy clay.

However, the Project location is in the empty area of the group of companies in which the development will change the area conditions to support the operation of the Project. For the impact on soil resources, the Project activities are landfilling in the area using the existing soil in the Project area. From the results of soil quality analysis in the Project area, it was found that all soil quality was in accordance with the Notification of the National Environment Board No. 25, B.E. 2547 (2004) issued under the National Environmental Quality Promotion and Conservation Act. B.E. 2535 (1992), on Soil Quality Standards. This standard is soil quality standard used for other than residential and agricultural purposes.

For oils used in machinery and equipment in which the Project will use in small quantities, the Project shall store oil in a tank in a concrete floor area. If there is a leak, absorbent material will be used to clean. Hence, the chance of land contamination with hazardous substances is low.

2) Operation period

Activities that may affect soil resources include chemicals, waste, and storage of spare fuel (diesel), The project shall perform correctly according to technical principles. The details are summarized as follows:

(a) Diesel (for an emergency)

The Project shall prepare two cylinder tanks in the area of the Project (valid for 3 days), which will store no more than 90% of the tank volume. There is a concrete bund wall around the tank. In the case of an oil spill, the concrete bund wall will have sufficient capacity to contain all spilled oil. This is in accordance with the Ministerial Regulation on Oil Depots of the Ministry of Energy. The oil tanks must be stable and strong and meet the accepted standards with an endorsement from a practitioner of the controlled engineering profession or other person prescribed by the Minister. Besides, the Project shall install an oil separator to accommodate rainwater that may be contaminated with oil in the area where there is a potential oil leak. Moreover, the quality of treated water must have the oil and grease content of lower than 5 milligrams/liter.

(b) Chemical

Most of the chemicals and additives used in the project are anti-scale and sludge protection chemicals for boilers and cooling systems. Chemicals used in the Project do not have properties that are extremely dangerous. For chemical storage, they will be classified according to their chemical properties and utilization. The liquid chemicals will be kept in an area with providing a concrete bund wall with sufficient capacity to handle the largest amount of leakage of the chemical contained in the container. Inside the concrete bund wall around the chemical storage area, there is a concrete track around it with a sump in case of a leak before being pumped into the tank and sent for disposal by the authorized agency. Moreover, the Project shall provide chemical safety information (SDS Board) for the speedy and appropriate handling of spilled chemicals.

(c) Waste

The waste generated from the Project will be collected in the waste collection area locates within the building. Waste shall be separated as general solid waste storage and industrial waste storage area before sending it to waste disposer that has been authorized by the Department of Industrial Works to dispose of.

Considering the fuel and chemical storage of the Project found that waste shall not be stored on the area in contact with the soil. The Project will store waste in a building with a concrete floor. In the event of a spill, there is no opportunity to come into contact with the soil and become contaminated. Besides, the Project shall perform correctly according to academic principles. Therefore, there is no contamination from fuel, chemicals, and waste storage of the Project.

Therefore, the impact on soil resources during construction and operation periods of the Project is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	2	1	2	(4) = 2	1	2	low

5.3.2 Impact on air quality

Assessing air quality impacts was performed according to the mathematical modeling approach as summarized in **Table 5.3.2-1**, details are as follows:

(1) Model selection

The Consultant considered using the AERMOD mathematical model, 19191 version, the latest version required by the U.S. EPA.

(2) Emission rate determination

The Project is not located in the pollution control area of Rayong Province. The results of the ambient air quality measurement in the study area have NO_2 and SO_2 values not exceeding 80% of the ambient air quality standard.

(3) Source information

1) Construction period

(a) Construction activities in the Project area

The construction period of the Project is approximately 33-44 months. There is a period of construction activities that may cause impacts on air pollution i.e., land adjustment and foundation work which is a source of pollution. The period of area adjustment and foundation work is approximately 12 months.

(b) Raw water and wastewater pipelines installation activities of the Project

Raw water and wastewater pipeline installation of the Project will take about 10 months. Before the installation, the old raw water pipeline must be moved out. Construction activities that may cause impacts on air pollution include area adjustments, excavation for open-cut installation, use of machinery, and pipeline covering. These are classified as area sources of air pollution.

(c) Pollution from equipment and machinery used in construction

The Consultant used emission factor data from Air Emission Calculations and Methodology of the Virginia Department of Mines Minerals and Energy, 2015 to calculate the pollutants generated from construction activities within the Project site and the installation of raw water and wastewater pipelines of the Project as shown in **Table 5.3.2-2.**

Table 5.3.2-1

Methods for Assessing Air Quality Impact by using Models to show the Spreading of Air Pollution

Principles of air quality impact assessment	Operation
1. Model selection	- The Consultant considered using the AERMOD mathematical model, 19191 version, the latest version required by the U.S. EPA.
2. Emission rate determination	- The Project is not located in the pollution control area of Rayong Province. The results of the ambient air quality measurement in the study area have NO_x and SO_2 values not exceeding 80% of the ambient air quality standard.
3. Source information	**Construction period** - **Construction activities in the Project area** are approximately 33-42 months. There is a period of construction activities that may cause air pollution impacts i.e., land adjustment and foundation work. These are classified as area sources of air pollution. - **Raw water and wastewater pipeline installation of the Project** will take about 10 months. Construction activities that may cause impacts on air pollution include area adjustments, excavation for open-cut installation, use of machinery, and pipeline covering. These are classified as area sources of air pollution. - The Consultant used emission factors from Air Emission Calculations and Methodology of the Virginia Department of Mines Minerals and Energy, 2015 to calculate machine-generated pollutants as shown in **Table 5.3.2-2**. Land excavation activity was based on the US EPA "Compilation of Air Pollution Emission Factors" data publication NO.AP-42 (1995). Total suspended particulate (TSP) is approximately 1.2 tons/acre/month or 0.000114 gram/square meter/second. Considering the characteristic of the soil in the Project area is sandy loam, particulate matter with a diameter of smaller than 10 microns is 30-70 percent, about 0.42 tons/acre/month or 0.0000496 gram/square meter/second

Table 5.3.2-1

Methods for Assessing Air Quality Impact by using Models to show the Spreading of Air Pollution

Principles of air quality impact assessment	Operation
	(http://www.garrison.hawaii.army.mil/sbctEIS/feis/ Appendices/Appendix%20G2.pdf). The construction activity is scheduled only during 8:00 - 17:00 o'clock.
	- **Variation coefficient;** Assessing the 1-hour average and 1-year average concentrations of atmospheric nitrogen dioxide by distance was performed according to the Final Localized Significance Threshold Methodology, South Coast Air Quality Management District, July 2008. **Operation period** - The source of air pollution is the two boiler stacks of the Project which are considered as the point source of air pollution, the emission rate of the Project is shown in **Table 5.3.2-3.** - The Consultant calculated the emission rate of particulate matter with a diameter of smaller than 10 microns and the emission rate of particulate matter with a diameter of smaller than 2.5 microns. In the case of using natural gas fuel, the calculation employed the information from Emission factors for uncontrolled gas turbines natural gas engines from the National Pollutant Inventory Emission Estimation Technique Manual for Combustion engines Version 3.0 June 2008. In the case of using diesel fuel, the Consultant used comparative data of particulate matter with a diameter of smaller than 10 microns, and proportion of total suspended particulate to particulate matter with a diameter of smaller than 2.5 microns from the Appendix B.2 Generalized Particle Size Distributions AP-42 of the U.S.EPA. - The coefficient of variation in assessing the highest 1-hour average and one-year average concentrations of nitrogen dioxide in the atmosphere from the predictive results of mathematical models was based on the U.S. EPA guidelines.

Table 5.3.2-1

Methods for Assessing Air Quality Impact by using Models to show the Spreading of Air Pollution

Principles of air quality impact assessment	Operation
	The default conversion factors used for the assessing of 1-hour average concentration and 1-year average concentration were 0.8 and 0.75, respectively.
4. Meteorological information	- Meteorological data at Ratchaburi Meteorological Station was used. It is a meteorological station of the Meteorological Department, station number 48464, with the location of the station (latitude/longitude) 13 ° 29 '21.5 "N, 99 ° 47' 32.6" E. It is the closest meteorological station to the Project. The distance from the Project is approximately 8 kilometers. Three-hour data basis from 2016-2018 were used, including wind direction, wind speed, temperature, altitude, cloud base layer, and the amount of cloud cover. The wind rose is shown in **Figure 5.3.2-4**. - Due to the upper meteorological data of Thailand can be measured by the five stations of the Meteorological Department i.e., Chiang Mai, Ubon Ratchathani, Bang Na, Hat Yai, and Phuket Airport. However, not all data is measured throughout the year. So, the Consultant used satellite data from Lakes Environmental (AERMOD program provider) by referring to the coordinates of Bangna Meteorological Station which is the upper meteorological data monitoring station of the Meteorological Department. The station is closest to the study area at (latitude/longitude) 13.65 N, 100.60 E. The station number is 99999. Data from 2016-2018 were used by arranging in FSL format with a grid resolution of 4 kilometers (50 x 50 kilometers) - Meteorological data of the area based on land use characteristics include surface roughness length, Bowen ratio, and Albedo value, the Consultant considered land use characteristics from Google Earth imagery in 2019. Land use data from the Land Development Department in 2017 were used. The Ratchaburi meteorological station locates approximately 8 kilometers from the Project and the land use characters are different from the Project area. Therefore,

Table 5.3.2-1

Methods for Assessing Air Quality Impact by using Models to show the Spreading of Air Pollution

Principles of air quality impact assessment	Operation
	the Consultant prepared data on land use characteristics in the Project area to calculate the surface roughness length, Bowen ratio, and Albedo value, according to the Air Dispersion Modeling Guideline for Ontario according to the calculation method as shown in **Appendix 5-2.** The area division for the surface roughness length, Bowen ratio, and Albedo value are illustrated in **Figure. 5.3.2-5** and **Figure 5.3.2-6.**
5. Receptor and terrain elevation information	- The Consultant used the Unversity Transverse Mercator (UTM) geographic coordinates and the standard and global morphology, WGS84. - The Consultant used altitude data of the study area from SRTM at the resolution of 3-Arc Second (90 x 90 meters). - Assessing impact from the Project's activities include construction activities in the Project area and activities during the operation period. The Consultant defined the study area of 20 x 20 kilometers by using two types of grids (**Figure 5.3.2-7**): 1) uniform cartesian, the same grid, using a resolution of 500 meters, and 2) multi-tier, a non-static grid with the Project location as the center point and determines the variable grid resolution for use as a study observation point as follows: 2.1) in the Project area, up to a distance of 3.0 kilometers from the fence line, resolution of 100 meters, and 2.2), distance 3.0-4.0 kilometers, use the resolution of 250 meters for 21 additional observation points, as shown in **Table 5.3.2-4** and **Figure 5.3.2-8**. - Assessing of impact from raw water and wastewater pipelines installation activities of the Project, the Consultant defined a study area covering an area of 12 x 12 kilometers using a 250 meters uniform cartesian grid as shown **in Figure 5.3.2-9.** The additional 10 observation points are shown in **Table 5.3.2-5** and **Figure 5.3.2-10.**

Table 5.3.2-1

Methods for Assessing Air Quality Impact by using Models to show the Spreading of Air Pollution

Principles of air quality impact assessment	Operation
6. Background concentration	- The Consultant monitored ambient air quality two times, the first time was during 12-18 February 2019 and the second time was during 10-16 July 2019. Results of ambient air quality monitoring are expressed in **Table 5.3.2-6**.
7. Cumulative air pollution concentration which indicates the total impact	- In assessing the impact of total air quality (including background concentration), the Consultant considered the 24-hour average total suspended particulate (TSP), the 24-hour average concentration of particulate matter with a diameter of smaller than 10 microns (PM-10), and the 24-hour average concentration of particulate matter with a diameter of smaller than 2.5 microns (PM-2.5). For sulfur dioxide and nitrogen dioxide, the Consultant used the highest values from the monitoring results to consider in the assessment where the background concentrations were considered.

Table 5.3.2-2

Pollutant Emission Rate from Machines and Construction Equipments

Emission Source	Horse power	Emission Factor (g/hourse power.hr)		
		NO_x	PM-10	SO_2
Construction Activities in the Project's Area				
Water Truck	150	0.670	0.040	0.004
Diesel Dump Truck	150	0.670	0.040	0.004
Diesel Cement&Mortar Mixers	90	4.190	0.380	0.005
Diesel Cranes	200	1.670	0.080	0.004
Diesel Bull Dozers	100	2.550	0.310	0.005
Diesel Front End Loaders	100	3.940	0.710	0.006
Raw Water Pipes and Sewage Pipes Installation Activity (open pit installation)				
Excavator	142	1.070	0.060	0.004
Raw Water Pipes and Sewage Pipes Installation Activities (Drilling method installation)				
HDD RIg	540	3.660	0.190	0.004
Generator	215	3.650	0.190	0.004
HDD Mud Pump	600	3.650	0.170	0.005

Source : Virginia Department of Mines Minerals and Energy, 2015

(d) Particulate matter from land excavation

In the assessing of total suspended particulate (TSP) and particulate matter with a diameter of smaller than 10 microns (PM-10) from the surface opening of construction activities in the raw water and wastewater pipelines installation, The Consultant used data from the US EPA "Compilation of Air Pollution Emission Factors" data publication NO.AP-42 (1995). Total suspended particulate (TSP) is approximately 1.2 tons/acre/month or 0.000114 gram/square meter/second. Considering the characteristic of the soil in the Project area is sandy loam, particulate matter with a diameter of smaller than 10 microns is 30-70 percent, about 0.42 tons/acre/month or 0.0000496 gram/square meter/second (http://www.garrison.hawaii.army.mil/sbctEIS/feis/ Appendices/Appendix%2 0 G2 . pdf). The construction activity is scheduled only during 8:00 - 17:00 o'clock. The air quality impact assessment has considered the concentration of particulate matter with a diameter of smaller than 10 microns from the use of construction machinery together with the opening of the land surface. However, in assessing the impact on air quality, the Consultant considered using the variable emission rate by hour/day function of the AERMOD mathematical model, which can assess the impact on air quality, covering the nature of the Project's activities during the construction period.

a) The excavation of the ground surface from construction activities in the Project area

The Project shall excavate the ground surface to prepare the site for the construction, which will be gradually operated which assumes that the construction of the Project will open the ground surface area of approximately 3,200 square meters (according to the machine power).

b) The excavation of the ground surface from raw water and wastewater pipelines installation

Raw water and wastewater pipelines installation of the Project shall be performed with the following techniques:

- **Open cut technique**

The installation of the Project’s raw water and wastewater pipelines is divided into three phases as shown in **Figure 5.3.2-1,** details are as follows:

<u>Figure 5.3.2-1</u> Spacing between pipelines

*** Phase 1 installation of the Project's raw water and wastewater pipelines;** the Project shall excavate on a part by part basis. Each part is approximately 25 meters, the trench is approximately 3 meters wide with an open excavated area of 75 square meters.

*** Phase 2 installation of the Project's raw water and wastewater pipelines and natural gas distribution pipeline installation;** the Project will perform an excavation for raw water and wastewater pipelines installation in intervals of approximately 25 meters, the trench is approximately 3 meters width with an open excavated area of 75 square meters, along with excavation for natural gas distribution pipeline installation. The Project will excavate on a basis of 50 meters interval with the trench of 1.5 meter width, resulting in an excavated area of 75 square meters. The raw water pipeline installation is approximately 7 meters from the natural gas distribution pipeline.

*** Phase 3 installation of the Project's raw water and wastewater pipelines together with natural gas distribution pipeline installation;** the Project will perform an excavation for raw water, wastewater, and natural gas pipelines installation in intervals of approximately 25 meters, the trench is approximately 4.9 meters width with an open excavated area of 122.5 square meters.

- **Horizontal directional drilling (HDD) technique**

For the pipeline installation by horizontal directional drilling, the Project designed the entry and exit holes to have a size of 4.5 x 4.5 meters which is 20.25 square meters.

(e) Variation coefficient

The assessment of average 1-hour and average 1-year concentrations of nitrogen dioxide by distance was performed according to data from Final Localized Significance Threshold Methodology, South Coast Air Quality Management District, July 2008, with NO_2/ NO_x ratio by different distance as shown in the table below.

Downwind Distance (m)	NO_2/NO_x Ratio
20	0.053
50	0.059
70	0.064
100	0.074
200	0.114
500	0.258
1,000	0.467
2,000	0.75
3,000	0.9
4,000	0.978
5,000	1

2) Operation period

(a) Data on air pollution emission rate

The sources of air pollution used to predict air quality in this study were the 2 boiler stacks of the Project which are considered as point sources (location of the boiler stacks is shown in **Figure 5.3.2-**2).

The Consultant considered to design the stack in accordance with the good engineering practice (GEP) according to the Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) (Revised), U.S. Environmental Protection Agency, June 1985. It is calculated as followed.

$$Hg = H + 1.5L$$

Where: Hg = Approprate height of the stack
H = Height of the nearest building
L = The smaller value between the building height and the widest side of the neighboring building

As for the surrounding area of the Project's stacks, it was found that nearby buildings were located in the south, next to the gas metering station, with a building height of approximately 20 meters and a width of 10 meters. There is a boiler building in the north with a height of approximately 25 meters and a width of 20 meters. From the calculation with the mentioned equation, it can be substituted the equation as follows:

The height of the stacks of the Project is 60 meters, which is according to the design of the appropriate stacks. Therefore, the Consultant did not assess the impact of the downwash phenomenon.

The Project uses two types of fuel, natural gas, and diesel. In normal operation, the Project will use natural gas as primary fuel except in the event of an emergency when natural gas distributors are unable to deliver natural gas to the Project, therefore, the Project needs to use diesel as a fuel. The Project shall reserve diesel which can be used not more than 3 days (according to the reserve quantity). It will depend on the halt plan for the repair of the natural gas distribution system or the improvement of the gas network system of the natural gas supply and wholesaler licensee. In such a case, the Project will be notified at least 180 days in advance (except in the case of an emergency and in the event that affects the safety and stability of the gas distribution system). The halt shall be performed annually in which there will be a different number of days to natural gas distribution.

From the consideration of the power plants that have been operational by the group of companies with similar operating characteristics to the Hin Kong Power Plant Project, namely Ratchaburi Electricity Generating Power Plant of Ratchaburi Electricity Generating Company Limited, located at 128 Village Moo 6, Pikulthong Subdistrict, Mueang Ratchaburi District, Ratchaburi Province. The power plant also uses natural gas as the primary fuel which is supplied from the western gas field (Myanmar). The power plant has 4 reserve diesel tanks with a capacity of approximately 17,000 cubic meters, with an installed capacity of 2,175 megawatts, commercially operational since 2002 or for a period of 18 years. Details of electricity generating by using diesel fuel (over the past 5 years data) are as follows:

- April 2015, operated the diesel power generator for about seven days (due to the annual halt of Yadana and Zawtika natural gas fields of Myanmar),
- February 2016, operated the diesel power generator for about five days, and
- 2017-2019, there was no diesel power generation.

In the future, Thailand will connect to the east and west gas distribution pipelines network of the country. If the gas distribution system on either side has a plan to stop supplying natural gas, the other side will be able to supply natural gas to the power plant. Hence, Hin Kong Power Plant has a lower frequency to use diesel fuel than the past statistics of the Ratchaburi Power Plant.

The control of the air pollution emission rate of the Project is shown in **Table 5.3.2-3**.

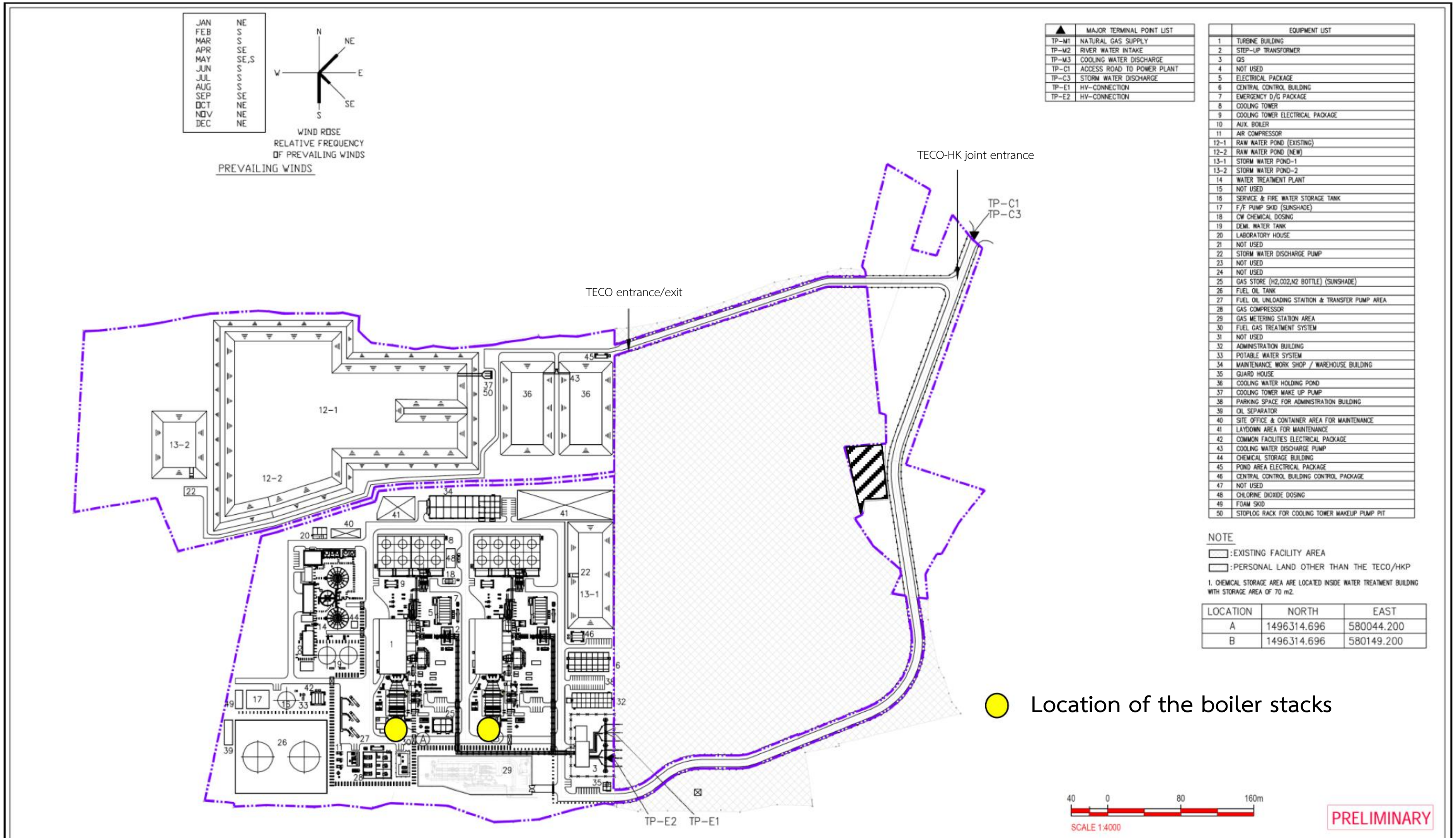
Air pollution emissions rate of the Project used in the air impact assessment are shown in **Table 5.3.2-4**. In addition, the Consultant calculated the emission rate of particulate matter with a diameter of smaller than 10 microns and the emission rate of particulate matter with a diameter of smaller than 2.5 microns. In the case of using natural gas fuel, the emission factors for uncontrolled gas turbines natural gas engines data were from the National Pollutant Inventory Emission Estimation Technique Manual for Combustion engines Version 3.0, June 2008. In the case of using diesel fuel, the ratio of total suspended particulate to particulate matter with a diameter of smaller than 10 microns and the ratio of total suspended particulate to particulate matter with a diameter of smaller than 2.5 microns from the USEPA's Appendix B.2 Generalized Particle Size Distributions AP-42 was used (an example of an emission rate calculation is shown in **Appendix 5 -1**).

(b) Variation coefficient

The assessing of the highest 1-hour average and one-year average concentrations of nitrogen dioxide from the mathematical modeling results was considered according to the U.S. EPA as follows:

a) The highest 1-hour average concentration used the default conversion of 0.8

b) The highest 24-hour average concentration used the default conversion of 0.75



<u>Figure 5.3.2-2</u> location of the boiler stacks

Table 5.3.2-3
Air pollution emission rate from the Project's boiler stacks

Occasion	Chimney's Size		Emission Details					Concentration[1/]			Emission Rate		
	Height	Diameter	Temperature	Gas Speed	$\%O_2$	Moisture	Flow Rate[1/]	NO_X	SO_2	TSP	NO_X	SO_2	TSP
	(m)	(m)	(K)	(m/s)			(Nm^3/s)	(ppm)	(ppm)	(mg/Nm^3)	(g/s)	(g/s)	(g/s)
1. Full Load (Natural Gas)													
- HRSG Stack Unit 1	60	7.34	354	24.2	11.7	1.08	734.9	59	10	20	59	13.9	9.7
- HRSG Stack Unit 2	60	7.34	354	24.2	11.7	1.08	734.9	59	10	20	59	13.9	9.7
Total											**118**	**27.8**	**19.4**
2. . Full Load (Diesel)[3/]													
- HRSG Stack Unit 1	60	7.34	380	27.5	13.4	1.12	744.4	99	20	35	81.4	22.9	14
- HRSG Stack Unit 2	60	7.34	380	27.5	13.4	1.12	744.4	99	20	35	81.4	22.9	14
Total											**162.8**	**45.8**	**28**
3. Minimum Generation Load (Natural Gas)													
- HRSG Stack Unit 1	60	7.34	345	15.6	12.3	1.07	488.2	59	10	20	36.7	8.6	6.1
- HRSG Stack Unit 2	60	7.34	345	15.6	12.3	1.07	488.2	59	10	20	36.7	8.6	6.1
Total											**73.4**	**17.2**	**12.2**
4. Minimum Generation Load (Diesel[3/]													
- HRSG Stack Unit 1	60	7.34	379	22.6	13.3	1.12	612.8	99	20	35	67.8	19.1	11.7
- HRSG Stack Unit 2	60	7.34	379	22.6	13.3	1.12	612.8	99	20	35	67.8	19.1	11.7
Total											**135.6**	**38.2**	**23.4**
Power Plant's standard value in case of using natural gas[2/]								120	20	60	-	-	-
Power plant's standard value in case of using diesel[2/]								180	320	120	-	-	-

Remarks: [1/] Actual conditions: actual temperature, actual pressure, actual excess oxygen, and wet basis

[2/] Emission standard according to the Notification of the Ministry of Industry B.E. 2547 (2004) on air emission standard for production or transmission of electric power (for a new power plant that received a license to operate after 1 October 2004) and the notification of the Ministry of Natural Resources and Environment B.E.2552 (2009) on the emission control standards from new power plants.

[3/] In the event of an emergency that the natural gas cannot be supplied to the Project only, the Project will use diesel as a reserve fuel for not more than 3 days each time.

Table 5.3.2-4
Air pollution emission rate from the Project that was used in the assessment of air pollution impacts

Occasion	Chimney's Size		Emission Details					Concentration[1/]			Emission Rate				
	Height	Diameter	Temperature	Gas Speed	$\%O_2$	Moisture	Flow Rate[1/]	NO_X	SO_2	TSP	NO_X	SO_2	TSP	PM-10[4/,5/]	PM-2.5[4/,5/]
	(m)	(m)	(K)	(m/s)			(Nm^3/s)	(ppm)	(ppm)	(mg/Nm^3)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)
1. Full Load (Natural Gas)															
- HRSG Stack Unit 1	60	7.34	354	24.2	11.7	1.08	734.9	59	10	20	59	13.9	9.7	1.48	1.48
- HRSG Stack Unit 2	60	7.34	354	24.2	11.7	1.08	734.9	59	10	20	59	13.9	9.7	1.48	1.48
Total											**118**	**27.8**	**19.4**	**2.96**	**2.96**
2. . Full Load (Diesel)[3/]															
- HRSG Stack Unit 1	60	7.34	380	27.5	13.4	1.12	744.4	99	20	35	81.4	22.9	14	13.44	12.6
- HRSG Stack Unit 2	60	7.34	380	27.5	13.4	1.12	744.4	99	20	35	81.4	22.9	14	13.44	12.6
Total											**162.8**	**45.8**	**28**	**26.88**	**25.2**
Power Plant's standard value in case of using natural gas[2/]								**120**	**20**	**60**	-	-	-	-	-
Power plant's standard value in case of using diesel[2/]								**180**	**320**	**120**	-	-	-	-	-

Remarks: [1/] Actual conditions: actual temperature, actual pressure, actual excess oxygen, and wet basis

[2/] Emission standard according to the Notification of the Ministry of Industry B.E. 2547 (2004) on air emission standard for production or transmission of electric power (for a new power plant that received a license to operate after 1 October 2004) and the notification of the Ministry of Natural Resources and Environment B.E.2552 (2009) on the emission control standards from new power plants.

3/ In the event of an emergency that the natural gas cannot be supplied to the Project only, the Project will use diesel as a reserve fuel for not more than 3 days each time.

4/The emission rate of particulate matter with a diameter of smaller than 10 microns and the emission rate of particulate matter with a diameter of smaller than 2.5 microns in the cause of using natural gas used data from the Emission Factors for Uncontrolled Gas Turbines Natural Gas Engines from National Pollutant Inventory Emission Estimation Technique Manual For Combustion Engines Version 3.0, June 2008

5/ The emission rate of particulate matter with a diameter of smaller than 10 microns and the emission rate of particulate matter with a diameter of smaller than 2.5 microns in the cause of using diesel fuel used the comparative data of the ratio of total suspended particulate to particulate matter with a diameter of smaller than 10 microns and the ratio of total suspended particulate to particulate matter with a diameter of smaller than 2.5 microns from Appendix B.2 Generalized Particle Size Distributions AP-42 of U.S.EPA.

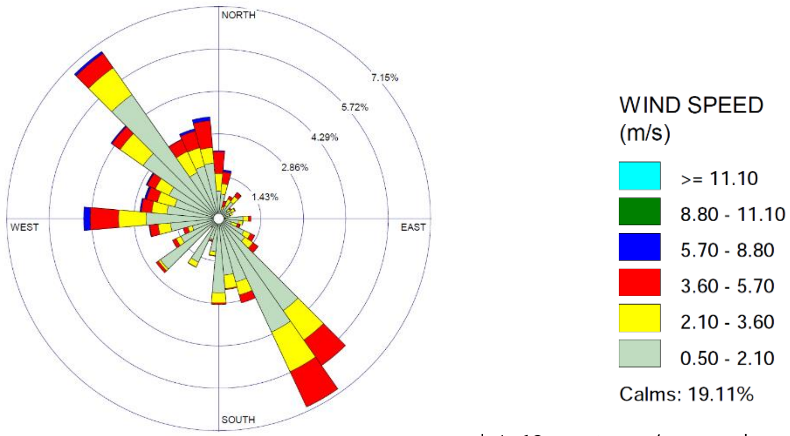
(4) Meteorological data

1) Surface meteorological data

Surface meteorological data were from the Ratchaburi meteorological station of the Meteorological Department, station number 48464 with the location of (latitude/longitude) 13 ° 29 '21.5' 'N, 99 ° 47' 32.6 " E. It is the closest meteorological station to the Project. The distance from the Project is approximately 8 kilometers. The data were on a three-hour basis from the year 2016-2018, including wind direction, wind speed, temperature, altitude, cloud base layer, and the amount of cloud cover. The Consultant used a step-wise linear interpolation approach to estimate the data above and prepare it in SCRAMformat (shortened of CD-144 format) to be used in the AERMOD model. The meteorological data prepared by the AERMET program before applied to the AERMOD mathematical model. From the meteorological data prepared in 2016, the most occurring wind directions were northwest and southwest while in 2017 and 2018, the most occurring wind direction was northwest as shown in **Figure 5.3.2-3**.

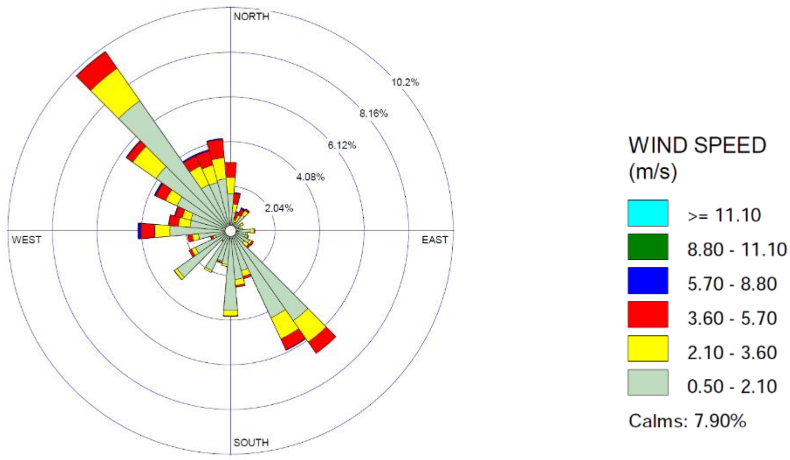
2) Upper air meteorological data

Due to the upper meteorological data of Thailand can be measured by the five stations of the Meteorological Department i.e., Chiang Mai, Ubon Ratchathani, Bang Na, Hat Yai, and Phuket Airport. However, not all data is measured throughout the year. So, the Consultant used satellite data from Lakes Environmental (AERMOD program provider) by referring to the coordinates of Bangna Meteorological Station which is the upper meteorological data monitoring station of the Meteorological Department. The station is closest to the study area at (latitude/longitude) 13.65 N, 100.60 E. The station number is 99999. Data from 2016-2018 were used by arranging in FSL format with a grid resolution of 4 kilometers (50 x 50 kilometers).



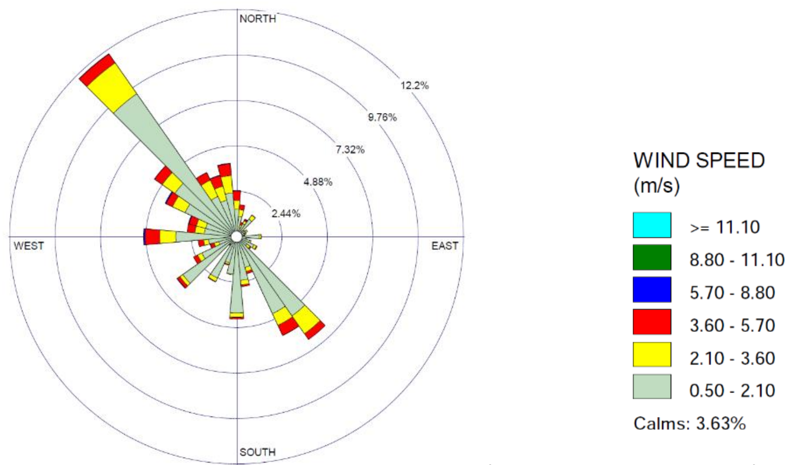
Average speed 1.63 meters /second

B.E. 2559 (2016)



Average speed 1.69 meters /second

B.E. 2560 (2017)



Average speed 1.66 meters /second

B.E. 2561 (2018)

Figure 5.3.2-3 Wind's Direction and Speed from Meteorological Station of Ratchaburi B.E. 2559-2561 (2016-2018)

3) Meteorological data of the area according to land use characteristics

Meteorological data of the area based on land use characteristics include surface roughness length, Bowen ratio, and Albedo value, the Consultant considered land use characteristics from Google Earth imagery in 2019. Land use data from the Land Development Department in 2017 were used. The Ratchaburi meteorological station locates approximately 8 kilometers from the Project and the land use characters are different from the Project area. Therefore, the Consultant prepared data on land use characteristics in the Project area to calculate the surface roughness length, Bowen ratio, and Albedo value, according to the Air Dispersion Modeling Guideline for Ontario according to the calculation method as shown in **Appendix 5-2**.

(a) The surface roughness length was based on an inverse distance-weighted geometric mean of 3 kilometers radius divided into 8 segments (**Figure 5.3.2-**),

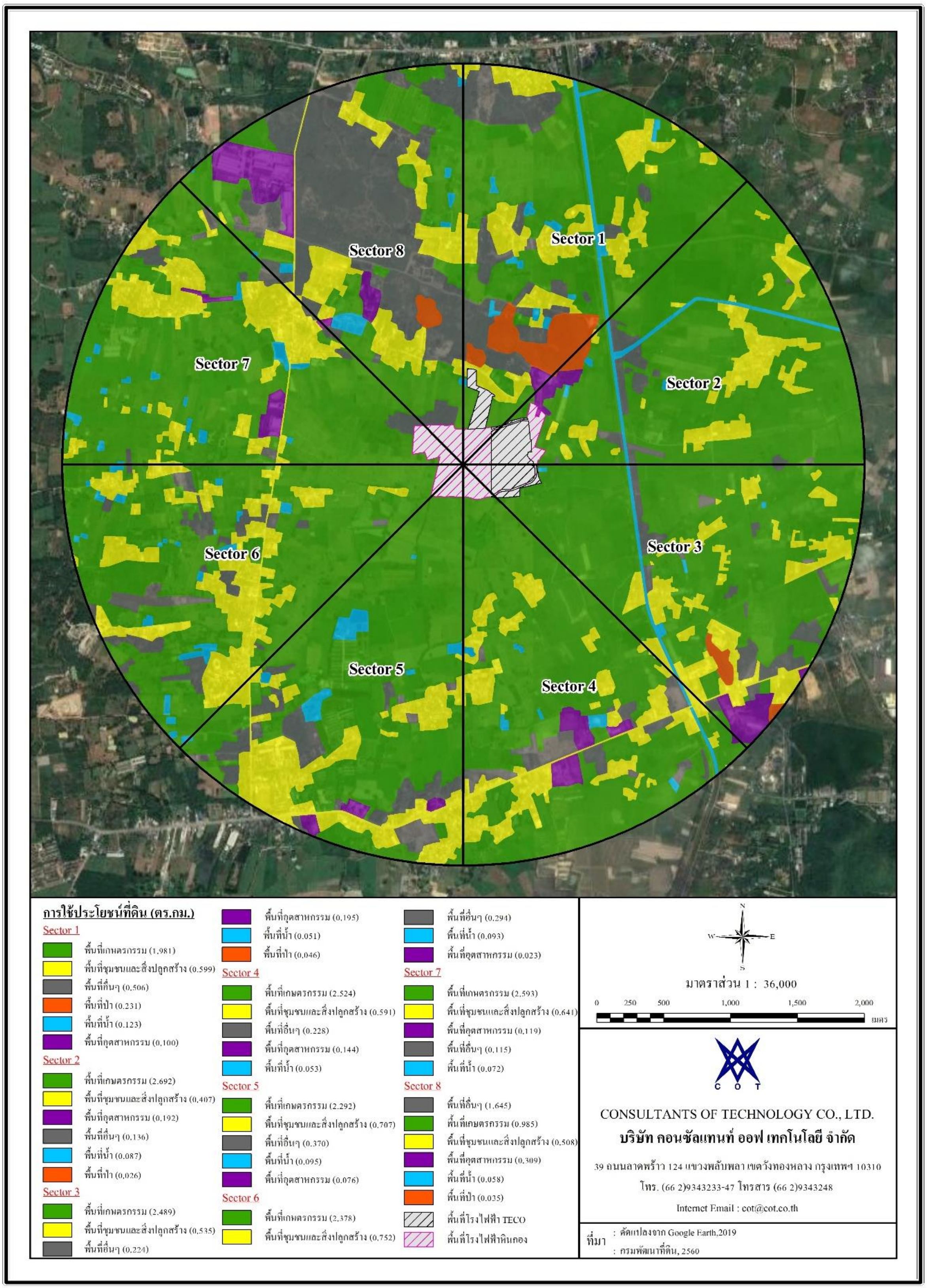
(b) The Bowen ratio was based on a weighted geometric mean within an area of 10 x 10 kilometers (**Figure 5.3.2-5**), and

(c) The Albedo value was based on a weighted geometric mean within an area of 10 x 10 kilometers (**Figure 5.3.2-5**).

The mean values of the surface roughness length, Bowen ratio and Albedo values regarding the land use characteristics were calculated according to the above method are as follows:

Frequency/Sector	Surface Roughness Length	Bowen Ratio	Albedo
0° - 45°	0.22	Average Dry Value = 1.52 Average Wet Value = 0.35	0.18
45° - 90°	0.27		
90° - 135°	0.21		
135° - 180°	0.21		
180° - 225°	0.23		
225° - 270°	0.20		
270° - 315°	0.25		
315° - 360°	0.19		

Remark: Bowen Ratio, average dry value used in assessing impact from November to April
Bowen Ratio, average wet value used in assessing impact from May to October



<u>Figure 5.3.2-4</u> Area Division for determining SURFACE ROUGHNESS

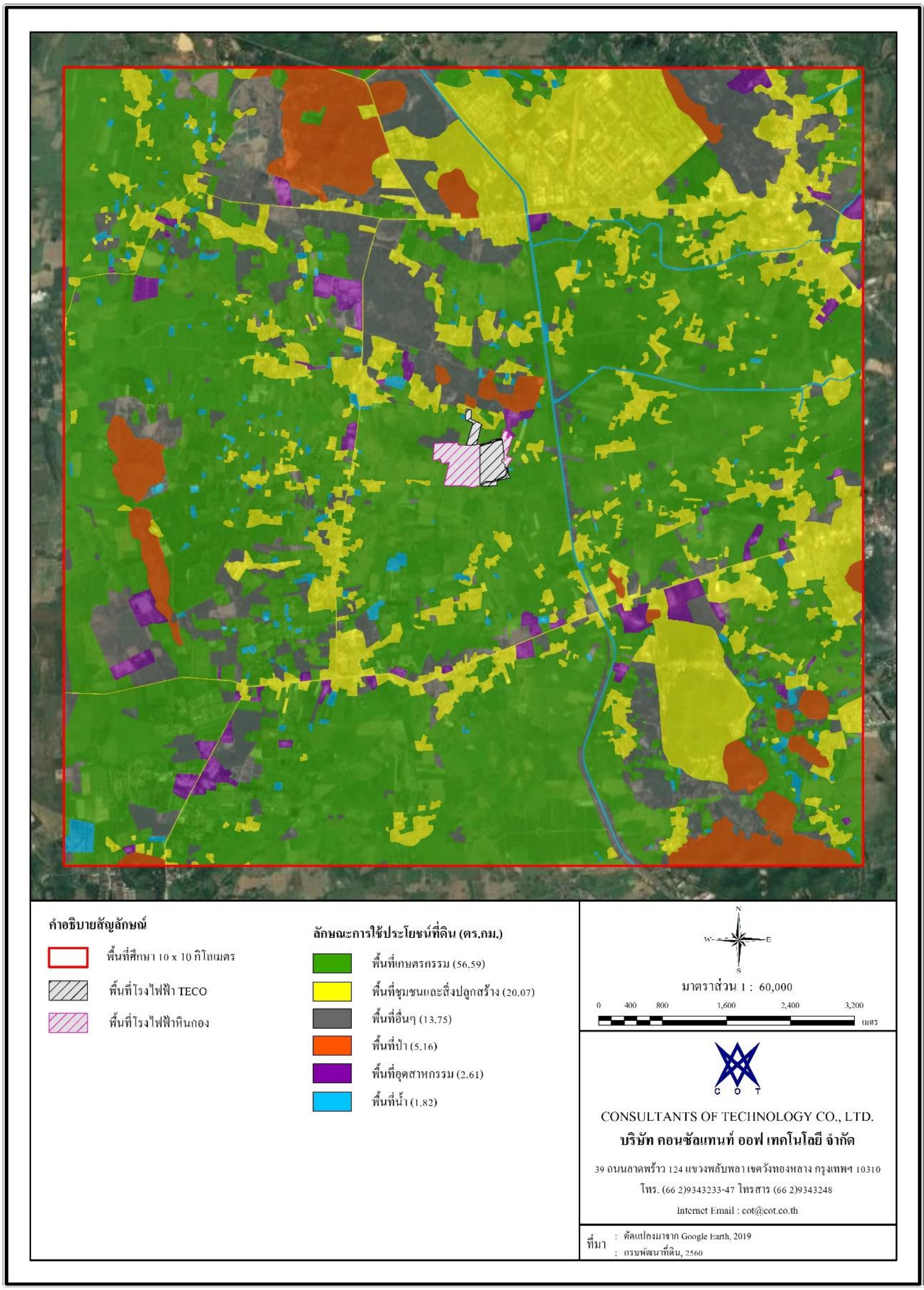


Figure 5.3.2-5 Area Scope 10 x 10 kilometers for determining BOWEN RATIO value and ALBEDO value

(5) Input data for AERMAP

1) Terrain elevation information

The Consultant used elevation data of the study area from SRTM with the resolution of the 3-arc second (90 x 90 meters).

2) Determination of study area and receptors data

(a) Study area and receptor data for the assessing of impacts from activities in the Project area

For assessing the impact of activities in the Project area, including construction activities in the Project area and activities during the operation period, the Consultant defined the study area to cover an area of 20 x 20 kilometers using 2 types of grids (**Figure 5.3.2-6**) as follows:

a) Uniform Cartesian, the uniform grid with the resolution of 500 meters, and

b) Multi-Tier, the non-static grid with the Project location as the center point and determines the variable grid resolution to as receptor points.

- In the project area up to a distance of 3.0 kilometers from the outside of the fence (fence line), resolution of 100 meters
- The distance of 3.0-4.5 kilometers, resolution of 250 meters

For selecting sensitive receptors to air pollution impacts, The Consultant considered the housing of the community to be used in determining the trend that air pollution from the Project would directly affect the health of the people living in the study area within a radius of 20x20 square kilometers around the Project. The sensitive areas in this impact assessment were 21 receptor points, details are shown in **Table 5.3.2-5** and **Figure 5.3.2-7**.

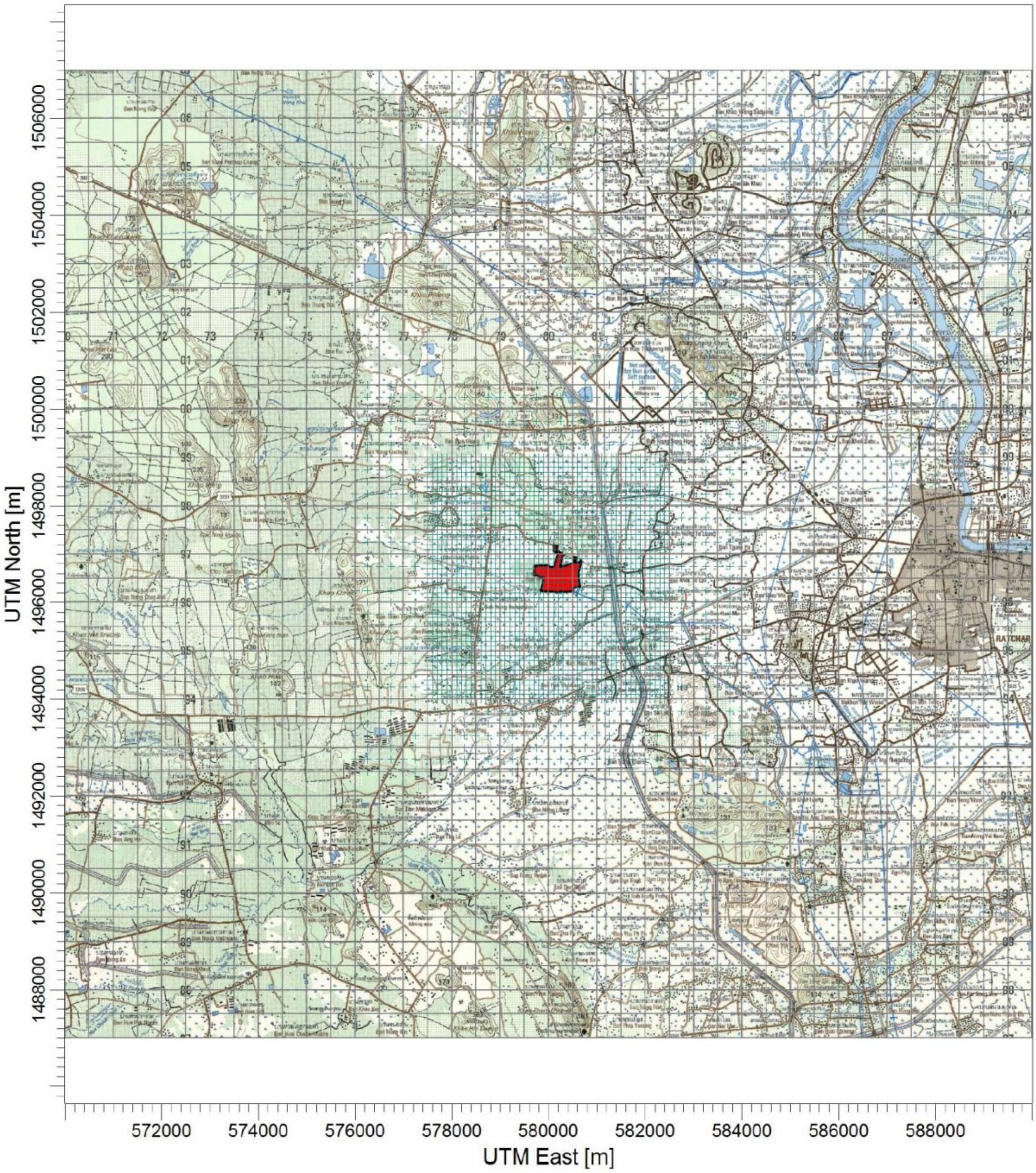


Figure 5.3.2-6 Multi-Tier Grid for assessing air quality impact from project's activities

Table 5.3.2-5

Sensitive Receptor for Assessing Impacts from Project's Activities

Sensitive Receptor	Coordinates		Distance from the Project (km)
	X	Y	
1. Wat Huai Moo School	583654	1496249	2.9
2. Wat Nong Taluang School	582305	1497204	1.7
3. Wat Huai Pladuk School	578661	1497485	1.3
4. Wat Na Nong School	582739	1491742	4.9
5. Wat Kor Loi School	583914	1503426	7.3
6. Wat Kao Gruad School	580661	1499468	2.4
7. Wat Huai Phai School	578684	1494082	2.4
8. Jedi Huk Private Hospital (Baan Huai Moo)	586415	1497447	5.7
9. Kor PlubPla Private Hospital	582234	1502249	5.5
10. Huai Phai Private Hospital	578333	1493853	2.8
11. Hin Kong Private Hospital	579490	1499649	2.7
12. Kao Gruad Temple	580731	1499766	2.7
13. Aroon Ratanasiri Temple	582528	1494781	2.4
14. Huai Phai Temple	579810	1493899	2.2
15. Nong Num Khun Temple	578431	1495924	1.4
16. Nong Luang Temple	579254	1492161	4.0
17. Hin Kong Temple	580352	1498218	1.1
18. Huai Phai Community	582129	1496035	1.5
19. Nong Karm House	580025	1494814	1.2
20. Nong Song Hong House	582682	1499665	3.4
21. Nong Gratoom Temple	577635	1499815	3.6

Source: Consultants of Technology Co,.L.td, 2563 (2020)

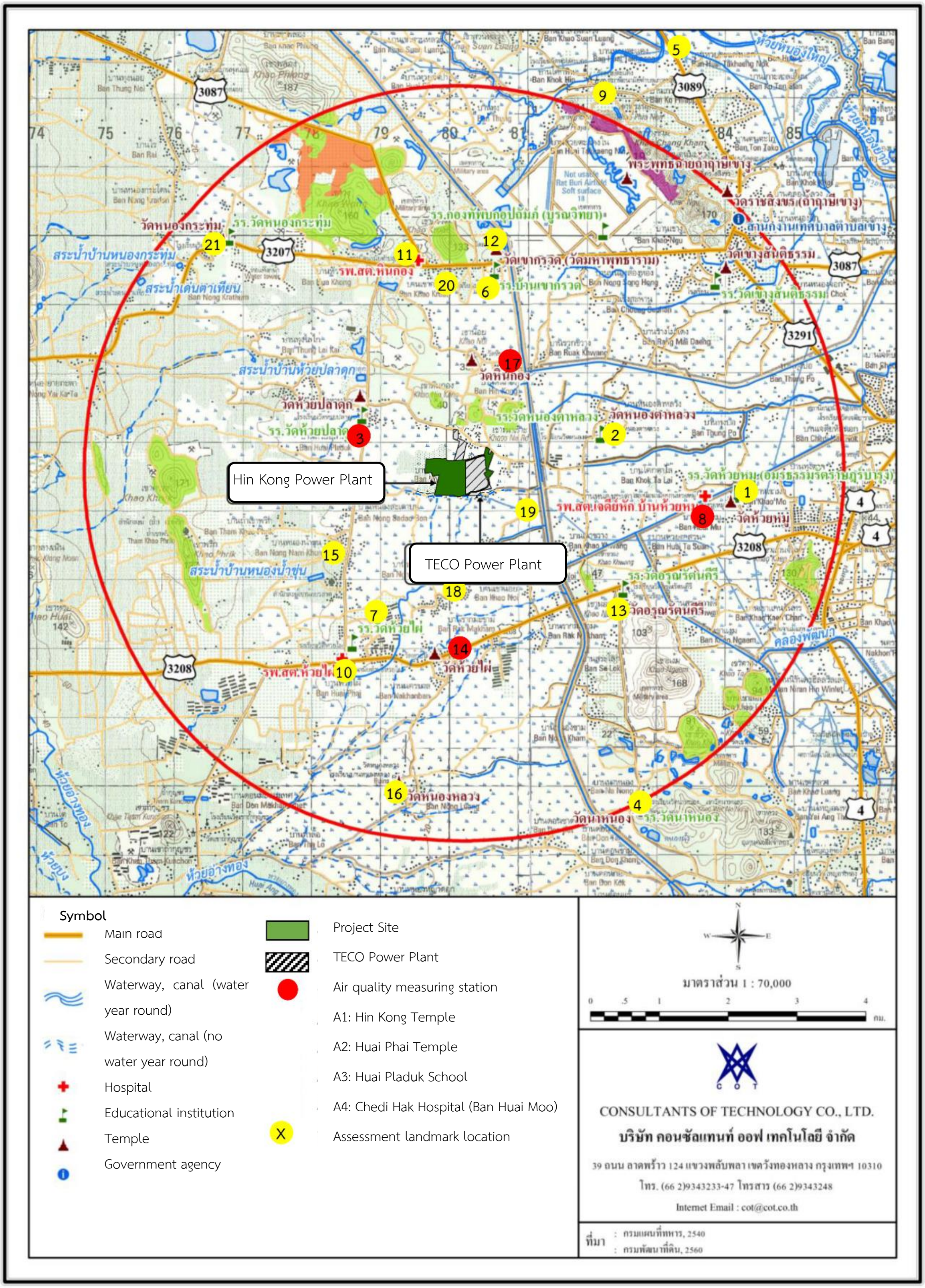


Figure 5.3.2-7 Sensitive receptor used for assessing air pollution from project's activities

(b) Study area and receptor data for impact assessment of raw water and wastewater pipelines installation activities of the Project

For assessing the impact of raw water and wastewater pipelines installation activities of the Project, the Consultant defined the study area covering an area of 12 x 12 kilometers using the uniform cartesian grid with the resolution of 250 meters, as shown in **Figure 5.3.2-8**.

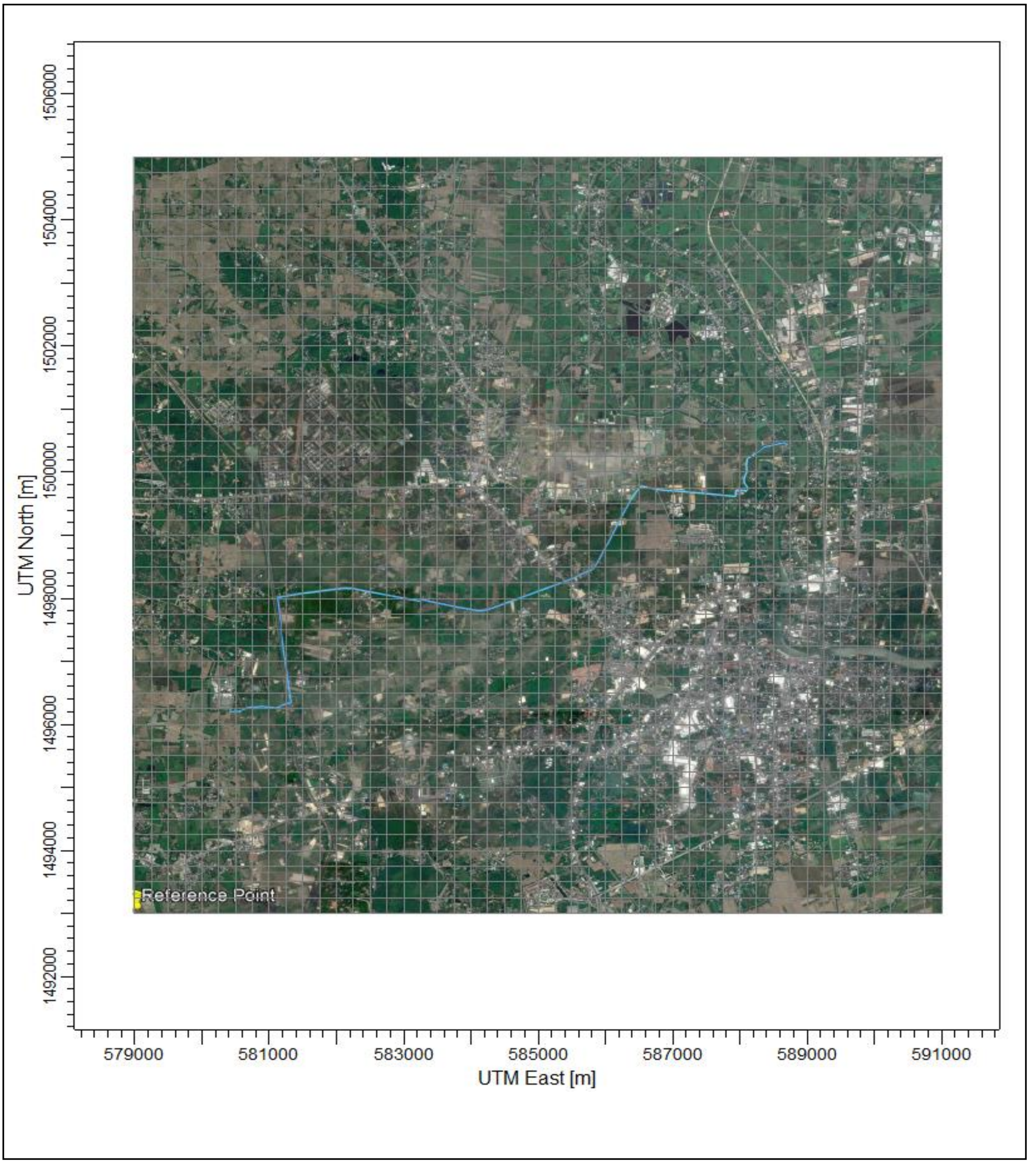


Figure 5.3.2-8 Uniform Cartesian Grid assessing air quality impact from intstalling raw water pipes and sewage pipes.

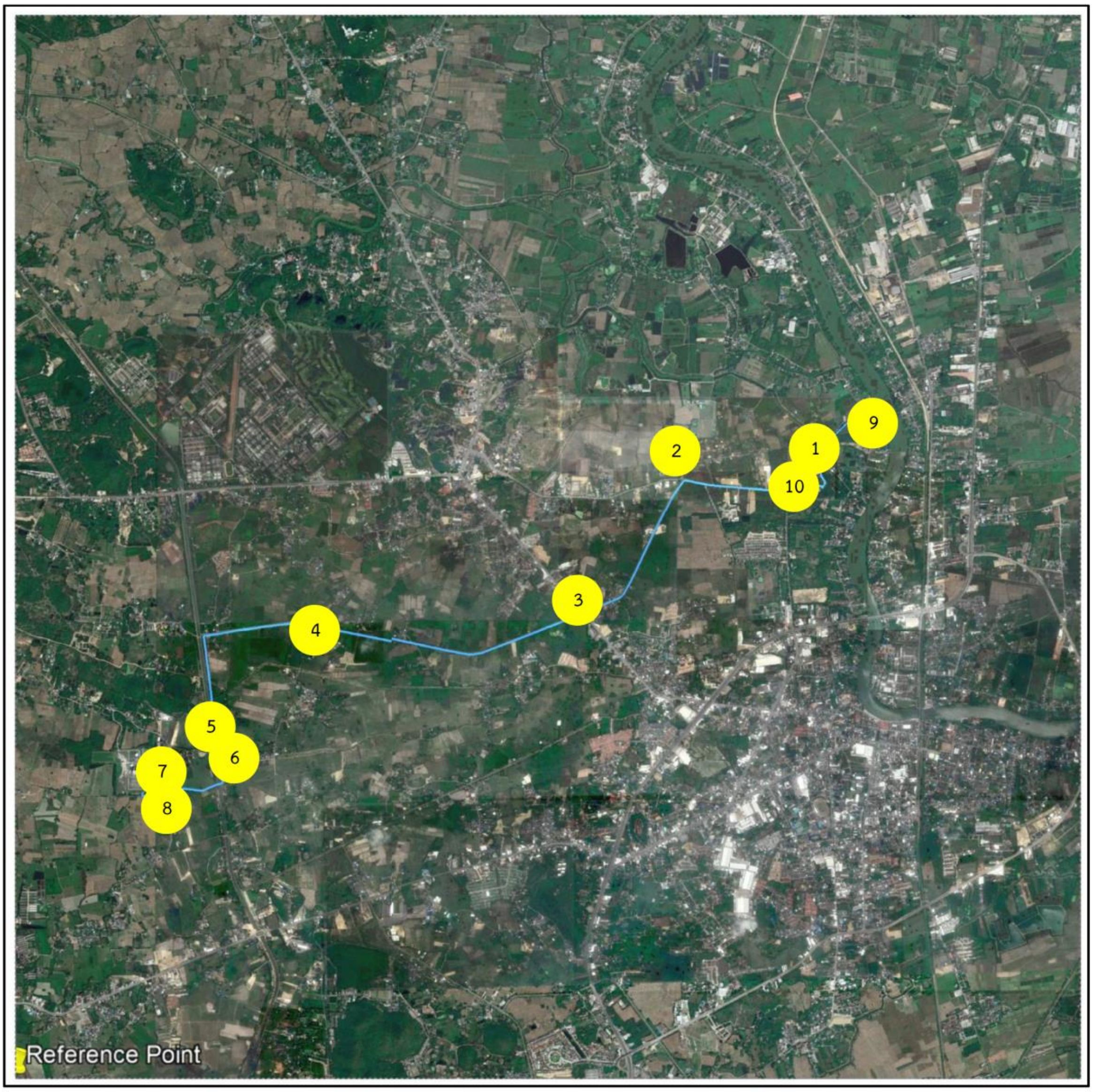
For the selection of sensitive receptors to air pollution impact, the sensitive areas for this impact assessment are along the raw water and wastewater pipelines as shown in **Table 5.3.2-6** and **Figure 5.3.2-9**.

Table 5.3.2-6

Sensitive Receptor Assessing Air Quality Impact from Intstalling Raw Water Pipes and Sewage Pipes.

Sensitive Receptor	Coordinates		Distance from the pipelines (meter)
	x	y	
Open pit construction			
1. Ban Klong Loomdin Community Moo 3, Loom Din subdistrict	588014	1499873	5
2. Ban Aranyik Community Moo 4, Jedi Huk subdistrict	586508	1499945	70
3. Ban Nong Jork Community Moo 5, Jedi Huk subdistrict	585366	1498316	40
4. Ban Rak Kwang Community Moo 3, Hin Kong subdistrict	582443	1498029	20
5. Ban Nong Taluang Shop Moo 3, Hin Kong subdistrict	581280	1496732	5
6. Ban Nong Taluang Community Moo 3, Hin Kong subdistrict	581365	1496592	50
7. Ban Nong Ruk Community Moo 5, Hin Kong subdistrict	580713	1496270	10
8. Ban Nong Sadao Bon Community Moo 6, Hin Kong subbdistrict	580706	1496222	10
Drilled construction			
9. Ban Plubpla Community Moo 7, Loom Din subdistrict	588641	1500367	30
10. Ban Klong Loom Din Community Moo 3, Loom Din subdistrict	587846	1499716	20
5. Ban Nong Taluang Shop Moo 3, Hin kong subdistrict	581280	1496732	5
6. Ban Nong Taluang Community Moo 3, Hin Kong subdistrict	581365	1496592	50

Remark: Sensitive areas 5. Shop at Moo 3 Ban Nong Ta Luang, Hin Kong Subdistrict, and 6. Moo 3 community, Ban Nong Ta Luang, Hin Kong Subdistrict, the assessment was considered together for the construction by both open-cut and horizontal directional drilling techniques



Label

1. Ban Klong Loomdin Community Moo 3, Loom Din subdistrict
2. Ban Aranyik Community Moo 4, Chedi Hak subdistrict
3. Ban Nong Jork Community Moo 5, Chedi Hak subdistrict
4. Ban Rak Kwang Community Moo 3, Hin Kong subdistrict
5. Ban Nong Taluang Shop Moo 3, Hin Kong subdistrict
6. Ban Nong Taluang Community Moo 3, Hin Kong subdistrict
7. Ban Nong Ruk Community Moo 5, Hin Kong subdistrict
8. Ban Nong Sadao Bon Community Moo 6, Hin Kong subbdistrict
9. Ban Plubpla Community Moo 7, Loom Din subdistrict
10. Ban Klong Loom Din Community Moo 3, Loom Din subdistrict

Figure 5.3.2-9 Sensitive Receptor in assessing air pollution impact from installation of raw water pipes and sewage pipes.

(6) Background concentration of ambient air pollutants

The Consultant monitored the ambient air quality in the study area. The parameters include 24-hours average concentration total suspended particulate (TSP), 24-hours average concentration of particulate matter with a diameter smaller than 10 microns, 24-hours average concentration of particulate matter with a diameter smaller than 2.5 microns, 1-hour and 24-hour average concentrations of sulfur dioxide (SO_2), and 1-hour average concentration of nitrogen dioxide (NO_2).

The Project conducted the ambient air quality monitoring 2 times, the first time was during 12-18 February 2019 and the second time was during 10-16 July 2019. During the monitoring periods, TECO was not operated. There were four monitoring stations of the Project (**Figure 5.3.2-10**), details are as follows:

A1 = Hin Kong Temple (about 1.75 kilometers north of the Project), the environment surrounding the monitoring station is a community,

A2 = Huai Phai Temple (about 2.65 kilometers south of the Project), the environment surrounding the monitoring station is a community,

A3 = Wat Huai Pla Duk School (about 1.70 kilometers east of the Project), the environment surrounding the monitoring station is a community, and

A4 = Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo) (about 3.55 kilometers east of the Project), the environment surrounding the monitoring station is a community and agricultural area.

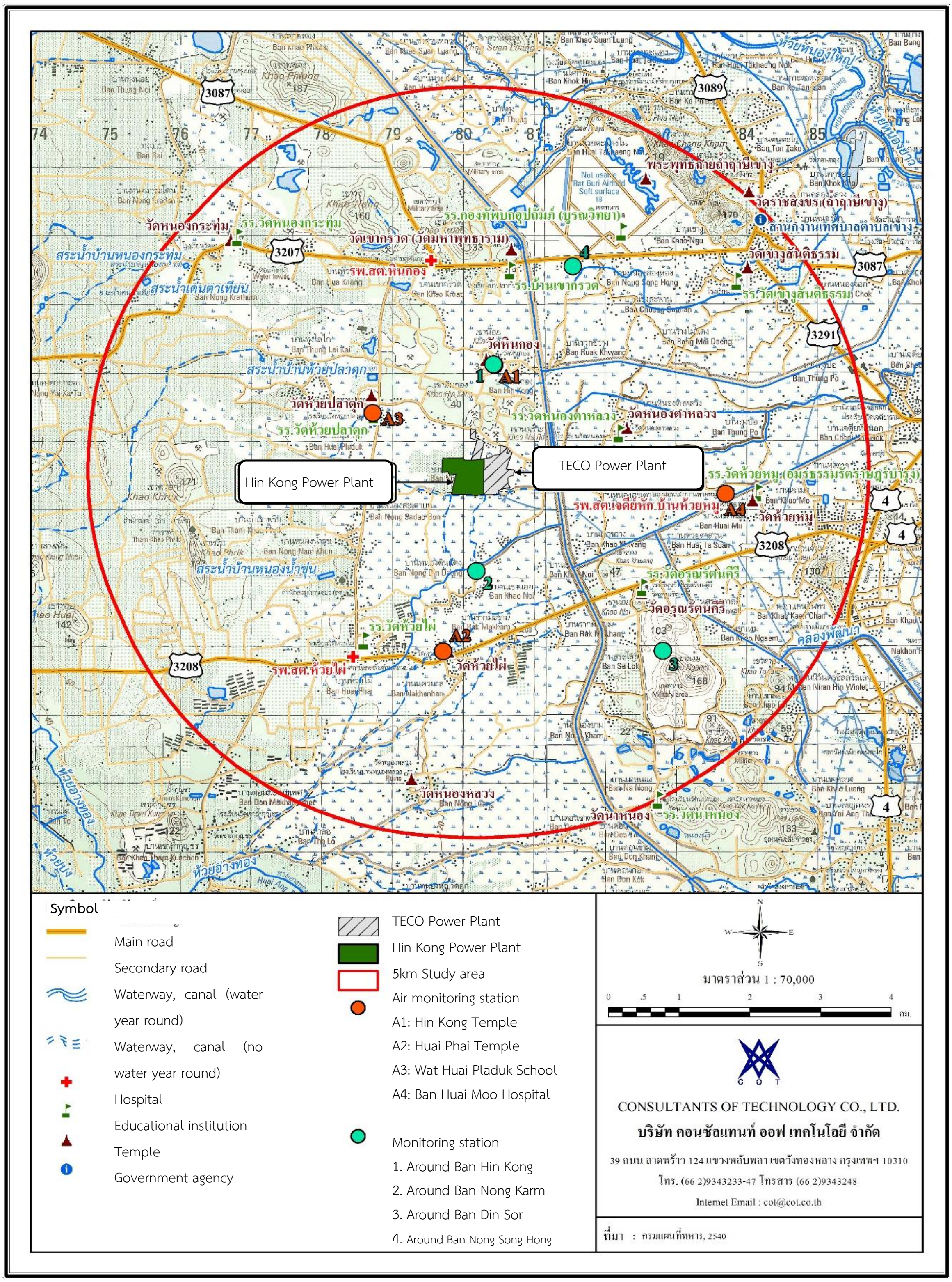


Figure 5.3.2-10 Measuring Site for air quality

Results of the ambient air quality monitoring are expressed in **Table 5.3.2-7** and can be summarized as follows:

1) 24-hour average concentration of total suspended particulate (TSP)

From the results of the monitoring conducted during 12-18 February and 10-16 July 2019, it was found that the 24-hour average concentrations of total suspended particulate (TSP) at Hin Kong Temple were in the range of 25-185 micrograms per cubic meter. TSP concentrations at Huai Phai Temple were in the range of 28-170 micrograms per cubic meter. The concentrations at Wat Huai Pla Duk School were in the range of 19-140 micrograms per cubic meter. TSP concentrations in the area of Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo) were in the range of 17-433 micrograms per cubic meter.

The monitoring results were compared with the ambient air quality standard according to the Notification of the National Environment Board Notification No. 24 B.E.2547 (2004). The 24-hour average concentration of total suspended particulate must not exceed 330 micrograms per cubic meter. It was found that the monitoring results were within the specified standard except for the concentration at the area of Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo) that exceeded the standard for a period of time (433 micrograms per cubic meter) on 12 February 2019. However, the monitoring results of total suspended particulate concentrations during 13-18 February 2019 were in the range of 48-230 micrograms per cubic meter which are within the specified standard (**Figure 5.3.2-11**).

2) 24-hour average concentration of particulate matter with a diameter smaller than 10 microns

From the results of the monitoring conducted during 12-18 February and 10-16 July 2019, it was found that the 24-hour average concentrations of particulate matter with a diameter smaller than 10 microns (PM-10) at Hin Kong Temple were in the range of 12-95 micrograms per cubic meter. PM-10 concentrations at Huai Phai Temple were in the range of 14-87 micrograms per cubic meter. The concentrations at Wat Huai Pla Duk School were in the range of 12-85 micrograms per cubic meter. PM-10 concentrations at the area of Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo) were in the range of 9-198 micrograms per cubic meter.

Table 5.3.2-7
Atmosphere Air Quality Measurement Result

Measuring Station	Date of measurement	Measurement Result (microgram/ cubic meters)						
		Total suspended particles (TSP) 24 hour average	PM-10 24 hour average	PM 2.5 24 hour average	Sulfur Dioxide gas		Nitrogen Dioxide gas	
					1 hour average	24 hour average	1 hour average	24 hour average
Hin Kong Temple	12 February 62	185	95	61	2.62	2.62	24.46	13.17
	13 February 62	151	77	58	2.62	2.62	20.70	13.17
	14 February 62	123	53	20	2.62	2.62	15.05	11.29
	15 February 62	117	54	33	2.62	2.62	15.05	11.29
	16 February 62	107	50	30	2.62	2.62	15.05	9.41
	17 February 62	118	44	30	2.62	2.62	20.70	11.29
	18 February 62	50	28	16	2.62	2.62	15.05	7.53
	10 July 62	68	22	6	5.24	2.62	5.24	2.62
	11 July 62	62	28	13	7.86	5.24	2.62	2.62
	12 July 62	58	33	15	7.86	5.24	2.62	2.62
	13 July 62	35	18	11	10.48	5.24	2.62	2.62
	14 July 62	45	18	6	7.86	5.24	2.62	2.62
	15 July 62	25	14	8	7.86	5.24	2.62	2.62
	16 July 62	25	12	<5	7.86	7.86	2.62	2.62
	Lowest value-highest value	**25-185**	**12-95**	**<5-61**	**2.62-10.48**	**2.62-7.86**	**2.62-24.46**	**2.62-13.17**

Measuring Station	Date of measurement	Measurement Result (microgram/ cubic meters)						
		Total suspended particles (TSP) 24 hour average	PM-10 24 hour average	PM 2.5 24 hour average	Sulfur Dioxide gas		Nitrogen Dioxide gas	
					1 hour average	24 hour average	1 hour average	24 hour average
Huai Phai Temple	12 February 62	170	86	62*	5.24	2.62	35.75	16.94
	13 February 62	160	87	52*	5.24	2.62	28.23	15.05
	14 February 62	131	56	34	5.24	2.62	18.82	13.17
	15 February 62	124	63	33	5.24	2.62	26.35	13.17
	16 February 62	126	59	31	5.24	2.62	18.82	9.41
	17 February 62	89	45	31	5.24	5.24	30.11	11.29
	18 February 62	58	26	17	5.24	5.24	15.05	11.29
	10 July 62	37	23	11	5.24	2.62	23.58	7.86
	11 July 62	73	29	21	5.24	2.62	20.96	7.86
	12 July 62	58	34	15	5.24	2.62	20.96	7.86
	13 July 62	56	24	19	5.24	2.62	7.86	5.24
	14 July 62	84	30	23	5.24	2.62	13.10	5.24
	15 July 62	28	14	7	5.24	2.62	20.96	7.86
	16 July 62	55	49	32	2.62	2.62	10.48	5.24
	Lowest value-highest value	**28-170**	**14-87**	**7-62**	**2.62-5.24**	**2.62-5.24**	**7.86-35.75**	**5.24-16.94**
Wat Pladuk School	12 February 62	140	85	58*	5.24	2.62	28.23	13.17
	13 February 62	135	83	54*	5.24	5.24	26.35	13.17
	14 February 62	103	58	30	5.24	2.62	18.82	11.29

Measuring Station	Date of measurement	Measurement Result (microgram/ cubic meters)						
		Total suspended particles (TSP) 24 hour average	PM-10 24 hour average	PM 2.5 24 hour average	Sulfur Dioxide gas		Nitrogen Dioxide gas	
					1 hour average	24 hour average	1 hour average	24 hour average
	15 February 62	88	46	39	2.62	2.62	15.05	7.53
	16 February 62	92	51	27	5.24	2.62	26.35	16.94
	17 February 62	99	47	28	2.62	2.62	20.70	11.29
	18 February 62	81	42	27	5.24	2.62	18.82	9.41
	10 July 62	32	19	7	7.86	5.24	10.48	5.24
	11 July 62	43	29	12	7.86	5.24	7.86	5.24
	12 July 62	47	25	12	7.86	5.24	7.86	5.24
	13 July 62	29	14	6	7.86	5.24	7.86	2.62
	14 July 62	26	15	5	5.24	5.24	5.24	5.24
	15 July 62	26	14	6	7.86	5.24	5.24	5.24
	16 July 62	19	12	6	7.86	5.24	7.86	5.24
	Lowest value-highest value	**19-140**	**12-85**	**5-58**	**2.62-7.86**	**2.62-5.24**	**5.24-28.23**	**5.24-16.94**
Jedi Huk Private Hospital (Ban Huai Moo)	12 February 62	433*	198*	52*	13.10	2.62	31.99	16.94
	13 February 62	230	105	57*	10.48	5.24	31.99	15.05
	14 February 62	114	59	29	7.86	2.62	18.82	11.29
	15 February 62	104	61	32	7.86	2.62	20.70	11.29
	16 February 62	111	58	29	7.86	2.62	26.35	11.29
	17 February 62	76	45	26	5.24	2.62	26.35	16.94

Measuring Station	Date of measurement	Measurement Result (microgram/ cubic meters)						
		Total suspended particles (TSP) 24 hour average	PM-10 24 hour average	PM 2.5 24 hour average	Sulfur Dioxide gas		Nitrogen Dioxide gas	
					1 hour average	24 hour average	1 hour average	24 hour average
	18 February 62	48	31	16	7.86	2.62	20.70	13.17
	10 July 62	45	22	12	5.24	2.62	15.72	5.24
	11 July 62	48	25	12	5.24	2.62	10.48	5.24
	12 July 62	47	26	15	5.24	2.62	15.72	7.86
	13 July 62	17	10	9	7.86	2.62	13.10	7.86
	14 July 62	26	13	10	5.24	5.24	13.10	7.86
	15 July 62	22	13	6	5.24	2.62	10.48	7.86
	16 July 62	17	9	6	5.24	2.62	10.48	7.86
	Lowest value-highest value	**17-433**	**9-198**	**6-57**	**5.24-13.10**	**2.62-5.24**	**10.48-31.99**	**5.24-16.94**
Standard Value		330[1/]	120[1/]	50[2/]	780[3/]	300[1/]	320[4/]	-

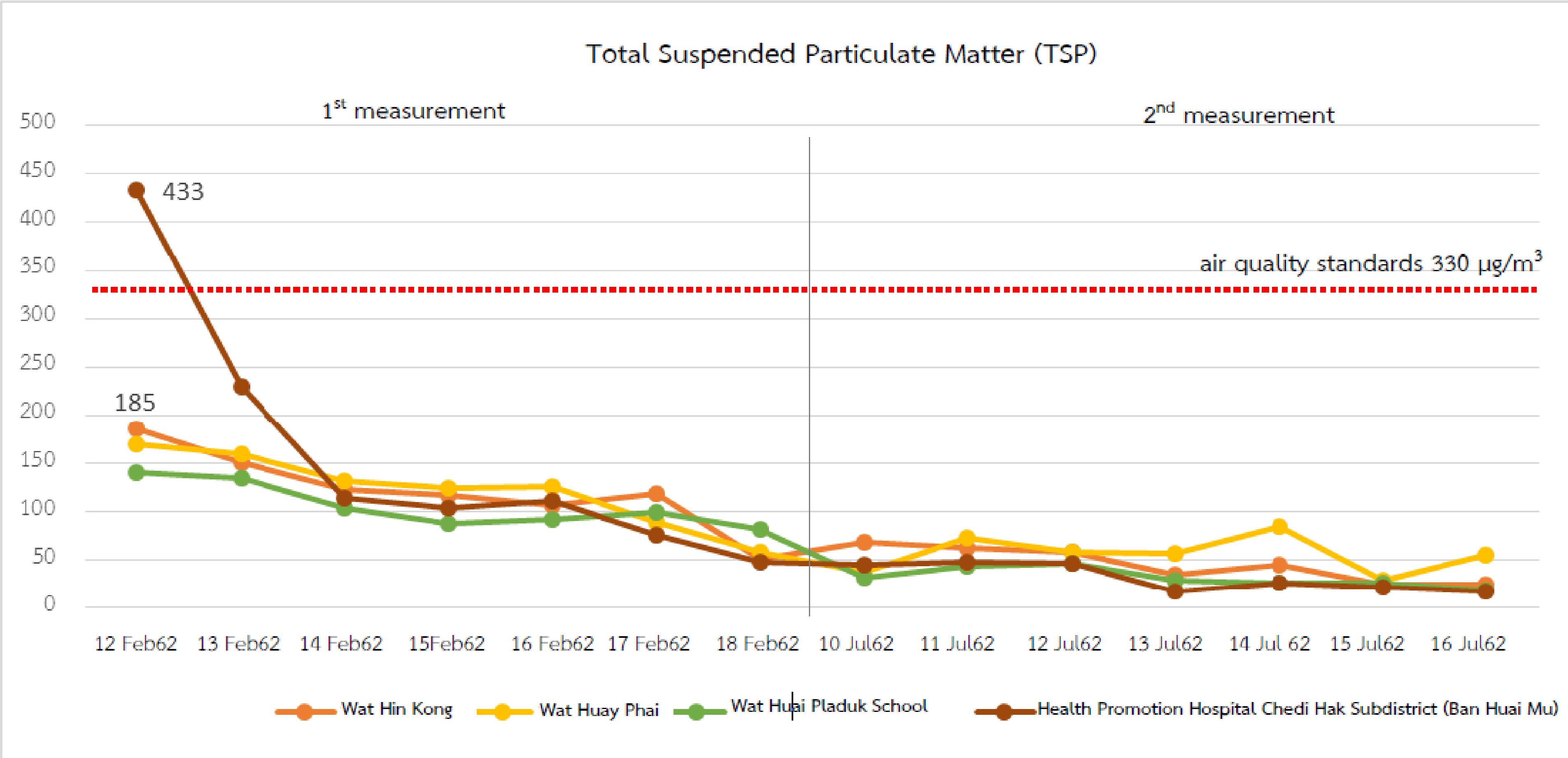


Figure 5.3.2-11 Graph showing air quality from total suspended particles (TSP) results, average 24 hour

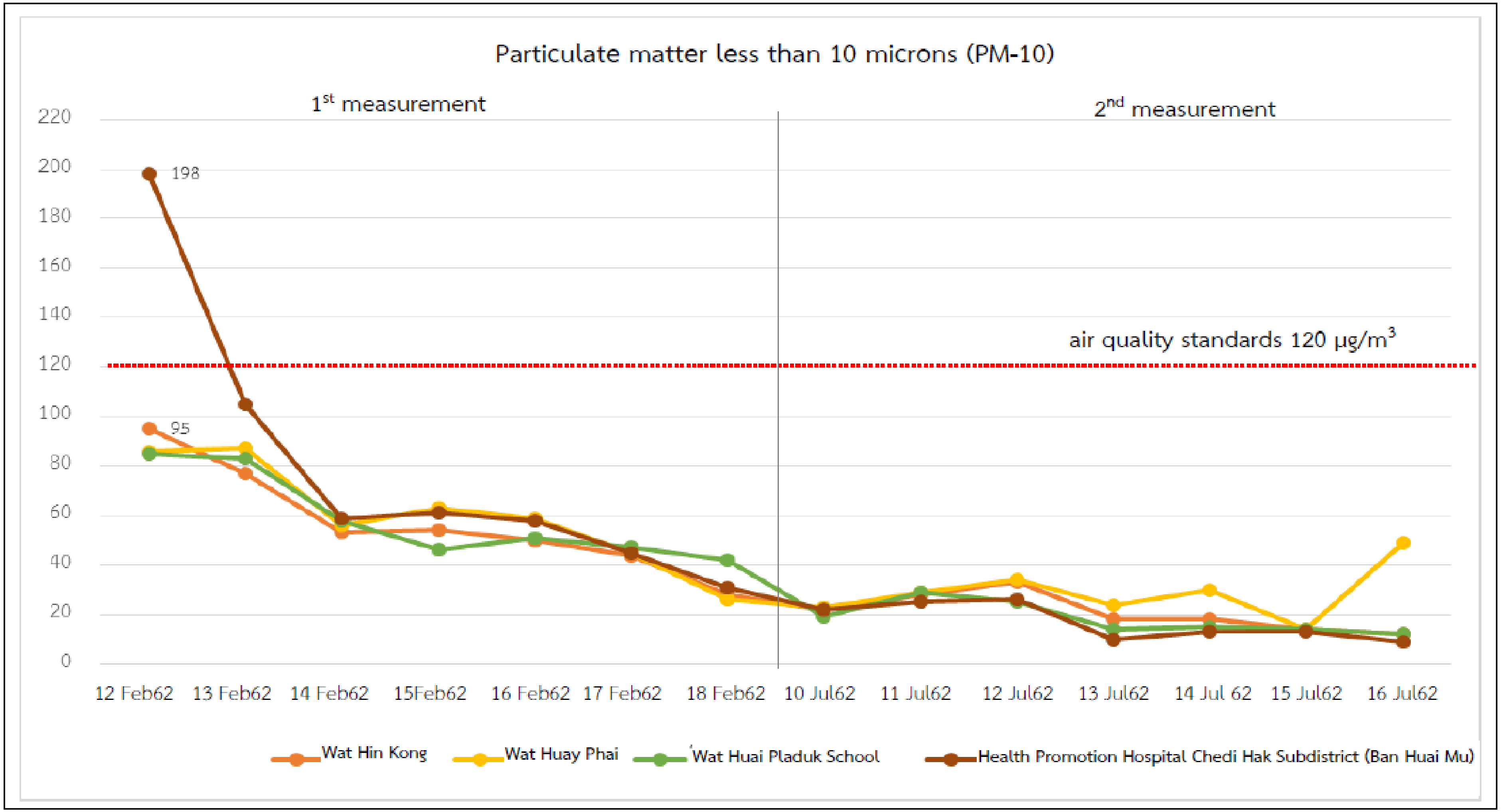


Figure 5.3.2-12 Graph showing air quality from PM-10 results, 24 hour average

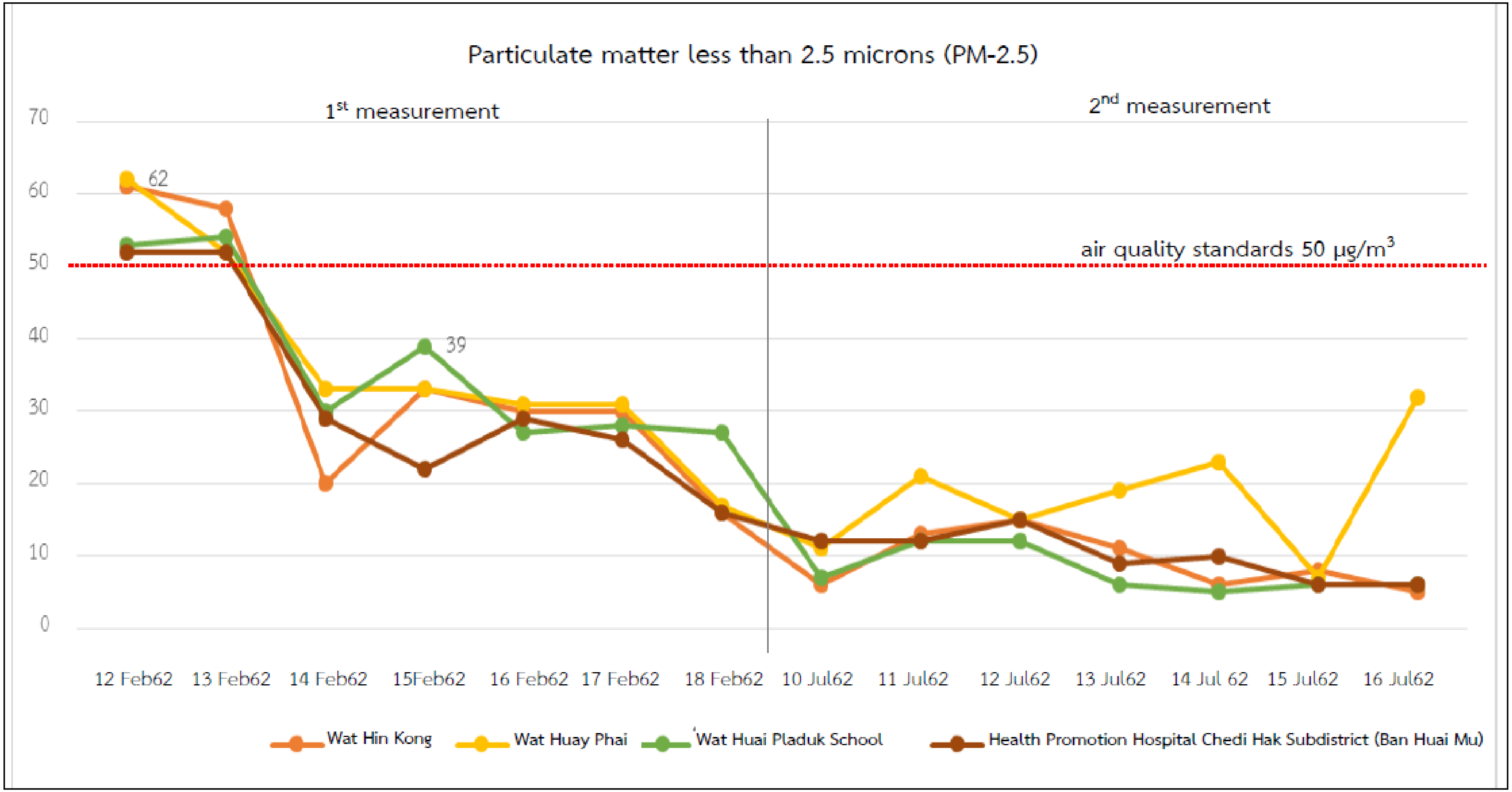


Figure 5.3.2-13 Graph showing air quality from PM2.5 results, average 24 hour

The monitoring results were compared with the ambient air quality standard according to the Notification of the National Environment Board Notification No. 24 B.E.2547 (2004). The 24-hour average concentration of particulate matter with a diameter smaller than 10 microns must not exceed 120 micrograms per cubic meter. It was found that the majority of the monitoring results were within the specified standard except for the concentration at the area of Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo) that exceeded the standard for a period of time (198 micrograms per cubic meter) on 12 February 2019. However, the monitoring results of particulate matter with a diameter smaller than 10 microns concentrations during 13-18 February 2019 were in the range of 31-105 micrograms per cubic meter which are within the specified standard (**Figure 5.3.2-12**).

From the results of dust monitoring (TSP and PM-10) in the study area, especially in the dry season (November to February), it was found that the concentrations of dust at most monitoring stations (Hin Kong Temple, Huai Phai Temple, and Wat Huai Pla Duk School) of all 7 days were within the specified standard, except for the monitoring station of at Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo) that exceeds the standard for 1 day, on 12 February 2019.

3) 24-hour average concentration of particulate matter with a diameter smaller than 2.5 microns

From the results of the monitoring conducted during 12-18 February and 10-16 July 2019, it was found that the 24-hour average concentrations of particulate matter with a diameter smaller than 2.5 microns (PM-2.5) at Hin Kong Temple were in the range of 5-61 micrograms per cubic meter. PM-2.5 concentrations at Huai Phai Temple were in the range of 7-62 micrograms per cubic meter. The concentrations at Wat Huai Pla Duk School were in the range of 5-58 micrograms per cubic meter. PM-2.5 concentrations at the area of Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo) were in the range of 6-57 micrograms per cubic meter.

The monitoring results were compared with the ambient air quality standard according to the Notification of the National Environment Board Notification No. 24 B.E.2547 (2004). The 24-hour average concentration of particulate matter with a diameter smaller than 2.5 microns must not exceed 50 micrograms per cubic meter. It was found that during 14-18 February 2019, concentrations of PM-2.5 of all stations were within the standard. However, during 12-13 February 2019, concentrations of PM-2.5 of all stations exceed the standard because the weather was less buoyant and calm wind, which causes the amount of dust to accumulate. This was in line with the monitoring results of the Pollution Control Department that were conducted in the Ratchaburi Province in the area of the Environment Office Region 8, Na Muang Subdistrict, Mueang Ratchaburi District, Ratchaburi Province. The concentration was 78 micrograms per cubic meter. (**Figure 5.3.2-13**).

4) 1-hour average concentration of sulfur dioxide (SO_2)

From the results of the monitoring conducted during 12-18 February and 10-16 July 2019, it was found that the 1-hour average concentrations of sulfur dioxide (SO_2) at Hin Kong Temple were in the range of 2.62-10.48 micrograms per cubic meter. Sulfur dioxide concentrations at Huai Phai Temple were in the range of 2.62-5.24 micrograms per cubic meter. The concentrations at Wat Huai Pla Duk School were in the range of 2.62-7.86 micrograms per cubic meter. Sulfur dioxide concentrations in the area of Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo) were in the range of 5.24-13.10 micrograms per cubic meter.

The monitoring results were compared with the ambient air quality standard according to the Notification of the National Environment Board Notification No. 21 B.E.2544 (2001). The 1-hour average concentration of sulfur dioxide (SO_2) must not exceed 780 micrograms per cubic meter. It was found that the monitoring results of all stations were within the specified standard.

5) 24-hour average concentration of sulfur dioxide (SO_2)

From the results of the monitoring conducted during 12-18 February and 10-16 July 2019, it was found that the 24-hour average concentrations of sulfur dioxide (SO_2) at Hin Kong Temple were in the range of 2.62-7.86 micrograms per cubic meter. Sulfur dioxide concentrations at Huai Phai Temple were in the range of 2.62-5.24 micrograms per cubic meter. The concentrations at Wat Huai Pla Duk School were in the range of 2.62-5.24 micrograms per cubic meter. Sulfur dioxide concentrations in the area of Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo) were in the range of 2.62-5.24 micrograms per cubic meter.

The monitoring results were compared with the ambient air quality standard according to the Notification of the National Environment Board Notification No. 21 B.E.2544 (2001). The 24-hour average concentration of sulfur dioxide (SO_2) must not exceed 300 micrograms per cubic meter. It was found that the monitoring results of all stations were within the specified standard.

6) 1-hour average concentration of nitrogen dioxide (NO_2)

From the results of the monitoring conducted during 12-18 February and 10-16 July 2019, it was found that the 1-hour average concentrations of nitrogen dioxide (NO_2) at Hin Kong Temple were in the range of 2.62-24.46 micrograms per cubic meter. Nitrogen dioxide concentrations at Huai Phai Temple were in the range of 7.86-35.75 micrograms per cubic meter. The concentrations at Wat Huai Pla Duk School were in the range of 5.24-28.23 micrograms per cubic meter. Nitrogen dioxide concentrations in the area of Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo) were in the range of 10.48-31.99 micrograms per cubic meter.

The monitoring results were compared with the ambient air quality standard according to the Notification of the National Environment Board Notification No. 33 B.E.2552 (2009). The 1-hour average concentration of nitrogen dioxide (NO_2) must not exceed 320 micrograms per cubic meter. It was found that the monitoring results of all stations were within the specified standard.

From the first ambient air monitoring during 12-18 February 2019, the weather in Thailand was less buoyant and the wind is calm. These weather conditions cause the accumulation of dust. Hence, the concentrations of dust were greater than the standard. However, this was in line with the monitoring results of the Pollution Control Department that were conducted in the Ratchaburi Province in the area of the Environment Office Region 8, Na Muang Subdistrict, Mueang Ratchaburi District, Ratchaburi Province. From the data of the Pollution Control Department during December to March concentration (details are shown in **Table 5.3.2-8** and **Figure 5.3.2-14**), 24-hour average concentrations of particulate matter with a diameter smaller than 10 microns (PM-10) and particulate matter with a diameter smaller than 2.5 microns (PM-2.5) were higher than 120 and 50 micrograms per cubic meter, respectively, which exceed the ambient standard. The reason that small particulate matter has accumulated a lot was that the time from December to April is an opening season of the sugar factory. So, sugarcane farmers usually harvest the cane during this period. In addition, during this month, the weather is usually less buoyant, and the wind is calm, which causes the accumulation of dust.

From the monitoring of dust (TSP and PM-10) in the study, especially during the dry season (November to February), it was found that concentrations of dust at most of the monitoring stations (Hin Kong Temple, Huai Phai Temple, and Wat Huai Pla Duk School) throughout the seven days of monitoring were within the standard. However, the concentrations monitored at Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo) were higher than the standard for one day (from seven days) which was on 12 February 2019.

For concentrations of particulate matter with a diameter smaller than 2.5 microns (PM-2.5), it was found that concentrations at all monitoring stations were higher than the standard for 2 days (from seven days) which was during 12-13 February 2019.

The considering of representative monitoring station found that the area surrounding the monitoring station at Chedi Hak Subdistrict Health Promoting Hospital (Ban Huai Moo), 3.55 kilometers east of the Project, is community and agricultural area while the rest of the stations are surrounded with community areas.

Table 5.3.2-8

Maximum Air Quality Measurement Result in Environmental Department Section 8 Station, Na Mueng subdistrict, Ratchaburi district, Ratchaburi Province, during B.E. 2558-2562

Month	Maximum Dust amount Result (microgram/cubic meters)									
	Particulate matter less than 10 micron (PM-10)					Particulate matter less than 2.5 micron (PM-2.5)				
	B.E. 2558	**B.E.2559**	**B.E.2560**	**B.E 2561**	**B.E 2562**	**B.E 2558**	**B.E 2559**	**B.E 2560**	**B.E 2561**	**B.E. 2562**
January	116	108	90	114*	144*	84*	78*	55*	73*	102*
February	134*	167*	121*	133*	102	105*	136*	84*	89*	78*
March	74	146*	116	108	85	54*	108*	82*	74*	60*
April	76	76	77	80	60	54*	49	40	39	33
May	40	41	45	49	74	23	43	20	22	37
June	24	35	62	52	40	18	18	22	17	25
July	48	46	43	57	45	25	15	15	34	26
August	26	46	44	64	46	17	18	17	21	15
September	51	34	33	40	69	39	18	12	23	35
October	77	47	95	80	74	49	30	57*	44	35
November	73	61	87	79	101	39	34	50	45	58*
December	102	83	112	88	122*	71*	56*	66*	60*	75*
Standard value	**120**					**50**				

Remark : * Result exceeding standard value due to low air flow causing dust accumulation

[1/] Annoucement of National Environment Board No.24 (B.E. 2547) on regulating standard atmosphere quality

Annoucement of National Environment Board No. 36 (B.E. 2553) on regulating P.M. 2.5 in atmosphere

source : plan and assessment regarding dealing with air quality and noise and controlling air pollution (Information found on 18 April .B.E. 2563 from : http://air4thai.pcd.go.th/)

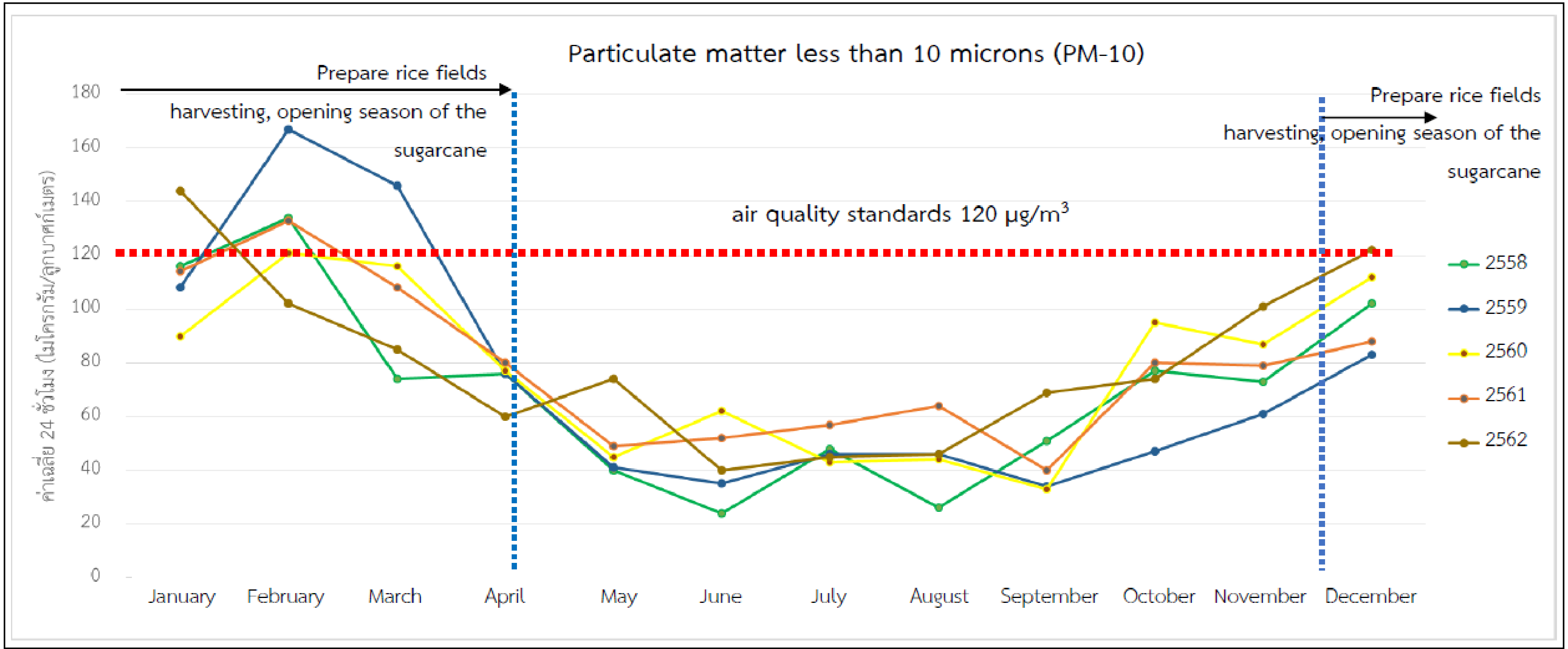
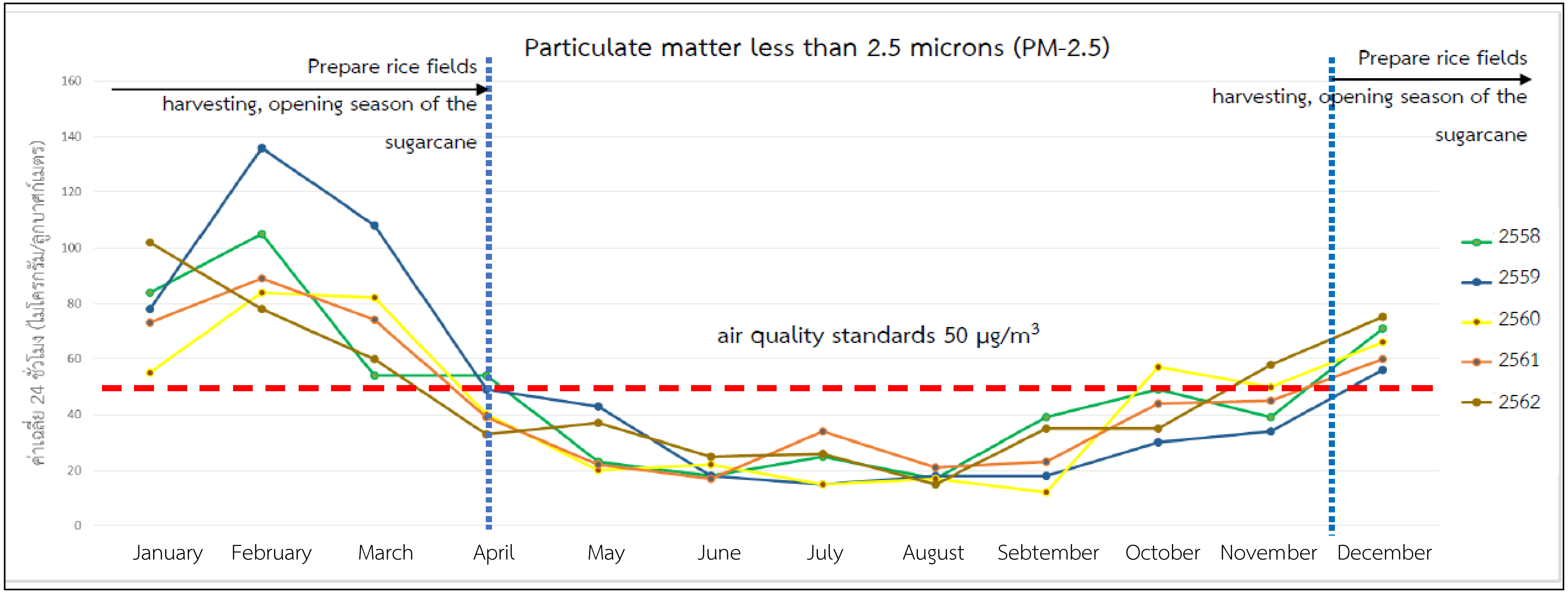


Figure 5.3.2-14 Graph showing measurement result of particulate matter less than 10 micron (PM-10) on 24 hour average from Environment Department Section 8 Na Mueng subdistrict, Ratchaburi district, Ratchaburi Province during B.E. 2558-2562 (2015-2019)



<u>Figure 5.3.2-14</u> (continue) Graph showing measurement result of particulate matter less than 10 micron (PM-10) on 24 hour average from Environment Department Section 8 Na Mueng subdistrict, Ratchaburi district, Ratchaburi Province during B.E. 2558-2562 (2015-2019)

The Project of Hin Kong Power Plant that uses natural gas as primary fuel with the construction period of approximately three years can cause an impact on dust from the land adjustment activity which will take place for about six months. Therefore, the Consultant considered to use the maximum monitored concentrations of the 24-hour average concentration of total suspended particulate (TSP) and the 24-hour average concentration of particulate matter with a diameter smaller than 10 microns (PM-10) of the monitoring station at Hin Kong Temple (1.7 kilometers north of the Project. Meanwhile, for the 24-hour average concentration of particulate matter with a diameter of smaller than 2.5 microns (PM-2.5), the Consultant considered the maximum values monitored during 14-17 February 2019 in the assessment along with the background concentration. The basic values used in the assessment are summarized as follows:

Parameter	**Highest Concentration Value (microgram/cubic meter)**	**Standard concentration value used in assessment (microgram/cubic meter)**	**Standard value (microgram/cubic meter)**
Total suspended particles (TSP) 24 hour average	433 (Jedi Huk Private Hospital Station (Ban Huai Moo))	185 (Wat Hin Kong Station)	330
Particulate Matter less than 10 micron (PM-10) 24 hour average	198 (Jedi Huk Private Hospital Station (Ban Huai Moo))	95 (Wat Hin Kong Station)	120
Particulate Matter less than 2.5 micron (PM-2.5) 24 hour average	62 (Wat Huai Phai Station)	39 (Wat Huai Pladuk School Station)	50
Nitrogen Dioxide gas (NO_2) 1 hour average	35.75 (Wat Huai Phai Station)	35.75 (Wat Huai Phai Station)	320
Sulfur Dioxide (SO_2) 1 hour average	13.09 (Jedi Huk Private Hospital Station (Ban Huai Moo))	13.09 (Jedi Huk Private Hospital Station (Ban Huai Moo))	780
Sulfur Dioxide (SO_2) 24 hour average	7.85 (Wat Hin Kong Station)	7.85 (Wat Hin Kong Station)	300

(7) Scenarios in the assessment

Scenarios used in the air pollution impact assessment are as follows:

1) Scenario 1 predict the sources of air pollution from construction activities in the Project area
2) Scenario 2 predict the sources of air pollution from raw water and wastewater pipelines installation by the open-cut technique
3) Scenario 3 predict the sources of air pollution from raw water and wastewater pipelines installation by the horizontal directional drilling technique
4) Scenario 4 predict the sources of air pollution of the Project in the case of full load (100%) operation by using natural gas as a fuel
5) Scenario 5 predict the sources of air pollution of the Project in the case of full load (100%) operation by using diesel as a fuel

(8) Results of the study by using mathematical modeling

1) Scenario 1 predict the sources of air pollution from construction activities in the Project area

Results of the study by using mathematical modeling for scenario 1 predict the sources of air pollution from construction activities in the Project area are shown in **Table 5.3.2-9** to **Table 5.3.2-12**.

(a) Total suspended particulate (TSP)

The maximum 24-hour average concentration of total suspended particulate is 112.04 microgram/cubic meter or counted for 33.95 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of total suspended particulate is 297.04 microgram/cubic meter (occurs in January) at the coordinates 580200E, 1496400N, in the Project area. The maximum 24-hour average concentration of total suspended particulate at the receptor is 1.89 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of total suspended particulate is 186.89 microgram/cubic meter, at Nong Krathum Temple.

Table 5.3.2-9

(TSP) Total Suspended Particles (TSP) Spreading Assessment Result

1st case, Estimating Air pollution Souce from Construction

Coordinate	Total suspended particles (TSP) (microgram/cubic meter)		
	24 hour average		1 year average
	Modeled value	Total basic value1/	Modeled value
Highest value	112.04	297.04	21.01
Period that the maximum value occured	January	January	-
Coordinate	(580200E, 1496400N)	(580200E, 1496400N)	(580200E, 1496500N)
Area	Project Area	Project Area	Project Area
Location			
1. Wat Huai Moo School	0.43	185.43	0.013
2. Wat Nong Taluang School	0.78	185.78	0.009
3. Wat Huai Pladuk School	0.80	185.80	0.015
4. Wat Na Nong School	0.37	185.37	0.008
5. Wat Kor Loi School	0.12	185.12	0.002
6. Wat Kao Gruad School	0.70	185.70	0.007
7. Wat Huai Phai School	0.66	185.66	0.006
8. Jedi Huk Private Hospital(Ban Huai Moo)	0.37	185.37	0.004
9. Kor PlubPla Private Hospital	0.11	185.11	0.002
10. Huai Phai Private Hospital	1.35	186.35	0.006
11. Hin Kong Private Hospital	0.46	185.46	0.010
12. Kao Gruad Temple	0.64	185.64	0.006
13. Aroon Ratanasiri Temple	0.70	185.70	0.017
14. Huai Phai Temple	1.44	186.44	0.012
15. Nong Num Khun Temple	0.92	185.92	0.009
16. Nong Luang Temple	0.41	185.41	0.005
17. Hin Kong Temple	0.76	185.77	0.016
18. Huai Phai Community	0.87	185.87	0.018
19. Nong Karm House	1.50	186.50	0.024
20. Nong Song Hong House	0.42	185.42	0.004
21. Nong Gratoom Temple	1.89	186.89	0.018
Standard value2/	**330**		**100**

Remark : 1/ Total basic value from basic value equaling 185 microgram/cubic meter

2/ Announcement of National Environment Board No. 24(B.E.2547) on regulating atmospheric quality standard

source : Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-10

Spreading of Particulate Matter less than 10 Microns (PM-10) Assessment Result

1st case, Estimating Air pollution Souce from Construction

Coordinate	Particulate Matter less than 10 Microns (PM-10) (microgram/cubic meter)		
	24 hour average		1 year average
	Modeled value	Total basic value1/	Modeled value
Highest Value	23.15	118.15	2.03
Period that the maximum value occured	December	December	-
Coordinate	(580100E, 1496500N)	(580100E, 1496500N)	(580200E, 1496400N)
Area	Project Area	Project Area	Project Area
Location			
1. Wat Huai Moo School	0.162	95.16	0.0013
2. Wat Nong Taluang School	0.047	95.05	0.0007
3. Wat Huai Pladuk School	0.439	95.44	0.0015
4. Wat Na Nong School	0.034	95.03	0.0007
5. Wat Kor Loi School	0.008	95.01	0.0001
6. Wat Kao Gruad School	0.228	95.23	0.0009
7. Wat Huai Phai School	0.182	95.18	0.0010
8. Jedi Huk Private Hospital(Ban Huai Moo)	0.023	95.02	0.0003
9. Kor PlubPla Private Hospital	0.085	95.09	0.0002
10. Huai Phai Private Hospital	0.192	95.19	0.0009
11. Hin Kong Private Hospital	0.074	95.07	0.0008
12. Kao Gruad Temple	0.187	95.19	0.0006
13. Aroon Ratanasiri Temple	0.113	95.11	0.0018
14. Huai Phai Temple	0.216	95.27	0.0014
15. Nong Num Khun Temple	0.407	95.41	0.0015
16. Nong Luang Temple	0.060	95.06	0.0005
17. Hin Kong Temple	0.141	95.14	0.0014
18. Huai Phai Community	0.065	95.07	0.0014
19. Nong Karm House	0.396	95.40	0.0031
20. Nong Song Hong House	0.027	95.03	0.0002
21. Nong Gratoom Temple	0.127	95.13	0.0017
Standard value2/	**120**		**50**

Remark : 1/ Total basic value from basic value equaling 95 microgram/cubic meter

2/ Announcement of National Environment Board No. 24(B.E.2547) on regulating air quality in atmosphere

source : Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-11

Spreading of Sulfur Dioxide (SO_2) Assessment Result

1st case, Estimating Air pollution Souce from Construction

Coordinate	Sulfur Dioxide gas (SO_2) (microgram/cubic meter)				
	1 hour average value		24 hour average value		1 year average value
	Modeled value	Total basic valuie1/	Modeled value	Total basic valuie1/	Modeled value
Highest value	9.661	22.751	0.580	8.430	0.045
Period that the maximum value occured	December		December		-
Coordinate	(580100E, 1496500N)		(580100E, 1496500N)		(580200E, 1496400N)
Area	Project area		Project area		Project area
Location					
1. Wat Huai Moo School	0.075	13.165	0.0034	7.853	0.000028
2. Wat Nong Taluang School	0.024	13.114	0.0010	7.851	0.000015
3. Wat Huai Pladuk School	0.165	13.255	0.0092	7.859	0.000031
4. Wat Na Nong School	0.015	13.105	0.0007	7.851	0.000016
5. Wat Kor Loi School	0.004	13.094	0.0002	7.850	0.000003
6. Wat Kao Gruad School	0.086	13.176	0.0048	7.855	0.000019
7. Wat Huai Phai School	0.076	13.166	0.0039	7.854	0.000021
8. Jedi Huk Private Hospital(Ban Huai Moo)	0.006	13.096	0.0005	7.850	0.000006
9. Kor PlubPla Private Hospital	0.036	13.126	0.0018	7.852	0.000005
10. Huai Phai Private Hospital	0.098	13.188	0.0041	7.854	0.000018
11. Hin Kong Private Hospital	0.028	13.118	0.0016	7.852	0.000017
12. Kao Gruad Temple	0.070	13.160	0.0040	7.854	0.000013
13. Aroon Ratanasiri Temple	0.047	13.137	0.0024	7.852	0.000038
14. Huai Phai Temple	0.100	13.190	0.0046	7.855	0.000029
15. Nong Num Khun Temple	0.204	13.294	0.0086	7.859	0.000032
16. Nong Luang Temple	0.025	13.115	0.0013	7.851	0.000010
17. Hin Kong Temple	0.057	13.147	0.0029	7.853	0.000029
18. Huai Phai Community	0.032	13.122	0.0014	7.851	0.000029
19. Nong Karm House	0.185	13.275	0.0085	7.858	0.000065
20. Nong Song Hong House	0.008	13.098	0.0006	7.851	0.000005
21. Nong Gratoom Temple	0.059	13.149	0.0027	7.853	0.000035
Standard value2/	**780**		**300**		**100**

Remark : 1/ Total basic value from highest basic value measured with 1 hour average concentration equaling 13.09 microgram/cubic meters and 24 hour average concentration equaling 7.85 microgram/cubic meters

2/ Announcement of National Environment Board No. 21(B.E.2544) and No. 24(B.E.2547)

source : Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-12

Spreading of Nitrogen Dioxide (NO_2) Assessment Result

1st case, Estimating Air pollution Souce from Construction

Coordinate	Nitrogen Dioxide (NO_2) (microgram/cubic meter)		
	24 hour average		
	Modeled value	Total basic value[1/]	Modeled value
Highest value	40.93	76.68	2.03
Period that the maximum value occured	September	September	-
Coordinate	(580100E, 1496500N)	(580100E, 1496500N)	(580200E, 1496400N)
Area	Project area	Project area	Project area
Location			
1. Wat Huai Moo School	0.94	36.69	0.004
2. Wat Nong Taluang School	0.82	36.57	0.002
3. Wat Huai Pladuk School	1.71	37.46	0.004
4. Wat Na Nong School	1.00	36.75	0.002
5. Wat Kor Loi School	0.71	36.46	0.001
6. Wat Kao Gruad School	1.42	37.17	0.002
7. Wat Huai Phai School	0.86	36.61	0.002
8. Jedi Huk Private Hospital(Ban Huai Moo)	0.94	36.69	0.002
9. Kor PlubPla Private Hospital	0.67	36.42	0.001
10. Huai Phai Private Hospital	1.21	36.96	0.002
11. Hin Kong Private Hospital	1.24	36.99	0.003
12. Kao Gruad Temple	1.40	37.15	0.002
13. Aroon Ratanasiri Temple	1.89	37.64	0.004
14. Huai Phai Temple	1.13	36.88	0.003
15. Nong Num Khun Temple	1.62	37.37	0.002
16. Nong Luang Temple	1.15	36.90	0.002
17. Hin Kong Temple	1.06	36.81	0.002
18. Huai Phai Community	1.79	37.54	0.004
19. Nong Karm House	0.85	36.60	0.005
20. Nong Song Hong House	1.26	37.01	0.001
21. Nong Gratoom Temple	1.64	37.39	0.005
Standard value[1/]	**320**		**57**

Remark : [1/] Total Basic value from the highest basic value measured from 1 hour average concentration equaling 35.75 microgram/cubic meter

[2/] Announcement of National Environment Board No. 33(B.E.2552)

source : Consultants of Technololgy Co.,L.td, B.E.2563

The maximum 1-year average concentration of total suspended particulate is 21.01 microgram/cubic meter or counted for 21.01 percent of the standard limit at the coordinates 580200E, 1496400N, in the Project area. The maximum 1-year average concentration of total suspended particulate at the receptor is 0.018 microgram/cubic meter, at Nong Krathum Temple.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-9**.

(b) Particulate matter with a diameter of smaller than 10 microns (PM-10)

The maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 23.15 microgram/cubic meter or counted for 19.29 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 118.15 microgram/cubic meter (occurs in December) at the coordinates 580200E, 1496400N, in the Project area. The maximum 24-hour average concentration at the receptor is 0.439 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 95.44 microgram/cubic meter, at Wat Huai Pra Duk School.

The maximum 1-year average concentration of particulate matter with a diameter smaller than 10 microns is 2.03 microgram/cubic meter or counted for 4.06 percent of the standard limit at the coordinates 580200E, 1496400N, in the Project area. The maximum 1-year average concentration of particulate matter with a diameter smaller than 10 microns at the receptor is 0.0031 microgram/cubic meter, at Ban Nong Kham.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-10**.

Most of the dust generated can easily fall into the area. This will result in confined dust in the construction area and there are construction workers who are directly affected. Therefore, the Project requires to set measures to prevent and mitigate environmental impacts that will occur as follows:

1) Construction area which has vehicles and work that may generate dust, there must be water spraying around the Project construction area and the road as well as entrance-exit area. The frequency is at least twice a day (morning-afternoon) and will be considered to increase the frequency when the weather is dry and windy to prevent dust from spreading into the atmosphere and affect adjacent communities.

2) Construction materials transportation trucks may cause dispersion of dust such as soil, cement, etc., that must be properly covered with a tarpaulin while transporting.

3) Clean truck wheels before leaving the construction area onto public roads to prevent dirt from creating external contamination.

4) Limit truck speed within the Project's construction area not to exceed 20 kilometers per hour to reduce the diffusion of dust particles.

5) Check the conditions and maintain the vehicle, engine/machinery used in construction for the period specified in the engine/machinery maintenance manual to control the emitted pollution to meet the design criteria.

6) Do not burn the material or solid waste in the construction area

7) Stop the engine/machine every time it is idle.

8) Supervise the contractor to clean up debris in the construction area and adjacent area which may be washed down by rainwater down the drainage gutters, such as dirt, sand attached to truck wheels, plastic bags, scrap paper, etc.

(c) Sulfur dioxide (SO_2)

The maximum 1-hour average concentration of sulfur dioxide (SO_2) is 9.661 microgram/cubic meter or counted for 1.24 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of sulfur dioxide (SO_2) is 22.751 microgram/cubic meter (occurs in December) at the coordinates 580100E, 1496500N, in the Project area. The maximum 1-hour average concentration at the receptor is 0.204 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of sulfur dioxide (SO_2) is 13.294 microgram/cubic meter, at Nong Nam Khun Temple.

The maximum 24-hour average concentration of sulfur dioxide (SO_2) is 0.580 microgram/cubic meter or counted for 0.19 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of sulfur dioxide (SO_2) is 8.430 microgram/cubic meter (occurs in December) at the coordinates 580100E, 1496500N, in the Project area. The maximum 24-hour average concentration at the receptor is 0.0092 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of sulfur dioxide (SO_2) is 7.859 microgram/cubic meter, at Wat Huai Pla Duk School.

The maximum 1-year average concentration of sulfur dioxide (SO_2) is 0.045 microgram/cubic meter or counted for 0.04 percent of the standard limit. It will occur at the coordinates 580200E, 1496400N, in the Project area. The maximum 1-year average concentration at the receptor is 0.000038 microgram/cubic meter, at Arun Rattanakhiri Temple.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.21 B.E. 2544 (2001) and No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-11**.

(d) Nitrogen dioxide (NO_2)

The maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 40.93 microgram/cubic meter or counted for 12.79 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 76.68 microgram/cubic meter (occurs in September) at the coordinates 580100E, 1496500N, in the Project area. The maximum 1-hour average concentration at the receptor is 1.89 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 37.64 microgram/cubic meter, at Arun Rattanakhiri Temple.

The maximum 1-year average concentration of nitrogen dioxide (NO_2) is 2.03 microgram/cubic meter or counted for 3.56 percent of the standard limit. It will occur at the coordinates 580200E, 1496400N, in the Project area. The maximum 1-year average concentration at the receptor is 0.005 microgram/cubic meter, at Nong Krathum Temple.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.33 B.E. 2552 (2009) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-12**.

2) Scenario 2 predict the sources of air pollution from raw water and wastewater pipelines installation by the open-cut technique

Results of the study by using the mathematical modeling for scenario 2 predict the sources of air pollution from raw water and wastewater pipelines installation by the open-cut technique are shown in **Table 5.3.2-13** to **Table 5.3.2-16**.

(a) Total suspended particulate (TSP)

The maximum 24-hour average concentration of total suspended particulate is 92.43 microgram/cubic meter or counted for 28.01 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of total suspended particulate is 277.43 microgram/cubic meter (occurs in May) at the coordinates 585500E, 1498250N. The maximum 24-hour average concentration of total suspended particulate at the receptor is 81.95 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of total suspended particulate is 266.95 microgram/cubic meter, at the community in Moo 6 Ban Nong Sadao Bon, Hin Kong Subdistrict.

The maximum 1-year average concentration of total suspended particulate is 6.56 microgram/cubic meter or counted for 6.56 percent of the standard limit at the coordinates 580706E, 1496222N, in the area of Moo 6 Ban Nong Sadao Bon, Hin Kong Subdistrict. The maximum 1-year average concentration of total suspended particulate at the receptor will occur at the area of Moo 6 Ban Nong Sadao Bon, Hin Kong Subdistrict as well.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-13**.

(b) Particulate matter with a diameter of smaller than 10 microns (PM-10)

The maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 12.97 micrograms/cubic meter or counted for 10.81 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 107.97 microgram/cubic meter (occurs in December) at the coordinates 585500E, 1498250N. The maximum 24-hour average concentration at the receptor is 8.83 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 103.83 microgram/cubic meter, at the area of Moo 3 Ban nong Ta Luang, Hin Kong Sub-district.

Table 5.3.2-13

Spreading of Total Suspended Particles (TSP) in 2nd and 3rd case of Estimating Air Pollution caused from Constructing Raw Water Pipes and Sewage Pipes using Open Pit and Drilled Construction

Location	Total suspended particlesTSP) (microgram/cubic meter)		
	24 hour average		1 year average
	Modeled value	Total Basic Value1/	Modeled value
Open pit construction			
Highest Value	92.43	277.43	6.56
Occuring Month	May	May	-
Coordinate	(585500E, 1498250N)	(585500E, 1498250N)	(580706E, 1496222N)
-Ban Klong Loomdin Community Moo 3, Loom Din subdistrict	24.01	209.01	0.49
-Ban Aranyik Community Moo 4, Jedi Huk subdistrict	17.54	202.54	1.36
-Ban Nong Jork Community Moo 5, Jedi Huk subdistrict	16.65	201.65	0.28
-Ban Rak Kwang Community Moo 3, Hin Kong subdistrict	60.44	245.44	3.40
-Ban Nong Taluang Shop Moo 3, Hin Kong subdistrict	56.75	241.75	5.63
-Ban Nong Taluang Community Moo 3, Hin Kong subdistrict	62.93	247.93	5.18
-Ban Nong Ruk Community Moo 5, Hin Kong subdistrict	64.13	249.13	4.62
-Ban Nong Sadao Bon Community Moo 6, Hin Kong subbdistrict	81.95	266.95	6.56
Drilled Construction			
Highest Value	68.86	253.86	3.60
Occuring Month	January	January	-
Coordinate	(588641E, 1500367N)	(588641E, 1500367N)	(581280E, 1496732N)
-Ban Plubpla Community Moo 7, Loom Din subdistrict	68.86	253.86	1.92
-Ban Klong Loom Din Community Moo 3, Loom Din subdistrict	2.69	187.69	0.27
-Ban Nong Taluang Shop Moo 3, Hin kong subdistrict	27.14	212.14	3.60
-Ban Nong Taluang Community Moo 3, Hin Kong subdistrict	28.13	213.13	0.77
Standard value2/	**330**		**100**

Remark : 1/ Total basic value from basic value equaling 185 microgram/cubic meter
2/ Announcement of National Environment Board No. 24(B.E.2547) on regulating atmospheric air quality standard

source : Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-14

Spreading of Particulat Matter less than 10 Miron (P.M. 10) in 2nd and 3rd case of Estimating Air Pollution caused from Constructing Raw Water Pipes and Sewage Pipes using Open Pit and Drilled Construction

Location	Particulate matter less than 10 microns (PM-10) (microgram/cubic meter)		
	24 hour average		1 year average
	Modeled value	Total basic value[1/]	Modeled value
Open pit construction			
Highest Value	12.97	107.97	0.89
Occuring Month	May	May	-
Coordinate	(585500E, 1498250N)	(585500E, 1498250N)	(581250E, 1496750N)
-Ban Klong Loomdin Community Moo 3, Loom Din subdistrict	3.37	98.37	0.07
-Ban Aranyik Community Moo 4, Jedi Huk subdistrict	2.46	97.46	0.19
-Ban Nong Jork Community Moo 5, Jedi Huk subdistrict	2.34	97.34	0.04
-Ban Rak Kwang Community Moo 3, Hin Kong subdistrict	8.48	103.48	0.48
-Ban Nong Taluang Shop Moo 3, Hin Kong subdistrict	7.96	102.96	0.77
-Ban Nong Taluang Community Moo 3, Hin Kong subdistrict	8.83	103.83	0.72
-Ban Nong Ruk Community Moo 5, Hin Kong subdistrict	5.46	100.46	0.39
-Ban Nong Sadao Bon Community Moo 6, Hin Kong subbdistrict	6.97	101.97	0.56
Drilled construction			
Highest Value	30.89	125.89	3.45
Occuring Month	January	January	-
Coordinate	(588641E, 1500367N)	(588641E, 1500367N)	(581280E, 1496732N)
-Ban Plubpla Community Moo 7, Loom Din subdistrict	30.89	125.89	1.23
-Ban Klong Loom Din Community Moo 3, Loom Din subdistrict	2.58	97.58	0.26
-Ban Nong Taluang Shop Moo 3, Hin kong subdistrict	26.01	121.01	3.45
-Ban Nong Taluang Community Moo 3, Hin Kong subdistrict	26.96	121.96	0.74
Standard value[2/]	**120**		**50**

Remark : [1/] Total basic value from basic value equaling 95 microgram/cubic meter

[2/] Announcement of National Environment Board No. 24(B.E.2547) on regulating atmospheric air quality standard

source : Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-15

Spreading of Sulfur Dioxide (SO_2) in 2nd and 3rd case of Estimating Air Pollution caused from Constructing Raw Water Pipes and Sewage Pipes using Open Pit and Drilled Construction

Location	Sulfur Dioxide gas (SO_2) (microgram/cubic meter)				
	1 hour average		24 hour average		1 year average
	Modeled value	Total basic value	Modeled value	Total basic value	Modeled value
Open pit construction					
Highest Value	5.08	18.17	0.89	8.74	0.061
Occuring Month	April		May		-
Coordinate	(586500E, 1499750N)		(585500E, 1498250N)		(581250E, 1496750N)
- Ban Klong Loomdin Community Moo 3, Loom Din subdistrict	2.62	15.71	0.23	8.08	0.005
- Ban Aranyik Community Moo 4, Jedi Huk subdistrict	0.96	14.05	0.17	8.02	0.013
- Ban Nong Jork Community Moo 5, Jedi Huk subdistrict	1.55	14.64	0.16	8.01	0.003
- Ban Rak Kwang Community Moo 3, Hin Kong subdistrict	2.44	15.53	0.58	8.43	0.033
- Ban Nong Taluang Shop Moo 3, Hin Kong subdistrict	2.37	15.46	0.55	8.40	0.053
-. Ban Nong Taluang Community Moo 3, Hin Kong subdistrict	2.65	15.74	0.61	8.46	0.049
-. Ban Nong Ruk Community Moo 5, Hin Kong subdistrict	2.34	15.43	0.36	8.21	0.026
- Ban Nong Sadao Bon Community Moo 6, Hin Kong subbdistrict	2.33	15.42	0.46	8.31	0.037
Drilled Construction					
Highest Value	27.62	40.71	1.61	9.46	0.084
Occuring month	January		January		-
Coordinate	(588641E, 1500367N)		(588641E, 1500367N)		(581280E, 1496732N)
- Ban Plubpla Community Moo 7, Loom Din subdistrict	27.62	40.71	1.61	9.46	0.045
- Ban Klong Loom Din Community Moo 3, Loom Din subdistrict	0.49	13.58	0.06	7.91	0.006
-. Ban Nong Taluang Shop Moo 3, Hin kong subdistrict	3.15	16.24	0.63	8.48	0.084
- Ban Nong Taluang Community Moo 3, Hin Kong subdistrict	15.59	28.68	0.66	8.51	0.018
Standard value[1/]	**780**		**300**		**100**

Remark : [1/] Total basic value from highest basic value measured with 1 hour average concentration equaling 13.09 microgram/cubic meters and 24 hour average concentration equaling 7.85 microgram/cubic meters

[2/] Announcement of National Environment Board No. 21(B.E.2544) and No. 24(B.E.2547)

source : Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-16

Spreading of Nitrogen Dioxide (NO_2) in 2nd and 3rd case of Estimating Air Pollution caused from Constructing Raw Water Pipes and Sewage Pipes using Open Pit and Drilled Construction

Location	Nitrogen Dioxide (NO_2) (microgram/cubic meters)		
	1 hour average		1 year average
	Modeled value	Total basic value[1/]	Modeled value
Open pit construction			
Highest Value	76.24	111.99	0.92
Occuring Month	April	April	-
Coordinate	(585500E, 1498250N)	(585500E, 1498250N)	(581250E, 1496750N)
- Ban Klong Loomdin Community Moo 3, Loom Din subdistrict	8.85	44.60	0.02
- Ban Aranyik Community Moo 4, Jedi Huk subdistrict	15.71	51.46	0.21
- Ban Nong Jork Community Moo 5, Jedi Huk subdistrict	22.55	58.30	0.04
- Ban Rak Kwang Community Moo 3, Hin Kong subdistrict	32.94	68.69	0.44
- Ban Nong Taluang Shop Moo 3, Hin Kong subdistrict	8.01	43.76	0.18
-. Ban Nong Taluang Community Moo 3, Hin Kong subdistrict	39.79	75.54	0.74
-. Ban Nong Ruk Community Moo 5, Hin Kong subdistrict	16.46	52.21	0.18
- Ban Nong Sadao Bon Community Moo 6, Hin Kong subbdistrict	16.41	52.16	0.26
Drilled Construction			
Highest Value	236.20	271.95	1.09
Occuring month	February	February	-
Coordinate	(588641E, 1500367N)	(588641E, 1500367N)	(581280E, 1496732N)
- Ban Plubpla Community Moo 7, Loom Din subdistrict	236.20	271.95	1.09
- Ban Klong Loom Din Community Moo 3, Loom Din subdistrict	21.35	57.10	0.28
-. Ban Nong Taluang Shop Moo 3, Hin kong subdistrict	16.29	52.04	0.26
- Ban Nong Taluang Community Moo 3, Hin Kong subdistrict	128.66	164.41	0.53
Standard value[2/]	**320**		**57**

Remark : [1/] Total basic value from highest basic value measured with 1 hour average concentration equaling 35.75 micrograms/cubic meters

[2/] Announcement of National Environment Board No.33 (B.E. 2552)

source : Consultants of Technololgy Co.,L.td, B.E.2563

The maximum 1-year average concentration of particulate matter with a diameter smaller than 10 microns is 0.89 micrograms/cubic meter or counted for 1.78 percent of the standard limit at the coordinates 581250E, 1496750N. The maximum 1-year average concentration of particulate matter with a diameter smaller than 10 microns at the receptor is 0.77 microgram/cubic meter, at the area of Moo 3 Ban Nong Ta Luang, Hin Kong Sub-district.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-14**.

(c) Sulfur dioxide (SO_2)

The maximum 1-hour average concentration of sulfur dioxide (SO_2) is 5.08 microgram/cubic meter or counted for 0.65 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of sulfur dioxide (SO_2) is 18.17 microgram/cubic meter (occurs in April) at the coordinates 586500E, 1499750N. The maximum 1-hour average concentration at the receptor is 2.65 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of sulfur dioxide (SO_2) is 15.74 microgram/cubic meter, at the area of Moo 3 Ban Nong Ta Luang, Hin Kong Sub-district.

The maximum 24-hour average concentration of sulfur dioxide (SO_2) is 0.89 micrograms/cubic meter or counted for 0.30 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of sulfur dioxide (SO_2) is 8.74 microgram/cubic meter (occurs in May) at the coordinates 585500E, 1498250N. The maximum 24-hour average concentration at the receptor is 0.61 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of sulfur dioxide (SO_2) is 8.64 microgram/cubic meter, at the area of Moo 3 Ban Nong Ta Luang, Hin Kong Sub-district.

The maximum 1-year average concentration of sulfur dioxide (SO_2) is 0.061 microgram/cubic meter or counted for 0.06 percent of the standard limit. It will occur at the coordinates 581250E, 1496750N, in the Project area. The maximum 1-year average concentration at the receptor is 0.053 microgram/cubic meter, at a shop in Moo 3 Ban Nong Ta Luang, Hin Kong Sub-district.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.21 B.E. 2544 (2001) and No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-15**.

(d) Nitrogen dioxide (NO_2)

The maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 76.24 microgram/cubic meter or counted for 23.83 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 111.99 microgram/cubic meter (occurs in April) at the coordinates 585500E, 1498250N. The maximum 1-hour average concentration at the receptor is 39.79 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 75.54 microgram/cubic meter, at the area of Moo 3 Ban Nong Ta Luang, Hin Kong Sub-district.

The maximum 1-year average concentration of nitrogen dioxide (NO_2) is 0.92 micrograms/cubic meter or counted for 1.61 percent of the standard limit. It will occur at the coordinates 581250E, 1496750N, in the Project area. The maximum 1-year average concentration at the receptor is 0.74 microgram/cubic meter, at the area of Moo 3 Ban Nong Ta Luang, Hin Kong Sub-district.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.33 B.E. 2552 (2009) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-16**.

3) Scenario 3 predict the sources of air pollution from raw water and wastewater pipelines installation by the horizontal directional drilling technique

Results of the study by using the mathematical modeling for scenario 3 predict the sources of air pollution from raw water and wastewater pipelines installation by the horizontal directional drilling technique are shown in **Table 5.3.2-13** to **Table 5.3.2-16**.

(a) Total suspended particulate (TSP)

The maximum 24-hour average concentration of total suspended particulate is 68.86 microgram/cubic meter or counted for 20.86 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of total suspended particulate is 253.86 microgram/cubic meter (occurs in January) at the coordinates 588641E, 1500367N, at the area of Moo 7 Ban Phlub Phla, Lumdin Subsitrict. The maximum 24-hour average concentration of total suspended particulate at the receptor will occur in the area of Moo 7 Ban Phlub Phla, Lumdin Subsitrict as well.

The maximum 1-year average concentration of total suspended particulate is 3.60 microgram/cubic meter or counted for 3.6 percent of the standard limit at the coordinates 581280E, 1496732N, at a shop in Moo 3 Ban Nong Ta Luang, Hin Kong Subdistrict. The maximum 1-year average concentration of total suspended particulate at the receptor will occur at a shop in Moo 3 Ban Nong Ta Luang, Hin Kong Subdistrict as well.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-13**.

(b) Particulate matter with a diameter of smaller than 10 microns (PM-10)

The maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 30.89 microgram/cubic meter or counted for 25.74 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 125.89 microgram/cubic meter (occurs in January) at the coordinates 588641E, 1500367N, the area of Moo 7 Ban Phlub Phla, Lumdin Subsitrict. The maximum 24-hour average concentration at the receptor will occur in the area of Moo 7 Ban Phlub Phla, Lumdin Subsitrict as well.

The maximum 1-year average concentration of particulate matter with a diameter smaller than 10 microns is 3.45 microgram/cubic meter or counted for 6.90 percent of the standard limit at the coordinates 581280E, 1496732N, at a shop in

Moo 3 Ban Nong Ta Luang, Hin Kong Subdistrict. The maximum 1-year average concentration of particulate matter with a diameter smaller than 10 microns at the receptor will occur at a shop in Moo 3 Ban Nong Ta Luang, Hin Kong Subdistrict.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-13**. However, the area where pipeline installation by horizontal directional drilling is approximately 0.850 kilometers. The horizontal directional drilling shall be applied where there are obstacles such as a very wide road, heavy traffic roads, and large water sources, etc. The steps in the process will start from excavating entry-exit holes with the dimension of, width x length x depth, 4.5x4.5x3.2 meters. However, most of the areas where horizontal directional drilling will take place are wide roads and across the irrigation canal. Therefore, it was projected that the communities will be affected at a low level.

(c) Sulfur dioxide (SO_2)

The maximum 1-hour average concentration of sulfur dioxide (SO_2) is 27.62 microgram/cubic meter or counted for 3.54 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of sulfur dioxide (SO_2) is 40.71 microgram/cubic meter (occurs in January) at the coordinates 588641E, 1500367N, the area of Moo 7 Ban Phub Phla, Lumdin Subdistrict. The maximum 1-hour average concentration at the receptor will occur in the area of Moo 7 Ban Phub Phla, Lumdin Subdistrict as well.

The maximum 24-hour average concentration of sulfur dioxide (SO_2) is 1.61 micrograms/cubic meter or counted for 0.49 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of sulfur dioxide (SO_2) is 9.46 microgram/cubic meter (occurs in January) at the coordinates 588641E, 1500367N, a shop in the area of Moo 7 Ban Phlub Phla, Lumdin Subdistrict. The maximum 24-hour average concentration at the receptor will occur at a shop in the area of Moo 7 Ban Phlub Phla, Lumdin Subdistrict as well.

The maximum 1-year average concentration of sulfur dioxide (SO_2) is 0.084 micrograms/cubic meter or counted for 0.08 percent of the standard limit. It will occur at the coordinates 581280E, 1496732N, at a shop in the area of Moo 7 Ban Phlub

Phla, Lumdin Subdistrict. The maximum 1-year average concentration at the receptor will occur at a shop in the area of Moo 3 Ban Phlub Phla, Lumdin Subdistrict as well.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.21 B.E. 2544 (2001) and No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-15**

(d) Nitrogen dioxide (NO_2)

The maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 236.20 microgram/cubic meter or counted for 73.81 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 271.95 microgram/cubic meter (occurs in February) at the coordinates 588641E, 1500367N, at the area in Moo 7 Ban Phlub Phla, Lumdin Subdistrict. The maximum 1-hour average concentration at the receptor will occur at the area in Moo 7 Ban Phlub Phla, Lumdin Subdistrict as well.

The maximum 1-year average concentration of nitrogen dioxide (NO_2) is 1.09 microgram/cubic meter or counted for 1.91 percent of the standard limit. It will occur at the coordinates 588641E, 1500367N, at the area in Moo 7 Ban Phlub Phla, Lumdin Subdistrict. The maximum 1-year average concentration at the receptor will occur at the area in Moo 7 Ban Phlub Phla, Lumdin Subdistrict as well.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.33 B.E. 2552 (2009) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-16**.

4) Scenario 4 predict the sources of air pollution of the Project in the case of full load (100%) operation by using natural gas as a fuel

Results of the study by using the mathematical modeling for scenario 4 predict the sources of air pollution of the Project in the case of full load (100%) operation by using natural gas as a fuel are shown in **Table 5.3.2-17** to **Table 5.3.2-21**.

(a) Total suspended particulate (TSP)

The maximum 24-hour average concentration of total suspended particulate is 7.53 microgram/cubic meter or counted for 2.28 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of total suspended particulate is 192.53 microgram/cubic meter (occurs in November) at the coordinates 583250E, 1493500N, foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 24-hour average concentration of total suspended particulate at the receptor is 1.70 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of total suspended particulate is 186.70 microgram/cubic meter, at Ban Nong Kham.

Table 5.3.2-17

Assessment of the 4th Case about the Spread of Total Suspended Particles (TSP) in Estimating Air pollution from the Project in case of Operating at Full Load (100%) with natural gas as fuel.

Location	concentration (microgram/cubic meters)		
	24 hour average		1 year average
	Modeled value	Total basic value[1/]	Modeled value
Highest value	7.53	192.53	0.70
Occuring month	November	November	-
Coordinates	(583250E , 1493500N)	(583250E , 1493500N)	(583250E , 1493500N)
Area	Khao Gnam, around 3.4 kilometers South East of the project	Khao Gnam, around 3.4 kilometers South East of the project	Khao Gnam, around 3.4 kilometers South East of the project
Location			
1. Wat Huai Moo School	1.14	186.14	0.18
2. Wat Nong Taluang School	1.63	186.63	0.18
3. Wat Huai Pladuk School	1.37	186.37	0.26
4. Wat Na Nong School	0.87	185.87	0.18
5. Wat Kor Loi School	0.48	185.48	0.07
6. Wat Kao Gruad School	0.76	185.76	0.14
7. Wat Huai Phai School	0.97	185.97	0.16
8. Jedi Huk Private Hospital(Ban Huai Moo)	0.89	185.89	0.11
9. Kor PlubPla Private Hospital	0.59	185.59	0.09
10. Huai Phai Private Hospital	0.89	185.89	0.14
11. Hin Kong Private Hospital	0.93	185.93	0.17
12. Kao Gruad Temple	0.78	185.78	0.13
13. Aroon Ratanasiri Temple	1.11	186.11	0.22
14. Huai Phai Temple	0.92	185.92	0.21
15. Nong Num Khun Temple	0.95	185.95	0.17
16. Nong Luang Temple	0.80	185.80	0.14
17. Hin Kong Temple	0.94	185.94	0.18
18. Huai Phai Community	1.11	186.11	0.23
19. Nong Karm House	1.70	186.70	0.30
20. Nong Song Hong House	0.66	185.66	0.11
21. Nong Gratoom Temple	1.31	186.31	0.18
Standard value[2/]	**330**		**100**

Remark : [1/] Total basic value from basic value equaling 185 microgram/cubic meter
[2/] Announcement of National Environment Board No. 24(B.E.2547) on regulating atmospheric air quality standard

Source: Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-18

Assessment of the 4th Case about the Spread of Particulate less than 10 microns (PM-10) in Estimating Air pollution from the Project in case of Operating at Full Load (100%) with natural gas as fuel.

Location	concentration (microgram/cubic meters)		
	24 hour average		1 year average
	Modeled value	Total basic value[1/]	Modeled value
Highest value	1.15	96.15	0.11
Occuring month	November	November	-
Coordinate	(583250E , 1493500N)	(583250E , 1493500N)	(583250E , 1493500N)
Area	Khao Gnam, around 3.4 kilometers South East of the project	Khao Gnam, around 3.4 kilometers South East of the project	Khao Gnam, around 3.4 kilometers South East of the project
Location			
1. Wat Huai Moo School	0.17	95.17	0.03
2. Wat Nong Taluang School	0.25	95.25	0.03
3. Wat Huai Pladuk School	0.21	95.21	0.04
4. Wat Na Nong School	0.13	95.13	0.03
5. Wat Kor Loi School	0.07	95.07	0.01
6. Wat Kao Gruad School	0.12	95.12	0.02
7. Wat Huai Phai School	0.15	95.15	0.02
8. Jedi Huk Private Hospital(Ban Huai Moo)	0.14	95.14	0.02
9. Kor PlubPla Private Hospital	0.09	95.09	0.01
10. Huai Phai Private Hospital	0.14	95.14	0.02
11. Hin Kong Private Hospital	0.14	95.14	0.03
12. Kao Gruad Temple	0.12	95.12	0.02
13. Aroon Ratanasiri Temple	0.17	95.17	0.03
14. Huai Phai Temple	0.14	95.14	0.03
15. Nong Num Khun Temple	0.15	95.15	0.03
16. Nong Luang Temple	0.12	95.12	0.02
17. Hin Kong Temple	0.14	95.14	0.03
18. Huai Phai Community	0.17	95.17	0.04
19. Nong Karm House	0.26	95.26	0.05
20. Nong Song Hong House	0.10	95.10	0.02
21. Nong Gratoom Temple	0.20	95.20	0.03
Standard value[2/]	**120**		**50**

Remark : [1/] Total basic value from basic value equaling 95 microgram/cubic meter

[2/] Announcement of National Environment Board No. 24(B.E.2547) on regulating atmospheric air quality standard

Source: Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-19

Assessment of 4th Case about the Spread of Particulate less than 2.5 microns (PM-2.5) in Estimating Air pollution from the Project in case of Operating at Full Load (100%) with natural gas as fuel.

Location	Concentration (microgram/cubic meter)		
	24 hour average		1 year average
	Modeled value	Total baic value1/	Modeled value
Highest value	1.15	40.15	0.11
Occuring month	November	November	-
Coordinate	(583250E , 1493500N)	(583250E , 1493500N)	(583250E , 1493500N)
Area	Khao Gnam, around 3.4 kilometers South East of the project	Khao Gnam, around 3.4 kilometers South East of the project	Khao Gnam, around 3.4 kilometers South East of the project
Location			
1. Wat Huai Moo School	0.17	39.17	0.03
2. Wat Nong Taluang School	0.25	39.25	0.03
3. Wat Huai Pladuk School	0.21	39.21	0.04
4. Wat Na Nong School	0.13	39.13	0.03
5. Wat Kor Loi School	0.07	39.07	0.01
6. Wat Kao Gruad School	0.12	39.12	0.02
7. Wat Huai Phai School	0.15	39.15	0.02
8. Jedi Huk Private Hospital(Ban Huai Moo)	0.14	39.14	0.02
9. Kor PlubPla Private Hospital	0.09	39.09	0.01
10. Huai Phai Private Hospital	0.14	39.14	0.02
11. Hin Kong Private Hospital	0.14	39.14	0.03
12. Kao Gruad Temple	0.12	39.12	0.02
13. Aroon Ratanasiri Temple	0.17	39.17	0.03
14. Huai Phai Temple	0.14	39.14	0.03
15. Nong Num Khun Temple	0.15	39.15	0.03
16. Nong Luang Temple	0.12	39.12	0.02
17. Hin Kong Temple	0.14	39.14	0.03
18. Huai Phai Community	0.17	39.17	0.04
19. Nong Karm House	0.26	39.26	0.05
20. Nong Song Hong House	0.10	39.10	0.02
21. Nong Gratoom Temple	0.20	39.20	0.03
Standard value2/	**50**		**25**

Remark : 1/ Total basic value from basic value equaling 39 microgram/cubic meter
2/ Announcement of National Environment Board No. 36(B.E.2547) on regulating standard atmospheric air quality standard

Source : Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-20

Assessment of the 4th Case about the Spread of Sulfur Dioxide (SO_2) in Estimating Air pollution from the Project in case of Operating at Full Load (100%) with natural gas as fuel.

Location	Concentration (microgram/cubic meter)				
	1 hour average		24 hour average		1 year average
	Modeled value	Total basic value[1/]	Modeled value	Total basic value[1/]	Modeled value
Highest value	82.66	95.75	10.79	18.64	1.01
Occuring month	April		November		
Coordinates	(576000E , 1496500N)		(583250E , 1493500N)		(583250E , 1493500N)
Area	khao Krok, around 3.5 kilometers west of the project		Khao Gnam, around 3.4 kilometers South East of the project		Khao Gnam, around 3.4 kilometers South East of the project
Location					
1. Wat Huai Moo School	9.69	22.78	1.63	9.48	0.26
2. Wat Nong Taluang School	8.35	21.44	2.34	10.19	0.26
3. Wat Huai Pladuk School	9.68	22.77	1.97	9.82	0.38
4. Wat Na Nong School	8.34	21.43	1.24	9.09	0.25
5. Wat Kor Loi School	6.13	19.22	0.69	8.54	0.10
6. Wat Kao Gruad School	9.05	22.14	1.10	8.95	0.20
7. Wat Huai Phai School	8.86	21.95	1.38	9.23	0.23
8. Jedi Huk Private Hospital(Ban Huai Moo)	7.24	20.33	1.28	9.13	0.16
9. Kor PlubPla Private Hospital	6.60	19.69	0.85	8.70	0.12
10. Huai Phai Private Hospital	8.73	21.82	1.28	9.13	0.20
11. Hin Kong Private Hospital	9.20	22.29	1.33	9.18	0.24
12. Kao Gruad Temple	8.92	22.01	1.11	8.96	0.19
13. Aroon Ratanasiri Temple	10.81	23.90	1.59	9.44	0.32
14. Huai Phai Temple	8.95	22.04	1.31	9.16	0.30
15. Nong Num Khun Temple	7.87	20.96	1.37	9.22	0.25
16. Nong Luang Temple	8.63	21.72	1.15	9.00	0.20
17. Hin Kong Temple	8.78	21.87	1.34	9.19	0.26
18. Huai Phai Community	8.92	22.01	1.60	9.45	0.33
19. Nong Karm House	7.69	20.78	2.44	10.29	0.42
20. Nong Song Hong House	8.53	21.62	0.95	8.80	0.16
21. Nong Gratoom Temple	9.49	22.58	1.88	9.73	0.26
Standard value[2/]	**780**		**300**		**100**

Remark : [1/] Total basic value from highest basic value of concentration in average 1 hour equaling to 13.09 microgram/cubic meter and 24 hour average concentration equaling 7.85 microgram/cubic meter

[2/]Announcement of National Environment Board No. 24(B.E.2547) on regulating air quality in atmosphere

source : Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-21

Assessment of the 4th Case about the Spread of Nitrogen Dioxide (NO_2) in Estimating Air pollution from the Project in case of Operating at Full Load (100%) with natural gas as fuel.

Location	Concentration (microgram/ cubic meters)		
	1 hour average		1 year average
	Modeled value	Total basic value[1/]	Modeled value
Highest value	280.70	316.45	3.21
Occuring	April	April	-
Coordinates	(576000E , 1496500N)	(576000E , 1496500N)	(583250E , 1493500N)
Area	khao Krok, around 3.5 kilometers west of the project	khao Krok, around 3.5 kilometers west of the project	Khao Gnam, around 3.4 kilometers South East of the project
Location			
1. Wat Huai Moo School	32.91	68.66	0.82
2. Wat Nong Taluang School	28.36	64.11	0.81
3. Wat Huai Pladuk School	32.86	68.61	1.20
4. Wat Na Nong School	28.31	64.06	0.80
5. Wat Kor Loi School	20.82	56.57	0.32
6. Wat Kao Gruad School	30.73	66.48	0.64
7. Wat Huai Phai School	30.08	65.83	0.72
8. Jedi Huk Private Hospital(Ban Huai Moo)	24.59	60.34	0.52
9. Kor PlubPla Private Hospital	22.41	58.16	0.39
10. Huai Phai Private Hospital	29.65	65.40	0.64
11. Hin Kong Private Hospital	31.24	66.99	0.77
12. Kao Gruad Temple	30.28	66.03	0.60
13. Aroon Ratanasiri Temple	36.70	72.45	1.01
14. Huai Phai Temple	30.40	66.15	0.97
15. Nong Num Khun Temple	26.74	62.49	0.80
16. Nong Luang Temple	29.30	65.05	0.62
17. Hin Kong Temple	29.81	65.56	0.84
18. Huai Phai Community	30.28	66.03	1.07
19. Nong Karm House	26.11	61.86	1.35
20. Nong Song Hong House	28.97	64.72	0.50
21. Nong Gratoom Temple	32.24	67.99	0.81
Standard value[2/]	**320**		**57**

Remark : [1/] Total basic value from highest basic value of concentration in average 1 hour equaling to 35.75 microgram/cubic meter and 24 hour average concentration equaling 7.85 microgram/cubic meter

[2/]Announcement of National Environment Board No 33 (B.E. 2552)

Source : Consultants of Technololgy Co.,L.td, B.E.2563

The maximum 1-year average concentration of total suspended particulate is 0.70 microgram/cubic meter or counted for 0.70 percent of the standard limit at the coordinates 583250E, 1493500N, foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 1-year average concentration of total suspended particulate at the receptor is 0.30 microgram/cubic meter will occur in the area of Ban Nong Kham.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-17**.

(b) Particulate matter with a diameter of smaller than 10 microns (PM-10)

The maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 1.15 microgram/cubic meter or counted for 0.96 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 96.15 microgram/cubic meter (occurs in November) at the coordinates 583250E, 1493500N, at foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 24-hour average concentration at the receptor is 0.26 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 95.26 microgram/cubic meter, at the area of Ban Nong Kham.

The maximum 1-year average concentration of particulate matter with a diameter smaller than 10 microns is 0.11 microgram/cubic meter or counted for 0.22 percent of the standard limit at the coordinates 583250E, 1493500N, at foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 1-year average concentration of particulate matter with a diameter smaller than 10 microns at the receptor is 0.05 microgram/cubic meter, at the area of Ban Nong Kham.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-18**.

(c) Particulate matter with a diameter of smaller than 2.5 microns (PM-2.5)

The maximum 24-hour average concentration of particulate matter with a diameter smaller than 2.5 microns is 1.15 microgram/cubic meter or counted for 2.30 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 2.5 microns is 40.15 microgram/cubic meter (occurs in November) at the coordinates 583250E, 1493500N, at foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 24-hour average concentration at the receptor is 0.26 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 2.5 microns is 39.26 microgram/cubic meter, at the area of Ban Nong Kham.

The maximum 1-year average concentration of particulate matter with a diameter smaller than 2.5 microns is 0.11 microgram/cubic meter or counted for 0.44 percent of the standard limit at the coordinates 583250E, 1493500N, at foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 1-year average concentration of particulate matter with a diameter smaller than 2.5 microns at the receptor is 0.05 microgram/cubic meter, at the area of Ban Nong Kham.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.36 B.E. 2553 (2010) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-19**.

(d) Sulfur dioxide (SO_2)

The maximum 1-hour average concentration of sulfur dioxide (SO_2) is 82.66 microgram/cubic meter or counted for 10.60 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of sulfur dioxide (SO_2) is 95.75 microgram/cubic meter (occurs in April) at the coordinates 576000E, 1496500N, at the area of Khao Khrok, about 3.5 kilometers south of the Project. The maximum 1-hour average concentration at the receptor is 10.81 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of sulfur dioxide (SO_2) is 23.90 microgram/cubic meter, at Arun Rattanakhiri Temple.

The maximum 24-hour average concentration of sulfur dioxide (SO_2) is 10.97 micrograms/cubic meter or counted for 3.60 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of sulfur dioxide (SO_2) is 18.64 microgram/cubic meter (occurs in November) at the coordinates 583250E, 1493500N, at foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 24-hour average concentration at the receptor is 2.44 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of sulfur dioxide (SO_2) is 10.29 microgram/cubic meter, at the area of Ban Nong Kham.

The maximum 1-year average concentration of sulfur dioxide (SO_2) is 1.01 microgram/cubic meter or counted for 1.01 percent of the standard limit. It will occur at the coordinates 583250E, 1493500N, at foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 1-year average concentration at the receptor is 0.38 microgram/cubic meter, at Wat Huai Pla Duk School.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.21 B.E. 2544 (2001) and No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-20**.

(e) Nitrogen dioxide (NO_2)

The maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 280.70 microgram/cubic meter or counted for 87.72 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 316.45 microgram/cubic meter (occurs in April) at the coordinates 576000E, 1496500N, at the area of Khao Khrok, about 3.5 kilometers south of the Project. The maximum 1-hour average concentration at the receptor is 36.70 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 72.45 microgram/cubic meter, at Arun Rattanakhiri Temple.

The maximum 1-year average concentration of nitrogen dioxide (NO_2) is 3.21 microgram/cubic meter or counted for 5.63 percent of the standard limit. It will occur at the coordinates 583250E, 1493500N, at foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 1-year average concentration at the receptor is 1.35 microgram/cubic meter, at the area of Ban Nong Kham.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.33 B.E. 2552 (2009) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-21**.

5) Scenario 5 predict the sources of air pollution of the Project in the case of full load (100%) operation by using diesel gas as a fuel

Results of the study by using the mathematical modeling for scenario 5 predict the sources of air pollution of the Project in the case of full load (100%) operation by using diesel as a fuel are shown in **Table 5.3.2-22** to **Table 5.3.2-26**.

(a) Total suspended particulate (TSP)

The maximum 24-hour average concentration of total suspended particulate is 7.87 microgram/cubic meter or counted for 2.38 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of total suspended particulate is 192.87 microgram/cubic meter (occurs in April) at the coordinates 579500E, 1505500N, foot of Khao Raeng, about 8 kilometers north of the Project. The maximum 24-hour average concentration of total suspended particulate at the receptor is 2.02 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of total suspended particulate is 187.02 microgram/cubic meter, at Ban Nong Kham.

The maximum 1-year average concentration of total suspended particulate is 0.63 microgram/cubic meter or counted for 0.63 percent of the standard limit at the coordinates 583250E, 1493500N, foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 1-year average concentration of total suspended particulate at the receptor is 0.32 microgram/cubic meter will occur in the area of Ban Nong Kham.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-22**.

Table 5.3.2-22

Assessment of the 5th Case about the Spread of Total Suspended Particles (TSP) in Estimating Air pollution from the Project in case of Operating at Full Load (100%) with disel as fuel.

Location	Concentration (microgram/cubic meters)		
	24 hour average		1 year average
	Modeled value	Total basic value1/	Modeled value
Highest value	7.87	192.87	0.63
Occuring month	April	April	-
Coordinates	(579500E , 1505500N)	(579500E , 1505500N)	(583250E , 1493500N)
Area	Khao Rang, 8 kilometers North of the project	Khao Rang, 8 kilometers North of the project	Khao Gnam, 3.4 kilometers South East of the project
Location			
1. Wat Huai Moo School	1.29	186.29	0.21
2. Wat Nong Taluang School	1.67	186.67	0.20
3. Wat Huai Pladuk School	1.51	186.51	0.29
4. Wat Na Nong School	1.04	186.04	0.21
5. Wat Kor Loi School	0.63	185.63	0.09
6. Wat Kao Gruad School	0.86	185.86	0.17
7. Wat Huai Phai School	1.13	186.13	0.19
8. Jedi Huk Private Hospital(Ban Huai Moo)	1.04	186.04	0.14
9. Kor PlubPla Private Hospital	0.70	185.70	0.11
10. Huai Phai Private Hospital	0.95	185.95	0.17
11. Hin Kong Private Hospital	1.02	186.02	0.20
12. Kao Gruad Temple	0.85	185.85	0.16
13. Aroon Ratanasiri Temple	1.19	186.19	0.25
14. Huai Phai Temple	1.13	186.13	0.25
15. Nong Num Khun Temple	1.09	186.09	0.20
16. Nong Luang Temple	0.98	185.98	0.17
17. Hin Kong Temple	0.99	185.99	0.21
18. Huai Phai Community	1.22	186.22	0.25
19. Nong Karm House	2.02	187.02	0.32
20. Nong Song Hong House	0.81	185.81	0.14
21. Nong Gratoom Temple	1.44	186.44	0.22
Standard value2/	**330**		**100**

Remark : 1/ Total basic value from basic value equaling 185 microgram/cubic meter
2/ Announcement of National Environment Board No. 24(B.E.2547) on regulating atmospheric air quality standard

Source: Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-23

Assessment of the 5th Case about the Spread of Particulate less than 10 microns (PM-10) in Estimating Air pollution from the Project in case of Operating at Full Load (100%) with diesel as fuel.

Loation	Concentration (microgram/cubic meters)		
	24 hour average		1 year average
	Modeled value	Total basic value[1/]	Modeled value
Highest value	7.56	102.56	0.60
Occuring month	April	April	-
Coordinates	(579500E , 1505500N)	(579500E , 1505500N)	(583250E , 1493500N)
Area	Khao Rang, 8 kilometers North of the project	Khao Rang, 8 kilometers North of the project	Khao Gnam, 3.4 kilometers South East of the project
Location			
1. Wat Huai Moo School	1.24	96.24	0.20
2. Wat Nong Taluang School	1.60	96.60	0.19
3. Wat Huai Pladuk School	1.45	96.45	0.28
4. Wat Na Nong School	1.00	96.00	0.20
5. Wat Kor Loi School	0.61	95.61	0.09
6. Wat Kao Gruad School	0.83	95.83	0.16
7. Wat Huai Phai School	1.09	96.09	0.18
8. Jedi Huk Private Hospital(Ban Huai Moo)	1.00	96.00	0.14
9. Kor PlubPla Private Hospital	0.67	95.67	0.10
10. Huai Phai Private Hospital	0.91	95.91	0.16
11. Hin Kong Private Hospital	0.98	95.98	0.19
12. Kao Gruad Temple	0.82	95.82	0.15
13. Aroon Ratanasiri Temple	1.15	96.15	0.24
14. Huai Phai Temple	1.08	96.08	0.24
15. Nong Num Khun Temple	1.05	96.05	0.19
16. Nong Luang Temple	0.94	95.94	0.16
17. Hin Kong Temple	0.95	95.95	0.20
18. Huai Phai Community	1.17	96.17	0.24
19. Nong Karm House	1.94	96.94	0.31
20. Nong Song Hong House	0.78	95.78	0.13
21. Nong Gratoom Temple	1.38	96.38	0.21
Standard value[2/]	**120**		**50**

Remark : [1/] Total basic value from basic value equaling 95 microgram/cubic meter

[2/] Announcement of National Environment Board No. 24(B.E.2547) on regulating atmospheric air quality standard

Source: Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-24

Assessment of 5th Case about the Spread of Particulate less than 2.5 microns (PM-2.5) in Estimating Air pollution from the Project in case of Operating at Full Load (100%) with diesel as fuel.

Location	Concentration (microgram/cubic meters)		
	24 hour average		1 year average
	Modeled value	Total basic value[1/]	Modeled value
Highest value	7.08	46.08	0.57
Occuring month	April	April	-
Coordinates	(579500E , 1505500N)	(579500E , 1505500N)	(583250E , 1493500N)
Area	Khao Rang, 8 kilometers North of the project	Khao Rang, 8 kilometers North of the project	Khao Gnam, 3.4 kilometers South East of the project
Location			
1. Wat Huai Moo School	1.17	40.17	0.19
2. Wat Nong Taluang School	1.50	40.50	0.18
3. Wat Huai Pladuk School	1.36	40.36	0.26
4. Wat Na Nong School	0.93	39.93	0.19
5. Wat Kor Loi School	0.57	39.57	0.08
6. Wat Kao Gruad School	0.78	39.78	0.15
7. Wat Huai Phai School	1.02	40.02	0.17
8. Jedi Huk Private Hospital(Ban Huai Moo)	0.94	39.94	0.13
9. Kor PlubPla Private Hospital	0.63	39.63	0.10
10. Huai Phai Private Hospital	0.85	39.85	0.15
11. Hin Kong Private Hospital	0.92	39.92	0.18
12. Kao Gruad Temple	0.77	39.77	0.14
13. Aroon Ratanasiri Temple	1.07	40.07	0.23
14. Huai Phai Temple	1.02	40.02	0.22
15. Nong Num Khun Temple	0.98	39.98	0.18
16. Nong Luang Temple	0.88	39.88	0.15
17. Hin Kong Temple	0.89	39.89	0.19
18. Huai Phai Community	1.10	40.10	0.23
19. Nong Karm House	1.82	40.82	0.29
20. Nong Song Hong House	0.73	39.73	0.12
21. Nong Gratoom Temple	1.30	40.30	0.20
Standard value[2/]	**50**		**25**

Remark : [1/] Total basic value from basic value equaling 39 microgram/cubic meter
[2/] Announcement of National Environment Board No. 36(B.E.2547) on regulating standard atmospheric air quality standard

Source : Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-25

Assessment of the 5th Case about the Spread of Sulfur Dioxide (SO_2) in Estimating Air pollution from the Project in case of Operating at Full Load (100%) with Diesel as fuel.

Loaction	Concentration (microgram/cubic meters)				
	1 hour average		24 hour average		1 year average
	Modeled value	Total basic value1/	Modeled value	Total basic value1/	Modeled value
Highest value	72.41	85.50	12.87	20.72	1.03
Occuring month	December		April		
Coordinates	(583000E , 1501000N)		(579500E , 1505500N)		(583250E , 1493500N)
Area	Khao Chang, around 4.5 kilometers North East of the project		Khao Rang, around 8 kilometers North of the project		Khao Gnam, around 3.4 kilometers South East of the project
Location					
1. Wat Huai Moo School	12.69	25.78	2.12	9.97	0.34
2. Wat Nong Taluang School	10.35	23.44	2.73	10.58	0.33
3. Wat Huai Pladuk School	10.81	23.90	2.47	10.32	0.48
4. Wat Na Nong School	10.20	23.29	1.70	9.55	0.35
5. Wat Kor Loi School	7.70	20.79	1.03	8.88	0.15
6. Wat Kao Gruad School	11.36	24.45	1.41	9.26	0.27
7. Wat Huai Phai School	10.63	23.72	1.85	9.70	0.31
8. Jedi Huk Private Hospital(Ban Huai Moo)	9.10	22.19	1.70	9.55	0.23
9. Kor PlubPla Private Hospital	8.53	21.62	1.14	8.99	0.18
10. Huai Phai Private Hospital	11.26	24.35	1.55	9.40	0.28
11. Hin Kong Private Hospital	11.18	24.27	1.67	9.52	0.33
12. Kao Gruad Temple	11.47	24.56	1.39	9.24	0.26
13. Aroon Ratanasiri Temple	13.67	26.76	1.95	9.80	0.41
14. Huai Phai Temple	10.24	23.33	1.85	9.70	0.40
15. Nong Num Khun Temple	8.79	21.88	1.78	9.63	0.32
16. Nong Luang Temple	10.72	23.81	1.60	9.45	0.28
17. Hin Kong Temple	10.16	23.25	1.63	9.48	0.34
18. Huai Phai Community	10.10	23.19	2.00	9.85	0.41
19. Nong Karm House	10.58	23.67	3.30	11.15	0.52
20. Nong Song Hong House	9.94	23.03	1.32	9.17	0.22
21. Nong Gratoom Temple	12.76	25.85	2.36	10.21	0.36
Standard value2/	**780**		**300**		**100**

Remark : 1/ Total basic value from highest basic value of concentration in average 1 hour equaling to 13.09 microgram/cubic meter and 24 hour average concentration equaling 7.85 microgram/cubic meter

2/Announcement of National Environment Board No.21 (B.E.2544) and No. 24(B.E.2547) on regulating air quality in atmosphere

source : Consultants of Technololgy Co.,L.td, B.E.2563

Table 5.3.2-26

Assessment of the 5th Case about the Spread of Nitrogen Dioxide (NO_2) in Estimating Air pollution from the Project in case of Operating at Full Load (100%) with diesel as fuel.

Coordinate	Concentration (microgram/cubic meters)		
	1 hour average		1 year average
	Modeled value	Total basic value1/	Modeled value
Highest value	205.90	241.65	2.74
Occuring month	December	December	-
Coordinates	(583000E , 1501000N)	(583000E , 1501000N)	(583250E , 1493500N)
Area	Khao Chang, around 4.5 kilometers North East of the project	Khao Chang, around 4.5 kilometers North East of the project	Khao Gnam, around 3.4 kilometers South East of the project
Location			
1. Wat Huai Moo School	36.10	71.85	0.91
2. Wat Nong Taluang School	29.44	65.19	0.88
3. Wat Huai Pladuk School	30.74	66.49	1.28
4. Wat Na Nong School	29.00	64.75	0.93
5. Wat Kor Loi School	21.89	57.64	0.39
6. Wat Kao Gruad School	32.30	68.05	0.73
7. Wat Huai Phai School	30.23	65.98	0.82
8. Jedi Huk Private Hospital(Ban Huai Moo)	25.87	61.62	0.62
9. Kor PlubPla Private Hospital	24.26	60.01	0.48
10. Huai Phai Private Hospital	32.02	67.77	0.74
11. Hin Kong Private Hospital	31.78	67.53	0.88
12. Kao Gruad Temple	32.63	68.38	0.69
13. Aroon Ratanasiri Temple	38.88	74.63	1.10
14. Huai Phai Temple	29.12	64.87	1.07
15. Nong Num Khun Temple	25.00	60.75	0.86
16. Nong Luang Temple	30.49	66.24	0.74
17. Hin Kong Temple	28.88	64.63	0.90
18. Huai Phai Community	28.73	64.48	1.11
19. Nong Karm House	30.07	65.82	1.40
20. Nong Song Hong House	28.26	64.01	0.59
21. Nong Gratoom Temple	36.29	72.04	0.95
Standard value2/	**320**		**57**

Remark : 1/ Total basic value from highest basic value of concentration in average 1 hour equaling to 35.75 microgram/cubic meter

2/Announcement of National Environment Board No 33 (B.E. 2552)

Source : Consultants of Technololgy Co.,L.td, B.E.2563

(b) Particulate matter with a diameter of smaller than 10 microns (PM-10)

The maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 7.56 microgram/cubic meter or counted for 6.30 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 102.56 microgram/cubic meter (occurs in April) at the coordinates 579500E, 1505500N, at foot of Khao Raeng, about 8 kilometers north of the Project. The maximum 24-hour average concentration at the receptor is 1.94 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 10 microns is 96.94 microgram/cubic meter, at the area of Ban Nong Kham.

The maximum 1-year average concentration of particulate matter with a diameter smaller than 10 microns is 0.60 micrograms/cubic meter or counted for 1.20 percent of the standard limit at the coordinates 583250E 1493500N, at foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 1-year average concentration of particulate matter with a diameter smaller than 10 microns at the receptor is 0.31 microgram/cubic meter, at the area of Ban Nong Kham.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-23**.

(c) Particulate matter with a diameter of smaller than 2.5 microns (PM-2.5)

The maximum 24-hour average concentration of particulate matter with a diameter smaller than 2.5 microns is 7.08 microgram/cubic meter or counted for 14.16 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 2.5 microns is 46.08 microgram/cubic meter (occurs in April) at the coordinates 579500E, 1505500N, at foot of Khao Raeng, about 8 kilometers north of the Project. The maximum 24-hour average concentration at the receptor is 1.82 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of particulate matter with a diameter smaller than 2.5 microns is 40.82 microgram/cubic meter, at the area of Ban Nong Kham.

The maximum 1-year average concentration of particulate matter with a diameter smaller than 2.5 microns is 0.57 microgram/cubic meter or counted for 2.28 percent of the standard limit at the coordinates 583250E, 1493500N, at foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 1-year average concentration of particulate matter with a diameter smaller than 2.5 microns at the receptor is 0.29+ microgram/cubic meter, at the area of Ban Nong Kham.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.36 B.E. 2553 (2010) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-24**.

(d) Sulfur dioxide (SO_2)

The maximum 1-hour average concentration of sulfur dioxide (SO_2) is 72.41 microgram/cubic meter or counted for 9.28 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of sulfur dioxide (SO_2) is 85.50 microgram/cubic meter (occurs in December) at the coordinates 583000E, 15010000N, at the area of Khao Chang, about43.5 kilometers northeast of the Project. The maximum 1-hour average concentration at the receptor is 13.67 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of sulfur dioxide (SO_2) is 26.76 microgram/cubic meter, at Arun Rattanakhiri Temple.

The maximum 24-hour average concentration of sulfur dioxide (SO_2) is 12.87 microgram/cubic meter or counted for 4.29 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 24-hour average concentration of sulfur dioxide (SO_2) is 20.72 microgram/cubic meter (occurs in November) at the coordinates 579500E, 1505500N, at foot of Khao Raeng, about 8 kilometers north of the Project. The maximum 24-hour average concentration at the receptor is 3.30 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum

24-hour average concentration of sulfur dioxide (SO_2) is 11.15 microgram/cubic meter, at the area of Ban Nong Kham.

The maximum 1-year average concentration of sulfur dioxide (SO_2) is 1.03 microgram/cubic meter or counted for 1.03 percent of the standard limit. It will occur at the coordinates 583250E, 1493500N, at foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 1-year average concentration at the receptor is 0.52 microgram/cubic meter, at Ban Nong Kham.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.21 B.E. 2544 (2001) and No.24 B.E. 2547 (2004) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-25**.

(e) Nitrogen dioxide (NO_2)

The maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 209.90 microgram/cubic meter or counted for 64.37 percent of the standard limit. When considered the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 241.65 microgram/cubic meter (occurs in December) at the coordinates 583000E, 1501000N, at the area of Khao Chang, about 4.5 kilometers northeast of the Project. The maximum 1-hour average concentration at the receptor is 38.88 microgram/cubic meter. When combined with the background concentration from the monitoring, it was found that the maximum 1-hour average concentration of nitrogen dioxide (NO_2) is 74.63 microgram/cubic meter, at Arun Rattanakhiri Temple.

The maximum 1-year average concentration of nitrogen dioxide (NO_2) is 2.74 micrograms/cubic meter or counted for 4.81 percent of the standard limit. It will occur at the coordinates 583250E, 1493500N, at foot of Khao Ngam, about 3.4 kilometers southeast of the Project. The maximum 1-year average concentration at the receptor is 1.40 microgram/cubic meter, at the area of Ban Nong Kham.

From the concentrations at the ground predicted by using the mathematical modeling in comparison with the ambient air quality standard according to the Notification of National Environmental Board No.33 B.E. 2552 (2009) found that all the study results meet the standard including in the case of combining the background concentration. Details are shown in **Table 5.3.2-26**.

Summary of impacts during the operation period

From forecasting air quality using mathematical modeling, the concentration contour of each scenario is shown in **Appendix 5-3.**

From the air pollution impact assessment from the Project's source in the case of full load (100%) operation by using natural gas and diesel as fuel was performed by considering the background concentration of the air pollutants i.e., total suspended particulate (TSP), particulate matter with a diameter smaller than 10 microns, particulate matter with a diameter smaller than 2.5 microns, sulfur dioxide (SO_2), and nitrogen dioxide (NO_2). The results found that ambient air quality meets the standard, or it can be concluded that the total impact is within the ambient air quality standard.

Regarding the results of the air quality impact assessment by using the mathematical model for various scenarios indicate maximum concentration in the areas of Khao Ngam, Khao Khrok, and Khao Chang, therefore, the Consultant conducted a review of land use within the study area of the 5-kilometer radius. The Consultant used geographic information system together with the map of the Department of Land Development (2018) and the map of the Royal Thai Survey Department (1997) with a scale of 1:70,000. Moreover, the Consultant also conducted a field survey on the land use characteristic of the study area. The land use in the area can be classified into six categories: 1) agriculture, 2) community and buildings, 3) other without utilization, 4) forest, 5) industrial, and 6) water source such as irrigation canal.

For the land use in the forest area, mostly cover the mountain areas. The majority of the forests are deciduous forests of 3.56 square kilometers or 78.07 percent of the total forest area in the study area. It has a characteristic of mixed deciduous forest and deciduous dipterocarp forest. The nature of the mixed deciduous forest is a sparse forest. All trees are deciduous in the dry season. The characteristic of the soil is sandy loam. Important plants include Teak, Makha, Daeng, Pradu, and Rosewood which are mixed with different types of bamboo such as Sang bamboo, Ruak bamboo, Bong bamboo at the height of the area from 50-800 m MSL. The deciduous dipterocarp forest has a distinctive rubber tree which can be found in northern, central, and northeast regions. Important plants include dipterocarp, antimony, Phayom, Makhampom, Pradudaeng, etc., lower ground plants include cycad, grass, etc. at the height of the area of 50- 1,300 m MSL. Such forest areas are covered with woody plants in the low mountain area scattered around the Project area. The closest mountains to the project location are about 1 kilometer, including Khao Hin Kong and Khao Narao, which are limestone hills. For the northern area, at a distance of approximately 3.5 kilometers from the Project, there are Khao Wong, Khao Kruad, Khao Phra Prab, Khao Phra Non, and Khao Chang Kham, which are limestone hills. In the southeast at a distance of about 4 kilometers from the Project, there are Khao Kwang, Khao Kaen Chan, Khao Noi, Khao Takong, Khao Khi Wua, and Khao Ngam, which are limestone hills. In the south at a distance of about 3.5 kilometers from the Project, there are Khao Khrok, Khao Wong, Khao Ngam, and Khao Prik, which are limestone hills. Some areas are in the military area, as shown in **Figure 5.3.2-15.**

Therefore, the air quality impact during the operation period is expected to occur at a moderate level.

Summary	**Size**	**Boundary**	**Duration**	**Severity**	**Importnace**	**Importance Order**	
	2	2	2	(8) = 2	2	4	Medium

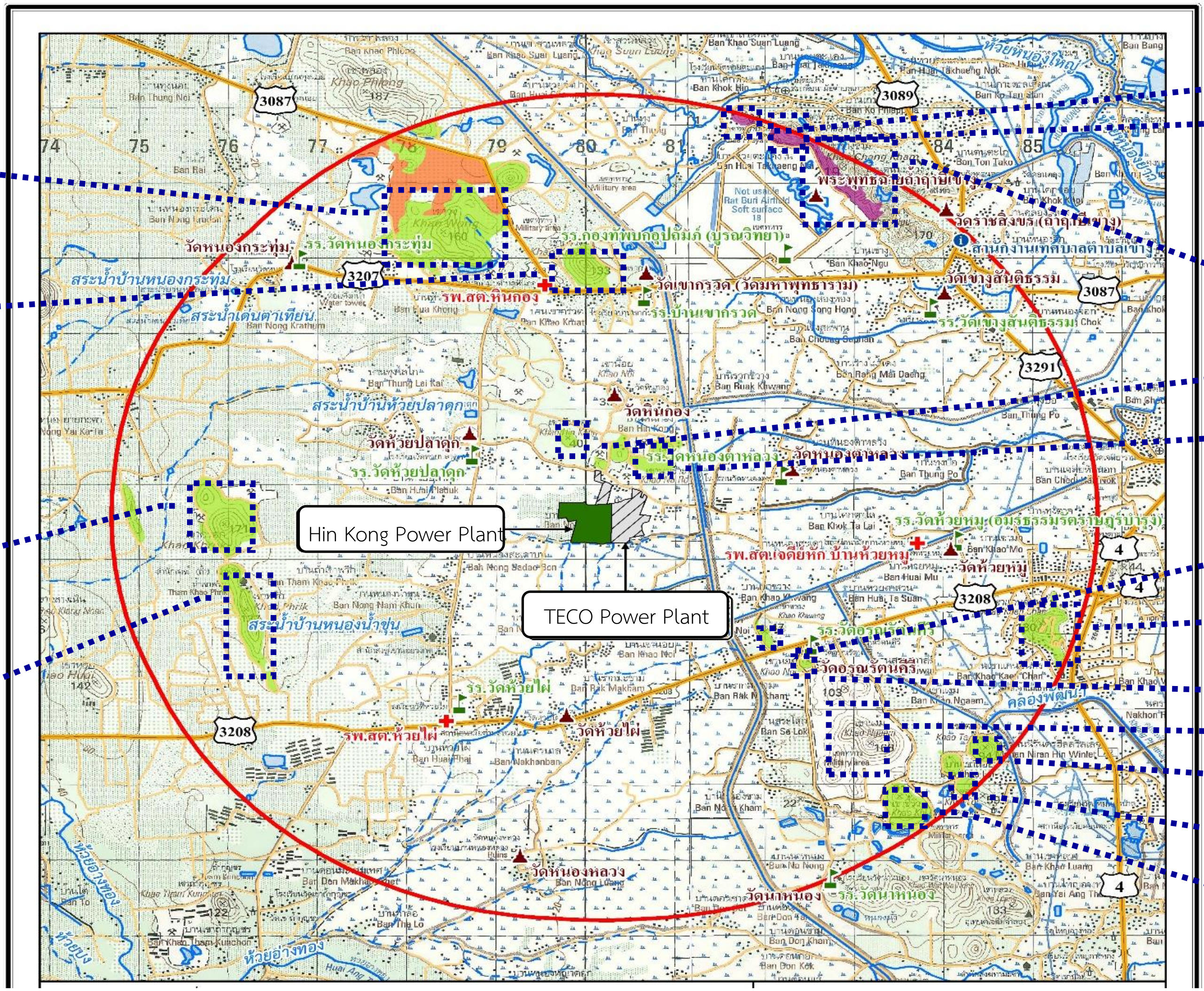


Figure 5.3.2-15 **Mountain ranges within 5km radius from the project site**

5.3.3 Noise impact

The Project is located in an empty area of TECO power plant with the objective of replacing the terminated power generation capacity of TECO power plants and increasing the energy potential of the area in the future with current technology that is more efficient and modern. Machine and equipment specifications were set to have an average noise level from machines or sound-absorbing material at a distance of 1 meter, not more than 85 dB(A). The installation of machines that generate noise, a sound reduction equipment such as a silencer must be installed or build a building to cover the machine to prevent and reduce the noise impact that may affect the nearby area of the Project, both during the construction and operation periods.

However, the Project activities during both construction and operation periods may have a noise impact to the adjacent communities. Therefore, the Consultant assessed impacts of ambient noise and disturbing noise by classifying into two period, construction and operation periods as follows:

(1) Construction period: 1.1 The case of no noise barrier
1.2 The case of a temporary 18 ga steel noise barrier with a height of five meters using
(2) Operation period: 2.1 The case of high noise level machines, such as gas and steam turbine, are installed in a close building
2.2In the case of the south side of the Project where there is a concrete fence with a height of 2 meters

For assessing the noise impact of the Project, the Consultant conducted the assessment according to the criteria for considering the noise impact om environmental assessment report for the petrochemical and energy industry projects of the Office of Natural Resources and Environmental Policy and Planning. The 24-hour average ambient noise level was considered according to the Notification of the National Environment Board No. 15 B.E.2540 (1997) on ambient noise level standard. Regarding the standard, the 24-hour average ambient noise level must not exceed 70 dB(A). The Consultant also conducted an assessment on disturbing noise according to the Notification of the Pollution Control Department on basic noise level measurement method, measuring and calculation of disturbing noise, calculation of the disturbing noise level, and the noise measurement record form published in the Government Gazette, Volume 124, Special Section 145 Ngor, dated 28 September 2007 and the Noise Measurement Guideline (revised version) of the Office of Air Quality and Noise Management, Pollution Control Department. Details of the assessment are as follows:

(1) Calculation of 24-hour noise level from sources

Calculation of 24-hour noise level from sources is the calculation of noise level from sources for a certain period of time. It is the adjustment of noise from machine operation to an average noise level for a certain period of time bu using Equation (1).

Where: Leq_T = Sound level occurring at the certain time, dB(A)
Lp = Sound level at source, dB(A)
t = Time duration of sound from the source, hour
T = Time duration of sound that is needed to assess, hour

(2) Noise impact assessment method

1) Ambient noise level; the Consultant considered the 24-hour average ambient noise level of the community in accordance with the Notification of the National Environmental Board No.15 B.E.2540 (1997) on ambient noise level standard. Regarding the standard, the 24-hour average ambient noise level must not exceed 70 dB(A). The assessment of noise impact from the Project at receptors consists of two steps as follows:

(a) Evaluation of noise levels that are attenuated by distance at receptors by employing Equation (2).

$$Lp_2 = Lp_1 - 20 \log R_2/R_1 \qquad (2)$$

Where: R_1 = Distance between noise sources, meter
R_2 = Distance between noise source and receptor, meter
Lp_1 = Noise level from a machine at a distance of X meters, dB(A)
Lp_2 = Noise level at each distance, dB(A)

(b) Evaluation of noise levels from the Project's activities together with the background noise level at receptors by employing Equation (3).

Where: Lp_1 = Noise level from source 1, dB(A)
Lp_n = Noise level from source n, dB(A)

2) Disturbing noise

Disturbing noise, the Consultant assessed the impact of the nuisance that may have increased by considering the disturbing noise level by using the method according to the Notification of the Pollution Control Department on basic noise level measurement method, measuring and calculation of disturbing noise, calculation of the disturbing noise level, and the noise measurement record form published in the Government Gazette, Volume 124, Special Section 145 Ngor, dated 28 September 2007 and the Noise Measurement Guideline (revised version) of the Office of Air Quality and Noise Management, Pollution Control Department. The seven steps of the assessment are summarized in **Table 5.3.3-1.**

Table 5.3.3-1

Steps in assessing noise disturbance

<table>
<tr><th>No.</th><th>Detail</th><th>Remark</th></tr>
<tr><td>Step 1</td><td>Collects noise level data while there is no disturbance at the receptors, the data used for this assessment consist of equivalent continuous sound level (L_{eq}) and background sound level (L_{90}), with daytime data used for 1 hour and night time using 5 minute data</td><td>L_{eq} = A
L_{90} = B</td></tr>
<tr><td>Step 2</td><td>Estimate the noise level from the Project's noise source being attenuated by distances and obstructions at the receptors by using the following equation
$Lp_2 = Lp_1 - 20 \log R_2/R_1$</td><td>$Lp_2$ = C</td></tr>
<tr><td>Step 3</td><td>Estimate the total noise level during the Project’s activities at receptors by using the following equation
$L_{total} = 10 \log \sum_{i=1}^{n} 10^{Li/10}$</td><td>$L_{Total}$ = D</td></tr>
<tr><td>Step 4</td><td>Calculate the difference of the volume value (D-A) and compare the table to find the modifier as follows
unit: dB(A)
<table>
<tr><th>Difference of the sound level (D-A)</th><th>Sound level modifier (E)</th></tr>
<tr><td>1.4 or lower</td><td>7.0</td></tr>
<tr><td>1.5 to 2.4</td><td>4.5</td></tr>
<tr><td>2.5 to 3.4</td><td>3.0</td></tr>
<tr><td>3.5 to 4.4</td><td>2.0</td></tr>
<tr><td>4.5 to 6.4</td><td>1.5</td></tr>
<tr><td>6.5 to 7.4</td><td>1.0</td></tr>
</table></td><td>F = D-E</td></tr>
</table>

<table>
<tr><th>No.</th><th>Detail</th><th>Remark</th></tr>
<tr><td></td><td><table><tr><td>7.5 t0 12.4</td><td>0.5</td></tr><tr><td>12.5 or higher</td><td>0</td></tr></table>Later, the modifier (E) is then subtracted from the total noise level during the Project’s activity (C), the disturbing noise level (F) is obtained</td><td></td></tr>
<tr><td>Step 5</td><td>Adjust the value in various cases as follows:
(1) + 3 dBA for areas that need tranquility and at night
(2) + 5 dBA in the event that there is sound from a shock, sharp, loud or vibrating source</td><td>G = F+3 dB(A)
or +5 dB(A)</td></tr>
<tr><td>Step 6</td><td>Estimate the level of disturbing from the equation
Disturbing level = Noise level during disturb – Background noise level
If it exceeds 10 dB(A), the noise level from the Project is considered disturbing noise</td><td>G – B < 10</td></tr>
<tr><td>Step 7</td><td>If it exceeds 10 dB(A), consider additional measures to reduce the noise level from the source and reassess from step 2 to step 6 until the disturbing level is acceptable</td><td></td></tr>
</table>

(3) Existing environmental conditions

The Consultant considered existing environmental conditions from two sources as follows:

1) Gather data from the results from the environmental impact prevention and mitigation measures implementation reports of the 700 MW Combined cycle power plant (natural gas) Project of Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch) during 2015-2019 (in 2019, the data cover for the first half of the year from January to June, the monitoring were carried out during 25-28 February 2019 and 28-31 May 2019). There were 8 stations, conducted 4 times a year, and 3 days continuously for each time. The stations are located at different distances from the Project i.e. 100 meters north along the fence, 100 meters south along the fence, 240 meter southeast of the power plant, 300 meters north of the power plant, 400 meters northeast of the plant, Ban Nong Rak station 1 (650 meters), Ban Nong Kham station 2 (650 meters), and Ban Nong Kham station 1 (820 meters). The monitoring results are shown in **Table 5.3.3-2**

2) **Monitoring of noise level in the study area by the Consultant,** there are 3 monitoring stations with the following distances from the Project: in the area of the house behind the power plant with a distance of 30 meters, at Ban Nong Rak station 2 with a distance of 300 meters, and the area of Ban Nong Kham with a distance of 820 meters. The first noise level monitoring was carried out during 12-18 February 2019 and the second noise level monitoring was carried out during 25-31 October 2019. **During both monitorings, the TECO Power Plant was not operational. Therefore, the Consultant used these monitoring results as the background noise level noise impact assessment**.

The monitoring results are presented in **Table 5.3.3-2** and can be summarized as follows:

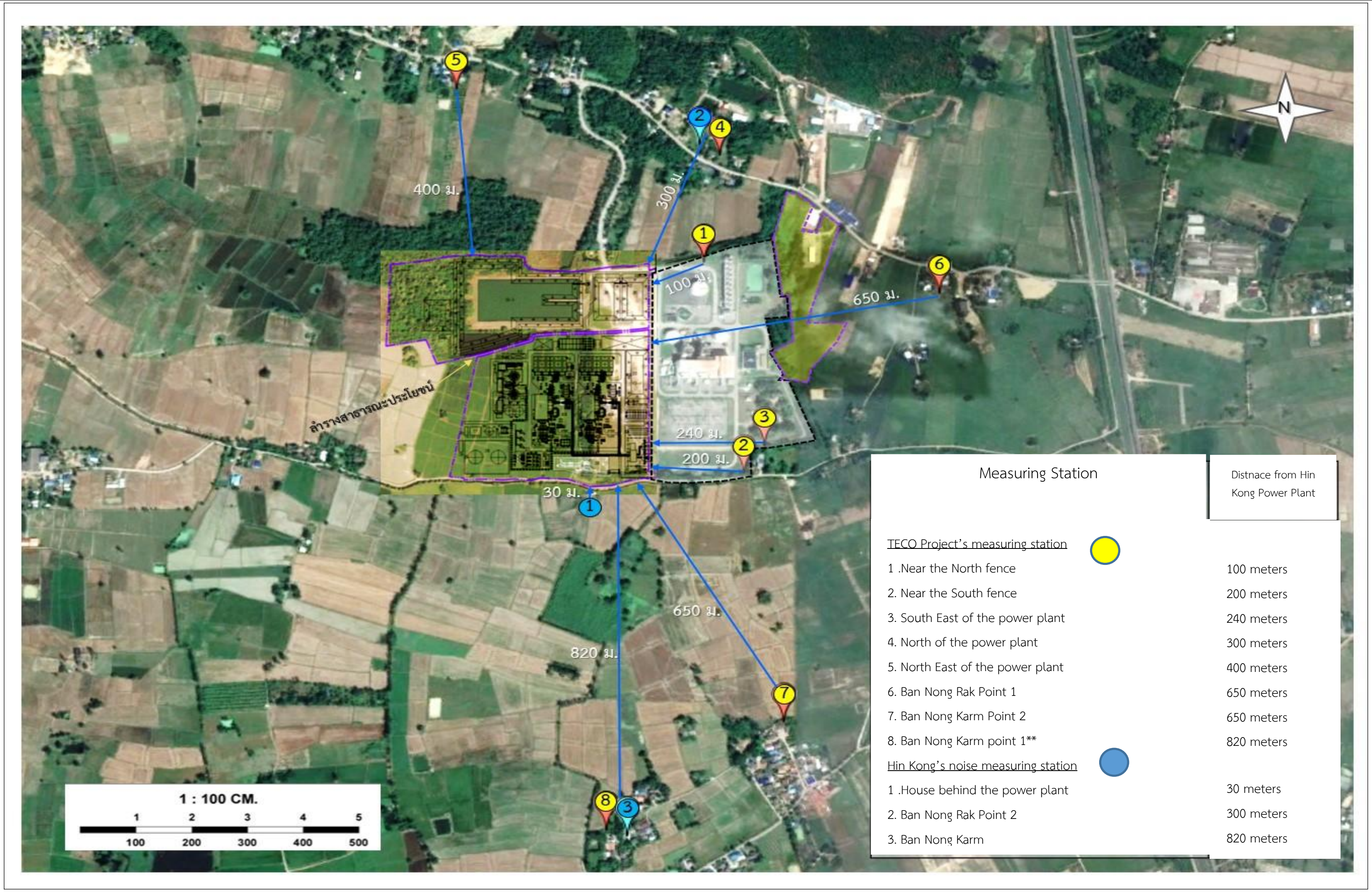
1) **24-hour average noise level ($L_{eq\ 24\ hr}$)**

From the results of the 24-hour average noise level monitoring ($L_{eq\ 24\ hr}$) from the TECO Power Plant measures implementation report from 2015 to 2019 and the monitoring by the Consultant during 12-18 February 2019 and 25-31 October 25-31 2019 (the TECO Power Plant was not operational), it was found that when the monitoring results were compared with the standard values according to the Notification of the Ministry of Industry on the noise level configuration and disturbing noise levels arising from factory operations B.E.2548 (2005) and the standards according to the National Environment Board No. 15 B.E.2540 (1997) on the standard of the ambient noise level. According to the standards the 24-hour average noise level must not exceed 40 dB(A). A comparison of the results with the standards found that all results are within the standards.

2) **Background noise level (L_{90})**

From the results of the monitoring of background noise level (L_{90}) of TECO Power Plants from the measures implementation reports from 2015 to 2019 and the monitoring by the Consultant during 12-18 February 2019 25-31 October 2019 (which the TECO Power Plant was not operational) found that the noise levels were in the range of 31.8-59.8 dB(A). **However, from the measures implementation reports and the monitoring conducted by the Consultant, there were the levels of background noise (L_{90}) were low at sometimes**.

It can be concluded that from the results of noise level monitoring from the measure implementation reports of the TECO Power Plant for the past 5 years (2015 - 2019) and the results of noise monitoring conducted by the Consultant during 12-18 February and 25-321 October 2019. 24-hour average noise levels were within the specified standards every year.



<u>Figure 5.3.3-1</u> TECO's and Hin Kong Power Plant's Noise measuring stations

Table 5.3.3-2
Noise measuring result of the TECO Power Plant and Consultant Company

Measuring site	Distance from the project (meters)	Measuing result (decibel A)		
		B.E.	Leq 24hr	L90
Measurement spot of TECO Power Plant2/				
1 Near the fence in the North	100	2558	49.3-67.0	36.4-66.7
		2559	58.2-65.1	54.3-69.5
		2560	66.9-69.7	64.2-68.5
		2561	46.5-68.3	40.2-68.4
		2562	47.0-51.4	38.8-50.0
2 Near the fence in the South	200	2558	49.3-67.0	47.1-64.4
		2559	56.6-66.0	44.9-64.3
		2560	53.7-60.8	50.1-60.7
		2561	52.8-63.0	42.2-59.0
		2562	52.3-54.3	40.9-53.8
3 Southeast of the power plant	240	2558	55.8-64.3	38.2-69.1
		2559	53.7-58.1	41.3-59.2
		2560	57.4-64.6	52.3-66.1
		2561	52.9-59.1	44.5-57.1
		2562	49.4-52.5	40.5-52.4
4 North of the power plant*	300	2558	53.6-61.6	35.6-66.6
		2559	52.2-63.1	36.2-63.6
		2560	50.7-58.4	42.5-57.0
		2561	50.2-56.5	40.2-53.5
		2562	51.5-57.9	40.6-57.2
5 Northwest of the powerplant	400	2558	47.9-63.9	30.4-71.5
		2559	46.4-56.9	33.4-57.3
		2560	47.1-58.8	38.4-60.4
		2561	48.4-53.7	40.1-55.2
		2562	49.0-51.3	38.4-50.5
6 Ban Nong Rak site 1	650	2558	52.9-57.7	39.5-56.4
		2559	52.5-64.3	41.4-61.9
		2560	56.1-61.0	45.1-61.8
		2561	52.6-56.8	41.6-54.8
		2562	48.3-51.7	41.2-49.9
7 Ban Nong Karm site 2	650	2558	48.7-59.9	33.0-60.0
		2559	53.4-59.7	32.4-39.4
		2560	53.4-58.8	41.0-62.8
		2561	58.2-60.1	40.2-63.0
		2562	60.2-60.6	44.0-59.8
8 Ban Nong Karm site 2**	820	2558	48.3-59.5	31.5-64.9

Table 5.3.3-2(cont)

Measuring site	Distance from the project (meters)	Measuing result (decibel A)		
		B.E.	Leq 24hr	L90
		2559	45.9-63.3	33.0-63.0
		2560	48.8-63.3	39.7-67.6
		2561	54.4-60.9	41.2-61.0
		2562	47.6-55.5	40.0-55.2
Noise Measuring station of Hin Kong Power Plant1/				
1 Ban Lung Rong Fai Fa	30	2562	51.5-56.5	31.8-59.8
2 Ban Nong Ruk Site 2*	300		51.2-54.4	34.4-50.5
3 Ban Nong Karm**	820		52.2-54.4	34.7-58.4
Standard value3/			**70**	

Remarks* and ** refer to monitoring stations at the same location

1/From the noise level monitoring by ALS Laboratory Group (Thailand) Company Limited during 12-18 February 2019 and 25-31 October 2019, the TECO Power Plant was not operational, these monitoring results were used as background noise levels in the noise impact assessment

2/ Environmental impact prevention and mitigation measures and environmental impact monitoring program implementation reports of the 700 MW combined cycle power plant (natural gas) of Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch) during 2015-2019 (for 2019, the information were for the first half of the year from January to June which was monitored during 25-28 February 2019 and 28-31 May 2019)

3/ The Notification of the Ministry of Industry on noise level configuration and disturbing noise levels arising from factory operations B.E.2548 (2005) and the standards according to the National Environment Board No. 15 B.E.2540 (1997) on the ambient noise level

(4) Impact assessment during the construction period

1) Construction duration

The implementation of the construction period was considered from the area adjustment activities throughout the system testing activities, the 1,400 MW Hin Kong Power Plant Project has a total duration of approximately 3 years comprising the Project #1 of 700 MW and the Project #2 of 700 MW as detailed in **Table 5.3.3-3**. The main operational activities 1-6 will be performed simultaneously (begin to adjust the area in 2021) by using a single set of construction equipment and machinery teams as follows:

Table 5.3.3-3

Activities during Construction Period

Activities	Noise level (dBA)	Duration (month)	B.E. 2564 (2021)				B.E. 2565 (2022)				B.E. 2566 (2023)				B.E. 2567 (2024)	
			month													
			1-3	4-6	6-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30	31-33	34-36	37-39	40-42
1. Area adjustment	83	6														
2 Prepare for foundation laying	71	3														
3. Create foundation	77	9														
4. Create structure and buildings	72	9														
5. Decorations and Inspection	74	9														
6. Machines and system installation	74	12														
7. Test the system	-	6											project#1 700 megawatt			
															project#2 700 megawatt	

Source: Hin Kong Co.,L.td, B.E. 2563

Remark: Noise level is according to Table5.3.3-4 (Carry W. Canter, 1997) Construction of Industrial Factories Case II – Highest noise level for the Minimum requirement for operating the machines is used to assess the impact from the activites that are using said machines.

(a) Land adjustment (month 1-6), a total of 6 months
(b) Excavation work (month 6-9), a total of 3 months
(c) Foundation work (month 10-18), a total of 9 months
(d) Structural and building work (month 16-24), a total of 9 months
(e) Finishing work and inspection (month 19-27), a total of 9 months
(f) Machine installation and system testing work (month 22-33), a total of 12 months
(g) Commissioning work can be divided into two phases as follows:

The Project #1; 700 MW (month 31-36), the Project will gradually continue commissioning after complete the installation and system work by using the period of commissioning the system of 6 months, will start production and supply electricity to the system in 2024, and

The Project #2; 700 MW (month 37-42), the Project will perform the commissioning after the completing the commissioning of the Project #1, with the period of commissioning the system of 6 months, will start production and supply electricity to the system in 2025.

2) Information on maximum noise level (L_{max}) from construction activities

The Consultant considered the construction noise lever reference value from the Canter's Environmental Impact Assessment Manual (1997) (**Table 5.3.3-4**) that collected the maximum noise levels (L_{max}) generated from construction activities. It was found that the construction period of the Project which will be performed 8 hours a day, all the machines will not be operated at the same time. Therefore, the reference noise level of industrial factory construction activities case II was selected in which referred to the minimum requirement. The maximum noise level will be generated from the land adjustment activities with the maximum noise level of 83 dB(A) for a period of approximately 6 months, this was then used in the assessing the noise impact from the Project during the construction period.

3) Noise impact on workers in the construction areas

The results of the assessing of impact on construction workers and workers in the area by using the noise level from the land adjustment of 83 dB(A) at the distance of 15 meters as a representative noise level, the 8-hour average noise level can be calculated by employing Equation (2).

It was found that construction workers and other workers in the area will be exposed to noise from construction activities at the level of 83.0 dB(A), which is not exceeding the noise level standard according to the Notification of the Department of Labor Protection and Welfare on the average noise level standard acceptable to daily working hours B.E. 2561 (2018), which sets the noise standard that allows workers to be exposed to a value of no more than 85 dB(A) in the period of 8 hours working time.

Table 5.3.3-4

Highes Noise Level in Each Stage of Construction within 15 Meters of the Sources

Construction stages*	Building/Construction type							
	Residential Building		Office, Hotel, School, and Utilities		Industrial factory, parking areas, mall, and service station		road, highway, and water drainage system	
	I	II	I	II	I	II	I	II
Area adjustment	83	83	84	84	84	83	84	84
Digging to prepare for foundation	88	75	89	79	89	71	88	78
Lay/create foundation	81	81	78	78	77	77	88	88
Create structures and buildings	81	65	87	75	84	72	79	78
Decoration/ Inspect work	88	72	89	75	89	74	84	84

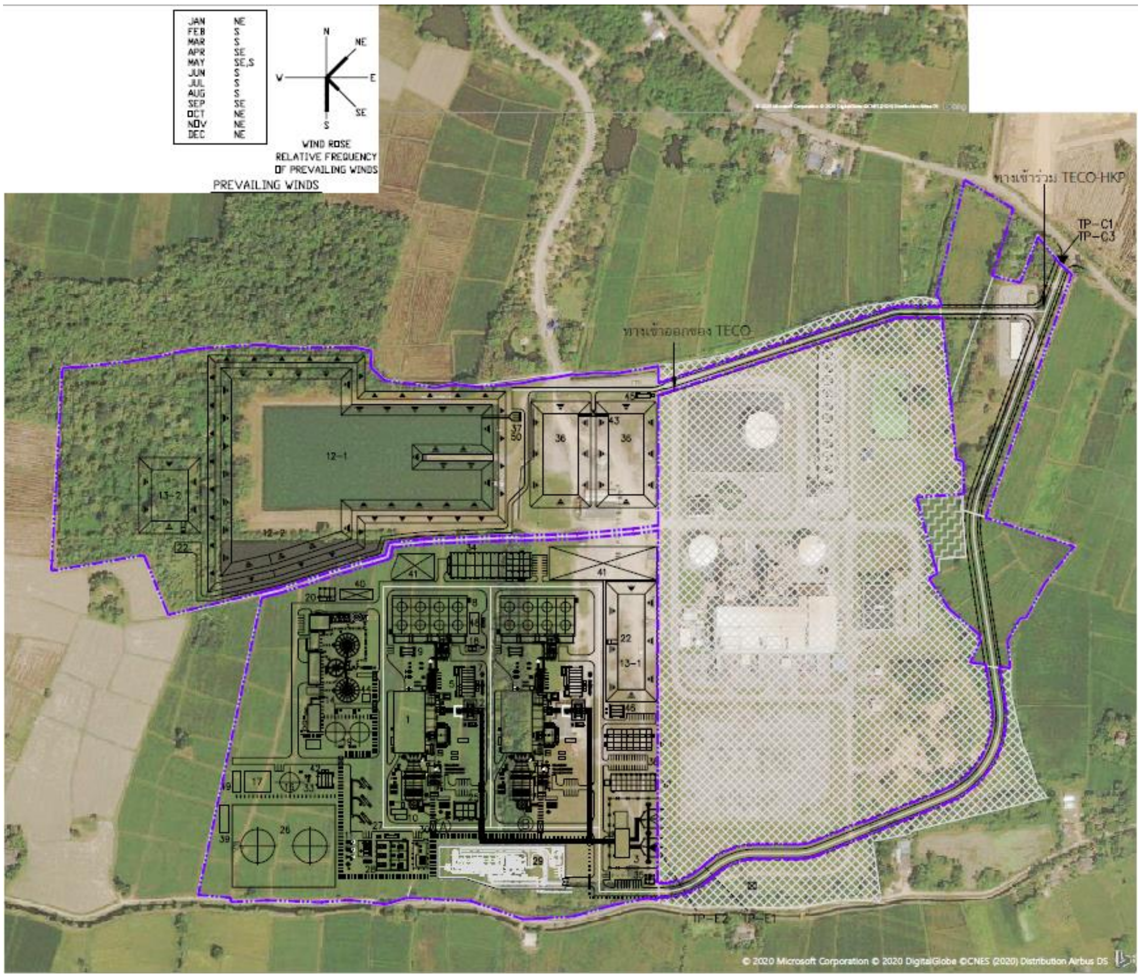
Remark : I = Highest Noise level in the case that all the machines operate at the same time (All pertinent Equipment)
II = Highest noise level when the needed/required machines operate (Minimum Requirement)
Source : Carry W. Canter, Environmental Impact Assessment, (1997)

However, the Project has imposed measures requiring construction workers and other workers in noisy areas to wear personal protective equipment especially those who carrying out construction activities that cause noise. This measure is to reduce the chance of impact on the health of workers. Personal protective equipment includes earmuffs and earplugs. The workers are requested to wear personal protective equipment throughout the working time in noisy areas. Moreover, the Project shall avoid carrying activities that cause excessive noise for a long time. Therefore, the impact on the workers in the construction area is expected at a low level.

4) Noise impact at the observation points

a) Observation points

From the field survey in conjunction with checking maps of the Royal Thai Survey Department, satellite images, and pictures from the unmanned aerial vehicle in the construction area of Hin Kong Power Plant and the TECO Power Plant, it was found that there are small communities nearby in the construction area of 7 houses, with the houses closest to the power plant being 1-story cement houses, surrounding the open area. There is a distance of approximately 30 meters from the construction area to the house (**Figure 5.3.3-2**).



<u>Figure 5.3.3-2</u> **Landmark location of the house area behind the power plant**

b) 24-hour average noise level

The calculation of the 24-hour average noise level at the observation points in the calculation of the noise level from the construction activities of the Project to the observation points in combine with the existing 24-hour average noise level, the highest level monitored during 25 October to 1 November 2019 was 56.5 dB(A), the average 24-hour noise level at the observation points can then be determined. Details are shown in **Table 5.3.3-5.**

$$\mathrm{Leq}_{24ชม.} = 83.0 + 10 \log 8/24$$
$$= 78 \text{ decibel}$$

Table 5.3.3-5

Total Noise Level of the Machines and the Noise's Traveling Distance

Distance from the source to the landmark (meters)	24 hour average (decibel A)				Assessment result
	Source	Landmark (1)	Current state[1/] (2)	Total[2/] (1)+(2)	
Houses behind the power plant					
30	78	72.0	56.5	72.1	Fail
40		69.5		69.7	Pass
50		67.5		67.9	Pass
60		66.0		66.4	Pass
70		64.6		65.2	Pass
80		63.5		64.3	Pass
90		62.4		63.4	Pass
100		61.5		62.7	Pass
150		58.0		60.3	Pass
200		55.5		59.0	Pass
300		52.0		57.8	Pass
400		49.5		57.3	Pass
500		47.5		57.0	Pass
Standard[3/]				**70**	

Remark: [1/] 24 hour average value of 56.5 decibel A from October 24- 1 November B.E. 2562

[2/] Combined noises regarding energy, combined noises regarding project's wastes

[3/] Annoucement from the National Environment Board No. 15 (B.E. 2540) on regulating regular noises section 32 (5) National Environment Quality Promotion and Conservation Act B.E. 2535 on March 12, B.E. 2540

From the results of the assessment, the noise level from construction activities of the power plant to the closest house at the distance of 30 meters is 72.1 dB(A), which exceeds the ambient noise level standard according to the Notification of the National Environment Board. However, when the machinery is moved to perform construction activities at a distance from the observation point, the noise level decreases with distance, from the distance from the construction area of 40 meters or more, the 24-hour average noise level is within the ambient noise level standard according to the Notification of the National Environment Board. Considering the result together with the construction plan during the land adjustment activity of the Project, the impact that occurs at a distance of 30-40 meters will last for no more than one day.

However, in the construction, the Project has considered installing a soundproof wall to reduce the noise impact that may arise from construction activities. It will take into account the suitability from materials that can reduce the noise level from construction activities to receptors (**Table 5.3.3-6**), safety and engineering operations, and opinions on the installation of soundproof walls from affected people. Details of each scenario are as follows:

Table 5.3.3-6

Tranmission Loss from using various noise absorbing obects

Meterial	Thickness (mm)	Surface Density (Kg/m^2)	Transmission Loss* (dB)
Polycarbonate	8-12	10-14	30-33
Acrylic (Poly-Methyl-Acrylate (PPMA)	15	18	32
Concrete block 200x200x400 light weight	200	151	34
Dense concrete	100	244	40
Light concrete	150	244	39
Light concrete	100	161	36
Brick	150	288	40
Steel, 18 ga	1.27	9.8	25
Steel, 20 ga	0.95	7.3	22
Steel, 22 ga	0.79	6.1	20
Steel, 24 ga	0.64	4.9	18
Aluminum sheet	1.59	4.4	23
Aluminum sheet	3.18	8.8	25
Aluminum sheet	6.35	17.1	27
Wood	25	18	21
Plywood	13	8.3	20
Plywood	25	16.1	23
Absorptive panels with polyester film backed by sheet	50-125	20-30	30-47

Remark : *Value assuming no openings or gaps in the barriers

Source : modified from Environmental Protection Department and Highway Department, Government of the Hong Kong SAR., 2003

Scenario 1, without a soundproof wall, and

Scenario 2, with the installation of an 18 ga steel wall which is available in the market and easy to move during construction activities, it has a transmission loss (TL) of 25 dB(A) at the height of five meters.

In the process of calculating the noise level in the case of selecting different types of sound-reducing materials as soundproof walls at different heights to calculate the noise level resulting from transmission across the sound-reducing material by determining the Fresnel number from Equation (4) (**Figure 5.3.3-3**). The Fresnel number was then used to find a decrease in noise level from the graph (**Figure 5.3.3-4**). Later, the decreased noise level was subtracted from the noise level generated from the construction activities. The sound levels at the receptors in the sensitive area were received.

Where: N_O = Fresnel number

a = Displacement between the noise source and the top edge of the wall (meter)

b = Displacement between the edge of the wall and the receptor (meter)

c = Displacement between the source and the receptor (meter)

w = Sound wavelength (m) = v/f = 0.70

v = Sound wave speed (m/s) = 331.4 $[1+(T_c/273.2)]^{1/2}$ = 347.74

T_c = Average atmospheric temperature (27.6 degrees Celsius) based on climate statistics in the period of 13 years, 2006-2018, of the Ratchaburi Meteorological Station

f = Sound wave frequency = 550 Hz

Detailed calculation of the decreased noise level due to transmission through the sound attenuation material is shown in **Table 5.3.3-7**.

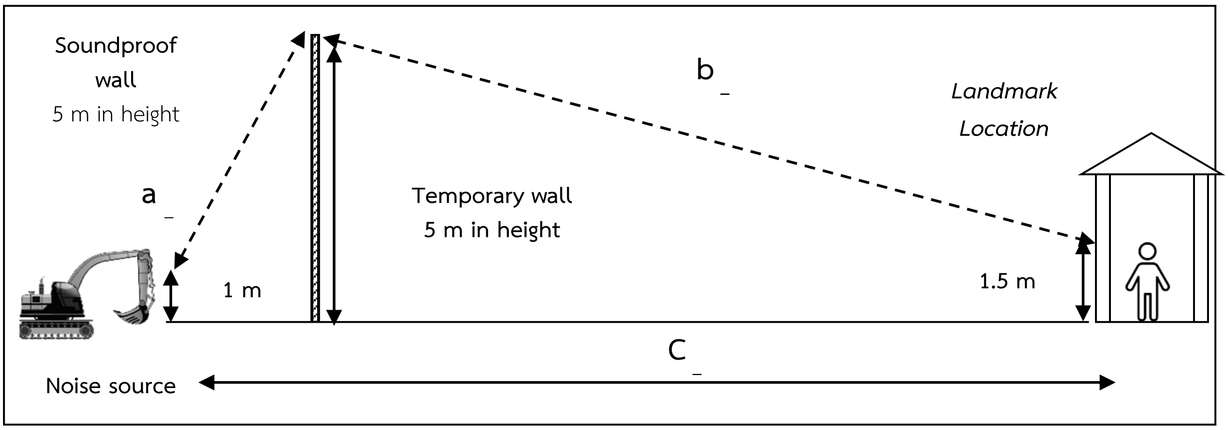


Figure 5.3.3-3 Reference distance used in calculating Fresnel number

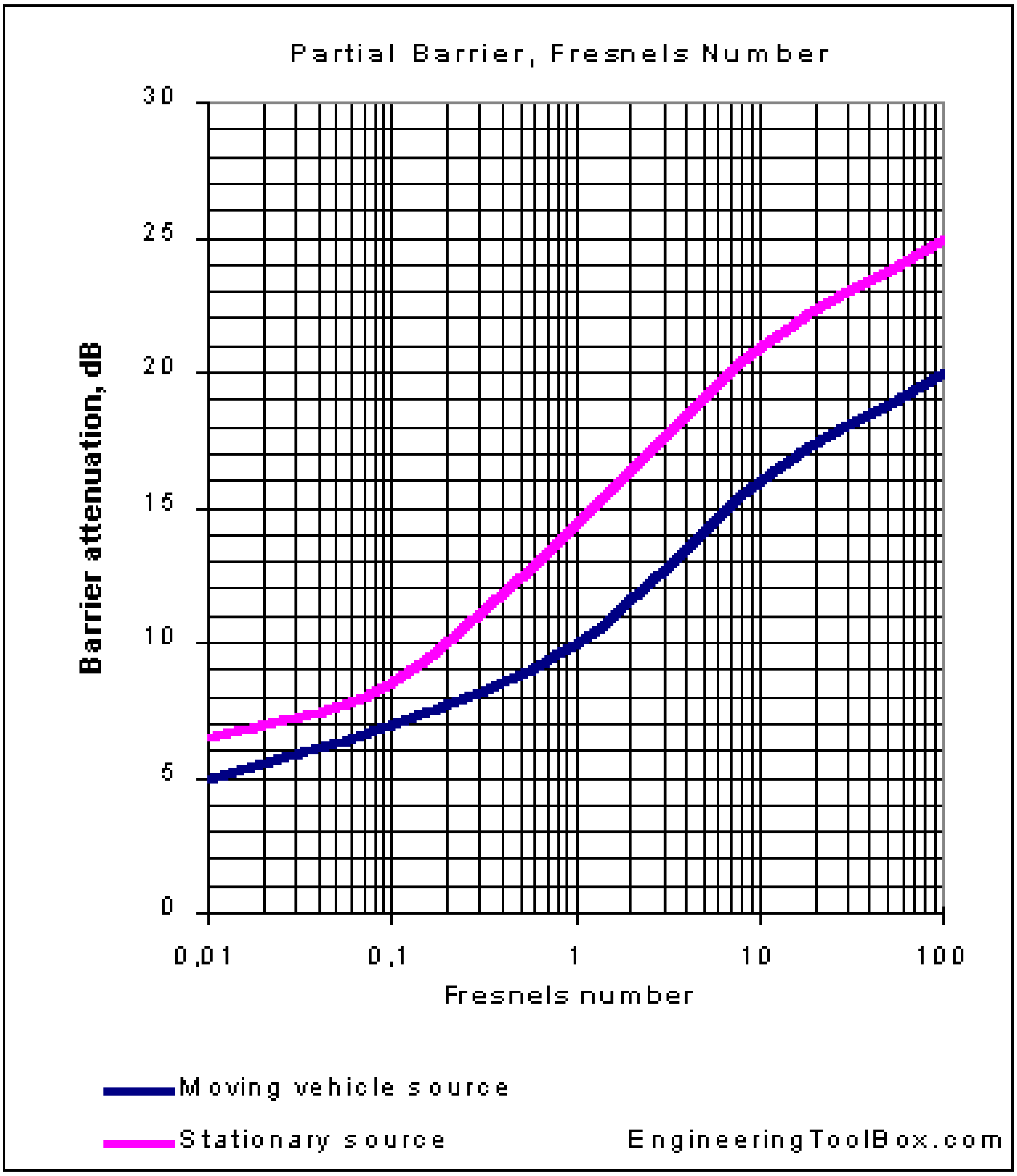


Figure 5.3.3-4 Graph showing relationship of Fresnel number and Noise Attenuation value

Using the above data, substituting the value in Equation (4), the Fresnel number was obtained and investigating the relationship between the Fresnel number and the transmission loss (TL) of 25 dB(A), five meters height is reduced at 30 meters, approximately 21 dB(A) (**Table 5.3.3-8**).

Table 5.3.3-7

Finding Fresnel number and Barrier attenuation from 5 meters tall temporary wall

Distance from source to landmark (meter)	Distance (meter)					Fresnel number	Barrier attenuation, dB
	Source to wall	Wall to landmark	a	b	c		
30	1	29	4.1	29.2	30.0	9.5	21.0
40	10	30	10.8	30.2	40.0	2.8	18.0
50	20	30	20.4	30.2	50.0	1.7	16.0
60	30	30	30.3	30.2	60.0	1.3	16.0
70	40	30	40.2	30.2	70.0	1.2	16.0
80	50	30	50.2	30.2	80.0	1.0	15.0
90	60	30	60.1	30.2	90.0	1.0	15.0
100	70	30	70.1	30.2	100.0	0.9	15.0
110	80	30	80.1	30.2	110.0	0.9	15.0
120	90	30	90.1	30.2	120.0	0.8	15.0
130	100	30	100.1	30.2	130.0	0.8	15.0
230	200	30	200.0	30.2	230.0	0.7	14.0
330	300	30	300.0	30.2	330.0	0.7	14.0
430	400	30	400.0	30.2	430.0	0.6	13.0
530	500	30	500.0	30.2	530.0	0.6	13.0

Remark : a = Displacement from source to the wall's upper edge (meter)

b = Displacement from upper edge of the wall to the receptor (meter)

c = Displacement from source to receptor (meter)

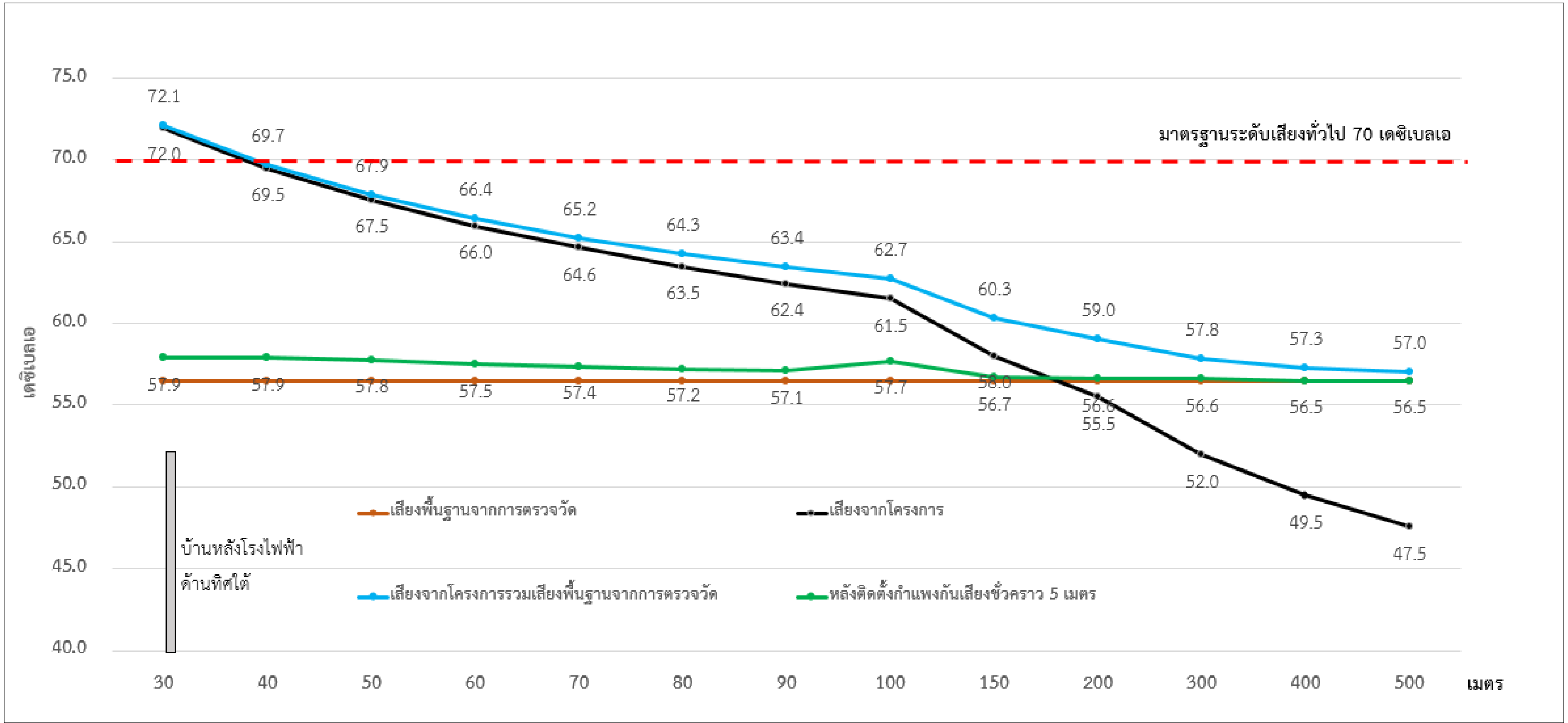
Table 5.3.3-8

Noise level from all the machines at each distance (After installing sound-proof wall)

Distance from the noise source to the landmark (meter)	24 hour average (decibel A) at landmark			
	Before installing sound-proof wall		After installing 5 meter tall temporary sound-proof wall	Assessment result
30	72.1	fail	57.9	pass
40	69.7	pass	57.9	pass
50	67.9	pass	57.8	pass
60	66.4	pass	57.5	pass
70	65.2	pass	57.4	pass
80	64.3	pass	57.2	pass
90	63.4	pass	57.1	pass
100	62.7	pass	57.7	pass
200	59.0	pass	56.6	pass
300	57.8	pass	56.6	pass
400	57.3	pass	56.5	pass
500	57.0	pass	56.5	pass

Remark : Noise level standard for 24 hour should not exceed 70 decibel A according to the Announcement of the National Environment Board No. 15 (B.E. 2540) on regulating regular noises section 32 (5) National Environment Quality Promotion and Conservation Act B.E. 2535 on March 12, B.E. 2540

From considering the total noise level at each distance after installing a temporary sound barrier at a height of 5 meters, it was found that the observation area had a decrease in the 24-hour average noise level. **The 24-hour average noise level is within the ambient noise level standard. The installing of the temporarily soundproof at a height of five meters, causing the highest noise level reduction** as shown in **Table 5.3.3-9** and **Figure 5.3.3-5**. The length or width of the soundproof barrier according to the recommendations of The Federal Highway Administration (FHWA) (2006), suggests that the length of the sound barrier is four times the distance between the sound barrier to the sensitive area. In this regard, when considering the condition of the sensitive area in the south, it was found that there are around 7 houses, the closest houses to the Project area is at a distance of about 30 meters. Hence, the Project shall install a temporary soundproof wall at the south of the Project boundary at a height of five meters from the ground with a length of at least 120 meters or along the project boundary **(Figure 5.3.3-6**) to maintain noise level not to differ from the current conditions.



<u>Figure 5.3.3-5</u> 24 hour average noise level at landmark location

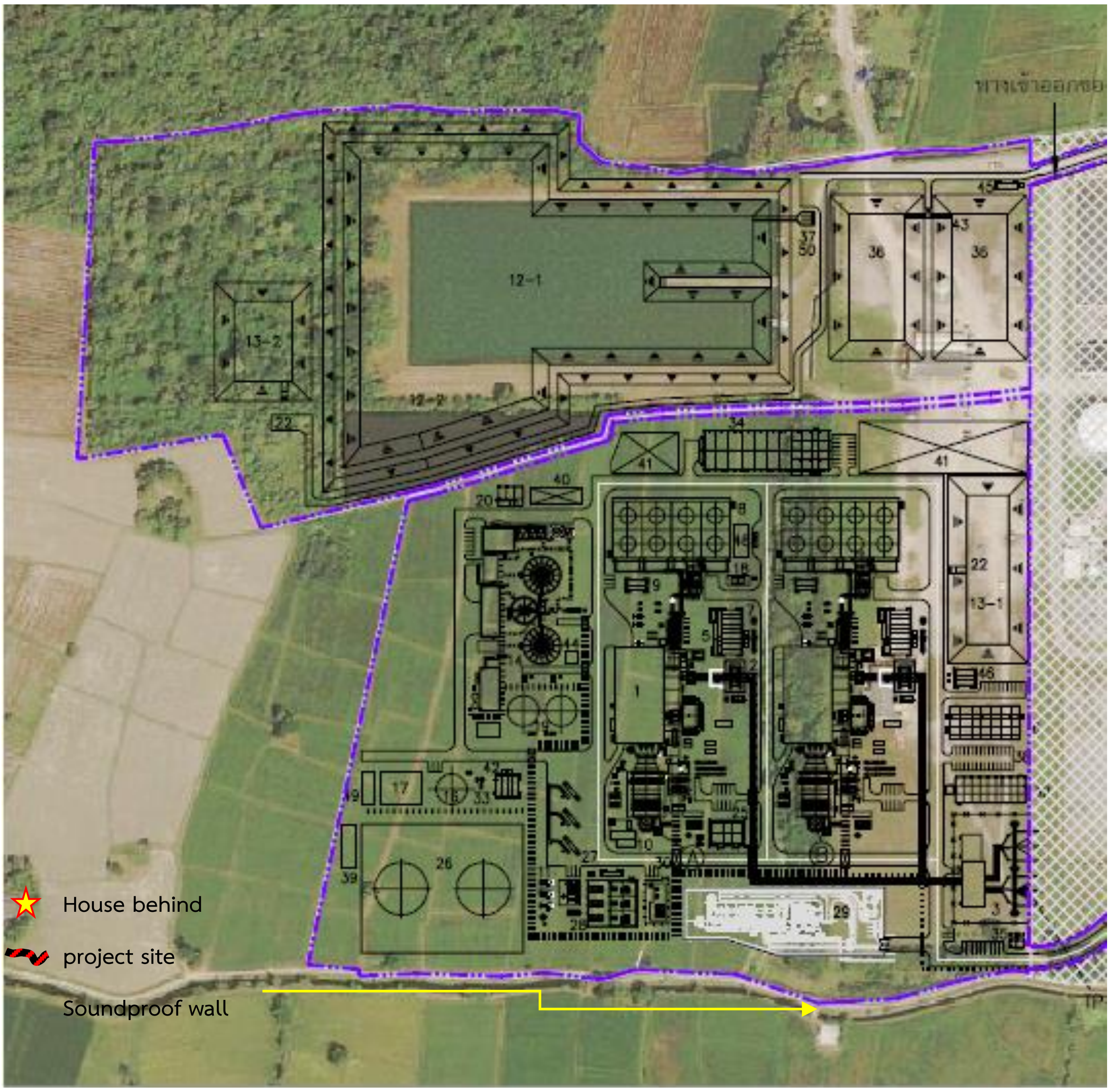


Figure 5.3.3-6 Wall boundary to stop noises

c) Disturbing noise

Assessing the disturbing noise arising from construction activities at the nearest house to the power plant was performed by evaluating impact from the construction activities from 08.00 – 17.00 o'clock at the receptor. It was found that before the implementation of the Project's activities, the noise levels were in the range of -4.7 to 16.4 dB(A) (6 time periods of noise exceeding 10 dB(A) can be summarized as follows:

- In the case that there is no sound barrier (**Table 5.3.3-9**), it was found that the disturbing noise levels in the construction period were in the range of -3.7 to 25.2 dB(A) (60 times of noise exceeding 10 dB(A), and

- In the case that there is an 18 ga steel temporary wall (Table 5.3.3-1), the material is available in the market and is easy to move during construction activities It has a transmission loss (TL) of 25 dB(A) at the height of five meters. It was found that the noise levels at the observation point were in the range of -4.7 to 16.4 dB(A). There will be 6 periods that disturbing noise levels are over 10 dB(A) (which are the same period as before the Project activity). It can be classified as disturbing noise that will remain unchanged from the noise level before the Project development of three periods. The rest of the three periods that the noise levels will be changed of approximately 0.1 dB(A).

Summary of noise impact assessment during the <u>construction period</u>

<u>The 24-hour average total noise level</u>

From the data collected from the measures implementation reports of the TECO Power Plant for five years (2015-2019) and the results of the monitoring conducted by the Consultant during 12-18 February 2019 and 25-31 October 2019, it was found that **the 24-hour average noise levels were within the standards every year**. From the assessing of noise level at the observation points during the Project construction activities by combining noise level that decrease with distance to the sensitive area (the nearest house to the power plant at the distance of 30 meters) with the 24-hour average noise level from the monitoring found that with the installation of a temporary 18 ga steel wall at the height of five meters, **the noise level is within the standard according to the Notification of the National Environmental Board No.15 B.E.2540 (1997) on ambient noise level standard specified that ambient noise level of lower than 70 dB(A).**

<u>The result of the calculation of disturbing noise level</u> at the observation point during construction activities, 08.00-17.00 o'clock found that in the case of installation of a temporary 18 ga steel wall with the height of five meters, the disturbing noise levels are in the range of -4.7 to 16.4 dB(A). Considering the results found that there are six periods that the disturbing noise levels exceed 10 dB(A) (which are the same period before the Project's activities will take place). It can be classified as disturbing noise that will remain unchanged from the noise level before the Project development of three periods. The rest of the three periods that the noise levels will be changed of approximately 0.1 dB(A).

Considering the period where the disturbing noise levels exceed 10 dB(A) found that during that period the 1-hour average noise level ($L_{eq\text{-}1\ hr}$) and the background noise level (L_{90}) of the observation point (the house behind the power plant) are much different. For instance, the 1-hour average noise level ($L_{eq\text{-}1\ hr}$) from 15.00-16.00 o'clock on 25 October 2019 was 52.3 dB(A) and the background noise level (L_{90}) was 33.6 dB(A). The big gap of the noise levels before the Project development resulting in a higher disturbing noise level after combined the noise level from the Project's activities.

However, during the construction period from the land adjustment activity throughout the commissioning, the Project determines to prevent and control the source of the noise. For the preventing of noise at the receptors or the adjacent communities, the Project shall install a soundproof wall by considering the type of the material together with the appropriate height not to cause impact to the adjacent communities. Moreover, the Project shall take safety and engineering operational into account. Despite proper capacity to reduce the noise level to the communities, if the operation is not safe and may cause damage to the permanent wall, the Project shall not consider that option.

Therefore, the Project considered both safety and engineering principles. Hence, the Project shall install a temporary 18 ga steel wall with a height of five meters. The material is available in the market and can be moved easily during construction activities. Construction of a concrete wall before the land adjustment, it may be damaged. The Project interviewed the landlord, age of 64 years old, (two people in the family) graduated in elementary school. He is a Ratchaburi people by birth with the main occupation is a farmer and a secondary occupation is a general contractor. When inquiring about his opinions on the temporary soundproof wall installation measures, it was found that he agreed with the temporary sound protection measures during the construction period and there is no concern if the Project will install a soundproof wall at a height of five meters (he has seen the same kind of the soundproof wall at Ratchaburi Hospital). Hence, there is no concern about safety and obscuring the vision because the area surrounding the house is an agricultural area (rice planting).

<u>Therefore, from the season mentioned above, the Project considered the installation of a temporary wall at the south side by using 18 ga steel. The material is available in the market and easy to move during the construction activities. Moreover,</u>

it has a transmission loss (TL) of 25 dB(A) with a height of five meters from the ground and the length of at least 120 meters or throughout the south side boundary of the Project to prevent disturbing noise to the communities.

However, apart from installing a temporary soundproof wall, the Project shall continuously coordinate with the community (the house behind the power plant) to build a good relationship. Moreover, the Project shall coordinate with community leaders and relevant agencies to support and fix if there is an impact from the Project. In the case that the impact is directly from the Project, the Project shall appropriately compensate.

There, noise impact during the construction period is expected to occur at a moderate level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	2	2	2	(8) = 2	2	4	medium

Table 5.3.3-9

Disturbance levels from construction activities for houses areas behind the power plant (in case of no installation of sound prood wall)

Measurement time period		Measurement value		Reduced Noise level at landmark location	Total noise level from the project's activities	Combined noise level at landmark after adjusting value			Disturbance values [2/]		Assessment result
		Noise level from 1 hour average (Leq-1 hr)	Basic noise level (L90)			After the project		During activities			
						Differences in noise level	Modifier	Noise level-modifier	Before the project	During activities	
		A	B	C	D	D-A	E	F			
25 October 2562											
DAY	08:00-09:00	50.6	35.4	56.5	57.5	6.9	1.0	56.5	8.2	21.1	fail
	09:00-10:00	41.3	32.2	56.5	56.6	15.3	0.0	56.6	2.1	24.4	fail
	10:00-11:00	40.5	31.8	56.5	56.6	16.1	0.0	56.6	1.7	24.8	fail
	11:00-12:00	50.3	32.9	56.5	57.4	7.1	1.0	56.4	10.4	23.5	fail
	12:00-13:00	57.3	43.4	56.5	59.9	2.6	3.0	56.9	6.9	13.5	fail
	13:00-14:00	43.1	32.7	56.5	56.7	13.6	0.0	56.7	3.4	24.0	fail
	14:00-15:00	43.4	33.4	56.5	56.7	13.3	0.0	56.7	3.0	23.3	fail
	15:00-16:00	52.3	33.6	56.5	57.9	5.6	1.5	56.4	11.7	22.8	fail

Table 5.3.3-9(cont)

Measurement time period		Measurement value		Reduced Noise level at landmark location	Total noise level from the project's activities	Combined noise level at landmark after adjusting value			Disturbance values [2/]		Assessment result
		Noise level from 1 hour average (Leq-1 hr)	Basic noise level (L90)			After the project		During activities			
						Differences in noise level	Modifier	Noise level-modifier	Before the project	During activities	
		A	B	C	D	D-A	E	F			
	16:00-17:00	52.6	38.8	56.5	58.0	5.4	1.5	56.5	6.8	17.7	fail
26 October 2562											
DAY	08:00-09:00	57.5	40.5	56.5	60.0	2.5	3.0	57.0	10.0	16.5	fail
	09:00-10:00	46.8	39.7	56.5	56.9	10.1	0.5	56.4	0.1	16.7	fail
	10:00-11:00	45.6	36.3	56.5	56.8	11.2	0.5	56.3	2.3	20.0	fail
	11:00-12:00	54.1	41.1	56.5	58.5	4.4	2.0	56.5	6.0	15.4	fail
	12:00-13:00	41.7	37.5	56.5	56.6	14.9	0.0	56.6	-2.8	19.1	fail
	13:00-14:00	48.4	37.7	56.5	57.1	8.7	0.5	56.6	3.7	18.9	fail
	14:00-15:00	44.9	38.1	56.5	56.8	11.9	0.5	56.3	-0.2	18.2	fail
	15:00-16:00	46.6	39.3	56.5	56.9	10.3	0.5	56.4	0.3	17.1	fail
	16:00-17:00	49.6	43.7	56.5	57.3	7.7	0.5	56.8	-1.1	13.1	fail

Table 5.3.3-9(cont)

Measurement time period		Measurement value		Reduced Noise level at landmark location	Total noise level from the project's activities	Combined noise level at landmark after adjusting value			Disturbance values 2/		Assessment result
		Noise level from 1 hour average (Leq-1 hr)	Basic noise level (L90)			After the project		During activities	Before the project	During activities	
						Differences in noise level	Modifier	Noise level-modifier			
		A	B	C	D	D-A	E	F			
27 October 2562											
DAY	08:00-09:00	45.8	37.5	56.5	56.8	11.0	0.5	56.3	1.3	18.8	fail
	09:00-10:00	45.3	36.7	56.5	56.8	11.5	0.5	56.3	1.6	19.6	fail
	10:00-11:00	44.8	35.3	56.5	56.8	12.0	0.5	56.3	2.5	21.0	fail
	11:00-12:00	48.9	34.4	56.5	57.2	8.3	0.5	56.7	7.5	22.3	fail
	12:00-13:00	58.3	34.9	56.5	60.5	2.2	4.5	56.0	16.4	21.1	fail
	13:00-14:00	47.3	33.7	56.5	57.0	9.7	0.5	56.5	6.6	22.8	fail
	14:00-15:00	43.3	34.9	56.5	56.7	13.4	0.0	56.7	1.4	21.8	fail
	15:00-16:00	44.3	38.3	56.5	56.7	12.4	0.5	56.2	-1.0	17.9	fail
	16:00-17:00	47.3	41.4	56.5	57.0	9.7	0.5	56.5	-1.1	15.1	fail

Table 5.3.3-9(cont)

Measurement time period		Measurement value		Reduced Noise level at landmark location	Total noise level from the project's activities	Combined noise level at landmark after adjusting value			Disturbance values 2/		Assessment result
		Noise level from 1 hour average (Leq-1 hr)	Basic noise level (L90)			After the project		During activities	Before the project	During activities	
						Differences in noise level	Modifier	Noise level-modifier			
		A	B	C	D	D-A	E	F			
28 October 2562											
DAY	08:00-09:00	46.3	36.0	56.5	56.9	10.6	0.5	56.4	3.3	20.4	fail
	09:00-10:00	52.7	34.6	56.5	58.0	5.3	1.5	56.5	11.1	21.9	fail
	10:00-11:00	44.2	34.5	56.5	56.7	12.5	0.0	56.7	2.7	22.2	fail
	11:00-12:00	43.3	34.0	56.5	56.7	13.4	0.0	56.7	2.3	22.7	fail
	12:00-13:00	46.6	33.3	56.5	56.9	10.3	0.5	56.4	6.3	23.1	fail
	13:00-14:00	45.5	33.8	56.5	56.8	11.3	0.5	56.3	4.7	22.5	fail
	14:00-15:00	45.6	34.4	56.5	56.8	11.2	0.5	56.3	4.2	21.9	fail
	15:00-16:00	46.7	36.2	56.5	56.9	10.2	0.5	61.4	3.5	25.2	fail
	16:00-17:00	45.4	38.4	56.5	56.8	11.4	0.5	61.3	0.0	22.9	fail
29 October 2562											

Table 5.3.3-9(cont)

Measurement time period		Measurement value		Reduced Noise level at landmark location	Total noise level from the project's activities	Combined noise level at landmark after adjusting value			Disturbance values [2/]		Assessment result
		Noise level from 1 hour average (Leq-1 hr)	Basic noise level (L90)			After the project		During activities			
						Differences in noise level	Modifier	Noise level-modifier	Before the project	During activities	
		A	B	C	D	D-A	E	F			
DAY	08:00-09:00	48.1	37.4	56.5	57.1	9.0	0.5	56.6	3.7	19.2	fail
	09:00-10:00	51.8	36.3	56.5	57.7	5.9	1.5	56.2	8.5	19.9	fail
	10:00-11:00	57.2	36.3	56.5	59.9	2.7	3.0	56.9	13.9	20.6	fail
	11:00-12:00	41.2	35.2	56.5	56.6	15.4	0.0	56.6	-1.0	21.4	fail
	12:00-13:00	38.5	32.6	56.5	56.5	18.0	0.0	56.5	-1.1	23.9	fail
	13:00-14:00	41.0	33.2	56.5	56.6	15.6	0.0	56.6	0.8	23.4	fail
	14:00-15:00	50.9	36.1	56.5	57.5	6.6	1.0	56.5	7.8	20.4	fail
	15:00-16:00	62.1	59.8	56.5	63.1	1.0	7.0	56.1	-4.7	-3.7	pass
	16:00-17:00	47.9	43.2	56.5	57.0	9.1	0.5	56.5	-2.3	13.3	fail
30 October 2562											
DAY	08:00-09:00	47.4	42.9	56.5	57.0	9.6	0.5	56.5	-2.5	13.6	fail

Table 5.3.3-9(cont)

Measurement time period		Measurement value		Reduced Noise level at landmark location	Total noise level from the project's activities	Combined noise level at landmark after adjusting value			Disturbance values [2/]		Assessment result
		Noise level from 1 hour average (Leq-1 hr)	Basic noise level (L90)			After the project		During activities	Before the project	During activities	
						Differences in noise level	Modifier	Noise level-modifier			
		A	B	C	D	D-A	E	F			
	09:00-10:00	46.5	43.2	56.5	56.9	10.4	0.5	56.4	-3.7	13.2	fail
	10:00-11:00	50.8	43.0	56.5	57.5	6.7	1.0	56.5	0.8	13.5	fail
	11:00-12:00	43.1	35.7	56.5	56.7	13.6	0.0	56.7	0.4	21.0	fail
	12:00-13:00	42.6	35.7	56.5	56.6	14.0	0.0	56.6	-0.1	20.9	fail
	13:00-14:00	62.6	41.1	56.5	63.5	0.9	7.0	56.5	14.5	15.4	fail
	14:00-15:00	40.9	35.6	56.5	56.6	15.7	0.0	56.6	-1.7	21.0	fail
	15:00-16:00	41.8	36.5	56.5	56.6	14.8	0.0	56.6	-1.7	20.1	fail
	16:00-17:00	52.2	40.5	56.5	57.8	5.6	1.5	56.3	4.7	15.8	fail
31 October 2562											
DAY	08:00-09:00	50.8	47.8	56.5	57.5	6.7	1.0	56.5	-4.0	8.7	pass
	09:00-10:00	54.3	47.9	56.5	58.5	4.2	2.0	56.5	-0.6	8.6	pass

Table 5.3.3-9(cont)

Measurement time period		Measurement value		Reduced Noise level at landmark location	Total noise level from the project's activities	Combined noise level at landmark after adjusting value			Disturbance values 2/		Assessment result
		Noise level from 1 hour average (Leq-1 hr)	Basic noise level (L90)			After the project		During activities			
						Differences in noise level	Modifier	Noise level-modifier	Before the project	During activities	
		A	B	C	D	D-A	E	F			
	10:00-11:00	50.3	41.1	56.5	57.4	7.1	1.0	56.4	2.2	15.3	fail
	11:00-12:00	48.9	36.0	56.5	57.2	8.3	0.5	56.7	5.9	20.7	fail
	12:00-13:00	43.9	36.1	56.5	56.7	12.8	0.0	56.7	0.8	20.6	fail
	13:00-14:00	50.0	42.4	56.5	57.4	7.4	1.0	56.4	0.6	14.0	fail
	14:00-15:00	43.4	35.8	56.5	56.7	13.3	0.0	56.7	0.6	20.9	fail
	15:00-16:00	43.0	35.7	56.5	56.7	13.7	0.0	56.7	0.3	21.0	fail
	16:00-17:00	44.6	37.2	56.5	56.7	12.1	0.5	56.2	0.4	19.0	fail
Standard 3/		**70**								**10**	

(5) Operation period

In the assessing of noise impact during the operation period, the Consultant assessed the impact of noise and disturbing noise from the Project's activities at the receptor, south of the Project (the house that locates 30 meters from the boundary of the Project), by considering the measures to reduce noise level including engineering design of the machinery, installing of machine and equipment inside the building, and the installing of a soundproof wall (the Project's fence). The consideration can be divided into two scenarios as follows:

- Scenario 1, noise from the machines such as gas and steam turbines that will be installed in a closed building (without taking into account the reduced noise level by the concrete wall), and

- Scenario 2, the noise level from the south side of the Project by considering the concrete wall with a height of two meters.

Details of the assessment are as follows:

1) Activities of the Project

The main noise generating sources of the Project is from the electricity generation activities. The machines and equipment considered in this assessment are shown in **Figure 5.3.3-7**.

Noise level from Source	Noise level from the machine with 1 meter distance from the source (decibel)
1. Cooling Tower Make up Pump	85
2. Cooling Tower #1	91
3. Cooling Tower #2	91
4. Steam Turbine #1	85
5. Steam Turbine #2	85
6. Generator #1	85
7. Generator #2	85
8. Gas Turbine #1	85
9. Gas Turbine #2	85
10. HRSG #1	85
11. HRSG #2	85
12. Air Compressor #1	85
13. Air Compressor #2	85
14. Gas Compressor Station#1	85
15. Gas Compressor Station#2	85
16. Gas MR Station	85
17. Cooling Water Discharge Pump	85

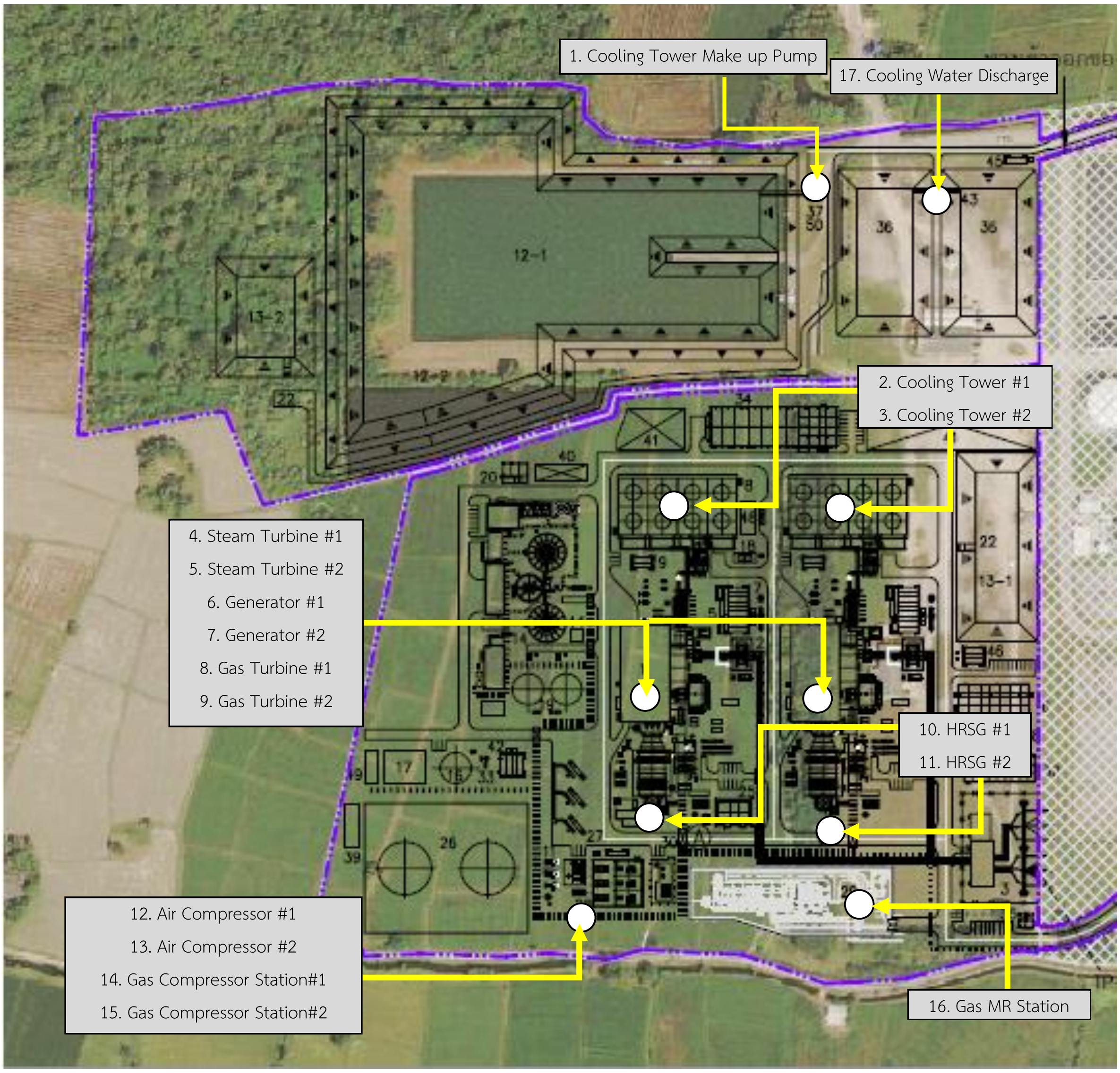


Figure 5.3.3-7 Main noise source of the project

The Project considered using machines and equipment that generate low noise level with the maximum noise level of 85 dB(A) or lower at the distance of one meter from the source except for the cooling tower that generates noise at the level of 91 dB(A) or lower at the distance of one meter.

2) Assessment results

1) 8 and 24-hour average noise levels

Considering noise impacts on the Project's employees found that the machine and equipment used for electricity generating of the Project will not cause a high noise level. In addition, the Project requests employees who work in an area with a high noise level to wear personal protective equipment such as earmuffs and earplugs all the time. The employee will be assigned to work in an area with a noise level higher than 90 dB(A) for not longer than eight hours. Hence, the noise impact on the Project's employee is expected to occur at a low level.

For the noise impact on the sensitive area which is the house behind the power plant with the distance from the machines as detailed in **Table 5.3.3-11,** the Consultant considered the power generating activities which will be operational 24 hours. In the event that all machines are operated at the same time except the control valves and the safety relier values, noise reduction by distance from sources to the receptor can be calculated by employing the following equation.

$$Lp2 = Lp1 - 20 \log (r_2/r_1)$$

For instance, the noise level of cooling tower can be calculated as following:

$Lp1$ = Noise level at the distance of one meter from the source (91 dB(A))

Lp_2 = Noise level at the sensitive area

r_1 = Distance from the source that has been measured for noise level (one meter)

r_2 = Displacement between the source and the sensitive area (the community south side of the source, 340 meters)

Therefore, the noise level of the Cooling Tower Clectrical Package at the house behind the power plant is:

$$= 91- 20 \log (340/1)= 40.4 \text{ decibel A}$$

Table 5.3.3-11

Distance from machines to Impacted Sensitive Receptors

Machine	Machine's noise level with 1 meters distance from the source (dB(A))	Noises from machines inside close door/roof buildings (dB(A))	Distance from sensitive receptors to niose source (m.)	Expected noise[1/] dB(A)	Expected noise reduction from 2 meters soundproof wall[1/] dB(A)
1. Cooling Tower Make up Pump	85	85	530	30.5	15.5
2. Cooling Tower #1	91	91	340	40.4	21.5
3. Cooling Tower #2	91	91	323	40.8	21.5
4. Steam Turbine #1	85	49[2/]	209	2.6	-20.5
5. Steam Turbine #2	85	49[2/]	208	2.6	-20.5
6. Generator #1	85	49[2/]	276	0.2	-20.5
7. Generator #2	85	49[2/]	258	0.8	-20.5
8. Gas Turbine #1	85	49[2/]	214	2.4	-20.5
9. Gas Turbine #2	85	49[2/]	198	3.1	-20.5
10. HRSG #1	85	85	168	40.5	15.5
11. HRSG #2	85	85	173	40.2	15.5
12. Air Compressor #1	85	85	122	43.3	15.5
13. Air Compressor #2	85	85	120	43.4	15.5
14. Gas Compressor Station#1	85	60[2/]	123	18.2	-9.5
15. Gas Compressor Station#2	85	60[2/]	122	18.3	-9.5
16. Gas MR Station	85	85	89	46.0	15.5
17. Cooling Water Discharge Pump	85	85	534	30.4	15.5
Total noise from sources to sensitive receptors[3/] (dB (A))				**51.1**	**26.3**
Standard value[4/] (dB (A))				**70**	

Remark : [1/]calculated from the equation: Lp2 = Lp1 - 20 log (r_2/r_1)

[2/] Machines inside close door/roof buildings made from materials with loss value of 25 decibels A and 36 decibels A (85-25 = 60 decibel A) (85-36 = 49 decibel A)

[3/] calculated from the equation: $Lp_{total} = 10 \log (\sum_{i=1}^{n} 10^{(Lpi/10)})$

[4/] Standard noise level according to the Annoucement of National Environment Board No. 15 (B.E. 2540)

Followed by considering the noise impact from the power generating activities of the Project on the sensitive area by taking into account the existing noise level using the following equation.

$$Lp_{total} = 10 \log \left(\sum_{i=1}^{n} 10^{(Lpi/10)} \right)$$

For instance, assessing the total noise level in the area of the house behind the power plant as follows:

$$\begin{aligned} Lp_{\text{total at houses area behind powerplant}} &= 10 \log (10^{(30.5/10)}+10^{(40.4/10)}+10^{(40.8/10)} \\ &+10^{(2.6/10)}+10^{(2.6/10)}+10^{(0.2/10)}+10^{(0.8/10)} \\ &+10^{(2.4/10)}+10^{(3.1/10)}+10^{(40.5/10)}+10^{(40.2/10)} \\ &+10^{(43.3/10)}+10^{(43.4/10)}+10^{(18.2/10)}+ 10^{(18.3/10)} \\ &+10^{(46.0/10)} +10^{(30.4/10)} \\ &= 51.1 \text{ decibel A} \end{aligned}$$

Nevertheless, electricity generating takes place 24 hours. So, the noise level from the electricity generating activities at the house behind the power plant can be investigated as follows:

$$\text{Leq 24 hr.} = 51.1 + 10 \log (24/24) = 51.1 \text{ decibel A}$$

When considering the noise level from the 24-hour continuous power generation activity in the event that all machines are operated simultaneously, in the case of machines with high noise levels such as gas and steam turbines installed inside the building, etc., when combined with the maximum 24-hour average noise level from monitoring, the noise level at the area of the house behind the power plant is 56.5 dB(A). The total noise level from the source to the sensitive area is 57.3 dB(A). In the case that there is a concrete fence with the height of two meters south side of the Project, when combined with the 24-hour average noise level from the monitoring, the noise level at the area of the house behind the power plant is 56.5 dB(A). The total noise level from the source to the sensitive area is 56.5 dB(A). These noise levels are with the standard in which 24-hour average noise level must not exceed 70 dB(A) as shown in **Table 5.3.3-12**.

Table 5.3.3-12

Estimated result of noise impact on sensitive receptors during operation period

Sensitive Receptors's impacts on noise	Noise level for 24 hour average (decibel A)		
	Electricity generation activity	Highest value from the measurement[1/]	Total noise level
Case 1 Machines with noises inside a closed building	51.1	56.5	57.3
Case 2 2 meters concrete wall	26.3	56.5	56.5
Standard	**70[2/]**		

Remark : [1/]Noise level results of 24 hour average during October 25 -1 November, B.E.2562 from the measurements of ALS Laboratory Group (Thailand) Co.,Ltd , B.E. 2562

[2/] Refer to standard from Annoucement of National Environment Board No. 15 (B.E. 2540) on regulating general noise level.

2) Disturbing noise

The assessment of disturbing noise impact on the people in the sensitive area was performed by considering the Project's activities that the operation is continuously 24 hours. This operational characteristic is classified into the case 1 and 4 according to the manual of disturbing noise level measurement. Therefore, 1-hour average noise levels were used as the representative of the noise level from 07.00-22.00 o'clock, and 5-minute average noise levels were used as the representative of the noise level from 22.00-07.00 o'clock.

By considering the results of 5-minute average noise level (Leq 5 min) and the background noise level (L90) from the monitoring at the area of the house behind the power plant during 24 October to 1 November 2019 by time, day time (07.01-22.00 o'clock) and nighttime (22.00-0.700 o'clock), the disturbing noise assessment can be summarized as follows:

Scenario 1 noise from machines in closed buildings. During the daytime, the disturbing noise level was 19.2 dB(A) while during the night the disturbing noise level was in the non-disturbing range to 16.2 dB(A) (**Table 1** and **Appendix 5-4**). The disturbing noise levels are higher the standard specified that the disturbing noise level must not exceed 10 dB(A) according to the Notification of the National Environment Board No. 29 B.E.2550 (2007) on disturbing noise level standards. However, considering the time with disturbing noise levels greater than 10 dB(A), there were 199 times with 6 disturbance be for the Project development (out of a total of 861-time intervals, which were assigned 1-hour average noise levels to represent the noise level during 07.00-22.00 o'clock and the 5-minute average noise levels were used to represent the noise during the time of 22.00-07.00 o'clock). Every time the disturbing noise level was changed from before the development of the Project. The change has a noise level of approximately 17.5 dB(A).

Scenario 1 the presence of a two meters concrete wall. noise from machines in closed buildings. During the daytime, the disturbing noise level was 16.4 dB(A) while during the night the disturbing noise level was in the non-disturbing range to 12.3 dB(A) (**Table 2** and **Appendix 5-4**). The disturbing noise levels are higher the standard specified that the disturbing noise level must not exceed 10 dB(A) according to the Notification of the National Environment Board No. 29 B.E.2550 (2007) on disturbing noise level standards. However, considering the time with disturbing noise levels greater than 10 dB(A), there were 10 times with 6 disturbance be for the Project development (out of a total of 861-time intervals, which were assigned 1-hour average noise levels to represent the noise level during 07.00-22.00 o'clock and the 5-minute average noise levels were used to represent the noise during the time of 22.00-07.00 o'clock). There were six times of disturbing noise levels that are not changed from before the development of the Project while there were four times disturbing noise levels that are changed from before the development of the Project. The change has a noise level of approximately 3.0 dB(A) (this is due to the adjustment in the calculation for areas that require tranquility and nighttime).

<u>**Summary of noise impact assessment during the operation period**</u>

The Consultant collected data from the environmental impact prevention and mitigation measures and environmental impact monitoring program implementation reports of the 700 MW combined cycle power plant (natural gas) of Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch). Comparison of the monitoring results with the standard according to the Notification of the Ministry of Industry on the determination of noise levels, disturbing noise, and noise levels arising from factory operations B.E. 2548 (2005) and the standards under the Notification of the National Environment Board No. 15 B.E. 2540 (1997) on ambient noise level standards specified that ambient noise level must not greater than 70 dB(A), found that the monitoring results are within the specified standard. The assessing of noise impact during the operation period caused by various activities was performed by considering the noise reduction measures the Project by engineering design, such as the design of noiseless machines, providing a building to cover machinery to reduce the noise level at source, and reduction of noise level at the pathway by providing a fence. , In both cases, the average noise level of 24 hours was found in sensitive areas. **For both cases, it was found that the 24-hour average noise level at the sensitive area, the house behind the power plant, is within the standard.**

For the noise level at the observation point, it was found that in the case of a permanent concrete soundproof wall with a height of two meters, the noise level ranged from -6.4 to 16.4 dB(A). When considering the noise period exceeding 10 dB(A), it was found that there were 10 periods, divided into the unchanged noise from before, there were 6 periods and changed from before there were 4 periods. The change in noise level increased by 3.0 dB(A) occurred from 22.00-07.00 o'clock, due to the adjustment in the calculation of +3.0 dB(A) only in the case of quiet and nighttime areas.

However, the Project has set environmental impact prevention and mitigation measures related to noise in the working area to be implemented during the operation period as follows:

1) For any machinery that generates noise, the Project shall install noise reduction equipment such as Silencer at HRSG,
2) Checks and investigate the performance of Silencer regularly,
3) Provide signs or symbols in areas where the noise level exceeds 85 dB(A),
4) Provide personal protective equipment such as earmuffs or earplugs for employees who work in areas with noise levels higher than 85 dB(A),
5) Specify the area of high noise level such as the boiler area, the combustion chamber of the gas turbine, and the area of gas turbine generators, etc. with warning signs installed and people who will work in the area must wear earplugs or earmuffs, and
6) Manage to prevent employees from being exposed to noise levels for a long time, such as setting a working period to reduce the time that employees are exposed to noise or staff shifting/working day switching for employees who work in a high noise level area.

From the survey of household representatives in close proximity to the Project, it was found that the current environmental impacts from the TECO Power Plant operating with the same activity, most respondents (20 people or 76.9%) are not affected by the noise level. However, some of the respondents (6 people or 23.1%) mentioned they are moderately affected by noise level for some period of time. In addition, they have not complained to any agency.

However, during the operation period, the Project has set noise level reduction measures by employing engineering designing approaches such as design the machine not to generate high noise level, provide a building to cover high noise level machines and install a two-meter height fence at the south side of the Project. In addition, the Project shall continuously coordinate with the community (the house behind the power plant) to build a good relationship. Moreover, the Project shall coordinate with community leaders and relevant agencies to support and fix if there is an impact from the Project. In the case that the impact is directly from the Project, the Project shall appropriately compensate.

Therefore, the noise impact during the operation period is expected to occur at a moderate level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	2	2	2	(8) = 2	2	4	medium

5.3.4 Impact on vibration

The assessment of vibration impacts was performed by considering characteristics that may cause vibration including the distance of the source and origin and source of vibration. Then the calculated vibration levels were compared with the Whiffin and Leonand criteria (details are presented in **Table 5.3.4-1**) to the extent that humans felt the vibration and a higher level of vibration will have an effect on the destruction or damage to the historic site or buildings compared to DIN 4 1 5 0 requirements (details are shown in **Table 5.3.4-2**).

Table 5.3.4-1
Vibration impacts on human and buildings

Peak particle velocity, inch/second (mm/second)	Impact on human	Impact on a building structure
0 - 0.006 (0 - 0.15)	Unable to feel	Does not affect/damage all types of structures
0.006 - 0.012 (0.15 - 0.3)	Possible to feel	Does not affect/damage all types of structures
0.079 (2.0)	Can feel the vibration	The higher the level of vibration will result in the destruction or damage to the archaeological site
0.098 (2.5)	If the vibration continues, it will create a feeling of annoyance	No risk of damage to general buildings or architectural structures
0.197 (5)	The vibrations disturb people living in the building (corresponds to the degree that affects people who are on the bridge and have been exposed for a short time)	The level that will result in damage to the architectural structure, typical houses with plaster walls and ceilings (a mixture of cement, sand, water, and fibers), in the case of flexible walls/ceilings, will be slightly damaged
0.394 – 0.591 (10 - 15)	People will feel dissatisfied if they experience constant vibration and people walking on the bridge will not be able to bear it	The level of vibration is higher than normal traffic, this will cause slightly architectural structural damage and damage to the structure

Source : Whiffin, A.C., and Leonard, D.R., A Survey of Traffic Induced Vibration, Eng., 1971.

Table 5.3.4-2

Vibration requirements on buildings of DIN 4150

Peak particle velocity, inch/second (mm/second)	Impact on building
0.079 (2.0)	No danger even for an ancient building
0.197 (5.0)	Old architectural damage begins to damage
0.394 (10.0)	It is acceptable for dwellings that are in good condition
0.787-1.575 (20.0-40.0)	It is acceptable a factory

Source: Deutsches Institut fuer Normung, Berlin, Germany, DIN 4150-3, Structural Vibration Part 3: Effects of Vibration on Structures, 1999

(1) Construction period

During the construction period, the Project has activities that may cause vibration such as excavation, land reclamation, building construction, etc. However, the level of vibration effect depends on the type of equipment and machinery used and the construction method as well as the distance of the source of vibration and the receptor. Details of the assessment of the impact of construction vibrations on the residences nearby the Project are as follows:

In the calculation of the vibration level from the construction machinery, USEPA data were used to study the magnitude of vibration induced by each type of machinery and equipment while performing construction activities at a distance of 25 feet from the source. **Table 5.3.4-3** shows the reference vibration levels by calculating the level of vibration occurring on the residence on the west side of the Project (the distance of the Project fence to the house is approximately 32 meters as shown in **Figure 5.3.4-1**). The equation of the U.S. Department of Transportation (1998) was used in the assessment.

$$PPV_{equip} = PPV_{ref} \times (25/D)^{1.5}$$

Where: PPV_{equip} = Peak particle velocity caused by the machine at a various distance (inch/second)

$PPVref$ = Reference vibration level at the distance of 25 feet (inch/second)

D = Distance between the machine and the adjacent community (feet)

Table 5.3.4-3

Vibration levels caused from equipments used in 25 feets of the source during construction period

Machines Types	Maximum speed at 25 foot (inch/sec)
1. Digging to lay foundation	0.734
2. Clam Shovel Drop Excavator	0.202
3. Grinding machine	0.008
4. Big sized grader	0.089
5. Chimney drilling machine	0.089
6. Truck	0.076
7. Rock drill machine	0.035
8. Small sized grader	0.003

Source : Transit Noise and Vibration Impact Assessment, 1995

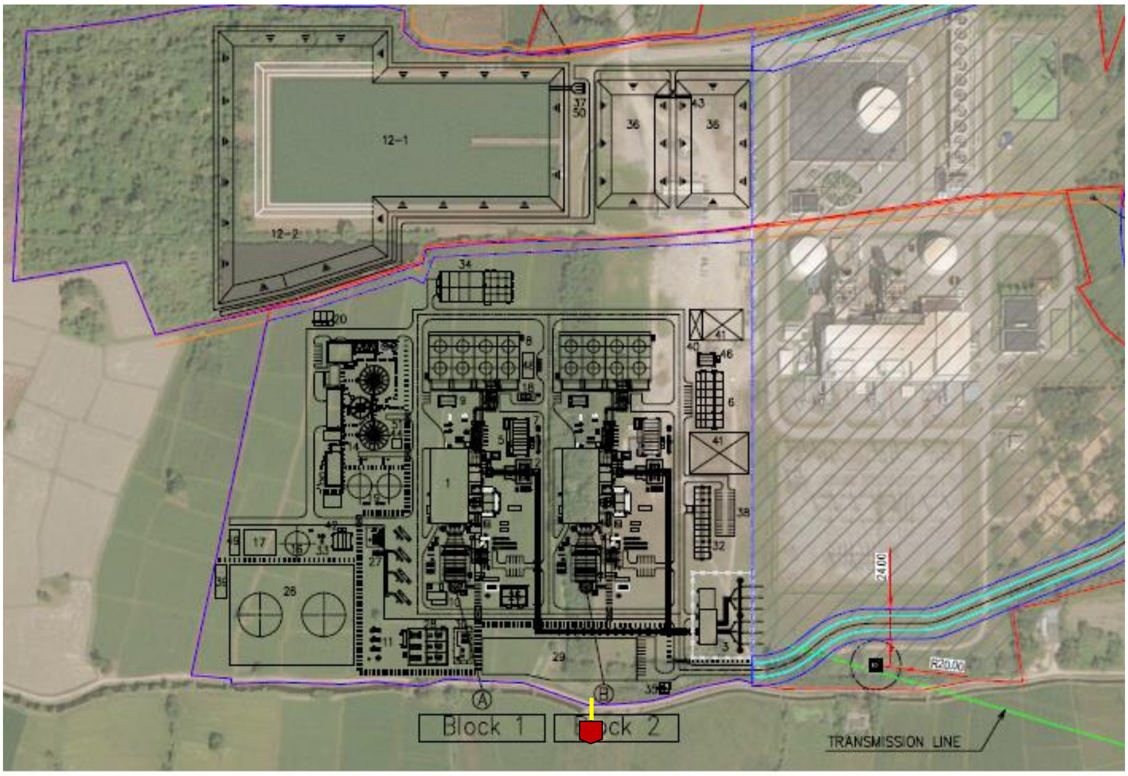


Figure 5.3.4-1 **Location used in assessing vibration impacts**

From **Table 5.3.4-3,** when considering the vibrations arising from activities in the construction period of the Project, it was found that the excavation for the foundation construction was can cause the most vibration to the structures of the nearby households. The peak particle velocity at 25 feet was 0.734 inches/second. So, the Consultant considered the vibration value of the excavation for foundation construction as a source of vibration for construction activities. The activities will be carried out in the building construction area. From **Figure 5.3.4-1**, it can be seen that the construction area is approximately 32 meters or 105 feet from the households. The vibration values can be calculated as follows:

$$PPV_{equip} = 0.734 \times (25/105)^{1.5}$$
$$= 0.0853 \text{ inch/sec or } 0.0034 \text{ millimeter/sec}$$

Comparison of the calculated vibration levels with the Whiffin and Leonand criteria (**Table 5.3.4-1**) found that the vibration level in the residential housing on the south side of the Project was 0.0853 inches/second or 2.1660 millimeters/second. <u>It is the level that humans can feel the vibrations and a higher level of vibration will have an effect on destruction or damage to the historic site</u>. For impacts on buildings compared to DIN 4150 requirements (**Table 5.3.4-2**), the value was found to be near 2.0 millimeters/second. Therefore, it is not at a dangerous level even for the old buildings (ancient buildings). However, drilling operations that can cause such impact will only occur during the construction period. Therefore, the vibration impact is expected to occur at a low level.

<table>
<tr><th rowspan="2">Conclusion</th><th>Size</th><th>Scope</th><th>Duration</th><th>Severity</th><th>Importance</th><th colspan="2">Order of Importance</th></tr>
<tr><td>1</td><td>2</td><td>2</td><td>(4) = 2</td><td>1</td><td>2</td><td>low</td></tr>
</table>

(2) Operation period

Most of the Project activities that can cause vibration are the transportation of chemicals by large trucks. The frequency of transportation is approximately once a month. The Project will avoid transportation in the route that passes through the community. The assessing of vibration impact on the structures of the nearest dwellings considered the peak particle velocity at 25 feet of 0.076 inches/second (**Table 5.3.4-3**). From **Figure 5.3.4-1**, the road area is approximately 30 meters or 98.4 feet from the residential area. The vibration value was calculated as follows:

$$PPV_{equip} = 0.076 \times (25/98.4)^{1.5}$$

$$= 0.0097 \text{ inch/sec or } 0.2472 \text{ millimeter/sec}$$

Comparison of the calculated vibration levels with the Whiffin and Leonand criteria (**Table 5.3.4-1**) found that the vibration level in the residential housing on the south side of the Project was 0.0097 inches/second or 0.2472 millimeters/second. It is the level that humans can feel the vibrations and there is no impact on destruction or damage to any type of buildings. For impacts on buildings compared to DIN 4150 requirements (**Table 5.3.4-2**), the value was found to be lower than 2.0 millimeters/second. Therefore, it is not at a dangerous level even for the old buildings (ancient buildings). Therefore, the vibration impact is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	2	2	(4) = 2	1	2	low

5.3.5 Impacts on surface and groundwater resources

5.3.5.1 Impacts on surface water quality

(1) Construction period

Wastewater from the construction activities of the Project is from two sources, wastewater from consumption of workers and wastewater from the construction activities.

1) Wastewater from consumption of construction workers

Wastewater from the consumption of construction workers will be generated for approximately 240 cubic meters per day (calculated from 80% of the rate of 100 liters of water per person per day x 3,000 construction workers (Kriengsak Udom Sin Roj, 2007)). The Project shall request a contractor to provide toilets for construction workers. The wastewater from toilets will be pre-treated by a ready-made septic tank before sending it to the authorized agencies for disposal.

2) Wastewater from construction activities

Wastewater from construction activities (from washing tools and construction equipment) will be generated approximately 50 cubic meters per day. It will be contaminated with sediment. Therefore, the Project will construct a temporary drainage gutter in the same line with the drainage gutter during the operation period of the Project with a temporary reservoir for sedimentation before using the water for plants watering, road spraying, and wheels washing. The Project will arrange a weekly check of the sedimentation pond to remove sediment and to check water quality every 6 months.

For other activities that may cause contamination, such as the area where the engine oil tank is placed and the maintenance area, the Project shall provide a tray and a temporary roof to prevent rainwater to minimize the chance of contamination with rainwater. Hence, the impact on surface water quality is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	1	(1) = 1	1	1	low

(2) Operation period

1) Source, quantity, and management of wastewater

The wastewater of the Project is divided into 3 sources: 1) wastewater from the consumption of employees, 2) wastewater from the production process which is cooling tower effluent and boiler drainage, and 3) rainwater that may be contaminated with oil. Most of the wastewater to be generated is from cooling tower effluent. In the event of a full load operational using natural gas as fuel, the maximum amount of wastewater will be 6,913 cubic meters per day. However, this category of wastewater has low contamination. In addition, the Project has a sewerage pond to inspect the wastewater quality according to the law before discharging into the Mae Klong River. The details are as follows:

(a) Wastewater from consumption of workers of 30 cubic meters per day will be collected into an anaerobic on-site package sanitary treatment tank, which will be installed at every building, before sending it to the holding pond of the Project.

(b) Wastewater from the production process includes the effluent from the cooling system (cooling water blowdown) of 6,836 cubic meters per day. It will be stored in a reservoir below the cooling tower basin, which can be used as a reservoir to collect wastewater from the cooling tower and reduce its temperature for not less than one day before sending it to the holding ponds. There will be two holding ponds. Each pond has a capacity to store wastewater for not less than one day and also be able to receive wastewater in an emergency. Moreover, the holding ponds will be equipped with a continuous monitoring system for water quality online monitoring before discharging into the Mae Klong River. The parameters include temperature, pH value, and electrical conductivity (to determine total dissolved solids).

(c) Contaminated rainwater (in the case of rain) is wastewater caused by oil contamination from areas such as the transformer area and the area around the diesel fuel storage tank. The oil-contaminated rainwater from the first 15 minutes of rainfall in the area will be collected into the oil-water separator tank. The tank will be designed for oil contamination in the water of not more than 5 milligrams per liter. This is according to the Notification of the Ministry of Natural Resources and Environment B.E. 2559 (2016) on the establishment of industrial wastewater control standards, industrial estates, and industrial zones, and the Notification of the Ministry of Industry on the specification of effluent standard B.E.2560 (2017). After that, it will be sent to the holding ponds. For separated oil, it will be stored in a close 200-liter tank, stored in a waste storage building before sending it for disposing of by an agency authorized by the Department of Industrial Works.

For managing wastewater from cooling water sump in both normal case and in the case where the water quality does not meet the standard, the Project shall manage as follows:

- Wastewater and emergency reservoirs. The drainage water from the cooling system (cooling water blowdown) will be stored in the cooling tower basin, a concrete well. It can be used as a reservoir for collecting wastewater from the cooling tower and reducing temperature. It has the capacity to collect wastewater for at least one day. There are twp holding ponds where wastewater quality will be checked before discharging. Each pond is lined with HDPE and can handle at least one day. The holding ponds are able to receive wastewater in case of an emergency. In addition, there is a continuous wastewater quality online monitoring system to measure the temperature, pH value, and electrical conductivity (to determine total dissolved solids) before discharging into the Mae Klong River.

- Control valves. The main valve system is the 1st valve which closes when the water quality from the cooling tower exceeds the required standard. The 2nd and the 3rd valves are responsible for controlling the water entering the 1st reservoir and the 1st holding pond). The 6th valve opens when the water quality does not meet the standard according to the Notification of the Department of Industrial Works and returns to the 2nd holding pond, which serves as the Project's emergency pond. The 7th valve is responsible for controlling the drainage from the cooling tower if the water quality meets the standards of the Department of Industrial Works before discharging into the Mae Klong River.

2) The Project's wastewater reservoir

The project will drain the treated wastewater that the quality meets the standards through the wastewater collection pipes to the two holding ponds before discharging into the Mae Klong River at the area of the water pumping station of the power plant. The station locates approximately 13 kilometers from the Project. The flow direction of the Mae Klong River is from north to south.

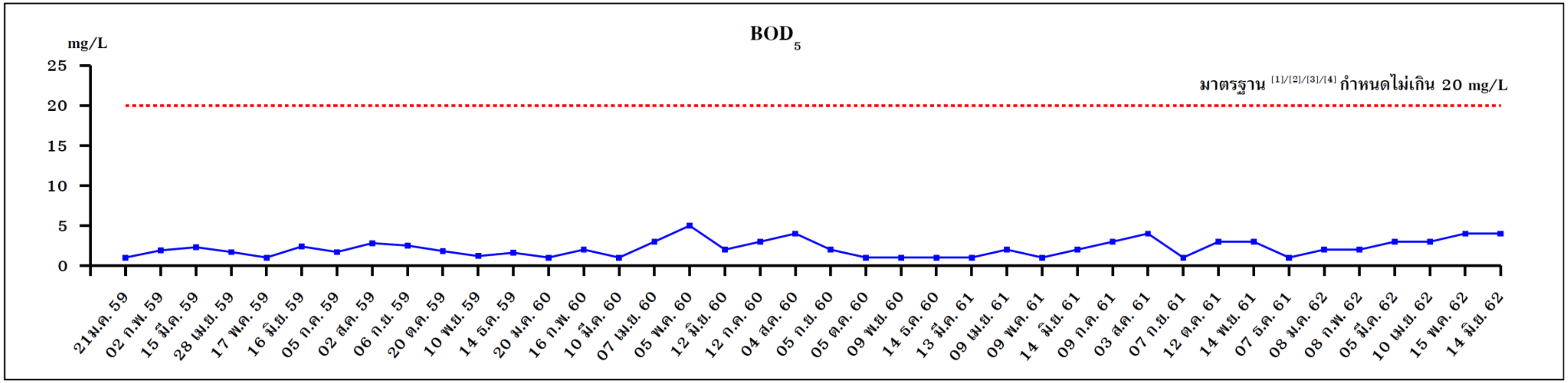
From the socio-economic study that interviewed the heads of households living near the pumping station found that most of the people did not use the water from the Mae Klong River for consumption.

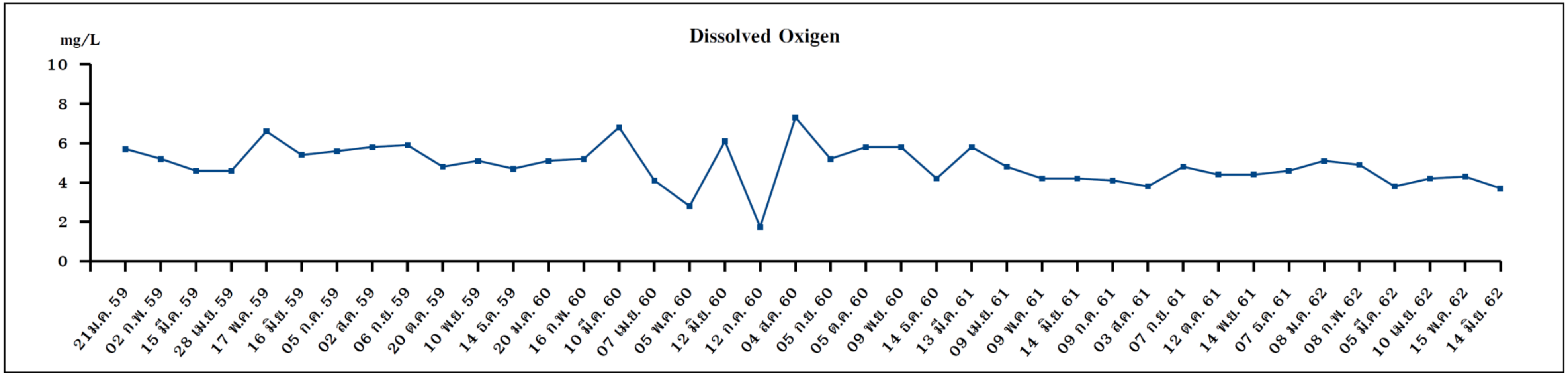
3) Assessment of the mixing of total dissolved solids (TDS)

(a) Data from the monitoring pf the TECO Power Plant

a) Results of wastewater quality in the holding ponds

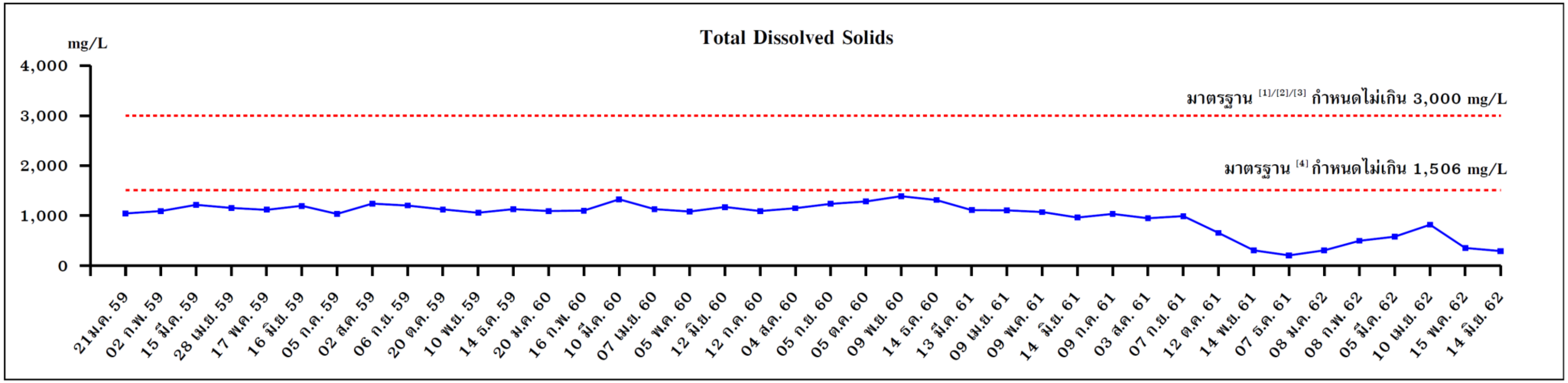
The Consultant collected data on wastewater quality at the holding ponds from the environmental impact prevention and mitigation measures and environmental impact monitoring program implementation reports of the 700 MW combined cycle power plant (natural gas) of Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch) during 2015-2019. It can be observed that the concentrations of BOD_5, DO, TDS, and SS meet the standard according to the Notification of the Ministry of Industry on factory effluent standard B.E.2560 (2017) (details are presented in **Figure 5.3.5-1**).

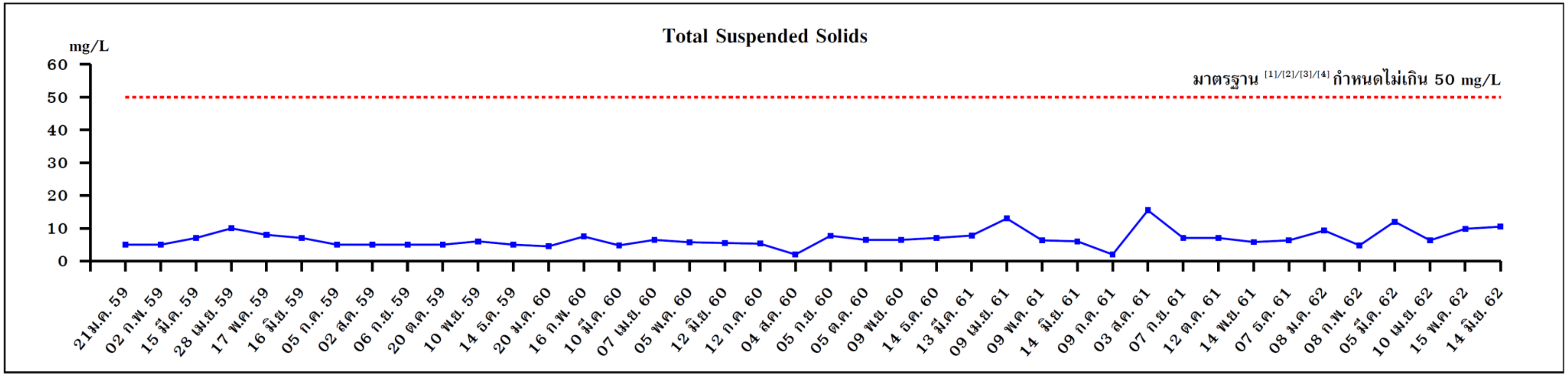




Remark : [1] Values from water quality in treatment system of each part of TECO power plant
[2] Annoucement of Minitry of Industry on regulating waste water emission from factories No. 2 B.E. 2539
[3] Annoucement of Minitry of Industry on regulating waste water emission from factories B.E. 2560
[4] EIA Measures in accordance with Environmental Impact Assessment EIA

Figure 5.3.5-1 Water quality results from wastewater retention pond in TECO Power Plan





Remark : [1] Values from water quality in treatment system of each part of TECO power plant
[2] Annoucement of Minitry of Industry on regulating waste water emission from factories No. 2 B.E. 2539
[3] Annoucement of Minitry of Industry on regulating waste water emission from factories B.E. 2560
[4] EIA Measures in accordance with Environmental Impact Assessment EIA

Figure 5.3.5-1 Water quality results from wastewater retention pond in TECO Power Plant (cont)

Table 5.3.5-1

Analysis results of Surface water quality in Mae Klong River during B.E. 2558-25562

Measurement index	Unit	Year	Water quality testing station										Standard[1/]
			Ban Chong Temple		Bang Li Temple*		Koak Mor Temple		Siriluk Bridge		Wat Kor Area		
			Dry season	Rain season	Dry season	Rain season	Dry season	Rain season	Dry season	Rain season	Dry season	Rain season	
Total Dissolved Solids; TDS	Milligram per liters (mg/l)	2558	166	124	172	122	162	134	226	135	174	174	-
		2559	158	166	176	164	177	165	170	165	170	167	
		2560	124	150	178	150	136	136	112	146	148	158	
		2561	216	130	224	140	208	154	204	158	294	134	
		2562	136	-	138	-	166	-	196	-	172	-	
Total Suspended Solids ; SS	Milligram per liters (mg/l)	2558	6	<5	8	<5	10.0	<5	8	<5	6	<5	
		2559	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	
		2560	7.8	20.7	5	15.3	6.0	10.0	6.3	17.8	8.3	19.8	
		2561	4.3	36	11	39	11.5	30.5	13.8	33.5	13.8	31.5	
		2562	7.3	-	4.3	-	6.0	-	3.8	-	4	-	
BOD	Milligram per liters (mg/l)	2558	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	≤2
		2559	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
		2560	1.8	0.6	1.8	0.8	1.4	1.5	1.3	0.8	1.1	1.2	
		2561	1.3	0.6	1.0	1.3	1.3	1.1	1.1	1.0	1.2	0.8	
		2562	0.7	-	1.2	-	1.1	-	1.3	-	1.1	-	

Measurement index	Unit	Year	Water quality testing station										Standard[1/]
			Ban Chong Temple		Bang Li Temple*		Koak Mor Temple		Siriluk Bridge		Wat Kor Area		
			Dry season	Rain season	Dry season	Rain season	Dry season	Rain season	Dry season	Rain season	Dry season	Rain season	
Dissolved Oxygen : DO	Milligram per liters (mg/l)	2558	4.5	5.2	4.4	5.4	4.1	5.5	4.1	5.7	4.0	5.4	≥4.0
		2559	5.4	5.3	5.5	6.6	5.5	5.5	5.2	6.2	5.3	6.8	
		2560	5.2	5.4	5.3	5.2	5.7	4.5	5.8	5.4	6.0	5.6	
		2561	5.6	6	5.4	5.4	5.2	5.7	5.2	5.9	5.5	6.3	
		2562	5.5	-	5.6	-	2.8	-	5.7	-	5.6	-	

Remark **:** [1/] Annoucement of National Environment Board No. 8 (B.E. 2537) based on National Environmental Support and Conservation Act B.E. 2535 on regulating surface water quality

3rd type: water sources that received waste water from certain activities but can still be used for human consumption and agriculture after disinfection process and water quality treatment process.

ธ = no higher than 3 celcius of its natural temperature

* Measurement station near emission site of the project

b) Results of Mae Klong River water quality

The Consultant collected data on Mae Klong River water quality from the environmental impact prevention and mitigation measures and environmental impact monitoring program implementation reports of the 700 MW combined cycle power plant (natural gas) of Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch) during 2015-2019. The monitoring was conducted twice a year at five monitoring stations i.e., Ban Chong Temple, Bang Li Temple, Khok Mo Temple, Sirilak Bridge, and Koh Temple. The monitoring parameters include total dissolved solids (TDS), total suspended solids (SS), dissolved oxygen (DO), and $BOD_{5.}$ The surface water quality monitoring results are presented in **Table 5.3.5-1**. It can be observed that the concentrations of DO and BOD_5 of every station meet the standard according to the Notification of the National Environmental Board No.8 B.E.2537 (1994) on surface water quality standard (type 3). However, the standard has not been specified for concentrations of total dissolved solids and total suspended solids.

(b) The Project's wastewater

Most of the wastewater from the power plant has a low concentration of BOD, including cooling water blowdown of 6,836 cubic meters per day (approximately 98% of the total wastewater from a total of 6,913 cubic meters per day). The wastewater from the cooling system will be stored in the cooling tower basin below the cooling tower which will be equipped with an online continuous water quality monitoring system to measure the temperature, pH, and electrical conductivity. The wastewater will be sent to the water holding pond where an automatic online monitoring system is installed to measure temperature, pH, and electrical conductivity (to determine total dissolved solids). If the wastewater quality is found to exceed the standard of the Department of Industrial Works (TDS> 3,000 milligrams/liter), the Project will send the wastewater to an emergency pond that can hold wastewater for one day. When the wastewater quality meets the standard, therefore, will be discharged into the Mae Klong River. If the wastewater quality still does not meet the standard, the Project will send wastewater to dispose of outside the project by an agency that is legally authorized.

For wastewater in the holding ponds that the quality meets the standard, the Project will recirculate the wastewater to water the plants in the green area, approximately 50 cubic meters/day. The remaining wastewater will be discharged into the Mae Klong River of approximately 6,913 cubic meters/day (or 0.080 cubic meters/second).

(c) Assessment of the impact on water quality at the wastewater receiving source of the Project

From the water quality monitoring data at the station near the wastewater discharging point of the Project, Bang Li Temple station, it was found that the maximum BOD concentration in the dry season was 1.80 milligrams per liter while it was 1.3 milligrams per liter in the rainy season. Based on the BOD mixing assessment, the Project's effluent into the Mae Klong River will be immediately completely mixed at the point of discharge. It is under the worst-case and dry season when the Project discharges effluent into the Mae Klong River (at the beginning) will result in the BOD concentration at the first mixing point equal to 1.82 milligrams/liter. By comparing the BOD concentrations in the present condition and after the project development, it was found that the BOD concentration at the first mixing point was not different from the value before the Project development. The mixed BOD concentration is similar to the original value (1.80 milligrams/liter) while the DO concentration in the first mixing point is 4.40 milligrams/liter. By comparing the DO concentrations in the present condition and after the Project development, it was found that the DO concentration at the first mixing point is the same as before the Project development (4.40 milligrams/liter). Summary of the calculation of the BOD Mixing and the DO Mixing are presented in **Table 5.3.5-2.** When considered the discharging rate of 0.080 cubic meters/second or 0.13 percent of the water flow rate of the Mae Klong River (59.93 cubic meter/second), it was found that there is no impact on the water quality of the Mae Klong River. Therefore, it is not necessary to assess the water quality impact in terms of BOD Mixing and DO Sag Curve on the Mae Klong River.

Table 5.3.5-2
BOD mixing and DO Mixing of Mae Kong River

Parameter	Unit	Dry season	Rainy season
BOD concentration before discharge from the power plant (current condition)	mg/l	1.80	1.32
BOD concentration at the discharging point of the power plant	mg/l	1.82	1.32
DO concentration before discharge from the power plant (current condition)	mg/l	4.40	5.20
DO concentration at the discharging point of the power plant	mg/l	4.40	5.20

Source : Consultants of Technololgy Co.,L.td, B.E.2563

However, the Project has set measures to monitor wastewater quality in the holding ponds of the Project. The parameters include temperature, pH, electrical conductivity, total dissolved solids (TDS), suspended solids (SS), oil and grease, BOD_5 with a frequency of one time per month.

For assessing the mixing of total dissolved solids, the Project shall control the total dissolved solids content in the effluent using the factory effluent standard according to the Notification of the Ministry of Industry B.E.2560 (2017) on the factory effluent standard. In case of discharging into the water source, total dissolved solids content must not exceed 3,000 milligrams per liter. However, from the water quality monitoring data at the station near the discharge point of the Project, the Bang Li Temple monitoring station, it was found that the maximum TDS content in the dry season was 224 milligrams per liter while it was 164 milligrams per liter in the rainy season.

However, the Consultant calculated the total dissolved solids (TDS) within the Mae Klong River after the Project development, with the following calculation parameters:

Parameter	Unit	Waste water after treatment	Mae Klong River
TDS	mg/l	3,000[1/]	157[2/]
Q (flow)	m^3/s	0.080[3/]	66.24[2/]

Remark : [1/] Standard value in accordance with Annoucement of Ministry of Industry on regulating waste water emission from factories – not exceeding 3,000 milligrams / liters in case of emitting onto water sources

[2/] Average value of runoff amount from Panya Consultants Co.,Ltd

[3/] Q value of Hin Kong Power Plant Project

Based on the above data, total dissolved solids (TDS) content of the Project's wastewater receiving source (Mae Klong River) was calculated using the following equation.

$$TDS_{total} = \frac{(Q_{water\ source} \times TDS_{water\ source}) + (Q_{project} \times TDS_{project})}{Q_{total}}$$

Where: TDS_{Total} = Concentration of TDS in Mae Klong River after wastewater discharging from the Project

$TDS_{Water\ source}$ = Concentration of TDS in Mae Klong River at the Project's discharge point

$TDS_{Project}$ = Concentration of TDS in the Project's effluent (3,000 milligrams/liter), <u>using the standard value in the assessment</u>

Q_{Total} = Flow rate of Mae Klong River (66.24 cubic meter/second, the Project's discharge point)

$Q_{Water\ source}$ = Flow rate of Mae Klong River (66.24 cubic meter/second, before the Project's discharge point)

$Q_{Project}$ = Flow rate of effluent from Hin Kong Power Plant (0.005 cubic meter/second)

$$\text{As such} \quad TDS_{total} = \frac{(66.24 \times 157) + (0.005 \times 3{,}000)}{66.24}$$

$$= 157.23 \text{ milligram/liters}$$

From the calculation of TDS value in Mae Klong River which is a receiving source of effluent from the Hin Kong Power Plant Project, it was found that after the Project discharges effluent into Mae Klong River, the TDS content is 157.23 milligrams per liter. The TDS concentration is lower than the standard. The calculation was performed by using the standard values for factory effluent according to the Notification of the Ministry of Industry B.E.2560 (2017) on the factory effluent standard. Regarding the standard, total dissolved solids (TDS) content must not exceed 3,000 milligrams per liter to prevent impacts on consumption, fisheries, and agriculture.

However, from the water quality monitoring data at the station near the discharge point of the Project, Bang Li Temple monitoring station, it was found that the maximum concentration of TDS in the dry season was 224 milligrams per liter while it was 164 milligrams per liter in the rainy season. Therefore, the Project's effluent is expected to affect the use of water in the Mae Klong River for agricultural purposes at a low level.

4) Assessment of the potential impacts of sodium hypochlorite on primary producers such as aquatic biological resources

The Consultant considered the utilization of the Mae Klong River after the Project's discharge point.

a) Threat and source

Hin Kong Power Plant Project uses 10% sodium hypochlorite to kill germs, prevent algae, and prevent biofilm from occurring in water production systems and cooling tower systems, with a total quantity of 1,000 cubic meters per year.

b) Threat data review

Sodium hypochlorite dissolves in water to form free chlorine and sodium hydroxide (NaOH). Considering the dissolution equation of sodium hypochlorite solution as follows:

$$NaClO + H_2O \longrightarrow HOCl^- + Na^+ + OH^-$$
$$HOCl \longrightarrow H^+ + OCl^-$$

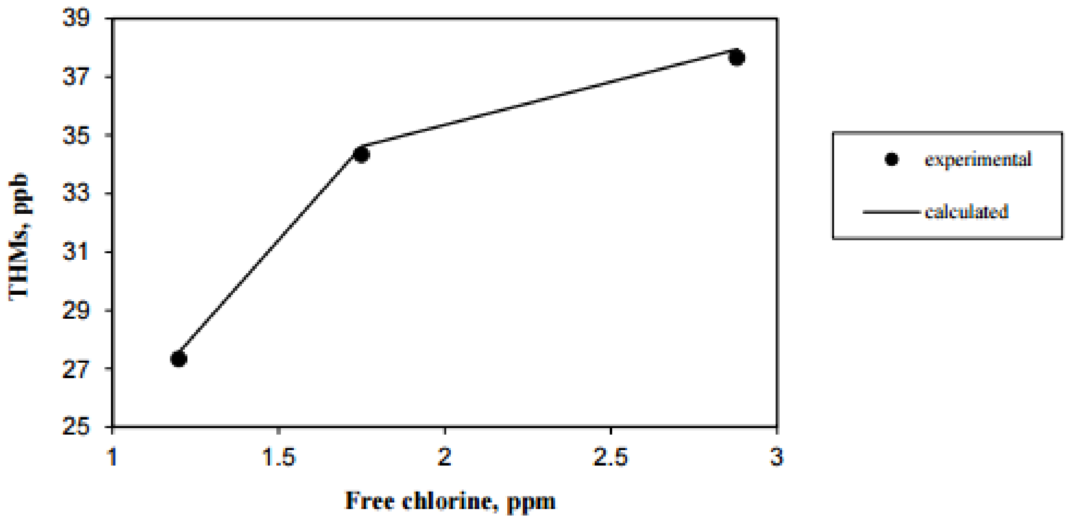
When sodium hydroxide (NaOH), a strong base, reacts with H_2SO_4 in the cooling tower system, sodium sulfate (Na_2SO_4) or epsom salt is the neutral salt will be formed, which is not a toxic substance as shown in the equation.

$$NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O$$

Another form is hypochlorous acid (HOCl) and OCl^-, which depend on the pH of the water, both of which have different properties, HOCl is much more sterilizing than OCl^- because HOCl has a higher oxidizing effect. In addition, OCl^- has an anionic charge, so it cannot bind to cells that have the same anion. HOCl is a non-ionic substance that better binds with all types of cells. HOCl and OCl^- are called free available chlorine, which chlorine can react with dissolved organic compounds to break down and recombine into a group of carcinogens, trihalomethane (THMs).

Factors affecting the generation of trihalomethane (THMs) are summarized into six factors:

- **Content of organic matter in water.** The organic matter in water is a precursor to the formation of THMs. Without organic matter in the water, there would be no precursor that could cause a by-product as THMs. So, in low organic matter content in a water body, there would be less THMs (Stevens, 1976; Trussell, 1978; Babcock., 1979; and USEPA, 1994).
- **Chlorine content** is directly proportional to the formation of THMs in water, that is, if chlorine is added at high concentrations, it will affect the level of THMs in the water (Trussel and Umphres, 1978; and El-Shahat et al., 2001, Kawamura, 1991). However, the addition of chlorine depends on the need for residual chlorine at a sufficient concentration to be disinfected which is depending on the quality of the water. The relationship is shown in **Figure 5.3.5-2.**



(Source : INVESTIGATION OF FACTORS AFFECTING THMs FORMATIONIN DRINKING WATER,MotasemSaidana, Khaled Rawajfehb , ManarFayyadc)

Figure 5.3.5-2 Relationship between free chlorine and THMs occurance

- **The concentration of bromide ion** has a direct influence on the formation of THMs. There are studies showing that the formation rate of THMs varies with the bromide ion concentrations. If the water has a high concentration of bromide ion, the higher the rate of bromodichloromethane (BDCM) and dibromochloromethane (DBCM) formations, as well as the higher THMs formation (Investigating effects of bromide ions on trihalomethanes and developing a model for predicting bromodichloromethane in drinking water, Shakhawat Chowdhury, Pascale Champagne, P. James McLellan, 2009.).
- **pH.** The pH of water affects the formation of THMs in water **(Figure 5.3.5-3).**

* The pH of the water is less than 1, the remaining free chlorine will be in the form of chlorine gas (Cl_2) and will evaporate into the atmosphere

* The pH values in the range of 1-3.5, free chlorine is in the gas phase and HOCl

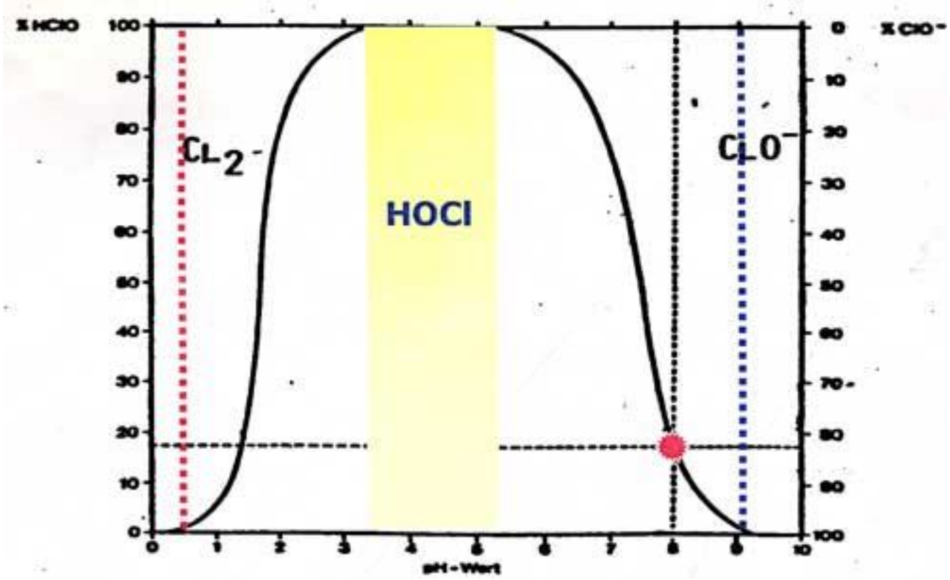
* The pH values in the range of 3.5-5.5, all free chlorine is in the form of HOCl

* The pH values in the range of 5.5-9, free chlorine is in the HOCl and OCl^- forms form

* The pH values above 9, free chlorine is in the OCl^- forms

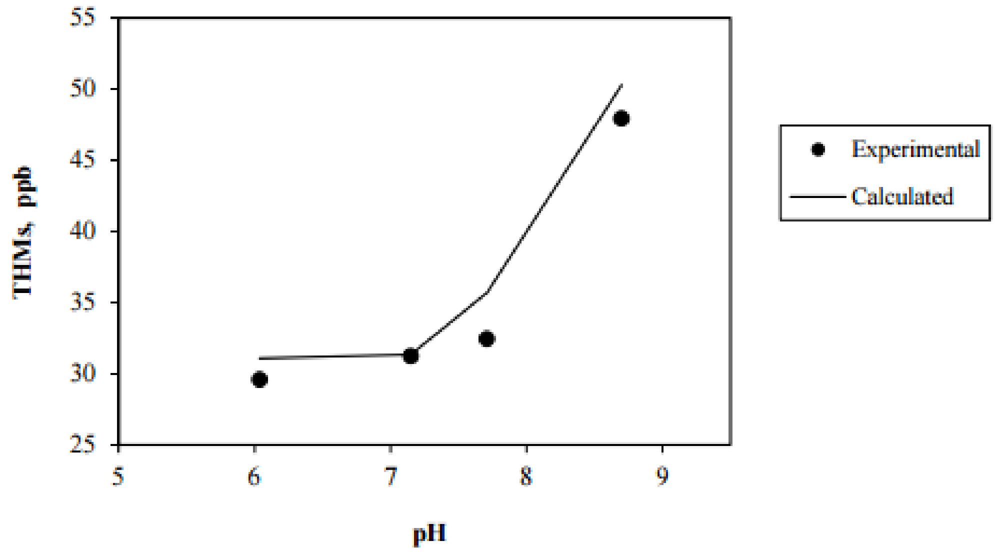
For wastewater discharged from the Project, pH values are in the range of 6.5-8.5 (according to the effluent standard of the Department of Industrial Works), free chlorine is in the form of HOCl and OCl^{-}.

From the literature review, it was found that the pH value can affect the amount of THMs produced, and the increased pH is associated with the increased THMs as shown in **Figure 5.3.5-4**, which is consistent with the results of Steven et al., 1976; and Trussel and Umphres. , 1978, Kawamura (1991), indicating that pH alteration affects functional groups of precursor molecules in THMs formation.



(source : www.mwa.co.th /ewt_dl_link.php?nid=440 search on July 7 B.E. 2562)

Figure 5.3.5-3 Relationship between pH of the water and free leftover chlorine



(Source : INVESTIGATION OF FACTORS AFFECTING THMs FORMATIONIN DRINKING WATER,MotasemSaidana, Khaled Rawajfehb , ManarFayyadc)

Figure 5.3.5-4 Relationship between PH and THMs occurance THMs

- **Reaction Time.** There is research indicated that the increased exposure time to chlorine with water will increase THMs. However, the reaction rate will increase during the first chlorine exposure to the organic matter in water and the reaction rate will gradually decrease (Trussell and Umphres, 1978; Recknow and Singer, 1984; and El-Shahat et al., 2001).
- **Water temperature** has a direct influence on the incidence of THMs, the research indicating that higher water temperature produces more THMs (Stevens et al. (1976; Otson et al., 1981; El-Shahat et al., 2001; Kawamura, 1991). This is because when water temperature increases, the efficiency of chlorine will increase and resulting in better reaction with water-soluble organic substances.

c) Summary of impacts

Regarding the formation factors of THMs, it can be seen that the organic matter in water is a precursor to react with free chlorine. This will vary with the level of THMs. There must be suitable factors for the reaction as THMs i.e., the concentration of organic matter in the water, chlorine concentration in water, bromide ion concentration, pH level, and duration of the reaction as well as water temperature. The optimum factors would lead to high THMs formation.

Hin Kong Power Plant Project uses sodium hypochlorite (NaOCl) in the water cooling system as a disinfectant. The amount of sodium hypochlorite addition of the solution is appropriately controlled to enable efficient disinfection of the water. Including controlling the remaining free chlorine in the effluent to not exceed the standard value according to the Notification of the Ministry of Natural Resources and Environment Announcement on the standard effluent from industry, industrial estate, and industrial zone B.E.2559 (2016) and the Notification of the Ministry of Industry factory effluent standard B.E. 2560 (2017) which have set free chlorine value not more than 1 milligram/liter. Therefore, the Consultant calculated free chlorine content in the Mae Klong River by using the parameters as shown in **Table 5.3.5-3**.

Table 5.3.5-3

Parameters used in the calculation of free chlorine content in Mae Klong River

Parameter	Unit	Waste water after treatment	Mae Klong River
Residual Cl_2	mg/l	<0.1-1[1/]	0.14[2/]
Q (flow)	m^3/s	0.080[3/]	66.24[4/]

Remarks: [1/] The effluent standard according to the Notification of the Ministry of Natural Resources and Environment Announcement on the standard effluent from industry, industrial estate, and industrial zone B.E.2559 (2016) and the Notification of the Ministry of Industry factory effluent standard B.E. 2560 (2017) on industrial effluent standard

[2/] The maximum value from the holding pond

[3/] The Q value of Hin Kong Power Plant

[4/] Average value, considered at the discharge point of the Project

From the above information, the residual chlorine content in the Mae Klong River can be calculated by employing the following equation.

$$Cl_{2\ total} = \frac{(Q_{water\ body} \times Cl_{2\ water\ body}) + (Q_{project} \times Cl_{2\ project})}{Q_{total}}$$

Where: $Cl_{2\ Total}$ = Concentration of free chlorine in Mae Klong River after the Project discharged wastewater

$Cl_{2\ Water\ body}$ = Concentration of free chlorine in Mae Klong River (0.14 milligrams/liter)

$Cl_{2\ Project}$ = Concentration of free chlorine in the Project's wastewater (1.0 milligrams/liter), using the standard value in the assessment

Q_{Total} = Flow rate of Mae Klong River (at the discharge point of the Project (66.24 cubic meters/second))

$Q_{Water\ body}$ = Flow rate of Mae Klong River (after the discharge point of the Project (66.24 cubic meters/second))

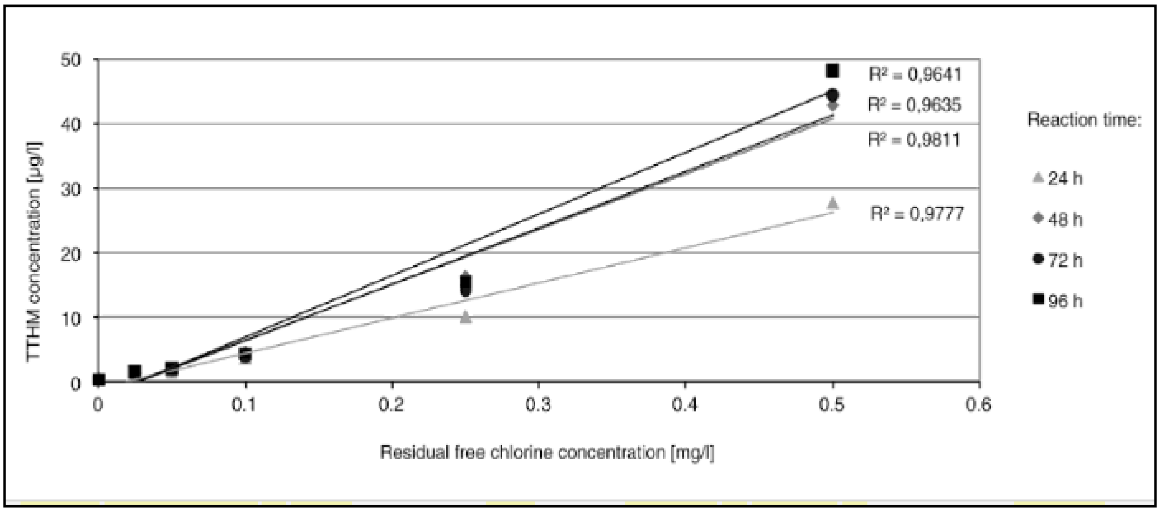
$Q_{Project}$ = Dischargin flow rate of the Project (0.080 cubic meter/second))

$$\text{As such} Cl_{2\ total} = \frac{(66.24 \times 0.14) + (0.080 \times 1.0)}{66.24}$$

$$= 0.14 \text{ milligram/liter}$$

However, free chlorine in water can react with natural organic matter (NOM) present in water to form trihalomethanes (THMs), a carcinogen. The factors affecting the trihalomethane formation are free residual chlorine, organic matter (precursor), contact time, pH, and temperature. Regarding the factors affecting THMs formation above, it can be seen that the organic matter in the water is a precursor to react with free chlorine which will vary with the level of THMs formation. If any of these factors is missing, the formation of THMs will not occur.

From the calculation of the free chlorine content in Mae Klong River, which is the wastewater receiving source of the Hin Kong Power Plant Project, it was found that after discharging the Project's wastewater into Mae Klong River, the residual free chlorine is 0.14 milligrams per liter. When considered together with the graph showing the relationship of THMs with free chlorine content, as shown in **Figure 5.3.5-5** and **Figure 5.3.5-6**, it was found that at the reaction time of 96 hours, the effluent of the project can cause the THMs formation in Mae Klong River, approximately 10.65 micrograms per liter or 0.01 milligrams per liter.



Remark : reaction time at 24 hr; y = 54.691x – 1.0159 (R2 = 0.9777)

reaction time at 48 hr; y = 85.582x – 2.1394 (R2 = 0.9811)

reaction time at 72 hr; y = 87.458x – 2.4114 (R2 = 0.9635)

reaction time at 96 hr; y = 95.284x – 2.6925 (R2 = 0.9777)

Source: Document on Disinfection By-products: Relevance to Human Health, edited by Steve E. Hrudey,Jeffrey W.A. Charrois

Figure 5.3.5-5 Relationship between THMs Occurance and amount of free chlorine

Disinfection By-product	Drinking Water Regulations Parametric Value	World Health Organisation Guideline Value	US EPA Maximum Contaminant Level
Aldehydes			
Bromate	10 µg/l	10 µg/l	10 µg/l
Brominated Acetic Acids		Note 1	
Bromohydrins			
Bromomethanes			
Chloral Hydrate		Note 2	
Chloramines		3 mg/l (Note 3)	4 mg/l (Note 4)
Chlorate		0.7 mg/l	
Chlorite		0.7 mg/l	1.0 mg/l
Chloroacetones		Note 1	
Chloride	250 mg/l		
Chlorophenols		0.2 mg/l (Note 5)	
Chloropicrin		Note 1	
Cyanogen Chloride		0.6 mg/l (Note 2 and 6)	
Dichloramines			
Dichloroacetic Acid		0.05 mg/l	
Formaldehyde		Note 2	
Haloacetic acids	80 µg/l (Note 7)		60 mg/l
Halofurans			
Halogenated Acetonitriles		Note 8	
Iodine		Note 1	
Monochloroacetic Acids		0.02 mg/l	
MX		Note 2	
N-Nitrosodimethylaime (NDMA)		0.1 µg/l	
Trichloroacetic Acid		0.2 mg/l	
Trichloramines			
Trihalomethanes (total)	100 µg/l	Note 9	80 µg/l

Note 1: Available data inadequate to permit derivation of health based guideline values.

Note 2: Occurs in drinking-water at concentrations well below those of health concern.

Note 3: This WHO guideline value relates to monochloramine.

Note 4: This standard is a Maximum Residual Disinfection Level Goal and the Maximum Residual Disinfectant level, expressed as (Cl_2).

Note 5: This WHO guideline value is for 2,4,6-Trichlorophenol.

Note 6: This is a WHO health based value for long term exposure.

Note 7: No guideline value currently exists but this is a value proposed by the European Commission.

Note 8: There are WHO Guideline Values for 2 of the 4 individual acetonitriles – Dibromoacetonitrile (70 µg/l), Dichloroacetonitrile (20 µg/l).

Note 9: There are WHO Guideline Values for the 4 individual trihalomethanes – Chloroform (0.3 mg/l). bromoform (0.1 mg/l), dibromochloromethane (0.1 mg/l) and bromodichloromethane (0.06 mg/l).

Source: EPA Drinking Water Guidance on Disinfection By-prodictsAdvice Note,
Advice Note No.4 Version 2, 2012

Figure 5.3.5-6 Standard on driking-water quality

5) Calculation of the amount of water used to water plants with regard to the infiltration rate

The assessment of the impact of using water from the holding ponds to water the green area of the Project considered the factors of the rate of infiltration rate of soil and the field capacity (FC). The green areas of the Project is approximately 9 rai, 3 ngan, 11 square wa (15,646 square meters), representing 5.18 percent of the total Project area. The calculation is considered only the event where there is no rain. To give the assessment a clear scope, the Consultant used the KC value of mango trees to represent the trees growing in the Project area of 15,646 square meters and assumed that the Project will water the plants only days without rain. Details of the calculation of the water demand of plants in the green area are as follows:

For assessing water consumption in watering plants in the green area of the Project, the Consultant chooses a method to calculate the water consumption of plants using the evaporation potential of the plants or potential evapotranspiration (ETp) and plant water consumption coefficient (Kc) because this method is highly accurate. The calculations are based on local climate data used in the calculation and the method is adopted by the Royal Irrigation Department. The calculation formula is presented below.

$$ETc = ETp \times Kc$$

Where: ETc = Required water consumption for the plant, milliliter/day

ETp = Potential evaporation of the reference plant (by Penman Monteith method) as details shown in **Table 5.3.5-4**, milliliter/day

Kc = Water consumption coefficient of the plant (by Penman Monteith method) as details shown in **Table 5.3.5-5**

Table 5.3.5-4
Amount of water used by ETp
using Potential Evapotranspiration by Penman Monteith method

(unit : millimeter/day)

Province	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ratchaburi	4.04	4.61	5.27	5.15	4.00	3.96	3.57	3.63	3.44	3.39	3.86	4.01

Source : Royal Irrigation Department , 2557

Table 5.3.5-5
Water consumption coefficient of plants in each month (Kc)

Plant	Month												Average
	Jan	Jan	Jan	Jan	Jan	Jan	Jan	Jan	Jan	Jan	Jan	Jan	
Mango	1.44	1.29	1.04	1.06	1.04	1.84	2.06	2.33	2.07	2.12	2.29	1.54	1.60

Source:, Handbook on amount of water used by plants and reference plant and plant coefficient value from Royal Irrigation Department, B.E. 2554

3) Water management for watering green area

The project will plant a perennial plant of approximately 15,646 square meters with plants that follow the above plant selection criteria, such as Ashoka, Indian palm, Dolichandrone Serrulata, and mahogany, and will be covered with ground cover including shrubs and lawns.

For calculations, the Consultant used the KC value of mango trees to represent the plants grown in the project area of 15,646 square meters and required the project to water the plants only on days without rain. Details of the amount of water used for watering plants obtained from the calculation are shown in **Table 5.3.5-6**. The calculation of the water demand of plants in the green area of the Project found that the demand for water is 23,518.26 cubic meters/year and the averages water consumption of plants (ETc) is 64.43 cubic meters/day. The Project's effluent after passing the water quality inspection to comply with the standards of 6,913 cubic meters per day can be sufficiently used for watering in the green area of the Project. In addition, the Project has the policy to maximize the use of the treated wastewater.

From the calculation of monthly water consumption in watering green areas of the Project which calculated the amount of water used to water the green areas only days without rain, it was found that the amount of wastewater of the Project is sufficient for watering the green areas. Therefore, the impact of the wastewater used for watering the plants of the Project is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	2	2	(4) = 2	1	2	low

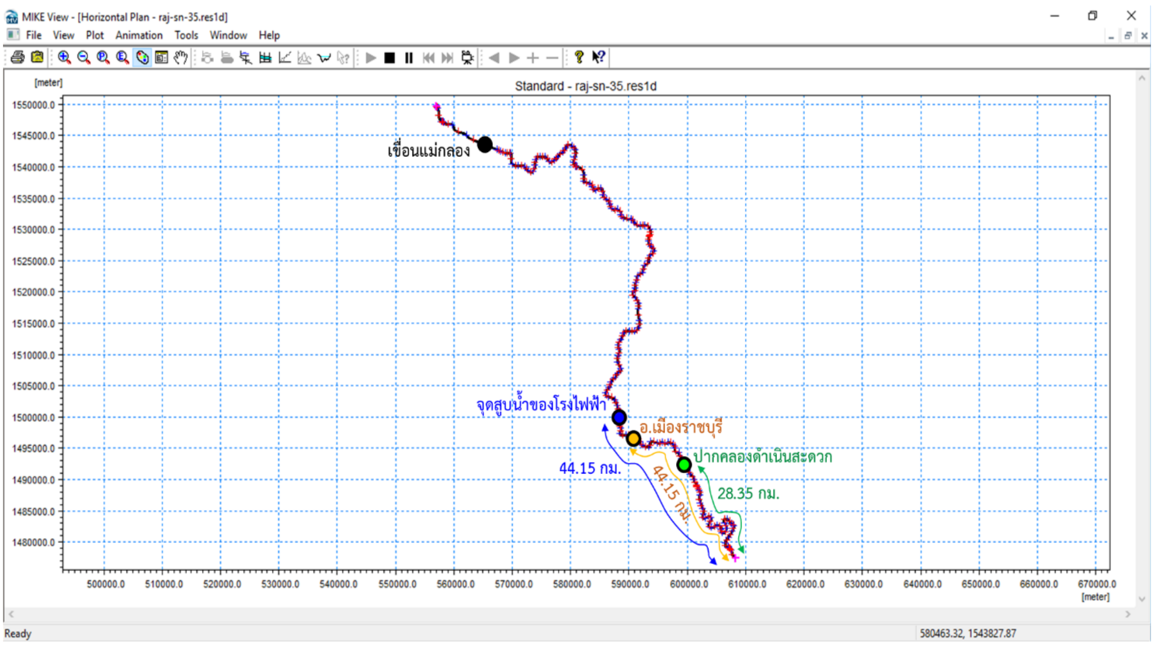
<u>Table 5.3.5-6</u>

<u>Water consumption for watering plants in the green area</u>

List	Month											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Water needs for watering green area, green area ranges 15,646 square meters												
Potential Evapotranspiration: ETp (mm./day)	4.04	4.61	5.27	5.15	4	3.96	3.57	3.63	3.44	3.39	3.86	4.01
Crop coefficient (Kc) based on mango	1.44	1.29	1.04	1.06	1.04	1.84	2.06	2.33	2.07	2.12	2.29	1.54
Crop water usage (ETc) (mm./day)	5.82	5.95	5.48	5.46	4.16	7.29	7.35	8.46	7.12	7.19	8.84	6.18
Total Amount of water used on green area (cubic meter/day)	90.78	92.80	85.53	85.19	64.92	113.70	114.76	131.99	111.12	112.15	137.94	96.37
Days with no rain (refer from statistics from 13 years periodic climate of (B.E. 2549-2561) Ratchaburi Meteorological Station (day/month)	28.4	28.8	26.3	24.8	14.3	13.7	12	12.1	10.2	11.9	23.7	28.1
Water needs calculated from only from plant watering during ‘no rain’ period (cubic meter/ month)	2,578.26	2,672.68	2,249.38	2,112.65	928.31	1,557.75	1,377.15	1,597.02	1,133.42	1,334.59	3,269.15	2,707.92
	Total average amount of water used on green area annually is 23,518.26 cubic meters per year, or 64.43 cubic meters per day											

6) Invasion of seawater

The study of the invasion of seawater was to analyze salinity values in different areas of Mae Klong River, from the downstream of Mae Klong Dam to the Gulf of Thailand to analyze the sufficiency of the remaining water in Mae Klong River from different activities to push the saltwater. The spatial scope of the study is from the downstream area of Mae Klong Dam to the Gulf of Thailand. The cross-sectional figures of the river were collected and put in the set up of the MIKE11 mathematical model developed by the Danish Hydraulic Institute (DHI), Denmark. The MIKE11 mathematical model program set up for this study and the point of determining the salinity are shown in **Figure 5.3.5-7**.



<u>Figure 5.3.5-7</u> Set Up Methematical model MIKE 11 set up for the study of the salt water invasion and the salinity consideration location

The data used to study seawater invasion with MIKE11 model include the following:

(a) River cross-sectional data and the coordinates of the Mae Klong River from the downstream area of Mae Klong Dam to the Gulf of Thailand,

(b) Data on minimum residual water for ecological preservation to push saltwater in the current and future conditions,

(c) Data on seawater level at Samut Songkhram Station which measured by the Marine Department, the location of the Samut Songkhram Station is shown in **Figure 5.3.5-8**, and

(d) Data on average salinity of the Gulf of Thailand of 30 grams/liter.

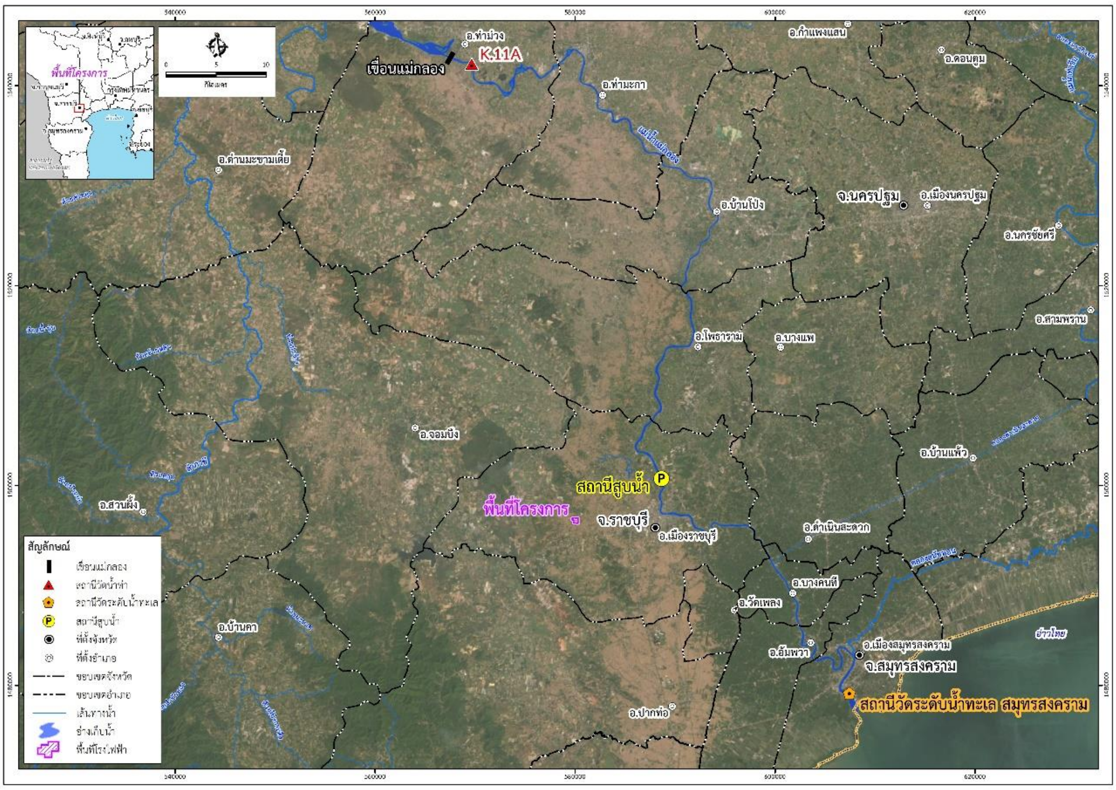
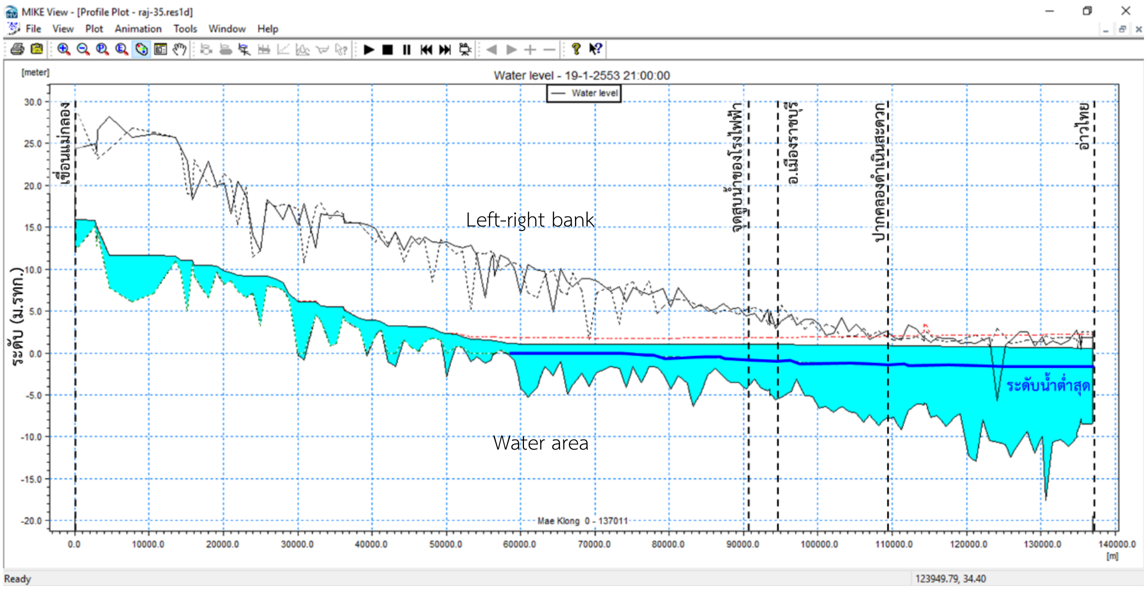


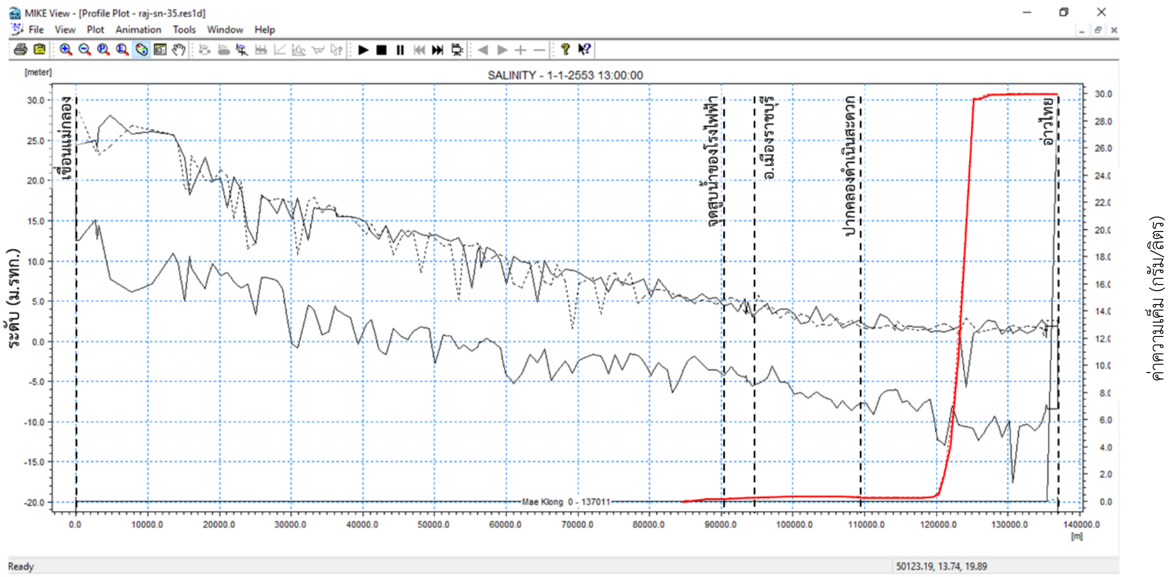
Figure 5.3.5-8 Runoff measurement staion K.11A and water measurement station for Samut Songkram Sea

(a) The results of seawater invasion in the current water usage conditions

The results of the assessment of seawater invasion in current conditions, using the minimum residual water for pushing the saltwater of 35.34 m^3/second, are shown in **Figure 5.3.5-9** and **Figure 5.3.5.-10.**



<u>Figure 5.3.5-9</u> Analysis result of lowest water level in Mae Klong River from current water usage



<u>Figure 5.3.5-10</u> Analysis result of salinity in each location of Mae Klong River from current water usage

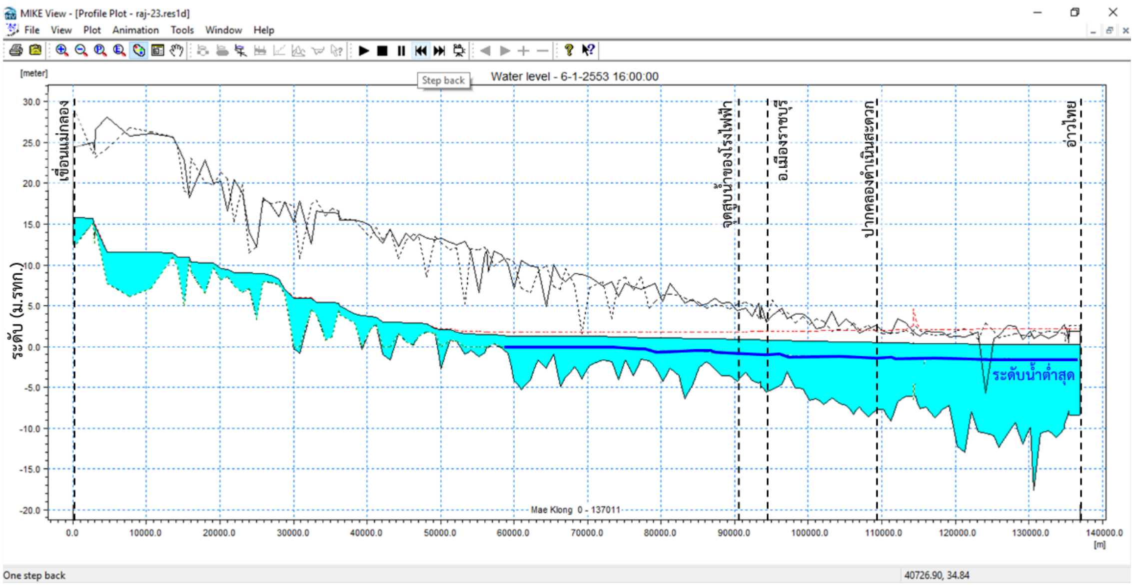
From the analysis results in **Figure 5.3.5-9** and **Figure 5.3.5-10**, it was found that in the current water use conditions, which has the lowest residual water volume for pushing the saltwater of 35.34 m^3/second, the saltwater will poach into Mae Klong River for a distance of about 54 km (about 6 km above the water pumping, at the area of Nong Klang Na Subdistrict Health Station). The area of the Hin Kong Power Plant pumping point will have the lowest water level of about -0.80 m MSL and approximate salinity in the consideration points as follows:

- Downstream of Mae Klong Dam salinity of 0.00 gram/liter
- Pumping point of the power plant salinity of 0.06 gram/liter
- Mueang Ratchaburi District salinity of 0.21 gram/liter
- Damnoen Saduak canal estuary salinity of 0.33 gram/liter
- Mae Klong River estuary (the Gulf of Thailand)
  salinity of 30.00 grams/liter

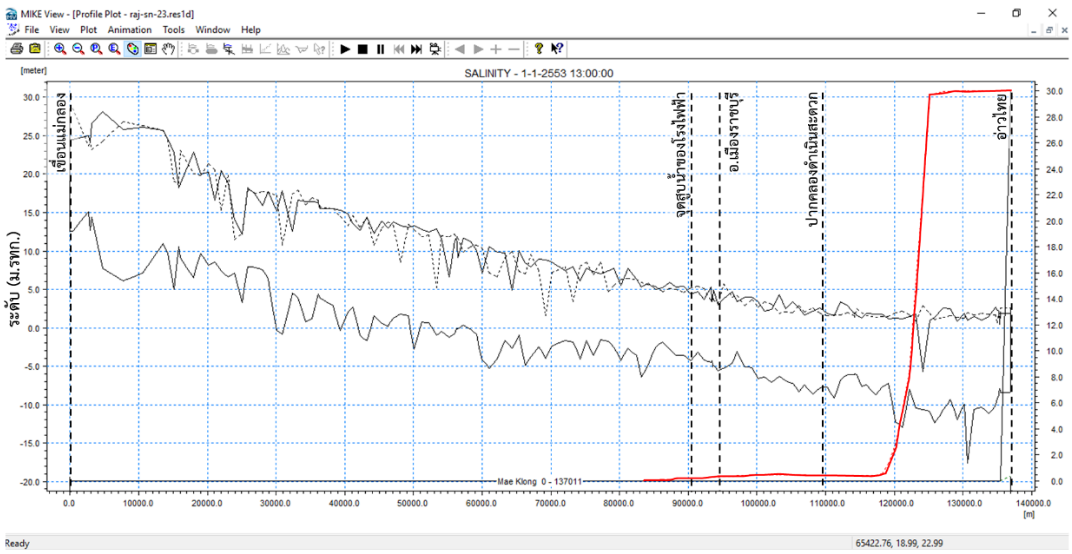
From the above salinity analysis results, it was found that in the area of Damnoen Saduak canal estuary, which was the monitoring point and the control of salinity has a salinity of approximately 0.33 gram/liter, which is lower than the criteria specified by the was Royal Irrigation Department for orchids farming of 0.75 gram/liter and lower than the surveillance criteria for agriculture of 2 grams/liter.

(b) The results of seawater invasion after the development of the Hin Kong Power Plant Project

From the results of the analysis of seawater invasion in the future conditions when the Hin Kong Power Plant will be developed by using the lowest residual water volume for pushing the saltwater of 24.19 m^3/second, the analysis results are presented in **Figure 5.3.5-11** and **Figure 5.3.5-12.**



<u>Figure 5.3.5-11</u> **Analysis results of lowet water level in Mae Klong River from future water usage when the Hin Kong Power Plant is developed**



<u>Figure 5.3.5-12</u> **Analysis results of salinity in each location of Mae Klong River from future water usage when the Hin Kong Power Plant is developed**

From the analysis results in **Figure 5.3.5-11** and **Figure 5.3.5-12**, it was found that in the conditions after the development of the Hin Kong Power Plant, which has the lowest residual water volume for pushing the saltwater of 24.19 m^3/second, the saltwater will poach into Mae Klong River for a distance of about 54 km (about 6 km above the water pumping, at the area of Nong Klang Na Subdistrict Health Station). The area of the Hin Kong Power Plant pumping point will have the lowest water level of about -0.85 m MSL and approximate salinity in the consideration points as follows:

- Downstream of Mae Klong Dam salinity of 0.00 gram/liter
- Pumping point of the power plant salinity of 0.02 gram/liter
- Mueang Ratchaburi District salinity of 0.25 gram/liter
- Damnoen Saduak canal estuary salinity of 0.43 gram/liter
- Mae Klong River estuary (the Gulf of Thailand) salinity of 30.00 grams/liter

From the above salinity analysis results, it was found that in the area of Damnoen Saduak canal estuary, which was the monitoring point and the control of salinity has a salinity of approximately 0.43 gram/liter, which is lower than the criteria specified by the was Royal Irrigation Department for orchids farming of 0.75 gram/liter and lower than the surveillance criteria for agriculture of 2 grams/liter.

(c) Summary of the assessment of seawater invasion

The results of the assessment revealed that although the current and future use of water, after developing of the Hin Kong Power Plant, there will be lesser water quantity for ecological preservation to push saltwater than the criteria set by the Royal Irrigation Department (70 m^3/s). However, the salinity value in the Mae Klong River will not exceed the standard set by the Royal Irrigation Department (2 grams/liter at the Damnoen Saduak canal estuary), which will not affect agriculture. **Therefore, it can be concluded that The development of the Hin Kong Power Plant, which will use the water from Mae Klong River, will not affect the use of water for agriculture, livestock, and consumption, tourism, and industry in the Mae Klong River basin.**

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	1	(1) = 1	1	1	low

5.3.5.2 Impact on groundwater quality

1) Construction period

During construction, groundwater will not be used. Therefore, it has no direct impact caused by the contamination of the wastewater from the construction of the Project which will affect the quality of the groundwater because the Project shall treat the wastewater from the Project construction to meet the standards. Hence, there is no wastewater contaminates the groundwater. Therefore, there is no impact on groundwater quality.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of importance	
	1	1	1	(1) = 1	1	1	low

2) Operation period

The Consultant conducted a groundwater survey of the Project area and the surrounding area of 81 wells and in the nearby area of 3 wells (mention in **Chapter 3 topic 3.1.**7). The data were used in the preparation of the groundwater profile and flow direction analysis. From the results, it was found that the groundwater is stable from the level of 5.00-27.00 meters from the ground. The groundwater wells have s range depth between 51-80 meters. The direction of underground water flow is from the Project area to the northeast. The direction of groundwater flow in the Project and surrounding areas are illustrated in **Figure 5.3.5-13**.

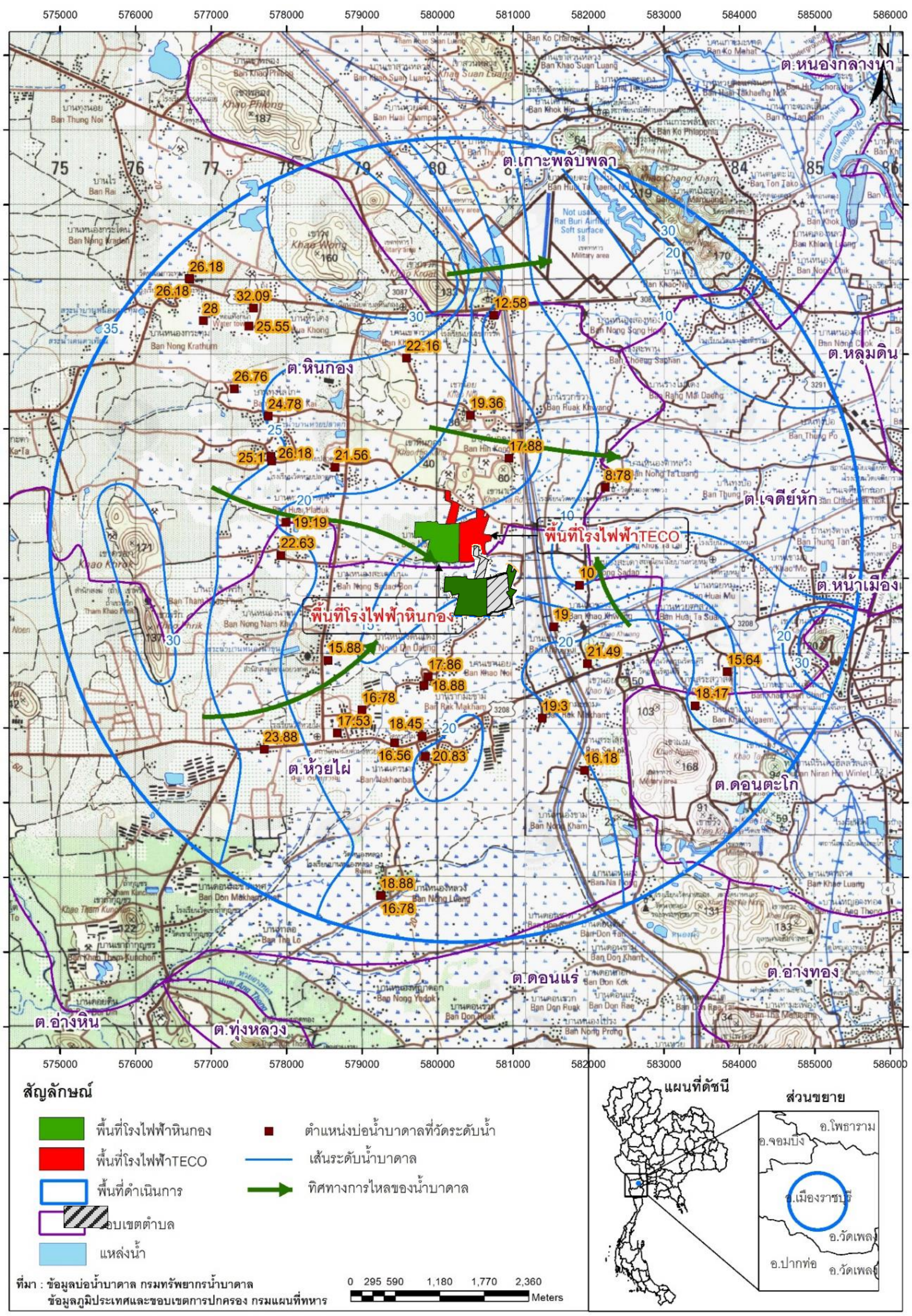


Figure 5.3.5-13 Direction of underground water flow and underground water measurement station in the study area

For the analysis of groundwater quality around the Project area (**Figure 5.3.5-13**) of 3 wells, parameters include pH, turbidity, chloride (Cl), arsenic (As), cadmium (Cd), iron (Fe), lead. (Pb), manganese (Mn), and mercury (Hg) (groundwater analysis results are presented in **Chapter 3**). The results of groundwater quality analysis showed that most of the parameters were no different except for chloride, turbidity, and iron, that the concentrations at some wells were higher than others which can be summarized as follows:

(1) GW1 well, Nong Krathum

From the analysis results, it was found that all parameters meet the groundwater standard for consumption purposes except the amount of coliform which has an inappropriate value.

(2) GW2 well, Arun Rattanakhiri Temple

From the analysis results, it was found that all parameters meet the groundwater standard for consumption.

(3) GW3 well, Ban Nong Kham

From the analysis results, it was found that all parameters meet the groundwater standard for consumption.

However, from the survey of the community area surrounding the Project, it was found that because groundwater has some parameters that exceed the standard, therefore, people who use groundwater improve the groundwater quality before use and use it for consumption only.

In the operation period of the Project, groundwater shall not use groundwater. For the Project's effluent, most of it comes from the cooling water from the production process. Therefore, in order to prevent any impact that may occur on people who use groundwater, the Project, therefore, set measures to build a water quality inspection pond, water holding ponds, and an emergency manhole. All of them are waterproof concrete ponds. Thus, preventing the effects of effluent into groundwater.

The impact on groundwater from the use of effluent to water the green area of the Project was determined by assessing the water infiltration rate. The Consultant collected information from the geographic information system (GIS) of the Royal Thai Survey Department (1997) and the soil series data from the Land Development Department (2004). It was found that most of the Project areas are located in the combined unit of Khao Yoi soil series and Pak Tho soil series. These soil series have the characteristic of loam or sandy loam and the lower soil is sandy loam. The water infiltration rates are shown in **Table 5.3.5-7**.

Table 5.3.5-7

Water's seepage rate through soil

Soil type	Water's seepage rate (mm/hr)	Water's seepage rate (cm/day)
Mold	5-10	12-24
Clay	1-5	2.4-12

Source: http://www.pcat.ac.th/_files_school/00000831/data/00000831_1_20141103-212748.pdf

From the properties of the soil in the study area, the maximum water permeability of the soil series in the Project area is approximately 24 centimeters per day (the Consultant considered to use the value between loam and clay). Therefore, when considered water as a contaminant that accumulates on the soil into the groundwater at a depth of 40 meters (the closest well to the Project), it takes approximately 125 days to goes into the groundwater. However, in fact, the soil will lose its moisture by evaporation and the use of plants.

From the study mentioned above together with the review of data on types and amount of chemicals usage of the Project, it was found that the Project shall not use chemicals that may cause contamination in the Project area according to Appendix 1 attached to the Notification of the Ministry of Industry on "Determination of soil and groundwater contamination criteria, monitoring of soil and groundwater quality, and control and reduction of groundwater contamination reporting B.E.2559 (2016)". Moreover, the Project will keep chemicals in a covered area. In addition, the project does not have any hazardous waste disposal by landfill in the Project area and the water quality inspection pond, water holding ponds, and the emergency manhole are reinforced concrete to prevent leakage problems.

Therefore, from the management approach mention above, the impact of the Project on the groundwater quality is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	3	(3) = 1	1	1	low

5.4 Impact on biological resources

5.4.1 Impact on terrestrial biological resources

(1) Results of the terrestrial biological resource survey

The Consultant conducted a survey on terrestrial resources including forest and wildlife resources in the study area of the Project. The results of the survey can be summarized as follows:

1) Forest resources

The overall land use patterns are quite diverse. Most of them are agricultural areas especially rice fields and livestock. This also includes areas of government agencies where some of the original forests remain. Observation of some outstanding plants shown that the area used to have a deciduous forest (according to the animal husbandry area or areas with shallow soil conditions which is sandy or gravel soil), mixed deciduous and dry evergreen forests (in the limestone mountain area or the forest edge). There is also a deserted area, ponds, roads, and hump areas near the ditch, which still remains a bit of the original plants.

From the survey results, there are 63 families, 178 genera, and 250 species of plants. By considering the nature of the plants found in the survey area, at least 187 native plants were found. Common trees and shrubs throughout the survey area such as *Tectona grandis*, *Pterocarpus macrocarpus, Albizia lebbekoides, Cassia fistula, Buchanania lanzan, Atalantia monophyla*, and *Leucaena leucocephala.* There are also ground plants such as *Azima sarmentosa, Coccinia grandis, Ipomoea aquatica, Olax psittacorum, Aeschynomene indica, and Solanum trilobatum.*

However, some areas have land use patterns as a residential area, roads, ponds, etc. With the nature of the area that is disturbed and transformed by humans, many exotic plants are often found that arise from the cultivation of households, roadside, or grow up by themselves in a deserted area. From the survey, at least 63 exotic plant species were found e.g., *Albizia saman*, *Delonix regia, Muntingia calabura, Tamarindus indica, Plumeria obtuse, Eucalyptus camaldulensis, Jatropha gossypifolia, Tecoma stans, Cereus hexagonus, Mimosa pudica*, *Calotropis gigantea, Cocos nucifera, Areca catechu, Roystonea regia, Wodyetia bifurcate, Crotalaria juncea, Chromolaena odorata, Ruellia tuberosa, Passiflora foetida, and Lantana camara.*

However, this survey did not find a large natural plant society, all plants are not rare or endangered species.

2) Wildlife resources

From the field survey, it was found that the area surrounding the Project within a radius of 5 kilometers is an agricultural area with irrigation canals, making the study area similar to a wetland. There are many forest areas around the Project area, including limestone hills. There is an agricultural community area with rice fields and a forest park next to a degraded forest and urban areas. As a result, there are many ecological characteristics that can be found in a wide variety of wildlife. In this study, a total of 84 species of wildlife were found which can be classified into 53 bird species, 6 reptiles, 7 amphibians, and 18 mammals.

(2) Impact on terrestrial biological resources

The impacts of the Project during the operation period on terrestrial biological resources include impacts on forest and wildlife resources are as follows:

1) Impact on forest resources

Because the Project is in legally documented areas and not in forested areas. Therefore, there is no loss of forest area. Moreover, the operation of the Project has no impact on agricultural areas in which most of them are agricultural areas such as rice fields, livestock areas, etc. There are also urban areas and the area of government agencies. There are wasteland, limestone forest, and some water sources. The Project is in a legally documented area and construction is not undertaken in an agricultural area. Therefore, the impact on forest resources is expected to occur at a low level.

2) Impact on wildlife

The impact of noise and various pollutants from the construction and operation of the Project may disrupt the livelihoods of wildlife. However, as most areas are agricultural areas with irrigated canals, the study area resembles a wetland. There are many forest areas around the Project area, including limestone hills. There is an agricultural community area with rice fields and a forest park next to a degraded forest and urban areas. As a result, there are many ecological characteristics that can be found in a wide variety of wildlife. Therefore, wildlife can migrate to areas that are not affected by the Project. During the operation period, many wildlife can return to the area the Project for both as a habitat and for livelihoods. For migratory birds, they can still return to the neighborhood of the Project, which is similar to the original ecosystem. Therefore, the impact on wildlife is expected to occur at a low level.

Construction and operation of the Project are performed in legally documented areas and not in forested areas. The forest area was found to be spread further away from the Project area and less dense. For the study area surrounding the Project within a radius of 5 kilometers, the area is generally agricultural and urban areas. There is an area of forest (Khao Wang) in the military area. General characteristics are short limestone hills. Most of the wildlife found in the area are not rare or endangered species, such as small finches, shrike birds, grasshoppers, bulldozers, black-tailed squirrels, white-eared bat, etc. The wildlife is animals that have a sparse habitat area or agricultural areas near the community. However, the Project is not operating in forested areas. Therefore, the impact on terrestrial resources is expected to occur at a low level.

<table>
<tr><td rowspan="2">Conclusion</td><td>Size</td><td>Scope</td><td>Duration</td><td>Severity</td><td>Importance</td><td colspan="2">Order of importance</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>(1) = 1</td><td>1</td><td>1</td><td>low</td></tr>
</table>

5.4.2 Impact on aquatic biological resources

(1) Construction period

Construction of the Project may require some heavy equipment to be transported into the construction site. Land adjustment and excavation are performed which the potential to generate dust and dirt. When it rains, it may be washed into a water source, clouding the water and blocking the light and affect the photosynthesis rate of plankton. However, the Project has built a dike around the Project area to prevent and reduce the problem of sediment leaching into nearby surface water bodies. Thus, the impact on aquatic biological resources is expected to occur at a low level.

The main wastewater which will be generated during the construction of the Project is general wastewater from the consumption of construction workers. It is expected that there will be 3,000 construction workers, resulting in about 240 cubic meters of wastewater per day (calculated from 80% of the consumption of 100 liters of water per person per day x 3,000 construction workers, Kriengsak Udomsinroj, 2007). The effluent from toilets will be preliminarily treated by prefabricated septic tanks before sending it to the authorized agencies for disposal. Thus, the impact on aquatic biological resources is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of importance	
	1	1	1	(1) = 1	1	1	low

(2) Construction period

1) Results of the monitoring of aquatic biological resources

The Consultant conducted monitoring of aquatic biological resources include phytoplankton, zooplankton, benthos, and aquatic plants. There were 3 stations in Mae Klong River: Bang Li Temple (BW1), Khok Mo Temple (BW2), and Sirilak Bridge (BW3) in both dry and rainy seasons. Details of the monitoring results can be summarized as follows:

a) Phytoplankton

From the sampling at 3 stations in Mae Klong River, phytoplanktons were found for three divisions i.e, Division Cyanophyta, Division Chlorophyta, and Division Chromophyta. The most common phytoplankton found in the dry and rainy seasons is *Peridinium* sp. and *Oscillatoria* sp., respectively.

b) Zooplankton

From the sampling at 3 stations in Mae Klong River, zooplanktons were found for three phyla i.e, Phylum Protozoa, Phylum Rotifera, and Phylum Arthropoda. The most common zooplankton found in the dry season is *Arcella vulgaris while Difflugia acuminate and Trichocerca pusilla* were commonly found in the rainy seasons.

c) Benthos

From the sampling at 3 stations in Mae Klong River, benthos was found for three phyla i.e, Phylum Annelida, Phylum Arthropoda, and Phylum Mollusca. The most common benthos found in both dry and rainy seasons is the Racing Red and Amphipods.

d) Aquatic animals

From the sampling at 3 stations in Mae Klong River, benthos was found for three phyla i.e, one phylum of the aquatic animal was found which is Phylum Chordata. During the dry season, aquatic animals were found for a total of 4 families, 5 species with a length of 4.50-43.10 centimeters with a total weight of 2,658.69 grams. In the rainy season, aquatic animals were found for a total of 4 families of 6 species with a length of 4.40-31.10 centimeters and a total weight of 1,062.37 grams. The most common aquatic animal in both dry and rainy seasons is Barbonymus schwanenfeldii.

f) Aquatic plant species

From the sampling at 3 stations in Mae Klong River, aquatic plants in the area consist of floating plants and merginal plants. The most common aquatic plants in both dry and rainy seasons are hyacinths and common grass.

2) Wastewater management of the Project

Wastewater of the Project can be classified into four categories as follows:

a) Wastewater from the consumption of employees. It will be collected into the anaerobic on-site package sanitary treatment tank installed at every building before being sent to the holding pond for further analysis of wastewater quality.

b) Wastewater from the production process. It consists of discharge water from a cooling tower with a volume of 6,836 cubic meters per day and the blowdown from the boiler of 192 cubic meters per day.

c) Wastewater from the production support units. It consists of five cubic meters per day of drainage from the chemical laboratory, 100 cubic meters per day of demineralized wastewater, and 121 cubic meters per day from other activities such as water that rinse through the water quality sampling system.

d) Rainwater may be contaminated with oil (in case of rain). From the calculation, it was found that oil-contaminated water is approximately 92 cubic meters per day. It will be collected into the water-oil separator tank to trap oil that is contaminated. The Project designed the system to have an efficiency to separate oil contamination in water to a concentration of less than 5 milligrams per liter. This is according to the Notification of the Ministry of Natural Resources and Environment B.E. 2559 (2016) on the effluent standard for industries, industrial estates, and industrial zones and the Notification of the Ministry of Industry on industry effluent standard B.E. 2560 (2017). After this, oil separated wastewater will be sent to collect in the holding pond. Separated oil will be collected in a 200-liter tank with a tight lid and will be stored in the waste collection building before sending for external disposal by an agency authorized by the Department of Industrial Works.

The total amount of wastewater of the Project is 6,871 cubic meters per day (excluding contaminated rainwater) will be checked for wastewater quality. The parameters are pH, temperature, and electrical conductivity. The automatic measurement tools will be installed at the wastewater quality inspection pond with a capacity of 30 cubic meters to inspect the quality of effluent to meet the standard criteria according to the notification of the Ministry of Industry Notification on industrial effluent standard B.E. 2560 (2017). Later, wastewater will be sent to the holding pond with a capacity of 6,963 cubic meters (can keep wastewater for not less than one day). Wastewater that the quality meets the standard shall be managed by two approaches. The Project will reuse the wastewater for watering plants in the Project area with the maximum amount of 50 cubic meters per day while the rest of 6,913 cubic meters per day will be discharged into the Mae Klong River.

In case the effluent quality does not comply with the specified standard, the water quality monitoring tool will send a signal to switch the drain valve to the emergency sump which has a capacity of 350 cubic meters (can keep wastewater for not less than one day) before sending to the authorized agency by the government for treatment.

3) Impact on aquatic biological resources

The impacts of the Project on aquatic biological resources in the Mae Klong River, which is the effluent receiving a source of the Project, are as follows:

a) Suitability for the livelihood of aquatic biological resources

From the water quality effects assessment in the form of total dissolved solids and BOD mixing of Mae Klong River from the effluent of the Project, the results are summarized as follows

- Calculation of TDS in Mae Klong River, which is an effluent receiving source of the Project, found that after the Project discharges into the Mae Klong River, it will result in the TDS content of 157.54 milligrams per liter. Regarding the standard according to the notification of the Ministry of Industry on industrial effluent standard B.E.2560 (2017), TDS must not exceed 3,000 milligrams per liter to prevent adverse effects on consumption. Fishery, and agriculture, the calculated value of TDS is within the standard.
- Comparison of dissolved oxygen and BOD of Mae Klong River after the development of the Project with the existing conditions found that dissolved oxygen and BOD values at the first mixing point were not different from those before the Project development. Dissolved oxygen and mixed BOD values were similar to the previous values because the Project has control measures to comply with the Notification of the Ministry of Industry. Therefore, the Project's effluent is expected to affect the water quality of the Mae Klong River at a low level.

Therefore, the discharging of the effluent of the Project is expected to affect aquatic biological resources in the Mae Klong River at a low level.

b) The impact of using sodium hypochlorite on primary producer such as aquatic biological resources

The Project uses sodium hypochlorite (NaOCl) in the cooling system as a disinfectant. The amount of sodium hypochlorite usage is appropriate to control disinfection efficiency and maintain the proper amount of free chlorine remaining in the effluent to not exceed the standard according to the Notification of the Ministry of Natural Resources and Environment on the effluent standard for industries, industrial estates, and industrial zones B.E.2559 (2016) and the Notification of the Ministry of Industry on industrial effluent standard B.E. 2560 (2017), which specify the content of not higher than 1 milligram/liter.

The Consultant calculated the amount of free chlorine in the Mae Klong River, which is the effluent receiving source of the Project, it was found that after discharge effluent into the Mae Klong River, the content of free chlorine is 0.14 milligrams per liter. When considering the result together with the graph of the relationship of THMs with free chlorine content, it was found that the water quality of Mae Klong River still has a safe quantity of THMs. Therefore, the impact of using sodium hypochlorite (NaOCl) on aquatic biological resources in the Mae Klong River is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	1	(1) = 1	1	1	low

5.5 Human use values

5.5.1 Land use

(1) Compliance with laws especially the setback that affects the community

The Project is classified as a category 3 factory (a factory with a total horsepower of more than 50 horsepower and/or a workforce of more than 50 people or a factory that causes pollution or a factory that must receive a license before setting up a factory). According to the Ministerial Regulation No. 2, B.E. 2535 (1992) issued under the Factory Act, B.E. 2535 (1992), there are prohibitions apply to establish category 3 factories as follows:

(1) Housing estates, condominiums, and townhouses for residential purposes, and

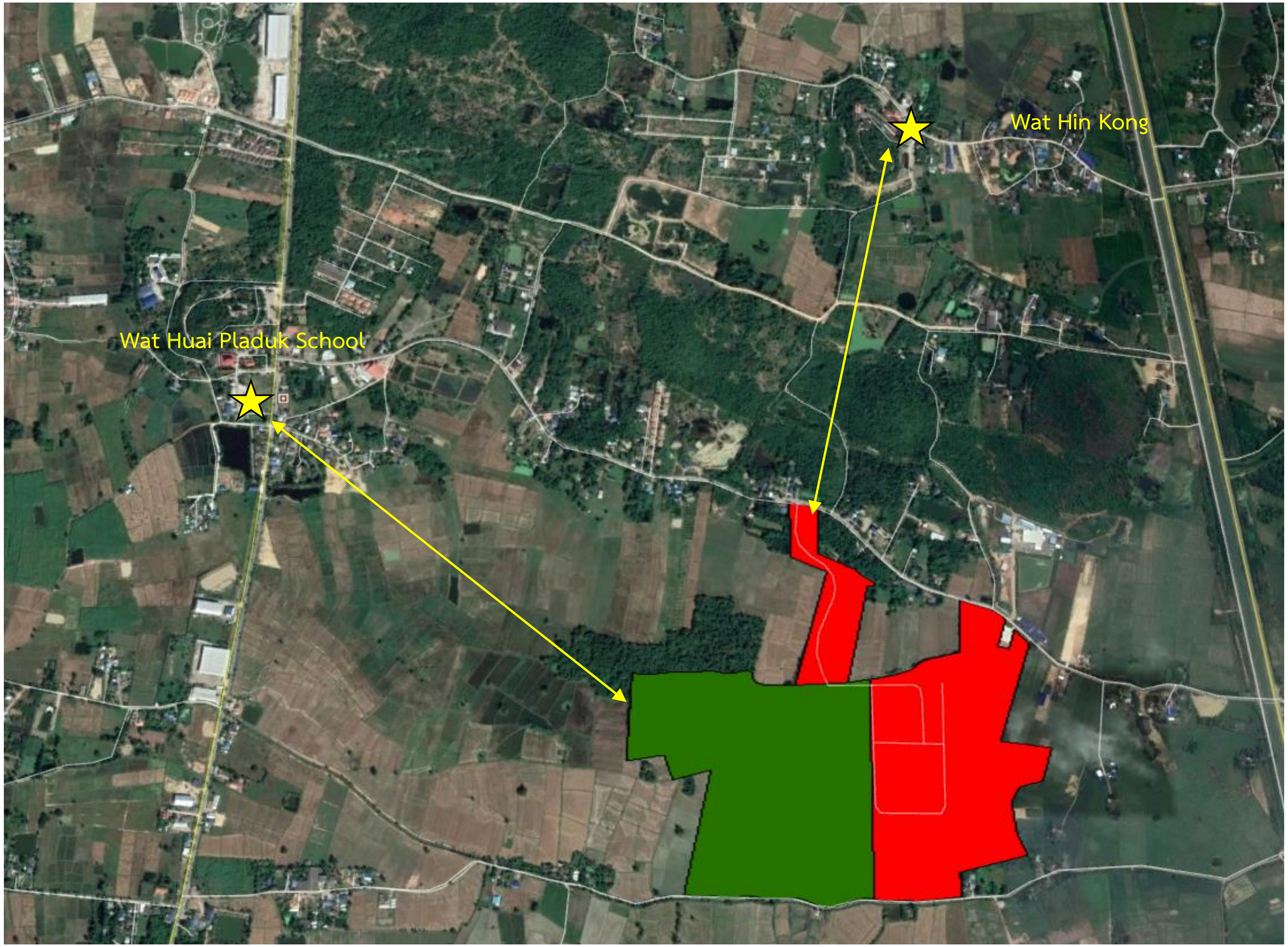
(2) Within 100 meters from the boundary area of public places such as schools or educational institutions, temples or religious establishments, hospitals, archaeological sites, and offices of government agencies including natural resource and environmental conservation resources, as determined by the Cabinet.

From inspecting the Project location and surrounding areas, it was found that the closest public places are Wat Huai Pladuk School, with a distance of 1.7 kilometers and Hin Kong Temple with a distance of approximately 1.75 kilometers, as shown in **Figure 5.5.1-1**. So, it does not contradict such requirements. Therefore, it can be concluded that the operation of the Project has a low impact.

(2) Compliance with city planning requirements

From the inspection of the Project area according to the city plan of Ratchaburi Province, 2012, it was found that the land plot in the Project area locates in Hin Kong Subdistrict, Mueang Ratchaburi District, Ratchaburi Province is under the city plan of Ratchaburi Province on the category of community and agricultural land. According to the land use category, the land can be used for agriculture, residential, educational institutions, religious institutions, government institutions, and public utilities. The Notification of the Ratchaburi Province City Plan (No.2) issued on 4 December 2015 of There is a total city plan announcement (No. 2) announced on December 4, 2015, has expired on 29 May 2017. However, the city plan has specified types of factories in which a combined cycle power plant (only non-coal and nuclear-fired operations) can be operated on communal and agricultural land. Therefore, the Project operation is not contrary to the Notification of the Ratchaburi City Plan (No. 2).

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	3	(3) = 1	1	1	low



<u>Figure 5.5.1-1</u> Public Area around project site

5.5.2 Transportation

The COnsultant has assessed the impact on the transportation during the construction and operation periods on the Highway No. 3207, Highway No. 3208, Rural Highway Kor Jor 4004, and the main road in front of the power plant (**Figure 5.5.2-1**). The assessment was performed by investigating the traffic volume by focusing on the volume capacity ratio under the following conditions (the Analysis Report of Traffic Congestion Index and Traffic Congestion Year 2018, Office of Safety Administration, Department of Highways, March 2019).

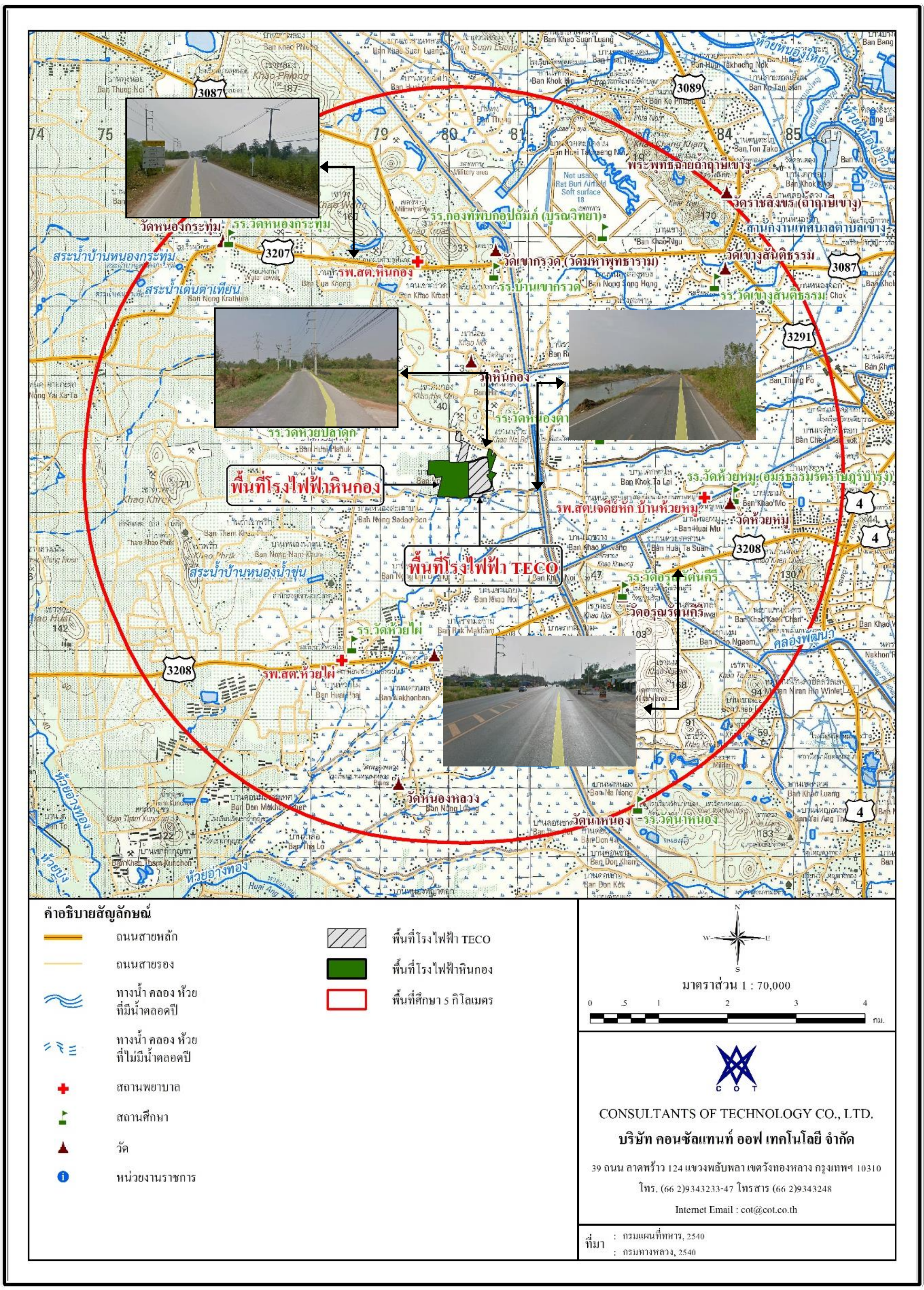
$$\boxed{\text{Traffic index} = V/C}$$

Where: V = The traffic volume on the highway during peak hours
C = The capacity of the highway

(1) Calculation of the traffic volum into passenger car unit

The data used in this analysis were from the traffic statistics of the two highways, Highway No. 3207 and Highway No. 3208, data were recorded by the Office of Safety Administration, Department of Highways. The traffic volume was assessed by adjusted the number of cars into passenger car unit (PCU) by employing the passenger car equivalents (PCEs) of each type of car to adjust the recorded car volume to be in the same unit as the passenger car unit as follows:

1)	Passenger car < 7 Person	=	1.0	PCU
2)	Passenger car > 7 Person	=	1.0	PCU
3)	Light bus	=	1.5	PCU
4)	Medium bus	=	1.5	PCU
5)	Heavy bus	=	2.1	PCU
6)	Light truck or pick up (4 wheels)	=	1.0	PCU
7)	Medium truck (6 wheels)	=	2.1	PCU
8)	Heavy truck (10 wheels)	=	2.5	PCU
9)	Full trailer	=	2.5	PCU
10)	Semi-trailer	=	2.5	PCU
11)	Motorcycle	=	0.333	PCU



<u>Figure 5.5.2-1</u> State of ingoing roads and routes to the project area

(2) Calculation of peak hour volumes on highways (V)

1) Estimating the percentage of traffic volume in peak hours
- Highways in Bangkok and metropolitan areas use $Y = 0.07889\ X^{0.97494}$
- Highways outside Bangkok and metropolitan areas use $Y = 0.1122\ X^{0.9387}$

Where: Y = Percentage of peak hour volume per the average daily volume

X = Annual average daily traffic (AADT)

2) The result of Y on highways is then used to calculate the traffic volume during peak hours

Where: V = Traffic during peak hours (PCU/peak hours)

Y = Percentage of peak hour volume

HV = Percentage of truck compare to the annual average daily traffic

(3) Calculation of the highway capacity (C)

Calculate the capacity of highway capacity (C) by considering decreasing capacity from following factors:

1) For highways with multilane
2) For highways with two lanes, two directions

Where: C represents capacity of the highway

N represents number of traffic lanes

R_L represents capacity of the highway corrected by lane width

R_L = 1.00 when the lane width (W_L) >= 3.25 meters

R_L = $0.24 \times W_L + 0.27$ when $W_L < 3.25$ meters

R_C represents the capacity of the highway corrected by lateral clearance

R_C = 1.00 when the lateral clearance (W_C) >= 0.75 meter

R_C = $0.18 \times W_C + 0.86$ when $W_C < 0.75$ meter

R_N represents the capacity of the highway corrected by mixed with two-wheel vehicles

Where: M_C represents the percentage of motorcycles to all vehicles

R_I represents the capacity of highway corrected by the roadside situation

In this analysis, R_I = 0.90 for corrected by outside Bangkok and metropolitan areas roadside situation

R_I = 0.70 for corrected by Bangkok and metropolitan areas roadside situation roadside situation

R_J represents the capacity of highway corrected by volume of heavy vehicles

Where: HV represents the percentage of heavy vehicles to all vehicles

(4) Assessing of traffic volume in the future

The data used in the assessment of the future traffic volumes were obtained from the average daily traffic volume statistical data for the year 2014-2018 (based on the 2018 Road Traffic Report prepared by the Office of Safety Administration, Department of Highways, March 2019). Regarding the data, Highway No. 3207 which is the main road to the Project will have an average annual increase of 15.25 percent while Highway No. 3208 which is the second road to the Project will have the average annual increase of 1.46 percent.

Comparison of the volume capacity ratio (V/C) based on the Analysis Report of Traffic Congestion and Traffic Congestion in 2018 prepared by the Office of Safety Administration, Department of Highways, March 2019 are as follows:

Service level	Traffic condition	V/C Ratio
A	The service level that the vehicle can move freely with free-flow speed, that is, the driver can freely select the speed of travel without being influenced by other means of transport in the traffic flow. Vehicle traffic is not interrupted by other vehicles even in traffic conditions with the highest intensity of service level A. The distance between vehicles is approximately 167 meters (550 feet), or the approximate length of 27 cars. It is the service level that is the most comfortable to drive. Accidents and road conditions that impede driving will not have a big impact at this service level.	0.00 - 0.60
B	The service level that the vehicle can move freely with free-flow speed. The distance between vehicles is approximately 100 meters (330 feet), or the	0.61 - 0.70

Service level	Traffic condition	V/C Ratio
	approximate length of 16 cars. Changing lanes may be slightly limited. Overall, it remains the service level that provides a comfortable drive as same as the service level A. Accidents and road conditions that impede driving will not have a big impact at this service level.	
C	The service level that the traffic speeds close to the free speed. Traffic flow will be more limited. Drivers need to be more careful when changing lanes. The average distance between vehicles is approximately 67 meters (220 feet), or the approximate length of 11 cars. Road accidents do not have a significant impact on traffic conditions but road conditions that impede driving may start to have a bigger impact and may cause waiting lines or traffic jams in locations where road conditions significantly impede traffic.	0.71 - 0.80
D	The service level that the traffic speed starts to decrease slightly as traffic volume and congestion begins to increase rapidly. The freedom to move in traffic flows has noticeably been eliminated. This reduces driving comfort and increases driving stress. Few accidents can lead to traffic jams at this service level, because there are less traffic and maneuvering space. The average distance between vehicles is 50 meters (160 feet) or equivalent to the approximate length of 8 cars.	0.81 - 0.90
E	The service level at the highest level that the road can handle. Commuting is difficult. The interval between vehicles is uncertain, approximately comparable to the length of 6 cars, it has less space to move and change lanes. Still, the speed exceeds 80 kilometers/hour (50 miles per hour). The slightest interruption of traffic whether changing lanes or that the vehicle runs from the link into the main traffic stream, etc., can cause traffic jams. At this maximum traffic level, if there is a slight accident, it can cause severe traffic jams because there is not enough space. This is a traffic condition that causes a lot of discomfort and stress to the drivers.	0.91 - 1.00
F	The service level where traffic congestion occurs. This is generally observed from the queuing lines formed behind the jamming point. The main causes of traffic congestion are as follows: (a) The accident happens momentarily. As a result, the road during the accident has reduced the ability to handle the traffic. That is, the	> 1.00

Service level	Traffic condition	V/C Ratio
	number of cars that come in is greater than the number of cars that have been passed from there. (b) There is traffic going into a location where traffic conflicts occur, such as merging, weaving, or lane drop, etc., is greater than the traffic exits of the location (c) Wrong estimation of traffic volumes lead to peak-hour flow rates higher than the capacity of the road	

Source: The Analysis Report of Traffic Congestion and Traffic Congestion in 2018 prepared by the Office of Safety Administration, Department of Highways, March 2019

(5) Transportation of the Project

1) Construction period

The construction period of the Project will take approximately 35-42 months. The construction is expected to begin in January 2021 and end around December 2023. Transport during the early of the construction is to transport the soil for land reclamation, transport construction equipment, machinery used in the production process, and construction workers. The main vehicles consist of trucks and trailers. For the traffic volume during the construction period, it is expected that the land reclamation in which 10-wheeler trucks will be used with a maximum of 120 travels per day. The transport of construction materials and machinery used in the production process is expected for a maximum of 90 travels per day and for the normal situation of approximately 74 travels per day. The transportation will be mainly on Highway No. 4031 and Highway No. 4004 to the Project area. In which trucks transporting machinery, equipment, and production units must use the specified main route only. In addition, they must avoid the path that passes through the community area. The shuttles, for construction workers, are expected to have a maximum of 134 travels per day and in a normal situation of 110 travels per day (excluding traveling by motorcycle). Some construction workers are local residents they may travel by motorcycle using Highway No. 4004. The construction workers accommodation will be located outside the Project area, which the Project shall request the construction company to be responsible for arranging accommodation. The operation of the construction company must strictly comply with the labor laws. The transportation of the Project during the construction period can be summarized in **Table 5.5.2-1**.

2) **Operation period**

From the characteristic of the Project, during the operation period, there will be the transport of fuel, chemicals, ash, and employees. Transportation will take Highway No. 4031 and Highway No. 4004 as the main route. The transport vehicles must strictly use the specified main routes only as summarized in **Table 5.5.2-2.**

Table 5.5.2-1
Amount of transportation during construction period

Car Type	Noraml phase		Maximum phase	
	Number of trip/day (round trip)	PCU/day	Number of Trip/day (round trip)	PCU/day
1. Dumper truck				
10 wheel truck	120	300.00	120	300.00
2. transportation of machines, equipments, and products				
Semi-trailer truck	20	50.00	24	60.00
Trailer truck	24	60.00	28	72.00
10 wheel truck	14	35.00	18	45.00
6 wheel truck	16	33.60	20	42.00
Total	74		90	
3. Woker transport car				
Large sized bus	40	84.00	48	100.80
Medium sized bus	30	45.00	36	54.00
Small sized bus	24	36.00	30	45.00
4 wheel bus	16	16.00	20	20.00
Total				
4. Operational vehicles for contracted construction				
car for transporting less than 7 people	86	86.00	86	86.00
car for transporting 7 people or more	22	22.00	22	22.00
Total				
Total Passenger Car Unit (PCU)		767.60		844.80

Remark : Number of transportation trips during construction take into account the maximum construction workers-3000 workers.

Table 5.5.2-2

Transportation of chemical substances and employees

Transportation	Type of car	Number of vehicles (vehicle/day)	Number of Round trip (trip/day)
Chemical substance	4 wheel truck, 10 wheel truck, or trailer truck	1	2
Sludge and wastes from water treatment system	4 wheel truck, 10 wheel truck	1	2
Employees and visitors	car for transporting less than 7 people, car for transporting 7 people or more, and motorcycle	50	100
	Total	**52**	**104**

Source : Hin Kong Power Co.,Ltd, 2563

(6) Results of the V/C ratio calculations based on the current traffic

1) Results of the V/C ratio calculations based on the current traffic from the Department of Highways

(a) Highway No. 3207 at km 3+000 (Khao Kruat – Nong Chae Sao)

The results of the calculation of the V/C ratio and traffic density during 2014-2018 were 0.13, 0.15, 0.18, 0.10, and 0.20, respectively (**Table 5.5.2-3**). Comparison of the results with the criteria according to the Transportation Research Board found that in 2014-2018, the service level of the road was in A level, traffic is free to flow, vehicles can move with freely without limitation in maneuvering, and delays caused by car stopping at the intersection are minimal.

(b) Highway No. 3208 at km 3+000 (Khao Wang – Nam Pu)

The results of the calculation of the V/C ratio and traffic density during 2014-2018 were 0.50, 0.53, 0.49, 0.40, and 0.50, respectively (**Table 5.5.2-4**). Comparison of the results with the criteria according to the Transportation Research Board found that in 2014-2018, the service level of the road was in A level, traffic is free to flow, vehicles can move with freely without limitation in maneuvering, and delays caused by car stopping at the intersection are minimal.

Table 5.5.2-3
Average daily traffic throughout the year and V/C ratio of highway no. 3207
3+000 kilometers (Khao Kruat-Nong Cha-saeng) during 2014-2018

Order	Type of vehicles	PCU Factor	B.E. 2557				B.E 2558				B.E 2559				B.E. 2560				B.E. 2561			
			Amount vehicle/day	%	PCU/day	PCU/hr	Amount vehicle/day	%	PCU/day	PCU/hr	Amount vehicle/day	%	PCU/day	PCU/hr	Amount vehicle/day	%	PCU/day	PCU/hr	Amount 2561	%	PCU/day	PCU/hr
1	car for less than 7 passengers	1	946	21.22	946	39	1,290	25.55	1,290	54	1,590	25.65	1,590	66	1,792	25.33	1,792	75	2,211	28.19	2,211	92
2	car for 7 or more passengers	1	460	10.32	460	19	507	10.04	507	21	716	11.55	716	30	866	12.24	866	36	956	12.19	956	40
3	small bus	1.5	32	0.72	48	2	44	0.87	66	2	49	0.79	74	3	11	0.16	17	1	20	0.25	30	1
4	medium sized bus	1.5	31	0.70	47	2	22	0.44	33	1	16	0.26	24	1	32	0.45	48	2	1	0.01	2	0
5	large bus	2.1	11	0.25	23	1	2	0.04	4	0	14	0.23	29	1	15	0.21	32	1	0	0.00	0	0
6	small truck (4 wheel)	1	1,235	27.70	1,235	51	1,739	34.45	1,739	72	2,110	34.04	2,110	88	2,311	32.66	2,311	96	2,465	31.43	2,465	103
7	2 axles truck (6 wheel)	2.1	177	3.97	372	15	112	2.22	235	5	193	3.11	405	17	210	2.97	441	18	186	2.37	391	16
8	3 axles truck (10 wheel)	2.5	187	4.19	468	19	162	3.21	405	7	168	2.71	420	18	155	2.19	388	16	135	1.72	338	14
9	Trailer truck (more than 3 axles)	2.5	96	2.15	240	10	56	1.11	140	2	43	0.69	108	4	109	1.54	273	11	30	0.38	75	3
10	semi-trailer truck (more than 3 a	2.5	50	1.12	125	5	6	0.12	15	0	4	0.06	10	0	93	1.31	233	10	16	0.20	40	2
11	motorcycle and tricycle	0.333	1,233	27.66	411	17	1,108	21.95	369	46	1,295	20.89	431	18	1,482	20.94	494	21	1,824	23.25	607	25
Total			**4,458**	**100**	**4,373**	**182**	**5,048**	**100**	**4,803**	**210**	**6,198**	**100**	**5,917**	**247**	**7,076**	**100**	**6,892**	**287**	**7,844**	**100**	**7,114**	**296**
V/C Ratio			0.13				0.15				0.18				0.20				0.21			
Level of Service			A				A				A				A				A			

Highway Capacity(C) assessment with 2 traffic lanes = 2,500 x R_L x R_C x R_N x R_I x R_J C = **1,408**

substituted into equation as such

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.85	0.90	0.73

MC = 23.25 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 36.10 Percentage of amount of big vehicles traffic out of the amount of all traffics

<u>Source</u> :Bereau of Highway Safety, Department of Highways, B.E. 2562

Table 5.5.2-4

Average daily traffic throughout the year and V/C ratio of highway no. 3208

Km. 3+000 (Khao Wang-Nam) during 2014-2018

Order	Type of vehicles	PCU Factor	B.E. 2557				B.E 2558				B.E 2559				B.E. 2560				B.E. 2561			
			Amount vehicle/day	%	PCU/day	PCU/hr	Amount vehicle/day	%	PCU/day	PCU/hr	Amount vehicle/day	%	PCU/day	PCU/hr	Amount vehicle/day	%	PCU/day	PCU/hr	Amount 2561	%	PCU/day	PCU/hr
1	car for less than 7 passengers	1	2,588	17.21	2,588	108	2,438	14.51	2,438	102	2,666	17.55	2,666	111	2,556	19.98	2,556	107	3,420	22.37	3,420	143
2	car for 7 or more passengers	1	1,168	7.77	1,168	49	2,386	14.20	2,386	99	1,805	11.88	1,805	75	1,438	11.24	1,438	60	1,444	9.45	1,444	60
3	small bus	1.5	40	0.27	60	3	65	0.39	98	3	65	0.43	98	4	42	0.33	63	3	61	0.40	92	4
4	medium sized bus	1.5	36	0.24	54	2	40	0.24	60	2	50	0.33	75	3	32	0.25	48	2	44	0.29	66	3
5	large bus	2.1	24	0.16	50	2	22	0.13	46	1	44	0.29	92	4	15	0.12	32	1	23	0.15	48	2
6	small truck (4 wheel)	1	6,668	44.35	6,668	278	7,130	42.44	7,130	297	6,274	41.29	6,274	261	4,514	35.28	4,514	188	4,978	32.57	4,978	207
7	2 axles truck (6 wheel)	2.1	649	4.32	1,363	57	613	3.65	1,287	26	716	4.71	1,504	63	520	4.06	1,092	46	678	4.44	1,424	59
8	3 axles truck (10 wheel)	2.5	752	5.00	1,880	78	518	3.08	1,295	22	463	3.05	1,158	48	564	4.41	1,410	59	694	4.54	1,735	72
9	Trailer truck (more than 3 axles)	2.5	308	2.05	770	32	303	1.80	758	13	222	1.46	555	23	161	1.26	403	17	408	2.67	1,020	43
10	semi-trailer truck (more than 3 axles)	2.5	189	1.26	473	20	229	1.36	573	10	125	0.82	313	13	108	0.84	270	11	212	1.39	530	22
11	motorcycle and tricycle	0.333	2,613	17.38	870	36	3,055	18.19	1,017	127	2,765	18.20	921	38	2,843	22.22	947	39	3,323	21.74	1,107	46
Total			15,035	100	15,944	664	16,799	100	17,087	700	15,195	100	15,459	644	12,793	100	12,772	532	15,285	100	15,863	661
V/C Ratio			0.50				0.53				0.49				0.40				0.50			
Level of Service			A				A				A				A				A			

Highway Capacity(C) assessment with 2 traffic lanes = 2,500 × R_L × R_C × R_N × R_I × R_J C = 1,327

substituted into equation as such

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.86	0.90	0.69

MC = 21.74 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 45.75 Percentage of amount of big vehicles traffic out of the amount of all traffics

Source :Bereau of Highway Safety, Department of Highways, B.E. 2562

2) Results of the V/C ratio calculations based on the current traffic from the survey of the Consultant

(a) Traffic volume during weekdays (Friday 12 July 2019 and Monday 28 October 2019)

a) Highway No. Kor Jor 4004

The results of the calculation of the V/C ratio and traffic density were 0.30, 0.26, and 0.39, respectively (**Table 5.5.2-5**). Comparison of the results with the criteria according to the Transportation Research Board found that the service level of the road was in A level, traffic is free to flow, vehicles can move freely without limitation in maneuvering, and delays are caused by car stopping at the intersection are minimal.

b) The road in front of the power plant

The results of the calculation of the V/C ratio and traffic density were 0.09, 0.07, and 0.08, respectively (**Table 5.5.2-6**). Comparison of the results with the criteria according to the Transportation Research Board found that the service level of the road was in A level, traffic is free to flow, vehicles can move freely without limitation in maneuvering, and delays are caused by car stopping at the intersection are minimal.

c) The road in front of Big Food Group Company Limited

The results of the calculation of the V/C ratio and traffic density were 0.22, 0.18, and 0.27, respectively (**Table 5.5.2-7**). Comparison of the results with the criteria according to the Transportation Research Board found that the service level of the road was in A level, traffic is free to flow, vehicles can move freely without limitation in maneuvering, and delays are caused by car stopping at the intersection are minimal.

(b) Traffic volume during weekends (Saturday 13 July 2019 and Sunday 27 October 2019)

a) Highway No. Kor Jor 4004

The results of the calculation of the V/C ratio and traffic density were 0.27, 0.18, and 0.29, respectively (**Table 5.5.2-8**). Comparison of the results with the criteria according to the Transportation Research Board found that the service level of the road was in A level, traffic is free to flow, vehicles can move freely without limitation in maneuvering, and delays are caused by car stopping at the intersection are minimal.

Table 5.5.2-5

Traffic volume on Highway No. 4004 weekdays (Friday, July 12, 2019)

Order	Type of vehicles	PCU Factor	Morning rush hours (07.00-08.00)			Outside rush hours (12.00-13.00)			Afternoon rush hours (16.00-17.00)		
			vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane
1	car for less than 7 passengers	1	164	164.00	41.00	126	126.00	31.50	246	246.00	61.50
2	car for 7 or more passengers	1	0	0.00	0.00	2	2.00	0.50	2	2.00	0.50
3	small bus	1.5	4	6.00	1.50	4	6.00	1.50	2	3.00	0.75
4	medium sized bus	1.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
5	large bus	2.1	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
6	small truck (4 wheel)	1	100	100.00	25.00	132	132.00	33.00	164	164.00	41.00
7	2 axles truck (6 wheel)	2.1	14	29.40	7.35	10	21.00	5.25	16	33.60	8.40
8	3 axles truck (10 wheel)	2.5	20	50.00	12.50	2	5.00	1.25	8	20.00	5.00
9	Trailer truck (more than 3 axles)	2.5	2	5.00	1.25	2	5.00	1.25	4	10.00	2.50
10	semi-trailer truck (more than 3 axles)	2.5	12	30.00	7.50	4	10.00	2.50	2	5.00	1.25
11	motorcycle and tricycle	0.333	104	34.63	8.66	114	37.96	9.49	184	61.27	15.32
Total			**420.00**	**419.03**	**104.76**	**396.00**	**344.96**	**86.24**	**628.00**	**544.87**	**136.22**
V/C Ratio			0.30			0.26			0.39		
Level of Service			A			A			A		

Highway Capacity(C) assessment with 2 traffic lanes = 2,500 x R_L x R_C x R_N x R_I x R_J substituted values into equation as follows

C1= **1,403**
C2= **1,342**
C3= **1,409**

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.84	0.90	0.74

<u>Morning rush hours</u> MC = 24.76 Percentage of amount of motocycle traffics out of the amount of all traffics
HV = 35.24 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.82	0.90	0.73

<u>Outside rush hours</u> MC = 28.79 Percentage of amount of motocycle traffics out of the amount of all traffics
HV = 37.88 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.82	0.90	0.76

<u>Afternoon rush hours</u> MC = 29.30 Percentage of amount of motocycle traffics out of the amount of all traffics
HV = 30.89 Percentage of amount of big vehicles traffic out of the amount of all traffics

<u>Source</u> : Consultant of Technology Co.,Ltd, 2562

Table 5.5.2-6

Traffic volume on the road in front of the power plant during

Order	Type of vehicle	PCU Factor	Morning rush hours (07.00-08.00)			Outside rush hours (12.00-13.00)			Afternoon rush hours (16.00-17.00)		
			vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane
1	car for less than 7 passengers	1	64	64.00	16.00	40	40.00	10.00	58	58.00	14.50
2	car for 7 or more passengers	1	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
3	small bus	1.5	8	12.00	3.00	0	0.00	0.00	4	6.00	1.50
4	medium sized bus	1.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
5	large bus	2.1	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
6	small truck (4 wheel)	1	26	26.00	6.50	20	20.00	5.00	12	12.00	3.00
7	2 axles truck (6 wheel)	2.1	0	0.00	0.00	2	4.20	1.05	0	0.00	0.00
8	3 axles truck (10 wheel)	2.5	2	5.00	1.25	0	0.00	0.00	0	0.00	0.00
9	Trailer truck (more than 3 axles)	2.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
10	semi-trailer truck (more than 3 axles)	2.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
11	motorcycle and tricycle	0.333	70	23.31	5.83	94	31.30	7.83	106	35.30	8.82
Total			**170.00**	**130.31**	**32.58**	**156.00**	**95.50**	**23.88**	**180.00**	**111.30**	**27.82**
V/C Ratio			0.09			0.07			0.08		
Level of Service			A			A			A		

Highway Capacity(C) assessment with 2 traffic lanes = 2,500 x R_L x R_C x R_N x R_I x R_J substituted values into equation as follows

C1= **1,476**

C2= **1,358**

C3= **1,463**

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.76	0.90	0.86

<u>Morning rush hours</u> MC = 41.18 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 16.47 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.69	0.90	0.88

<u>Outside rush hours</u> MC = 60.26 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 14.10 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.69	0.90	0.94

<u>Afternoon rush hours</u> MC = 58.89 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 6.67 Percentage of amount of big vehicles traffic out of the amount of all traffics

Source : Consultant of Technology Co.,Ltd, 2562

Table 5.5.2-7

Traffic volume on the road in front of Big Food Group Co., Ltd. weekdays (Monday, October 28, 2019)

Order	Type of vehicle	PCU Factor	Morning rush hours (07.00-08.00)			Outside rush hours (12.00-13.00)			Afternoon rush hours (16.00-17.00)		
			vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane
1	car for less than 7 passengers	1	96	96.00	24.00	55	55.00	13.75	113	113.00	28.25
2	car for 7 or more passengers	1	3	3.00	0.75	5	5.00	1.25	5	5.00	1.25
3	small bus	1.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
4	medium sized bus	1.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
5	large bus	2.1	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
6	small truck (4 wheel)	1	127	127.00	31.75	118	118.00	29.50	153	153.00	38.25
7	2 axles truck (6 wheel)	2.1	4	8.40	2.10	5	10.50	2.63	8	16.80	4.20
8	3 axles truck (10 wheel)	2.5	6	15.00	3.75	2	5.00	1.25	6	15.00	3.75
9	Trailer truck (more than 3 axles)	2.5	0	0.00	0.00	2	5.00	1.25	2	5.00	1.25
10	semi-trailer truck (more than 3 axles)	2.5	0	0.00	0.00	4	10.00	2.50	4	10.00	2.50
11	motorcycle and tricycle	0.333	119	39.63	9.91	57	18.98	4.75	107	35.63	8.91
Total			**355.00**	**289.03**	**72.26**	**248.00**	**227.48**	**56.87**	**398.00**	**353.43**	**88.36**
V/C Ratio			**0.22**			**0.18**			**0.27**		
Level of Service			**A**			**A**			**A**		

Highway Capacity(C) assessment with 2 traffic lanes = 2,500 x RL x RC x RN x RI x RJ substituted values into equation as follows

C1= **1,297**

C2= **1,256**

C3= **1,305**

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.80	0.90	0.72

<u>Morning rush hours</u> MC = 33.52 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 38.59 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.85	0.90	0.65

<u>Outside rush hours</u> MC = 22.98 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 52.82 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.83	0.90	0.70

<u>Afternoon rush hours</u> MC = 26.88 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 43.47 Percentage of amount of big vehicles traffic out of the amount of all traffics

<u>Source :</u> Consultant of Technology Co.,Ltd, 2562

Table 5.5.2-8

Traffic volume on Highway No. 4004 during the holidays (Saturday, July 13, 2019)

Order	Type of vehicles	PCU Factor	Morning rush hours (07.00-08.00)			Outside rush hours (12.00-13.00)			Afternoon rush hours (16.00-17.00)		
			vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane
1	car for less than 7 passengers	1	108	108.00	54.00	112	112.00	56.00	132	132.00	66.00
2	car for 7 or more passengers	1	0	0.00	0.00	0	0.00	0.00	2	2.00	1.00
3	small bus	1.5	0	0.00	0.00	0	0.00	0.00	4	6.00	3.00
4	medium sized bus	1.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
5	large bus	2.1	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
6	small truck (4 wheel)	1	124	124.00	62.00	100	100.00	50.00	144	144.00	72.00
7	2 axles truck (6 wheel)	2.1	6	12.60	6.30	2	4.20	2.10	18	37.80	18.90
8	3 axles truck (10 wheel)	2.5	2	5.00	2.50	0	0.00	0.00	2	5.00	2.50
9	Trailer truck (more than 3 axles)	2.5	8	20.00	10.00	4	10.00	5.00	4	10.00	5.00
10	semi-trailer truck (more than 3 axles	2.5	2	5.00	2.50	2	5.00	2.50	4	10.00	5.00
11	motorcycle and tricycle	0.333	218	72.59	36.30	72	23.98	11.99	106	35.30	17.65
Total			**468.00**	**347.19**	**173.60**	**292.00**	**255.18**	**127.59**	**416.00**	**382.10**	**191.05**
V/C Ratio			0.27			0.18			0.29		
Level of Service			A			A			A		

Highway Capacity(C) assessment with 2 traffic lanes = 2,500 x R_L x R_C x R_N x R_I x R_J substituted values into equation as follows

C1= **1,279**

C2= **1,386**

C3= **1,336**

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.74	0.90	0.77

<u>Morning rush hours</u> MC = 46.58 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 30.34 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.84	0.90	0.73

<u>Outside rush hours</u> MC = 24.66 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 36.99 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.84	0.90	0.71

<u>Afternoon rush hours</u> MC = 25.48 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 41.35 Percentage of amount of big vehicles traffic out of the amount of all traffics

<u>Source : Consultant of Technology Co.,Ltd, 2562</u>

b) The road in front of the power plant

The results of the calculation of the V/C ratio and traffic density were 0.10, 0.06, and 0.10, respectively (**Table 5.5.2-9**). Comparison of the results with the criteria according to the Transportation Research Board found that the service level of the road was in A level, traffic is free to flow, vehicles can move freely without limitation in maneuvering, and delays are caused by car stopping at the intersection are minimal.

c) The road in front of Big Food Group Company Limited

The results of the calculation of the V/C ratio and traffic density were 0.14, 0.21, and 0.24, respectively (**Table 5.5.2-10**). Comparison of the results with the criteria according to the Transportation Research Board found that the service level of the road was in A level, traffic is free to flow, vehicles can move freely without limitation in maneuvering, and delays are caused by car stopping at the intersection are minimal.

(6) Study results

The Consultant assessed the impact on transportation from the Project's operation. Details are as follows:

1) Impact on traffic volume and capacity of the roads

(a) Construction period

The project will start the construction from the year 2021-2023, with a traffic volume of 844.80 PCU/day or equivalent to 105.60 PCU/hour (considered only 8 working hours) as the assumptions mentioned above. The V/C ratio can be compared in the absence of the Project and in the case of having the Project using the average PCU value, as follows:

a) Highway No. Kor Jor 4004

The traffic index of the Highway No. Kor Jor 4004 in comparison with the case of absence of the Project are presented in **Table 5.5.2-11**. It can be found that the V/C ratios in 2019-2020 during weekdays and weekends were in the range of 0.08-0.31. With the Project construction period in 2021-2023, the increase of the traffic cause and increasing of the V/C ratios to be in the range of 0.09-0.43. This revealed that the presence of the Project does not change the traffic condition as it is remaining in the service level A (V/C ratio = 0.00-0.60). With this service level, the vehicle can move freely with free-flow speed. Therefore, the impact on road users is expected to occur at a low level.

Table 5.5.2-9

Amount of traffics infront of the powerplant during weekends (Saturday, 13 July B.E. 2562)

Order	Type of vehicle	PCU Factor	Morning rush hours (07.00-08.00)			Outside rush hours (12.00-13.00)			Afternoon rush hours (16.00-17.00)		
			vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane
1	car for less than 7 passengers	1	42	42.00	21.00	40	40.00	20.00	38	38.00	19.00
2	car for 7 or more passengers	1	0	0.00	0.00	2	2.00	1.00	4	4.00	2.00
3	small bus	1.5	0	0.00	0.00	2	3.00	1.50	0	0.00	0.00
4	medium sized bus	1.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
5	large bus	2.1	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
6	small truck (4 wheel)	1	32	32.00	16.00	18	18.00	9.00	38	38.00	19.00
7	2 axles truck (6 wheel)	2.1	0	0.00	0.00	2	4.20	2.10	8	16.80	8.40
8	3 axles truck (10 wheel)	2.5	0	0.00	0.00	2	5.00	2.50	0	0.00	0.00
9	Trailer truck (more than 3 axles)	2.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
10	semi-trailer truck (more than 3 axles	2.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
11	motorcycle and tricycle	0.333	170	56.61	28.31	44	14.65	7.33	92	30.64	15.32
Total			**244.00**	**130.61**	**65.31**	**110.00**	**86.85**	**43.43**	**180.00**	**127.44**	**63.72**
V/C Ratio			0.10			0.06			0.10		
Level of Service			A			A			A		

Highway Capacity(C) assessment with 2 traffic lanes = 2,500 x RL x RC x RN x RI x RJ substituted values into equation as follows

C1= **1,306**

C2= **1,442**

C3= **1,295**

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.66	0.90	0.88

<u>Morning rush hours</u> MC = 69.67 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 13.11 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.77	0.90	0.83

<u>Outside rush hours</u> MC = 40.00 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 20.00 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.72	0.90	0.80

<u>Afternoon rush hours</u> MC = 51.11 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 25.56 Percentage of amount of big vehicles traffic out of the amount of all traffics

<u>Source :</u> Consultant of Technology Co.,Ltd, 2562

Table 5.5.2-10

Traffic on the road in front of Big Food Group Co., Ltd. during the holidays (Sunday, October 27, 2019)

Order	Type of vehicle	PCU Factor	Morning rush hours (07.00-08.00)			Outside rush hours (12.00-13.00)			Afternoon rush hours (16.00-17.00)		
			vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane	vehicle/hr	PCU/hr	PCU/hr/traffic lane
1	car for less than 7 passengers	1	38	38.00	19.00	81	81.00	40.50	91	91.00	45.50
2	car for 7 or more passengers	1	0	0.00	0.00	6	6.00	3.00	2	2.00	1.00
3	small bus	1.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
4	medium sized bus	1.5	0	0.00	0.00	0	0.00	0.00	2	3.00	1.50
5	large bus	2.1	1	2.10	1.05	0	0.00	0.00	0	0.00	0.00
6	small truck (4 wheel)	1	93	93.00	46.50	148	148.00	74.00	162	162.00	81.00
7	2 axles truck (6 wheel)	2.1	2	4.20	2.10	4	8.40	4.20	3	6.30	3.15
8	3 axles truck (10 wheel)	2.5	2	5.00	2.50	4	10.00	5.00	5	12.50	6.25
9	Trailer truck (more than 3 axles)	2.5	3	7.50	3.75	0	0.00	0.00	1	2.50	1.25
10	semi-trailer truck (more than 3 axles	2.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
11	motorcycle and tricycle	0.333	65	21.65	10.82	65	21.65	10.82	84	27.97	13.99
Total			**204.00**	**171.45**	**85.72**	**308.00**	**275.05**	**137.52**	**350.00**	**307.27**	**153.64**
V/C Ratio			**0.14**			**0.21**			**0.24**		
Level of Service			A			A			A		

Highway Capacity(C) assessment with 2 traffic lanes = 2,500 x RL x RC x RN x RI x RJ substituted values into equation as follows

C1= **1,215**
C2= **1,289**
C3= **1,281**

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.81	0.90	0.67

<u>Morning rush hours</u> MC = 31.86 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 49.51 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.86	0.90	0.66

<u>Morning rush hours</u> MC = 21.10 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 50.65 Percentage of amount of big vehicles traffic out of the amount of all traffics

R_L	R_C	R_N	R_I	R_J
1.00	1.00	0.85	0.90	0.67

<u>Afternoon rush hours</u> MC = 24.00 Percentage of amount of motocycle traffics out of the amount of all traffics

HV = 48.86 Percentage of amount of big vehicles traffic out of the amount of all traffics

<u>Source :</u> Consultant of Technology Co.,Ltd, 2562

b) The road in front of the power plant

The traffic index of the road in front of the power plant in comparison with the case of absence of the Project are presented in **Table 5.5.2-12**. It can be found that the V/C ratios in 2019-2020 during weekdays and weekends were in the range of 0.02-0.11. With the Project construction period in 2021-2023, the increase of the traffic cause and increasing of the V/C ratios to be in the range of 0.03-0.20. This revealed that the presence of the Project does not change the traffic condition as it is remaining in the service level A (V/C ratio = 0.00-0.60). With this service level, the vehicle can move freely with free-flow speed. Therefore, the impact on road users is expected to occur at a low level.

c) The road in front of Big Food Group Company Limited

The traffic index of the road in front of Big Food Group Company Limited in comparison with the case of absence of the Project are presented in **Table 5.5.2-13**. It can be found that the V/C ratios in 2019-2020 during weekdays and weekends were in the range of 0.06-0.25. With the Project construction period in 2021-2023, the increase of the traffic cause and increasing of the V/C ratios to be in the range of 0.06-0.37. This revealed that the presence of the Project does not change the traffic condition as it is remaining in the service level A (V/C ratio = 0.00-0.60). With this service level, the vehicle can move freely with free-flow speed. Therefore, the impact on road users is expected to occur at a low level.

(b) Operation period

The project will start the operation from the year 2024, with a traffic volume of 103.00 PCU/day or equivalent to 4.31 PCU/hour (considered 24 working hours) as the assumptions mentioned above. The V/C ratio can be compared in the absence of the Project and in the case of having the Project using the average PCU values as summarized in **Table 5.5.2-11** and **Table 5.5.2-13**, details are as follows:

a) Highway No. Kor Jor 4004

The traffic index of the Highway No. Kor Jor 4004 in comparison with the case of absence of the Project are presented in **Table 5.5.2-11**. It can be found that the V/C ratios in 2024-2026 during weekdays and weekends were in the range of 0.10-0.41. The traffic condition is remaining in the service level A (V/C ratio = 0.00-0.60). With this service level, the vehicle can move freely with free-flow speed. Therefore, the impact on road users is expected to occur at a low level.

b) The road in front of the power plant

The traffic index of the road in front of the power plant in comparison with the case of absence of the Project are presented in **Table 5.5.2-12**. It can be found that the V/C ratios in 2024-2026 during weekdays and weekends were in the range of 0.03-0.15. The traffic condition is remaining in the service level A (V/C ratio = 0.00-0.60). With this service level, the vehicle can move freely with free-flow speed. Therefore, the impact on road users is expected to occur at a low level.

c) The road in front of Big Food Group Company Limited

The traffic index of the road in front of Big Food Group Company Limited in comparison with the case of absence of the Project are presented in **Table 5.5.2-13**. It can be found that the V/C ratios in 2024-2026 during weekdays and weekends were in the range of 0.08-0.33. The traffic condition is remaining in the service level A (V/C ratio = 0.00-0.60). With this service level, the vehicle can move freely with free-flow speed. Therefore, the impact on road users is expected to occur at a low level.

2) Impact on accident from transportation

In order to prevent an accident from transportation, the Project has set prevention and mitigation measures as summarized below:

(a) Construction period

a) In the case of transportation of large machines, coordinate with the traffic police to plan and facilitate the transportation to minimize the impact on traffic,

b) Avoid transportation during peak hours to reduce traffic congestion,

c) To control the speed of vehicles in construction areas and areas passing through communities, not exceed 30 kilometers per hour,

d) Control the weight of the truck according to the law,

e) Request the contractor company to train and control the drivers to strictly obey traffic rules, and

f) Provide security guards to facilitate the entrance-exit area of the Project.

Table 5.5.2-11

Assess the impact of traffic on Highway No. 4004

B.E.	2562						2563					
	Weekdays			Weekends			Weekdays			Weekends		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	In case of no project											
PCU/hr	419.03	104.76	396.00	347.19	173.60	292.00	438.11	109.53	414.03	363.00	181.50	305.29
V/C	0.30	0.08	0.28	0.27	0.13	0.22	0.31	0.08	0.29	0.28	0.13	0.23
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period(B.E. 2564-2566) project has traffics of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr												
V/C												
LOS												
Operation period (B.E.2567-2569) project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr												
V/C												
LOS												
B.E.	2564						2565					
	Weekdays			Weekends			Weekdays			Weekends		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	In case of no project											
PCU/hr	458.05	114.51	432.87	379.52	189.76	319.19	478.90	119.72	452.58	396.80	198.40	333.72
V/C	0.33	0.09	0.31	0.30	0.14	0.24	0.34	0.09	0.32	0.31	0.14	0.25
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period (B.E. 2564-2566) project has traffics of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr	563.65	220.11	538.47	485.12	295.36	424.79	584.50	225.32	558.18	502.40	304.00	439.32
V/C	0.40	0.09	0.38	0.38	0.21	0.32	0.42	0.17	0.40	0.39	0.22	0.33
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Operation period (B.E.2567-2569) project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr												
V/C												
LOS												
B.E.	2566						2567					
	Weekdays			Weekends			Weekdays			Weekends		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	In case of no project											
PCU/hr	500.70	125.17	473.18	414.86	207.43	348.91	523.49	130.87	494.72	433.74	216.87	364.79
V/C	0.36	0.09	0.34	0.32	0.15	0.26	0.37	0.10	0.35	0.34	0.16	0.27
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period (B.E. 2564-2566) project has traffics of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr	606.30	230.77	578.78	520.46	313.03	454.51						
V/C	0.43	0.09	0.41	0.41	0.23	0.34						
LOS	A	A	A	A	A	A						
Operation period(B.E.2567-2569)project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr							527.80	135.18	499.02	438.05	221.18	369.10
V/C							0.38	0.10	0.35	0.34	0.16	0.28
LOS							A	A	A	A	A	A
B.E.	2568						2569					
	Weekdays			Weekends			Weekdays			Weekends		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	In case of no project											
PCU/hr	547.32	136.83	517.24	453.49	226.74	381.40	572.23	143.06	540.78	474.13	237.07	398.76
V/C	0.39	0.10	0.37	0.35	0.16	0.29	0.41	0.11	0.38	0.37	0.17	0.30
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period (B.E. 2564-2566) project has traffic of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr												
V/C												
LOS												
Operation period (B.E.2567-2569) project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr	551.63	141.14	521.54	457.79	231.05	385.70	576.54	147.36	545.09	478.44	241.37	403.06
V/C	0.41	0.11	0.37	0.36	0.17	0.29	0.41	0.11	0.39	0.37	0.17	0.30
LOS	A	A	A	A	A	A	A	A	A	A	A	A

Remark: Increase in yearly ratio of amount of trips according to Transportation on national highway report in B.E. 2561 by Bereau of Highway Safety, Department of Highway in March B.E. 2562 with Average amount of trips yearly on national highway is 4.552 %

Source : Consultant of Technology Co.,Ltd, 2562

Table 5.5.2-12

Assess the impact of traffic on the road in front of the power plant.

B.E.	2562						2563					
	Weekdays			Weekends			Weekdays			Weekends		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	In case of no project											
PCU/hr	130.31	32.58	156.00	130.61	65.31	110.00	136.24	34.06	163.10	136.56	68.28	115.01
V/C	0.09	0.02	0.11	0.10	0.05	0.08	0.09	0.03	0.11	0.10	0.05	0.09
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period(B.E. 2564-2566) project has traffics of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr												
V/C												
LOS												
Operation period (B.E.2567-2569) project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr												
V/C												
LOS												

B.E.	2564						2565					
	Weekdays			Weekends			Weekdays			Weekends		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	In case of no project											
PCU/hr	142.44	35.61	170.53	142.77	71.39	120.24	148.93	37.23	178.29	149.27	74.64	125.72
V/C	0.10	0.03	0.12	0.11	0.05	0.09	0.10	0.03	0.12	0.11	0.05	0.10
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period(B.E. 2564-2566) project has traffics of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr	248.04	141.21	276.13	248.37	176.99	225.84	259.33	147.64	288.69	259.68	185.04	236.12
V/C	0.17	0.03	0.19	0.19	0.12	0.17	0.18	0.11	0.20	0.20	0.13	0.18
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Operation period (B.E.2567-2569) project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr												
V/C												
LOS												

B.E.	2566						2567					
	Weekdays			Weekends			Weekdays			Weekends		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	In case of no project											
PCU/hr	155.71	38.93	186.40	156.07	78.03	131.44	162.79	40.70	194.89	163.17	81.58	137.42
V/C	0.11	0.03	0.13	0.12	0.05	0.10	0.11	0.03	0.13	0.12	0.06	0.11
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period(B.E. 2564-2566) project has traffics of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr	261.31	144.53	292.00	261.67	183.63	237.04						
V/C	0.18	0.11	0.20	0.20	0.13	0.18						
LOS	A	A	A	A	A	A						
Operation period (B.E.2567-2569) project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr							167.10	45.00	199.19	167.47	85.89	141.73
V/C							0.11	0.03	0.14	0.13	0.06	0.11
LOS							A	A	A	A	A	A

B.E.	2568						2569					
	Weekdays			Weekends			Weekdays			Weekends		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	In case of no project											
PCU/hr	170.20	42.55	203.76	170.60	85.30	143.68	177.95	44.49	213.04	178.36	89.18	150.22
V/C	0.12	0.03	0.14	0.13	0.06	0.11	0.12	0.03	0.15	0.14	0.06	0.12
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period(B.E. 2564-2566) project has traffics of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr												
V/C												
LOS												
Operation period (B.E.2567-2569) project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr	174.51	46.86	208.07	174.90	89.60	147.98	182.26	48.79	217.34	182.67	93.49	154.52
V/C	0.12	0.03	0.14	0.13	0.06	0.11	0.12	0.04	0.15	0.14	0.06	0.12
LOS	A	A	A	A	A	A	A	A	A	A	A	A

Remark: Increase in yearly ratio of amount of trips according to Transportation on national highway report in B.E. 2561 by Bereau of Highway Safety, Department of Highway in March B.E. 2562 with Average amount of trips yearly on national highway is 4.552 %

Source : Consultant of Technology Co.,Ltd, 2562

Table 5.5.2-13

Assess the impact of traffic on the road in front of the Big Food Group Co., Ltd.

B.E.	2562						2563					
	Weekdays			Weekends			Weekdays			Weekdays		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	No project											
PCU/hr	289.03	72.26	248.00	171.45	85.72	308.00	302.18	75.55	259.29	179.25	89.62	322.02
V/C	0.22	0.06	0.19	0.14	0.07	0.24	0.23	0.06	0.20	0.15	0.07	0.25
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period(B.E. 2564-2566) project has traffics of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr												
V/C												
LOS												
Operation period (B.E.2567-2569) project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr												
V/C												
LOS												
B.E.	2564						2565					
	Weekdays			Weekends			Weekdays			Weekdays		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	No project											
PCU/hr	315.94	78.98	271.09	187.41	93.70	336.68	330.32	82.58	283.43	195.94	97.97	352.00
V/C	0.24	0.06	0.21	0.15	0.07	0.26	0.25	0.07	0.22	0.16	0.08	0.27
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period(B.E. 2564-2566) project has traffics of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr	421.54	184.58	376.69	293.01	199.30	442.28	440.73	192.99	393.84	306.35	208.38	462.41
V/C	0.32	0.06	0.29	0.24	0.15	0.35	0.34	0.15	0.30	0.25	0.16	0.36
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Operation period (B.E.2567-2569) project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr												
V/C												
LOS												
B.E.	2566						2567					
	Weekdays			Weekends			Weekdays			Weekdays		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	No project											
PCU/hr	345.36	86.34	296.33	204.86	102.43	368.03	361.08	90.27	309.82	214.18	107.09	384.78
V/C	0.27	0.07	0.23	0.17	0.08	0.29	0.28	0.07	0.24	0.18	0.08	0.30
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period(B.E. 2564-2566) project has traffics of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr	450.96	191.94	401.93	310.46	208.03	473.63						
V/C	0.35	0.15	0.31	0.26	0.16	0.37						
LOS	A	A	A	A	A	A						
Operation period (B.E.2567-2569) project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr							365.37	94.56	314.11	218.48	111.38	389.07
V/C							0.28	0.08	0.24	0.18	0.09	0.30
LOS							A	A	A	A	A	A
B.E.	2568						2569					
	Weekdays			Weekends			Weekdays			Weekdays		
	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs	Morning rush hrs	Outside rush hrs	Afternoon rush hrs
	No project											
PCU/hr	377.51	94.38	323.93	223.93	111.97	402.30	394.70	98.67	338.67	234.13	117.06	420.61
V/C	0.29	0.08	0.25	0.18	0.09	0.31	0.30	0.08	0.26	0.19	0.09	0.33
LOS	A	A	A	A	A	A	A	A	A	A	A	A
Construction period(B.E. 2564-2566) project has traffics of 844.80 PCU/day or 105.60 PCU/hr												
PCU/hr												
V/C												
LOS												
Operation period (B.E.2567-2569) project has traffics of 103.33 PCU/day or 4.31 PCU/hr												
PCU/hr	381.81	98.67	328.22	228.23	116.26	406.59	398.99	102.97	342.96	238.42	121.36	424.90
V/C	0.29	0.08	0.25	0.19	0.09	0.32	0.31	0.08	0.26	0.20	0.09	0.33
LOS	A	A	A	A	A	A	A	A	A	A	A	A

Remark: Increase in yearly ratio of amount of trips according to Transportation on national highway report in B.E. 2561 by Bereau of Highway Safety, Department of Highway in March B.E. 2562 with

Average amount of trips yearly on national highway is 4.552 %

Source : Consultant of Technology Co.,Ltd, 2562

(b) Operation period

a) The project shall request chemical transport operators to strictly comply with chemical transportation to ensure community safety. For instance, drivers are trained to have knowledge and understanding of the dangers of chemicals in order to have knowledge and abilities in solving initial problems in an emergency. All chemical trucks must be properly labeled as required by the Department of Land Transport. Each truck must be equipped with necessary emergency suspension equipment.

b) For land transportation of fuel, the Project will create a detour and a waiting point to wait for the fuel delivery queue to the fuel storage area of the Project, without having to park and wait along the roadside. Moreover, the Project will set up rules for the fuel transportation operator to be strictly implemented.

c) The Project shall provide training and educate drivers about the transportation procedures in the case of emergency and other relevant regulations as well as requiring drivers to strictly abide by traffic rules.

d) Install warning signs and symbols such as traffic signs, entrance-exit signs, and speed limit signs, etc.

e) Avoid transportation during peak hours on weekdays to reduce traffic jams and limit the maximum speed of vehicles.

f) Avoid using transportation routes that pass through communities to reduce the impact of transportation that may occur, including other routes in the event that the route used in the transport is found to affect the community.

g) Limit the speed of the vehicle within the Project area to not exceed 30 kilometers per hour by having a speed control sign, for other areas that passing through a community or other areas use the speed as required by law.

h) Define the terms of the contract for the fuel supplier to prevent the spreading of the transportation route, including inspections and maintenance of the vehicles to be in good condition to reduce vehicle exhaust problems during engine start-up and parking for fuel loading.

Therefore, with the above assessment and the strict measures, the impact is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of importance		Health assessment
Construction	1	2	2	(4) = 2	1	1	low	Nothing significant
Operation	1	2	2	(4) = 2	1	1	low	Nothing significant

5.5.3 Waste management

Unused materials, solid waste and industrial waste arising from the operation of the Project can be classified into 2 main categories:

1) Unused materials that are not required to have permission before taken outside the factory, and

2) Unused materials that are required to have permission before taken outside the factory in accordance with the Notification of the Ministry of Industry on disposal of waste or unused material B.E. 2548 (2005).

- Hazardous waste-absolute entry (HA)
- Hazardous waste-mirror entry (HM)
- Non-hazardous waste

(1) Construction period

Solid waste to be generated during the construction period can be classified into two categories as follows:

1) Solid waste arising from the consumption of construction workers, such as food waste, plastic bags, etc., the maximum amount is 3,000 kilograms per day (based on the generation rate of one kilogram of solid waste per person per day), the Project will provide a 200-liter waste container with a closed lid to accommodate the solid waste that occurred before being disposed of by a licensed waste processor.

2) Solid waste from construction activities that can be recycled such as steel, wood, and brick, etc., the Project will collect them in the Project area before contacting an outside agency in sending and selling for further recycling.

For each type of waste, the Project has set the area for appropriate storage with adequate containers for all types of waste generated in the construction of the Project. The waste containers shall be provided according to types of waste and will be collected once a day. The contractor company is responsible for waste management.

Regarding the data on the Environmental Situation Report, 2018 of the Office of the Environment Region 8, Ratchaburi, Office of the Permanent Secretary, Ministry of Natural Resources and Environment, June 2019 issue, concluded that Ratchaburi Province has 16 waste disposal sites, one of which has been currently closed while 15 sites have been of which are currently operational. They are owned by 11 local administrative organizations and four private agencies. Six waste disposal sites are operated correctly. The operation pattern includes the sorting system, sanitary landfill, and controlled dumping. There are two transfer stations. Regarding the management of the waste disposal facility of the local government agencies, the landfill improvement is approximately 1-2 times a year depending on the amount of solid waste and the area size of each landfill facility. This is because of the limited budget and the local government organizations do not have a machine for frequent improvement. The area surrounding the Project has waste disposal facilities of both government and private agencies. The Project can contact them for general waste disposal. to get the general waste of the project to be eliminated. For the waste disposal facility, the nearest waste disposal facility to the Project is Ang Hin Subdistrict Administrative Organization, which is located approximately 17 kilometers from the Project area and takes approximately 24 minutes.

Therefore, the impact of waste and unused materials management during the construction period is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of importance	
	1	1	1	(1) = 1	1	1	low

(2) Operation period

1) Compliance of the management with laws and regulations

The waste to be generated during the operation period of the Project can be classified into 2 categories: waste from office and consumption of employees and waste from the production process. Details are as follows:

(a) Waste from the office and consumption of employees

Most of the general waste from the office and the consumption of employees are paper, unused material, and food waste. The amount of general waste is approximately 30 kilograms per day (calculated from the generational rate of 0.5 kilograms of solid waste per person per day, from 60 employees). For general waste that is recyclable, the Project has a policy of recycling as much as possible. The rest after sorting, the Project will provide sufficient containers with a closed lid, to be placed in different areas. Waste will be collected every day in sealed black plastic bags to the waste storage area.

The project will dispose of the mentioned waste in accordance with other relevant laws such as the Public Health Act B.E. 2535 (1992) without causing any impact on health and the environment. The project will contact local authorities to collect, transport, and dispose of in a sanitary manner.

Hin Kong Subdistrict Administrative Organization, the local government agency at the Project site, has the capacity to manage general waste. The Project can also contact the relevant agencies to dispose of waste according to sanitation principles. The area surrounding the Project has waste disposal facilities of both government and private agencies. The Project can contact them for general waste disposal. to get the general waste of the project to be eliminated. For the waste disposal facility, the nearest waste disposal facility to the Project is Ang Hin Subdistrict Administrative Organization, which is located approximately 17 kilometers from the Project area and takes approximately 24 minutes.

(b) Waste from the production process

The waste generated from the production process is classified as industrial waste according to the Notification of the Ministry of Industry B.E. 2548 (2005), the permission from the Department of Industrial Works is required for disposal of waste outside the factory.

a) Hazardous waste with HA label (hazardous waste-absolute entry) includes used lubricants from maintenance work and oil from water-oil separators (including oil containers) is classified as hazardous waste in sections 13 02 08 (engine oil waste, gear oil, lubricating oil) and section 13 05 06 (oil from water-oil separator) according to the Notification of the Ministry of Industry regarding waste or unused material disposal B.E.2548 (2005). The total amount is 800 liters per month. It will be collected in a 200-liter used oil container in an area with a bund wall, stored in a waste collection building, and sent to a licensed waste processor by the Department of Industrial Works for further disposal.

b) Hazardous waste with HM label (hazardous waste-mirror entry) includes unused containers, water filters, and air filter panel. It is classified as waste in section 15 02 02 (absorbent material, filter material including oil filter element other than those mentioned in 16 01 07) according to the Notification of the Ministry of Industry regarding waste or unused material disposal B.E.2548 (2005). The total amount is 2,512 pieces per year. It will be collected in a 200-liter, stored in a waste collection building, and sent to a licensed waste processor by the Department of Industrial Works for further disposal.

c) Non-hazardous waste includes sludge from the water treatment system which is classified as waste in section 19 09 02 (sludge from water treatment) according to the Notification of the Ministry of Industry regarding waste or unused material disposal B.E.2548 (2005). The total amount is 0.36 tons per year. It will be collected in a big steel container, stored in the water treatment building, and sent to a licensed waste processor by the Department of Industrial Works for further disposal.

2) Assessing the waste storage potential of waste storage areas

(a) Storage area for general waste

The project has a policy of recycling as much as possible. The rest after sorting will be collected in provide containers with closed lids placed in different areas. Every day, all waste will be collected in sealed black plastic bags and transferred to the waste storage area.

(b) Storage area for industrial waste

The Project will arrange a waste collection area at the source of that waste to wait for disposal. The Project shall separate chemicals and waste storage areas by sharing the building wall but using separate entrances. The building is a brick block covered with a metal sheet roof and there are windows for proper ventilation. In addition, each type of waste will be collected separately. There is clearly a label indicating each type of waste. Waste will be sent to dispose of within 90 days. Waste collection shall be performed in accordance with the Notification of the Ministry of Industry on hazardous waste manifest system B.E. 2547 (2004). The Project shall perform weekly inspections of the storage building. In addition, fire extinguishers will be provided as well as a sump to collect spillage in the emergency. Moreover, water shall be provided for cleaning purposes.

In the event of a spill, the Project will use an absorbent material such as sand or sawdust before keeping into a container with a closed lid before sending it to a waste processor that is authorized by the Department of Industrial Works for disposal. The waste collection area in the Project building is used to temporarily collect the waste in a short period of time that the waste processor cannot collect the waste on time.

At present, there are many waste processors. Therefore, the Project has more alternatives without having to keep waste in the Project for a long time. Regarding the mentioned waste collection and transfer approaches, the impact of waste management on communities, and the environment is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of importance	
	1	1	1	(1) = 1	1	1	low

5.5.4 Water consumption

(1) Construction period

Water consumption during the construction period can be classified into two types of activities: water used for consumption of construction workers and water used for construction activities as follows:

1) **Water used for consumption of construction workers.** During the construction period, it is expected that up to approximately 3,000 construction workers will travel back and forth. There is no outstanding stay in the Project area. The amount of water consumption is approximately 300 cubic meter (m^3) per day (calculated from the rate of water consumption 100 liters/person/day x 3,000 people). The Project requests the contractor company to provide adequate drinking water which is usually bottled water or commercially available buckets.

2) **Water used for construction activities.** It is water used for washing tools and equipment as well as for concrete mixing. The amount of water required for these purposes is very low because the construction of the Project will mainly use ready-mixed concrete. It is estimated that the water consumption in construction activities is about 50 cubic meter (m^3) per day. The water source for construction activities will be the same as the water used for consumption by construction workers.

Therefore, the impact on water consumption of the community is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of importance	
	1	1	1	(1) = 1	1	1	low

(2) Operation period

The Project will pump water from the Mae Klong River to store it in a raw water reservoir within the Project. The Project will improve the current water reservoir to expand its capacity to be able store water for at least 3 days.

In water balance analysis, the Consultant considered the use of water from the downstream of Mae Klong Dam until the Gulf of Thailand by conducting a 25-year water simulation using runoff data from 1993 to 2017 with 4 scenarios as follows:

Scenario 1: Current condition by using runoff water data from 1993 to 2017, Scenario 2: The future condition without supplying water to the power plant,

Scenario 3: The future condition, with supplying water to the power plant of 0.37 cubic meter (m^3)/second, and

Scenario 4: Worst case condition in the future, with supplying water to the power plant, side flow was not considered.

1) Scenario 1 water balance analysis results of scenario 1: current condition

Results of water balance analysis from 1993 to 2017 are presented in **Table 5.5.4-1**, it was found that an average water demand is 1,404.28 million cubic meter (m^3) per year with a total water shortage of 10 years as shown in **Table 5.5.4-2.** In 1993 there was the highest water shortage of 203.09 million cubic meter (m^3), accounting for 6.57% of that year because in the year 1993 there was less rainfall than usual and there was a drought crisis causing the need to divert water from the Mae Klong River into the Tha Chin River to help drive the saltwater in the Chao Phraya River Basin. As a result, the amount of supply water used for various activities, including the use of water to drive saltwater in the Mae Klong River basin was decreased.

For the years 1998, 2005, 2014, 2015, 2016, and 2017 where water shortages occurred, it was also the years of the country's drought. Water shortages were 1.63%, 2.65%, 1.02%, 0.09%, 4.64%, and 0.41% of the respective years. For other years, there were water shortage of only 0.11% - 0.64% of water supply in that year. Such water shortage did not affect the demand for other areas because it was a lack of water to preserve the ecosystem to push the saltwater alone. The lowest residual water for ecological preservation to drive saltwater is 91.60 million cubic meter (m^3) per month, or 35.34 cubic meter (m^3) per second.

Table 5.5.4-1

Amount of current water needs

B.E.	Current amount of water needs (million m^3/month)												
	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
2536	215.02	212.86	21.97	24.92	21.81	17.69	17.79	19.45	208.86	222.33	201.20	220.19	1,404.10
2537	216.38	211.11	21.41	24.46	21.58	19.55	19.21	19.90	208.89	222.29	201.06	222.90	1,408.74
2538	215.63	212.34	21.23	22.30	22.36	17.43	18.73	19.49	208.97	222.33	200.96	225.52	1,407.29
2539	212.96	210.37	21.21	23.73	21.05	19.07	18.39	18.98	208.96	222.27	200.94	223.70	1,401.63
2540	215.32	213.62	23.80	24.87	23.96	18.17	18.41	18.74	208.97	222.33	200.65	225.01	1,413.85
2541	216.95	213.27	19.63	22.47	23.31	19.09	18.70	19.02	208.87	221.96	200.45	224.68	1,408.38
2542	207.91	209.94	23.02	25.28	22.31	18.64	17.84	19.31	208.94	221.94	199.57	225.08	1,399.77
2543	207.31	211.12	21.19	24.63	22.06	20.21	17.91	19.23	208.92	221.08	200.67	213.91	1,388.24
2544	215.83	211.21	22.37	25.26	24.37	19.01	17.79	19.24	208.88	221.58	200.61	223.08	1,409.24
2545	215.24	210.55	20.82	25.72	22.22	18.78	19.56	18.19	208.29	222.33	200.31	218.42	1,400.42
2546	214.05	210.63	20.29	23.38	21.82	18.20	19.09	19.85	208.96	221.18	197.84	225.60	1,400.92
2547	213.87	210.56	21.88	25.28	21.23	17.79	20.27	19.70	208.97	221.43	201.03	220.90	1,402.92
2548	214.49	212.36	22.42	23.62	22.03	18.96	18.13	18.92	208.15	222.13	199.45	222.28	1,402.93
2549	214.96	211.67	21.56	25.33	22.87	19.17	19.03	19.36	208.80	222.01	200.84	224.57	1,410.18
2550	209.15	209.91	21.31	23.89	19.72	19.35	19.88	18.70	208.92	222.23	196.80	222.90	1,392.60
2551	210.01	211.41	21.40	23.99	22.61	19.66	18.00	19.01	208.96	222.32	201.17	220.72	1,399.26
2552	212.51	211.04	21.24	23.34	23.62	19.02	18.49	19.60	208.97	222.24	201.05	224.47	1,405.61
2553	215.53	212.88	20.30	21.81	19.50	18.10	18.87	19.78	208.47	222.27	199.69	219.81	1,397.01
2554	214.20	212.40	23.33	23.50	21.21	19.14	17.89	19.42	208.94	221.47	200.91	222.61	1,405.02
2555	215.69	211.14	23.85	23.05	23.11	17.89	18.75	17.73	208.88	222.29	201.17	224.75	1,408.31
2556	215.36	212.75	21.30	24.02	23.42	18.18	18.32	18.07	208.91	222.33	201.10	224.88	1,408.65
2557	216.01	212.39	21.90	24.88	20.96	19.83	18.00	18.35	206.36	221.35	199.78	223.14	1,402.95
2558	214.79	211.72	21.82	25.08	22.40	18.61	19.22	19.17	208.80	221.50	201.18	225.43	1,409.70
2559	214.79	211.72	21.82	25.08	22.40	18.61	19.22	19.17	208.80	221.50	201.15	225.43	1,409.68
2560	214.79	211.72	21.82	25.08	22.40	18.61	19.22	19.17	208.80	221.50	201.18	225.25	1,409.52
Average	213.95	211.63	21.72	24.20	22.17	18.75	18.67	19.10	208.73	221.93	200.43	223.01	**1,404.28**

Source : report on water usage of Mae Klong River in Hin Kong Power Plant by Panya Consultants Co.,Ltd

Table 5.5.4-2
Water shortage at present

B.E.	Amount of current water shortage (million m^3/month)												
	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
2536	15.72	35.76	-	-	-	-	-	-	32.37	41.69	9.02	68.51	203.09
2537	10.51	-	-	-	-	-	-	-	-	-	-	-	10.51
2538	-	-	-	-	-	-	-	-	-	-	-	-	-
2539	-	-	-	-	-	-	-	-	-	-	-	-	-
2540	-	-	-	-	-	-	-	-	-	-	-	-	-
2541	-	-	-	-	-	-	-	-	-	-	27.04	55.90	82.94
2542	-	-	-	-	-	-	-	-	-	-	-	-	-
2543	-	-	-	-	-	-	-	-	-	-	-	-	-
2544	-	-	-	-	-	-	-	-	-	-	36.33	-	36.33
2545	-	-	-	-	-	-	-	-	-	-	-	-	-
2546	-	-	-	-	-	-	-	-	-	-	-	-	-
2547	-	-	-	-	-	-	-	-	-	-	5.16	-	5.16
2548	11.31	84.07	-	-	-	-	-	-	-	-	-	-	95.39
2549	-	-	-	-	-	-	-	-	-	-	-	-	-
2550	-	-	-	-	-	-	-	-	-	-	-	-	-
2551	-	-	-	-	-	-	-	-	-	-	-	-	-
2552	-	-	-	-	-	-	-	-	-	-	-	-	-
2553	-	-	-	-	-	-	-	-	-	-	-	-	-
2554	-	-	-	-	-	-	-	-	-	-	-	-	-
2555	-	-	-	-	-	-	-	-	-	-	-	-	-
2556	-	-	-	-	-	-	-	-	-	-	-	-	-
2557	-	29.54	-	-	-	-	-	-	-	-	-	-	29.54
2558	-	-	-	-	-	-	-	-	-	2.70	-	-	2.70
2559	-	-	-	-	-	-	-	-	-	-	54.36	88.24	142.60
2560	16.89	-	-	-	-	-	-	-	-	-	-	-	16.89
Average	2.18	5.97	-	-	-	-	-	-	1.29	1.78	5.28	8.51	**25.01**

Source : report on water usage of Mae Klong River in Hin Kong Power Plant by Panya Consultants Co.,Ltd

2) Scenario 2 water balance analysis results for the future condition without supplying water to the power plant

The results of the water balance analysis in the future without supplying water to the power plant during 2025 - 2049 (Hin Kong Power Plant will be fully operational in 2025) are presented in **Table. 5.5.4-3**. It was found that, the average demand is 1,585.91 million cubic meter (m^3) per year. The year with the worst water shortage is the first year (2025) with the water demand of 295.72 million cubic meter (m^3), accounting for 9.57% of that year. Because the data of runoff water in the year 1993 in the analysis, was the year of the drought crisis, as described in the analysis results in the current condition scenario. Year 6 (2030), year 13 (2037), year 22 (2046), year 23 (1947), year 24 (2048), year and 25 (2049), are the years that the runoff water data of years of drought in the country were used in the analysis as well. The water shortages are 2.23%, 3.49%, 1.54%, 1.07%, 6.17%, and 0.78% of the water content in the respective years. While other years there have water shortages but not drought, there will be only 0.34% - 0.90% water shortage of that year as shown in **Table 5.5.4-4**. However, the water shortage does not affect the demand for other areas of water. This is because there is a lack of water to preserve the ecosystem to push the saltwater only, as is the result of the current analysis, the lowest residual water used to preserve the ecosystem to push the saltwater is 77.53 million cubic meter (m^3) per month, or 29.91 cubic meter (m^3) per second.

Table 5.5.4-3

Future Water needs where no water is supplied to the power plant

No.	B.E.	Future amount of water needs (million m^3/ month)												
		April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Total
1	**2568**	229.95	228.29	36.90	40.35	37.24	32.62	33.22	34.38	224.29	237.75	215.13	235.62	1,585.73
2	**2569**	231.31	226.54	36.33	39.88	37.00	34.48	34.64	34.83	224.32	237.72	214.99	238.33	1,590.37
3	**2570**	230.56	227.76	36.16	37.73	37.78	32.36	34.16	34.42	224.40	237.75	214.90	240.94	1,588.92
4	**2571**	227.89	225.80	36.14	39.16	36.48	34.00	33.81	33.91	224.38	237.70	214.87	239.12	1,583.26
5	**2572**	230.24	229.05	38.73	40.29	39.38	33.10	33.84	33.67	224.40	237.75	214.58	240.43	1,595.48
6	**2573**	231.87	228.70	34.56	37.90	38.73	34.02	34.12	33.95	224.29	237.38	214.38	240.11	1,590.01
7	**2574**	222.84	225.36	37.95	40.71	37.74	33.57	33.27	34.24	224.36	237.36	213.51	240.51	1,581.40
8	**2575**	222.24	226.54	36.12	40.06	37.48	35.13	33.34	34.16	224.34	236.50	214.60	229.34	1,569.87
9	**2576**	230.76	226.64	37.30	40.68	39.80	33.94	33.22	34.17	224.31	237.00	214.54	238.51	1,590.87
10	**2577**	230.17	225.98	35.75	41.14	37.65	33.71	34.99	33.12	223.72	237.75	214.24	233.85	1,582.05
11	**2578**	229.01	226.06	35.22	38.81	37.25	33.13	34.51	34.78	224.39	236.60	211.77	241.02	1,582.55
12	**2579**	228.79	225.99	36.81	40.70	36.66	32.72	35.70	34.63	224.40	236.86	214.96	236.33	1,584.54
13	**2580**	229.42	227.78	37.35	39.04	37.46	33.89	33.56	33.84	223.57	237.56	213.38	237.70	1,584.56
14	**2581**	229.89	227.10	36.49	40.76	38.29	34.10	34.45	34.29	224.23	237.44	214.78	240.00	1,591.81
15	**2582**	224.08	225.33	36.24	39.32	35.14	34.28	35.31	33.63	224.35	237.66	210.73	238.32	1,574.39
16	**2583**	224.94	226.83	36.33	39.41	38.04	34.59	33.43	33.94	224.39	237.75	215.10	236.15	1,580.89
17	**2584**	227.44	226.48	36.17	38.77	39.05	33.95	33.91	34.53	224.40	237.66	214.98	239.90	1,587.24
18	**2585**	230.45	228.30	35.23	37.24	34.93	33.03	34.30	34.71	223.90	237.69	213.63	235.23	1,578.64
19	**2586**	229.13	227.82	38.26	38.93	36.63	34.06	33.31	34.35	224.37	236.90	214.85	238.04	1,586.65
20	**2587**	230.62	226.57	38.77	38.48	38.54	32.82	34.17	32.66	224.31	237.72	215.11	240.18	1,589.94
21	**2588**	230.29	228.17	36.23	39.44	38.85	33.11	33.75	33.00	224.34	237.75	215.03	240.31	1,590.28
22	**2589**	230.94	227.82	36.83	40.30	36.38	34.76	33.42	33.28	221.78	236.78	213.71	238.57	1,584.58
23	**2590**	229.71	227.14	36.75	40.50	37.82	33.53	34.64	34.10	224.23	236.92	215.11	240.85	1,591.33
24	**2591**	229.71	227.14	36.75	40.50	37.82	33.53	34.64	34.10	224.23	236.92	215.09	240.85	1,591.31
25	**2592**	229.71	227.14	36.75	40.50	37.82	33.53	34.64	34.10	224.23	236.92	215.11	240.68	1,591.15
average		228.88	227.05	36.64	39.62	37.60	33.68	34.09	34.03	224.16	237.35	214.36	238.44	**1,585.91**

Table 5.5.4-4

Future water shortage where no water is supplied to the power plant

No.	B.E.	Future amount of water shortage (million m^3/month)													% of wter shortage	Remark	% of increasing water shortage
		April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	Total			
1	**2568**	30.52	50.38	-	-	-	-	-	-	47.76	56.53	22.93	87.60	295.72	9.57%	Use runoff data from B.E. 2536 which have drought	3.00%
2	**2569**	24.32	7.21	-	-	-	-	-	-	-	-	-	-	31.53	0.34%	use runoff data from B.E. 2537	0.23%
3	**2570**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2538	-
4	**2571**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2539	-
5	**2572**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2540	-
6	**2573**	-	-	-	-	-	-	-	-	-	-	41.49	71.71	113.20	2.23%	use runoff data from B.E. 2541 which have drought	0.59%
7	**2574**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2542	-
8	**2575**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2543	-
9	**2576**	-	-	-	-	-	-	-	-	-	-	50.66	-	50.66	0.90%	use runoff data from B.E. 2544	0.25%
10	**2577**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2545	-
11	**2578**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2546	-
12	**2579**	-	-	-	-	-	-	-	-	-	-	19.23	-	19.23	0.47%	use runoff data from B.E. 2547	0.34%
13	**2580**	26.45	99.05	-	-	-	-	-	-	-	-	-	-	125.50	3.49%	use runoff data from B.E. 2548 which have drought	0.84%
14	**2581**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E.2549	-
15	**2582**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2550	-
16	**2583**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2551	-
17	**2584**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2552	-
18	**2585**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2553	-
19	**2586**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E.2554	-
20	**2587**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2555	-
21	**2588**	-	-	-	-	-	-	-	-	-	-	-	-	-		use runoff data from B.E. 2556	-
22	**2589**	-	44.49	-	-	-	-	-	-	-	-	-	-	44.49	1.54%	use runoff data from B.E.2557 which have drought	0.52%
23	**2590**	-	-	-	-	-	-	-	-	12.69	18.11	-	-	30.79	1.07%	use runoff data from B.E. 2558 which have drought	0.98%
24	**2591**	6.60	-	-	-	-	-	-	-	11.06	-	68.34	103.67	189.66	6.17%	use runoff data from B.E. 2559 which have drought	1.53%
25	**2592**	31.82	-	-	-	-	-	-	-	-	-	-	-	31.82	0.78%	use runoff data from B.E. 2560 which have drought	0.37%
Average		4.79	8.05	-	-	-	-	-	-	2.86	2.99	8.11	10.52	**37.30**			

3) Scenario 3 : water balance analysis results for the future condition with supplying water to the power plant

The results the water balance for the future condition with supplying water to the power plant 2025 - 2049 (Hin Kong Power Plant will be fully operational in 2025) are shown in **Table 5.5.4. -5**. It was found that the demand for water is 1,597.46 million cubic meters (m^3) per year. The average water shortage increased from the future case where water is not supplying to the power plants of approximately 0.02% - 0.19% of the runoff water volume as presented in **Table 5.5.4-6**. The water shortage does not affect demand in other areas. This is because there is a lack of water to preserve the ecosystem to push saltwater only, as is the result of the current analysis. The lowest residual water used to preserve the ecosystem to push the saltwater is 76.57 million cubic meters (m^3) per month, or 29.54 cubic meters (m^3) per second.

Table 5.5.4-5

Amount of future water usage where water is supplied to the power plant

No.	B.E.	Amount of future water needs in case of sending water to power plant (million m^3/month)												
		April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
1	**2568**	230.89	229.27	37.85	41.33	38.22	33.57	34.20	35.33	225.27	238.73	216.02	236.60	1,597.28
2	**2569**	232.26	227.52	37.28	40.86	37.98	35.43	35.62	35.78	225.30	238.70	215.87	239.31	1,601.91
3	**2570**	231.51	228.75	37.10	38.71	38.76	33.31	35.14	35.37	225.38	238.73	215.78	241.92	1,600.46
4	**2571**	228.84	226.78	37.09	40.14	37.46	34.94	34.79	34.86	225.36	238.68	215.76	240.10	1,594.80
5	**2572**	231.19	230.03	39.68	41.27	40.36	34.05	34.82	34.62	225.38	238.73	215.47	241.42	1,607.02
6	**2573**	232.82	229.68	35.51	38.88	39.71	34.97	35.10	34.89	225.27	238.36	215.26	241.09	1,601.55
7	**2574**	223.79	226.34	38.90	41.69	38.72	34.52	34.25	35.19	225.35	238.34	214.39	241.49	1,592.95
8	**2575**	223.19	227.52	37.07	41.04	38.46	36.08	34.32	35.11	225.32	237.48	215.48	230.32	1,581.41
9	**2576**	231.70	227.62	38.25	41.66	40.78	34.89	34.20	35.12	225.29	237.98	215.43	239.49	1,602.41
10	**2577**	231.11	226.96	36.70	42.12	38.63	34.66	35.97	34.07	224.70	238.73	215.12	234.83	1,593.60
11	**2578**	229.96	227.04	36.17	39.79	38.23	34.08	35.49	35.73	225.37	237.58	212.66	242.00	1,594.10
12	**2579**	229.74	226.97	37.75	41.68	37.64	33.67	36.68	35.58	225.38	237.84	215.85	237.31	1,596.09
13	**2580**	230.37	228.76	38.30	40.03	38.44	34.84	34.54	34.79	224.55	238.54	214.27	238.68	1,596.11
14	**2581**	230.84	228.08	37.44	41.74	39.27	35.05	35.43	35.24	225.21	238.42	215.66	240.98	1,603.35
15	**2582**	225.03	226.31	37.19	40.30	36.12	35.23	36.29	34.58	225.33	238.64	211.62	239.30	1,585.94
16	**2583**	225.89	227.82	37.28	40.39	39.02	35.54	34.41	34.88	225.37	238.73	215.98	237.13	1,592.43
17	**2584**	228.39	227.46	37.12	39.75	40.03	34.90	34.89	35.48	225.38	238.65	215.86	240.88	1,598.78
18	**2585**	231.40	229.28	36.18	38.22	35.91	33.98	35.28	35.66	224.88	238.67	214.51	236.21	1,590.18
19	**2586**	230.08	228.80	39.21	39.91	37.61	35.01	34.29	35.30	225.35	237.88	215.73	239.02	1,598.20
20	**2587**	231.57	227.55	39.72	39.46	39.52	33.76	35.15	33.61	225.29	238.70	215.99	241.16	1,601.49
21	**2588**	231.24	229.15	37.18	40.42	39.83	34.06	34.73	33.95	225.32	238.73	215.92	241.29	1,601.82
22	**2589**	231.89	228.80	37.78	41.28	37.36	35.71	34.40	34.23	222.76	237.76	214.60	239.55	1,596.12
23	**2590**	230.66	228.12	37.70	41.48	38.81	34.48	35.62	35.05	225.21	237.90	216.00	241.83	1,602.87
24	**2591**	230.66	228.12	37.70	41.48	38.81	34.48	35.62	35.05	225.21	237.90	215.97	241.83	1,602.85
25	**2592**	230.66	228.12	37.70	41.48	38.81	34.48	35.62	35.05	225.21	237.90	216.00	241.66	1,602.69
Average		229.83	228.03	37.59	40.60	38.58	34.63	35.07	34.98	225.14	238.33	215.25	239.42	**1,597.46**

Source : report on water usage of Mae Klong River in Hin Kong Power Plant by Panya Consultants Co.,Ltd

Table 5.5.4-6

Future Water shortage where water is supplied to the power plant

No.	B.E.	Amount of future water shortage in case of sending water to power plant (million m^3/month)													% of water	Remark	% of increasing water shortage
		April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total			
1	**2568**	31.47	51.36	-	-	-	-	-	-	48.74	57.51	23.82	88.58	301.48	9.76%	Use runoff data from B.E. 2536 which has drought	0.19%
2	**2569**	25.27	8.19	-	-	-	-	-	-	-	-	-	-	33.46	0.36%	Use runoff data from B.E. 2537	0.02%
3	**2570**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2538	-
4	**2571**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2539	-
5	**2572**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2540	-
6	**2573**	-	-	-	-	-	-	-	-	-	-	42.37	72.69	115.07	2.26%	Use runoff data from B.E.2541 which has drought	0.04%
7	**2574**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2542	-
8	**2575**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2543	-
9	**2576**	-	-	-	-	-	-	-	-	-	-	51.54	-	51.54	0.91%	Use runoff data from B.E.2544	0.02%
10	**2577**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2545	-
11	**2578**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2546	-
12	**2579**	-	-	-	-	-	-	-	-	-	-	20.12	-	20.12	0.49%	Use runoff data from B.E. 2547	0.02%
13	**2580**	27.40	100.03	-	-	-	-	-	-	-	-	-	-	127.43	3.54%	Use runoff data from B.E. 2548 which has drought	0.05%
14	**2581**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2549	-
15	**2582**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2550	-
16	**2583**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2551	-
17	**2584**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2552	-
18	**2585**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2553	-
19	**2586**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2554	-
20	**2587**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2555	-
21	**2588**	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2556	-
22	**2589**	-	45.47	-	-	-	-	-	-	-	-	-	-	45.47	1.57%	Use runoff data from B.E. 2557 which has drought	0.03%
23	**2590**	-	-	-	-	-	-	-	-	13.67	19.09	-	-	32.75	1.14%	Use runoff data from B.E. 2558 which has drought	0.07%
24	**2591**	7.54	-	-	-	-	-	-	-	12.04	-	69.23	104.65	193.46	6.29%	Use runoff data from B.E. 2559 which has drought	0.12%
25	**2592**	32.76	-	-	-	-	-	-	-	-	-	-	-	32.76	0.80%	Use runoff data from B.E. 2560 which has drought	0.02%
Average		4.98	8.20	-	-	-	-	-	-	2.98	3.06	8.28	10.64	**29.76**			

4) Scenario 4: water balance analysis results for the future condition with supplying water to the power plant without taking the side flow into the consideration

The results of water balance analysis in the future condition with supplying water to the power plant without taking the side flow into the consideration in 2025 - 2049 (Hin Kong Power Plant will be fully operational in 2025), are shown in **Table 5.5.4-7.** It was found that the average water demand is equal to that of the case of the presence of the power plant. There is an increase in average water shortage from the future case where water is not supplying to the power plants of approximately 0.02% - 3.54% of the runoff water volume as shown in **Table 5.5.4-8**. The water shortage does not affect demand in other areas. This is because there is a lack of water to preserve the ecosystem to push saltwater only, as is the result of the current analysis. The lowest residual water used to preserve the ecosystem to push the saltwater is 62.70 million cubic meters (m^3) per month, or 24.19 cubic meters (m^3) per second.

Table 5.5.4-7

Side Flow Amount of future water usage where no water is supplied to the power plant (not taking Side Flow into consideration)

No.	B.E.	nount of future water needs when sending water to power platn without considering side flow (million m^3/mont											
		April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
1	2568	230.89	229.27	37.85	41.33	38.22	33.57	34.20	35.33	225.27	238.73	216.02	236.60	1,597.28
2	2569	232.26	227.52	37.28	40.86	37.98	35.43	35.62	35.78	225.30	238.70	215.87	239.31	1,601.91
3	2570	231.51	228.75	37.10	38.71	38.76	33.31	35.14	35.37	225.38	238.73	215.78	241.92	1,600.46
4	2571	228.84	226.78	37.09	40.14	37.46	34.94	34.79	34.86	225.36	238.68	215.76	240.10	1,594.80
5	2572	231.19	230.03	39.68	41.27	40.36	34.05	34.82	34.62	225.38	238.73	215.47	241.42	1,607.02
6	2573	232.82	229.68	35.51	38.88	39.71	34.97	35.10	34.89	225.27	238.36	215.26	241.09	1,601.55
7	2574	223.79	226.34	38.90	41.69	38.72	34.52	34.25	35.19	225.35	238.34	214.39	241.49	1,592.95
8	2575	223.19	227.52	37.07	41.04	38.46	36.08	34.32	35.11	225.32	237.48	215.48	230.32	1,581.41
9	2576	231.70	227.62	38.25	41.66	40.78	34.89	34.20	35.12	225.29	237.98	215.43	239.49	1,602.41
10	2577	231.11	226.96	36.70	42.12	38.63	34.66	35.97	34.07	224.70	238.73	215.12	234.83	1,593.60
11	2578	229.96	227.04	36.17	39.79	38.23	34.08	35.49	35.73	225.37	237.58	212.66	242.00	1,594.10
12	2579	229.74	226.97	37.75	41.68	37.64	33.67	36.68	35.58	225.38	237.84	215.85	237.31	1,596.09
13	2580	230.37	228.76	38.30	40.03	38.44	34.84	34.54	34.79	224.55	238.54	214.27	238.68	1,596.11
14	2581	230.84	228.08	37.44	41.74	39.27	35.05	35.43	35.24	225.21	238.42	215.66	240.98	1,603.35
15	2582	225.03	226.31	37.19	40.30	36.12	35.23	36.29	34.58	225.33	238.64	211.62	239.30	1,585.94
16	2583	225.89	227.82	37.28	40.39	39.02	35.54	34.41	34.88	225.37	238.73	215.98	237.13	1,592.43
17	2584	228.39	227.46	37.12	39.75	40.03	34.90	34.89	35.48	225.38	238.65	215.86	240.88	1,598.78
18	2585	231.40	229.28	36.18	38.22	35.91	33.98	35.28	35.66	224.88	238.67	214.51	236.21	1,590.18
19	2586	230.08	228.80	39.21	39.91	37.61	35.01	34.29	35.30	225.35	237.88	215.73	239.02	1,598.20
20	2587	231.57	227.55	39.72	39.46	39.52	33.76	35.15	33.61	225.29	238.70	215.99	241.16	1,601.49
21	2588	231.24	229.15	37.18	40.42	39.83	34.06	34.73	33.95	225.32	238.73	215.92	241.29	1,601.82
22	2589	231.89	228.80	37.78	41.28	37.36	35.71	34.40	34.23	222.76	237.76	214.60	239.55	1,596.12
23	2590	230.66	228.12	37.70	41.48	38.81	34.48	35.62	35.05	225.21	237.90	216.00	241.83	1,602.87
24	2591	230.66	228.12	37.70	41.48	38.81	34.48	35.62	35.05	225.21	237.90	215.97	241.83	1,602.85
25	2592	230.66	228.12	37.70	41.48	38.81	34.48	35.62	35.05	225.21	237.90	216.00	241.66	1,602.69

Source : report on water usage of Mae Klong River in Hin Kong Power Plant by Panya Consultants Co.,Ltd

Table 5.5.4-8

Amount of future water shortage when water is supplied to the power plant (not taking Side Flow into consideration)

No.	B.E.	ount of future water shortage when sending water to power platn without considering side flow (million m^3/mor													% of water	Remark	% of increasing water shortage
		April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total			
1	2568	31.93	57.77	-	-	-	-	-	-	64.57	64.37	25.95	89.27	333.86	10.80%	Use runoff data from B.E. 2536 which has drought	1.23%
2	2569	25.77	45.07	-	-	-	-	-	-	-	-	-	-	70.84	0.77%	Use runoff data from B.E. 2537	0.43%
3	2570	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2538	-
4	2571	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2539	-
5	2572	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2540	-
6	2573	-	-	-	-	-	-	-	-	-	-	43.49	72.99	116.47	2.29%	Use runoff data from B.E. 2541 which has drought	0.06%
7	2574	1.61	-	-	-	-	-	-	-	-	-	-	-	1.61	0.02%	Use runoff data from B.E. 2542	0.02%
8	2575	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2543	-
9	2576	-	-	-	-	-	-	-	-	-	-	54.08	-	54.08	0.96%	Use runoff data from B.E. 2544	0.06%
10	2577	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2545	-
11	2578	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E.2546	-
12	2579	-	-	-	-	-	-	-	-	-	-	20.67	-	20.67	0.50%	Use runoff data from B.E. 2547	0.03%
13	2580	27.99	113.77	-	-	-	-	-	-	23.77	-	-	-	165.54	4.60%	Use runoff data from B.E. 2548 which has drought	1.11%
14	2581	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2549	-
15	2582	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2550	-
16	2583	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2551	-
17	2584	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2552	-
18	2585	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2553	-
19	2586	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2554	-
20	2587	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2555	-
21	2588	-	-	-	-	-	-	-	-	-	-	-	-	-		Use runoff data from B.E. 2556	-
22	2589	-	55.84	-	-	-	-	-	-	15.87	10.59	2.09	-	84.39	2.92%	Use runoff data from B.E. 2557 which has drought	1.38%
23	2590	-	-	-	-	-	-	-	-	31.27	33.98	-	-	65.24	2.27%	Use runoff data from B.E. 2558 which has drought	1.20%
24	2591	26.62	18.71	-	-	-	-	-	-	50.96	-	84.08	118.20	298.58	9.71%	Use runoff data from B.E.2559 which has drought	3.54%
25	2592	51.84	-	-	-	-	-	-	-	-	-	-	-	51.84	1.27%	Use runoff data from B.E. 2560 which has drought	0.49%
Average		6.63	11.65	-	-	-	-	-	-	7.46	4.36	9.21	11.22	**50.52**			

Remark : Percent of increasing water shortage compared to scenario 2- future state where no water is sent to the power plant

Source : report on water usage of Mae Klong River in Hin Kong Power Plant by Panya Consultants Co.,Ltd

5.5.5 Impact on drainage and flood prevention systems

(1) Construction period

The Project will adjust the land of 0.5 meter height from the original ground level, so, the ground level will be equal to the area of the TECO Power Plant. For drainage of rainwater that falls within the construction area. The Project will construct temporary gutters and the surrounding area in line with permanent gutters. The project will build a rainwater collection pond and a sediment collection pond before connecting to the rainwater gutter. A portion of rainwater will be used while some part will be drained into the Mae Klong River. The rainwater flowing into the drainage gutter may wash away debris and various materials from construction activities such as soil, stone, sand, and building materials, etc. Therefore, in order to prevent the drainage gutters from becoming shallow, the Project has assigned a contractor to build a sedimentation pond to separate sediment from rainwater before flowing into the drain. The contractor must have a plan to check the condition of the blockage of the gutter and inspect the placement of various materials used in construction. So, they will not obstruct the flow or obstruct the drain. The inspection shall be performed on a monthly basis. For areas where rainwater may contaminate with oil, such as where the engine oil tank is placed or maintenance area, the Project shall set up a tray and a temporary roof to prevent rainwater.

Therefore, the impact on drainage and flood prevention systems is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	1	(1) = 1	1	1	low

(2) Operation period

1) Conditions of drainage of the area surrounding the power plant

From the study of the current drainage conditions surrounding the power plant from the river network data in the area surrounding Project, there are different directions of water source flowing into the Mae Klong River including the irrigation canals in the area as shown in **Figure 5.5.5-1**.

From examining the current drainage of the TECO Power Plant and the area to be developed as the Hin Kong Power Plant, it was found that the drainage is to the north side of the power plant into the irrigation canal prior flowing into the Mae Klong River as shown in **Figure 5.5.5-2**.

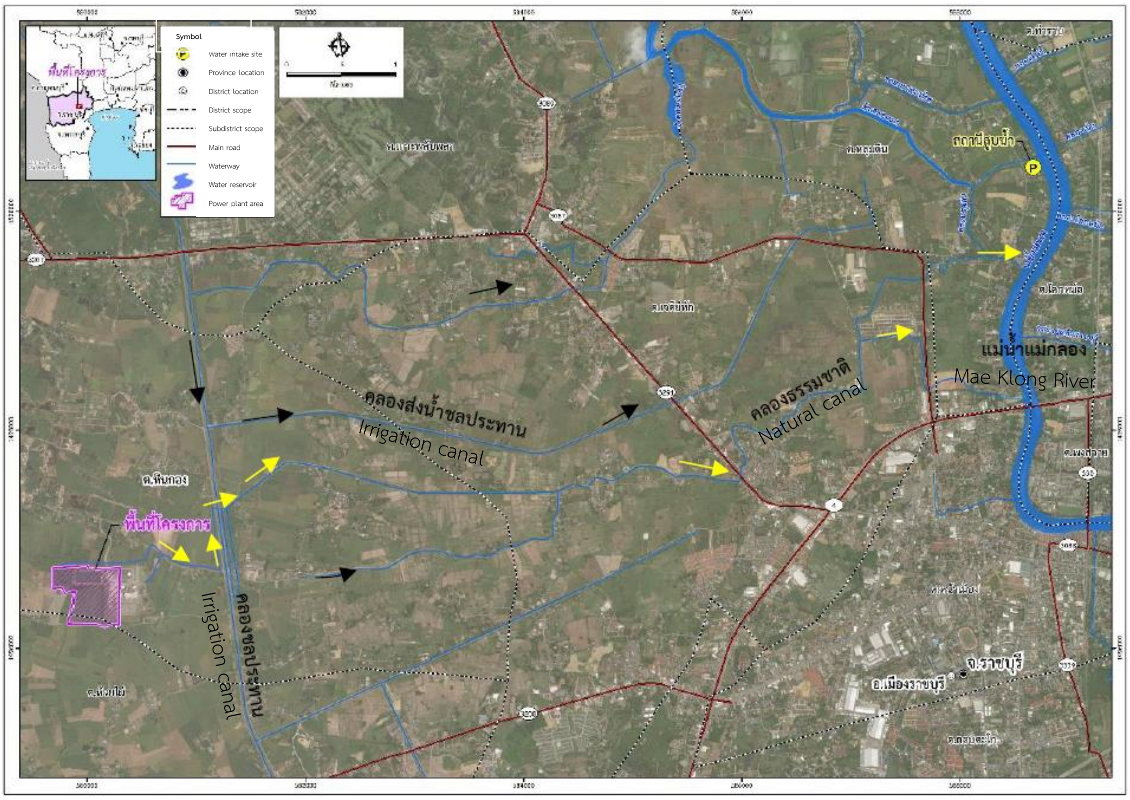


Figure 5.5.5-1 Direction of overall water flow

Figure 5.5.5-2 Current water drainage of TECO Power Plant and Hin Kong Power Plant's development area

The results of the preliminary examination of the drainage capacity of the drainage canal on the north side showed that the condition of the concrete canals is about one meter width at the bottom and six meters width at the top as shown in **Figure 5.5.5-3**.

Figure 5.5.5-3 North drainage pond's characteristics

In addition, preliminary examination of the drainage capacity of the southern side drainage canal found that the southern side drainage canal is concrete with the bottom width of approximately 1.25 meters and the top width of approximately 4.4 meters and the depth of approximately 1.8 meters, as shown in **Figure 5.5.5-4**.

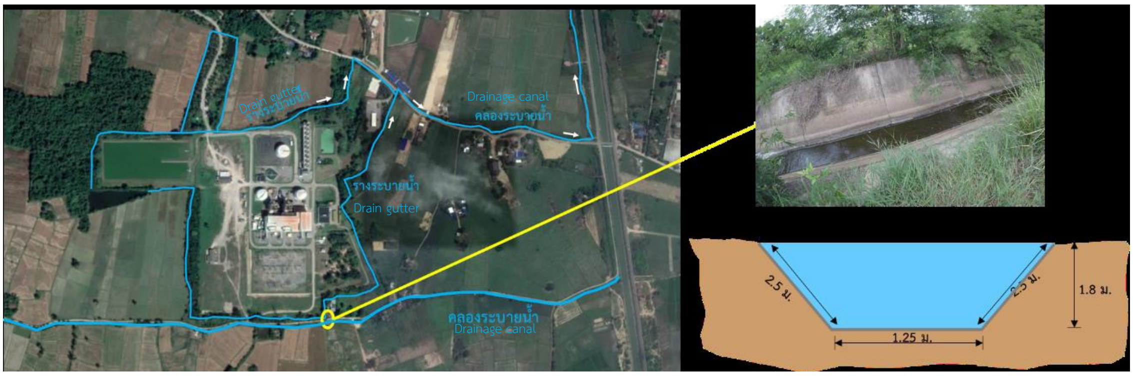
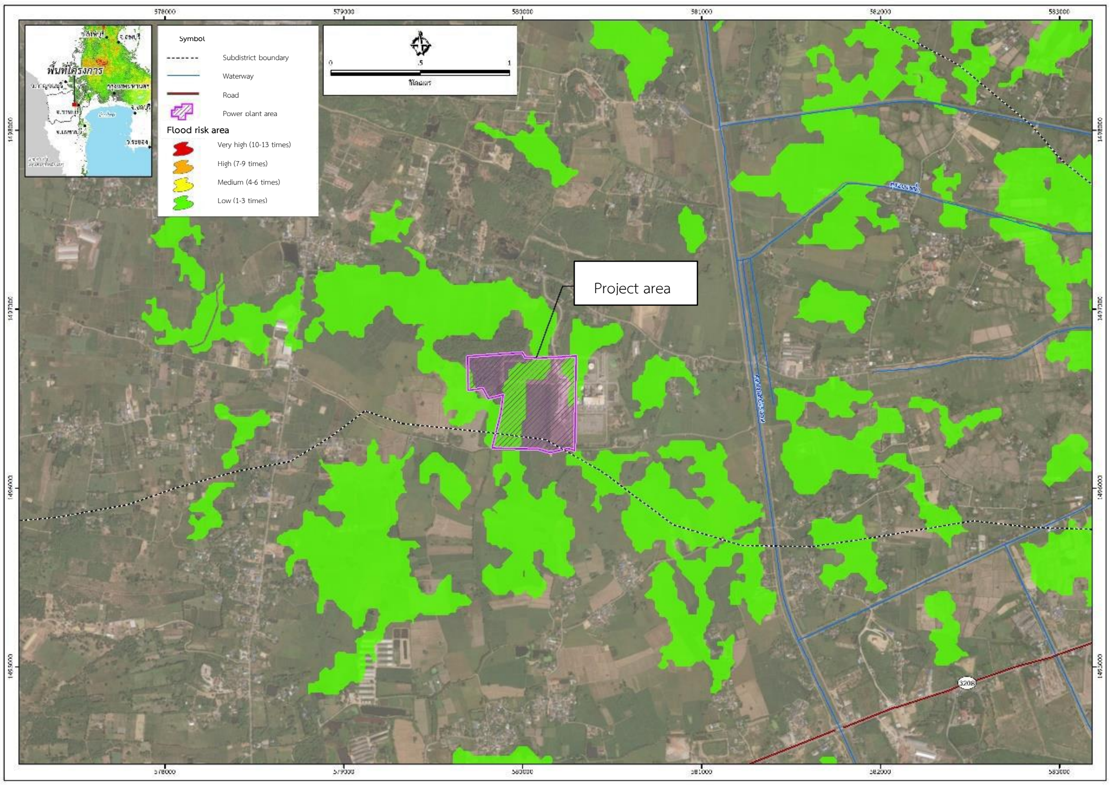


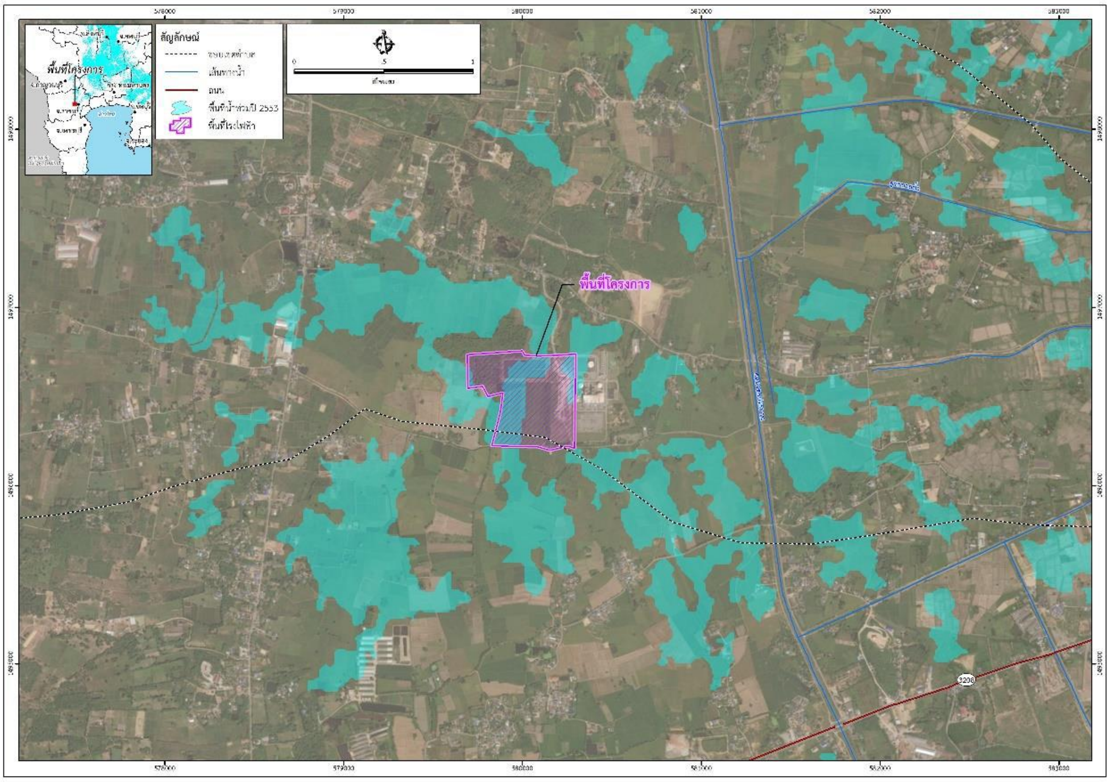
Figure 5.5.5-4 South drainage pond's characteristics

The Consultant investigated flood events in the pass in the area of the power plant and nearby areas using flood data from the Geo-Informatics and Space Technology Development Agency (GISTDA) from 2005 to 2017, it was found that the power plant area and nearby faced one flooding event in 2010. The flooding frequency of the power plant and nearby areas is shown as **Figure 5.5.5-5.** The aerial scope of the flooding in the area of the power plant and nearby areas that occurred in 2010 are shown in **Figure 5.5.5-6**. The cause of flooding in the area is due to heavy rainfall in the area, tropical storm "Kon Soen" (July) and tropical storm "Mindon Le" (August) resulted in the heavy rainfall and flooding in the upper western region in many areas.



Source : Data analysis from Geo Informatics and Space Technology Development Agent (GISTDA) during B.E. 2548 – B.E. 2560 (2005-2017)

Figure 5.5.5-5 Flooding frequency in power plant's area and nearby area.



Source : Data analysis from Geo Informatics and Space Technology Development Agent (GISTDA

Figure 5.5.5-6 Showing flooding area in B.E. 2553 (2010)

2) Analysis of flooding in the area

(a) Analysis of runoff volume

Analysis of the flooding from the rain in the project area was analyzed from the amount of runoff caused by rainfall during the year and various repetitions together with the drainage capacity of the drainage canal on the north side of the power plant as shown in **Figure 5.5.5-7**. Rainwater is drained into the catchment area of 2.74 square kilometers (km^2), where the catchment area is shown in **Figure 5.5.5-8**.

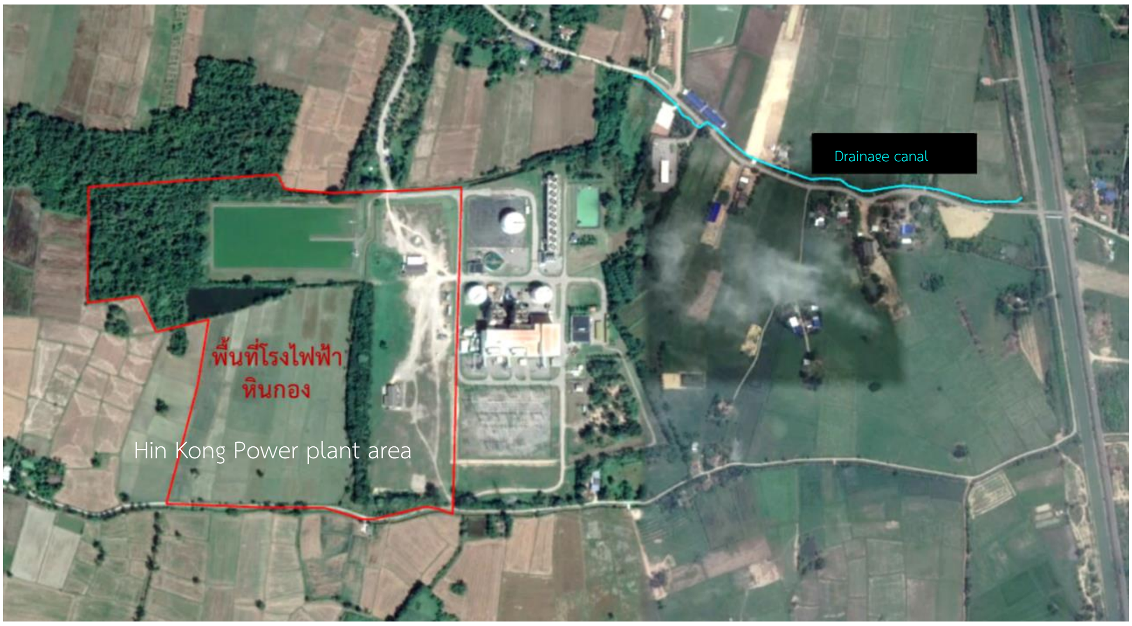


Figure 5.5.5-7 Drainage canal, North of power plant

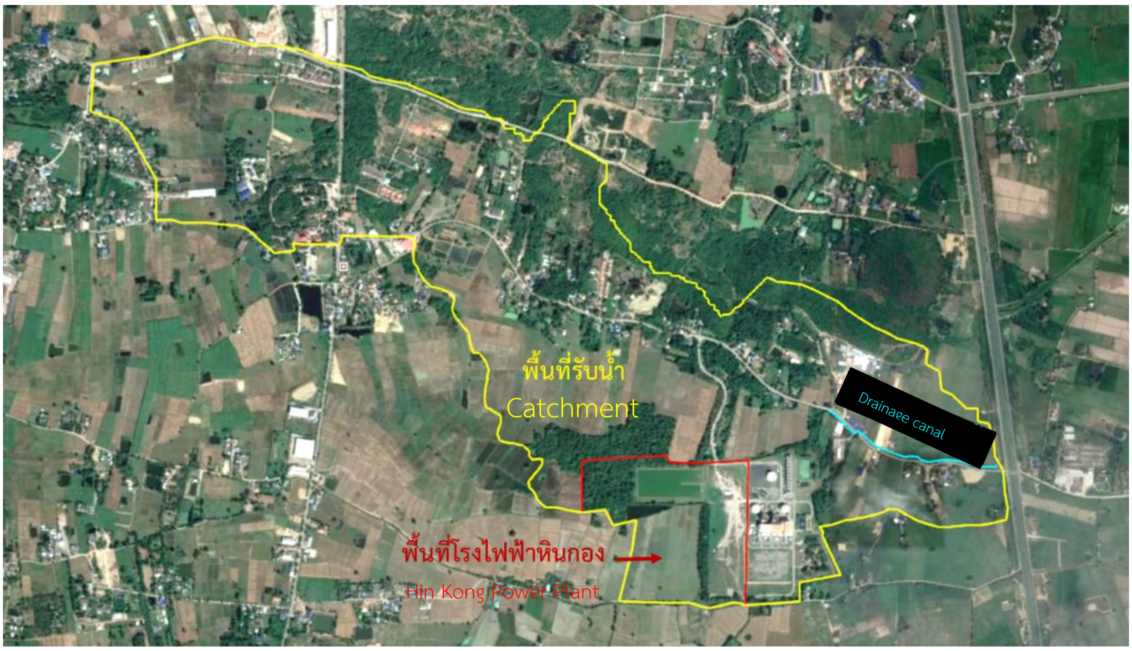


Figure 5.5.5-8 Water retention/catchment area in the North

To analyze the amount of runoff from rainfall in the catchment area of the north drainage canal, it is determined from the amount of water runoff caused by the amount of rainfall at various recurring years to be calculated from the following Rational Equation.

$$Q = 0.278\ CiA$$

where Q is the amount of runoffs (cubic meters (m^3) / sec)
C is the runoff coefficient in agricultural area and open spaces which are seepage area with C equal to 0.25
Concrete area with C equal to 0.85
i is the rain concentration (mm/hr) in various recurrence years (as shown in **Table 5.5.5-1**)

A is the size of the water retention area (square meter, m^2)

Table 5.5.5-1

Amount of rain in various recurrence years

Duration	Maximum amount of accumulated rain (mm) at various recurring years											
	2 years	5 years	10 years	15 years	25 years	50 years	100 years	150 years	200 years	250 years	500 years	1000 years
15 min*	27.6	36.8	42.8	45.7	50.6	56.2	61.9	65.0	67.4	69.3	74.9	80.5
30 min*	42.4	60.9	73.2	79.0	88.8	100.3	111.7	118.2	123.1	126.9	138.1	149.6
45 min*	50.3	71.8	86.2	93.0	104.3	117.7	131.1	138.6	144.4	148.8	161.9	175.1
1 hr*	57.5	82.0	98.3	106.0	119.0	134.1	149.3	157.9	164.3	169.4	184.3	199.4
2 hr*	66.2	95.9	115.7	125.0	140.7	159.1	177.4	187.9	195.7	201.9	219.9	238.3
3 hr.*	72.6	99.1	116.7	124.9	138.7	155.1	171.4	180.6	187.5	192.9	208.9	225.1
6 hr*	78.7	104.9	122.4	130.5	144.3	160.6	176.6	185.8	192.6	198.1	214.0	229.9
12 hr*	83.8	112.1	130.9	139.7	154.6	172.1	189.4	199.3	206.7	212.5	229.5	246.9
1 day**	85.6	117.5	138.6	150.5	165.3	185.1	204.7	216.2	224.3	230.6	250.1	269.6
2 days**	113.5	151.6	176.8	191.1	208.7	232.4	255.9	269.6	279.3	286.8	310.1	333.5
3 days**	130.9	168.6	193.6	207.7	225.2	248.6	271.8	285.4	295.0	302.4	325.6	348.6
4 days**	139.4	175.5	199.4	212.9	229.6	252.0	274.2	287.2	296.4	303.5	325.6	347.7
5 days**	149.5	185.9	210.0	223.6	240.5	263.1	285.5	298.6	307.9	315.1	337.3	359.6

Source : * Adjust from IDF curve details at Wat Num Ta K11A station from Royal Irrigation Department
** Analyses rain data from 424301 station of Meteorological Department

Runoff analysis can be divided into 2 scenarios: current condition and with presence of the Project as follows:

Scenario 1 current condition

Analysis of runoff in current conditions was divided into 2 parts: the amount of runoff from areas outside Hin Kong Power Plant and the amount of runoff from the Hin Kong Power Plant area as shown in **Table 5.5.5-2** and **Table 5.5.5-3**. The analysis considered areas for runoff analysis are water seepage area (area A1), concrete area of the TECO Power Plant (area A2), and seepage area at Hin Kong Power Plant (Area A3) as shown in **Figure 5.5.5-9**. The results of analysis of total runoff as shown in **Table 5.5.5-4.**

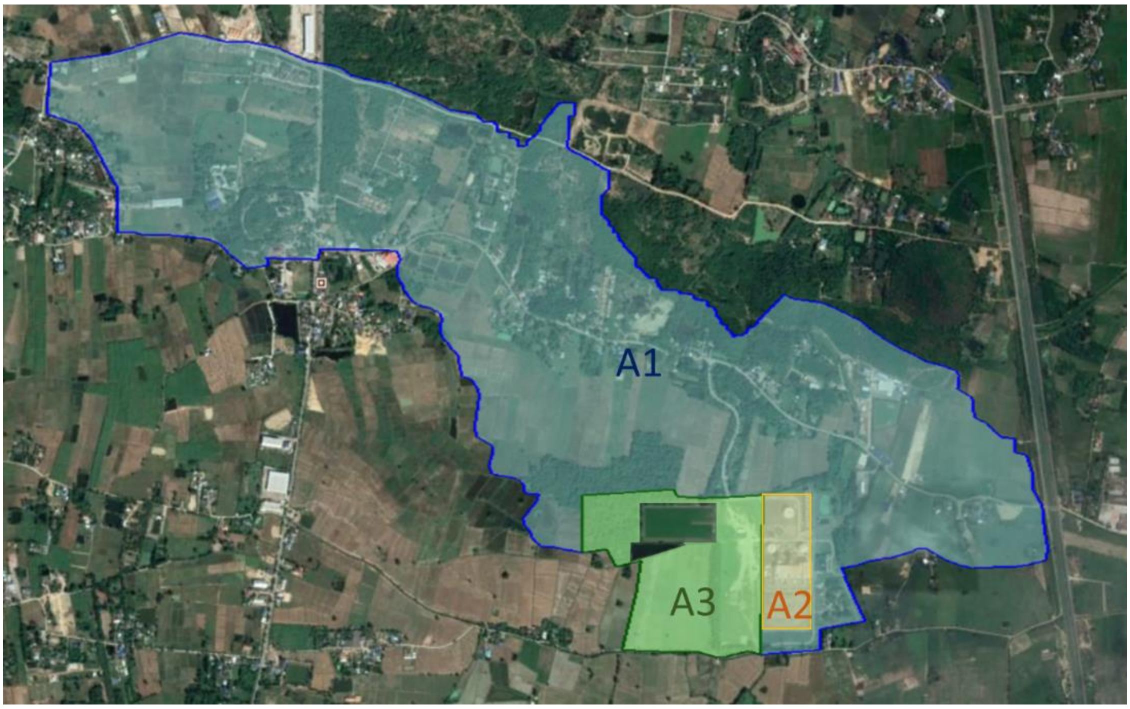


Figure 5.5.5-9 **Area division for analysing the amount of runoffs**

Table 5.5.5-2
Analysis result of runoff outside of Hin Kong Power Plant area (at present)

Recurrence years (year)	Rain concentration 24 hr., i (mm./hr.)	Concrete area (A2 area of TECO Power Plant as in Figure 5.5.5-9)		Seepage area (A1 area as in Figure5.5.5-9)		Runoff volume, Q (m^3/sec)
		Runoff coefficient, C	Catchment area, A (km^2)	Runoff coefficient, C	Catchment area, A (km^2)	
5	4.9	0.85	0.07	0.25	2.41	0.91
10	5.8	0.85	0.07	0.25	2.41	1.07
15	6.3	0.85	0.07	0.25	2.41	1.17
25	6.9	0.85	0.07	0.25	2.41	1.28
50	7.7	0.85	0.07	0.25	2.41	1.42
100	8.5	0.85	0.07	0.25	2.41	1.57

Table 5.5.5-3
Analysis result of runoff in project's area (at present)

Recurrence year (year)	Rain concentration 24 hr., i (mm./hr.)	Seepage area (A3 area of Hin Kong Power Plant as in Figure 5.5.5-9)		Runoff volume, Q (m^3/sec)
		Runoff coefficient, C	Catchment area, A (km^2)	
5	4.9	0.25	0.23	0.08
10	5.8	0.25	0.23	0.09
15	6.3	0.25	0.23	0.10
25	6.9	0.25	0.23	0.11
50	7.7	0.25	0.23	0.12
100	8.5	0.25	0.23	0.13

Table 5.5.5-4

Analysis result from runoff in all water retention area (at present)

Recurrence period (year)	Runoff volume outside power plant area (m^3/sec)	Runoff volume from power plant area (m^3/sec)	Total amount of runoffs (m^3/sec)
5	0.91	0.08	0.98
10	1.07	0.09	1.16
15	1.17	0.10	1.26
25	1.28	0.11	1.39
50	1.42	0.12	1.55
100	1.57	0.13	1.71
Remark	From **Table 5.5.5-2**	From **Table 5.5.5-3**	

Scenario 2 with presence of Hin Kong Power Plant

Runoff analysis in case of presence of Hin Kong Power Plant, the analysis was divided into 2 parts, the same as in the case of current condition, i.e. the amount of runoff from the area outside the Hin Kong Power Plant and the amount of water runoff from the Hin Kong Power Plant area as shown in **Table 5.5.5-5** and **Table 5.5.5-6**. The results of the analysis of total runoff are presented in **Table 5.5.5-7**.

Table 5.5.5-5

Analysis result on runoff volume outside Hin Kong Power Plant area (In case of presence Hin Kong Power Plant)

Recurrence years (year)	Rain concentration 24 hr., i (mm./hr.)	Concrete area (A2 area of TECO Power Plant as in Figure 5.5.5-9)		Seepage area (A1 area as in Figure5.5.5-9)		Runoff volume, Q (m^3/sec)
		Runoff coefficient, C	Catchment area, A (km^2)	Runoff coefficient, C	Catchment area, A (km^2)	
5	4.9	0.85	0.07	0.25	2.41	0.91
10	5.8	0.85	0.07	0.25	2.41	1.07
15	6.3	0.85	0.07	0.25	2.41	1.17
25	6.9	0.85	0.07	0.25	2.41	1.28
50	7.7	0.85	0.07	0.25	2.41	1.42
100	8.5	0.85	0.07	0.25	2.41	1.57

Table 5.5.5-6

Analysis result on runoff volume from Hin Kong Power Plant area (In case of presence of Hin Kong Power Plant)

Recurrence years (year)	Rain concentration 3 hr., i (mm./hr.)	Concrete area (After constructing Hin Kong Power Plant)		Seepage area (After constructing Hin Kong Power Plant)		Runoff volume, Q (m^3/sec)
		Runoff coefficient, C	Catchment area, A (km^2)	Runoff coefficient, C	Catchment area, A (km^2)	
5	33.0	0.85	0.11	0.25	0.07	1.04
10	38.9	0.85	0.11	0.25	0.07	1.22
15	41.6	0.85	0.11	0.25	0.07	1.31
25	46.2	0.85	0.11	0.25	0.07	1.46
50	51.7	0.85	0.11	0.25	0.07	1.63
100	57.1	0.85	0.11	0.25	0.07	1.80

Table 5.5.5-7

Results of the analysis of runoff from all catchment areas (in case of presence of Hin Kong Power Plant)

Recurrence period (year)	Runoff volume outside the power plant (m^3/s)	Runoff volume from the power plant area (m^3/s)	Total runoff volume (m^3/s)
5	0.91	1.04	1.95
10	1.07	1.22	2.30
15	1.17	1.31	2.48
25	1.28	1.46	2.73
50	1.42	1.63	3.05
100	1.57	1.80	3.37
Remark	From **Table 5.5.5-5**	From **Table 5.5.5-6**	

3) Assessment of the drainage capacity of the drainage canal on the north side of the power plant

The drainage capacity of the drainage canal on the north of the power plant can be calculated from the Manning's Equation as follows:

$$Q = \frac{1}{N} AR^{2/3} S^{1/2}$$

equation 1

Where: Q is the drainage rate (cubic meters (m^3) /second)

n is the roughness coefficient of drainage canal, which is a concrete slab canal, n equals to 0.020 (**Figure 5.5.5-10**)

A is the flow cross-section area (square meter (m^2)), equals to 8.75 m^2

R is the hydraulics radius (meter) calculated from A/P

P is the wet border (meter) is the length of the canal surface in contact with water, equals to 8 m (**Figure 5.5.5-10**)

S is the canal slope, approximately 1:20,000

From Equation 1, the drainage capacity of the canal north of the power plant equals to 3.28 cubic meters (m^3) /second.

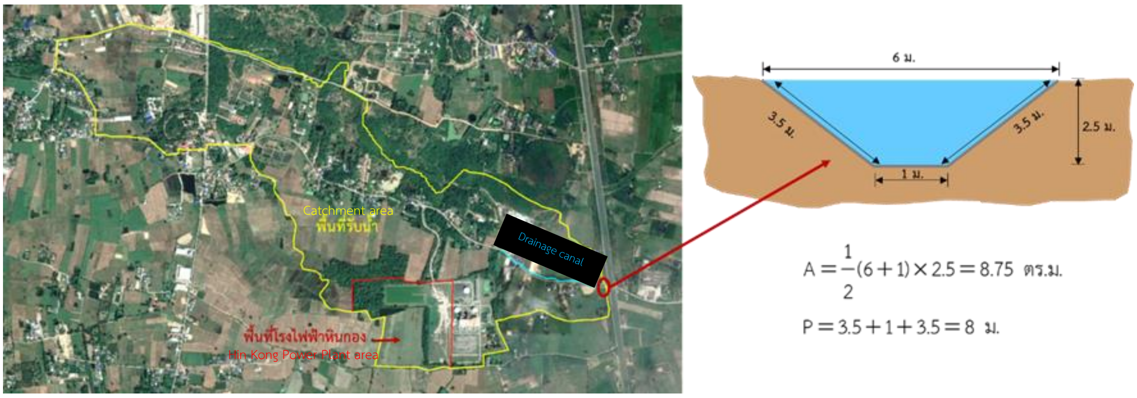


Figure 5.5.5-10 Section view of drainage pond in power plant area

Based on the results of the calculation of drainage capacity of the drainage canal and the amount of runoff at various recurrence years analyzed in **Table 5.5.5-4** and **Table 5.5.5-7**, the overflowing volume of the drainage canal was calculated as shown in **Table 5.5.5-8**.

Table 5.5.5-8

Amount of water overflowing from the drainage pond at recurring years

Recurrence period (year)	Amount of water able to be drained (m^3/sec)	Current		In case of presence of Hin Kong Power Plant	
		Total runoff volume (m^3/sec)	Amount of overflowing water from drainage pond (m^3/sec)	Total runoff volume (m^3/sec)	Amount of overflowing water from drainage pond (m^3/sec)
5	3.28	0.98	No overflow	1.95	No overflow
10	3.28	1.16	No overflow	2.30	No overflow
15	3.28	1.26	No overflow	2.48	No overflow
25	3.28	1.39	No overflow	2.73	No overflow
50	3.28	1.55	No overflow	3.05	No overflow
100	3.28	1.71	No overflow	3.37	0.09

From **Table 5.5.5-8**, it was found that the drainage canals on the north side of the power plant is able to handle runoff in the case of current conditions at the 100 recurrence year without overflowing of the drainage canal. In the case of having the Hin Kong Power Plant at the 100recurrence year, the runoff volume was 3.37 cubic meters (m^3) /second, slightly more than the capacity of the drainage canal of only 0.09 cubic meters (m^3) /second only.

Based on the amount of water that flows from the drainage canal at the various recurrence years in **Table 5.5.5-8**, it can be analyzed as the flood depth caused by rain in undrained areas as follows:

$$\boxed{Q = \frac{1}{N} AR^{2/3} S^{1/2}} \qquad \text{..........................equation 2}$$

Determine the cross-sectional of flood area A as a rectangle. Therefore, the equation can be rearranged as follows:

$$\boxed{Q = \frac{1}{n} A \left(\frac{A}{P}\right)^{2/3} S^{1/2}}$$

$$\boxed{Q = \frac{1}{N} (H \times L) \left(\frac{H \times L}{2H + L}\right)^{2/3} S^{1/2}} \qquad \text{..........................equation 3}$$

Where: Q is the overflow volume from the drainage canal (cubic meters (m^3) /s) as shown in **Table 5.5.5-8**

n is the roughness coefficient of drainage canal, which is a floodplain with plants, n equals to 0.200

H is the flood depth (meter)

L is the width of the catchment area (meter), which is 500 m as shown in **Figure 5.5.5-11**

S is the area slope, approximately 1:20,000

From Equation 3, the potential flood depths that may occur in the area of the power plant at various recurrence years can be analyzed as shown in **Table 5.5.5-9**.

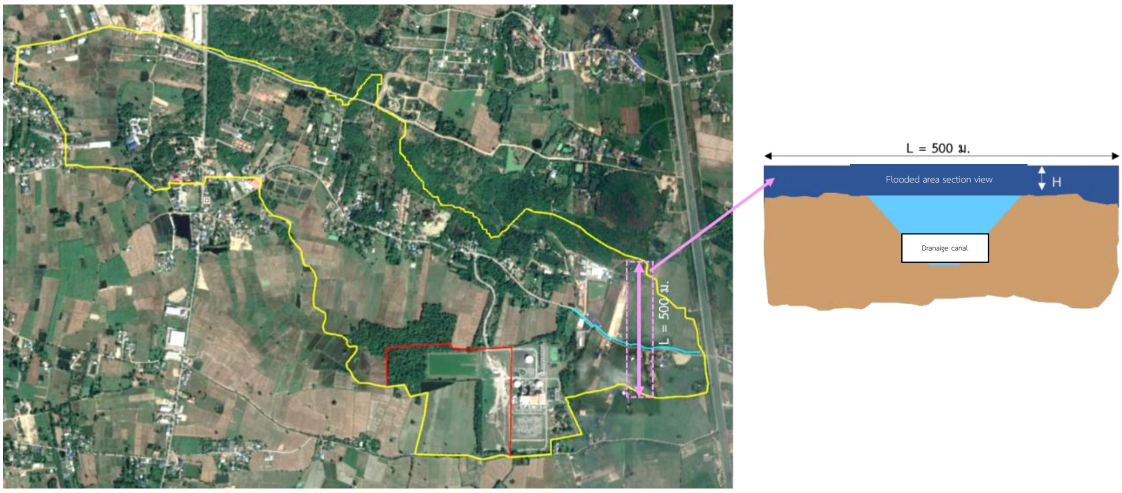


Figure 5.5.5-11 Section view of flooding area from water overflowing out of drainage pond

Table 5.5.5-9

Height of flooding area in case of the presence of Hin Kong Power Plant

Recurrence year (year)	Overflow volume from the drainage canal (m^3/s)	Manning n	Slope of the area	Length of the flood area (m)	Depth of flood (m)
5	No overflow	0.200	1 : 20,000	-	No flood
10	No overflow	0.200	1 : 20,000	-	No flood
15	No overflow	0.200	1 : 20,000	-	No flood
25	No overflow	0.200	1 : 20,000	-	No flood
50	No overflow	0.200	1 : 20,000	-	No flood
100	0.09	0.200	1 : 20,000	500	0.011

From **Table 5.5.5-9**, it was found that in the case of presence of Hin Kong power plant at a recurrence cycle of 5 years, 10 years, 15 years, 25 years, and 50 years, there will be no impact on flooding due to overflowing of the drainage canal but at the 100 recurrence years, the height of the flood level is 0.01 meter above the drainage canal, which is a negligible flood height.

3) Drainage and water retention guidelines in the power plant area

From the analysis of the flooding from the rainfall in the area, it was found that the construction of the Hin Kong Power Plant causes the seepage area to be reduced of about 113,000 square meter (m^2) from changing the area into concrete, which increases the amount of runoff. Therefore, in order to prevent problems that may affect the community, the Project has considered a rainfall retention pond in the Project that can support the accumulated rainfall continuously for one day (based on the intensity of rain at the 25 recurrence years).

For rainwater in the Project area that is not contaminated, i.e. covered and road areas, from the survey and preparation of the contour line, the Project has used in the design and construction. The rainwater that falls in the project area will be collected into a rain drainage gutter (**Figure 5.5.5-12**), which is a concrete track on the side of the power plant. The drainage system has the direction of water flow according to the slope of the area. Rainwater will be collected into two retention ponds. The Project has divided the catchment area into 2 areas: upper and lower areas. Details are as follows:

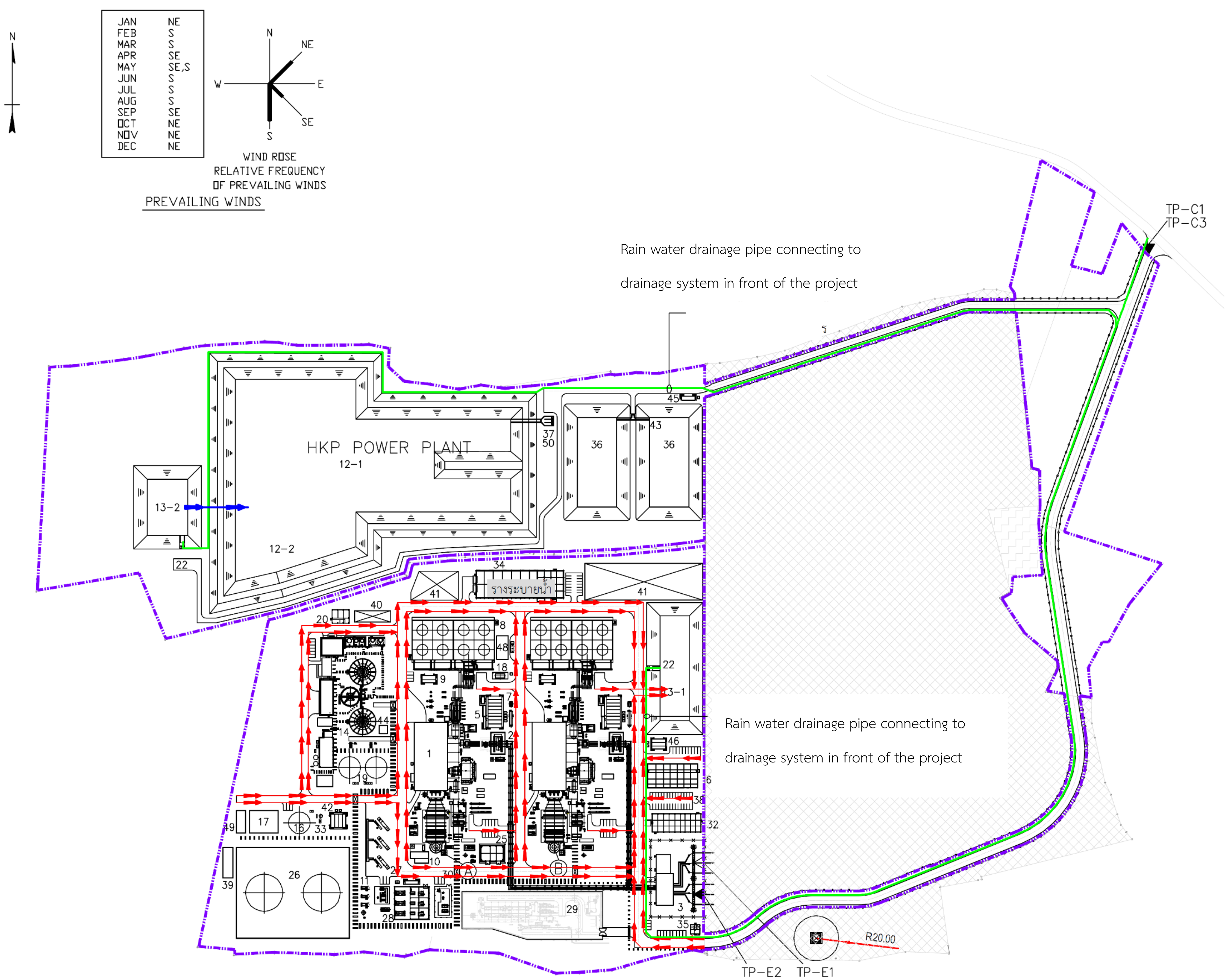
(a) Retention pond No.1 has a capacity of 13,240.57 cubic meters (m^3) to accommodate the rainwater in the lower part of the Project area, including the electricity generation process area and office building area, and

(b) Retention pond No. 2 has a capacity of 1,634.43 cubic meters (m^3) to accommodate the rainwater in the upper part of the Project area, including the water treatment and the holding ponds areas.

Details of the calculation of the size of the retention ponds can be calculated using the Rational Method as follows:

From the equation $Q = 0.278 \times 10^{-6} CIA$

where
- Q = flow rate (m^3/sec)
- C = flow coefficient
- I = rain concentration (millimeter/hour)
- A = water retention area (square meter (m^2))



▲	MAJOR TERMINAL POINT LIST	
LATER	TP-M1	NATURAL GAS SUPPLY
LATER	TP-M2	RIVER WATER INTAKE
LATER	TP-M3	COOLING WATER DISCHARGE
	TP-C1	ACCESS ROAD TO POWER PLANT
	TP-C3	STORM WATER DISCHARGE
	TP-E1	HV-CONNECTION
	TP-E2	HV-CONNECTION

	EQUIPMENT LIST
1	TURBINE BUILDING
2	STEP-UP TRANSFORMER
3	GIS
4	NOT USED
5	ELECTRICAL PACKAGE
6	CENTRAL CONTROL BUILDING
7	EMERGENCY D/G PACKAGE
8	COOLING TOWER
9	COOLING TOWER ELECTRICAL PACKAGE
10	AUX. BOILER
11	AIR COMPRESSOR
12-1	RAW WATER POND (EXISTING)
12-2	RAW WATER POND (NEW)
13-1	STORM WATER POND-1
13-2	STORM WATER POND-2
14	WATER TREATMENT PLANT
15	NOT USED
16	SERVICE & FIRE WATER STORAGE TANK
17	F/F PUMP SKID (SUNSHADE)
18	CW CHEMICAL DOSING
19	DEMI. WATER TANK
20	LABORATORY HOUSE
21	NOT USED
22	STORM WATER DISCHARGE PUMP
23	NOT USED
24	NOT USED
25	GAS STORE (H2,CO2,N2 BOTTLE) (SUNSHADE)
26	FUEL OIL TANK
27	FUEL OIL UNLOADING STAITION & TRANSFER PUMP AREA
28	GAS COMPRESSOR
29	GAS METERING STATION AREA
30	FUEL GAS TREATMENT SYSTEM
31	NOT USED
32	ADMINISTRATION BUILDING
33	POTABLE WATER SYSTEM
34	MAINTENANCE WORK SHOP / WAREHOUSE BUILDING
35	GUARD HOUSE
36	COOLING WATER HOLDING POND
37	COOLING TOWER MAKE UP PUMP
38	PARKING SPACE FOR ADMINISTRATION BUILDING
39	OIL SEPARATOR
40	SITE OFFICE & CONTAINER AREA FOR MAINTENANCE
41	LAYDOWN AREA FOR MAINTENANCE
42	COMMON FACILITIES ELECTRICAL PACKAGE
43	COOLING WATER DISCHARGE PUMP
44	CHEMICAL STORAGE BUILDING
45	POND AREA ELECTRICAL PACKAGE
46	CENTRAL CONTROL BUILDING CONTROL PACKAGE
47	NOT USED
48	CHLORINE DIOXIDE DOSING
49	FOAM SKID
50	STOPLOG RACK FOR COOLING TOWER MAKEUP PUMP PIT

NOTE

: EXISTING FACILITY AREA

: PERSONAL LAND OTHER THAN THE TECO/HKP

1. CHEMICAL STORAGE AREA ARE LOCATED INSIDE WATER TREATMENT BUILDING WITH STORAGE AREA OF 70 m2.

LOCATION	NORTH	EAST
A	1496314.696	580044.200
B	1496314.696	580149.200

40 0 80 160m

SCALE 1:4000

PRELIMINARY

Customer

HKP

บริษัท หินกองเพาเวอร์ จำกัด
HIN KONG POWER COMPANY LIMITED

Figure 5.5.5-12 Project's Rain drainage system

Table 5.5.5-10

Amount of runoff from rain in 25 year recurrence period at Hin Kong Power Plant area

เวลา (ชม.)	เวลา (นาที)	ความเข้มฝนที่รอบ 25 ปี (มม./ชม.)	ความเข้มฝนสะสมที่รอบ 25 ปี (มม.)	พื้นที่ตอนบนของโครงการ				พื้นที่ตอนล่างของโครงการ				ปริมาณน้ำท่าทั้งหมด (ลบม.)
				C เฉลี่ย	ความลึกน้ำท่าสะสม (มม.)	ขนาดพื้นที่ (ตรม.)	ปริมาณน้ำท่า (ลบม.)	C เฉลี่ย	ความลึกน้ำท่าสะสม (มม.)	ขนาดพื้นที่ (ตรม.)	ปริมาณน้ำท่า (ลบม.)	
0.0	0.0	0.0	0.0	0.25	0.0	49,793	0	0.76	0.0	132,183	0	0
0.25	15	202.4	25.3	0.25	6.3	49,793	315	0.76	19.3	132,183	2,551	2,866
0.5	30	177.6	69.7	0.25	17.4	49,793	868	0.76	53.2	132,183	7,028	7,895
0.75	45	139	96.5	0.25	24.1	49,793	1,202	0.76	73.6	132,183	9,734	10,936
1	60	119	111.6	0.25	27.9	49,793	1,389	0.76	85.1	132,183	11,255	12,645
2	120	70.4	129.8	0.25	32.5	49,793	1,616	0.76	99.1	132,183	13,093	14,709
3	180	46.2	141.8	0.25	35.4	49,793	1,765	0.76	108.2	132,183	14,298	16,063
6	360	24.1	143.6	0.25	35.9	49,793	1,787	0.76	109.5	132,183	14,480	16,267
12	720	12.9	149.5	0.25	37.4	49,793	1,861	0.76	114.0	132,183	15,072	16,933
24	1440	6.9	159.9	0.25	40	49,793	1,991	0.76	122.0	132,183	16,129	18,120
30	1800	ฝนไม่ตกเพิ่ม	165.3	0.25	41.3	49,793	2,057	0.76	126.1	132,183	16,668	18,725
36	2160		165.3	0.25	41.3	49,793	2,057	0.76	126.1	132,183	16,668	18,725

C calculation from upper area	Concrete area	Seepage area
Area's size (m^2)	0	49,793
C value	0.85	0.25
Average C value	0.25	

C calculation from lower area	Concrete area	Seepage area
Area's size (m^2)	112,996	19,187
C value	0.85	0.25
Average C value	0.76	

Analysis of the size of the retention ponds in case of water discharge from the power plant equal to the current condition case and from excess water considered the discharge rate that can be released outside the power plant and the amount of water that must be retarded in the power plant area are shown in **Table 5.5.5-11** and **Table 5.5.5-12**.

Table 5.5.5-11

The drainage rate that can be discharged outside the power plant in case that water discharge from the power plant is equal to the current condition

Recurrence year (year)	Total runoff volume in the current condition (m^3/s)	Runoff volume outside the power plant (m^3/s)	Discharge rate (m^3/s)
5	0.98	0.91	0.07
10	1.16	1.07	0.09
15	1.26	1.17	0.09
25	1.39	1.28	0.11
50	1.55	1.42	0.13
100	1.71	1.57	0.14

Table 5.5.5-12

Excess runoff water that must be stored in the retention ponds in the case of water discharge from the power plant equal to the current condition

Table 5.5.5-12 (cont)

Time (h)	Total runoff volume (m^3)	Discharging rate (m^3/s)	Discharge volume (m^3)	Store volume (m^3)
0	0	0.11	0	0
0.25	2,866	0.11	99	2,767
0.50	7,895	0.11	198	7,697
0.75	10,936	0.11	297	10,639
1	12,645	0.11	396	12,249

Table 5.5.5-12 (cont)

Time (h)	Total runoff volume (m^3)	Discharging rate (m^3/s)	Discharge volume (m^3)	Store volume (m^3)
2	14,709	0.11	792	13,917
3	16,063	0.11	1,188	14,875
6	16,267	0.11	2,376	13,891
12	16,933	0.11	4,752	12,181
24	18,120	0.11	9,504	8,616
30	18,725	0.11	11,880	6,845
36	18,725	0.11	14,256	4,469
42	18,725	0.11	16,632	2,093
48	18,725	0.11	19,008	-

From **Table 5.5.5-12**, it was found that in the case of water discharge from the power plant equal to the current condition which will not affect the drainage surrounding the power plant area, the discharging rate is 0.11 cubic meters (m^3) per second and takes about 48 hours to drain the water. The retention ponds must store excess water of at least 14,875 cubic meters (m^3) (for the retarding of rain in a period of 3 hours). Details of the Project water retention can be divided as follows:

(a) Retention pond No.1 has a capacity of 13,240.57 cubic meters (m^3) (50 meter width, 117 meters length, and 1.1 meters depth, store water at the depth of 0.8 meter and 0.3 meter free board), and

(b) Retention pond No.2 has a capacity of 1,634.43 cubic meters (m^3) (74 meter width and 0.8 meters depth, store water at the depth of 0.5 meter and 0.3 meter free board) (cross-sectional diagram of the retention ponds are presented in **Figure 5.5.5-13**).

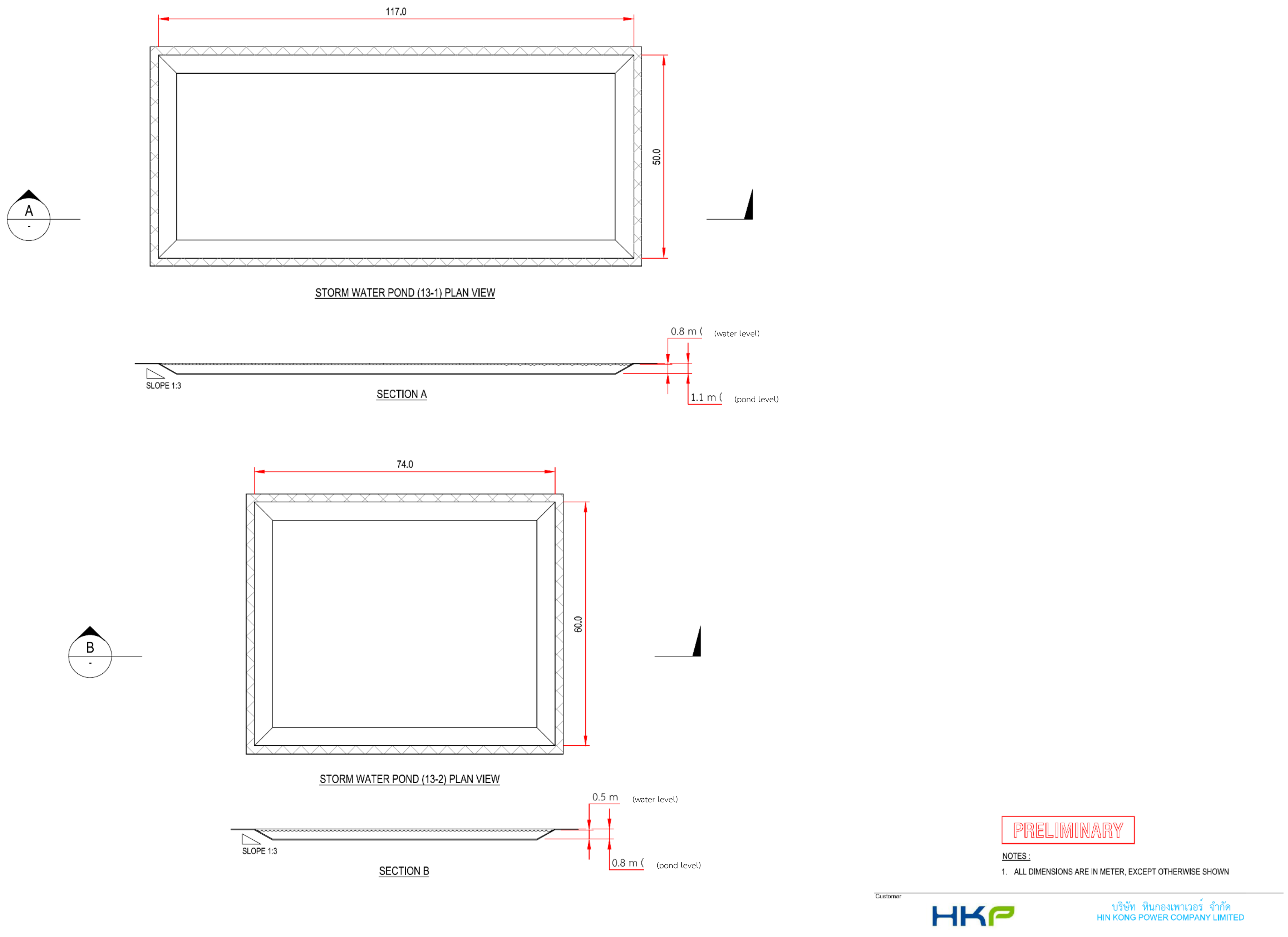


Figure 5.5.5-13 Section view of rainwater retarder pond No.1 and No.2

The drainage of rainwater from the retention ponds of the Project can be divided into 2 patterns: the water in the retention pond No.2 will be drained into the raw water well near the retention pond for use in the Project. Water in the retention pond No.1 will be drained after the rain has stopped to prevent problems with the water carrying capacity of the neighboring areas. However, in the current conditions, most of the Project area has sufficient capacity with the current condition, the Project will store excess rainwater that falls within the Project area for one day.

For the principle of draining the water outside the Project, it will be drained from the retention pond No.1 through the floodgate. The Project selected to use concrete pipes with a diameter of 1.2 meters and a slope of 0.002, water is discharged outside the Project with a flow rate of 0.11 cubic meters (m^3) /second, which will be able to drain the water completely within 48 hours. Considering the condition of the drainage canal on the north, found that it is a concrete paving canal with the bottom width of one meter, the top width six meters, and the depth of 2.5 meters.

However, during the current rainy season, the drainage canal on the north side of the power plant can support the amount of runoff in the current situation without overflowing the drainage canal. With the presence of Hin Kong Power Plant, it will have runoff of 3.37 cubic meters (m^3) /second, which is slightly greater than the water carrying capacity of the drainage canal, of only 0.09 cubic meters (m^3) /second (considering the intensity of rain at the 100 recurrence years). The height of the flood level above the drainage canal is 0.01 meter, it is a small flood height, which is not significant. Considering that the recurrence year of 5 years, 10 years, 15 years, 25 years, and 50 years indicate that there will be no flood effects from the overflowing water canal.

In this regard, the Project has submitted the documents for drainage permission to the responsible agency (**Appendix 2-10**).

Recurrence period (ปี)	Amount of water able to be drained (m^3/sec)	Current		In case of presence of Hin Kong Power Plant	
		Total runoff volume (m^3/sec)	Amount of overflowing water from drainage pond (m^3/sec)	Total runoff volume (m^3/sec)	Amount of overflowing water from drainage pond (m^3/sec)
5	3.28	0.98	No overflow	1.95	No overflow
10	3.28	1.16	No overflow	2.30	No overflow
15	3.28	1.26	No overflow	2.48	No overflow
25	3.28	1.39	No overflow	2.73	No overflow
50	3.28	1.55	No overflow	3.05	No overflow
100	3.28	1.71	No overflow	3.37	0.09

4) Summary of the analysis of the flood and drainage of the power plant

Hin Kong Power Plant has the original ground level of approximately +14.50 meter MSL which is not affected by floods that overflowed the Mae Klong River. However, it may be affected by the flooding in the area surrounding the power plant. At the 100 recurrence years, the height of the flood level above the drainage canal is only 0.01 - 0.03 m which is considered insignificant.

However, the construction of the Hin Kong Power Plant reduced the water seepage area by changing it to a solid concrete area of approximately 113,000 square meter (m^2). This will increase the amount of runoff. The Project has set up water retention ponds in the power plant area to prevent the impact of flooding on the surrounding area. The Project will build the retention pond in the upper area with a capacity of not less than 1,634.43 cubic meters (m^3) (excluding free board) and the retention pond in the lower area with a capacity of not less than 13,240.57 cubic meters (m^3) (excluding free board). The total water retention ponds capacity is not less than 14,875 cubic meters (m^3) (excluding free board), which can support at least 3 hours of rainwater that falls in the Project area.

Therefore, the impact on drainage flood prevention system during the construction and operation periods of the Project is expected to occur at a moderate level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	2	1	3	(3) = 1	2	3	medium

However, if in the rainy season the communities surrounding the power plant are affected by the rainwater drainage, the Project will coordinate with local authorities to expedite corrective action.

5.5.6 Impact on agriculture

In the impact assessment on agricultural crops, the Consultant considered the opportunity that the surrounding agricultural areas will be affected by the operation of the Project, it was found that the operation of the Project will discharge wastewater into the Mae Klong River. Most of them are from the cooling tower system which is classified as low contaminated wastewater. The Project has retention ponds that can hold water for one day and an emergency wastewater pond (one day water storage). Considering of the waste management found that the Project does not dispose of waste by landfill which will contaminate the soil in the farmland. For the air pollution impact of the Project, due to the burning of natural gas fuel the main pollutant is the emission of nitrogen oxides (NO_x).

(1) Change of agricultural land

The construction of the Project does not affect the change in agricultural areas. Since the Project is located in an empty area of the TECO Power Plant, it does not affect the area outside the project.

(2) Impacts of water use for agricultural areas

The Project uses water from the Mae Klong River. From the water balance analysis, it was found that in the current condition, although the Hin Kong Power Plant has not yet been developed, in the year of drought, the remaining water content for ecological preservation is lower than the criteria set by the Royal Irrigation Department. This is because the amount of water released from the Mae Klong Dam was lower than the amount of ecological preservation water to push the saltwater according to the measures set by the Royal Irrigation Department. However, there is no effect on water use in other activities. When the Hin Kong Power Plant is developed, the water demand is only 11.54 million cubic meters (m^3) /year, or only 0.16% of the annual average water volume. In the worst case (the water flowing to the side of the Mae Klong River is not considered) the water shortage increased from the current condition without power plant development, only about 0.02% - 3.54% of the runoff volume. This is the lack of water to preserve the ecosystem to push the saltwater, but it does not have any effect on water use for agriculture, livestock, consumption, tourism, and industrial purposes. However, the current Mae Klong River water management is carrying out by the Royal Irrigation Department according to the water allocation plan. The Project will comply with the conditions or requirements of the relevant government agencies. When the ministerial regulations or a notification of Department of Water Resource are issued, the Project shall continue to apply for permission to use water in accordance with the relevant laws.

(3) Impact from wastewater

Wastewater generated during the operation period of the Project is mainly due to drainage from the cooling tower system which is considered to be water with low contamination. The Project has a holding pond in the Project that can hold water for one day and an emergency wastewater reservoir (can retain wastewater for one day) if the wastewater quality does not meet the effluent standard. Before discharging wastewater, there will be a continuous water online quality monitoring system to measure the temperature, pH, and electrical conductivity (to determine total dissolved solids) to maintain the wastewater quality according to the notification of the Department of Industrial Works before discharging into the Mae Klong River. In addition, the Project shall monitor wastewater quality at the before and after the discharge point with a frequency of every six months. Therefore, the impact on farmers using the water in Mae Klong River is expected to occur at a low level.

(4) Impact of air pollution on plants

1) Information of types of plant and problems

The Consultant has compiled data from the environmental impact assessment report of the Ratchaburi World Cogeneration Project of Ratchaburi World Cogeneration Company Limited locates in Photharam District, Ratchaburi Province. Details are presented in **Table 5.5.6-1**. as follows.

Table 5.5.6-1

Details on the type of plant in the study area, Potharam district, and problem

(From the study done by the consultant company in B.E. 2555 (2012))

Type of plant	Respondent (person)	Problem	Expected cause
Banana	4	Yellow leaves from the top to bottom, leaves dry out, and eventually die	Soil degraded, pests, climate change
Orchid	1	Leaf fall, fungus on flowers	Climate change
Rice	8	Mealybug Yellow leaves and burnt leaves Curly leaves Grow slowly Declining of yield	Pest Climate change Pollution and chemicals from industries
Corn	5	seeds in the pod are not full Yellow leaves, many pests Rhizomes dry out quickly	Pest Climate change Pollution and chemicals from industries
Bean	1	Dry leaves, do not grow	Pollution and chemicals from industries
Lotus	2	Black stalk, dry leaves, black petal	Pollution and chemicals from industries
Pandan	1	Leaves burn	Pollution and chemicals from industries
Homegrown vegetable	7	Wing bean: Leaves burn Star gooseberry: Yellow leaves, small spots Betel Vine: Back flower Chili: rotten seed, grow slowly Gac: Insect piercing fruit, black leaves, not producing fruit	Climate
Lime, kaffir lime	2	Leaves burn due to rain, grow slowly	Pollution and chemicals from industries
Manila tamarind	5	The flower has a sticky black substance, yellow neck of the	Pest

Type of plant	Respondent (person)	Problem	Expected cause
		stalk, the top is burnt, the leaves are black like burnt, dry, dead leaves, rotten of fruit Usually have impacts after rain	Pollution and chemicals from industries
Coconut	4	Yellow spots on the fruit, yellow leaves, declining yield, grow slowly, die	Pest Pollution and chemicals from industries
Ornamental flowers	2	Dry and burn leaves Grow slowly	Climate change
Pummelo	1	Fruit fallout even is not ripe yet	Climate change
Sugarcane	5	Has less juice, taste is not sweet Dry and damaged leaves	Climate change Pollution and chemicals from industries
Total	**53**		

Source : Environmental Impact Assessment report by Ratchabuuri World Cogeneration Project of Ratchaburi World Cogeneration Co.,Ltd, B.E. 2555 (2012)

2) Operation of the Project that may affect agricultural factors

The occurrence of impact or damage to plants due to air pollutants generally depends on a number of factors which can be divided into 3 important issues as follows:

Plant	Exposure to pollutant	Environment/care
- Type of plant - The stage when plants grow while being exposed to pollutants	- Type of pollutants - Duration and number of exposure - Dose and concentration	- Area characteristic - Climate conditions (temperature, moisture, wind direction, wind speed, etc.) - Soil characteristic - How to control the cultivation, fertilization/ water

The factors related to activities of the Project is pollution exposure. The impact of air pollutants on plants varies according to the pollutant type. The main pollutants emitted from the Project stack is nitrogen oxides. The pollutant that can cause severe impact on plants is nitrogen dioxide (NO_2). It is classified as moderately toxic gas, meaning the concentration of the pollutant in the parts per billion (ppb) to part per million (ppm) can damage plants.

It is generally known that the degree of plant damage depends on the amount of exposure, pollutants, climate, duration, and so on, with more damage occurring during the day than at night, which is the time when plants have photosynthesis activities. Because it is the time with high humidity and the stomata is open enough.

3) Review of data on the impact of various pollutants on plants

There are two pathways for pollutants to penetrate plants as follows:

- Direct adhering to the plant surface or is it absorbed through the leaves (absorption into the stem through the leaf surface), and
- Indirect absorption through roots due to contaminated soil or water (root reabsorption). Normally, direct contamination through leaves is more damaging than indirect reabsorption.

There is a theory suggests that the primary pathway of infiltration of air pollutants is through the stomata in the front or back of the angiosperm's green leaves (typically 50-300 stomata per one square millimeter (mm^2)). The stomata structure is a small gap formed by two cells around the stomata. The amount of opening of these cells changes with the internal pressure of the plant. At night, the stoma is almost completely closed and open in daytime due to sunlight and gas exchange. In addition, the opening depends on the amount of water inside the stem to adjust the amount of transpiration as well. The plants take the CO_2 in the air through the stomata and then perform photosynthesis using water absorbed through the roots and sunlight to form hydrocarbons. If the stomata are open while gaseous pollutants or mist particles or aerosols are smaller than microns in diameter, it can easily enter the inside of the plant's leaves. Besides the infiltrating through stoma, soot and dust generally can cause a negative effect by adhering to the surface of the leaf as well.

The damage to plants due to air pollution is divided into visible and invisible damage to the eyes as follows:

(a) Damage that can be observed by the eyes can be divided into 3 types:

a) Acute damage is defined as having high concentrations of pollutants (typically higher than part per million) that are discharged from source to remain in farmland or forest within a short period of time. It causes an adverse effect to plants growing in that area which all the plants must be because they won't grow after that and the damages is unrecoverable. The leaves show severe symptoms of chlorosis (turning pale yellow) or nechlosis (cell and tissue death).

b) Chronic damage is defined as plants expose to when low concentrations of pollutants, generally those that are less than parts per million. It causes an adverse effect to abnormal growth conditions. Observable signs include slightly yellowing of leaves. If left, it can cause total damage. Damage due to air pollution in the suburbs is most likely the case.

c) Combined damage is defined as a case where both the acute and the chronic damage as mentioned above.

(b) Invisible damage is defined as cases where the plant has absorbed very low concentrations of pollutants. It is generally a concentration in parts per billion (ppb). Observable symptoms such as leaves damage is not visible. Rather, they do physical and biochemical damages in a way that slows the plants growth. Later, it may affect the amount of harvest. There is no theory yet to determine if this invisible damage exists. However, phenomena such as the narrowing of the tree ring is likely an indication of invisible damage.

<u>Characteristics of the damage caused by air pollution</u>

Critical pollutants related to the Project activities have a distinctive feature of plant damage. The distinguishing characteristics of plant leaf anomalies by type of air pollutant are shown in **Table 5.5.6-2** and **Table 5.5.6-3**. How plants show damage symptoms can be used to identify types of air pollutants. The main characteristic of the damage caused by the significant air pollutants, NO_2, leaf damage, is similar to that of SO_2. NO also damages plants to the same extent with NO_2.

Table 5.5.6-2

Characteristics of plant damage by air pollutants

Air pollutant	Concentration/time	Damage area	Damage characteristic
NO_2	2.5 ppm 4 hr	Leaf	White and brown between the leaf veins and spots of irregular shape

Source : Industrial Factory's 256Air Pollution System Treatment Textbook pg 1-23, B.E. 2547 (2004)

Table 5.5.6-3

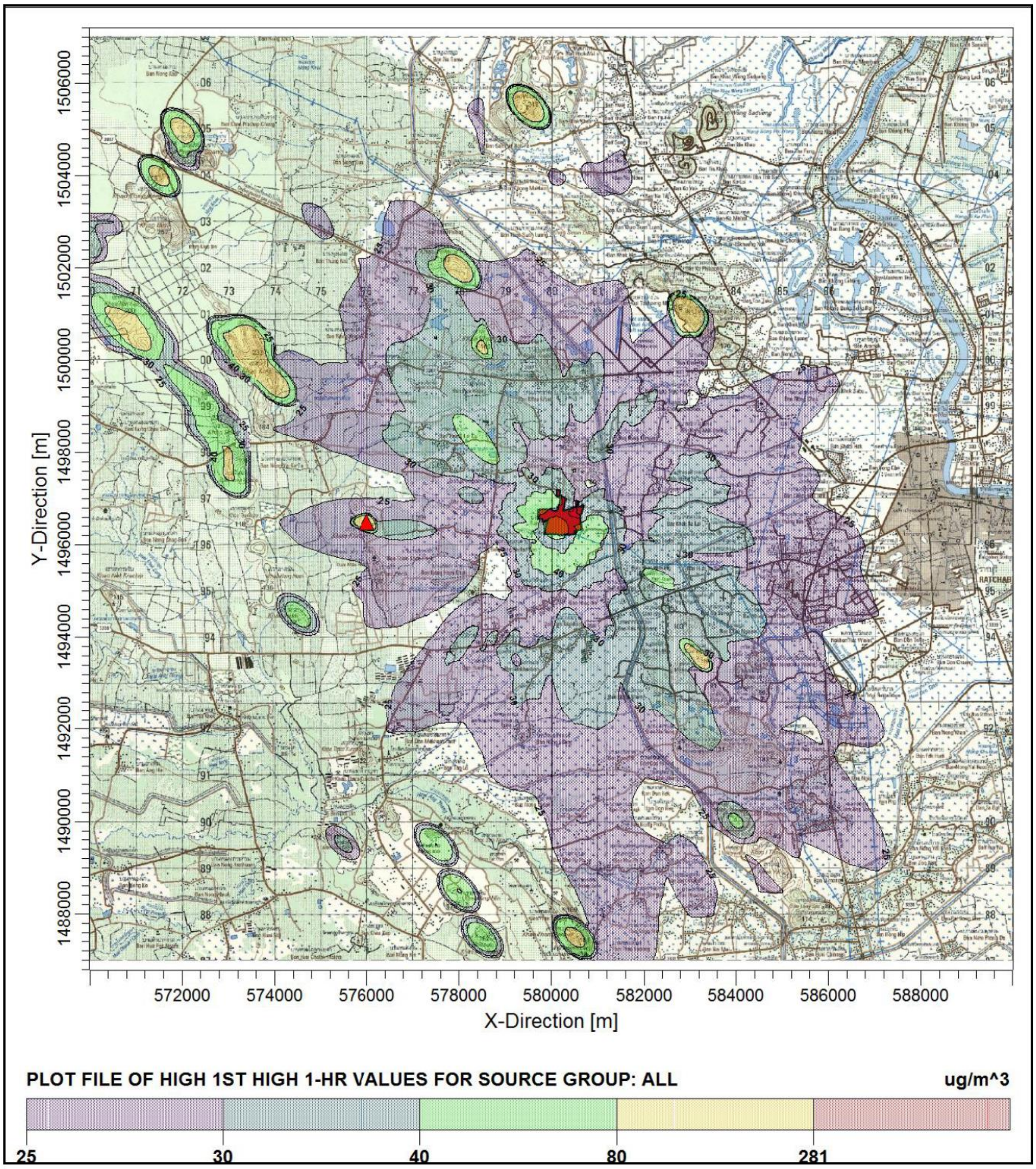
Distinctive features of abnormalities on leaf due to air pollution

Air pollutant	 Specks between the leaf's vein	 small dots/specks on leaf's surface
NO_2	Found occasionally	Found frequently

The sensitivity of plants to air pollutants typically differ by plant type. However, they also differ in nature and range of growth. In addition, the nature of leaf damage, such as speckling and the rate of decline in agricultural yield, is not necessarily proportionate. Especially second-season rice, grains, and fruits which want to harvest the fruits, damage during the flowering period can significantly reduce the harvesting yield.

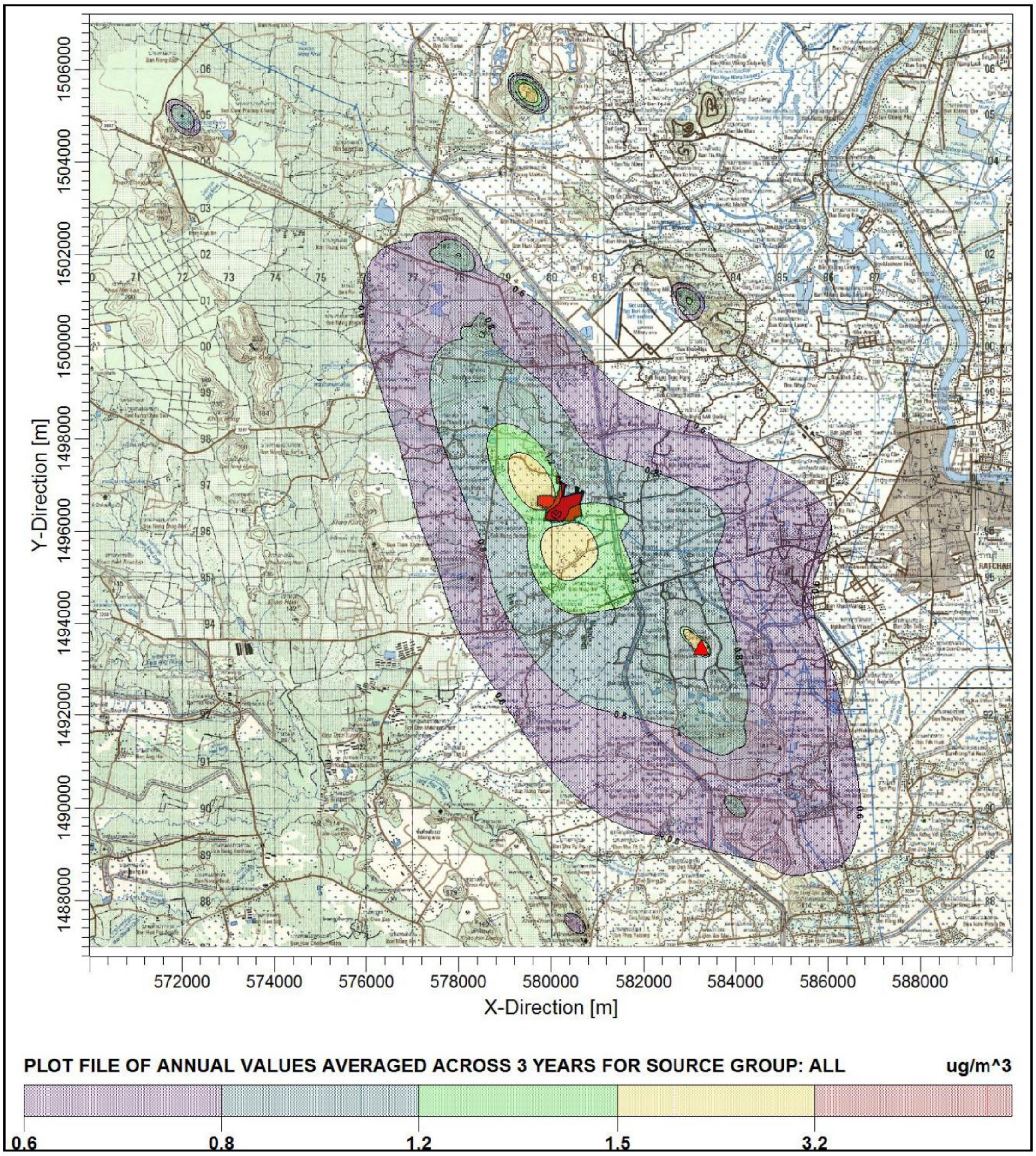
4) Assessment of the level of impact from the Project activities

From the assessment of air quality impacts by the mathematical model from the Project's emissions, in scenario 4, the Project pollution sources are forecasted in the case of operating at full load (100%) capacity, uses natural gas as fuel, it was found that the highest 1-hour average concentration of nitrogen dioxide (NO_2) from the model was 280.70 micrograms/ cubic meters (m^3) (occur in April) at coordinates 576000E, 1496500N at Khao Khrok, about 3.5 kilometers west of the Project (**Figure 5.5.6-1**). The highest 1-year average concentration of nitrogen dioxide (NO_2) was 3.21 micrograms/ cubic meters (m^3), at coordinates 583250E, 1493500N at Khao Ngam, 3.4 kilometers southeast of the Project (**Figure 5.5.6 -2**). Based on scenario 5, the Project pollution sources are forecasted in the case of operating at full capacity, full load (100%) capacity, uses diesel as fuel, it was found that the highest 1-hour average concentration of nitrogen dioxide (NO_2) from the model was 205.90 micrograms/ cubic meters (m^3) (occur in December) at coordinates 583000E, 1501000N, Khao Chang Kham, approximately 4.5 kilometers northeast of the Project (**Figure 5.5.6-3**). The highest 1-year average concentration of nitrogen dioxide (NO_2) was 2.74 micrograms/ cubic meters (m^3), at coordinates 583250E, 1493500N at Khao Ngam, 3.4 kilometers southeast of the Project (**Figure 5.5.6 -4**).



Symbol Project Site Location of highest concentration 280.70 microgram/ m^3

Figure 5.5.6-1 Lines showing concentration of Nitrogen Dioxide gas on 1 hour average in case of Full Load (natural gas)



Symbol Project Site Location of highest concentration 3.21 microgram/ m^3

Figure 5.5.6-2 Lines showing concentration of Nitrogen Dioxide gas in 1 year average in case of Full Load (natural gas)

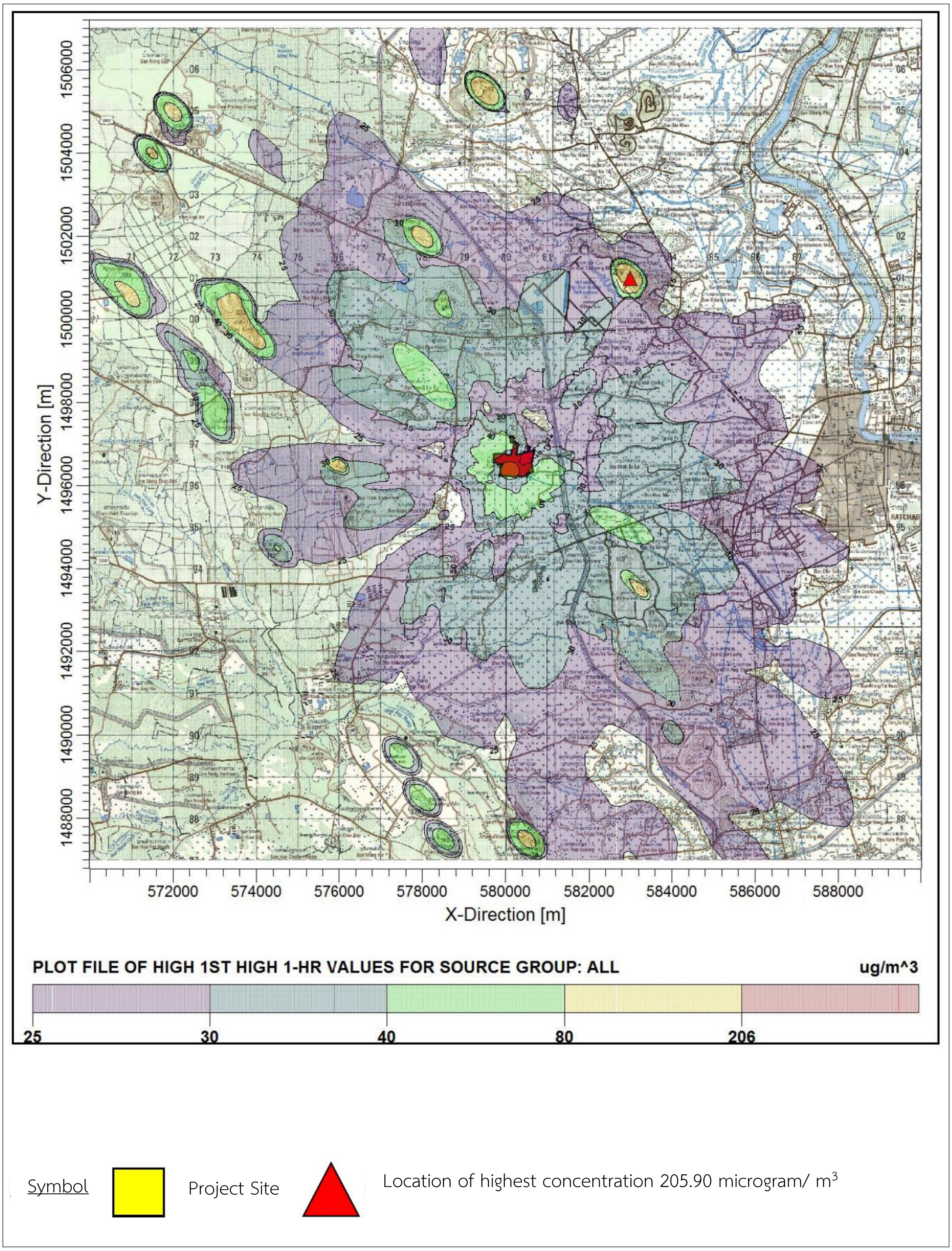


Figure 5.5.6-3 **Lines showing concentration of Nitrogen Dioxide gas in 1 hour average of operating under emergency case (using diesel oil)**

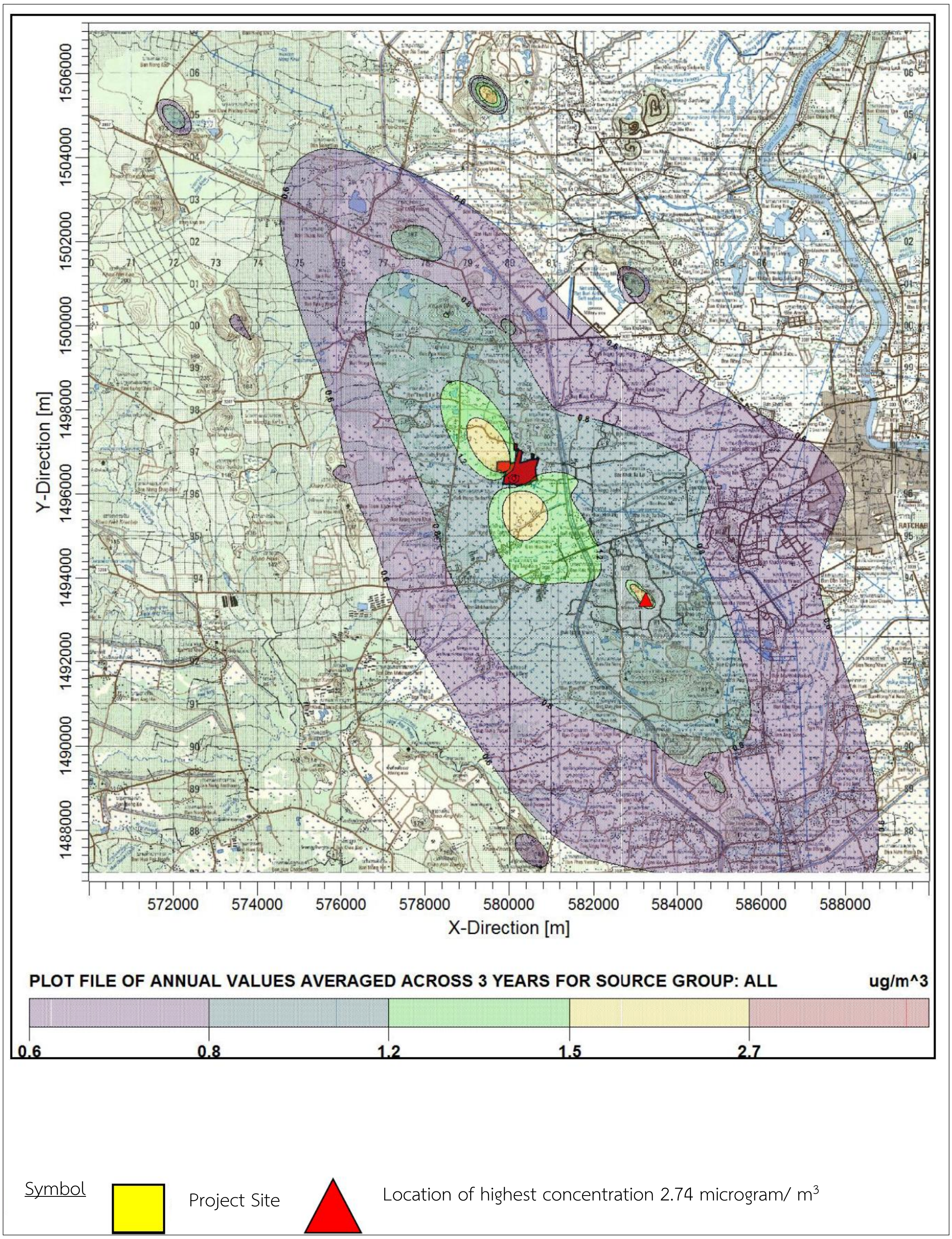


Figure 5.5.6-4 Lines showing concentration of Nitrogen Dioxide gas in 1 year average of operating under emergency case (using diesel oil)

When considering the reference values in the textbook of air pollution treatment systems of the Department of Industrial Works (2007), mentioning the nature of crop damage arising from exposure to 2.5 ppm (4,703 micrograms/ cubic meters (m^3)) of nitrogen dioxide in a 4-hour period, it will cause effects on leaves with white and brown between the leaf veins and irregularly shaped spots on leaves.

In this regard, the Consultant adjusted the average 1 - hour concentration obtained from the model to the mean of 4-hour average by using the correlation equation between average concentration of pollutants and average time (Wark, K and C, Wamer, 1981. Air Pollution: Origin and Control, 2 nd Edition, Harper Collins Publishers.).

$$(C_1/C_2) = (t_2/t_1)^n$$

Where C_1 and C_2) = average concentration at time t_1 and t_2 (minute)
n = constant value equals to 0.17-0.20 (used 0.20 because it has the highest severity case estimate

From the calculation with the above equation, the case of using natural gas, plants will be exposed to nitrogen dioxide with the 4-hour average concentration of 212.73 micrograms/ cubic meters (m^3) at the observation point at Khao Khrok. In the case of using diesel, the highest concentration is 156.04 micrograms/ cubic meters (m^3) at Khao Chang Kham. The values are within the recommended criteria (2.5 ppm or 4,703 micrograms / cubic meters (m^3)). It can be drawn that plants in the study area will be exposed to non-destructive levels of nitrogen gas.

However, nitrogen dioxide is considered to have moderate phytotoxicity, according to a study of the World Health Organization (WHO) that set recommended values for long-term exposure to nitrogen oxides (WHO Air Quality Guideline: Limit, Standard Values and Recommendations for Nitrogen Dioxide Pollution in Air). The recommended value for 1-year average concentration is 30 micrograms/ cubic meters (m^3). It is a safe value for vegetation protection and is a level that does not affect plants that are very sensitive to the environment. It was found that the highest air quality impact assessed from the natural and diesel fuel were 3.21 and 2.74 micrograms/ cubic meters (m^3), respectively. These values are within the WHO's recommended safe limits. In addition, the maximum concentration will be occurred in mountainous areas covered with perennial vegetation, so the surrounding agricultural areas were affected below this point. The surrounding agricultural area has the highest annual average concentration of not higher than 5 micrograms/ cubic meters (m^3). Therefore, the impact is expected to occur at a low level.

5) Contamination of soil and surface water source that used for agriculture

The Project's air pollution emission has no direct impact on soil and rainwater quality. This is because the impact of the emitted pollutants is within the standard. For pollutants that may accumulate and affect soil and water quality is sulfur dioxide. The Project has a very low amount of sulfur dioxide emission and the impact of the Project is also very low.

For the operation of the Project, although the majority of the Project wastewater is low contamination, it will be kept in the pond for quality inspection before discharging into the Mae Klong River. However, most people are concerned about this issue, so the Project has required the people and organizations to participate in the monitoring through a tripartite committee process, including regular presentation of environmental management information of the Project to different sectors.

Therefore, the impact of nitrogen dioxide on plants is expected to occur at a low level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	2	(2) = 2	1	2	low

Although the operational activities of the Project are assessed as being low, but to prevent the consequences that may occur, therefore, the Project proposed environmental impact prevention and mitigation measures and environmental impact monitoring program as well as safety regulations to be strictly implemented.

5.6 Quality of life values

5.6.1 Impact on socio-economic conditions

For the conceptual framework of the socio-economic impact assessment to adopt environmental impacts prevention and mitigation measures and environmental impact monitoring program are presented in **Figure 5.6.1-1**. The socio-economic impacts that arise from the Project from the survey of seven groups of and from collecting data in the study area of the Project, Socio-economic impacts can be divided into positive and negative impacts. Later, the evaluation results were considered in the formulation of the measures to prevent and correct the consequences.

The assessment of socio-economic impact was done to set environmental impacts prevention and mitigation measures and environmental impact monitoring program of the Project. The maximum number of workers in the construction period is 3,000 people and the maximum workforce during the operation period is 60 people.

(1) Socio-economic condition of people in the study area

From the collection of basic socio-economic data of the study area, there are 8 groups of stakeholders, including 1) government agencies, 2) educational institutions, 3) religious sanctuaries, 4) groups of water users in the area, 5) groups that may be affected by the construction of the raw water pipeline of the Project, 6) community leaders, 7) group of close range 0-100 meters, and 8) household. A total of 847 questionnaires were included. According to a survey of 743 households in the study area, the majority of the people in the study area were residents of the area. The main occupation is agriculture, followed by general employment. Overall, the quality of life of the people in the study area was at a good level. They have access to basic state services, have good health, water sources, drinking water are of good quality and has adequate supply. The source of drinking water is bottled/buckets water and the water source for other consumption comes from the village water supply system. For water, for agriculture, rainwater is used. Most of the environmental impact problems in the area are dust issues, followed by malodors and soot.

(2) Comments and concerns about the Project

From a survey of 8 stakeholder groups (1,317 examples), opinions and concerns can be summarized as shown in **Table 5.6.1-1** which can be described as follows:

Table 5.6.1-1

Summarization of target group opinions on various aspects of the project

Opinion on the project	Target group																														Total	
	Group 1										Group 2		Group 3		Group 4		Group 5		Group 6				Group 7		Group 8					
	Environmental and regulatory aspects agency group		Health service agency group		Utilities and public service agency group		Administration and governance agency group		Agricultural agency group		Educational institution group		Religious group		Agricultural group that uses local water		Potential affected group from raw water pipeline installation		Community leader				group near the project (100 m from the project		Household group					
																			0-3 km radius		3-5 km radius				0.1-3 km radius		3-5 km radius			
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
1) Know and informed on details of the project																														
- Not informed	0	0.0	1	14.3	1	14.3	2	33.3	1	33.3	5	62.5	1	7.7	25	83.3	19	44.2	1	4.3	0	0.0	3	11.5	96	39.5	97	36.5	252	35.6
- Informed	5	100.0	6	85.7	6	85.7	4	66.7	2	66.7	3	37.5	12	92.3	5	16.7	24	55.8	22	95.7	28	100.0	23	88.5	147	60.5	169	63.5	456	64.4
Total	5	100.0	7	100.0	7	100.0	6	100.0	3	100.0	8	100.0	13	100.0	30	100.0	43	100.0	23	100.0	28	100.0	26	100.0	243	100.0	266	100.0	708	100.0
2) Potential benefits from the project (can answer moer than 1 choice)																														
- Growth in overall economy of the area	3	60.0	1	14.3	3	42.9	1	16.7	2	66.7	6	27.3	9	37.5	4	19.0	4	33.3	1	5.9	7	16.3	14	22.6	75	23.5	92	16.1	222	19.0
- Create jobs and incomes for the community in the area	2	40.0	5	71.4	3	42.9	3	50.0	1	33.3	5	22.7	6	25.0	7	33.3	3	25.0	3	17.6	4	9.3	19	30.6	106	33.2	162	28.3	329	28.2
- Local agencies receive more taxes regarding area's nurture/ maintanance	2	40.0	5	71.4	1	14.3	2	33.3	1	33.3	3	13.6	1	4.2	1	4.8	1	8.3	2	11.8	8	18.6	11	17.7	44	13.8	94	16.4	176	15.1
- Have new power plant containing new technologies instead of the old power plant	4	80.0	3	42.9	1	14.3	2	33.3	1	33.3	2	9.1	3	12.5	3	14.3	1	8.3	1	5.9	5	11.6	6	9.7	20	6.3	74	12.9	126	10.8
- Have development funds around the power plant	2	40.0	4	57.1	2	28.6	2	33.3	1	33.3	3	13.6	4	16.7	2	9.5	1	8.3	9	52.9	16	37.2	8	12.9	36	11.3	91	15.9	181	15.5
- Create stability / sustainability to the electric system in the local area	2	40.0	2	28.6	0	0.0	2	33.3	1	33.3	3	13.6	1	4.2	4	19.0	2	16.7	0	0.0	3	7.0	4	6.5	38	11.9	60	10.5	122	10.5
- Others (supporting community)	0	0.0	0	0.0	10.0	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	5.9	0	0.0	0	0.0	0	0.0	0	0.0	11	0.9
Total	15	100.0	20	100.0	10	100.0	12	100.0	7	100.0	22	100.0	24	100.0	21	100.0	12	100.0	17	100	43	100	62	100	319	100	573	100	1167	100.0
3) Worries (can answer more than 1 choice)																														
- Worries about fuels used in production process	0	0.0	1	14.3	4	57.1	2	33.3	1	33.3	3	27.3	1	14.3	0	0.0	9	11.7	3	25.0	3	10.0	1	3.6	9	4.1	8	3.7	45	6.7
- Worries about water uses	1	20.0	1	14.3	2	28.6	0	0.0	0	0.0	1	9.1	0	0.0	2	25.0	9	11.7	2	16.7	1	3.3	2	7.1	9	4.1	11	5.0	41	6.1
- Air pollution / dust particles	2	40.0	3	42.9	1	14.3	3	50.0	1	33.3	5	45.5	2	28.6	0	0.0	13	16.9	3	25.0	5	16.7	4	14.3	53	24.3	62	28.3	157	23.3
- Disturbing smell	0	0.0	1	14.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	8	10.4	0	0.0	2	6.7	4	14.3	37	17.0	36	16.4	88	13.0
- Waste water	0	0.0	2	28.6	0	0.0	3	50.0	0	0.0	1	9.1	0	0.0	1	12.5	2	2.6	1	8.3	0	0.0	2	7.1	21	9.6	10	4.6	43	6.4
- Disturbance noise	2	40.0	3	42.9	0	0.0	3	50.0	0	0.0	0	0.0	2	28.6	0	0.0	11	14.3	1	8.3	3	10.0	12	42.9	45	20.6	46	21.0	128	19.0
- Accidents from natural gas pipeline	0	0.0	3	42.9	0	0.0	2	33.3	1	33.3	1	9.1	0	0.0	0	0.0	3	3.9	0	0.0	1	3.3	1	3.6	19	8.7	13	5.9	44	6.5
- Traffic congestion	0	0.0	0	0.0	0	0.0	1	16.7	0	0.0	0	0.0	1	14.3	0	0.0	5	6.5	0	0.0	0	0.0	0	0.0	3	1.4	7	3.2	17	2.5
- Theft / crimes	0	0.0	0	0.0	0	0.0	2	33.3	0	0.0	0	0.0	0	0.0	0	0.0	4	5.2	0	0.0	0	0.0	0	0.0	1	0.5	2	0.9	9	1.3
- Conflicts between community's citizens	2	40.0	2	28.6	0	0.0	2	33.3	1	33.3	0	0.0	0	0.0	0	0.0	5	6.5	1	8.3	2	6.7	0	0.0	3	1.4	5	2.3	23	3.4
- Increase in foreign workers	1	20.0	1	14.3	0	0.0	0	0.0	1	33.3	0	0.0	0	0.0	0	0.0	3	3.9	0	0.0	4	13.3	0	0.0	7	3.2	5	2.3	22	3.3
- Worries about integrity in the operation of the project	0	0.0	1	14.3	1	14.3	1	16.7	0	0.0	0	0.0	0	0.0	0	0.0	3	3.9	0	0.0	3	10.0	0	0.0	6	2.8	5	2.3	20	3.0
- Increasing impatcs on health	0	0.0	3	42.9	0	0.0	2	33.3	1	33.3	0	0.0	1	14.3	0	0.0	2	2.6	1	8.3	5	16.7	2	7.1	5	2.3	9	4.1	31	4.6
- Others	0	0.0	1	14.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	5	62.5	0	0.0	0	0.0	1	3.3	0	0.0	0	0.0	0	0.0	7	1.0
Total	8	100.0	22	100.0	8.0	100.0	21	100.0	6	100.0	11	100.0	7	100.0	8	100.0	77	100.0	12	100.0	30	100.0	28	100.0	218	100.0	219	100.0	675	100.0

Table 5.6.1-1

Summarization of target group opinions on various aspects of the project

Opinion on the project	Target group																														Total	
	Group 1										Group 2		Group 3		Group 4		Group 5		Group 6				Group 7		Group 8					
	Environmental and regulatory aspects agency group		Health service agency group		Utilities and public service agency group		Administration and governance agency group		Agricultural agency group		Educational institution group		Religious group		Agricultural group that uses local water		Potential affected group from raw water pipeline installation		Community leader				group near the project (100 m from the project		Household group					
																			0-3 km radius		3-5 km radius				0.1-3 km radius		3-5 km radius			
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
4) Trust in environmental management system and monitoring measures																														
of the project including the project's ability to protect community's health																														
- Fully trust	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	25.0	3	23.1	0	0.0	4.0	9.3	12	52.2	10	35.7	1	3.8	8	3.3	16	3.9	56	6.6
- Trust	2	40.0	2	28.6	2	28.6	0	0.0	1	33.3	4	50.0	3	23.1	7	23.3	9.0	20.9	3	13.0	5	17.9	11	42.3	74	30.5	114	27.6	237	27.8
- Not sure / unsure	3	60.0	3	42.9	5	71.4	2	33.3	2	66.7	2	25.0	5	38.5	14	46.7	18.0	41.9	5	21.7	10	35.7	10	38.5	98	40.3	176	42.6	353	41.4
- Not trusting / doubtful	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	15.4	1	3.3	5.0	11.6	1	4.3	2	7.1	3	11.5	34	14.0	47	11.4	95	11.2
- Very doubtful	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	6.7	5.0	11.6	0	0.0	1	3.6	0	0.0	9	3.7	19	4.6	36	4.2
- No opinion	0	0.0	2	28.6	0	0.0	1	16.7	0	0.0	0	0.0	0	0.0	6	20.0	2.0	4.7	2	8.7	0	0.0	1	3.8	20	8.2	41	9.9	75	8.8
Total	5	100.0	7	100.0	7.0	100.0	3	100.0	3	100.0	8	100.0	13	100.0	30	100.0	43	100.0	23	100.0	28	100.0	26	100.0	243	100.0	413	100.0	852	100.0
Mean	3.40		3.40		3.29		3.00		3.33		4.00		3.54		3.08		3.05		4.24		3.75		3.40		3.17		3.16		3.23	
S.D.	0.000		0.548		0.488		0.000		0.577		0.756		1.050		0.830		1.117		0.995		1.143		0.000		0.874		0.886		0.920	
Result interpretation [1/]	Feeling unsure		Feeling unsure		Feeling unsure		Feeling unsure		Feeling unsure		Trust		Feeling unsure		Feeling unsure		Feeling unsure		Trust		Trust		Feeling unsure		Feeling unsure		Feeling unsure		Feeling unsure	

Remark : [1/] Level of trust in the project can be assessed as such

overall score of 1.00 – 1.50 means very doubtful

overall score of 1.51 – 2.50 means doubtful

ovrall score of 2.51 – 3.50 means unsure (still have doubts and cannot fully trust but not to the level of complete untrust)

overall acore of 3.51 – 4.50 means trust

overall socre of 4.51 – 5.00 means fully trust

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Stakeholders

1) Government agencies

2)Educational institution

3) Religious group

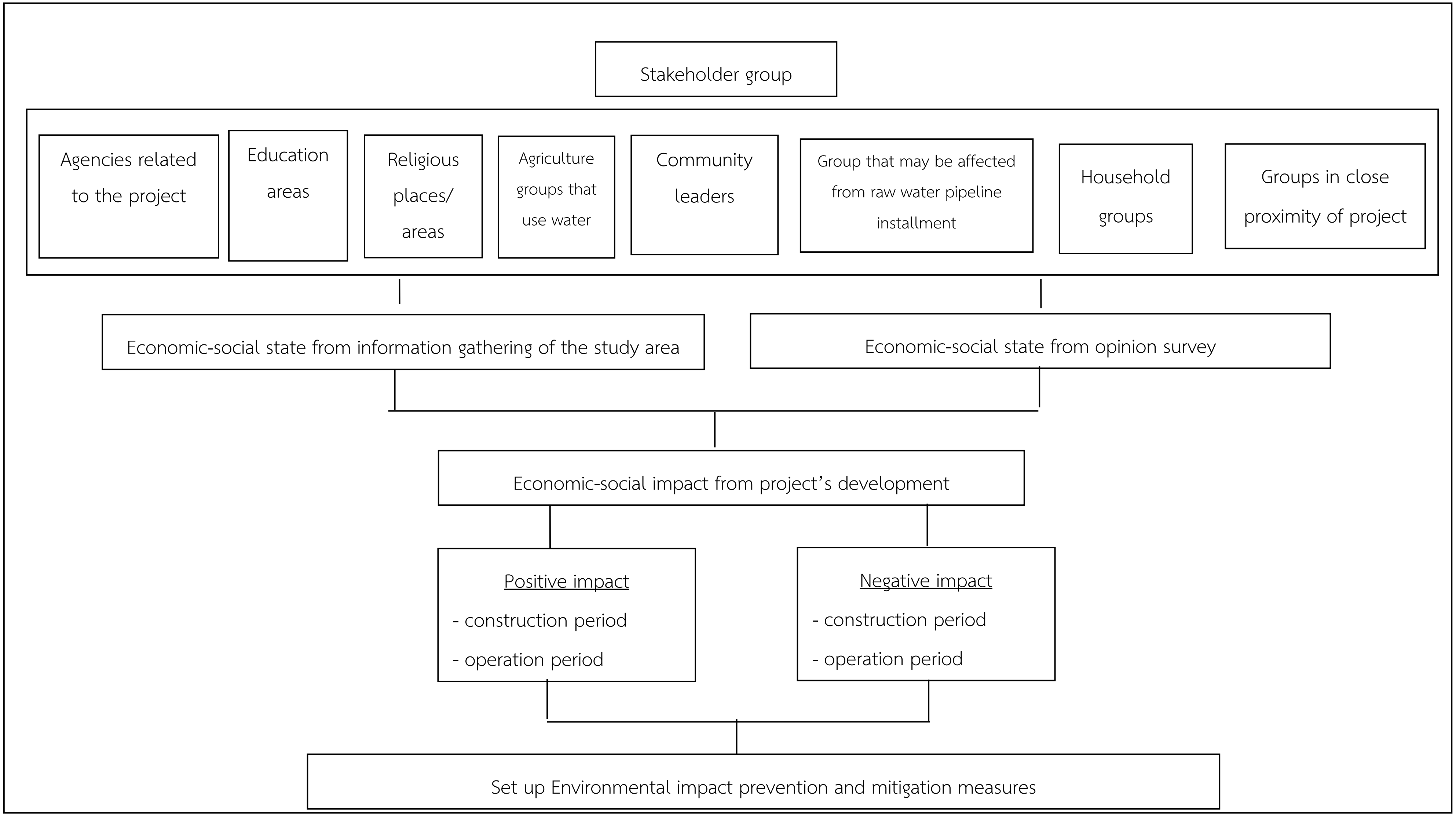
4) Agricultural group that uses local water

5)Potential affected group from raw water pipeline installation

6) Community leaders

7) Group living in close proximity 0-100 m

8) Household group



<u>Figure 5.6.1-1</u> Conceptual framework in economic-social assessment to define economic-social measures of the project

Acknowledged and received information about the Project, it was found that the sample group (59.1 percent) were aware of the Project's news on the benefit side of the Project to the community. The Project will create jobs and generate income to local communities (28.1 percent), followed by helping the overall economy of the area to grow (18.4 percent) and having the power plant fund (16.2 percent), respectively.

For concerns from having the Project, the respondents were concerned about air pollution/dust (24.7percent), followed by noise (19.8 percent) and odors (13.4 percent), respectively. For confidence on the environmental management and control of the Project and the protection potential of the health of the community, it was found that the samples indicated that their overall confidence was indifferent (felt that they were still not confident ($\bar{x}$ = 3.20, S.D. = 0.910). This may be because the operation of the Project in the current area still affects the surrounding communities. These are all factors that affect confidence of the people in the Project.

Therefore, there must be a continuous process of building up knowledge and understanding to build confidence in environmental management and concern for all parties. Nevertheless, additional measures have already been set in **Chapter 7** of this report.

From organizing the public participation meeting (PP1) to listen to opinions on the Project's proposal, the Project details, the study scope, and alternative of the Project and organizing the public participation meeting (PP2) to listen to opinions on the draft report and environmental impact prevention and mitigation measures and environmental impact monitoring measures, concerns can be summarized as follows:

1) Project details
2) Environmental
3) Economic and mass relations
4) Community Development Fund around the power plant
5) Transport
6) Air quality and heat
7) Safety

(3) Assessment of socio-economic impact

1) Positive impact

(a) Enhancing economic security

The Project is located at Hin Kong Subdistrict, Mueang Ratchaburi District, Ratchaburi Province. The area is responsible by the Hin Kong Subdistrict Administrative Organization. The Project's operation will benefit the economy, community, village, and local in Ratchaburi Province. Based on data from the Office of the National Economic and Social Development Board (Office of the National Economic and Social Development Board 2019, retrieved 10 November 2019), the gross provincial product (GPP) of Ratchaburi Province at the annual price in 2017 tended to decrease (1.17 percent) compared to the year 2016. Considering with the stakeholders opinion survey found that having the Project located in the area will create jobs and generate income for local communities (29.9 percent), followed by the overall economic growth of the area (19.3 percent), increase local tax (15.7 percent), respectively. Increasing economic stability is an indirect impact to be received from the Project, which can be divided into two periods of the impact assessment, details are as follows:

a) Construction period

The construction of the Project will result in an economic turnover in Ratchaburi Province due to the increasing supply of materials, equipment, and services among relevant sectors. Despite the construction of the Project will have a positive impact on improving the economic stability of the province to a certain extent but this positive impact will only occur during the Project construction period.

b) Operation period

The operation of this Project will result in more income coming into the province and increasing cash flow in the province. The operation of the Project will result in higher provincial gross production. There is also an increase in employment in the industrial sector. As a result, various fields of production continued to expand due to energy security. In addition, there is an increase in the purchase of goods and services between different sectors in Ratchaburi province. Therefore, the impacts of the Project are positive impacts, resulting in increased income and turnover in the province and local area.

(b) Increasing income tax to provinces and localities

The operation of the Project will result in more income coming into the province and increase provincial turnover from the value added tax and corporate tax to bring to develop adequate infrastructure and services. The local authorities will receive tax of signboard, house and land tax, and corporate income tax. Therefore, the impacts of the Project operation are positive impacts, resulting in higher income and turnover in the province and local area.

(c) Increase of employment

From the labor situation in Ratchaburi Province in the 4th quarter of 2018, it was found that there were 667,284 people, aged 15 years and over. Within this number, 456,935 people are in the labor force, 451,167 employed and 5,114 unemployed and non-workers of 210,349 people (Ratchaburi Province Labor Office, 2019, retrieved 24 December 2019) as shown in **Table 5.6.1-2**. With presence of the Project, employment in the area will be increased. This will be consistent with the results of the survey of stakeholders, that the sample group indicated that having the Project has beneficial to the community because it creates jobs and generates income for local communities. The impact assessment can be divided into 2 periods, details are as follows:

Table 5.6.1-2

Labor situation of Ratchaburi Province in the 4th quarter of 2018

Labor status	Number (people)
Population age 15 years and over	667,284
Labor force	456,935
Employment	451,167
Unemployment	5,114
Seasonally inactive labor force	654
Non-labor force	210,349
Unemployment rate	**1.119**

Remark: Unemployment rate = $\frac{\text{Unemployed x 100}}{\text{Labor force}}$

a) Construction period

During the construction period, the Project will take a total of 35-42 months, with a maximum of 3,000 construction workers, most of which are skilled workers provided by the contractor company. The Project gives the first priority to local people and has the policy for the contractor to hire workers who are local people. From estimating the number of unemployed people in the study area as shown in **Table 5.3.4.1-2, i**t was found that during the construction of the Project, there will be 5,114 unemployed people. When calculating the unemployment rate in the area, it was equal to 1.119. Therefore, it is possible to recruit local people with knowledge and abilities according to the qualifications required by the Project. This will reduce the unemployment rate in the study area as follows:

$$\text{Unemployment rate} = \frac{\text{Unemployed} \times 100}{\text{Labor force}}$$

Number of unemployment in the study area	= 5,114 people
Local unemployment will be reduced to	= 2,114 people
Unemployment rate	$= \frac{2{,}114 \times 100}{456{,}935}$
	= 0.462
Labor force in the study area	= 456,935 people
Employment in the study area	= 451,167 people
Accounting for	= 98.737 percent
The Project will increase employment of	= 3,000 people
Employment in the study area will increase to	= 454,167 people
Accounting for	= 99.394 percent

Therefore, during the construction period of the Project, unemployment rate in the study area will be reduced from 1.119 to 0.462 percent and increase the employment rate from 67.612 to 68.062 percent.

However, if certain positions are open, it is necessary to consider educational background or professional license because this is a specialized line of work that requires work expertise or special work experience. If unable to provide local labor with such qualifications, it is necessary to accept workers from other areas to work in such positions instead. It is feasible to estimate the number of unemployed people in the study area because the peak employment of 3,000 activities is non-skilled, so it can be expected to hire workers locally and all nearby provinces. However, during the time when skilled labor is required or have specialized expertise that cannot be obtained from local people because it is a specialized line of work that requires work expertise or requires special work experience, it is necessary to accept workers from other areas to work in such positions instead. In the worst case scenario, with inability to provide local workers will resulting in the evacuation of workers into the area (excluding the accompanying family) may cause other impacts, such as the ability to provide utilities and social services of the area, which must be brought in to serve migrant workers. However, it is unlikely that the Project will not be able to provide workers in the area. The impacts mentioned above are therefore unlikely to occur. Therefore, during the construction of the Project, the positive impact on employment is expected to occur at a low level. This impact will only occur during the Project construction period.

b) Operation period

When the Project begins to operate at full load capacity, the Project will have a total number of 60 employees. The employment will be based on qualifications, job vacancy, and experience requirement. The Project will focus on employees who are domiciled in the area. This will help reduce the unemployment rate in the area to a certain extent. The estimated number of unemployed people in the study area referred to in **Table 5.6.1-2**, it is found that during the operation period, the unemployment rate in the study area will be reduced from the original. Moreover, the rate of employment increased slightly from 98.74 to 98.75 percent, respectively.

$$\text{Unemployment rate} = \frac{\text{Unemployed} \times 100}{\text{Labor force}}$$

Number of unemployment in the study area = 5,114 people

Local unemployment will be reduced to = 5,114 people

$$\text{Unemployment rate} = \frac{5{,}114 \times 100}{456{,}935}$$

= 0.462

Labor force in the study area	= 456,935 people
Employment in the study area	= 451,167 people
Accounting for	= 98.74 percent
The Project will increase employment of	= 60 people
Employment in the study area will increase to	= 451,227 people
Accounting for	= 98.75 percent

However, during the time when skilled labor is required or have specialized expertise that cannot be obtained from local people because it is a specialized line of work that requires work expertise or requires special work experience, it is necessary to accept workers from other areas to work in such positions instead. In the worst case scenario, with inability to provide local workers will resulting in the evacuation of workers into the area (excluding the accompanying family) may cause other impacts, such as the ability to provide utilities and social services of the area, which must be brought in to serve migrant workers. However, it is unlikely that the Project will not be able to recruit workers in the area. Therefore, the impact is expected to occur at a low level.

(d) Enhancing the community economy

From the household socio-economic survey of the National Statistical Office, Ministry of Information and Communication Technology (National Statistical Office 2019, retrieved 10 August 2019) indicate that the average monthly expenses per household across the country in 2018 was 21,346 baht per month (711.53 baht/day). From the survey of stakeholder groups of 1,317 samples, it was found that the sample group indicated that having the Project will create jobs and generate income for local communities (28.1 percent), followed by the overall economic growth of the area (18.4 percent) and the power plant fund (16.2 percent) (**Table 5.6. 1-1**). The assessment was performed by dividing into two periods as follows:

a) Construction period

During the construction period, the Project will take a total of 35-42 months, with a maximum of 3,000 construction workers, by specifying one general worker being the leader of one family. From the data of the National Statistical Office, Ministry of Information and Communication Technology Statistics on average monthly expenses per household, it was found that households across the country in 2018 had an average expenses of 21,346 baht per month (711.53 baht/day), which is the expenses of consuming local goods and services in the study area. There will be local circulating spending from workers' daily consumption as follows:

From the statistics on average monthly expenses per household in 2018
The average daily expenses of a worker 711.53 Baht/day
Total number of workers 3,000 People
Local spending will be increased approximately 711.53 Baht/day

The construction of the Project will increase local spending of approximately 2,134,590 baht/day, resulting in turnover into the local area and affecting the household economy to have more income. In addition, certain types of construction materials can be purchased locally. The Project can ask the contractor to purchase certain materials from the community store or nearby areas which will cause income distribution to the local.

However, the construction period takes 35-42 months. After the construction is complete, the generating income from the Project construction workers will be gone. Therefore, the impact on community monetization is only a short-term positive impact and at a low positive impact level.

b) Operation period

In the operation of the Project, a maximum of 60 full-time employees will be employed. The most of them are local employees. This leads to spending in the communities surrounding the Project (except for some positions that need to consider educational background or professional licenses). This is because some work is a specialized line of work that requires work expertise or special work experience. If unable to hire local labor with such qualifications, the Project then will be necessary to recruit employees from other areas to work in such positions. However, the incoming migrant workers continue to spend in the community as well as local workers. By specifying one general worker to be a family leader, according to survey of the Statistical Office, Ministry of Information and Communication Technology, it was found that the average monthly expenditure per household in Ratchaburi Province in 2018 was 21,346 baht per month (711.53 baht/day). This is the expenses of consuming goods and services in the study area. Therefore, the operation of the Project will have a local revolving expenditure from the daily worker consumption of approximately 42,691.8 baht/day.

Therefore, the operation of the Project will increase local turnover. As a result, the study area has a better community economy. It will have a long-term positive impact as long as the Project is operational. However, the impact would occur at a low level.

(e) Increase the stability of the local power system

The operation of the Project will provide stability to the local power system. Regarding the previous statistics of the number of electricity users, details are as shown **Table 5.6.1-3**, it is found that the number of electricity users in Ratchaburi Province tends to increase continuously. It is foreseeable that the trend of the number of electricity users in the future will likely continue to increase according to the growing population. Therefore, the presence of the Project will increase the local electricity supply to the system. Due to the amount of electricity produced by the Project to be distributed to the Electricity Generating Authority (EGAT), the operation of the Project will have a positive impact on improving the stability of the local power system. The impact is a positive economic impact and long term, as long as the Project is operational.

(f) The power plant fund

The operation of the Project may affect the quality of life of the people and the environment in the area around the power plant. In order to create a new dimension of coexistence between the power plant and the communities around the power plant which will be a guideline for sustainable energy development and is a good model for other industries in the future, the Ministry of Energy has set up a community development fund in the area surrounding the power plant. The objective is to provide funding for the improvement of the quality of life of the people and the environment in the communities around the power plants which have been affected by the construction of power plants or power generation. Therefore, tit is a positive impact and long term, as long as the Project is operational.

Table 5.6.1-3

Number of electrical users and electric distribution according to types of user in Ratchaburi province in B.E. 2557-B.E. 2561 (2014-2018)

B.E.	Electricity user (people)	Electricity distribution (million kilowatt/hour)					
		Residence	Business area and Industry area	Government office And public area	Others	Free electricity	Total
2557	267,919.00	5,293,100,000.00	1,951,480,000.00	13,540,000.00	16,330,000.00	-	7,274,450,000.00
2558	267,919.00	5,293,100,000.00	1,951,480,000.00	13,540,000.00	16,330,000.00	-	7,274,450,000.00
2559	267,919.00	5,293,100,000.00	1,951,480,000.00	13,540,000.00	16,330,000.00	-	7,274,450,000.00
2560	760,539.00	8,794,460,026.81	353,523,026.49	666,334.29	8,304,336.62	-	9,156,953,724.21
2561	283,338.00	590,328,044.11	1,668,255,847.45	1,045,576.59	22,019,480.05	13,068,998.85	2,294,717,947.05

Source : Ratchaburi Provincial Electricity Authority, latest information searched on December B.E. 2562 (2019)

2) Negative impact

(a) Impact on agricultural occupation

From the survey of household leaders/spouses in the community in the radius of 5 kilometers from the Project location, it was found that the sample group was a farmer (11.7percent). When inquiries about water problems for agricultural use, it was found that the majority of the farmer samples indicated that there was no problem with the water used for agriculture. For those stating that there was a problem indicated that the problem is drought/insufficient water.

a) Construction period

The construction of the Project takes approximately 35-42 months, in which the labor contractor company will employ local labor force as the first priority in accordance with the suitability of the job and job description. Foreign workers shall be considered as the second rank. Therefore, during the construction of the Project, there is an opportunity to affect the behavior and lifestyle changes of the people in the community. Since farmers in the area may become construction workers during the non-farming period. However, after the construction is completed or during the farming period, labor in the area will return to work in agriculture as before. In addition, if the contractor company has accepted workers outside the area to work, the chances of people in the community permanently alter their occupational behavior is low.

b) Operation period

Operation of the Project may cause air pollution problems and effluent problems. These problems have an impact on the agriculture because water is supply for cultivation. The Consultant has completed an assessment of the impacts described in the preceding section and found that pollution from the Project operation will be prevented and reduced at the source of pollution through modern engineering techniques and technology to reduce pollution. Moreover, the Project shall appropriate and efficient manage to reduce pollution such as wastewater management which will be managed in accordance with the standards. The design of the pollution treatment system shall be effective in treating airborne pollutants. Therefore, it can be concluded that the impact of the Project is low.

(b) Impact on population change and migration

a) Construction period

The construction of the Project takes about 35-42 months, where labor is provided by the contractor company. It is expected that the workers are moved regarding the contractor. Usually the contractor will accept most of the worker in their region. It is assumed that most of the construction workers are from the local area. Thus, the construction period of the Project has a low level of impact on population change and other indirect impacts from labor migration. The highest demand for construction is 3,000 workers, which can have an impact on population change and migration.

b) Operation period

During the operation period, the Project will be able to accept the unemployed local workers according to the section of the increasing of employment. Regarding to the survey of the heads of households with questionnaires, it was found that there were migrations from other places (14.7percent). The maximum number of 60 employees joining the Project may be from migrant workers, resulting in the evacuation of workers into the area (excluding the accompanying family). This will cause population change. Activities in areas may also change to accommodate the growing population linking to the sufficiency of public utilities and utilities. The problem of feeling unfamiliar with life in which strangers come to live nearby may occur. However, it is very unlikely that the Project will not be able to recruit workers in the area. This is often caused by local people who are not interested in working in the position that the Project offers.

According to the results of the survey of community leaders in the study area by the Consultant in July 2019, it was found that most of the industrial workers of the study area were local workers as detailed in **Table 5.6.1-4**. It is therefore asserted that the likelihood of migrant workers entering the area is very low. Therefore, the impacts of population change and migration are less likely to occur.

In addition, the Project has the policy of accepting local workers as the first priority. It is positively affecting the composition of the population, balances the economy and society of the local community,that is, reducing the migration out of the province of the local labor force. From the basic population data in the local government area in the study area by compiling the population statistics in **Chapter 3**, it was found that the overall population in the study area showed a slight increase in population change rate. The implementation of this Project will be resulting in increasing of employment in the area. Therefore, the impacts on population change and migration are low.

Table 5.6.1-4

Employment in industrial sector

Employment in industrial sector	Adjacent area to the Project (0.1-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
1. Employment in industrial sector						
- Yes	3	33.3	11	40.7	14	38.9
- No	6	66.7	16	59.3	22	61.1
Total	9	100.0	27	100.0	36	100.0
2. The majority of the labor is from (can give more than one answer)						
- Local	3	100.0	8	72.7	11	78.6
- other areas	0	0.0	3	27.3	3	21.4
Total	3	100.0	11	100.0	14	100.0

Source : Consultants of Technololgy Co.,L.td, B.E.2562 (2019)

(c) Impact on livelihood of people in the community

a) Construction period

The presence of the project in the area will create employment. The Project has given local employment a priority. They will be considered according to qualifications, job position and experience requirement. The Project shall focus on employees who are domiciled in the area except for some positions, when the job is necessary to consider an educational background or professional license because this is a specialized line of work that requires work expertise or special work experience. If unable to provide local labor with such qualifications, the project will be necessary to accept workers from other areas to work in such positions instead. If there are foreign workers to work in many areas, it may cause a conflict of interest among the community population between those who agree and disagree with the operation of the Project. This is including paranoia and anxiety in life due to various activities in the construction period of the Project as well as various social and environmental problems that may occur in the future, such as environmental pollution problems, drug, burglary, controversy, and criminal problems.

b) Operation period

In the operation period, there is a maximum of 60 full-time employees, among which local will be the first priority. In the worst case if the Project unable to find local employee, foreign workers shall be accepted, which may affect the change in behavior and way of life of the people in the community who still maintain the local way of life, art, culture and traditions. However, if the Project can contribute to the community surrounding the Project, by cooperation through public relations activities to be appropriate to the social characteristics, impact on behavioral changes and relationships in the community are expected to occur at a low level.

(d) Impact on the safety of life and property

According to the results of the survey of household representatives in the study area on current life and property safety problems, the majority (64.7percent) of the sample group indicated that there was no problem in the community. Some of them mentioned that there was a problem (35.3 percent), which was a drug problem (39.7 percent), followed by crime/gambling/burglary (22.1 percent) and unemployment (18.9 percent), respectively, as shown in **Table 5.6.1-5.**

a) Construction period

During the construction period, the contractor company will hire labor by considering the local labor as the first priority based on the suitability of the work and the nature of the work. Foreign workers will be considered as the second rank. The consideration shall be according to qualifications, job position, and experience requirement. The focus will be given to employees who are domiciled in the area except for some positions if the job is necessary to consider an educational background or professional license because it is a specialized line of work that requires work expertise or special work experience. If unable to hire local workers with such qualifications, the Project will need to accept workers from other areas to work in such positions instead. So, the problem of unemployment in the area during the construction of the Project is likely to decrease. However, the problem of crime/gambling/theft, drug problem, and problems in slum communities may be increased as more migrant workers move to the area. The contractor has to put in place measures to supervise these workers in accordance with the regulations as specified by the Project in order to prevent any impact on life safety and property of surrounding communities. Therefore, the impact on the safety of life and property on the people of the community is low.

Table 5.6.1-5
Current problems in the community

Current problems in the Community	Close proximity (0- 100 meter)		Area close to the project (0.1-3 kilometers)		Area far from the project (3-5 kilometers)		All study area	
	Amount (people)	Percentage	Amount (people)	Percentage	Amount (people)	Percentage	Amount (people)	Percentage
1. State of problems in the community								
- no problem in the community	9	34.6	149	58.2	301	70.5	459	64.7
- problem in the community	17	65.4	107	41.8	126	29.5	250	35.3
Total	**26**	**100.0**	**256**	**100.0**	**427**	**100.0**	**709**	**100.0**
2. Problems consist of (can answer more than 1 choice)								
- crime/bet/theft	5	17.2	30	19.4	49	25.0	84	22.1
- drugs	11	37.9	86	55.5	54	27.6	151	39.7
- High living cost	8	27.6	18	11.6	36	18.4	62	16.3
- Unemployment	5	17.2	19	12.3	48	24.5	72	18.9
- Disagreement within the community	0	0.0	2	1.3	6	3.1	8	2.1
- Overpopulation	0	0.0	0	0.0	3	1.5	3	0.8
Total	**29**	**100.0**	**155**	**100.0**	**196**	**100.0**	**380**	**100.0**

Source : Consultants of Technololgy Co.,L.td, B.E.2563 (2020)

b) Operation period

The Project has placed a top priority on hiring local workers. Which will be considered according to qualifications, job position, and experience requirement. The focus is given to employees who are domiciled in the area except for some positions if the job position is necessary to consider an educational background or professional license because it is a specialized line of work that requires work expertise or special work experience. If unable to hire local workers with such qualifications. The project will be necessary to accept workers from other areas to work in such positions instead. However, if there is a need to accept foreign workers to work, Migrant workers shall move into the area and may result in problems such as crime/gambling/theft, drug problem, and slum problems, etc. The Project has established preventive and corrective measures to control these workers not to cause problems for the community. Therefore, the impact on the safety of life and property on the people in the community is low.

(e) Impact on changes in the behavior and relationships of people in the community

From the survey results of the household representative groups in the study area, it was found that they lived in a kinship basis and took the most relative benefit (37.9 percent) as shown in **Table 5.6.1-6.** In the construction and operation periods of the Project, it is imperative that the Project's employees come to live in the communities surrounding the Project must adapt to the residential community but may be in a different way. They rarely have a close relationship with people in the community which takes time to adapt. However, with the character of Thai people who see Thais as friends and relatives, adaptation in community relations is likely to be good with various traditional activities, merit-making, and temple fair. As long as the people in the community still have to depend on each other and help each other, the unity, generosity, and kinship will last forever. With the important characteristics of the relationships of people in such society, if the Project can understand and use this feature to support and caring for each other with the surrounding communities as well as coordinate the guidelines for public relations activities to suit the social characteristics of the people in the community. Therefore, the impact on the behavior changes and relationships of the people in the community is expected to be low.

(f) Impacts on community development such as community expansion, social services, or the urbanization

The Project is part of an indirect impact on community development or community expansion. However, the number of employees during the operation is 60 people, which has influenced the expansion of the community as well as social services or urbanization at a low level.

Table 5.6.1-6
Current relationship between communities

Nature of community relations	Close to the Project (0- 100 meters)		Adjacent area to the Project (0.1-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
1. Most people live in groups and uphold advantages of the majority	15	57.7	94	36.7	110	25.8	219	30.9
2. Most people live in a kinship and uphold advantages of the majority	10	38.5	99	38.7	160	37.5	269	37.9
3. Most people live a kinship and uphold kinship interests	0	0.0	49	19.1	63	14.8	112	15.8
4. Most people live on their own and uphold personal interests	1	3.8	14	5.5	94	22.0	109	15.4
Total	**26**	**100.0**	**256**	**100.0**	**427**	**100.0**	**709**	**100.0**

(g) Impact on water users in nearby water sources

The Project conducted a study on the potential of Mae Klong River water source and water user groups at the pumping point in the area of Lum Din Subdistrict. The Consultant has conducted a survey of 30 water users from the water as shown in **Table 5.6.1-7.** It was found that the people used water from the Mae Klong River (83.3 percent). In terms of their water-based activities, the first was for agriculture (86.4%), followed by aquaculture (4.5 percent) and others such as the use of village water production and washing (9.1 percent). Most of which use a water pump. The majority of the people state that there was no problem with water usage (84.0 percent). In the part that had water usage problem, they state that there was sludge and black water pollutants problems. For being affected by water use for other industrial plants in the area, there were interviewees who indicated that they were affected (12.0 percent). The impacts include malodor, turbidity, and wastewater, which were caused by a local brewery.

(h) The mental impact of anxiety and confidence on the Project development

From the analysis of the causes of public anxiety among the community leaders were self-projected (41.2 percent) as shown in **Table 5.6.1-8** and the opinion of the head of the household/spouse found that in the community near the project (radius 0.1-3 kilometers) (60.8 percent) and in the remote project community (3-5 kilometers radius) (64.6percent) is due to self-estimation. Details are shown in **Table 5.6.1-9.** This kind of community evaluation is based on the perception of information from community leaders and neighbors, shared with each other, or perception through various channels of the mass communication system. In other cases, the anxiety comes from the direct experience of the community who has seen similar projects in other areas. Thus, these influencing the community's thinking and decisions in the comments and/or recommendations made for the Project to lead to proper and appropriate clarification and understanding of the community in order to reduce conflicts. Therefore, it is the project's responsibility to bring concerns and suggestions from all target groups to formulate strategies for continually building knowledge and understanding of the community and creating a process for community involvement in order to relieve the concerns of the community as well as building confidence in the society that the Project will perform as promised to the community from the public participation meetings.

Table 5.6.1-7

Impact on water users around the raw water pumping station of the project

Details	Impact on people near the raw water pumping station	
	Amount (people)	Percentage
1. Water usage for agriculture		
- yes	25	83.3
- no	5	16.7
Total	30	100.0
2. Objectives in using the water		
- Agriculture	19	86.4
- Aquatic animal farm	1	4.5
- others (Used to produce water supply for the village, Washing)	2	9.1
Total	22	100.0
3. Problems in using water from the water source		
- No problem	21	84.0
- Found problems	4	16.0
Total	25	100.0
4. Impacts from using industrial factory’s water in other area		
- No impact	22	88.0
- Have Impact	3	12.0
Total	25	100.0

Source : Consultants of Technololgy Co.,L.td, B.E.2562

Table 5.6.1-8
The mental impact of anxiety and confidence on the Project development

Table 5.6.1-8 (Cont)

Detail	Adjacent area to the Project (0-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
1. If there is the Project. Do you have any concerns?						
- No	4	44.4	3	11.1	7	19.4
- Yes	5	55.6	24	88.9	29	80.6
Total	9	100.0	27	100.0	36	100.0
What sort of concern? (can give more than one answer)						
- Fuel used in the production	3	8.3	4	4.7	7	5.8
- Water consumption	2	5.6	9	10.6	11	9.1
- Air pollution/dust	5	13.9	12	14.1	17	14.0
- Odor	3	8.3	12	14.1	15	12.4
- Wastewater	4	11.1	11	12.9	15	12.4
- Noise	5	13.9	8	9.4	13	10.7
- Accident from the Project transportation	2	5.6	4	4.7	6	5.0
- Traffic congestion	1	2.8	0	0.0	1	0.8
- Burglary/crime	1	2.8	2	2.4	3	2.5
- Community conflict	1	2.8	5	5.9	6	5.0
- The increase of foreign workers	3	8.3	6	7.1	9	7.4
- Deforestation to be used as fuel	1	2.8	1	1.2	2	1.7
- Transparency in the operation of the Project	2	5.6	2	2.4	4	3.3
- Increase of health impact	3	8.3	9	10.6	12	9.9

Table 5.6.1-8 (Cont)

Detail	Adjacent area to the Project (0-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
Total	**36**	**100.0**	**85**	**100.0**	**121**	**100.0**
2. Causes of concern for various problems of the Project						
- From self-conjecture	5	41.7	16	41.0	21	41.2
- From hearsay of the neighbors	1	8.3	3	7.7	4	7.8
- From the operation of nearby industrial plants	3	25.0	12	30.8	15	29.4
- From information published through various public relations media	3	25.0	7	17.9	10	19.6
- Others (from the factory system control does not comply with the law and regulations on the installation of the factory)	0	0.0	1	2.6	1	2.0
Total	**12**	**100.0**	**39**	**100.0**	**51**	**100.0**
3. Level of confidence in entrepreneurs to be able to take care and manage the environment in the Project not to affect the community						
- High confidence	0	0.0	2	7.4	2	5.6
- Confidence	3	33.3	6	22.2	9	25.0
- Still unable to conclude (there is a feeling that still does not believe but it's still not up to the level of absolutely no confidence)	4	44.4	17	63.0	21	58.3
- Doubtful	0	0.0	0	0.0	0	0.0
- No confidence	1	11.1	0	0.0	1	2.8
- No comment	1	11.1	2	7.4	3	8.3
Total	**9**	**100.0**	**27**	**100.0**	**36**	**100.0**

Table 5.6.1-8 (Cont)

Detail	Adjacent area to the Project (0-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
Average	3.13		3.40		3.33	
SD	0.991		0.645		0.736	
Interpretation	Not sure		Not sure		Not sure	
4. What level of confidence do you have in government agencies? That the Project will not affect the environment, society, and health of the community						
- High confidence	0	0.0	1	3.7	1	2.8
- Confidence	3	33.3	7	25.9	10	27.8
- Still unable to conclude (there is a feeling that still does not believe but it's still not up to the level of absolutely no confidence)	4	44.4	17	63.0	21	58.3
- Doubtful	0	0.0	0	0.0	0	0.0
- No confidence	1	11.1	0	0.0	1	2.8
- No comment	1	11.1	2	7.4	3	8.3
Total	9	100.0	27	100.0	36	100.0
Average	3.13		3.36		3.30	
SD	0.991		0.569		0.684	
Interpretation	Not sure		Not sure		Not sure	
5. What do you think about the format of public relations/information provision of the Project to the community should be so that the community can be as thoroughly as possible?						
- None	1	5.9	2	5.4	3	5.6
- Notifying news through the village headman/ community leader/ news distribution tower of the village	6	35.3	18	48.6	24	44.4

Table 5.6.1-8 (Cont)

Detail	Adjacent area to the Project (0-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
- Meeting	5	29.4	12	32.4	17	31.5
- Board of the community	5	29.4	5	13.5	10	18.5
Total	**17**	**100.0**	**37**	**100.0**	**54**	**100.0**

Remark: Interpretation of the mean score

Range of score	Interpretation
4.21 - 5.00	High confidence
3.41 - 4.20	Confidence
2.61 - 3.40	Still unable to conclude (there is a feeling that still not confident but it's still not up to the level of absolutely no confidence)
1.81 - 2.60	Doubtful
1.00 - 1.80	No confidence

Source: Consultant of Technology Company Limited, 2019

Table 5.6.1-9
Mental impact on anxiety and confidence of leader of household/spouse in study area
Table 5.6.1-9 (cont.)

Detail	Close to the Project (0- 100 meters)		Adjacent area to the Project (0.1-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
1. If there is the Project. Do you have any concerns?								
- No	11	42.3	147	57.4	305	71.4	463	65.3
- Yes	15	57.7	109	42.6	122	28.6	246	34.7
Total	**26**	**100.0**	**256**	**100.0**	**427**	**100.0**	**709**	**100.0**
What sort of concern? (can give more than one answer)								
- Fuel used in the production	1	3.6	10	4.3	9	3.8	20	4.0
- Water consumption	2	7.1	10	4.3	13	5.4	25	5.0
- Air pollution/dust	4	14.3	58	25.0	66	27.5	128	25.6
- Odor	4	14.3	38	16.4	37	15.4	79	15.8

Table 5.6.1-9 (cont.)

Detail	Close to the Project (0- 100 meters)		Adjacent area to the Project (0.1-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
- Wastewater	2	7.1	21	9.1	11	4.6	34	6.8
- Noise	12	42.9	52	22.4	49	20.4	113	22.6
- Accident from the natural gas distribution pipeline	1	3.6	15	6.5	15	6.3	31	6.2
- Traffic congestion	0	0.0	5	2.2	8	3.3	13	2.6
- Burglary/crime	0	0.0	0	0.0	3	1.3	3	0.6
- Community conflict	0	0.0	3	1.3	6	2.5	9	1.8
- The increase of foreign workers	0	0.0	8	3.4	6	2.5	14	2.8
- Transparency in the operation of the Project	0	0.0	6	2.6	6	2.5	12	2.4
- Increase of health impact	2	7.1	6	2.6	11	4.6	19	3.8
Total	**28**	**100.0**	**232**	**100.0**	**240**	**100.0**	**500**	**100.0**
2. **Causes of concern for various problems of the Project**								
- From self-conjecture	12	70.6	76	60.8	93	64.6	181	63.3

Table 5.6.1-9 (cont.)

Detail	Close to the Project (0- 100 meters)		Adjacent area to the Project (0.1-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
- From hearsay of the neighbors	4	23.5	9	7.2	14	9.7	27	9.4
- From the operation of nearby industrial plants	0	0.0	24	19.2	26	18.1	50	17.5
- From information published through various public relations media	1	5.9	16	12.8	11	7.6	28	9.8
Total	**17**	**100.0**	**125**	**100.0**	**144**	**100.0**	**286**	**100.0**
3. Level of confidence in entrepreneurs to be able to take care and manage the environment in the Project not to affect the community								
- High confidence	1	3.8	8	3.1	16	3.7	25	3.5
- Confidence	11	42.3	77	30.1	114	26.7	202	28.5
- Still unable to conclude (there is a feeling that still does not believe but it's still not up to the level of absolutely no confidence)	10	38.5	102	39.8	184	43.1	296	41.7
- Doubtful	3	11.5	36	14.1	50	11.7	89	12.6
- No confidence	0	0.0	10	3.9	20	4.7	30	4.2

Table 5.6.1-9 (cont.)

Detail	Close to the Project (0- 100 meters)		Adjacent area to the Project (0.1-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
- No comment	1	3.8	23	9.0	43	10.1	67	9.4
Total	26	100.0	256	100.0	475	100.0	709	100.0
Average	3.40		3.16		3.15		3.16	
SD	0.764		0.879		0.885		0.878	
Interpretation	Not sure		Not sure		Not sure		Not sure	
4. What level of confidence do you have in government agencies? That the Project will not affect the environment, society, and health of the community								
- High confidence	1	3.8	5	2.0	10	2.3	16	2.3
- Confidence	12	46.2	84	32.8	113	26.5	209	29.5
- Still unable to conclude (there is a feeling that still does not believe but it's still not up to the level of absolutely no confidence)	10	38.5	93	36.3	166	38.9	269	37.9
- Doubtful	1	3.8	37	14.5	61	14.3	99	14.0

Table 5.6.1-9 (cont.)

Detail	Close to the Project (0- 100 meters)		Adjacent area to the Project (0.1-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
- No confidence	1	3.8	11	4.3	30	7.0	42	5.9
- No comment	1	3.8	26	10.2	47	11.0	74	10.4
Total	**26**	**100.0**	**256**	**100.0**	**427**	**100.0**	**709**	**100.0**
Average	**3.44**		**3.15**		**3.03**		**3.09**	
SD	**0.821**		**0.886**		**0.938**		**0.918**	
Interpretation	Not sure		Not sure		Not sure		Not sure	
5. What do you think about the format of public relations/information provision of the Project to the community should be so that the community can be as thoroughly as possible?								
- None	1	3.8	15	5.7	41	8.7	57	7.5
- Notifying news through the village headman/ community leader/ news distribution tower of the village	15	57.7	158	60.5	260	55.2	433	57.1
- Meeting	10	38.5	77	29.5	138	29.3	225	29.7
Board of the community	0	0.0	8	3.1	31	6.6	39	5.1

Table 5.6.1-9 (cont.)

Detail	Close to the Project (0- 100 meters)		Adjacent area to the Project (0.1-3 kilometers)		Remote area to the Project (3-5 kilometers)		Total study area	
	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent	Number (person)	Percent
- Other (online media, Facebook, invitation letter)	0	0.0	3	1.1	1	0.2	4	0.5
Total	**26**	**100.0**	**261**	**100.0**	**471**	**100.0**	**758**	**100.0**

Remark: Interpretation of the mean score

Range of score	Interpretation	Range of score	Interpretation
4.21 - 5.00	High confidence	3.41 - 4.20	Confidence
2.61 - 3.40	Still unable to conclude (there is a feeling that still not confident but it's still not up to the level of absolutely no confidence)		
1.81 - 2.60	Doubtful		
1.00 - 1.80	No confidence		

Source: Consultant of Technology Company Limited, 2019

Therefore, the Project has set measures to prevent and mitigate environmental impacts during the construction and the operation periods to be concrete and practical as shown in **Chapter 7** of this report, which recognizes the importance of public relations on the operation of the Project to establish correct understanding and acknowledge concerns/suggestions for the Project. This is also helping activities and improving the quality of life of the people surrounding the Project for the benefit of the society as a whole along with the determination to operate that does not affect the environment which is a real part of social responsibility. For the main policy on public relations, the Project provides an annual work plan and execute the work plan to be efficient and effective with community relations staff to publicize or provide adequate information. The information may inform by various means such as various media, through community leaders, or direct meeting.

After implementation of any activities, an annual community relations performance assessment will be conducted to reflect the Project's acceptance and assessing the effectiveness of the Project's relative mass action plan. This shall be perform by bringing the results of community opinion polls, community leaders and relevant representatives (the Project must be implemented annually as defined in the environmental impact monitoring measure of the Project) as a joint information to consider and evaluate the success of the operation. In addition, the Project has established a procedure for receiving complaints and resolve various problems in a timely manner not to cause environmental impacts and conflicts with the surrounding people.

Therefore, the socio-economic impacts of the Project can be summarized in **Table 5.6.1-10.**

Table 5.6.1-10

Level of socio-economic impact from the presence of the Project

Table 5.6.1-10 (cont.)

Aspect	Level of impact			Remark
	High	Moderate	Low	
Positive impact				
1. Enhancing economic security				The Project is located in the responsible area of the Hin Kong Subdistrict Administrative Organization, Mueang Ratchaburi District, Ratchaburi Province. The operation of the Project positively affects the economy of community, local village, and Ratchaburi Province.
- Construction period	/			
- Operation period	/			
2. Increasing income tax to the				The operation of the Project will be resulted in more income generation and there is more money in the province due to corporate tax.
province and localities	/			
- Construction period	/			
- Operation period				
3. Increasing employment				The Project has put local employment as the first priority by establishing the employment policy.
- Construction period	/			
- Operation period	/			
4. Enhancing community economy				The presence of the Project will increase local turnover, resulting in income circulating into the local. This will lead to consequences, including the household economy to have more income.
- Construction period	/			
- Operation period	/			

Table 5.6.1-10 (cont.)

Aspect	Level of impact			Remark
	High	Moderate	Low	
5. Increasing the stability of the local power system		/		The implementation of the Project will provide stability to the local power system. This is because some of the electricity produced by the Project will be distributed to the Electricity Generating Authority of Thailand (EGAT).
6. The power plant fund		/		To create a new dimension of coexistence between the power plant and the communities in the area surrounding the power plant, the Ministry of Energy has set up a community development fund in the area surrounding the power plant.
Negative impact				
1. Impact on agricultural occupation				From the survey of the sample group of household leaders/spouses in the community within 5 kilometers radius from the Project location, there is no problems related to water usage. However, some people stated that there was a problem of drought/insufficient water.
- Construction period	/			
- Operation period	/			

Table 5.6.1-10 (cont.)

Aspect	Level of impact			Remark
	High	Moderate	Low	
2. Impact on population change and migration - Construction period - Operation period	 / /			In the construction of the Project, a maximum of 3,000 workers will be employed, with a construction period of approximately 35-42 months, and a maximum of 60 employees during the operation period. This will result in a change in the population density in the area. According to the survey of community leaders in the study area, it was found that most of the industrial workers of the study area were local workers.
3. Impact on changes in the behavior and lifestyle of people in the community - Construction period - Operation period	 / /			Many foreign workers come to work the area may cause a conflict of interest among the community population between those who agree and disagree with the Project. This is including various social and environmental problems that may occur in the future, such as environmental pollution problems, drug problems, burglary, controversy, and criminal issues, etc. However, the Project has measures and regulations in place.
4. Impact on the safety of life and property - Construction period - Operation period	 / /			Must have measures to supervise employees to comply with the rules as specified by the Project to prevent impacts on life and property safety on the surrounding communities.

<u>Table 5.6.1-10 (cont.)</u>

Aspect	Level of impact			Remark
	High	Moderate	Low	
5. Changes in the behavior and relationships of people in the community				From the results of the survey of the head of the household, it was found that the relationship between the people in the community was based on kinship and based on the kinship benefits.
- Construction period	/			
- Operation period	/			
6. Impacts on community development such as community expansion, social services, or urbanization				The expansion of the community results in the need for relevant agencies to provide social services. There must be planning to support future development of the community in the development plan of each local government organization to prepare social services in the area with the potential capacity to provide.
- Construction period	/			
- Operation period	/			
7. Impacts on water users at water bodies nearby the Project area				Water users are affected by water use from other industrial plants in the area (12.0 percent).
- Construction period	/			
- Operation period	/			

<u>Table 5.6.1-10 (cont.)</u>

Aspect	Level of impact			Remark
	High	Moderate	Low	
8. The mental impact of anxiety and confidence on the Project development - Construction period - Operation period	 / /			According to the results of public opinion survey in the area, it was found that most of the concerns of the people in the area were concerns about dust. On the confidence of the Project, it was found that the area near the Project (radius 0.1-3 kilometers) and the remote area (3-5 kilometers radius) had confidence in the Project regarding the environmental management system and the environmental supervision measures of the Project in the level that cannot be concluded. As for the confidence in government agencies, it was found that the confidence at the level that cannot be concluded as well. In this regard, the Project has established measures to prevent and mitigate environmental impacts during the construction and operation periods to be concrete and practical.

<u>Source</u>: Consultant of Technology Company Limited, 2562 (2019)

5.6.2 Assessment of the major hazard of the Project

Activities that have a major hazard for the Project include, the occurrence of a serious incident on a gas pipeline, explosion of the gas turbine generator (GTG), and chemical spill. The Consultant has conducted the assessment of the risk assessment using the guidelines of the Department of Industrial Works on Criteria for Hazard Identification and the Risk Assessment and Risk Management Program B.E.2543 (2000). It includes the preparation of an inventory of risks and hazards, hazard identification, and the risk assessment as follows:

5.6.2.1 The inventory of risks and hazards

The risks and potential hazards of the Project are shown in **Table 5.6.2.1-1**. Therefore, the Consultant conducts a serious hazard assessment by divided into three main risks: 1) the major hazard to the gas pipeline, assessed by using a mathematical model, 2) electricity generator, steam turbine, steam generator (HRSG), switchyard, step up transformer, and 3) chemical leakage, assessed by Fault Tree Analysis (FTA) technique.

Table 5.6.2.1-1

The inventory of risks and hazards of the Project

Operation	Risk	Potential impact	Hazard identification method
1. Fuel transport	- Serious dangers at natural gas pipelines - Serious dangers of diesel tanks and pipelines	- Employees are injured - Damaged property, production has to be stopped - Danger to the environment	- Mathematical model
2. Production and transmission processes - Power generator - Steam turbine - Heat recover steam generator (HRSG) - Switchyard - Step up transformer - Gas turbine	- Explosion of the power generator - Explosion of steam turbine - Explosion and fire of heat recover steam generator (HRSG) - Fire of switchyard - Explosion and fire of the step up transformer - Fuel leaks due to broken pipes (assessed on fuel transportation)	- Employees are injured - Damaged property, production has to be stopped - Danger to the environment	- Fault Tree Analysis - Mathematical model
3. Chemical storage	- The rack used to store the package is made of wood, causing it to break when placing too heavy objects - More chemicals are stored than the building design - Chemical handlers do not wear PPE while working	- Chemical damage - Causing insufficient ventilation in the building, causes heat to react with chemicals, a fire can occur - May have an accident and employees are injured, such as falling of a container	- Fault Tree Analysis

Source: Consultant of Technology Company Limited, 2020

5.6.2.2 Assessment using the mathematical model

(1) Methodology

In this major hazard impact assessment, the Consultant used the PHAST mathematical model, a model developed by DNV Software, categorized as "Safeti" as a risk assessment and management tool in manufacturing processes. The PHAST mathematical model is used to assess consequences of impact to be used in determining or implementing any of the following:

1) Estimate the magnitude of consequences
2) Consider the location of the device, equipment layout, and design
3) Determine effect of modification
4) Prepare contingency plan
5) Comply with regulation
6) Insurance negotiations
7) Promote safety awareness
8) Quantitative risk assessment (QRA)

The PHAST mathematical model consists of a model to assess the magnitude of impact from hazardous events. There are 4 groups model as follows:

1) Discharge model:

(a) Liquid outflow model,
(b) Gas outflow model,
(c) Two phases outflow model, and
(d) Single or multi-component material.

2) Dispersion model:

(a) Aerosol formation assessment,
(b) Rain out assessment,
(c) Pool formation assessment,
(d) Pool evaporation assessment,
(e) Dense cloud dispersion assessment,
(f) Buoyant plume dispersion assessment, and
(g) Passive/Gaussian clouds assessment.

3) Radiation effects model:

(a) Pool fires assessment,

(b) Jet fires assessment,

(c) BLEVEs and fire ball assessment, and

(d) Flash fire assessment.

4) Explosion effects model:

(a) Vapor cloud explosion assessment, and

(b) BLEVE blast assessment.

Therefore, it can be seen that the PHAST mathematical model covers hazardous chemicals at all phases and critical events. Thus, it is appropriate to be used in this environmental impact study. The scope and methods of studying major hazard are shown in **Figure 5.6.2.2-1**.

The impact of such major hazard assessment results will be used as a preventive and mitigation measures for the Project, which is necessary to use the information in the study as follows:

1) Meteorological data for assessing magnitude of the major hazard

Meteorological data used to assess the major hazards are atmospheric temperature, relative humidity, or wind speed. It is the basic information to be used in conjunction with the Project detailed information in calculating the magnitude of serious potential hazards. The aforementioned meteorological data will influence the evaporation rate of the leaked material, distance of diffusion of gas groups, etc.

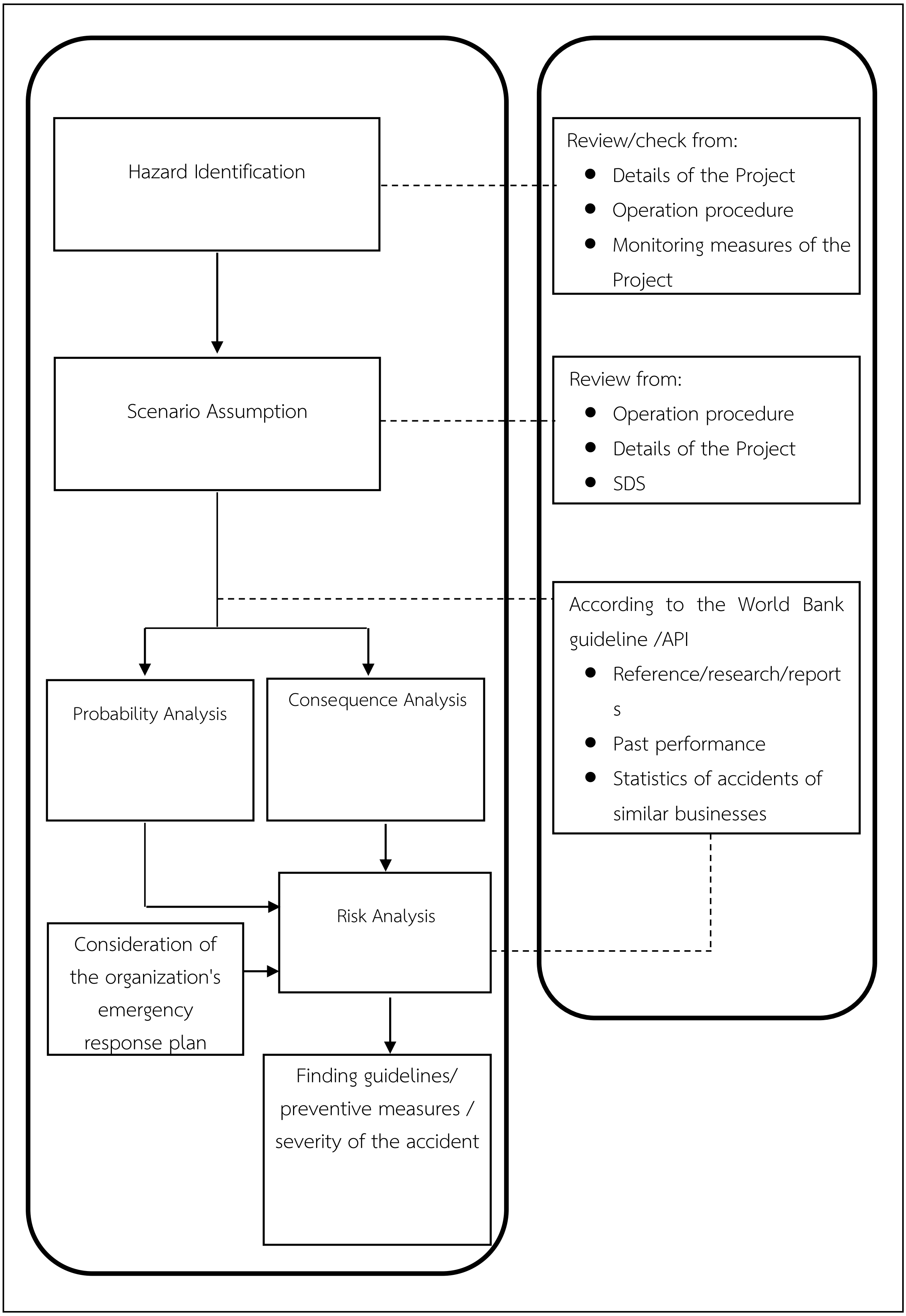


Figure 5.6.2.2-1 Scope and method of the major hazard studies

The meteorological data used to assess the magnitude of the major hazard were derived from climate statistics for the 13-year period (2006-2018) of the Ratchaburi Meteorological Monitoring Station. Details are shown in **Table 5.6.2.2-1**.

In addition to meteorological data, there is one parameter involved in the assessment of the major hazards, the surface roughness parameter, which indicates anomalous movement of the turbulence as it blows through a characteristic area. Uneven by the surface roughness parameter depends on the surface texture of the area as follows:

Surface characteristics	Surface Roughness Parameter
Sea	0.06
Flat Land with Few Trees	0.07
Open Farm Land	0.09
Open Countryside	0.11
Wood, Rural area, or industrial area	0.17
Urban	0.33

When considering the nature of the Project area comprising the industrial area and a suburban area, therefore, choosing to use a surface roughness parameter of 0.17

(2) Hazard identification and production unit that assess for major hazed

Hazard identification is an important step because it will indicate which processes or production units have the potential to cause major hazard and the nature of the hazard that may occur. The classification of the hazard can be determined by studying the details of the Project.

The study of Project descriptions consists of (1) the study of the process flow diagram from the chemical storage process, the entry of chemicals into the production process, related chemical reaction, (2) a detailed study of the production unit and the operating condition of the production unit, and (3) the study of protective equipment and various control systems that the Project installed.

Table 5.6.2.2-1

Periodic Climate Statistics of 13 years (B.E. 2549 – B.E. 2561 (2006-2018)) of the Weather Monitoring Station of Ratchaburi province

Station	Ratchaburi	Elevation of station above MSL	5.00 meters
Index station	48464	Height of barometer above MSL	0.00 meters
Latitude	13 degrees, 29 minutes north	Height of thermometer above ground	1.50 meters
Longitude	99 degrees long, 47 minutes east	Height of Anemometer above ground	10.00 meters
		Height of raingauge	0.80 meters

	jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Air pressure (Hectopascals)													
Mean	1012.2	1010.9	1010	1008.6	1007.2	1006.6	1006.8	1007.1	1007.8	1009.7	1010.8	1012.0	1009.14
Mean daily range	4.0	4.0	4.1	4.0	3.7	3.0	2.8	3.0	3.8	3.8	3.5	3.8	3.62
Max.	1022.75	1020.81	1018.35	1016.69	1013.98	1013.24	1012.84	1012.11	1015.82	1031.65	1017.99	1022.48	1031.65
Min.	1003.77	1003.0	1002.03	1001.18	1001.50	995.99	1000.69	1001.3	994.19	1002.63	1003.8	1003.55	994.19
Temperature (^{o} C)													
Mean max.	31.6	33.8	35.2	36.2	35	33.8	33.1	33.2	33	31.9	31.3	30.8	33.2
Ext. max.	36.5	37	40	41.5	39.7	37	36.5	37	36.6	36.5	36	35.5	41.5
Mean min.	20.5	22	23.9	25.2	25.6	25.3	25	25	24.8	24.6	23.4	21.4	23.9
Ext. min.	12	14.4	17.5	21.4	23	23.4	23.5	23	22.5	21.3	15.5	13.1	12
Mean	25.4	27.2	28.7	29.7	29.1	28.5	28	28.1	27.8	27.2	26.6	25.4	27.6
Dew point (^{o} C)													
Mean	19.5	21.3	23.1	24	24.8	24.5	24.1	24	24.4	24.5	22.7	20.1	23.1
Relative humidity (ร้อยละ)													
Mean	72	73	74	74	80	80	81	80	83	86	81	74	78.1
Mean max.	91	93	93	92	95	95	95	94	96	97	94	90	93.7
Mean min.	49	48	49	50	58	61	61	60	64	68	62	53	56.9
Ext. min.	17	18	24	28	33	44	17	45	48	45	40	29	17
Visibility (kilometers)													
7.00 a.m.	5.3	4.1	5.1	7.5	9.2	9.9	9.8	10.1	10.1	7.3	7.2	6.9	7.7
Cloud volume (1-10)													
Mean	2.7	1.9	2.5	4.2	6.9	7.8	8.5	8.4	8.3	7.2	4.7	3.5	5.6
Wind (knots)													
Directions	N,NW	SE	SE	SE	SE	W	W	W	W	NW	NW	NW	-
Mean	2.7	2.5	2.8	2.6	2.2	2	2.2	2.5	2.3	2.2	3	3.5	2.5
Max.	37	25	27	31	35	45	43	40	40	34	38	32	45
Evaporation (Millimeter)													
Average	125.9	135.1	160.2	179.8	166	137.7	132.3	139.3	133.9	111.2	107.1	121.6	1650.1
Rainfall volume (Millimeter)													
Mean	4.6	5.8	34.5	42.6	151.2	130.9	125.5	115.1	225.1	239.8	64.2	10.6	1149.9
Mean rainy day	1.6	1.2	3.7	5.2	15.7	16.3	18	17.9	19.8	18.1	6.3	1.9	125.7
Daily maximum	34.3	19.7	93.9	94.7	98.2	86.6	83.1	62.3	113	141.3	304.9	27	304.9
Natural phenomena (day)													
Fog	0.2	0.5	0.5	0	0.1	0	0	0	0.1	0.1	0.1	0	1.6
Haze	23.1	22.6	22.9	10.2	0.8	0.4	0	0.1	0.2	3.7	9.2	19.1	112.3
Hail	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0.2
Thunderstorm	0.4	0.8	2.1	5	12.4	7.8	6.4	5.6	7.7	9.5	1.9	0	59.6
Squall	0	0	0	0	0	0	0	0	0	0.1	0	0	0.1

Source : Meteorological Department, B.E. 2561(2018)

In determining whether a production unit is subject to major hazard assessment or not, it is determined from the properties of the chemicals involved. The Consultant considered the guidelines for chemical substances with hazardous properties referenced from "List of Hazardous Substances Requiring a Major Hazards Assessment, Guideline for Environmental Impact Assessment and Management of Chemical and Petrochemical Industries, Industrial Section, Division of Environmental Impact Evaluation, Office of Environmental Policy and Planning (1993)". This guideline has set criteria for determining the production units that fall within the scope of the critical hazard assessment. It is determined by the hazard properties and the amount of use/storage of the chemicals involved.

From the consideration of the Project's production process, it was found that the hazardous substances used in the Project are natural gas and diesel oil. For natural gas, its properties are gas at normal temperature, colorless, and odorless. It is classified as flammable gas. The flash point of about -187.8 degrees Celsius has a limit of flammability (LFL - UFL) equal to 5.3% - 15%. The LD_{50} (oral, rat) is greater than 5,000 milligrams/kilogram body weight. The properties of high speed diesel fuel are liquid, yellow, oily odor. It is classified as less flammable. Vapors can be generated at temperatures lower than room temperature. The self-ignition temperature is 250°C with a flash point of approximately 52°C.

From the details of the physical, chemical, and hazardous properties of the chemicals used and produced in the Project, it can be seen that the chemicals that fall within the scope of the critical hazard are natural gas. Therefore, the Consultant conducted a major hazard assessment in the event that it affects the health of the exposed person. In defining a case study, production units that involved with the chemical and operating condition i.e., higher pressure and temperature than normal would have a chance to cause major hazard.

The production units dealing with hazardous chemicals with higher operating conditions than normal atmosphere are natural gas pipelines at the metering gas station and diesel fuel storage tanks.

For natural gas, the Project receives from the licensed company to distribute the natural gas by connecting a 24-inch natural gas pipeline to the Project's natural gas control station. The Project will then connect a 16-inch natural gas pipeline from the natural gas control station to the gas turbine area within the Project area.

Therefore, in assessing the impact of the major hazards, the Consultant assessed the impacts at the gas pipelines around the metering gas station. Details of the gas pipeline are as follows:

(a) Metering gas station

The Project receives natural gas from the licensed company. It connects a 24-inch natural gas pipeline to the metering gas station area, which is distributed at 1,250 pounds/square inch of pressure and temperature of 112.8 degrees Fahrenheit. The Project then connects two 16-inch diameter natural gas pipelines from the metering gas station area to the gas turbine area within the Project area, which is distributed at a pressure of 1,250 pounds/square inch and the temperature of 112.3 degrees Fahrenheit.

(b) Area around the diesel storage tanks

The Project has a reserve of diesel for emergency use only. It is transported by a transportation truck before being stored in two storage tanks, 16-inch diameter to deliver diesel to the power generation unit.

(3) Hypothesis/sequence analysis leading to the occurrence of major hazard events

In the major hazard assessment, the worst case is assessed to study the impact of the major hazard and to review/define preventive and mitigation measures, or to determine guidelines for revising emergency control plans and evacuation plans in accordance with the nature and areas affected by major hazards from the operation of the Project. In this study, the case of natural gas and diesel oil leak are considered.

In the event of major hazards around the production unit, including fires and explosions. There are three factors that must be involved in the formation of fire, oxygen, fuel, and a heat/spark source. The Project has set up a system and measures to prevent serious hazards, such as leak prevention and leak detection of hazardous substances from the production process and restricted area designation to prevent source of heat/spark in the area as well as provide a fire extinguishing system. There is a fire protection system with water sprinklers, foam, and fire extinguishers. In addition, the Project has a safety system in the workplace. Therefore, the likelihood of hazard is very less or almost impossible.

For natural gas, which is in the gas state, the nature of the major hazards arising from a gas leak can be determined from the Event Tree analysis according to the World Bank guideline as shown in **Figure 5.3.6.2. 2,** can be explained as follows:

1) The study began from the calculation of the discharge rate of the hazardous substance leaked. The input data used in the calculation are the operating temperature and pressure and release rate.

2) Hazardous substances in the gaseous state will leak in the gas jet characteristic. Then consider whether within the jet dispersion there is an ignition source or not, and the leaked material will expose the spark or not. If there is a fire source, the leaked gas is set to ignite (jet fire) and radiates heat from combustion to determine the areas affected by different magnitude of thermal radiation as following.

Heat radiation intensity (kW/m^2)	Hazard characteristic	
	To building	To receptor
4.0	-	- Causing pain in the area of the exposed skin if longer than 20 seconds of
12.5	The wood material started to ignite. Plastic starts to melt.	- There is a 1% chance of death if exposed for 1 minute. First degree severe skin burns within 10 seconds.
25.0	Wooden structures can be ignited without flames.	- There is a 100% chance of death if exposed for 1 minute. - Serious injury may occur if exposed for longer than 10 seconds.
37.5	Damage to building or equipment	- There is a 100% chance of death if exposed for 1 minute. - There is a 1% chance of death if exposed for 10 seconds.

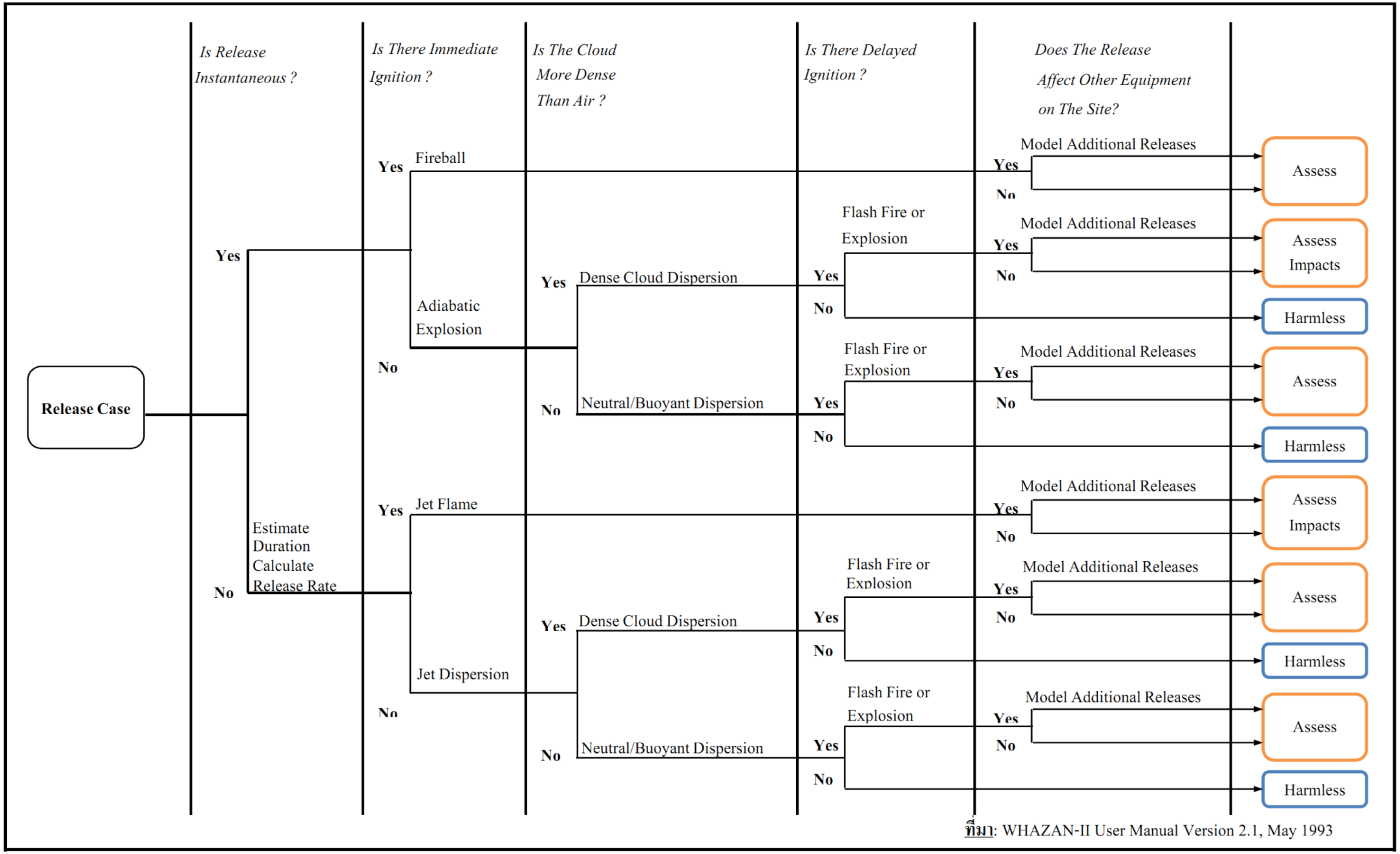


Figure 5.6.2.2-2 Order of dangerous events in case of gas leakage

3) In the absence of a source of fire in the area where the cloud of the hazardous gas cloud differs in the direction of the downwind dispersion, the assessment focused on the concentration levels such as lower flammable limits (LFL) in case of combustible substance and emergency response planning guidelines (ERPG) in the case of substances with properties hazardous to health. The input data used in the calculation are the leak rate, gas leak temperature, atmospheric category, surface roughness parameter, ambient temperature, relative humidity, and concentration of interest.

4) In the event that the gas cloud has a flammable quantity or concentration as the spread of gas is exposed to a source of ignition, these gases can be flash fire or Vapor cloud explosion (VCE). In the study, the distances affected by the compression pressure of the explosion were assessed. The input data used in the calculation were the amount of flammable gas in the air based on the lower flammable limit (LFL), combustion heat, explosive factor and size of compressed pressure due to explosion of gas cloud. The magnitude of compression pressure due to explosion is classified as follows.

Magnitude of explosion	**Hazard characteristic**	
	To building	**To receptor**
Heavy damage (0.21 bar)	Severe damage to nearby buildings and production equipment	- There is 1% chance of death due to tear of lung - There is > 50% chance of tearing the eardrum - There is > 50% chance of serious injury from floating object
Repairable damage (0.14 bar)	Partial damage to buildings	- There is > 1% chance of tearing the eardrum - There is > 1% chance of serious injury from floating object

Vapor cloud explosion (VCE) is different from the case of fires/pool fire/jet fires. In the case of gas explosion, fuel gas and air must be mixed before being flammable (premixed fuel-air mixture) provided that the combustible gas concentration in the air must be within the flammable limit then ignition. In case of fires/pool fires/

jet fires, it is the case where flammable gas/liquid with air is mixed together during combustion.

In combustion premixed fuel-air mixture, if the combustible gas is burned in large quantities in a short time (deflagration), such a characteristic will cause pressure from burning or pressure from overpressure explosion. If the combustion does not occur quickly (slow deflagration), it will not result in the burning pressure, it is called flash fires.

However, the ignition of the premixed fuel-air mixture that causes the gas to explode will occur when there is a concentration between the upper flammable limit (UFL) and the lower flammable limit (LFL).

The lower flammable limit (LFL) refers to the lowest concentration (%) of flammable gas in flammable air. When there is a spark source, if the concentration is lower than the LFL, then there is an insufficient amount of flammable gas (too lean) to cause ignition or explosion. The upper flammable limit (UFL) refers to the maximum concentration (%) of the combustible gas in the air. When there is a spark source, if the concentration is higher than the UFL, it means that there is an excessive amount of combustible gas (too rich), resulting in less oxygen in the air. Thus, it is not enough to cause fire or explosion.

Regarding the diffusion of the gas cloud occurs in the direction of downwind dispersion and the concentration gradually decreases as the distance from the source of leakage increases, the distance with the upper flammable limit (UFL) is located near the source of the leak is greater than the distance with the lower flammable limit (LFL). Therefore, to estimate the flammable distance or area of a gas cloud with a mathematical model, a lower flammable limit (LFL) value is used in the assessment in order to ensure that the distance at affected cases are covered in all cases.

(4) Scope Case study

1) Determining the major hazard assessment area

The production units considered to be potentially hazardous for the Project were studied in detail as to what areas are likely to leak to be determined as a case study in the assessment. It was performed based on recommendations from the World Bank Hazard Analysis Guide Book as mentioned in topic (1), it was found that production units with the potential to cause serious hazards from the Project is the natural gas pipeline, the World Bank recommends the following case studies for assessing the impact.

Pipeline distributing dangerous substances, the World Bank has recommended a case study in case of flange leak, pipe leak, and weld failure.

2) Leak hole size

Determining the leak size, the Consultant carried out a recommendation of the API that has defined four sizes of holes, small, medium, large, and rupture as follows:

Size of pipe leak hole	Consideration phase	Used index
small	0 - 0.25 inch	0.25 inch or 1/4 inch
medium	0.25 - 2 inches	1 inch
large	2 - 6 inches	4 inches
Rupture	> 6 inches	Diameter of the pipe (not more than 16 inches)

Source: API Publication 581, 2016

In determining the size of the leak in the major hazard assessment, the Consultant considered the leak size in accordance with the API recommendations to determine four leak sizes. The Consultant selected two leak sizes, small or 1/2-inch leak size and rupture, as a case study in assessing the danger of force. Small leaks, or 1/2 inch leaks, are the most likely to occur while the rupture size is the most severe leakage.

However, when considering the effect of flange leak, pipe leak, and weld failure of the same pipeline, consequential impacts are the same due to the same operating conditions and leak sizes. Therefore, in presenting the magnitude of impact from the case study of the pipeline, the Consultant did not separate impact from flange leak, pipe leak, and weld failure.

3) Case study

To determine the size of the leak in this major hazard assessment, the Consultant determined the size of the leak by representatives of small holes and rupture, as follows:

Case 1. Major hazard assessment in case of a leak of the natural gas pipeline at the metering gas station area of the Project, and

Case 2. Major hazard assessment in the area of diesel storage tanks.

Production unit	Case study			
	Small leak size	Medium leak size	Large leak size	Rupture
Natural gas pipeline, diameter of 24 inches	0.25 inch	1 inch	4 inches	16 inches
Natural gas pipeline, diameter of 16 inches	0.25 inch	1 inch	4 inches	16 inches
Leak at the pipeline joint to the diesel tank, diameter of 16 inches	0.25 inch	1 inch	4 inches	16 inches

5.6.2.3 The results of the assessment of the major hazards using the mathematical model

In the major hazard assessment of natural gas pipeline leak at the metering gas station, the Consultant has selected the worst case, the leak of the highest pressure of the natural gas pipeline (1,250 psig) (**Table 5.6.2.3-1**) and the major hazard assessment of the diesel storage tanks. The major hazard assessment results show the magnitude of the impacts calculated in a tabular format with a brief description and the radius of the hazard in case of the greatest impact on the Project plan for the benefit of determining the likely affected areas. This can be used as information in determining appropriate preventive and mitigation measures for the Project. The results of the assessment of the major hazards of the Project can be described as follows:

Table 5.6.2.3 -1

Danger assessment

Case study	Dangerous chemicals	State	Leak rate (kg./sec)	Impact distance from heat radiation (meter)						Spreading distance of the lower flammability level (LFL)(meter)	Impacted radius from vapor cloud explosion (VCE) (meter)	
				Jet Fire			Pressure from Firebell				0.14 bar gauge	0.21 bar gauge
				4.0 kW/m²	12.5 kW/m²	37.5 kW/m²	4.0 kW/m²	12.5 kW/m²	37.5 kW/m²			
1. 24 inch diameter Natural gas pipeline												
- Small	Natural gas	Pressurized gas	0.399	10.3	8.0	n/a	-	-	-	5.4	-	-
- Medium	Natural gas	Pressurized gas	6.382	44.8	35.2	28.0	-	-	-	25.6	31.0	28.3
- Large	Natural gas	Pressurized gas	102.11	163.4	119.0	90.6	520.5	285.6	121.5	135.1	183.9	170.4
- Rupture	Natural gas	Pressurized gas	1,633.79	572.3	398.8	304.3	1,153.2	631.1	246.2	498.0	561.6	528.7
2. 16 inch diameter Natural gas pipeline												
- Small	Natural gas	Pressurized gas	0.407	10.4	8.1	n/a	-	-	-	5.4	-	-
- Medium	Natural gas	Pressurized gas	6.514	45.3	35.6	28.2	-	-	-	26.0	31.1	28.3
- Large	Natural gas	Pressurized gas	104.23	164.9	120.1	91.3	523.6	287.3	122.1	137.3	184.4	170.8
- Rupture	Natural gas	Pressurized gas	1,667.70	577.6	402.7	307.1	1,159.9	634.8	247.4	509.5	564.3	533.1

Remark : "n/a" means impact is not found
" - " means there is no such impact

Source : Consultants of Technololgy Co.,L.td, B.E.2562 (2019)

(1) Case 1. Major hazard assessment in case of a leak of the natural gas pipeline at the metering gas station area of the Project

<u>Case study: The natural gas distribution pipeline with diameter of 24 inches</u>

1) The case of small leak size

In the event of leak of a natural gas pipeline with diameter of 24 inches and leak hole size of 0.25 inch, the natural gas will be leaked in the gas phase with the same leak rate of 0.399 kilogram/second. In the event that the leak is not yet controlled, such as closing the block valve, natural gas leakage will occur all the time. Therefore, it is characterized as a continuous release, which, if the leaked gas touches a spark, it will ignite in a manner known as a jet fire, which will cause the effect of heat radiation. The heat radius at 4.0 and 12.5 kilowatt/ square meter were 10.3 and 8.0 meters, respectively. However, there will be no radiation effects of 37.5 kilowatt/ square meter.

In case of natural gas leaking, it does not cause immediate fire. It diffuses by the downwind dispersion. The distance of dispersion that is higher than the lowest flammable limit (LFL) is 5.4 meters. However, due to the small amount of diffused gas cloud, therefore, explosion will not be occurred in the form of a vapor cloud explosion.

2) The case of medium leak size

In the event of leak of a natural gas pipeline with diameter of 24 inches and leak hole size of one inch, the natural gas will be leaked in the gas phase with the same leak rate of 6.382 kilogram/second. In the event that the leak is not yet controlled, such as closing the block valve, natural gas leakage will occur all the time. Therefore, it is characterized as a continuous release, which, if the leaked gas touches a spark, it will ignite in a manner known as a jet fire, which will cause the effect of heat radiation. The heat radius at 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 44.8, 35.2, and 28.0 meters, respectively.

In case of natural gas leaking, it does not cause immediate fire. It diffuses by the downwind dispersion. The distance of dispersion that is higher than the lowest flammable limit (LFL) is 25.6 meters. Natural gas cloud that spread in the said distance, if exposed to a source of ignition there will be a vapor cloud explosion, which has a dangerous distance from the compression of the explosion at the repairable damage and the heavy damage for a distance of 31.1 and 28.3 meters, respectively.

3) The case of large leak size

In the event of leak of a natural gas pipeline with diameter of 24 inches and leak hole size of one inch, the natural gas will be leaked in the gas phase with the same leak rate of 102.11 kilogram/second. In the event that the leak is not yet controlled, such as closing the block valve, natural gas leakage will occur all the time. Therefore, it is characterized as a continuous release, which, if the leaked gas touches a spark, it will ignite in a manner known as a jet fire, which will cause the effect of heat radiation. The heat radius at 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 163.4, 119.0, and 90.6 meters, respectively. The distances that were affected by heat radiation in the event of a fireball at 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 520.5, 285.6, and 121.5 meters.

In case of natural gas leaking, it does not cause immediate fire. It diffuses by the downwind dispersion. The distance of dispersion that is higher than the lowest flammable limit (LFL) is 135.1 meters. Natural gas cloud that spread in the said distance, if exposed to a source of ignition there will be a vapor cloud explosion, which has a dangerous distance from the compression of the explosion at the repairable damage and the heavy damage for a distance of 183.9 and 170.4 meters, respectively.

4) The case of rupture

In the event of a rupture of a natural gas pipeline with diameter of 24 inches and leak hole size of one inch, the natural gas will be leaked in the gas phase with the same leak rate of 1,633.79 kilogram/second. In the event that the leak is not yet controlled, such as closing the block valve, natural gas leakage will occur all the time. Therefore, it is characterized as a continuous release, which, if the leaked gas touches a spark, it will ignite in a manner known as a jet fire, which will cause the effect of heat radiation. The heat radius at 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 572.3, 398.8, and 304.3 meters, respectively. The distances that were affected by heat radiation in the event of a fireball at 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 1,153.2, 631.1, and 246.2 meters.

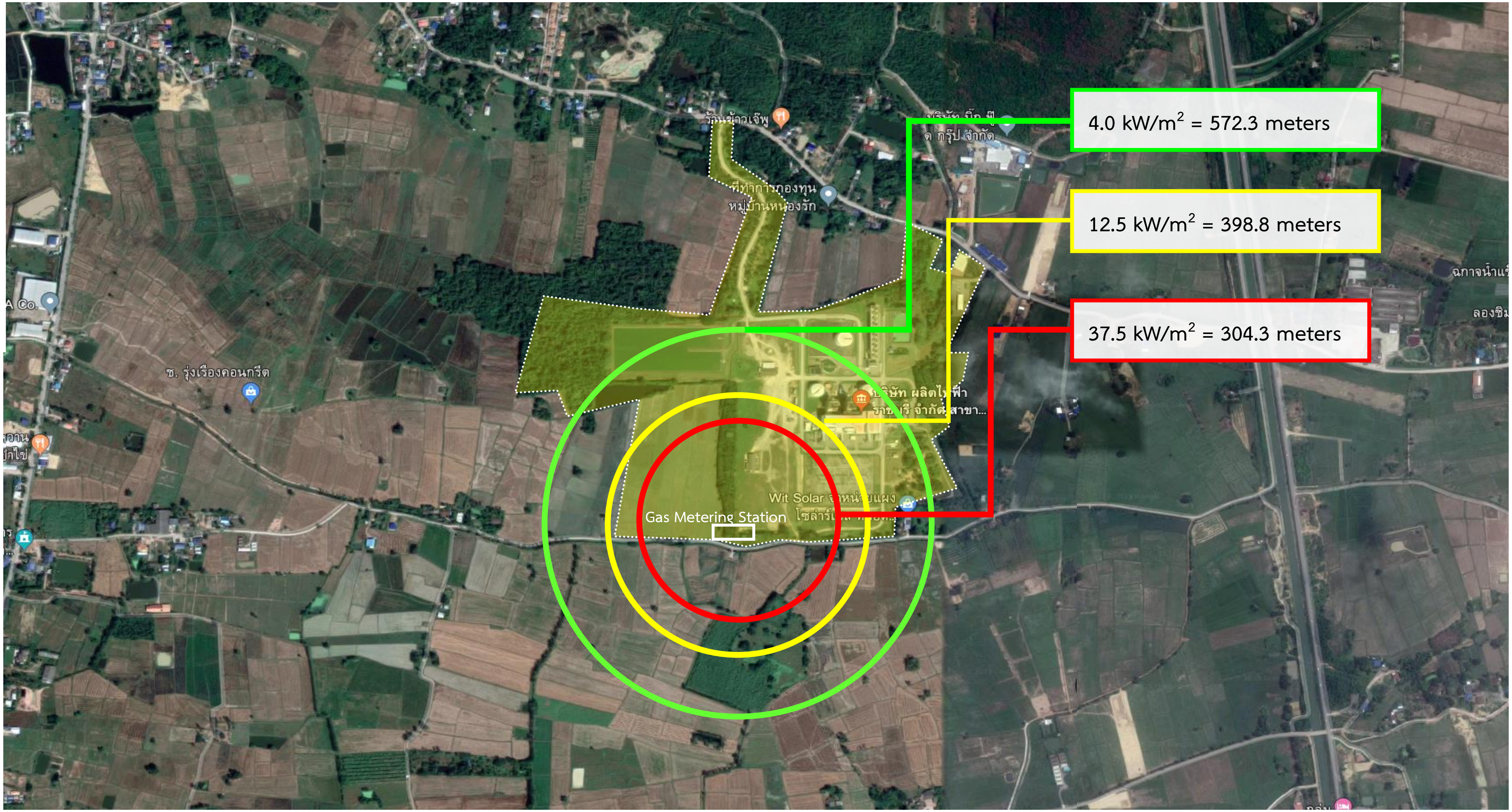
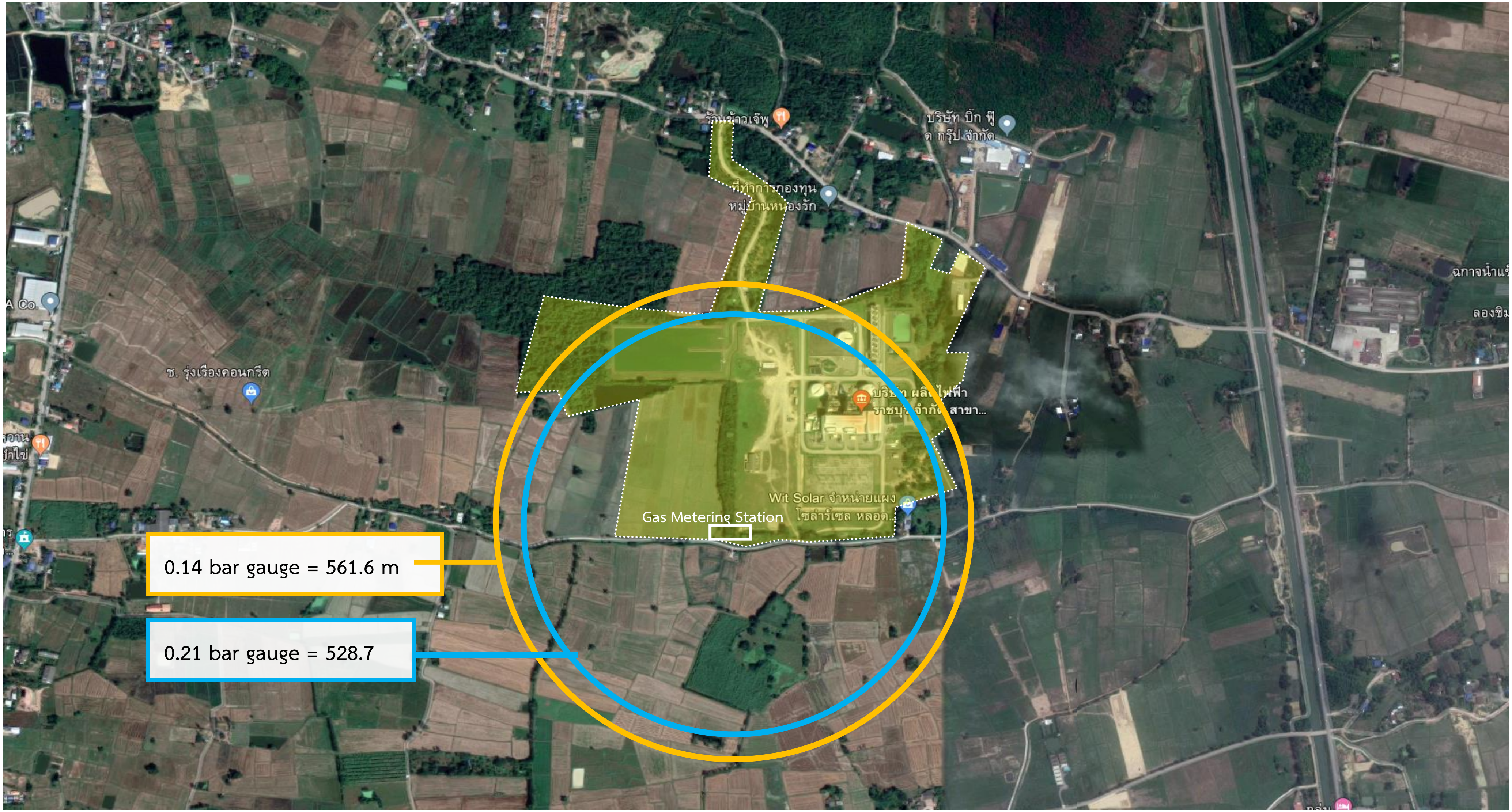


Figure 5.6.2.3 -1 Distance of impacted area from the heat of transporting natural gas through 24 inch pipe around Metering Gas Station

Table 5.6.2.3-2
The affected area in case of a leak in the jet fire manner
the case of the natural gas pipeline distribution with diameter of 24 inches at metering gas station Rupture

Case study	Heat radius (meter)	Affected area
- Intensity of heat radiation of 37.5 kW/m^2	304.3	North: The Project area and the TECO Power Plant East: The Project area and the TECO Power Plant West: The Project area and agricultural area South: The Project area, agricultural area, the house next to a power plant in the south
- Intensity of heat radiation of 12.5 kW/m^2	398.8	North: The Project area and the TECO Power Plant East: The Project area and the TECO Power Plant West: The Project area and agricultural area South: The Project area, agricultural area, the house next to a power plant in the south
- Intensity of heat radiation of 4.0 kW/m^2	572.3	North: The Project area and the TECO Power Plant East: The Project area, the TECO Power Plant, and the house next to a power plant in the east West: The Project area and agricultural area South: The Project area, agricultural area, the house next to a power plant in the south

In case of natural gas leaking that does not cause immediate fire. It diffuses by the downwind dispersion. The distance of dispersion that concentration is higher than the lowest flammable limit (LFL) is 498.0 meters. If the gas cloud spreading in the said distance exposes to a source of ignition, vapor cloud explosion will occur. It has a dangerous distance from the compression of the explosion at the repairable damage and heavy damage levels 561.6 and 528.7 meters, respectively. The affected areas are shown in **Figure 5.6.2.3-2** and **Table 5.6.2.3-3**.



<u>Figure 5.6.2.3-2</u> Impacted area from the pressure of Vapor Cloud Explosion in the case of rupture in 24 inch diameter pipe from transporting natural gas

Table 5.6.2.3-3
The affected area in case of vapor cloud explosion
the case of a rupture of the natural gas pipeline distribution with
diameter of 24 inches (Rupture)

Case study	Affected distance (meter)	Affected area
- Explosion intensity of 0.21 bar	528.7	North: The Project area and the TECO Power Plant East: The Project area, the TECO Power Plant, and the house next to a power plant in the east West: The Project area and agricultural area South: The Project area, agricultural area, the house next to a power plant in the south
- Explosion intensity of 0.14 bar	561.6	North: The Project area and the TECO Power Plant East: The Project area, the TECO Power Plant, and the house next to a power plant in the east West: The Project area and agricultural area South: The Project area, agricultural area, the house next to a power plant in the south

Case study: The natural gas distribution pipeline with diameter of 16 inches

1) The case of small leak size

In the event of leak of a natural gas pipeline with diameter of 16 inches and leak hole size of 0.25 inch, the natural gas will be leaked in the gas phase with the same leak rate of 0.407 kilogram/second. In the event that the leak is not yet controlled, such as closing the block valve, natural gas leakage will occur all the time. Therefore, it is characterized as a continuous release, which, if the leaked gas touches a spark, it will ignite in a manner known as a jet fire, which will cause the effect of heat radiation. The heat radius at 4.0 and 12.5 kilowatt/square meter (m^2) were 10.4 and 8.1 meters, respectively. However, there will be no radiation effects of 37.5 kilowatt/square meter (m^2).

In the case of natural gas leaking, it does not cause immediate fire. It diffuses by the downwind dispersion. The distance of dispersion that is higher than the lowest flammable limit (LFL) is 5.4 meters. However, due to the small amount of diffused gas cloud, therefore, explosion will not be occurred in the form of a vapor cloud explosion.

2) The case of medium leak size

In the event of leak of a natural gas pipeline with diameter of 16 inches and leak hole size of one inch, the natural gas will be leaked in the gas phase with the same leak rate of 6.514 kilogram/second. In the event that the leak is not yet controlled, such as closing the block valve, natural gas leakage will occur all the time. Therefore, it is characterized as a continuous release, which, if the leaked gas touches a spark, it will ignite in a manner known as a jet fire, which will cause the effect of heat radiation. The heat radius at 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 45.3, 35.6, and 28.2 meters, respectively.

In case of natural gas leaking, it does not cause immediate fire. It diffuses by the downwind dispersion. The distance of dispersion that is higher than the lowest flammable limit (LFL) is 26.0 meters. Natural gas cloud that spread in the said distance, if exposed to a source of ignition there will be a vapor cloud explosion, which has a dangerous distance from the compression of the explosion at the repairable damage and the heavy damage for a distance of 31.1 and 28.3 meters, respectively.

3) The case of large leak size

In the event of leak of a natural gas pipeline with diameter of 16 inches and leak hole size of one inch, the natural gas will be leaked in the gas phase with the same leak rate of 104.23 kilogram/second. In the event that the leak is not yet controlled, such as closing the block valve, natural gas leakage will occur all the time. Therefore, it is characterized as a continuous release, which, if the leaked gas touches a spark, it will ignite in a manner known as a jet fire, which will cause the effect of heat radiation. The heat radius at 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 164.9, 120.1, and 91.3 meters, respectively. The distances that were affected by heat radiation in the event of a fireball at 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 523.6, 287.3, and 122.3 meters.

In case of natural gas leaking, it does not cause immediate fire. It diffuses by the downwind dispersion. The distance of dispersion that is higher than the lowest flammable limit (LFL) is 137.3 meters. Natural gas cloud that spread in the said distance, if exposed to a source of ignition there will be a vapor cloud explosion, which has a dangerous distance from the compression of the explosion at the repairable damage and the heavy damage for a distance of 184.4 and 170.8 meters, respectively.

4) The case of rupture

In the event of a rupture of a natural gas pipeline with diameter of 16 inches and leak hole size of one inch, the natural gas will be leaked in the gas phase with the same leak rate of 1,667.70 kilogram/second. In the event that the leak is not yet controlled, such as closing the block valve, natural gas leakage will occur all the time. Therefore, it is characterized as a continuous release, which, if the leaked gas touches a spark, it will ignite in a manner known as a jet fire, which will cause the effect of heat radiation. The heat radius at 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 577.6, 402.1, and 307.1 meters, respectively. The distances that were affected by heat radiation in the event of a fireball at 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 1,159.9, 634.8, and 247.4 meters. The affected areas are shown in **Figure 5.6.2.3-1** and **Table 5.6.2.3-4**.

In case of natural gas leaking that does not cause immediate fire. It diffuses by the downwind dispersion. The distance of dispersion that concentration is higher than the lowest flammable limit (LFL) is 509.5 meters. If the gas cloud spreading in the said distance exposes to a source of ignition, vapor cloud explosion will occur. It has a dangerous distance from the compression of the explosion at the repairable damage and heavy damage levels 564.3 and 533.1 meters, respectively. The affected areas are shown in **Figure 5.6.2.3-4** and **Table 5.6.2.3-5**.

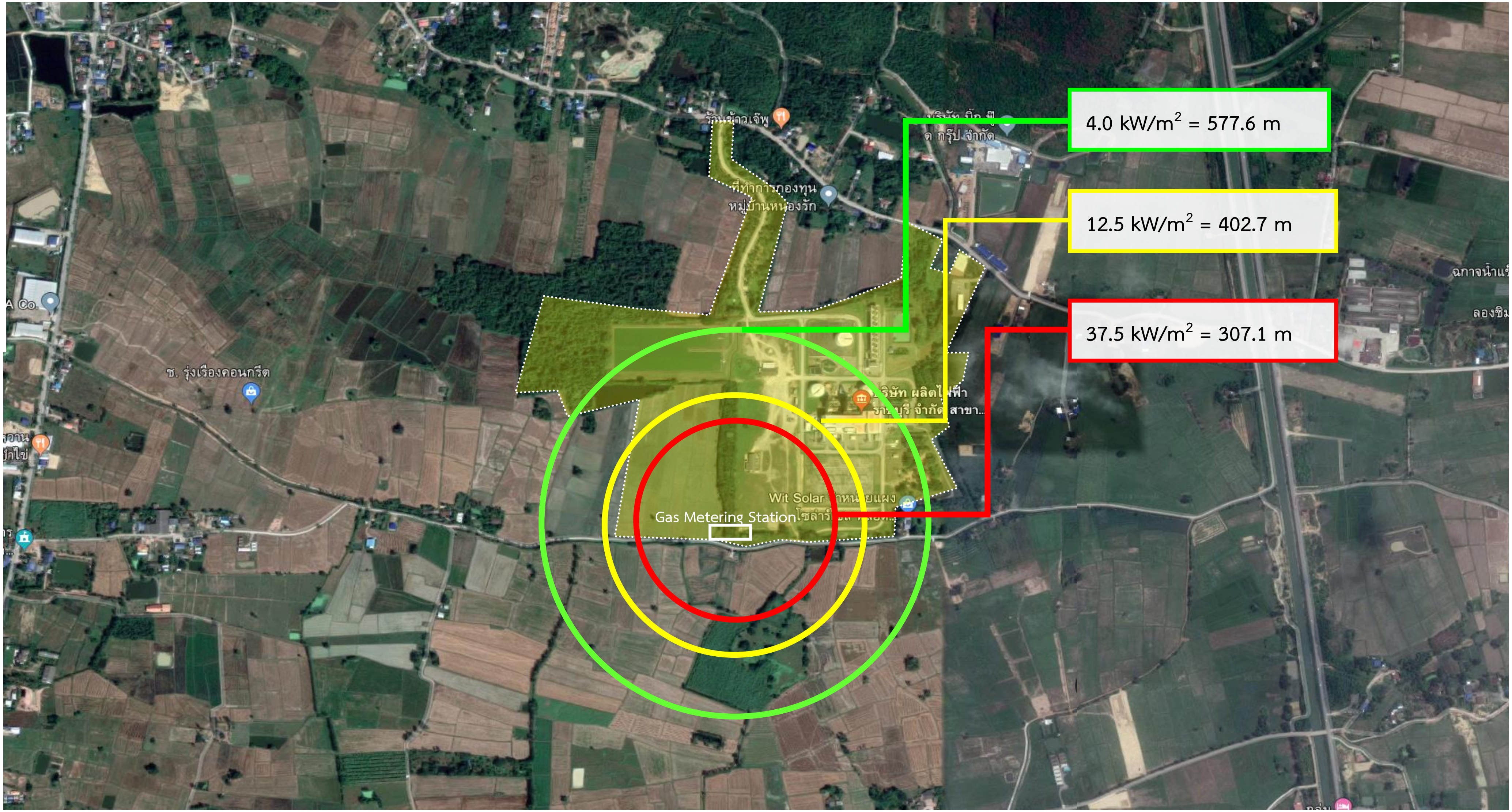


Figure 5.6.2.3-3 Distance of impact from the heat of 16 inch diameter pipe from transporting natural gas around the Metering Gas Station

Table 5.6.2.3-4
The affected area in case of a leak in the jet fire manner in the case of a rupture of the natural gas pipeline distribution with diameter of 16 inches at metering gas station

Case study	Heat radius (meter)	Affected area
- Intensity of heat radiation of 37.5 kW/m^2	307.1	North: The Project area and the TECO Power Plant East: The Project area and the TECO Power Plant West: The Project area and agricultural area South: The Project area, agricultural area, the house next to a power plant in the south
- Intensity of heat radiation of 12.5 kW/m^2	402.7	North: The Project area and the TECO Power Plant East: The Project area and the TECO Power Plant West: The Project area and agricultural area South: The Project area, agricultural area, the house next to a power plant in the south
- Intensity of heat radiation of 4.0 kW/m^2	577.6	North: The Project area and the TECO Power Plant East: The Project area, the TECO Power Plant, and the house next to a power plant in the east West: The Project area and agricultural area South: The Project area, agricultural area, the house next to a power plant in the south

<u>Figure 5.6.2.3-4</u> Impacted area from the pressure of Vapor Cloud Explosion in the case of rupture in 16 inch diameter pipe from transporting natural gas

Table 5.6.2.3-5
The affected area in case of vapor cloud explosion the case of a rupture of the natural gas pipeline distribution with diameter of 16 inches

Case study	Affected distance (meter)	Affected area
- Explosion intensity of 0.21 bar	533.1	North: The Project area and the TECO Power Plant East: The Project area, the TECO Power Plant, and the house next to a power plant in the east West: The Project area and agricultural area South: The Project area, agricultural area, the house next to a power plant in the south
- Explosion intensity of 0.14 bar	564.3	North: The Project area and the TECO Power Plant East: The Project area, the TECO Power Plant, and the house next to a power plant in the east West: The Project area and agricultural area South: The Project area, agricultural area, the house next to a power plant in the south

(2) Case 2. **Major hazard assessment in case of a leak of the connecting pipeline from the diesel tank with diameter of 16 inches to transfer diesel to the power production unit**

The storage characteristics of diesel fuel of the Project showed that the pressure and evaporation of diesel in the tanks were less likely to occur. This is because diesel has slow evaporation properties. Therefore, the study focused on the case of leakage of the connecting pipeline to the diesel tank. The results of the major hazard assessment from Project operation are shown in **Table 5.6.2.3-6** and can be described as follows:

Table 5.6.2.3-6

Danger Assessment result in the case of leakage in 16 inch diameter pipe connecting from diesel oil storage tank to the electricity generating unit.

Affected distance		Case study			
		Small leak hole (0.25 inch)	Medium leak hole (1 inch)	Large leak hole (4 inches)	Ruptured leak hole (diameter of less than 16 inches)
Jet Fire scenario	4.0 kW/m^2	14.1	49.2	168.2	410.4
	12.5 kW/m^2	11.0	38.2	128.8	313.4
	37.5 kW/m^2	9.0	31.3	104.8	254.3
Pool Fire scenario	4.0 kW/m^2	12.0	26.9	48.2	109.5
	12.5 kW/m^2	8.9	18.1	23.4	51.8
	37.5 kW/m^2	5.8	9.9	n/a	n/a
Spreading distance at different Lower Flammable Level (LFL)		4.7	51.7	176.0	572.9
Impacted distance from pressure of Vapor cloud explosion (VCE)	0.14 bar gauge	-	71.3	252.5	864.4
	0.21 bar gauge	-	65.9	231.9	790.7

Remark : " n/a " means no said impact found
" - " means said impact did not occur

Source : Consultants of Technololgy Co.,L.td, B.E.2563(2020)

1) The case of small leak size

In the event of leak of the diesel connecting pipeline with diameter of 16 inches and leak hole size of 0.25 inch, in the event that the leak is not yet controlled, such as closing the block valve, if diesel leakage exposes to a spark, it will cause a jet fire. This will cause the effect of heat radiation. The heat radius at the intensity of 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 14.1, 11.0, and 9.0 meters, respectively.

In the case of a pool fire, it will cause the effects of heat radiation. The heat radius at the intensity of 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 12.0, 8.9, and 5.8 meters, respectively.

In the case the diesel does not immediately ignite, diesel fuel evaporates and diffuses according to the downwind dispersion. The distance of dispersion that is higher than the lowest flammable limit (LFL) is 4.7 meters.

In the case that the diesel vapor cloud exposes to a spark and cause vapor cloud explosion, there will be no danger of compression of the explosion.

2) The case of medium leak size

In the event of leak of the diesel connecting pipeline with diameter of 16 inches and leak hole size of one inch, in the event that the leak is not yet controlled, such as closing the block valve, if diesel leakage exposes to a spark, it will cause a jet fire. This will cause the effect of heat radiation. The heat radius at the intensity of 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 49.2, 38.2, and 31.3 meters, respectively.

In the case of a pool fire, it will cause the effects of heat radiation. The heat radius at the intensity of 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 26.9, 18.1, and 9.9 meters, respectively.

In the case the diesel does not immediately ignite, diesel fuel evaporates and diffuses according to the downwind dispersion. The distance of dispersion that is higher than the lowest flammable limit (LFL) is 51.7 meters.

In the case that the diesel vapor cloud exposes to a spark and cause vapor cloud explosion, the danger distances from the compression pressure of the explosion are as follows:

- The distance of impact from compression pressure of the explosion at the repairable damage level is 71.3 meters, and
- The distance of impact from compression pressure of the explosion at the heavy damage level is 65.9 meters.

3) The case of large leak size

In the event of leak of the diesel connecting pipeline with diameter of 16 inches and leak hole size of four inches, in the event that the leak is not yet controlled, such as closing the block valve, if diesel leakage exposes to a spark, it will cause a jet fire. This will cause the effect of heat radiation. The heat radius at the intensity of 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 168.2, 128.8, and 104.8 meters, respectively.

In the case of a pool fire, it will cause the effects of heat radiation. The heat radius at the intensity of 4.0 and 12.5 kilowatt/square meter (m^2) were 48.2 and 23.4 meters, respectively.

In the case the diesel does not immediately ignite, diesel fuel evaporates and diffuses according to the downwind dispersion. The distance of dispersion that is higher than the lowest flammable limit (LFL) is 176.0 meters.

In the case that the diesel vapor cloud exposes to a spark and cause vapor cloud explosion, the danger distances from the compression pressure of the explosion are as follows:

- The distance of impact from compression pressure of the explosion at the repairable damage level is 252.5 meters, and
- The distance of impact from compression pressure of the explosion at the heavy damage level is 231.9 meters.

4) The case of a rupture

In the event of leak of the diesel connecting pipeline with diameter of 16 inches and leak hole size of four inches, in the event that the leak is not yet controlled, such as closing the block valve, if diesel leakage exposes to a spark, it will cause a jet fire. This will cause the effect of heat radiation. The heat radius at the intensity of 4.0, 12.5, and 37.5 kilowatt/square meter (m^2) were 410.4, 313.4, and 254.3 meters, respectively. The affected areas are shown in **Figure 5.6.2.3-5** and **Table 5.6.2.3-7.**

In the case of a pool fire, it will cause the effects of heat radiation. The heat radius at the intensity of 4.0 and 12.5 kilowatt/square meter (m^2) were 109.5 and 51.8 meters, respectively.

In the case the diesel does not immediately ignite, diesel fuel evaporates and diffuses according to the downwind dispersion. The distance of dispersion that is higher than the lowest flammable limit (LFL) is 572.9 meters.

In the case that the diesel vapor cloud exposes to a spark and cause vapor cloud explosion, the danger distances from the compression pressure of the explosion are as follows:

- The distance of impact from compression pressure of the explosion at the repairable damage level is 864.4 meters, and
- The distance of impact from compression pressure of the explosion at the heavy damage level is 790.7 meters.

The affected areas are shown in **Figure 5.6.2.3-6** and **Table 5.6.2.3-8.**

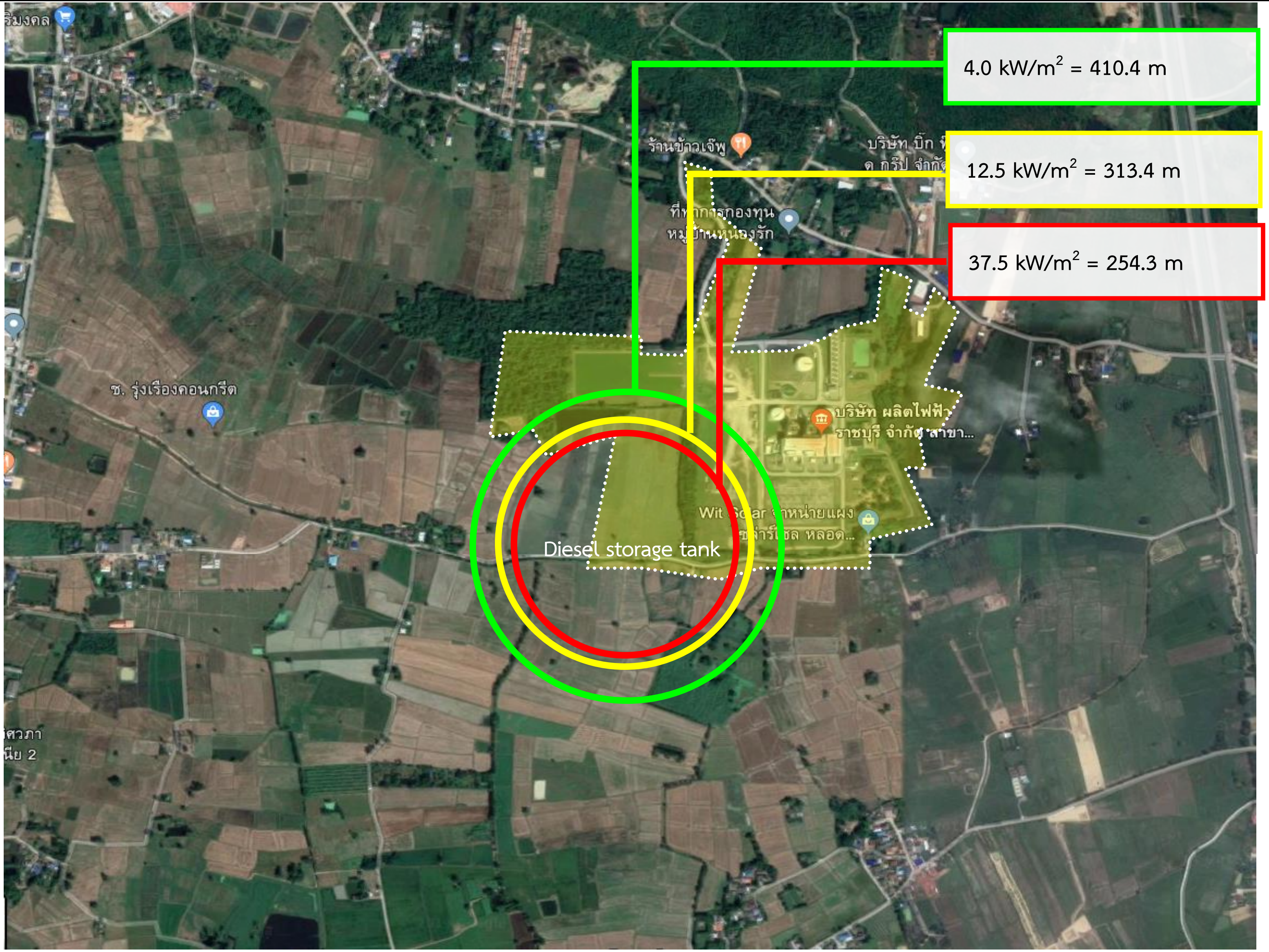


Figure 5.6.2.3-5 Impacted area from the case of leakage from rupture in 16 inch diameter pipe connecting to diesel tank and in case of leakage with Jet Fire

Table 5.6.2.3-7

The affected area in case of a jet fire from a rupture of the connecting pipeline from the diesel tank with diameter of 16 inches

Case study	Heat radius (meter)	Affected area
- Intensity of heat radiation of 37.5 kW/m^2	254.3	North: The Project area East: The Project area West: The Project area, agricultural area, and the house next to a power plant in the south South: The Project area, agricultural area, and the house next to a power plant in the south
- Intensity of heat radiation of 12.5 kW/m^2	313.4	North: The Project area East: The Project area West: The Project area, agricultural area, and the house next to a power plant in the south South: The Project area, agricultural area, and the house next to a power plant in the south
- Intensity of heat radiation of 4.0 kW/m^2	410.4	North: The Project area East: The Project area and the TECO Power Plant West: The Project area, agricultural area, and the house next to a power plant in the south South: The Project area, agricultural area, and the house next to a power plant in the south

Source : Consultants of Technololgy Co.,L.td, B.E.2563 (2020)

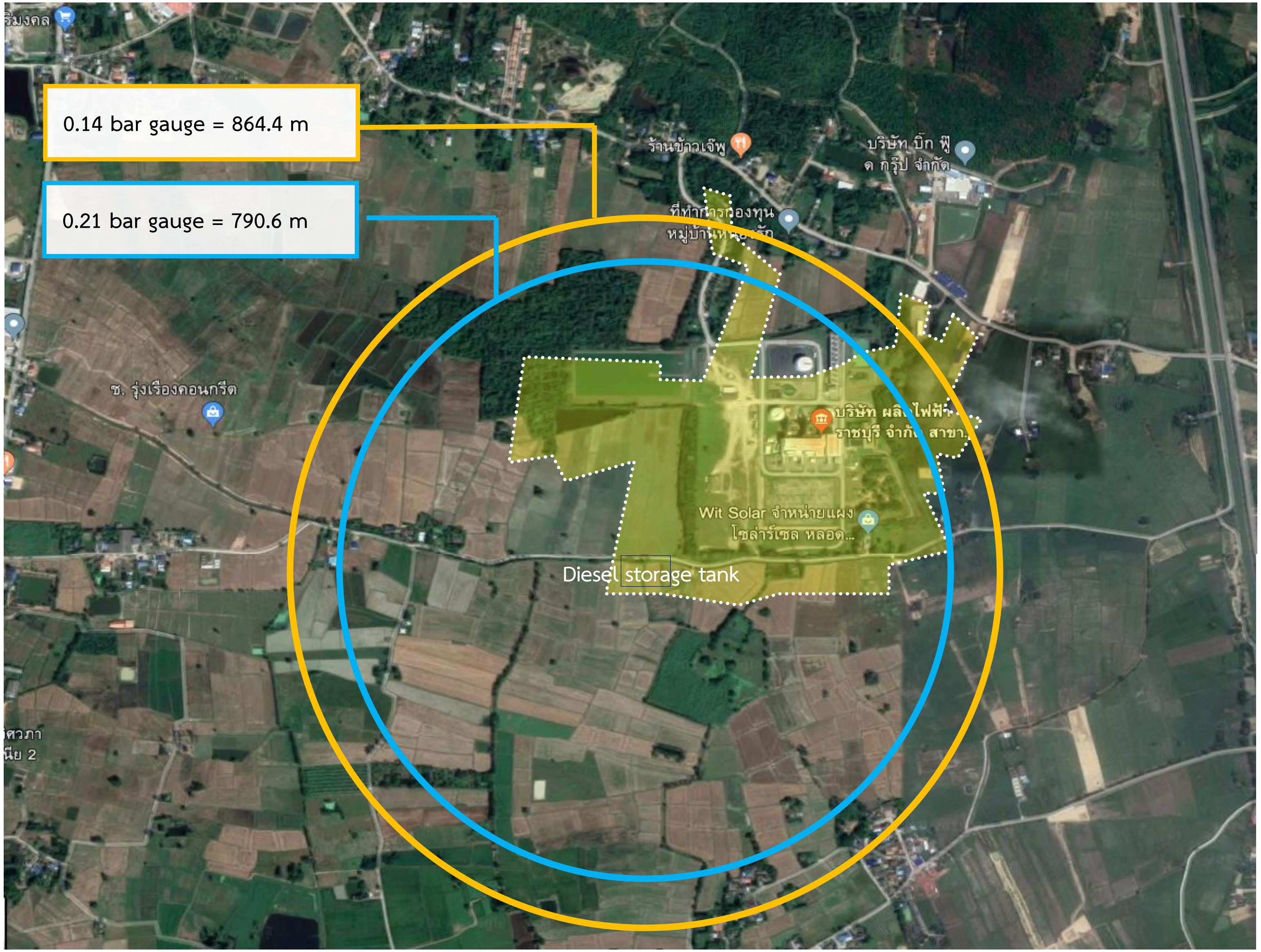


Figure 5.6.2.3-6 Impacted area from pressure of the Vapor Cloud Explosion in case of rupture in the 16 inch diameter pipe connecting to diesel tank

Table 5.6.2.3-8

Impacted area from pressure of the Vapor Cloud Explosion in case of rupture in the 16 inch diameter pipe connecting to diesel tank

Case Study	Impacted radius (meter)	Affected area
- severity of the 0.21 bar explosion	790.7	North: Project area, TECO Power Plant, and agricultural area East : Project's area, TECO Power Plant area, agricultural area, and houses In the East direction of TECO West : Project area, agricultural area, and houses In the West direction of TECO South : Project area, agricultural area, and houses In the South direction of TECO
- Severity of the 0.14 bar explosion	864.4	North: Project area, TECO Power Plant area, agricultural area, and Ban Nong Ruk Community East : Project area, TECO Power Plant area, agricultural area, and houses In the East direction of TECO West : Project area, agricultural area, and houses In the West direction of TECO South : Project area, agricultural area, and houses In the South direction of the power plant

(3) Domino effect of a rupture of two natural gas pipelines with diameter of 16 inches from the metering station to the gas turbine

In the event of a rupture of two natural gas pipelines with diameter of 16 inches from the metering station to the gas turbine will cause a domino effect, which will increase the level of impact. In the assessment, the Consultant assessed the major hazards and the consequences of the worst case due to failure of the function of protection devices, control systems, and all types of checking systems.

For assessing the magnitude of impact of the domino effect arising from leaking and fire of the natural gas pipelines, the Consultant assessed based on the worst case where two 16-inch natural gas pipelines which is installed in parallel with a distance of 20 meters cause a jet fire. This creates a level of heat radiation that damages neighboring pipes and pipe rack structures (heat radiation intensity of 37.5 kilowatt/square meter (m^2)). It is resulting in rupture of adjacent pipeline and the transported chemicals to be leaked out. The Consultant assessed the impact based on an event of a rupture of both pipelines. Details are shown in **Table 5.6.2.3-9**.

Table 5.6.2.3-9
Assessment result of Domino Effect in case of rupture in 16 inches diameter pipeline carrying natural gas

Case Study	Affected area from heat radiation (meter)		
	Jet Fire		
	4.0 kW/m^2	**12.5 kW/m^2**	**37.5 kW/m^2**
Power from total heat	816.8	569.7	434.3

Source : Consultants of Technololgy Co.,L.td, B.E.2563 (2020)

The affected areas by heat radiation in the event of the domino effect based on a jet fire are shown in **Table 5.6.2.3-10** and **Figure 5.6.2.3-5**.

Table 5.6.2.3-10

Affected areas in the case of a rupture of the natural gas pipelines with diameter of 16 inches in the jet fire manner

Case study	Heat radius (meter)	Affected area
- Intensity of heat radiation of 37.5 kW/m^2	434.3	North: The Project area East: The Project area and the TECO Power Plant West: The Project area, agricultural area, and the house next to a power plant in the south South: The Project area, agricultural area, and the house next to a power plant in the south
- Intensity of heat radiation of 12.5 kW/m^2	569.7	North: The Project area and the TECO Power Plant East: The Project area, the TECO Power Plant, and the next to the TECO Power Plant in the east West: The Project area and agricultural area South: The Project area, agricultural area, and the house next to a power plant in the south
- Intensity of heat radiation of 4.0 kW/m^2	816.8	North: The Project area, the TECO Power Plant, and Nong Rak community East: The Project area, the TECO Power Plant, agricultural area, and the next to the TECO Power Plant in the east West: The Project area, agricultural area, and the house at the west South: The Project area, agricultural area, and the house next to a power plant in the south

Source : Consultants of Technololgy Co.,L.td, B.E.2563(2020)

However, the Project shall prevent major hazards or domino effect in the Project area by considering the design and installation of equipment to comply with international standards such as API, ANSI, ASME, and NFPA, etc. Important equipment such as columns and tanks will shall be selected according to the above international standards and passed a leak test and has authorized inspection of an agency according to international standards to inspect and provide certification called U-Stamp Certificate such as ASME U-Stamp Boiler and Pressure Vessel Certification, etc. This is to ensure that those devices will not lead to accidents. Moreover, the Project shall install safety equipment and put the Company's safety management system in place to ensure safety as follows:

(1) Fire protection and suppression equipment

Details of the number and installation areas of the fire prevention and suppression system of the Project are shown in **Table 2.11.2-1**, whereby the Project will install fire prevention and suppression equipment in accordance with international standards and meet the criteria specified by laws as follows:

1) Warning and fire alarm system of the Project

It consists of heat detector, smoke detector, and flame detector, which will be installed in the building area and the area with a risk of fire.

2) The fire suppression equipment of the Project consists:

(a) Fire hydrant and fire hose, which will be installed to be able to cover the entire Project area.

(b) Portable fire extinguisher consists of carbon dioxide (CO_2), dry chemical, and Non-CFC liquid, which will use depending on the type of fuel in each area.

(c) Automatic CO_2 system, which will be installed at the gas turbine area by using automatic detectors to control the operation of the system

(d) Portable foam fire extinguisher set, which will be provided at the steam turbine building of the Project

(2) Emergency plan drill

The Project has set an emergency action plan drill for at least once a year, with a training exercise set in the area of the production process and the area for oil storage tanks for at least once a year and areas outside the production zone, including the office building area, maintenance area, chemical storage facility, and other areas at least once a year

5.6.2.4 The risk of major hazard

As previously mentioned, major hazard will arise from the leak of chemicals from the production unit of the Project. Therefore, in this topic, the risk of leakage was analyzed. It is based on assessing the likelihood of risks or leakage of the production unit and the severity of the impact. Details are as follows:

(1) Analysis of likelihood of accident

1) Leak frequency

Likelihood of leaks from the production unit area of the Project was assessed according to different hole sizes based on the Risk-Based Inspection Base Resource Documents of API Publication 581 (May 2000), which provides a leak chance that is based on historical data/statistics of errors (Database of Generic Failure Frequencies) of API Publication 581 (May 2000) of onshore refining and chemical processing equipment and pipe diameters from 0.75 inch to over 16 inches at leak size of 1/2, 1, and 4 inches and pipe rupture as detailed in the **Table. 5.6.2.4-1.**

As for the likelihood for flange leak was assessed according to different leak sizes, regarding the Process Equipment Leak Frequency Data for Use in QRA of DNV Company which is developed from Hydrocarbon Release Database (HCRD) by the UK Health and Safety Executive (HSE) based on over 4,000 leak events of the UK oil and gas plants. This database contains the leak frequency data of the 17 types of process equipment. Leak frequency of flange are shown in **Table 5.6.2.4-2**.

In determining the likelihood of major hazard, the leak frequency was compared with the criteria in the Handbook of Chemical Hazard Analysis Procedures, Federal Emergency Management Agency (FEMA), 1993, as shown in **Table 5.6.2.4-3.**

Table 5.6.2.4-1

Generic Equipment Failure Frequencies

Equipment Type	Leak Frequency (per year for four hole sizes)			
	¼ in	1 in	4 in	Rupture
Centrifugal Pump, Single Seal	6×10^{-2}	5×10^{-4}	1×10^{-4}	-
Centrifugal Pump, Double Seal	6×10^{-3}	5×10^{-4}	1×10^{-4}	-
Column	8×10^{-5}	2×10^{-4}	2×10^{-5}	6×10^{-6}
Compressor, Centrifugal	-	1×10^{-3}	1×10^{-4}	-
Compressor, Reciprocating	-	6×10^{-3}	6×10^{-4}	-
Filter	9×10^{-4}	1×10^{-4}	5×10^{-5}	1×10^{-5}
Fin/Fin Coolers	2×10^{-3}	3×10^{-4}	5×10^{-8}	2×10^{-8}
Heat Exchanger, Shell	4×10^{-5}	1×10^{-4}	1×10^{-5}	6×10^{-6}
Heat Exchanger, Tube Side	4×10^{-5}	1×10^{-4}	1×10^{-5}	6×10^{-6}
Piping, 0.75 in. diameter, per ft	1×10^{-5}	-	-	3×10^{-7}
Piping, 1 in. diameter, per ft	5×10^{-6}	-	-	5×10^{-7}
Piping, 2 in. diameter, per ft	3×10^{-6}	-	-	6×10^{-7}
Piping, 4 in. diameter, per ft	9×10^{-7}	6×10^{-7}	-	7×10^{-8}
Piping, 6 in. diameter, per ft	4×10^{-7}	4×10^{-7}	-	8×10^{-8}
Piping, 8 in. diameter, per ft	3×10^{-7}	3×10^{-7}	8×10^{-8}	2×10^{-8}
Piping, 10 in. diameter, per ft	2×10^{-7}	3×10^{-7}	8×10^{-8}	2×10^{-8}
Piping, 12 in. diameter, per ft	1×10^{-7}	3×10^{-7}	3×10^{-8}	2×10^{-8}
Piping, 16 in. diameter, per ft	1×10^{-7}	2×10^{-7}	2×10^{-8}	2×10^{-8}
Piping, > 16 in. diameter, per ft	6×10^{-8}	2×10^{-7}	2×10^{-8}	1×10^{-8}
Pressure Vessels	4×10^{-5}	1×10^{-4}	1×10^{-5}	6×10^{-6}
Reactor	1×10^{-4}	3×10^{-4}	3×10^{-5}	2×10^{-5}
Reciprocating Pumps	0.7	0.01	0.001	0.001
Atmospheric Storage Tank	4×10^{-5}	1×10^{-4}	1×10^{-5}	2×10^{-5}

Source: Risk-Based Inspection Base Resource Document, API Publication 581, First Edition, May 2000

Table 5.6.2.4-2

Process Equipment Leak Frequency: Flange

Flange size (inch)	Leak Hole size (mm)	Leak Frequency (per year)
0.5	1 - 3	3.725×10^{-5}
	> 3 - 10	1.364×10^{-5}
	> 10 - 50	1.227×10^{-5}
	> 50 - 150	-
	> 150	-
	Total	6.316×10^{-5}
1	1 - 3	4.037×10^{-5}
	> 3 - 10	1.479×10^{-5}
	> 10 - 50	1.279×10^{-5}
	> 50 - 150	-
	> 150	-
	Total	6.795×10^{-5}
2	1 - 3	4.628×10^{-5}
	> 3 – 10	1.695×10^{-5}
	> 10 – 50	6.126×10^{-6}
	> 50 – 150	7.661×10^{-6}
	> 150	-
	Total	7.701×10^{-5}
4	1 - 3	5.745×10^{-5}
	> 3 - 10	**2.104×10^{-5}**
	> 10 - 50	7.605×10^{-6}
	> 50 - 150	8.062×10^{-6}
	> 150	-
	Total	**9.415×10^{-5}**
6	1 - 3	6.816×10^{-5}
	> 3 - 10	**2.496×10^{-5}**
	> 10 - 50	9.023×10^{-6}
	> 50 - 150	1.594×10^{-6}
	> 150	6.852×10^{-6}
	Total	**1.106×10^{-4}**
10	1 - 3	8.880×10^{-5}
	> 3 - 10	3.252×10^{-5}
	> 10 - 50	1.176×10^{-5}
	> 50 - 150	2.077×10^{-6}
	> 150	7.110×10^{-6}
	Total	1.423×10^{-4}

Table 5.6.2.4-2 (cont)

Flange size (inch)	Leak Hole size (mm)	Leak Frequency (per year)
14	1 - 3	1.088×10^{-4}
	> 3 - 10	3.984×10^{-5}
	> 10 - 50	1.440×10^{-5}
	> 50 - 150	2.544×10^{-6}
	> 150	7.360×10^{-6}
	Total	1.729×10^{-4}
20	1 - 3	1.379×10^{-4}
	> 3 - 10	5.051×10^{-5}
	> 10 - 50	1.826×10^{-5}
	> 50 - 150	3.226×10^{-6}
	> 150	7.724×10^{-6}
	Total	2.176×10^{-4}

Remark : Leak Frequency covering Flanged Joint, Comprising Two Flange Faces, Gasket andTwo Weld to the Pipe covering Ring Type Joint, Spiral Wound, Clamp (Grayloc) and Hammer Union (Chicksan)

Source: document on Process Equipment Leak Frequency Data for Use in QRA company DNV

Table 5.6.2.4-3

Probability of the occurrence of major hazard

Probability level	Definition
Common	Chance of occurrence is 1 time/year or higher (> 1 time/year)
Likely	Chance of occurrence is at least 1 time in 10 years (> 0.1 time/year)
Reasonably likely	Chance of occurrence is at least 1 time in 10-100 years (> 0.1 to 1×10^{-2} time/year)
Unlikely	Chance of occurrence is at least 1 time in 100-1,000 years (1×10^{-2} to 1×10^{-3} time/year)
Very Unlikely	Chance of occurrence is less than 1 time in 1,000 years (< 1×10^{-3} time/year)

From the leak likelihood database of generic failure frequencies above production equipment it can summarize the potential for leaks from natural gas pipeline including the likelihood of major hazard as shown in **Table 5.6.2.4-4**.

Table 5.6.2.4-4
Leak frequency of the natural gas distribution pipeline
Case of pipe leak and weld failure

Size of leak	Length of pipeline (feet)	Leak Frequency		Probability of the occurrence of major hazard (compare to Table 5.6.2.4-3)
		API standard (time/year/feet[1/])	API standard x length of pipeline[2/] (time/year)	
Natural gas distribution pipeline, diameter of 24 inches				
Small (0.25 inch)	450 (1,476.45)	4×10^{-7}	5.906×10^{-4}	Very Unlikely
Rupture (6 inches)		8×10^{-8}	1.181×10^{-4}	Very Unlikely
Natural gas distribution pipeline, diameter of 16 inches				
Small (0.25 inch)	80 (262.48)	9×10^{-7}	2.362×10^{-4}	Very Unlikely
Rupture (4 inches)		7×10^{-8}	1.837×10^{-5}	Very Unlikely

Remark: 1/ It is leak frequency in the case of pipe according to the Risk-Based Inspection Base Resource Document, API Publication 581, First Edition, May 2000

2/ Length of the pipeline of the Project

Table 5.6.2.4-5
Leak frequency of the natural gas distribution pipeline in the case of flange leak

Size of leak	Leak frequency (time/year) [1/]	Probability of the occurrence of major hazard (compare to Table 5.6.2.4-3)
Natural gas distribution pipeline, diameter of 24 inches		
Small (0.25 inch)	2.496×10^{-5}	Very Unlikely
Rupture (6 inches)	1.106×10^{-4}	Very Unlikely
Natural gas distribution pipeline, diameter of 16 inches		
Small (0.25 inch)	2.104×10^{-5}	Very Unlikely
Rupture (4 inches)	9.415×10^{-5}	Very Unlikely

Remark : 1/ is Leak Frequency according to document on Process Equipment Leak Frequency Data for Use in QRA

It can be seen that the likelihood of leakage from the waste gas and natural gas pipeline systems have less than one chance of occurrence in 1,000 year. The likelihood of the leak is in the very unlikely level based on the criteria in the Handbook of Chemical Hazard Analysis Procedures, Federal Emergency Management Agency (FEMA), 1993.

2) Likelihood of fire

The production unit that has the potential to cause a major flammable hazard from the Project is the natural gas pipeline. The waste gas has a similar composition to natural gas. From the API study found that the probability of occurrence of a gas leak from the production equipment under operating conditions is lower temperature than auto ignition temperature (processed below AIT) of the substance is shown in **Table 5.7.2.5-6**. However, when considering the leakage of natural gas, one atom of hydrocarbon compound, from the distribution pipeline in the event that the leak is not yet controlled, it will be continuous release, which, if ignited, there is a chance of jet fire and a vapor cloud explosion (VCE) as shown in **Figure 5.7.2.5-1**.

For the likelihood of natural gas leakage and ignition, the Consultant considered the potential for leaks of different sizes of natural gas pipelines as suggested by API at two pore sizes (**Table 5.6.2.4-4** and **Table 5.6.2.5-5**) in conjunction with the potential for jet fire and gas formation (**Table 5.6.2.4-6**). The risk of jet-fire and ignition and the occurrence of vapor cloud explosion can be summarized in **Table 5.6.2.4-7** and **Table 5.6.2.4-8**, respectively.

Table 5.6.2.4-6

Specific Event Probabilities-Continuous Release Auto Ignition Not Likely

Substance	Event probabilities				
	Ignition	Vapor Cloud Explosion (VCE)	Flash Fire	Jet Fire	Pool Fire
C1-C2	0.2	0.04	0.06	0.1	-
C3-C4	0.1	0.03	0.02	0.05	-
C5	0.1	0.03	0.02	0.05	-
C6-C8	0.1	0.03	0.02	0.05	-
C9-C12	0.05	0.01	0.02	0.02	-
C13-C16	-	-	-	-	-
C17-C25	-	-	-	-	-
C25+	-	-	-	-	-
H_2	0.9	0.4	0.4	0.1	-
H_2S	0.9	0.4	0.4	0.2	-

Remark: Operate under temperature less than Auto Ignition Temperature (AIT) of the substance

Source: API, API Publication 581, first edition, May 2000

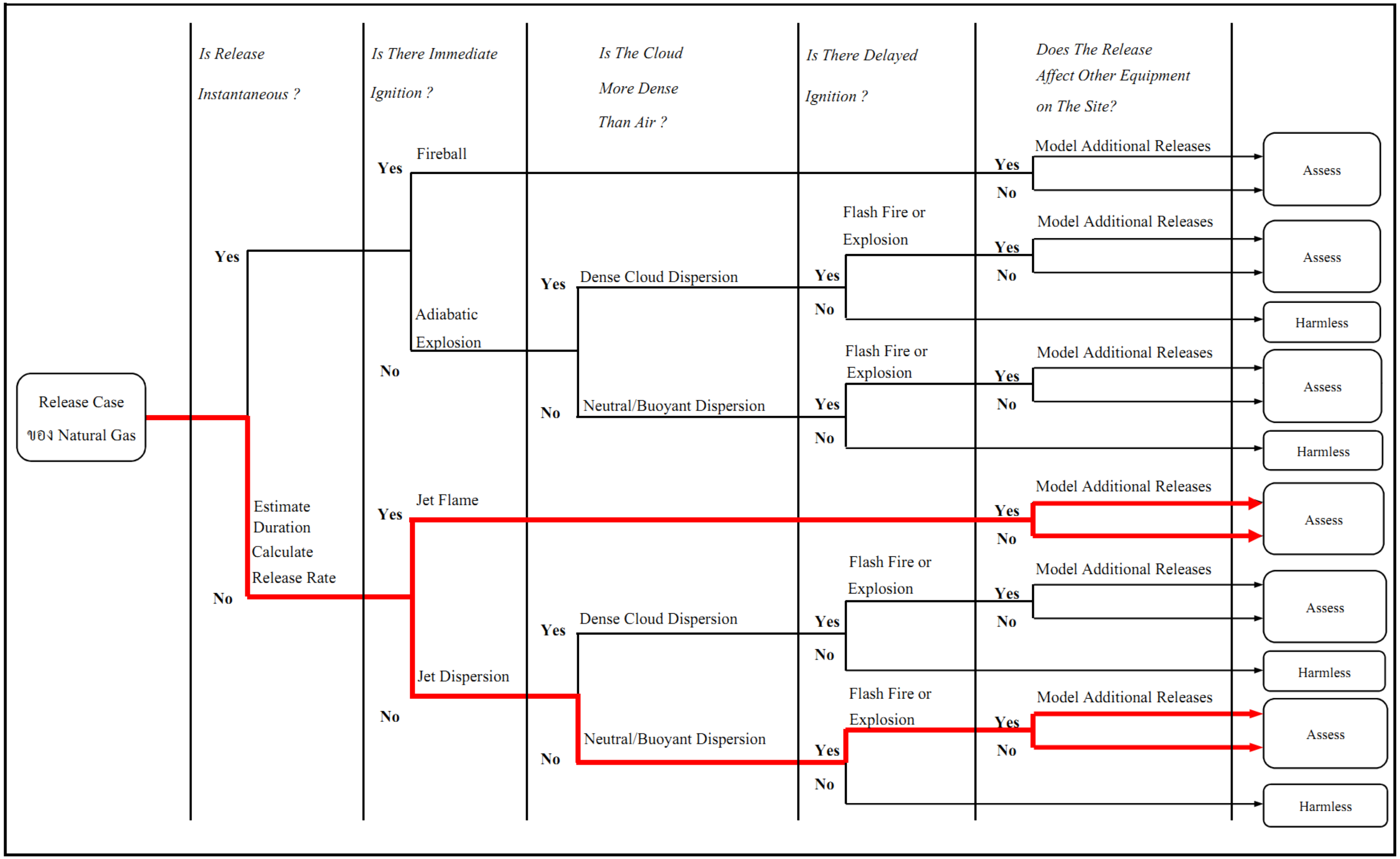


Figure 5.6.2.4-1 Order of occurrence of dangerous hazards in case of natural gas leakage

<u>Table 5.6.2.4-7</u>

<u>Likelihood of leakage and Jet Fire from Pipe Leak, Weld Failure, and Flange Leak</u>

Leakage case	Size	API standard (time/year)	API standard x length of pipeline[2/] (time/year)	Likelihood *(likelihood of leakage x likelihood of explosion [1/])* (time/year)	Probability of the occurrence of major hazard (compare to Table 5.6.2.4-3)
1. Natural gas distribution pipeline, diameter of 24 inches					
1.1 Pipe leak and weld failure *(Table 5.7.2.5-4 x Table 5.7.2.5-6)*	Small (0.25 inch)	4×10^{-7}	5.906×10^{-4}	$(5.906 \times 10^{-4}) \times 0.1 = 5.906 \times 10^{-5}$	Very Unlikely
	Rupture (6 inches)	8×10^{-8}	1.181×10^{-4}	$(1.181 \times 10^{-4}) \times 0.1 = 1.181 \times 10^{-5}$	Very Unlikely
1.2 Flange leak *(Table 5.7.2.5-5 x Table 5.7.2.5-6)*	Small (0.25 inch)	2.496×10^{-5}	-	$(2.496 \times 10^{-5}) \times 0.1 = 2.496 \times 10^{-6}$	Very Unlikely
	Rupture (6 inches)	1.106×10^{-4}	-	$(1.106 \times 10^{-4}) \times 0.1 = 1.106 \times 10^{-5}$	Very Unlikely
2. Natural gas distribution pipeline, diameter of 16 inches					
2.1 Pipe leak and weld failure *(Table 5.7.2.5-4 x Table 5.7.2.5-6)*	Small (0.25 inch)	9×10^{-7}	2.362×10^{-4}	$(2.362 \times 10^{-4}) \times 0.1 = 2.362 \times 10^{-5}$	Very Unlikely
	Rupture (4 inches)	7×10^{-8}	1.837×10^{-5}	$(1.837 \times 10^{-5}) \times 0.1 = 1.837 \times 10^{-6}$	Very Unlikely
2.2 Flange leak *(Table 5.7.2.5-5 x Table 5.7.2.5-6)*	Small (0.25 inch)	2.104×10^{-5}	-	$(2.104 \times 10^{-5}) \times 0.1 = 2.104 \times 10^{-6}$	Very Unlikely
	Rupture (4 inches)	9.415×10^{-5}	-	$(9.415 \times 10^{-5}) \times 0.1 = 9.415 \times 10^{-6}$	Very Unlikely

<u>Remark</u>: [1/] Likelihood of Jet Fire of natural gas is 0.1
[2/] length of the project's pipe

Table 5.6.2.4-8

Likelihood of leakage and vapor cloud explosion (VCE) in the case of pipe leak, weld failure, and flange leak

Leakage case	Size	API standard (time/year)	API standard x length of pipeline[2/] (time/year)	Likelihood *(likelihood of leakage x likelihood of explosion [1/])* (time/year)	Probability of the occurrence of major hazard (compare to Table 5.6.2.4-3)
1. Natural gas distribution pipeline, diameter of 24 inches					
1.1 Pipe leak and weld failure *(Table 5.7.2.5-4 x Table 5.7.2.5-6)*	Small (0.25 inch)	4×10^{-7}	5.906×10^{-4}	$(5.906 \times 10^{-4}) \times 0.04 = 2.362 \times 10^{-5}$	Very Unlikely
	Rupture (6 inches)	8×10^{-8}	1.181×10^{-4}	$(1.181 \times 10^{-4}) \times 0.04 = 4.724 \times 10^{-6}$	Very Unlikely
1.2 Flange leak *(Table 5.7.2.5-5 x Table 5.7.2.5-6)*	Small (0.25 inch)	2.496×10^{-5}	-	$(2.496 \times 10^{-5}) \times 0.04 = 9.984 \times 10^{-7}$	Very Unlikely
	Rupture (6 inches)	1.106×10^{-4}	-	$(1.106 \times 10^{-4}) \times 0.04 = 4.424 \times 10^{-6}$	Very Unlikely
2. Natural gas distribution pipeline, diameter of 16 inches					
2.1 Pipe leak and weld failure *(Table 5.7.2.5-4 x Table 5.7.2.5-6)*	Small (0.25 inch)	9×10^{-7}	2.362×10^{-4}	$(2.362 \times 10^{-4}) \times 0.04 = 9.448 \times 10^{-6}$	Very Unlikely
	Rupture (4 inches)	7×10^{-8}	1.837×10^{-5}	$(1.837 \times 10^{-5}) \times 0.04 = 7.348 \times 10^{-7}$	Very Unlikely
2.2 Flange leak *(Table 5.7.2.5-5 x Table 5.7.2.5-6)*	Small (0.25 inch)	2.104×10^{-5}	-	$(2.104 \times 10^{-5}) \times 0.04 = 8.416 \times 10^{-7}$	Very Unlikely
	Rupture (4 inches)	9.415×10^{-5}	-	$(9.415 \times 10^{-5}) \times 0.04 = 3.766 \times 10^{-6}$	Very Unlikely

Remark: [1/] Likelihood of Vapor Cloud Explosion (VCE) of natural gas is 0.04
[2/] Length of the Project of power generating unit

It can be seen that the likelihood of leakage and fire of all four cases is less than once in 1,000 years, and the likelihood of such a leak is rated as very unlikely according to the criteria in the Handbook of Chemical Hazard Analysis Procedures, Federal Emergency Management Agency (FEMA), 1993.

(2) Severity of the consequence

From the results of the major hazard assessment in **Section 5.6.2.4**, it was found that the severity of the consequence or serious danger around the natural gas pipeline of the Project was assessed by the mathematical model. The Consultant has taken into account the severity of the impact by referring to the Department of Industrial Works Regulations on Hazard Identification Criteria, Risk assessment, and the Preparation of the Risk Management Plan 2000, in which the severity of the impact on the community, environment, and property was assessed as shown in **Table 5.6.2.4-9** to **Table 5.6.2.4-10**.

Table 5.6.2.4-9

The severity rating of any dangerous event affecting the people

Level	Severity	Detail
1	Minor	A minor injury at the first aid level
2	Moderate	An injury that requires medical attention
3	Major	Serious injury or illness
4	Catastrophic	Disability or death

Table 5.6.2.4-10

The severity rating of any dangerous event affecting the community

Level	Severity	Detail
1	Minor	Does not affect the communities surrounding the Project or have little impact
2	Moderate	Affect the communities surrounding the Project and can be fixed in a short period of time
3	Major	Affect the communities surrounding the Project and takes time to fix the impact
4	Catastrophic	A severe impact on the community for a broad range or government agencies must take corrective action

Remark: Community impact means community nuisance, injury, and illness of the people and damage to property of the community and people

Table 5.6.2.4-11

The severity rating of any dangerous event affecting the environment

Level	Severity	Detail
1	Minor	Does not affect the environment or controllable
2	Moderate	Affect the environment at moderate level and can be fixed in a short period of time
3	Major	Seriously affect the environment and takes time to fix the impact
4	Catastrophic	A severe impact on the environment, need resources and time to fix the impact

Remark: Community impacts refer to environmental degradation and damage such as air, soil, water sources, etc.

Table 5.6.2.4-12

The severity rating of any dangerous event affecting the property

Level	Severity	Detail
1	Minor	Very less property damage or no damage
2	Moderate	Moderate property damage and can continue to operate
3	Major	Severe property damage and some production units must be stopped
4	Catastrophic	Severe property damage and all production units must be stopped

The level of severity of major hazard events affecting people, community, environment, and property, the Consultant considered based on 2 issues:

1) Severity of impact

The Consultant considered the nature of the danger posed by heat radiation and explosive compression pressures at different levels as defined in the study as follows:

(a) Characteristic of hazard from heat radiation

Heat radiation intensity (kW/m^2)	Hazard characteristic	
	To building	To receptor
4.0	-	- Causing pain in the area of the exposed skin if longer than 20 seconds of
12.5	The wood material started to ignite. Plastic starts to melt.	- There is a 1% chance of death if exposed for 1 minute. First degree severe skin burns within 10 seconds.
37.5	Damage to building or equipment	- There is a 100% chance of death if exposed for 1 minute. - There is a 1% chance of death if exposed for 10 seconds.

(b) Characteristic of hazard from explosive compression pressures

Magnitude of explosion	Hazard characteristic	
	To building	To receptor
Heavy damage (0.21 bar)	Severe damage to nearby buildings and production equipment	- There is 1% chance of death due to - tear of lung - There is > 50% chance of tearing the eardrum There is > 50% chance of serious injury from floating object
Repairable damage (0.14 bar)	Partial damage to buildings	- There is > 1% chance of tearing the - eardrum There is > 1% chance of serious injury from floating object

2) Affected areas

In addition to determining the severity of impact according to the nature of the harm caused by heat radiation and explosive compression pressure at different levels as described above. The Consultants also took into account the affected areas. The criteria for determining the severity of impact on the people, the community, the environment, and property are as follows:

People in the affected area	**The severity according to the nature of the impact on the person**				
	Heat radiation (kW/m^2)			**Pressure from explosion (bar-g)**	
	4.0	**12.5**	**37.5**	**0.14**	**0.21**
No	Low	Low	Low	Low	Low
Yes	Moderate	High	Very high	Very high	Very high

Community in the affected area	**The severity according to the nature of the impact on the community**				
	Heat radiation (kW/m^2)			**Pressure from explosion (bar-g)**	
	4.0	**12.5**	**37.5**	**0.14**	**0.21**
No	Low	Low	Low	Low	Low
Yes	Moderate	High	Very high	Very high	Very high

Environmental resources that need to be restored in the affected area	**The severity according to the nature of the impact on the environment**				
	Heat radiation (kW/m^2)			**Pressure from explosion (bar-g)**	
	4.0	**12.5**	**37.5**	**0.14**	**0.21**
No	Low	Low	Low	Low	Low
Yes	Low	High	Very high	Very high	Very high

The main production equipment in the affected area	The severity according to the nature of the impact on property				
	Heat radiation (kW/m^2)			Pressure from explosion (bar-g)	
	4.0	**12.5**	**37.5**	**0.14**	**0.21**
No	Low	Low	Low	Low	Low
Yes	Low	High	Very high	Very high	Very high

For the severity of major hazards from jet fire and vapor cloud explosion incidents in the event of a leak in the gas distribution pipeline of the Project, in the event of leaks of different sizes on the people, the community, the environment, and on property are shown in **Table 5.6.2.4-13** and **Table 5.6.2.4-14**. The severity of the impacts to be used in the risk assessment was selected for the highest severity to be use in the assessment. It can be described as follows

Table 5.6.2.4-13

Severity of the jet fire and vapor cloud explosion of the natural gas distribution pipeline with diameter of 24 inches on the people, the community, the environment, and property

Case study	Impact of heat radiation in the case of jet fire					
	Heat radiation intensity (kW/m^2)	Distance (meter)	Severity of impact			
			People	Community	Environment	Property
- Small leak size	4.0	10.3	Moderate	Low	Low	Low
	12.5	8.0	High	Low	Low	High
	37.5	n/a	-	-	-	-
- Rupture	4.0	572.3	Moderate	Low	Low	Low
	12.5	398.8	High	Low	Low	High
	37.5	304.3	Very high	Low	Low	Very high
Case study	Impact of vapor cloud explosion					
	Pressure (bar-g)	Distance (meter)	Severity of impact			
			People	Community	Environment	Property
- Small leak size	0.14	-	-	-	-	-
	0.21	-	-	-	-	-
- Rupture	0.14	561.6	Very high	Low	Low	Very high
	0.21	528.7	Very high	Low	Low	Very high

Remark: " - " means no impact was found at the level

Source: Consultant of Technology Company Limited, 2019

Table 5.6.2.4-14

Severity of the jet fire and vapor cloud explosion of the natural gas distribution pipeline with diameter of 16 inches on the people, the community, the environment, and property

Case study	Impact of heat radiation in the case of jet fire					
	Heat radiation intensity (kW/m^2)	Distance (meter)	Severity of impact			
			People	People	People	People
- Small leak size	4.0	10.4	Moderate	Low	Low	Low
	12.5	8.1	High	Low	Low	High
	37.5	n/a	-	-	-	-
- Rupture	4.0	577.6	Moderate	Low	Low	Low
	12.5	402.7	High	Low	Low	High
	37.5	307.1	Very high	Low	Low	Very high
Case study	Impact of vapor cloud explosion					
	Pressure (bar-g)	Distance (meter)	Severity of impact			
			People	People	People	People
- Small leak size	0.14	-	-	-	-	-
	0.21	-	-	-	-	-
- Rupture	0.14	564.3	Very high	Low	Low	Very high
	0.21	564.3	Very high	Low	Low	Very high

Remark: “ - ” means no impact was found at the level
Source: Consultant of Technology Company Limited, 2019

1) The case of natural gas distribution pipeline, diameter of 24 inches

(a) Impact from heat radiation in the case of jet fire

a) Small leak size

- Heat radiation intensity of 4.0 kilowatt/square meter (m^2), affected area of 10.3 meters radius. It does not cause any impact on buildings. Rather, it affects the receptor, causing pain in the exposed skin. If exposed for longer than 20 seconds. Impacts are as follows:

- Impact on the people. Causing pain in the skin of the employee upon contact, therefore, the level of severity is at a moderate level.

- Impact on the community. Since the affected area of 10.3 meters radius which is within the Project area, therefore, the level of severity is at a low level.

- Impact on the environment. Since the affected area of 10.3 meters radius which is within the Project area and is controllable, therefore, the level of severity is at a low level.

- Impact on the property. The heat radiation intensity of 4.0 kilowatt/ square meter does not cause impacts on production equipment and very less damage of the property, therefore, the level of severity is at a low level.

- Heat radiation intensity of 12.5 kilowatt/square meter(m^2), affected area of 8.0 meters radius. The wood material started to ignite. Plastic starts to melt and cause an impact on the receptor with a 1% chance of death if exposed for 1 minute and severe burns. Impact are as follows:

- Impact on the people. Exposure workers has 1% chance of death if exposed for one minute and severe burns, therefore, the level of severity is at a high level.

- Impact on the community. Since the affected area of 8.0 meters radius which is within the Project area, therefore, the level of severity is at a low level.

- Impact on the environment. Since the affected area of 10.3 meters radius which is within the Project area and is controllable, therefore, the level of severity is at a low level.

- Impact on the property. The heat radiation intensity of 12.5 kilowatt/square meter (m^2) causes impacts on production equipment and severe damage of the property, some production units must be stopped, therefore, the level of severity is at a high level.

b) **Rupture**

- Heat radiation intensity of 4.0 kilowatt/square meter (m^2), affected area of 572.3 meters radius. It does not cause any impact on buildings. Rather, it affects the receptor, causing pain in the exposed skin. If exposed for longer than 20 seconds. Impacts are as follows:

  - Impact on the people. Causing pain in the skin of the employee upon contact, therefore, the level of severity is at a moderate level.
  - Impact on the community. Since the affected area of 572.3 meters radius which is the Project and agricultural areas, therefore, the level of severity is at a low level.
  - Impact on the environment. Since the affected area of 572.3 meters radius which is within the Project and agricultural areas and is controllable, therefore, the level of severity is at a low level.
  - Impact on the property. The heat radiation intensity of 4.0 kilowatt/ square meter does not cause impacts on production equipment and very less damage of the property, therefore, the level of severity is at a low level.

- Heat radiation intensity of 12.5 kilowatt/square meter (m^2), affected area of 398.8 meters radius. The wood material started to ignite. Plastic starts to melt and cause an impact on the receptor with a 1% chance of death if exposed for 1 minute and severe burns. Impact are as follows:

  - Impact on the people. Exposure workers has 1% chance of death if exposed for one minute and severe burns, therefore, the level of severity is at a high level.
  - Impact on the community. Since the affected area of 398.8 meters radius which is within the Project and agricultural areas, therefore, the level of severity is at a low level.
  - Impact on the environment. Since the affected area of 398.8 meters radius which is within the Project and agricultural areas and is controllable, therefore, the level of severity is at a low level.
  - Impact on the property. The heat radiation intensity of 12.5 kilowatt/square meter (m^2)causes impacts on production equipment and severe damage of the property, some production units must be stopped, therefore, the level of severity is at a high level.

- Heat radiation intensity of 37.5 kilowatt/square meter (m^2), affected area of 304.3 meters radius. It causes damage to equipment and buildings and causing an impact on the contact with a 100% chance of death if exposed for one minute. Impacts are as follows:

- Impact on the people. The exposed employee has 100% chance of death if exposed for 1 minute, therefore, the level of severity is at a very high level.

- Impact on the community. Since the affected area of 304.3 meters radius which is the Project and agricultural areas, therefore, the level of severity is at a low level.

- Impact on the environment. Since the affected area of 304.3 meters radius which is within the Project and agricultural areas and is controllable, therefore, the level of severity is at a low level.

- Impact on the property. The heat radiation intensity of 12.5 kilowatt/square meter (m^2) causes impacts on production equipment and severe damage of the property, all production units must be stopped, therefore, the level of severity is at a very high level.

(b) Impact from vapor cloud explosion

a) Small leak size

In the case of small leak size, there is no impact from the explosion. Therefore, no impact on the people, the community, the environment, and the property.

b) Rupture

- Pressure of 0.14 bar gauge, affected area of 561.6 meters radius. It causes partial damage to buildings and causing an impact on the exposure more than 1% chance of tearing the eardrum and seriously injured by floating objects. Impacts are as follows:

- Impact on the people. Exposed employee has more than 1% chance of tearing the eardrum and seriously injured by floating objects, therefore, the level of severity is at a high level.

- Impact on the community. Since the affected area of 561.6 meters radius which is the Project and agricultural areas, therefore, the level of severity is at a low level.

- Impact on the environment. Since the affected area of 561.6 meters radius which is within the Project and agricultural areas and is controllable, therefore, the level of severity is at a low level.

- Impact on the property pressure of 0.14 bar gauge cause partial damage of production equipment, therefore, the level of severity is at a very high level.

- Pressure of 0.21 bar gauge, affected area of 528.7 meters radius. It causes partial damage to buildings and causing an impact on the exposure more than 1% chance of death from tearing the lung. Impacts are as follows:
  - Impact on the people. Exposed employee has more than 1% chance of death from tearing the lung, therefore, the level of severity is at a high level.
  - Impact on the community. Since the affected area of 528.7 meters radius which is the Project and agricultural areas, therefore, the level of severity is at a low level.
  - Impact on the environment. Since the affected area of 528.7 meters radius which is within the Project and agricultural areas and is controllable, therefore, the level of severity is at a low level.
  - Impact on the property. pressure of 0.21 bar gauge cause severe damage of production equipment, therefore, the level of severity is at a very high level.

2) The case of the natural gas distribution pipeline with diameter of 16 inches

(a) Impact from heat radiation in the case of jet fire

a) Small leak size

- Heat radiation intensity of 4.0 kilowatt/square meter (m^2), affected area of 10.4 meters radius. It does not cause any impact on buildings. Rather, it affects the receptor, causing pain in the exposed skin. If exposed for longer than 20 seconds. Impacts are as follows:
  - Impact on the people. Causing pain in the skin of the employee upon contact, therefore, the level of severity is at a moderate level.
  - Impact on the community. Since the affected area of 10.4 meters radius which is within the Project area, therefore, the level of severity is at a low level.
  - Impact on the environment. Since the affected area of 10.4 meters radius which is within the Project area and is controllable, therefore, the level of severity is at a low level.
  - Impact on the property. The heat radiation intensity of 4.0 kilowatt/ square meter does not cause impacts on production equipment and very less damage of the property, therefore, the level of severity is at a low level.
- Heat radiation intensity of 12.5 kilowatt/square meter (m^2), affected area of 8.0 meters radius. The wood material started to ignite. Plastic

starts to melt and cause an impact on the receptor with a 1% chance of death if exposed for 1 minute and severe burns of skin. Impact are as follows:

- Impact on the people. Exposure workers has 1% chance of death if exposed for one minute and severe burns, therefore, the level of severity is at a high level.
- Impact on the community. Since the affected area of 8.1 meters radius which is within the Project area, therefore, the level of severity is at a low level.
- Impact on the environment. Since the affected area of 8.1 meters radius which is within the Project area and is controllable, therefore, the level of severity is at a low level.
- Impact on the property. The heat radiation intensity of 12.5 kilowatt/square meter (m^2) causes impacts on production equipment and severe damage of the property, some production units must be stopped, therefore, the level of severity is at a high level.

b) Rupture

- Heat radiation intensity of 4.0 kilowatt/square meter (m^2), affected area of 577.6 meters radius. It does not cause any impact on buildings. Rather, it affects the receptor, causing pain in the exposed skin. If exposed for longer than 20 seconds. Impacts are as follows:
  - Impact on the people. Causing pain in the skin of the employee upon contact, therefore, the level of severity is at a moderate level.
  - Impact on the community. Since the affected area of 577.6 meters radius which is the Project and agricultural areas, therefore, the level of severity is at a low level.
  - Impact on the environment. Since the affected area of 577.6 meters radius which is within the Project and agricultural areas and is controllable, therefore, the level of severity is at a low level.
  - Impact on the property. The heat radiation intensity of 4.0 kilowatt/square meter (m^2) does not cause impacts on production equipment and very less damage of the property, therefore, the level of severity is at a low level.
- Heat radiation intensity of 12.5 kilowatt/square meter (m^2), affected area of 402.7 meters radius. The wood material started to ignite. Plastic starts to melt and cause an impact on the receptor with a 1% chance of death if exposed for 1 minute and severe burns of the skin. Impact are as follows:

- Impact on the people. Exposure workers has 1% chance of death if exposed for one minute and severe burns of the skin, therefore, the level of severity is at a high level.

- Impact on the community. Since the affected area of 402.7 meters radius which is within the Project and agricultural areas, therefore, the level of severity is at a low level.

- Impact on the environment. Since the affected area of 402.7 meters radius which is within the Project and agricultural areas and is controllable, therefore, the level of severity is at a low level.

- Impact on the property. The heat radiation intensity of 12.5 kilowatt/square meter (m^2) causes impacts on production equipment and severe damage of the property, some production units must be stopped, therefore, the level of severity is at a high level.

● Heat radiation intensity of 37.5 kilowatt/square meter (m^2), affected area of 307.1 meters radius. It causes damage to equipment and buildings and causing an impact on the contact with a 100% chance of death if exposed for one minute. Impacts are as follows:

- Impact on the people. The exposed employee has 100% chance of death if exposed for 1 minute, therefore, the level of severity is at a very high level.

- Impact on the community. Since the affected area of 307.1 meters radius which is the Project and agricultural areas, therefore, the level of severity is at a low level.

- Impact on the environment. Since the affected area of 307.1 meters radius which is within the Project and agricultural areas and is controllable, therefore, the level of severity is at a low level.

- Impact on the property. The heat radiation intensity of 1 2 .5 kilowatt/square meter (m^2) causes impacts on production equipment and severe damage of the property, all production units must be stopped, therefore, the level of severity is at a very high level.

(b) Impact of vapor cloud explosion

a) Small leak size

In the case of small leak size, there is no impact from the explosion. Therefore, no impact on the people, the community, the environment, and the property.

b) **Rupture**

- Pressure of 0.14 bar gauge, affected area of 564.3 meters radius. It causes partial damage to buildings and causing an impact on the exposure more than 1% chance of tearing the eardrum and seriously injured by floating objects. Impacts are as follows:

  - Impact on the people. Exposed employee has more than 1% chance of tearing the eardrum and seriously injured by floating objects, therefore, the level of severity is at a high level.
  - Impact on the community. Since the affected area of 564.3 meters radius which is the Project and agricultural areas, therefore, the level of severity is at a low level.
  - Impact on the environment. Since the affected area of 564.3 meters radius which is within the Project and agricultural areas and is controllable, therefore, the level of severity is at a low level.
  - Impact on the property. Pressure of 0.14 bar gauge cause partial damage of production equipment, therefore, the level of severity is at a very high level.

- Pressure of 0.21 bar gauge, affected area of 533.1 meters radius. It causes partial damage to buildings and causing an impact on the exposure more than 1% chance of death from tearing the lung. Impacts are as follows:

  - Impact on the people. Exposed employee has more than 1% chance of death from tearing the lung, therefore, the level of severity is at a high level.
  - Impact on the community. Since the affected area of 533.1 meters radius which is the Project and agricultural areas, therefore, the level of severity is at a low level.
  - Impact on the environment. Since the affected area of 533.1 meters radius which is within the Project and agricultural areas and is controllable, therefore, the level of severity is at a low level.
  - Impact on the property. pressure of 0.21 bar gauge cause severe damage of production equipment, therefore, the level of severity is at a very high level.

(3) Risk assessment

The consultant considered the method for assessing the level of risk according to the Handbook of Chemical Hazard Analysis Procedures, Federal Emergency Management Agency, U.S. Department of Transportation, U.S.EPA, 1990). Two related factors were considered, the likelihood of each incident and frequency of occurrence (as shown in **Table 5.6.2.4-3**) together with the severity of consequence (**Table 5.6.2.4-9** to **Table 5.6.2.4-12**). The analysis of frequency and severity was performed using the matrix table as shown in **Figure 5.7.2.5-2**.

Severity of Consequence

Frequency			Minor	Moderate	Major	Catastrophic
	High	Common				
	Medium	Likely				
		Reasonably likely				
		Unlikely				
	Low	Very Unlikely				

Source : Handbook of Chemical Hazard Analysis Procedures, Federal Emergency Management Agency (FEMA), 1993

Comprehensive planning and preparedness are essentially mandatory at the appropriate levels of government of industry (high risk)

Comprehensive planning is optional and does not necessarily warrant any major efforts or costs. Give consideration to sharing any necessary special response resources on a regional basis (moderate risk)

Comprehensive planning may be unwarranted and unnecessary (low risk)

Figure 5.6.2.4-2 Accident Frequency/ Severity Screening Matrix

The level of risk of major hazard in the event of a natural gas pipeline leak, diameter of 24 and 16 inches. The assessment was done based on the leak statistics suggested by API and DNV at various leak sizes, together with severity of consequence. The cases of jet fire and vapor cloud explosion (VCE) were considered. The risk level can be summarized as shown in **Table 5.6.2.4-15** and **Table 5.6.2.4-16**. The assessment of the risk level of major hazards around the two natural gas pipelines found that the most common risk level is in the moderate and low levels without experiencing a high level of risk.

In this assessment of the level of major hazard described above, it was based on the worst case scenario. However, the assessment has not considered the preventive and mitigation measures that the Project has prepared to reduce the chance of occurrence and the severity of the impact in the area of natural gas distribution pipelines as follows:

1) Install detection and alarm systems in case of gas leaks, water jets, pressure reducing devices, and fire alarm,

2) Provide measures to prevent overheating caused by failure of the temperature control system, which causes leakage of combustible gas from the system (from various seals):

- Install high temperature monitoring and alarm systems, and
- install gas detector monitoring and alarm systems.

3) Specify the area in the pipeline an area prohibited area of any activity which may result in spark or heat radiation,

4) Provide a permission system for entering the area in the event that it is necessary to access the area of the pipeline, those entering the area must be aware of the precautions related to preventing the occurrence of dangerous events,

5) Arrange a plan to regularly inspect and maintain the pipelines to be in proper conditions at all times,

Table 5.6.2.4-15

Level of risk of leakage and jet fire and vapor cloud explosion (VCE) of a 24 inches natural gas distribution pipeline

Case study	Likelihood (time/year)	Impact from heat radiation			Likelihood (time/year)	Impact from VCE		
		Heat radiation intensity (kW/m^2)	Severity	Risk level		Pressure (bar)	Severity	Risk level
- Small leak	5.906×10^{-5}	4.0	-	-	2.362×10^{-5}	0.14	-	-
	Pipe leak/weld failure	12.5	-	-	Pipe leak/weld failure	0.21	-	-
	(Very Unlikely)	37.5	-	-	(Very Unlikely)			
	2.496×10^{-6}	4.0	-	-	9.984×10^{-7}	0.14	-	-
	Flange leak	12.5	-	-	Flange leak	0.21	-	-
	(Very Unlikely)	37.5	-	-	(Very Unlikely)			
- Rupture	1.181×10^{-5}	4.0	Moderate	Low	4.724×10^{-6}	0.14	Catastrophic	Moderate
	Pipe leak/weld failure	12.5	Major	Low	Pipe leak/weld failure	0.21	Catastrophic	Moderate
	(Very Unlikely)	37.5	Catastrophic	Moderate	(Very Unlikely)			
	1.106×10^{-5}	4.0	Moderate	Low	4.424×10^{-6}	0.14	Catastrophic	Moderate
	Flange leak	12.5	Major	Low	Flange leak	0.21	Catastrophic	Moderate
	(Very Unlikely)	37.5	Catastrophic	Moderate	(Very Unlikely)			

Source: Consultant of Technology Company Limited, 2020

Table 5.6.2.4-16
Level of risk of leakage and jet fire and vapor cloud explosion (VCE) of a 16 inches natural gas distribution pipeline

Case study	Likelihood (time/year)	Impact from heat radiation			Likelihood (time/year)	Impact from VCE		
		Heat radiation intensity (kW/m^2)	Severity	Risk level		Pressure (bar)	Severity	Risk level
- Small leak	2.362×10^{-5}	4.0	-	-	9.448×10^{-6}	0.14	-	-
	Pipe leak/weld failure	12.5	-	-	Pipe leak/weld failure	0.21	-	-
	(Very Unlikely)	37.5	-	-	(Very Unlikely)			
	2.104×10^{-6}	4.0	-	-	8.416×10^{-7}	0.14	-	-
	Flange leak	12.5	-	-	Flange leak	0.21	-	-
	(Very Unlikely)	37.5	-	-	(Very Unlikely)			
- Rupture	1.837×10^{-6}	4.0	Moderate	Low	7.348×10^{-7}	0.14	Catastrophic	Moderate
	Pipe leak/weld failure	12.5	Major	Low	Pipe leak/weld failure	0.21	Catastrophic	Moderate
	(Very Unlikely)	37.5	Catastrophic	Moderate	(Very Unlikely)			
	9.415×10^{-6}	4.0	Moderate	Low	3.766×10^{-6}	0.14	Catastrophic	Moderate
	Flange leak	12.5	Major	Low	Flange leak	0.21	Catastrophic	Moderate
	(Very Unlikely)	37.5	Catastrophic	Moderate	(Very Unlikely)			

Source: Consultant of Technology Company Limited, 2020

6) Install signs, symbol, and warning signs at regular intervals in the pipeline area so that people should be aware of any cautions and precautions,

7) Provide fire protection equipment in accordance with NFPA or recognized international standards, consist of the following:

- Gas detector
- Flame detection
- Heat detector
- Portable dry chemical Fire extinguisher
- Fire hydrant
- Water curtain system
- CO_2 suppression system

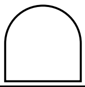
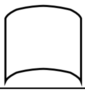
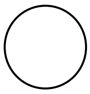
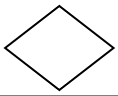
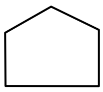
8) Set an action plan in case of an emergency within the Project area and a coordination plan to seek assistance from outside agencies as well as an evacuation plans for the community, arrange a drill of each plan for at least once a year.

5.6.2.5 Assessment by using the fault tree analysis (FTA)

(1) Hazard identification

From the inventory of risks and hazards which indicate the risk and the danger as well as methods of hazard identification to be used in hazard identification using the fault tree analysis (FTA) technique. It is a hazard identification technique that focuses on an accident or serious incident that occurs or is expected to occur in order to analyze the cause of the accident. It is a reverse thinking technique that relies on logic to apply principles and rationale to analyze the causes of accidents or serious accidents. The analysis begins from an accident or a serious accident that has occurred or is expected to occur to determine the first event that happened then break down the process of occurring in sub-events and how those sub-events occur. The analysis end when it is found that the cause of the sub-event is a result of a defect in a machine, equipment or an operation failure. The identified hazards are assessed based on the likelihood and severity of the incident to be further used as information in risk control operations. The symbols used in the analysis are presented in **Table 5.6.2.5-1**.

Table 5.6.2.5-1
Symbols used in the hazard identification analysis

Symbol	Name	Definition
	And Gate: Multiple causes	An event can occur due to the cause of every sub-event
	Or Gate: Any one cause	An event can occur for one or more of the minor causes
	Basic Event: The usual events	Sub-events that occur normally, which means the cause is obvious without further analysis of the cause. It is the first cause of accidents.
	Fault Tree Event: Minor events	Sub-events that result in a series of events that lead to an accident
	Undeveloped Event: Incalculable events	Sub-events that do not require further analysis because there is no supporting information
	External Event: External events	External events or external factors that cause events

Source: Regulation of the Department of Industrial Works on criteria for hazard identification, risk assessment, and the preparation of the risk management plan B.E.2543 (2000)

Steps of fault tree analysis are as follows:

(1) Select a scenario that can take place as the top event,

(2) Consider the possibility of such problems, this may arise from one sub-event only, use the symbol "or",

(3) If the event is caused by multiple sub-events, the simulation occurs, use the symbol "and”,

(4) At the said event level, it may be caused by more minor events, which is likely to arise from each event or multiple events at the same time, use the symbol "and or" on a case by case basis,

(5) In the end, when breaking down an event like this further, it is found that the last of the lowest sub-events are:

- Common events,
- Incalculable events, may be due to unknown or no information, and
- External events such as natural thunder and lightning.

Result of hazardous identification in the event of a generator explosion and the occurrence of general chemical spills are show in **Figure 5.6.2.5-1** to **Figure 5.6.2.5-2**.

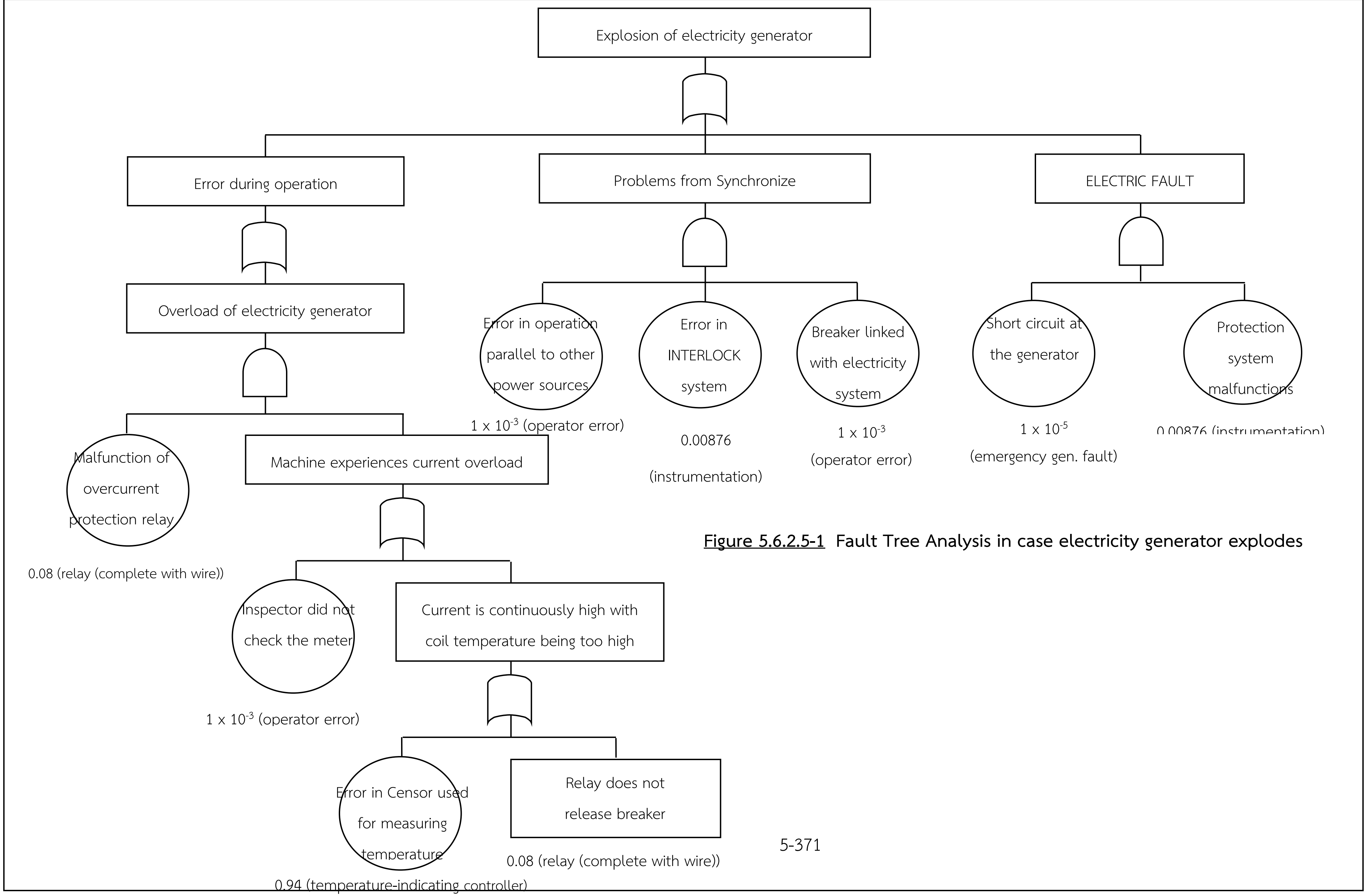


Figure 5.6.2.5-1 **Fault Tree Analysis in case electricity generator explodes**

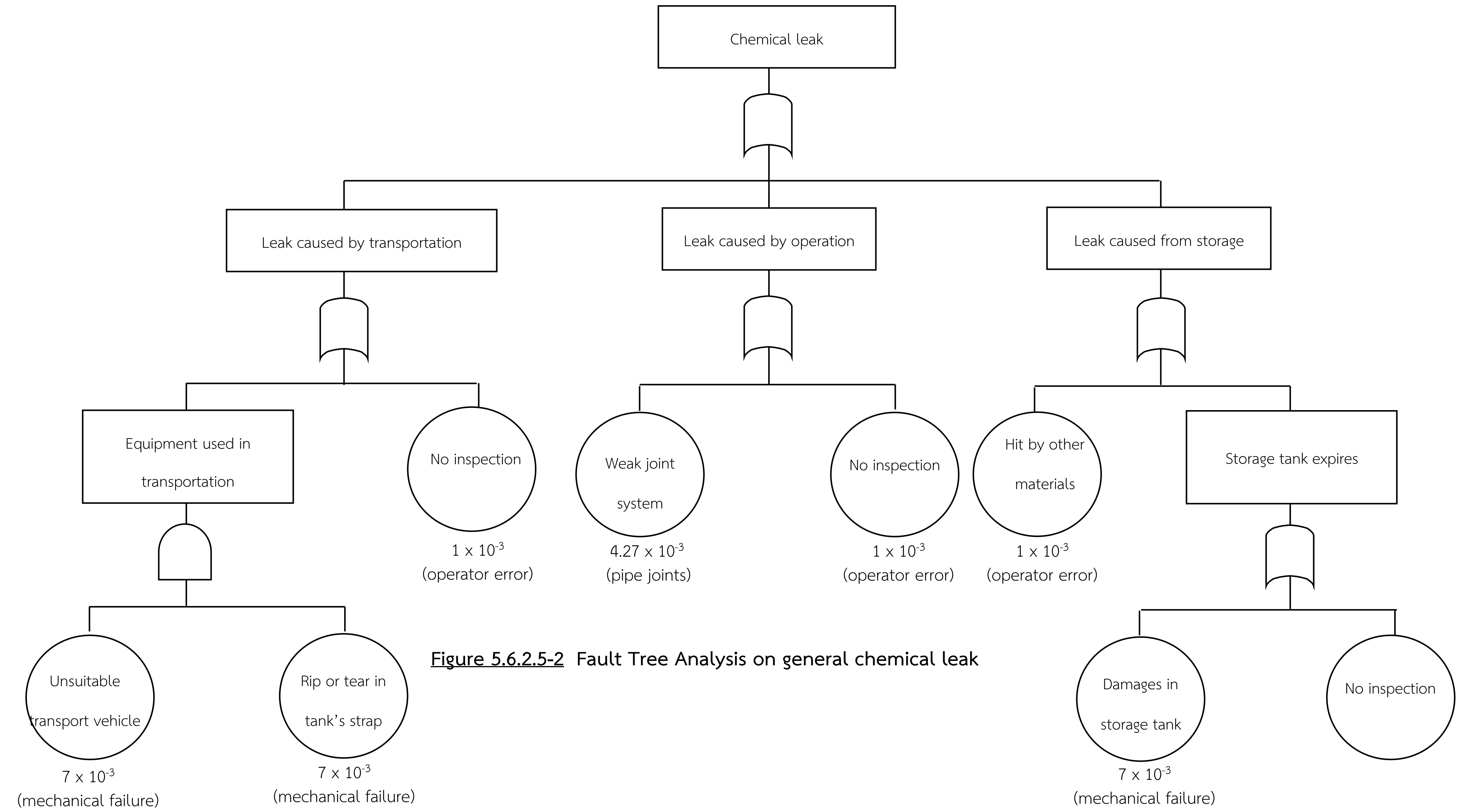


Figure 5.6.2.5-2 Fault Tree Analysis on general chemical leak

Table 5.6.2.5-2

Basic information on likelihood of failure in general production control equipment

1/		2/	
Ratio	Frequency (failure rate) (time per year)	Ratio	Frequency (failure rate) (time per year)
Power failure	10	Pressure vessels (general)	0.026
Limit switch failure	$1x10^{-4}$	Pressure vessels (high standard)	$2.56x10^{-3}$
Level switch failure	$8.2x10^{-6}$	Pipes	$1.71x10^{-3}$
Operator Error	$1x10^{-3}$	Pipejoints	$4.27x10^{-3}$
Pressure control fault	$1x10^{-4}$	Gaskets	$4.27x10^{-3}$
Solenoid valve fail to close	$1x10^{-3}$	Bellows	0.043
Level alarm failure	$8.2x10^{-6}$	Diaphragms (metal)	0.043
Vent Gas failure	$2x10^{-5}$	Diaphragms (rubber)	0.068
Inter-unit pipe (general)	$3.5x10^{-7}$	Unions	$3.41x10^{-3}$
Emergency gen. Fault	$1x10^{-5}$	Hoses (heavily stressed)	0.342
Mechanical failure	$7x10^{-3}$	Hoses (lightly stressed)	0.0342
P.Trip signal	0.2/D or $5.4x10^{-4}$/Y	Relife valves (leakage)	0.017
No immediate ignition	0.5/D or $1.4x10^{-3}$/Y	Relife valves (blockage)	$4.27x10^{-3}$
Immediate ignition	0.9386	Valves (hand-operated)	0.128
Sudden Weather Change	$1x10^{-2}$	Valves (ball)	$4.27x10^{-3}$
Third Party Error	$1x10^{-3}$	Seals (rotating)	0.0598
Impulse lines (blocked or leaking)	0.09	Seals (sliding)	0.0256
		Seals ("o" ring)	$1.708x10^{-3}$
Pressure switch	0.13	Filters (blockage)	$8.544x10^{-3}$
Cable (fracture or severed)	0.03	Filters (leakage)	$8.544x10^{-3}$
Loss of electric power Steam shut-off system	0.05	Pins	0.128
		Nuts	$1.708x10^{-3}$
Relay (complete with wire)	0.08	Bolts	$1.708x10^{-3}$
Solenoid valve	0.30	Boilers (all types)	$9.398x10^{-3}$
Loss of electric power	0.05	Pressure-indicating controller	1.15
Trip valve	0.25	Pressure-recovery controller	1.29
Air Supply line (block, broken)	0.02	Flow-indicating controller	1.51
		Flow-recording controller	2.14
Loss of air supply Pump shut-off system	0.02	Level-indicating controller	2.37
		Level-recording controller	2.25
Relay, etc, as above	0.08	Temperature-indicating controller	0.94
Pressure relife valve	0.02	Temperature-recording controller Trip initiator	1.99
Flame-failure detector	1.69		

Table 5.6.2.5-2 (cont)

3/		
Equipment	Failure Mode	Median Failure Rate
Batteries/ Power Supply	No output	3 X 10^{-6}/hr
Circuit breakers	Failure to operate	1 X 10^{-3}/hr
	Premature transfer	1 X 10^{-6}/hr
Diesel (complete plant)	Failure to start	3 X 10^{-2}/D
(Emergency loads)	Failure to run	3 X 10^{-3}/hr
Diesel (engine only)	Failure to run	3 X 10^{-4}/hr
Electric Motors	Failure to start Failure to run Failure to run-extreme environment	3 X 10^{-4}/D 1 X 10^{-5}/hr 1 X 10^{-3}/hr
Fuses	Premature open Failure to open	1 X 10^{-6}/hr 1 X 10^{-5}/hr
Gaskets	Leak	3 X 10^{-6}/hr
Flanges, Closures, Elbows	Leak/ rupture	3 X 10^{-7}/hr
Instrumentation (amplification, annunciators, transducers, caribration, combination)	Failure to operate Shift	1 X 10^{-6}/hr 3 X 10^{-5}/hr
Pipe > 3", high quality	Rupture (section)	1 X 10^{-10}/hr
Pipes < 3"	Rupture	1 X 10^{-9}/hr
Pumps	Failure to start Failure to run-normal Failure to run extreme environment	1 X 10^{-3}/D 3 X 10^{-5}/hr 1 X 10^{-3}/hr
Relays	Failure to energize Failure no contact to close Short across NO/NC contact Open NC contact	1 X 10^{-4}/D 3 X 10^{-7}/hr 1 X 10^{-8}/hr 1 X 10^{-7}/hr
Solid State Devices	Fails to function Short	3 X 10^{-6}/hr 1 X 10^{-6}/hr
Hi Power Application Low Power Application	Fails to function Short	1 X 10^{-6}/hr 1 X 10^{-7}/hr
Switches	Limit: fail to operate Torque: fail to operate Pressure: fail to operate Manual: fail to operate Manual: contacts short	3 X 10^{-4}/D 1 X 10^{-4}/D 1 X 10^{-4}/D 1 X 10^{-4}/D 1 X 10^{-8}/hr
Transformers	Open Short	1 X 10^{-6}/hr 1 X 10^{-6}/hr
Manually operated valve	Fails to operate (plug) Failure to remain open External leak-rupture	1 X 10^{-3}/D 1 X 10^{-4}/D 1 X 10^{-8}/hr
Solenoid operated valve	Fails to operate	1 X 10^{-3}/D
Air operated valve	Fails to operate Failure to remain open External leak-rupture	3 X 10^{-4}/D 1 X 10^{-4}/D 1 X 10^{-8}/hr

Table 5.6.2.5-2 (cont)

3/			
Equipment	Equipment	Equipment	Equipment
Check valve		Failure to open Reverse to remain open External leak-rupture	1 X 10^{-4}/D 1 X 10^{-7}/hr 1 X 10^{-8}/hr
Vacuum valve		Fails to operate Rupture	3 X 10^{-5}/D 1 X 10^{-8}/hr
Valve : orifices, flow, meter, (test)		Rupture	1 X 10^{-8}/hr
Valve (relief)		Failure to open Premature open	1 X 10^{-5}/D 1 X 10^{-5}/hr
Weld		Leak	3 X 10^{-9}/hr

Source : [1/] Smith and Warwick (1981)
[2/] Less, 1983; King, 1990
[3/] Cryogenic and Oxygen Deficiency Hazard Safety: ODH Risk Assessment Procedure, 27 Feb 2006 (update 13 Feb 2009)

For the level of chance of occurrence according to the risk assessment guidelines specified in the Department of Industrial Works Regulations on hazard identification, risk assessment, and the preparation of the risk management plan B.E.2543 (2000) can be categorized into 4 levels as follows:

Level	Detail
1	A rare likelihood of occurrence, for example, it has never been occurred in the period of 10 years or more
2	A low likelihood of occurrence, for example, the frequency of one occurrence in a 5-10 year period
3	A moderate likelihood of occurrence, for example, the frequency of one occurrence in a 1-5 year period
4	A high likelihood of occurrence, for example, the frequency of one occurrence in a one year period

However, when comparing the likelihood of incidents leading to accidents of the Project, compared with **Table 5.6.2.5-2** in **Figure 5.6.2.5-1** to **Figure 5.6.2.5-2**, it was found that the level of incident likelihood according to the assessment guidelines of the Regulation of the Department of Industrial Works Risks on hazard identification, risk assessment, and the preparation of a risk management plan B.E.2543 (2000) are shown in **Table 5.6.2.5-3**.

Table 5.6.2.5-3

Likelihood of various accidents in accordance to the risk assessment of industrial factory

Likelihood of occurrences leading to accidents of the project (Figure 5.6.2.5-1 to Figure 5.6.2.5-2)	Frequency of accident		Likelihood according to Industrial Department's standard	
	(time/year)	(year/time)	Details	Order
Pressure relief valves	0.02	50	< 1 time/ 10 years	1
Operator error	1×10^{-3}	1,000	< 1 time/ 10 years	1
Pressure-indicating controller	1.15	0.9	> 1 time/year	4
Loss of electric power	0.05	20	< 1 time/ 10 years	1
Pressure control fault	1×10^{-4}	10,000	< 1 time/ 10 years	1
Boilers (all types)	9.398×10^{-3}	106.4	< 1 time/ 10 years	1
Pumps: Failure to run normal	0.2628	3.8	1 time/ 1-5 years	3
Third party error	1×10^{-3}	1,000	< 1 time/ 10 years	1
Level alarm failure	8.2×10^{-6}	121,951.2	< 1 time/ 10 years	1
Mechanical failure	7×10^{-3}	142.9	< 1 time/ 10 years	1
Relay (complete with wire)	0.08	12.5	< 1 time/ 10 years	1
Temperature-indicating controller	0.94	1.1	1 time/ 1-5 years	3
Instrumentation	0.00876	114.2	< 1 time/ 10 years	1
Emergency gen. fault	1×10^{-5}	100,000	< 1 time/ 10 years	1
Pipe joints	4.27×10^{-3}	234.2	< 1 time/ 10 years	1

(2) Consequence of event

The severity of serious hazards from events of the Project to the people, the community, the environment, and property referred to the Regulation of the Department of Industrial Works Risks on hazard identification, risk assessment, and the preparation of a risk management plan B.E.2543 (2000), details are mentioned in **Table 5.6.2.5-9** to **Table 5.6.2.5-12**. The severity of the serious hazards of the generator explosion and chemical spills of the Project are summarized in **Table 5.6.2.5-1** to **Table 5.6.2.5-2**.

Table 5.6.2.5-4

Severity of consequences of the explosion of the Project power generator to the people, the community, the environment, and the property

Cause of serious accident	Consequential hazard	Severity of impact			
		People	Community	Environment	Property
The generator supplies overload					
• Overcurrent relay does not function/relay does not release breaker	• Explosion from burnt coil, short	2	1	1	3
• Employees do not check the meter	• Electricity continues to discharge too high	1	1	1	2
• Coil temperature sensor does not function	• The temperature of the coil rises beyond the control value, the relay does not disconnect • Overheating of the coil, insulation damage, severe burns, explosion	2	1	1	3
Problem caused by synchronize					
• Interlock system failure • Error in synchronize with other power sources • The breaker interruption is linked to the EGAT system	• Control cabinet explosion • Generator explosion	4	1	2	4
Electric fault in the system					
• Short circuit at the generator • The protection system does not function	• Severe short circuit to the distribution cabinet causing an explosion of the distribution cabinet and at the generator	4	1	2	4

Source: Regulation of the Department of Industrial Works Risks on hazard identification, risk assessment, and the preparation of a risk management plan B.E.2543 (2000)

Analyzed by: Consultant of Technology Company Limited, B.E. 2562 (2019)

Table 5.6.2.5-5

Severity of consequences of the chemical spill to the people, the community, the environment, and the property

Cause of serious accident	Consequential hazard	Severity of impact			
		To People	To community	To environment	To People
In case of mistakes from transfer					
• The vehicle is not suitable	• Drop, causing the chemical container to leak	1	2	2	2
• Broken of a strap • Employees do not check	• Chemical spill causing exposure of employees	2	1	1	2
In case of mistakes from use					
• The joint system is not strong • Employees do not check • Crash by other objects • Damage of container • Employees do not check	• Chemical spill causing exposure of employees	2	1	1	2

Source: Regulation of the Department of Industrial Works Risks on hazard identification, risk assessment, and the preparation of a risk management plan B.E.2543 (2000)

Analysed by : Consultants of Technololgy Co.,L.td, B.E.2563 (2020)

Dangers associated with explosions in gas turbine generator, transformer, switchyard, and chemical leak are shown from **Figure 5.6.2.5-3** to **Figure 5.6.2.5-5**

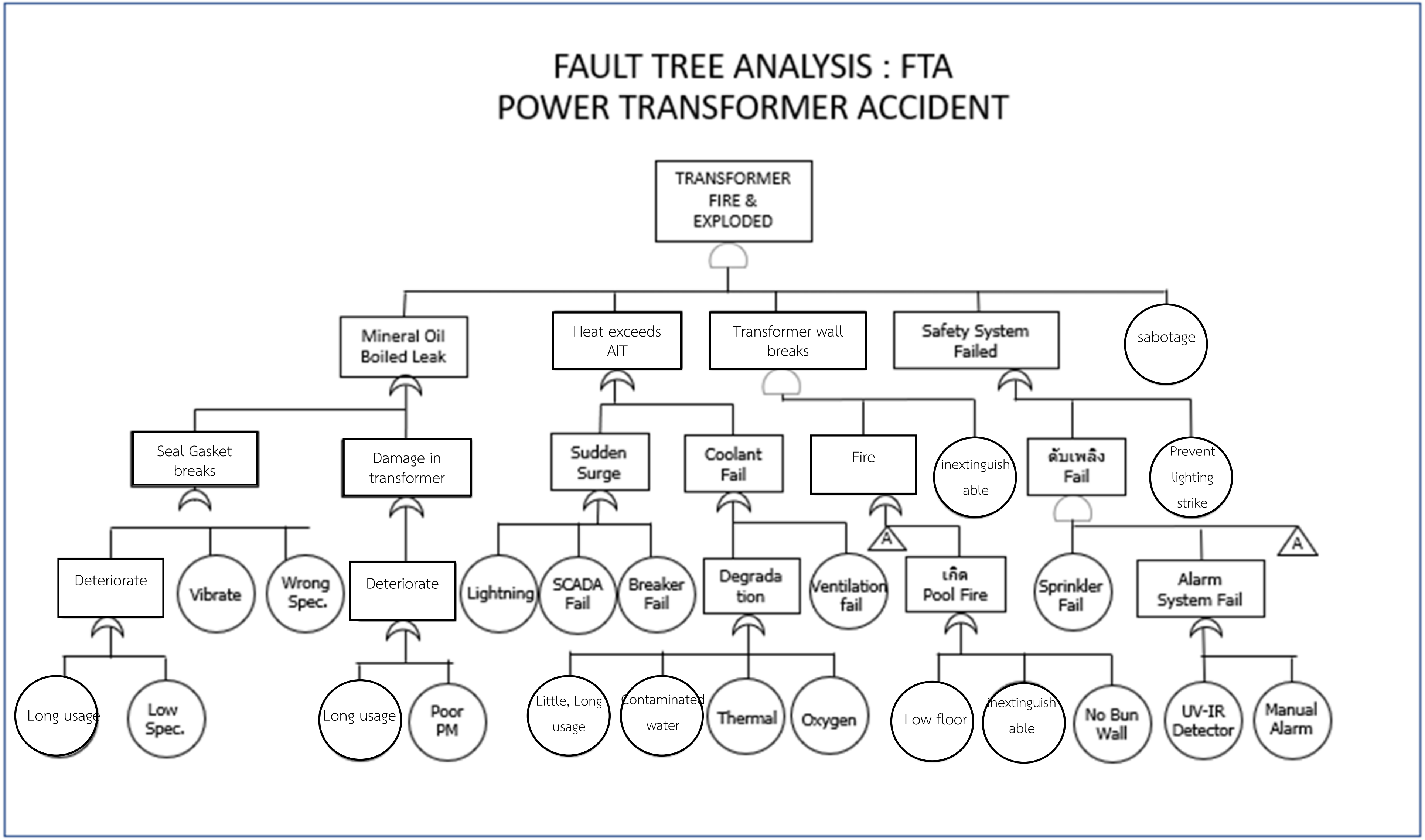


Figure 5.6.2.5-3 Fault Tree Analysis in case of explosion in gas turbine generator and transformer

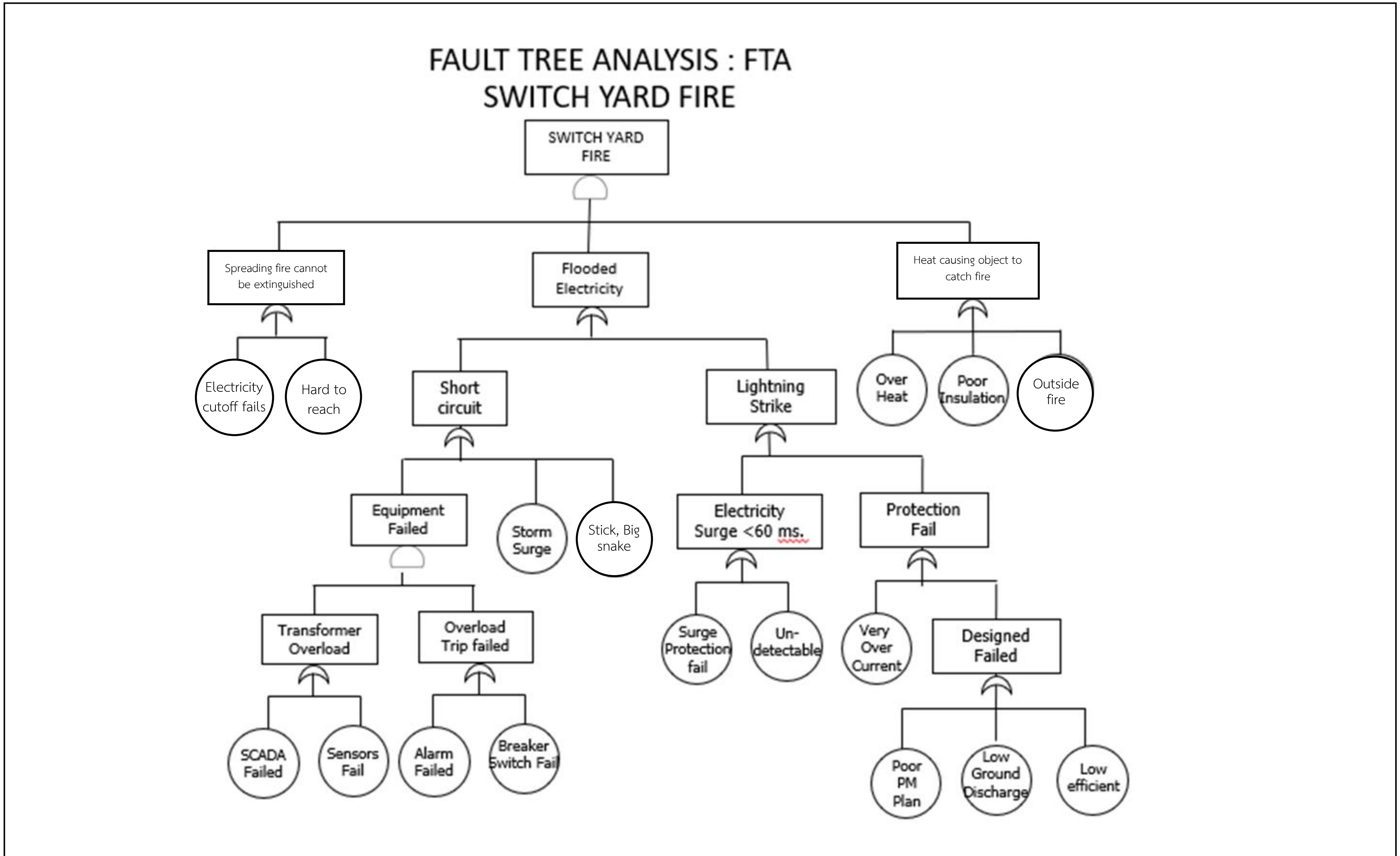


Figure 5.6.2.5-4 Fault Tree Analysis in case of explosion of Switch Yard

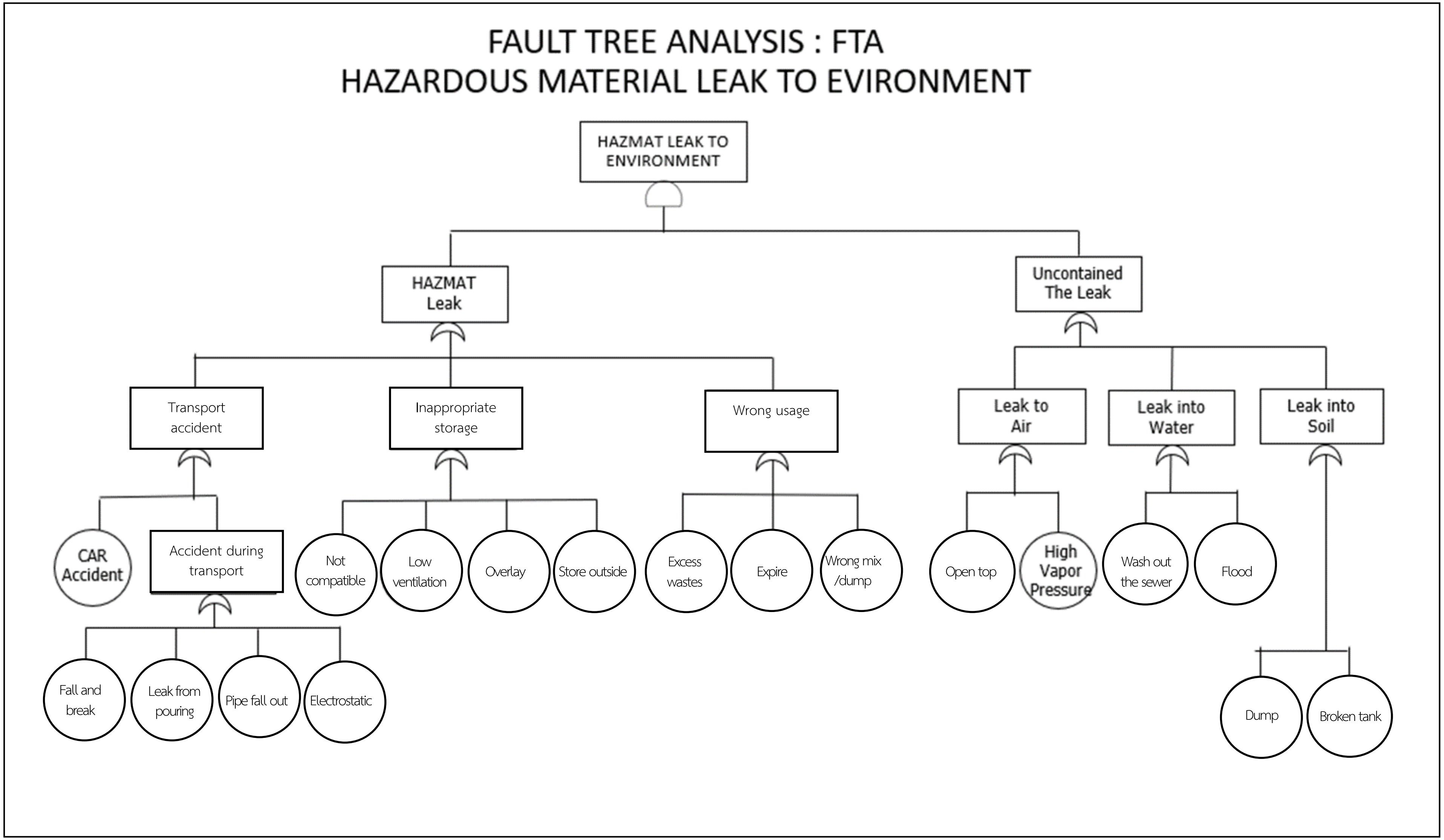


Figure 5.6.2.5-5 Fault Tree Analysis case of chemical leakage

5.6.2.6 Risk assessment

This analysis takes into account the likelihood and severity of the identified danger. Here the risk assessment was carried for the major hazard that can be identified. It categorizes the level of risk as a minor risk, acceptable risk, high risk, or unacceptable risk, to be used in the risk control operations. From the hazard identification, it was found that there is a potential hazard which is explosive of the steam generating unit, explosion of the generator, explosive of the steam turbine, and general chemical spills. The risk rating is based on the outcome of the likelihood level multiplied by the severity affecting the people, the community, the property, or the environment as follows:

Risk level = Likelihood x severity

Level of risk is classified into four levels as follows:

Risk level	Result	Definition
1	1-2	Minor risk
2	3-6	Acceptable risk, control measures must be reviewed
3	8-9	High risk, an operation to reduce the risk is required
4	12-16	Unacceptable risk, operation must be stopped to reduce the risk immediately

5.6.2.7 Results of risk assessment

(1) Explosion of the equipment in the production process of the Project

1) Risk assessment of consequences of explosion of the power generator

The results of the Project's power generator explosion hazard assessment, which may arise from various causes, are shown **in Table 5.6.2.7-1**. The risk level is different, most of them found that the level of risk of hazard ranging from 1-2, which is a minor to an acceptable risk levels in which control measures need to be reviewed. In addition, from the aforementioned risk assessment results, the risk value that may affect the property is level 3 (high risk, action must be done to reduce the risk) of the occurrence of the temperature sensor coil failure. This may result in the winding temperature rising beyond the control value and the relay does not disconnect, resulting in overheating of the coil, the insulation is damaged, severely burns, and explodes.

Table 5.6.2.7-1

Results of risk assessment of consequences of explosion of the power generator

Cause of sever accident	Consequential hazard	Risk assessment							
		Likelihood x severity				Result (risk level)			
		People	Community	Environment	Property	People	Community	Environment	Property
The generator supplies overload									
• Overcurrent relay does not function/relay does not release breaker	• Explosion from burnt coil, short circuit	1 x 2	1 x 1	1 x 1	1 x 3	2 (1)	1 (1)	1 (1)	3 (2)
• Employees do not check the meter	• Electricity continues to discharge too high	1 x 1	1 x 1	1 x 1	1 x 2	1 (1)	1 (1)	1 (1)	2 (1)
• Coil temperature sensor does not function	• The temperature of the coil rises beyond the control value, the relay does not disconnect • Overheating of the coil, insulation damage, severe burns, explosion	3 x 2	3 x 1	3 x 1	3 x 3	6 (2)	3 (2)	3 (2)	9 (3)
Problem caused by synchronize									
• Interlock system failure	• Control cabinet explosion • Generator explosion	1 x 4	1 x 1	1 x 2	1 x 4	4 (2)	1 (1)	2 (1)	4 (2)
• Error in synchronize with other power sources • The breaker interruption is linked to the EGAT system	• Control cabinet explosion • Generator explosion	1 x 4	1 x 1	1 x 2	1 x 4	4 (2)	1 (1)	2 (1)	4 (2)
Electric fault in the system									
• Short circuit at the generator • The protection system does not function	• Severe short circuit to the distribution cabinet causing an explosion of the distribution cabinet and at the generator	1 x 4	1 x 1	1 x 2	1 x 4	4 (2)	1 (1)	2 (1)	4 (2)

Results of studies, analyzes, and reviews of the Project operations for hazard identification and risk assessment using fault tree analysis method

Area/machine/process unit/procedure/activity : Step up transformer

	Cause of sever accident	Consequential hazard	Hazard prevention and control measure	Likelihood	Severity	Result	Level
1	Caused deterioration from long use, damaged seal	Hot mineral oil leak causing fire	Set service life and change according to plan	1	4	4	Acceptable
2	Poor quality seal device	Hot mineral oil leak causing fire	Enough spare parts according the specification PM planning	1	4	4	Acceptable
3	Electrical vibrations flowed through, torn seal	Hot mineral oil leak causing fire	Check abnormal vibration Check leakage	1	4	4	Acceptable
4	Wrong seal installation spec. or not heat resistant enough	Hot mineral oil leak causing fire	Enough spare parts according the specification PM planning	1	4	4	Acceptable
5	No maintenance on time, unable to stop the machine	Chamber damage	Safety policy, not slow the turn-around	2	3	6	Acceptable
6	SCADA Fail	Overheating causing fire	Check system	1	4	4	Acceptable
7	Breaker Fail, does not cut off when the current is over	Overheating causing fire	PM planning Temperature Sensor Alarm	1	4	4	Acceptable
8	Water infiltrates causing the degradation, heat cannot be reduced	Overheating causing fire	Sampling periodically	1	4	4	Acceptable
9	Thermal degradation, does not reduce the temperature	Overheating causing fire	Sampling periodically	1	4	4	Acceptable
10	The cooling fan system does not function	Overheating causing fire	Temperature Sensor Alarm	1	4	4	Acceptable

	Cause of sever accident	Consequential hazard	Hazard prevention and control measure	Likelihood	Severity	Result	Level
11	Transformer space I slow, the hot oil cannot flow out	Pool fire	Fuel drain channel Fire water system	1	4	4	Acceptable
12	Slow fire suppression or cannot be suppressed	Pool fire	Monthly inspection of fire extinguishing systems Pre-fire Plan	1	4	4	Acceptable
13	Fire spreading from adjacent transformers	Pool fire	Fire wall to prevent the spread	1	4	4	Acceptable
14	Failure of the sprinkler in the event of fire	Pool fire and explosion	Monthly inspection of fire extinguishing systems	1	4	4	Acceptable
15	Malfunction of UV-IR detector	Pool fire and explosion	Check the heat measurement system	1	4	4	Acceptable
16	Employees did not notice the fire, or it is too late	Pool fire and explosion	CCTV and alarm system	1	4	4	Acceptable
17	Lightning protection system failure	Pool fire and explosion	Check grounding system	1	4	4	Acceptable
18	Sabotage	Fore, explosion	Security System CCTV system CSR Program	1	4	4	Acceptable

Results of studies, analyzes, and reviews of the Project operations for hazard identification and risk assessment using fault tree analysis method

Area/machine/process unit/procedure/activity: Switchyard

	Cause of sever accident	Consequential hazard	Hazard prevention and control measure	Likelihood	Severity	Result	Level
1	Cannot enter the fire because there is electricity	It took long time, the fire broke out	Breaker switch cut off the power immediately	2	3	6	Acceptable
2	Difficult to get into the source of the fire	It took long time, the fire broke out	Hydrants around has enough length	2	3	6	Acceptable
3	SCADA failed	Sub-transformer temperature is very high	PM the SCADA system	1	3	3	Acceptable
4	Thermal sensors failed	Overload trip does not function, overheating	Have more than one sensor installed and tested regularly	1	3	3	Acceptable
5	Alarm bell failed	Anomaly is not known, overcurrent	Have more than one sensor installed and tested regularly	1	3	3	Acceptable
6	Breaker Overload Trip Failed	Overcurrent, resulting in high heat	Have a spare of the SCADA	1	3	3	Acceptable
7	Strom surge, strong wind	Short circuit, fire	Emergency shutdown the system	1	4	4	Acceptable
8	A branch or a snake across two wires	Short circuit, fire	Regular cleaning Gravel floor to prevent snake and weed	1	4	4	Acceptable
9	Surge Protection Fail	Does not cut off the over current, resulting in high heat	Effective lightning rod system Multiple grounding system	1	3	3	Acceptable
10	Surge less than 60 milisecond causing the sensor to fail	Overcurrent causing fire	Breaker Overload Trip	1	4	4	Acceptable

	Cause of sever accident	Consequential hazard	Hazard prevention and control measure	Likelihood	Severity	Result	Level
11	Overcurrent	Overcurrent causing fire	Breaker Overload Trip	1	4	4	Acceptable
12	Plans and maintenance errors	Protection fail when there is an overload	Maintenance efficiency	1	3	3	Acceptable
13	Grounding system failed	Overcurrent causing fire	Check the ground wire every 3 months	1	4	4	Acceptable
14	The lightning protection system is poor	Cannot protect against overcurrent	Use proven technology Check performance	1	3	3	Acceptable
15	Overheat from the current and sunlight	The equipment is worn out with ignition	Well ventilation Breaker switch cut off the power immediately	2	3	6	Acceptable
16	Poor Insulation	The equipment is worn out with ignition	Set the standard spec. PM Plan	1	3	3	Acceptable
17	External fire	Fire spread into the switchyard	Cleaning around the fence Fire extinguishing system ready	1	4	4	Acceptable

Results of studies, analyzes, and reviews of the Project operations for hazard identification and risk assessment using fault tree analysis method

Area/machine/process unit/procedure/activity: Chemical storage

	Cause of sever accident	Consequential hazard	Hazard prevention and control measure	Likelihood	Severity	Result	Level
1	Accident during transportation	A large amount of hazardous substances leaked	Truck inspection, drive according to the traffic rules, check the spill kit, MSDS	2	3	6	Acceptable
2	Drop during transfer	Leak of hazardous substances causing fire	Equipment and container, spill kit, and MSDS	2	3	6	Acceptable
3	Leak during loading	Leak of hazardous substances	Readiness of the loading equipment	2	3	6	Acceptable
4	The connecting pipe from the vehicle is disconnected while being pumped into the tank	Leak of large amount of hazardous substances	WI of chemical transport Loading and unloading in spill controlled area	1	4	4	Acceptable
5	Electrostatic	Fire	Grounding system	1	4	4	Acceptable
6	Leak and mix of incompatible chemicals	Reaction causing fire	Storage must be considered legally organized	1	4	4	Acceptable
7	Poor ventilation causing accumulation	Mixture range expansion, fire	Good ventilation Away from the production building	2	3	6	Acceptable
8	Stacked so much that it collapsed	Break of the container, leak of hazardous substances	Set the number of shelves Stable shelves that can prevent leakage	2	3	6	Acceptable
9	Place dangerous substances outside the building	Rain, leaks into the environment	With support tray and covered roof Taken to deposit in the	1	4	4	Acceptable

	Cause of sever accident	Consequential hazard	Hazard prevention and control measure	Likelihood	Severity	Result	Level
10	Left a lot of waste	Must be collected and disposed of or pour it into the ground	Waste storage area	1	3	3	Acceptable
11	Keep chemicals for a long time until they expire	Must be disposed of	Set service life Set waste dispose approach	1	3	3	Acceptable
12	Misuse, mix, and leave for a long time	Must be disposed of	WI for waste management	1	3	3	Acceptable
13	Open space, cannot contain the leak	Leak on the ground, fire of the storage area	Provide water curtain, fire suppression, sprinkler	1	4	4	Acceptable
14	High vapor pressure	Fire	Keep in suitable container and cover	1	4	4	Acceptable
15	Leaking out of the rain gutter	Hazardous substance leaks outside the plant	Chemical and storm sewer are separated Procedures and recovery equipment are ready	1	4	4	Acceptable
16	Flooding of hazardous substances storage area	Hazardous substance leaks outside the plant	Provide spare storage space	1	3	3	Acceptable
17	Dumped into the soil	Soil contamination	Prepare containers for hazardous waste Environmental protection policy	1	3	3	Acceptable
18	Tank is kept for a long time until it decayed	Soil contamination	Inventory management	1	3	3	Acceptable

Nevertheless, the Project has set measures to prevent and control the danger that may arise around the coil temperature sensor as follows:

- Regularly check the temperature sensor of the coil,
- Make sure the Temperature controller works according to the set temperature, and
- Regular check the spare sensor kits.

2) Measures to reduce the risk of explosion of process equipment

The Project has put in place measures to reduce the risk of explosion of equipment in the Project's production process, which may cause harm to people, community, environment and property as follows:

(a) Install various safety devices such as:
- Provide proper insulation for hot pipes,
- Provide electrical protection (Relay) at generators and transformers, and
- Provide a protection system as well as a warning system that cuts off the fuel system and automatically stop machines in case of emergency.

(b) Do a test for system readiness before activation by the control of a licensed engineer under the Professional Engineers Act, and

(c) Prepare for emergency events.

In addition, in the event of an emergency causing damage to any person, any organization, as well as the property of any person, juristic person, organization, and public due to the operation of the Project, the Project must be responsible for the expenses incurred. This includes expenses that are not covered by the all risk policy, which covers the insured property or any part of the insured property that has been damaged or lost from accidents or unforeseen events. The policy will cover damage arising from natural disasters and all kinds of accidents. Both arising from external factors and occur in a sudden and unforeseen event such as accidents, natural disasters, fire, lightning, and the actions of third parties, especially in damage to the life and property of the third party. The liability limit is set for each accident to provide protection against any impact or damage that occurs in the area related to the Project. However, the Project is willing to take care of, help, compensate the damage during the proof, the Project will take care and bear the expenses incurred by the preliminary treatment, both in life, medical expenses, and property damage before the insurance policy took care of.

(2) Results of risk assessment due to general chemical spills

Chemicals will be transported to the Project area by trucks and then stored within the area. The chemicals consist of sodium hypochlorite, sulfuric acid, sodium hydroxide, hydrochloric acid, citric acid, and some are spare and stored in chemical storage buildings, consisting of oxygen scavenger, liquid ammonia, trisodium phosphate, corrosion inhibitor, scale inhibitor, poly aluminum Chloride (PAC), polymer, sodium bisulfite, antiscalant, and biocide. The chemical shall be kept according to their properties for safety from the reaction between sensitive chemicals, especially the flammable material, which must clearly separate the area. By designing chemical storage areas, the Projects in accordance with the Notification of the Department of Industrial Works on Manual for the Storage of Chemicals and Hazardous Substances, B.E. 2550 (2007). The storage area must be big enough to handle all chemicals. Construction materials must be resistant to water and chemicals. The floor must not absorb liquid, smooth, not slippery, and free from cracks and easy to clean. The floor of the building must be designed to contain the spilled chemical and water from firefighting by the way of making a bund wall around The Project's chemical storage building area. This is to prevent leakage and seep into the soil, as well as the bund wall will prevent the spread of chemicals in the event of a leak into the soil and will not affect the groundwater.

The details of the design of the chemical storage building of the Project are consistent with the Notification of the Department of Industrial Works on the Handbook of Storage of Chemicals and Hazardous Substances B.E. 2550 (2007), which has specified details in the door and emergency exit of hazardous and chemical substances storage facilities as follows:

(1) At least 2 entry doors must be available, including the opposite emergency exit door,
(2) Entry-exit doors used for shipping, there must be safety for the operator, no obstacles and clearly labeled,
(3) Doors used as emergency exits must be easily opened one way from the inside, not less than 1.10 meters wide, must not be sealed with a key, not a sliding door, it must not be a door that leads to a dead end area.
(4) The area near the emergency door must have emergency lighting, clearly marked, right size that can be seen in the dark and free from obstructions.

(5) There must be 2 emergency doors in opposite directions in the case of large buildings, emergency exits are required at every 35 meters.

(6) Fire doors are part of the fire wall, must be able to endure the fire for at least the fire barrier.

(7) The fire-proof door as part of the fire barrier separating the rooms is designed to be automatically closed, which is connected to the alarm

(8) In - out cargo doors, fireproof sliding doors must be equipped with a safety device to prevent the track from falling off.

The interior of the building is clearly separated from the chemical storage area. The storage is divided into 3 parts with concrete walls for storage of 3 types of chemicals: oxidizing agent, class 5 . 1 (oxidizing agent), toxic substance class 6 . 1 (combustible/non-combustible substance with toxic properties), and corrosive class 8 (combustible/non-combustible corrosive properties). This is according to the information in the chemical and hazardous substance storage according to the Notification of the Department of Industrial Works, B.E.2550 (2007) stated that oxidizing agents Category 5.1 must be stored by separate storage with toxic substances Category 6.1 and Corrosive substances Category 8, in case they are stored in the same warehouse, fire extinguishers are separated from other substances by fire-resistant walls that can withstand fire for at least 90 minutes. In addition, the Project also provides fire extinguishers of type ABC installed at the entrance and exit of the chemical and waste storage building at 2 points.

The results of the Project's major hazard assessment of common chemical spills, which may arise from various causes, are shown in Table 5.6.2.7-2, all of which have a level 1 hazard rating, which is a minor risk. However, the Company has set safety measures as follows:

1) Provide training plans for occupational health and safety and educate the safety issues for employees at all levels according to the training plan set by the Project,

2) Arrange the Occupational Safety, Health and Environment Committee (NCPO) as required by law to inspect and supervise work safety,

3) Provide safety information for all chemicals that are used and label with details of chemicals posted on any type of container,

4) Separate types of chemicals that are susceptible to reaction, such as acids - bases or chemicals that cannot be stored close to each other, such as flammable chemicals,

5) There must be a good ventilation system in all chemical placement areas to allow air circulation, and

6) Prepare the dike around the tank so that it can handle all spilled chemicals in the event of a package leak, it is possible to prevent leaks along the building floor or gutters which will cause damage to the environment.

To ensure that the risk control program is within acceptable limits, the Project must have at least the following risk control plans.

1. Management plan for chemical transfer and fuel receiving through pipelines
2. Plan for the receive and storage of hazardous substances
3. Waste management and disposal plan
4. Productive maintenance plan
5. QA sampling plan
6. General and specific safety procedure
7. Machine operation procedure
8. Safety procedure
9. Hot work and drilling work procedure

In addition, the Project has provided an emergency prevention and management plan drill once a year and conducts with the community and the government/local authorities. This shall reduce likelihood of major hazard as well as consequences of impact from domino effect. Therefore, the impact of major hazard is low.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance		Health assessment
	1	2	2	(4) = 2	1	2	low	Not significant

5.6.3 Impact on aesthetics, recreation, and tourism

From the study of the study area, the radius of 5 kilometers around, these has no major tourist attractions and historic sites. The Project's activities do not affect the scenery due to the fact that the Project has not opened a new area. It is located within an empty area near the TECO Power Plant.

(1) Demolition and construction period

The construction activity of the Project does not affect the aesthetic source, recreation, and tourism because the Project has not opened a new area. Therefore, during the construction period, the impact on the aesthetic source, recreation, and tourism in the area is low.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	1	(1)=1	3	3	low

(2) Operation period

The Project nearby areas have no tourist sites with natural or historical importance. For the landscape architecture surrounding the Project area, the Project has provided a green area which will help keep the shade, relieve stress, and provide recreation for employees and visitors of the Project. This will create good scenery for outsiders. Thus, the Project activities do not affect the aesthetic aspects. Therefore, the impact is low.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	1	(1)=1	3	3	low

5.7 Summary of impacts

From the details of the impact assessment on each of the above issue, can summarize the environmental impact that may arise from the operational activities of the Project as presented in **Table 5.7-1**.

Table 5.7-1
Summarization of order of importance of environmental impacts of the project

resources/environmental values	Level of Impact					
	Construction period			Operation Period		
	low	medium	high	low	medium	high
1. Physical resources						
1.1 Topography, geology, soil resources, and earthquake	✓			✓		
1.2 air quality	✓				✓	
1.3 hydrology and water quality	✓					
1.4 noise level		✓			✓	
1.5 sludge	✓			✓		
2. Biolocial resources						
2.1 land biological resources	✓			✓		
2.2 aquatic biological resources	✓			✓		
3. Benefits from human resources						
3.1 land utilization	✓			✓		
3.2 trade	✓			✓		
3.3 water utilization	✓			✓		
3.4 water drainage system and flood prevention		✓			✓	
3.5 Occupation	✓			✓		
4. Living quality values						
4.1 Economy and social	+			+		
4.2 Hygiene and safety	✓			✓		
4.3 Tourism	✓			✓		
5. Danger/risk	-			✓		

Remark: ( ) means positive impact
Source : Consultants of Technololgy Co.,L.td, B.E.2563(2020)

5.8 Assessment of the environmental impact of dismantling activities and installation of raw water and wastewater pipelines

From the detailed review of the pipeline installation, the environmental impacts that need further study were found as follows: noise, vibration, water quality, solid waste management, and air quality (only the air quality impact assessment is presented in **Section 5.3.2 Air quality impact)**. For other impacts, the Consultant has conducted a study and assessed the impacts in the overall power plant. The details of each impact assessment are as follows:

5.8.1 Noise impact

Assessment the noise impact of raw water and wastewater pipelines installation activities of the Project was performed by considering the use of machinery and equipment which is the source of noise. The Consultant has reviewed the assessment data in accordance with the construction method. This was used to predict and determine measures to prevent and correct the noise impact of the Project. Details are as follows:

(1) Source of noise from the Project activities

The noise source from the Project construction activities consisted of two methods: open cut and horizontal directional drilling (HDD). The construction by open cut shall be done only during the daytime with intermittent work (up to 4 hours each time) and there is a lunch break between 12.00-13.00 o'clock (1 hour). During the lunch break, all work and engine or machine will stop. Therefore, during this period there is no noise from construction activities. But for HDD, the work on a 24-hour continuous working basis. The Consultants used the reference data from the pipeline installation activities of PTT Public Company Limited as shown in **Table 5.8.1-1**.

Table 5.8.1-1
Noise level from construction avticitites

Site	machine	Number of Machine	Maximum noise level (Lmax) in 1 meter distance[1/] (decibel A)
Open Cut[2/]			
1.	Backhoe	1	85.3
2.	crane	1	80.5
HDD [3/]			
1.	HDD machine/ broaching machine	1	89.4
2.	Electricity generator	1	80.6

Remark: [1/] Measure at 1 meter distance from the noise source
[2/] Operation period from 08.00-17.00 with lunch break during 12.00-13.00. During lunch break, all operation will stop and machines will be shut down
[3/] Continuously working for 24 hours duration

Source: * Studied and created data base on noise level during natural gas pipeline construction by PTT co.,Ltd B.E. 2558(2015)

The noise levels of each type of machinery were combined by using the total noise level equation (1), the total noise level from the machines of the open cut and horizontal directional drilling (HDD) activities are as follows:

L_{total} = Error! Objects cannot be created from editing field codes. ....(1) i =1

Where: L_{Total} = Total noise level from different sources, decibel(A)

Li = Noise level from each source, decibel(A)

n = Number of noise sources

Example of substituting values in equations to find the total noise level of the machinery from the pipeline installation by open cut method.

$$L_{total} = 10 \log (10^{85.3/10}+10^{80.5/10})$$
$$= 86.5 \text{ decibel(A)}$$

The total noise level during the open cut excavation activity of 86.5 decibel(A), the HDD activity of 89.9 decibel(A) and the thrust activity of 92.2 decibel(A), details are shown in **Table 5.8.1-2**.

Table 5.8.1-2
Total noise level in each aspect of construction

Site	Machine	Noise level (decibel A)	
		Maximum noise level (Lmax) in 1 meter distance	Total machines
Open Cut			
1.	Backhoe	85.3	**86.5**
2.	crane	80.5	
HDD			
1.	HDD machine/ broaching machine	89.4	**89.9**
2.	Electricity generator	80.6	

(2) Duration

The installation activities by open cut will be performed during 8.00-17.00 o'clock and break for lunch during 12.00-13.00 o'clock. The total working hours of 8 hours. The HDD work shall be performed 24 hours of continuously.

(3) Calculation of 24-hour source noise level

The calculation of 24-hour source noise level is the calculation of the average source noise level over the desired time period. It is the adjustment of the noise level occurring during the machine operating time to the average noise level at the time required by using equation (2). The forecast of total noise levels from the average 24-hour noise source is shown as **Table 5.8.1-3**.

$$Leq_T = Lp + 10 \log t/T \qquad \text{.................................} (2)$$

Where: Leq_T = Noise level occurring at the time of desired, deicbel(A)

Lp = Noise level arising from the source, decibel(A)

t = Duration of noise from the source, hour

T = Duration of noise of desired, hour

Table 5.8.1-3

Calculations of total noise level from pipeline installment activities

Site	Machine	Number of machine	Maximum noise level (Lmax) at 1 meter distance (decibel A)	Total noise level from machines at 1 meter distnace (decibel A)
Open Cut				
1.	Backhoe	1	85.3	**86.5**
2.	crane	1	80.5	
HDD				
1.	HDD machine/ broaching machine	1	89.4	**89.9**
2.	Electricity generator	1	80.6	

1) Pipeline installation by the open cut technique

When considering the working period of the Project, it was found that the working period is during 8.00-17.00 o'clock with a lunch break 12.00-13.00 o'clock. Total work period of 8 hours. The level of noise in the construction area for 8 hours a day was calculated using equation (2), details are as follows:

$$Leq_{8hr.\ (backhoe)} = 85.3 + 10\log 4/8$$
$$= 82.3 \text{ decibel A}$$
$$Leq_{8hr\ (crane)} = 80.5 + 10\log 4/8$$
$$= 77.5 \text{ decibel A}$$

The noise generated by the pipeline installation by the open cut technique activities can be combined by using equation (1) as follows:

$$L_{total} = 10 \log (10^{82.3/10}+10^{77.5/10})$$
$$= 83.5 \text{ decibel A}$$

The noise level determination from pipeline installation by the open cut technique activities by the average 24-hour was compared with the ambient noise level standards according to the Notification of the National Environment Board No. 15 B.E.2540 (1997), the average 24-hour noise level must not exceed 70 decibel(A). It was calculated from the average 8-hour noise level to the average 24-hour noise level by using Equation (2) with details as follows:

$$Leq_{24hr. \text{ (open cut)}} = 83.5 + 10\log 8/24$$
$$= 78.8 \text{ decibel A}$$

2) Pipeline installation by the horizontal directional drilling (HDD) technique

Considering the Project working period, it was found that there was a continuous working period of 24 hours, the calculation of the noise level in the construction site was performed by using Equation (2), details as follows:

$$Leq_{24hr \text{ (HDD machine)}} = 89.4 + 10\log 24/24$$
$$= 89.4 \text{ decibel A}$$
$$Leq_{24\text{ชม.} \text{ (electricity generator)}} = 80.6 + 10\log 24/24$$
$$= 80.6 \text{ decibel A}$$

The total noise level from pipeline installation by the horizontal direction drilling (HDD) technique of 24 working hours was compared with the ambient noise level standards according to the Notification of the National Environment Board No. 15 B.E.2540 (1997), the average 24-hour noise level must not exceed 70 decibel(A). Equation (2) was used as follows:

$$Leq_{24hr \text{ (HDD)}} = 10 \log (10^{89.4/10}+10^{80.6/10})$$
$$= 89.9 \text{ decibel A}$$

(4) Noise impact assessment

1) Noise impact on construction workers

Loud noise affects the performance of those working in the area, and if a worker is exposed to a loud noise of over 85 decibel(A) during an 8-hour working period, there is a chance of hearing loss or abnormal hearing impairment (NIOSH, 1998). Exposure to sound at levels above 85 decibel(A) in 8-hour of work over a long period of time can cause hearing loss. The sound will destroy the auditory nerve cells in the auditory organs of the inner ear and deteriorate and resulted in hearing loss (Passionate Asawawichienjinda, 2000; Sataloff, 2006). The study by the World Health Organization (WHO) found that exposure to noise ranging from 85 decibel(A) in 8-hour of work for a period of 6-12 months began to manifest signs of significant hearing loss. According to the Notification of the Department of Labor Protection and Welfare regarding the average noise level standard acceptable to the daily working hours, B.E. 2561 (2018). The sound standard is set to allows workers to experience a value of no more than 85 decibel(A) in 8-hour of work. From the calculation of the noise level arising from the Project construction activities, it was found that the noise level per worker in the construction area of an average of 8-hour during construction by the open cut method was 83.5 decibel(A) and the HDD method was 89.9 decibel(A) which exceeds the specified noise level standard.

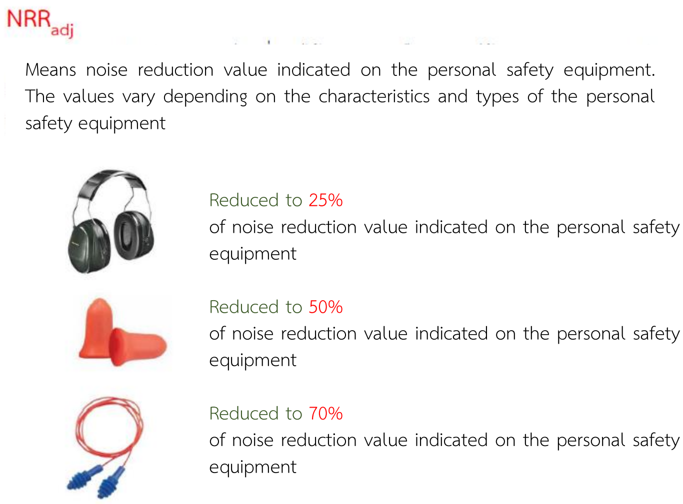
Therefore, the Project has set measures for construction workers that working in noisy areas to wear personal protective equipment i.e. earmuffs and earplugs especially during construction, by means of HDD to reduce the chance of impact on the health of employees. The workers shall avoid doing activities that cause excessive noise for a long time. However, when calculating the noise level of the ear when wearing personal protective equipment according to the Notification of the Department of Labor Protection and Welfare on the calculation of the noise level in the ears when wearing personal protective equipment dated 18 January 2018, calculated using the specified Noise Reduction Rating (NRR). It is placed on the measurement tool. The formula used in the calculation was equation (3).

Protected decibel A = Sound Level decibelA – [$NRR_{ad\ j}$ – 7] .... (3)

Where: Protected decibel (A) means Noise level in the ear when wearing a safety protection device in decibel(A)

Sound Level decibel (A) means Average noise level measured over an 8-hour working period in decibel(A)

NRR_{adj} mean Noise reduction value stated on the label of safety protection device. Adjustment is based on appearance and type of equipment as follows:



It was found that workers will expose to an average 8-hour noise level from the HDD method of 74.4 decibel(A). Therefore, the impact on workers in the construction area is low.

2) Noise impact at observation points

(a) Observation points

From the field survey in conjunction with the examination of maps of the Royal Thai Survey Department, Satellite photos, and pictures from unmanned aerial vehicle throughout the pipeline layout of the Project, it was found that the land use along the pipe is concentrated in some areas. For the open cut activity, the nearest house to the pipeline is within 2 meters and for the HDD activity, the nearest houses is within 10 meters. Thus, the Consultant assessed the noise impact of the Project's construction activities by distance. The results were used in the formulation of measures to prevent the impact arising from construction activities.

Both methods of pipeline installation were assessed for noise level generated by calculating the total noise level from construction activities by distance using Equation (4). The noise levels of all machines were combined using equation (1), details are shown in **Figure 3.1-1** and **Figure 3.1-2**.

$$Lp_2 = (Lp_1 - 20 \log R_2/R_1) \quad \text{.................................} \quad (4)$$

with; R_1 = distance of 1 meter from the noise source

R_2 = distance between the noise source and landmark location

Lp_1 = Loudest noise from machines in pipe installment activities at 1 meter distance

Lp_2 = noise level at various distances, decibel A

Noise level from open cut activities at certain distances

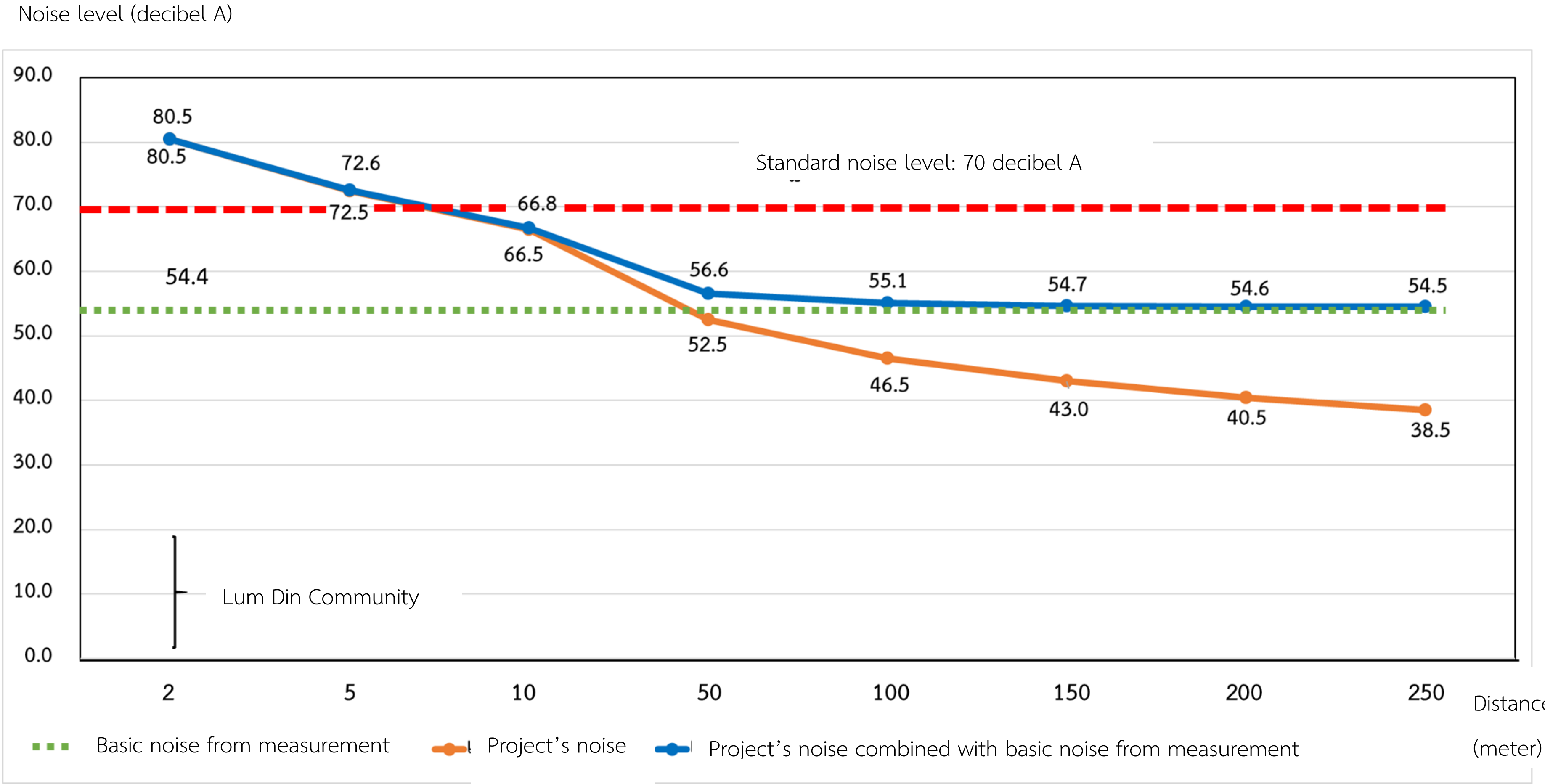


Figure 5.8.1-1 Noise level of Open cut activities at distances

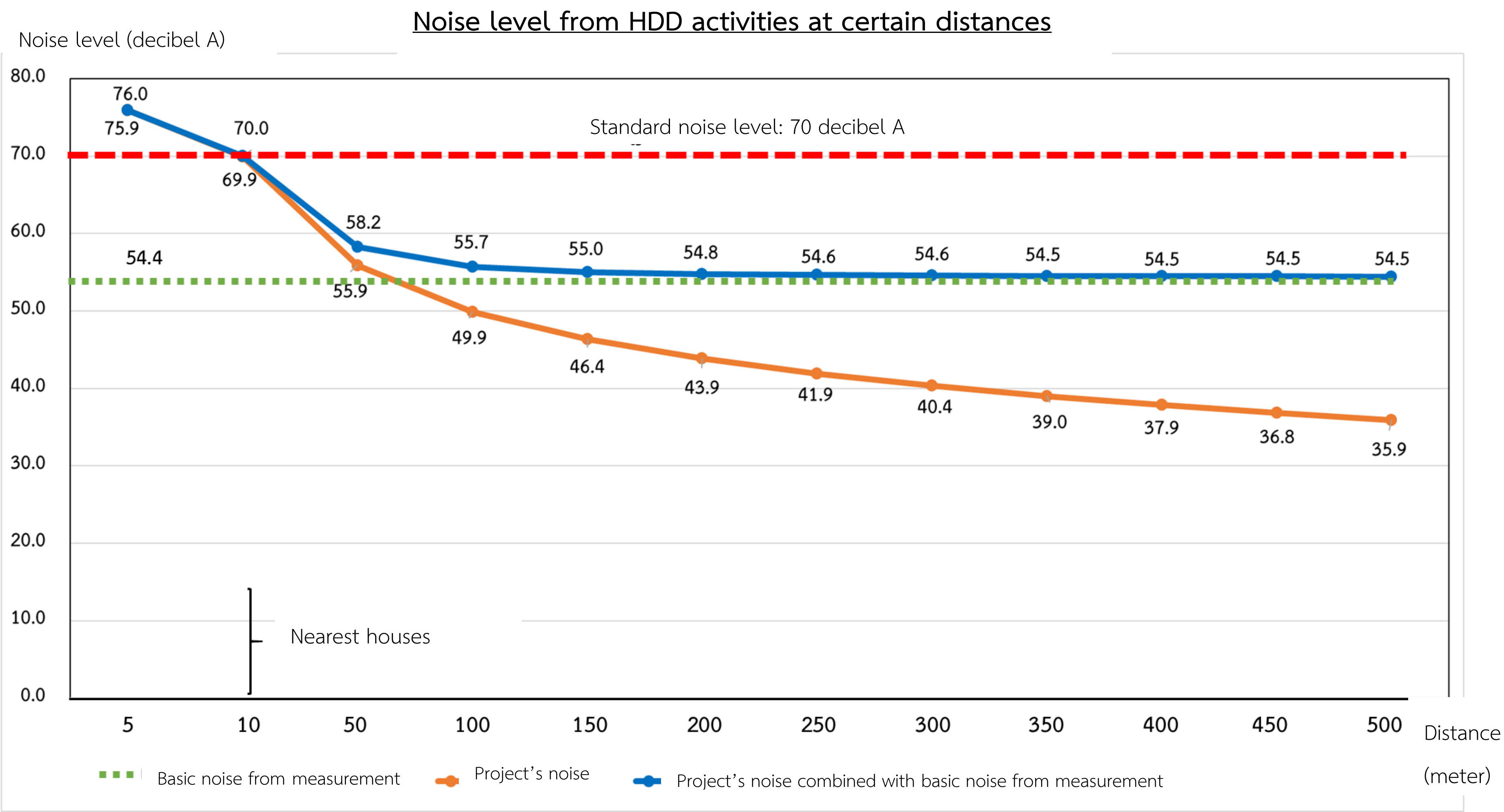


Figure 5.8.1-2 Noise level of HDD activities at distances

(b) 24-hour average noise level

The calculation of 24-hour average noise level at observation points from the Project's pipeline installation was combined with the current 24-hour average noise level, the maximum noise level measured during 12-18 February 2019, was 54.4 decibel(A). The 24-hour average noise level at the observation point can be obtained.

The projection of noise level from pipeline installation activities showed that the open cut method activity within 2 meters from the noise source, noise level exceeds the ambient noise level standard according to the Notification of the National Environment Board stated that 24-hour average noise level must not exceeds 70 decibel(A). For HDD method, noise level does not exceed the standard according to the Notification of the National Environment Board stated that 24-hour average noise level must not exceeds 70 decibel(A). In order to reduce the impact, the Project will install a temporary sound barrier. The Project considered 18 ga steel, a material that is available in the market and easy to move while having construction activities. There is a transmission loss (TL) of 25 decibel(A) (**Table 5.8.1-5**). It will be installed with a height of 2.5 meters above the ground.

Table 5.8.1-4

Transmission Loss from using various noise absorbing materials

Meterial	Thickness (mm)	Surface Density (Kg/m^2)	Transmission Loss* (dB)
Polycarbonate	8-12	10-14	30-33
Acrylic (Poly-Methyl-Acrylate (PPMA)	15	18	32
Concrete block 200x200x400 light weight	200	151	34
Dense concrete	100	244	40
Light concrete	150	244	39
Light concrete	100	161	36
Brick	150	288	40
Steel, 18 ga	1.27	9.8	25
Steel, 20 ga	0.95	7.3	22
Steel, 22 ga	0.79	6.1	20
Steel, 24 ga	0.64	4.9	18
Aluminum sheet	1.59	4.4	23
Aluminum sheet	3.18	8.8	25
Aluminum sheet	6.35	17.1	27
Wood	25	18	21
Plywood	13	8.3	20
Plywood	25	16.1	23
Absorptive panels with polyester film backed by sheet	50-125	20-30	30-47

Remark : *Value assuming no openings or gaps in the barriers

Source : Adapted from Environmental Protection Department and Highway Department, Government of the Hong Kong SAR., 2003

Calculation of the noise level in the case of using a sound attenuation material with a transmission loss (TL) of 25 decibel(A) was done by using the Fresnel number as shown in Equation (5) (**Figure 5.8.1-1**). The Fresnel number value was used to determine the noise level that reduced after pass through the barrier from the graph (**Figure 5.8.1-2**). Later, it is subtracted from the noise level of the Project's construction activity at various distances. Those who live in the area are exposed to noise which is reduced.

$$N_O = \frac{2(a + b - c)}{w} \quad \ldots\ldots(5)$$

with N_O = Fresnel number

a = displacement between noise source to upper part of the wall (meter)

b = displacement between upper part of the wall to the receptor (meter)

c = displacement from the noise source to the receptor (meter)

w = sound wavelength (meter) = v/f = 0.70

v = Sound waves velocity (meter/second) = $331.4\ [1+(T_c/273.2)]^{1/2}$ = 347.74

T_c = Average atmospheric temperature (27.6 Celsius) according to 13 years (B.E. 2549- B.E. 2561(2006-2018)) statistics of atmosphere from Weather Monitoring Station of Ratchaburi

f = Noise frequency = 550 Hertz

The details of the calculation for the noise level reduction from the travel across the sound attenuation material are shown in **Table 5.8.1-6**.

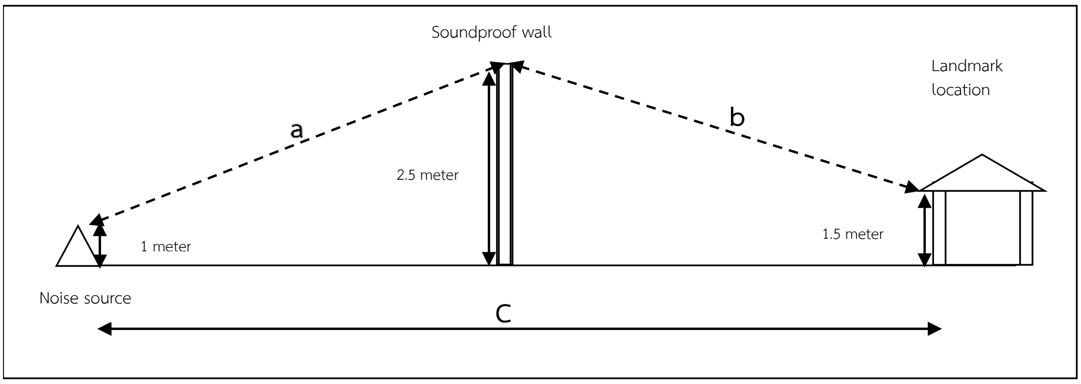


Figure 5.8.1-3 Distance according to the calculation from Fresnel number

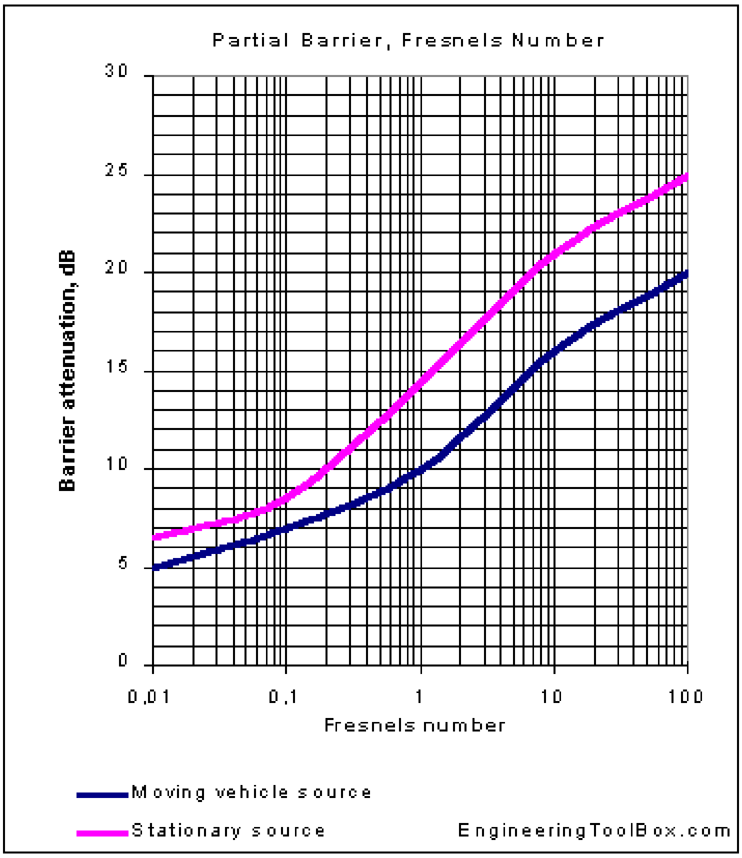


Figure 5.8.1-4 **Graph showing relationship between Fresnel number and reduced noise level**

Using the above data, substituting the value in Equation (4), obtain the Fresnel number, and investigating the relationship between Fresnel number and reduced noise level. The noise level is reduced about 16 decibel(A) (**Table 5.8.1-5**).

After installing a temporary sound barrier, it was found that the open cut activity at a distance of 2 meters and the HDD activity at a distance of 5 meters had the 24-hour average noise levels within the ambient noise level standard (details are shown in **Table 5.8.1-6**).

Table 5.8.1-5

Finding Fresnel number

Distance from source to landmark location (meter)	distance (meter)					N_0	Fresnel number
	From source to wall	From wall to landmark	a	b	c		
Open Cut							
2	1	1	1.8	1.4	2.0	3.5	16.0
HDD							
5	1	4	1.8	4.1	5.0	2.6	16.0
6	1	5	1.8	5.1	6.0	2.6	16.0
7	1	6	1.8	6.1	7.0	2.5	16.0
8	1	7	1.8	7.1	8.0	2.5	16.0
9	1	8	1.8	8.1	9.0	2.5	16.0
10	1	9	1.8	9.1	10.0	2.5	16.0

Table 5.8.1-6

Total noise level from machines at certain distances (after installing soundproof wall)

Distance from source to landmark location (meter)	Noise level on 24 hour average (decibel A) at landmark location		Assessment result
	No wall installment	Soundproof wall installment	
Open Cut			
2	72.8	57.3	pass
HDD			
5	76.0	61.4	pass
6	74.4	60.2	pass
7	73.1	59.2	pass
8	71.9	58.5	pass
9	70.9	57.9	pass

(c) Disturbing noise

Assessment of the nuisance that may increase was done by considering the disturbing noise. The assessment was performed in accordance with the method od the Notification of the Pollution Control Committee on basic noise level measurement method, noise level without interference, noise measurement and calculation during disturbances, and the noise measurement record published in the Government Gazette, Volume 124, Special Section 145 Ngor, dated 28 September 2007 and the Noise Measurement Guideline. (Revised version) of the Office of Air Quality and Noise Management Pollution Control Department which can be summarized into 7 steps as shown in **Table 5.8.1-7**.

Table 5.8.1-7

Steps in assessing disturbance noise

Table 5.8.1-7 (cont)

Order	Details	Remark
Step 1	Gather details on noise level without any disturbance at landmark location. The information used in this assessment include average noise level and standard noise level during 1 hour day time and 5 minutes night time.	L_{eq} = A L_{90} = B
Step 2	Noise level assessment from reduced noise source via distance and obstacles at landmark location. Equation used is $Lp_2 = Lp_1 - 20 \log R_2/R_1$	Lp_2 = C
Step 3	Assess total noise level from project's activities at landmark location using the following equation $L_{total} = 10 \log \sum_{i=1}^{n} 10^{Li/10}$	L_{total} = D
Step 4	Calculate difference between noise level (D-A) and compare to the following table to find modifier unit : decibel A <table><tr><td>Difference between noise level (**D-A**)</td><td>Noise level modifier (**E**)</td></tr><tr><td>1.4 or less</td><td>7.0</td></tr><tr><td>1.5 to 2.4</td><td>4.5</td></tr><tr><td>2.5 to 3.4</td><td>3.0</td></tr><tr><td>3.5 to 4.4</td><td>2.0</td></tr></table>	F = D-E

Table 5.8.1-7 (cont)

<table>
<tr><th>Order</th><th>Details</th><th>Remark</th></tr>
<tr><td></td><td><table><tr><td>4.5 to 6.4</td><td>1.5</td></tr><tr><td>6.5 to 7.4</td><td>1.0</td></tr><tr><td>7.5 to 12.4</td><td>0.5</td></tr><tr><td>12.5 or more</td><td>0</td></tr></table>Then, subtract modifier (E) from total noise level from the project's activities (C) to find noise level with disturbance (F)</td><td></td></tr>
<tr><td>Step 5</td><td>Adjust the values in various scenario as such
(1) + 3 dBA for area in need of quiet/peace and night time
(2) + 5 dBA for the case when the noise from source have loud bumping sound characteristics or cause vibration</td><td>G = F+3 dBA or +5 dBA</td></tr>
<tr><td>Step 6</td><td>Assessment of disturbance from equation
Disturbance level = noise level with disturbance – basic noise level
If more than 10 decibel A, the noise is considered as disturbance</td><td>G – B < 10</td></tr>
<tr><td>Step 7</td><td>If more than 10 decibel A, reconsider noise reduction measures and re-assess step 2 to step 6 until the noise level is within an acceptable range</td><td></td></tr>
</table>

From the assessment of the noise impact arising from construction activities, pipelines installation by the open cut method with the working period during 8.00-17.00 o'clock, it was found that the disturbing noise is at the distance of 250 meters. The graph showing results of the disturbing noise assessment are presented in **Figure 5.8.1-3.** Therefore, measures were prescribed for the Project to install a temporary sound barrier. It is 18 ga steel material, 18 ga with the transmission loss (TL) equal to 25 decibel(A) (**Table 5.8.1-5**). It will be installed at the height of 2.5 meters above the ground. From the assessment, it was found that after installing the sound barrier, houses located 50 meters away from the Project's construction activities will not be affected by noise from the Project. The disturbing levels are in the range of -0.8 to -10.2 decibel(A). The calculation of day 5 at 11: 00-12: 00 o'clock, before the Project operation has a level of 11.2 decibel(A), which exceeds the standard already. After installing the sound barrier, the noise level does not increase from before. A detailed noise assessment graph shows in **Figure 5.8.1-7**. From site inspection, it was found that the area required to install a sound barrier consist of STA 0 + 690 to STA 1 + 350, STA 40 + 050 to STA 4. +780 and STA 11 + 450 to 11 + 780 for houses within 50 meters of which may be affected from the disturbing noise at certain times. In addition, the Project has set additional measures.

From the assessment of the noise impact caused by the pipeline installation by the horizontal direction drilling (HDD), it was found that the area affected by the noise is within 500 meters (**Figure 5.8.1-5**) with the level of disturbing during daytime 07.00 to 22.00 o'clock in the range of -5.0 to - 11.2 decibel(A) and night 22.00-07.00 o'clock in the range of -6.1 to - 23.4 decibel(A). Therefore, measures were prescribed for the Project to install a temporary 18 ga steel sound barrier with transmission loss (TL) of 25 decibel(A) (**Table 5.8.1-5**). It will be installed at a height of 2.5 meters above the ground. From the assessment, it was found that after installing the sound barrier, houses located 60 meters from the Project's construction site will not be affected from the disturbing noise during daytime, 07.00-22.00 o'clock. The levels of disturbing noise are in the range of -5.1 to - 11.2 decibel(A). However, for the day 5 at 11.00-12.00 o'clock the noise level was already high, with a disturbing noise level of 11.2 decibel(A). This is already above the standard. After installing the sound barrier, the noise level does not increase from before. For the nighttime 22.00-07.00, the disturbing noise levels are in the range of -6.2 to - 23.4 decibel(A). Most of them had a noise level of less than 10 decibel(A), according to the notification of the National Environment Board No. 29 B.E.2550 (2007) on the disturbing noise level. There were only 46 periods, representing 6.08 percent of the interval that the disturbing level were higher than 10 decibel(A), which is considered a disturbing level according to the notification of the National Environment Board No. 29 B.E.2550 (2007) on the disturbing noise level. However, most operations are performed only during the daytime except for activities that need to be continued. The Project must notify the construction plan and relevant impact prevention and correction measures to the local government agency, responsible agency, and nearby communities to be informed in advance.

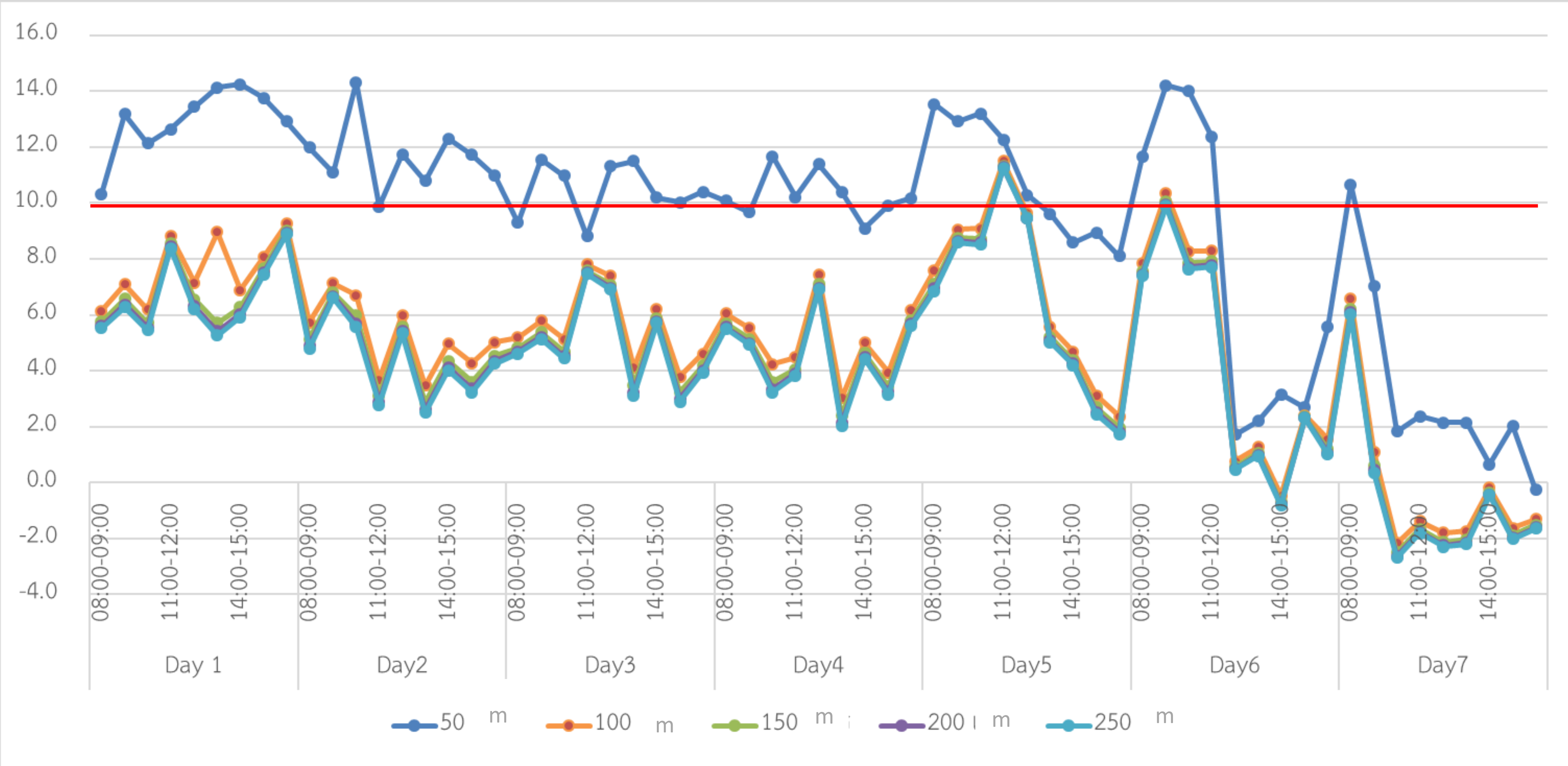
In this regard, additional measures to prevent and mitigate environmental impacts have been established as follows:

- Talk to homeowners or shops located within the construction area in order to plan the construction period with minimal impact
- Inform the residents, local government agencies, community leaders, and establishments in the vicinity of the Project area to be informed about the construction plan at least 1 week in advance of any construction activity in order to avoid traffic on the construction route
- Install a temporary sound barrier in the area where the pipe installation activity is performed by the open cut method,

near the houses, within 250 meters of the 18 ga steel with a transmission loss (TL) of 25 decibel(A) with the height of 2.5 meters from the ground to cover noise source at STA 0 + 690 to STA 1 + 350, STA 40 + 050 to STA 4 + 780, and STA 11 + 450 to 11 + 780

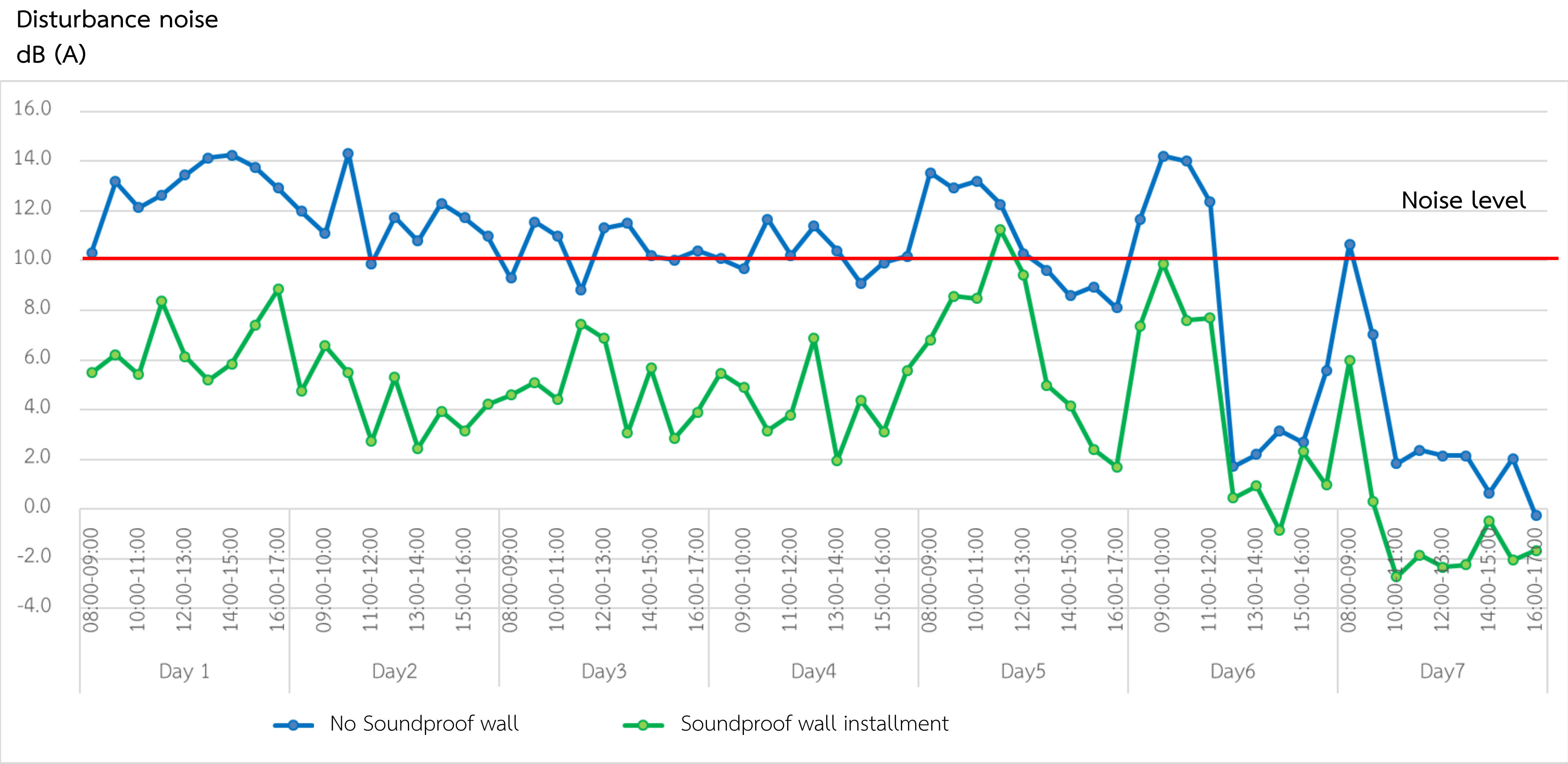
- Install a temporary sound barrier in the area where the pipe installation activity is performed by the open cut method, near the houses, within 250 meters of the 18 ga steel with a transmission loss (TL) of 25 decibel(A) with the height of 2.5 meters from the ground to cover noise source
- Construction activities must be carried out during the daytime (8.00-17.00 o'clock) only, except those that require ongoing operations which must inform the construction plan and related impact prevention and mitigation measures to the local government agency, responsible agency, and nearby communities to be informed in advance

Disturbance noise
dB(A)



<u>Remark</u>: Day 5 during 11:00-12:00 before the project, the disturbance is 11.2 decibel A which already exceed the standard

<u>Figure 5.8.1-5</u> Disturbance noise from open cut construction activities at certain distance



Remark: Day 5 during 11:00-12:00. Before the project, the disturbance is 11.2 decibel A which already exceed the standard. Thus, after installing soundproof wall, disturbance noise will not increase beyond before the project

Figure 5.8.1-6 Disturbance from open cut construction in 50 meters distance before and after soundproof wall installment

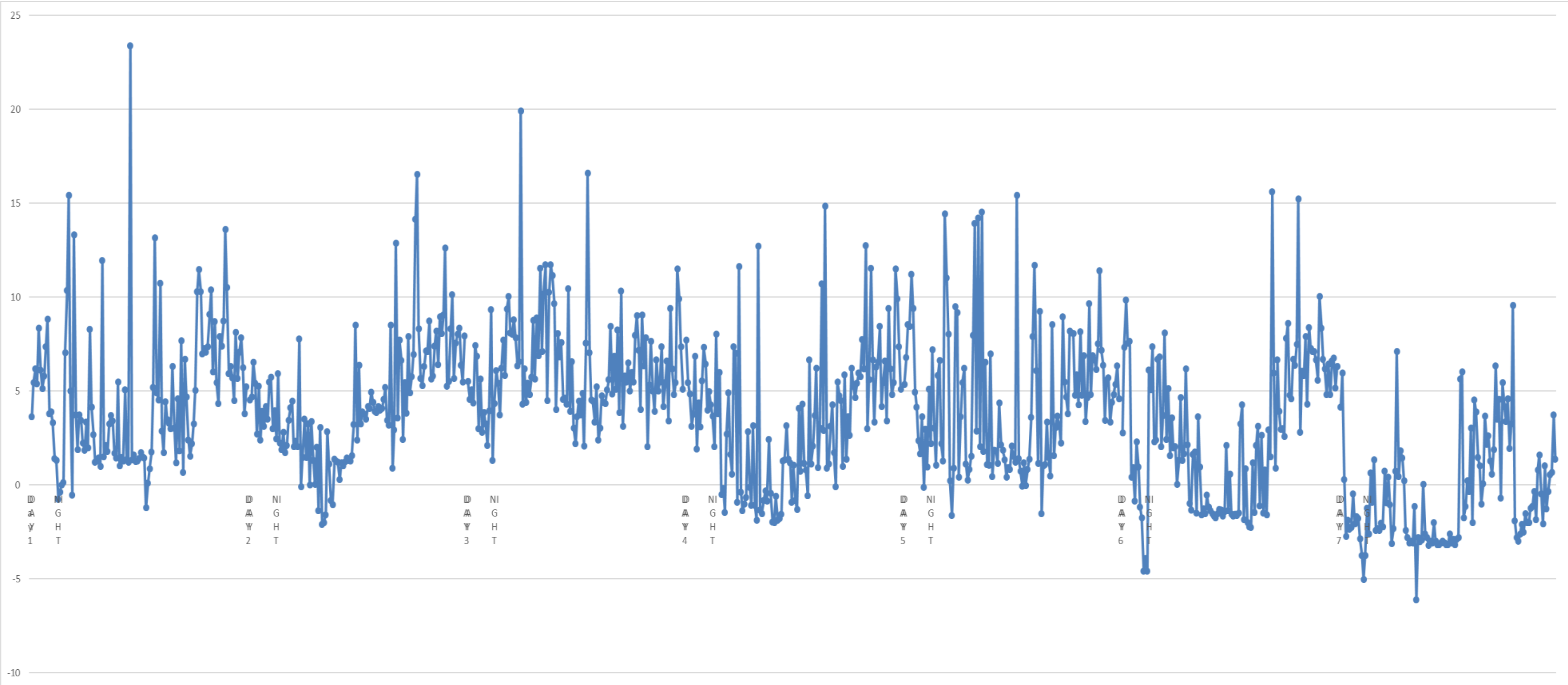


Figure 5.8.1-7 Disturbance_from HDD construction in 500 meters distance of the project

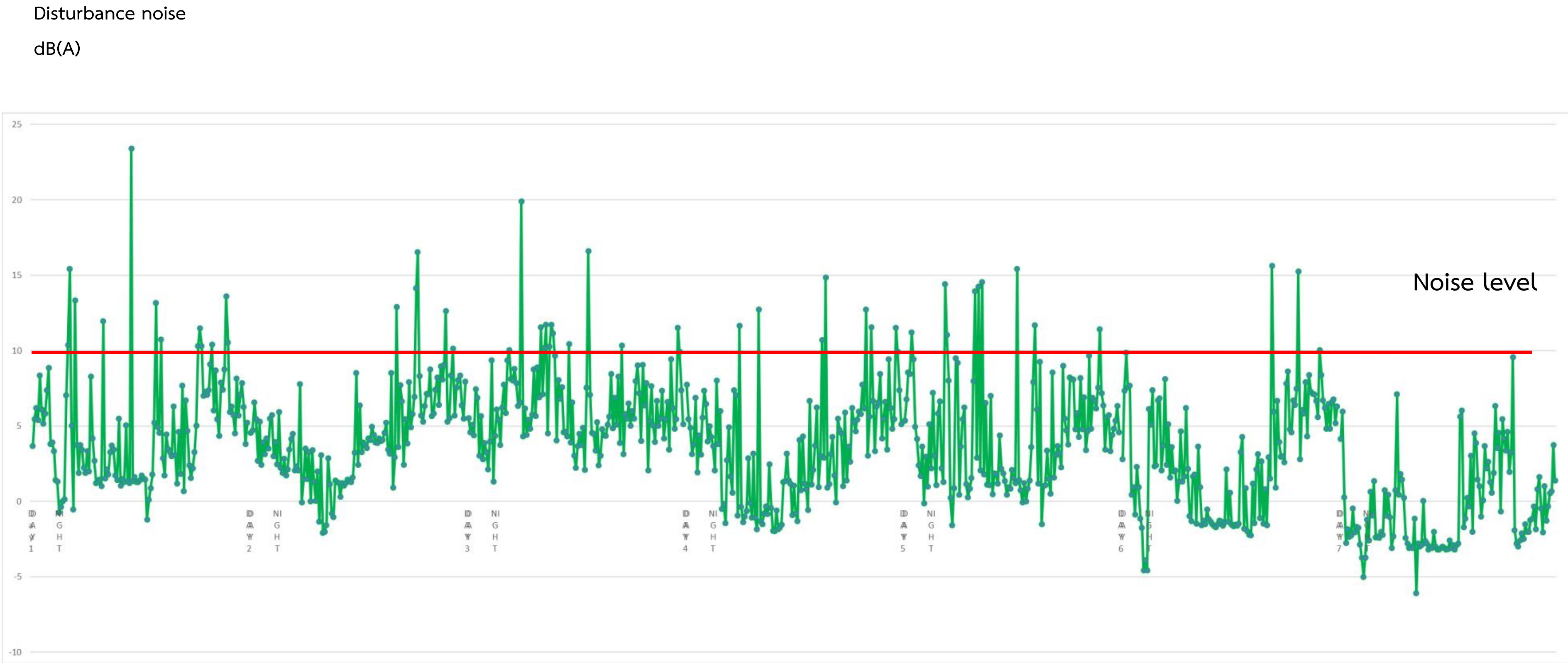


Figure 5.8.1-8 Noise disturbance during construction period using HDD method at 60 meters distance after installing soundproof wall

- Operating noisy heavy equipment need to speed up the process to complete and turn on the engine only during work and stop the engine immediately after use.
- While having construction activities through people's houses, coordinate closely and accelerate the process to complete as soon as possible
- Arrange compensation for damage as appropriate in the event that the Project construction activity causes damage to shops and houses located in the construction area

Therefore, the noise impact arising from the construction activities of the Project is at moderate level.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	2	2	2	(8) = 2	2	4	medium

Pipeline installation in the area of Ban Lum Din

In the area of Ban Lum Din community, from the examination it was found that the road condition is quite narrow with the road surface of about 3 meters. The pipeline will be installed at the depth of 2-3 meters by excavate the surface of 3 meters. There are 2 ways to get in and out of the community, namely from the road beside Khlong Jek Bridge and the entrance beside the Revenue Department Office. The construction, excavation, and pipe laying will be carried out periodically in order to minimize the impact on the public. The Project has the following operation to minimize the impacts.

(1) In the construction area near homes, soundproof walls will be installed. It is a 18 ga steel material with a transmission loss (TL) of 25 decibel(A) and the height of 2.5 meters above the ground (simulation of the installation of a soundproof wall and machine positions are shown in **Figure 5.8.1-9** and **Figure 5.8.1-10**)

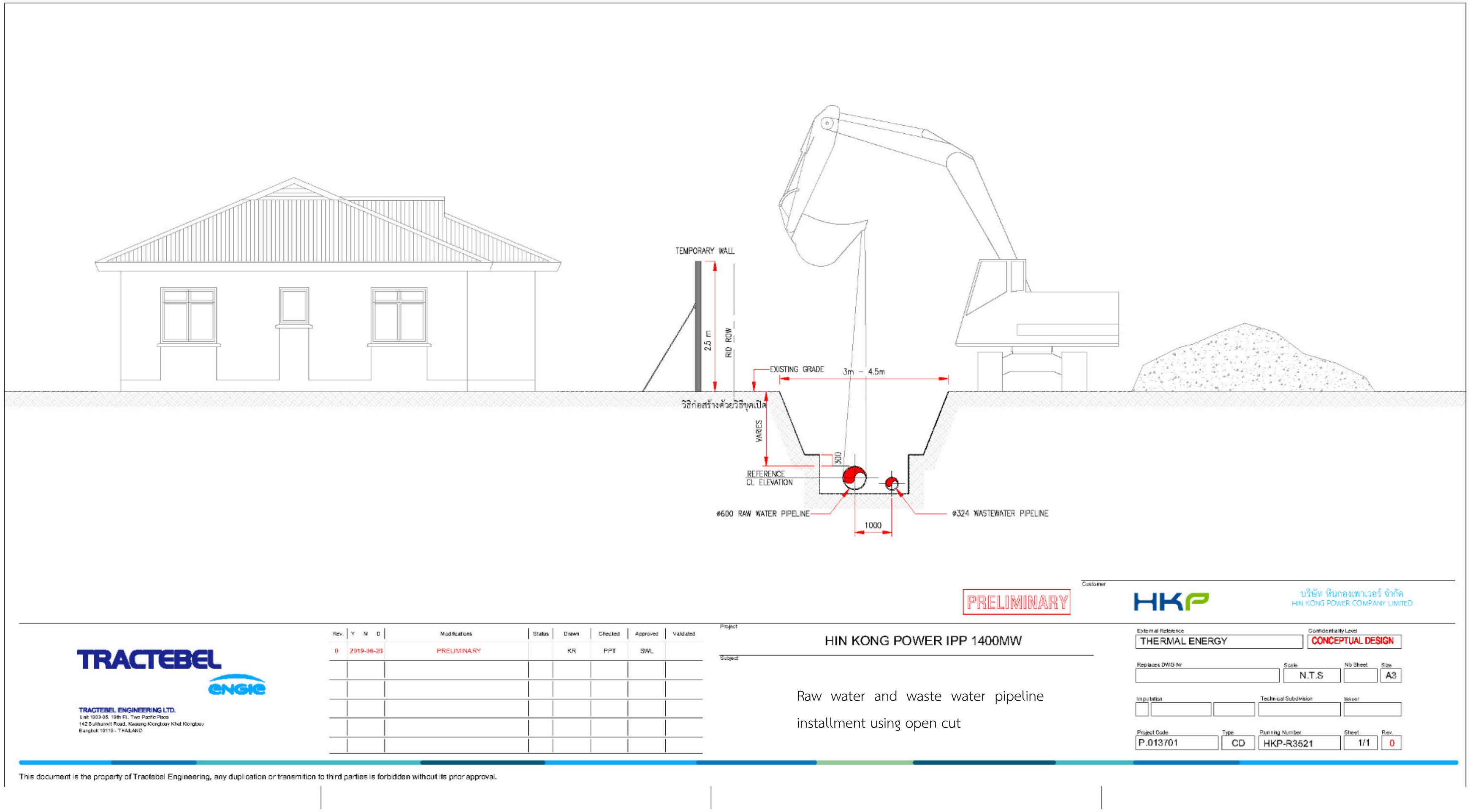
(2) The excavation begin periodically, starting from the road side of the Khlong Jek Bridge to the front of the houses. For the entrance-exit area, the excavation will be done in a half so that people can get in and out (as shown in **Figure 5.8.1-10**).

(3) Install the pipeline and cover by compacted to restore the road condition for use as an entrance - exit for houses and inform the homeowner to use the entry-exit route on the Khlong Jek Bridge (as shown in **Figure 5.8.1-11**) and accelerate the process to complete as soon as possible.

(4) Excavate the other side until reaching the next house and follow steps 3.1 to 3.3 and so on until the end of the road along the Lum Din Canal.

(5) In the event that any house cannot close the entrance-exit the Project will negotiate with the homeowner to open the fence for a temporary entrance-exit or make a temporary entrance-exit and restored after finishing the pipeline installation (**Figure 5.8.1-12**)

In the event that it is not possible to negotiate to open the fence, the Project may consider excavation time, pipeline laying, and covering at night as the case by case basis with agreement of the landlord.



<u>Figure 5.8.1-9</u> **Installment of soundproof wall and machines**

Figure 5.8.1-10 Simulated / modeled picture of soundproof wall installment

Figure 5.8.1-11 Simulated / modeled picture of installment of soundproof wall and machines during construction near houses of the Lum Din community

Figure 5.8.1-12 Simulation of the temporary entrance-exit area

5.8.2 Vibration impact

During the construction period, there are a number of activities that can cause vibrations, however, the magnitude of vibration effects different type of equipment, machinery used, construction methods. As well as distance of the source of vibration. Details of the assessment results as follows:

Various methods were used to study the velocity of particles generated in the construction of the Project to assess the impact on the buildings from the vibration of the construction activities of the Project by calculating the level of vibration caused by construction using the data from Transit Noise and Vibration Impact Assessment, 2006. The level of vibration caused by each type of machine-equipment was studied as shown in **Table 5.8.2-1**. The distance from the source of 25 feet or 7.62 meters is the reference vibration level.

Table 5.8.2-1

Vibration from equipment in construction at 25 feet (7.62 meters) from the source

Machine type	Peak particle velocity at 25 foot (mm./sec)
1. drilling machine	0.089 (2.3 mm./sec)
2. transport truck	0.076 (1.9 mm./sec)
3. back hoe vehicle	0.059 (1.5 mm./sec)
4. small Grader	0.003 (0.08 mm./sec)

In order to calculate the level of vibration that occurs near the Project, the equation below was used.

$$PPV_{equip} = PPV_{ref} \times \left(\frac{25}{D}\right)^{1.5} \qquad \text{----------(1)}$$

Where: PPV_{equip} = Peak Particle Velocity from machines (inch/second)

PPV_{ref} = Reference vibration level at 25 feet or 7.62 meter (inch/second)

D = Distance between the machine and the adjacent community (feet)

When considering the vibrations caused by the pipeline installation activities of the Project, the level of vibration of construction machinery by the open cut method was considered the peak particle velocity of 0.059 inch/second or 1.5 millimeter/second.

The Consultant performed an assessment of the effects of vibration on the building area at different distances, where the vibration values were calculated as **Table 5.8.2-2**.

Table 5.8.2-2
Particle velocity at various distances from each activities of the project

Activity	Velocity of particles at different distances (millimeter/second)						
	2 meters	3 meters	5 meters	10 meters	20 meters	30 meters	50 meters
Open cut	11.14	6.069	2.821	0.997	0.353	0.192	0.089
HDD	9.463	9.155	8.127	2.873	1.016	0.553	0.257
standard[1/]		<10					

Remark: [1/] Protection measures against vibration impacts on building at all frequency in accordance with the Announcement of National Environment Board No. 37 (B.E. 2553) on regulating vibration impact on buildings

By comparing the peak particle velocity from the vibration of construction activities, namely open cut and HDD with the vibration standard to prevent impacts on the building on each floor of every frequency, it was found that the vibration generated from the construction activities of the 3 activities at the distance from the construction site to the nearby sensitive area was more than 3 meters. The peak particle velocity was less than 10 mm/s. This is at the level that does not cause damage to the building category 1 , building category 2 , and building category 3 according to the National Environment Board No. 37 B.E. 2553 (2010) on the vibration standard to prevent impacts on buildings (category 1 buildings refer to factories, commercial buildings, office buildings, warehouse buildings, special buildings, large buildings, category 2 building refers to residential buildings, residential buildings including shophouses, shophouses, semi-detached houses, building used as a sanatorium, educational facility, building category 3 refers to archaeological sites, antiques, objects of art, any other building or construction that is unstable but has cultural value).

The Consultant gathered the sensitive areas near the construction site and found that the method of open cut, sensitive areas along the pipeline was more than 2 meters from the construction site. For the HDD, the sensitive area along the pipeline has a distance of more than 5 meters from the construction area. However, the Project has set measures in case of property damage from construction activities as follows:

1) Providing a public insurance system to cover the damage that may occur to life and property affected from the construction

2) In case of damage to property and construction, the contractor company must report the cause of the damage and the result of the damage to the company and record the details to prevent repeated damage and ensure the integrity of the operation

3) Coordinate with community leaders and relevant agencies to provide assistance, support, and resolve problems for people affected by the Project construction activities

4) Provide a system for complaints for damages and grievances that may arise from the operation of the Project throughout the construction period and if any complaints arising from the construction, the Project must be undertaken to assist and resolve as soon as possible

5) Arrange to have a staff to supervise the work of the contractor closely throughout the construction to be more careful including monitoring the impacts from pipelines installation and if any problems or damage occur, coordinate and take action to resolve the problem as soon as possible

Therefore, the vibration effect is low.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	1	(1)=1	3	3	low

5.8.3 Impact on water quality

Wastewater from construction activities of the Project is from two sources: general wastewater from consumption of 3,000 construction workers (power plant construction workers and pipeline installation workers) and wastewater from construction activities.

(1) Water consumption and wastewater from consumption of construction workers

During the construction period, it is expected that there will be up to approximately 3,000 construction workers. They will travel back and forth. There is no outstanding stay in the Project area. Which will require approximately 300 cubic meters of water consumption per day (calculated from the rate of water consumption of 100 liters/person/day x 3,000 people). The project requests the contractor company to provide adequate drinking water, which can usually buy bottled water or commercially available buckets.

General wastewater from consumption of construction workers is approximately 240 cubic meters per day (calculated from 80% of the rate of 100 liters of water per person per day x 3,000 construction workers (Kriengsak Udom Sin Roj, 2007)). The Project shall assign a contractor to supply toilets for construction workers. The wastewater from the toilets will be pre-treated by a ready-made septic tank before sending to the authorized agencies for disposal.

(2) Water usage and wastewater from pipeline installation

The Project requested to use water from the Mae Klong River from the Marine Department. The Project will also use water from the irrigation canal along the pipeline with a permission from the Royal Irrigation Department. Water will be used in the hydrostatic testing, the maximum total volume is expected to be approximately 5,044 cubic meters without adding any chemicals. The amount of water used and the wastewater from the test are the same. It can be divided into two periods, each of which does not occur simultaneously. Details are as follows:

1) Water use and wastewater from pre-cleaning and pre-test for HDD Portion (this is the test of the construction by the HDD method before pulling the pipe into the underground) at a distance of approximately 825 meters. Wastewater from the raw water pipeline is approximately 241 cubic meters while the wastewater from the wastewater pipeline is approximately 61 cubic meters, a total of 302 cubic meters. For the location of pumping and discharging water, the Project will select a location that is close to each phase of the pipe testing period. So, it will not affect the community. The pumping pipe used is a soft pipe, so that the car can pass by without any danger during the hydrostatic testing. The testing will be performed outside of peak hours to prevent impacts on road users.

2) Water use and wastewater from the Hydro-test Whole Line (this is the final test of the entire pipe system), discharged from raw water pipeline is approximately 3,793 cubic meters and wastewater pipeline is approximately 949 cubic meters, total of 4,742 cubic meter. The project will use water from the Mae Klong River. When the pipe testing is complete, the water will be drained from the pipeline into the Mae Klong River at the same point where it was pumped (the point of pumping and discharging from the hydrostatic testing is shown in **Figure 5.8.3-1**).

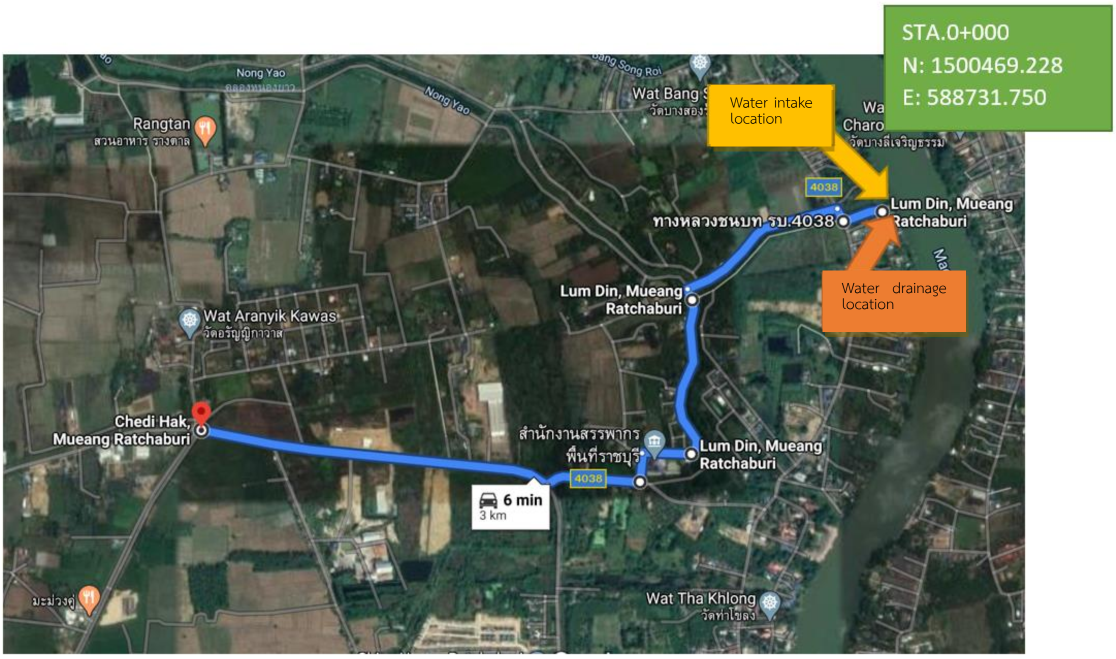


Figure 5.8.3-1 **Water pumping station and water drainage system from Hydro-test Whole Line**

Before pumping water for use and discharging water from the hydrostatic test, the Project must first obtain the consent of the responsible agency, namely the Marine Department and the Royal Irrigation Department. At present, the Project has already requested permission to the department (**Figure 5.8.3-2** and **Figure 5.8.3-3**). The discharging of water will be done after reducing the water pressure in the pipeline to the equivalent pressure level to the atmosphere. A strainer will be installed at the end of the pipe to trap solid debris or sediment, etc. The water quality will be examined before draining the wastewater, including temperature, pH, and total suspended solids content. The Project has set a measure to ensure that the water quality meets the irrigation effluent standards. If found that the water quality does not meet the aforementioned standards, the Project will send the wastewater to an authorized agency for further treatment.

For other activities that may cause contamination, such as the area where the engine oil tank is placed and maintenance area. The Project shall provide a tray and a temporary roof to prevent rainwater to minimize the chance of contamination with rainwater. It is expected that the impact on surface water quality is low.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	1	(1) = 1	1	1	low

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HKP 029/2563

18 มีนาคม 2563

เรื่อง ขอใช้น้ำดิบและปล่อยน้ำทิ้งลงสู่แม่น้ำแม่กลอง

เรียน ผู้อำนวยการสำนักงานเจ้าท่าภูมิภาคสาขานครปฐม

สิ่งที่แนบมาด้วย รายละเอียดแสดงการใช้น้ำดิบและน้ำทิ้ง

บริษัท หินกองเพาเวอร์ จำกัด (“บริษัทฯ ”) ผู้ประกอบกิจการโรงไฟฟ้าหินกองเป็นโครงการโรงไฟฟ้าขนาดใหญ่กำลังการผลิตไฟฟ้า 1,400 เมกะวัตต์ตั้งอยู่ที่ตำบลหินกอง อำเภอเมือง จังหวัดราชบุรี ซึ่งใช้ก๊าซธรรมชาติเป็นเชื้อเพลิงหลัก (“โครงการฯ”) โดยได้รับการพิจารณาให้จำหน่ายไฟฟ้าให้แก่การไฟฟ้าฝ่ายผลิตแห่งประเทศไทย ปัจจุบันอยู่ระหว่างเตรียมเอกสารเพื่อดำเนินการขออนุญาตขอวางท่อระบายน้ำดิบขนาดประมาณ 24 นิ้ว และท่อระบายน้ำทิ้งขนาดประมาณ 12 นิ้ว

ทั้งนี้ในระยะก่อสร้างวางท่อระบายน้ำดิบ และท่อระบายน้ำทิ้งดังกล่าวนี้ จะมีการนำน้ำจากทางน้ำชลประทานมาทำการทดสอบด้วยแรงดันน้ำ(Hydrostatic test) และระยะดำเนินการผลิตไฟฟ้านั้นจะมีการใช้น้ำดิบและปล่อยน้ำทิ้งลงสู่แม่น้ำแม่กลอง ดังรายละเอียดตามสิ่งที่แนบมาด้วย บริษัทฯ ยินดีที่จะปฏิบัติตามระเบียบขั้นตอนของหน่วยงานของท่านทุกประการ

บริษัทฯ หวังเป็นอย่างยิ่งว่าจะได้รับการพิจารณา เพื่อให้โรงไฟฟ้าสามารถดำเนินการได้อันจะก่อประโยชน์ในด้านความมั่นคงของระบบไฟฟ้าของประเทศ และเพื่อความเจริญของท้องถิ่น ทั้งนี้ใคร่ขอความอนุเคราะห์ส่งหนังสือตอบกลับมาที่ บริษัทฯ จักเป็นพระคุณยิ่ง

จึงเรียนมาเพื่อโปรดพิจารณา

ขอแสดงความนับถือ

(นายจตุพร โสภารักษ์)
หัวหน้าโครงการฯ

19 มี.ค. 63

นายณิชชานน บุญญาภาส
ผู้ประสานงาน
โทร 094-054-6445

<u>Figure 5.8.3-2</u> Copy of permission rights from Harbor Department on water utilization and releasing water from testing pipelines onto Mae Klong River

บริษัท หินกองเพาเวอร์ จำกัด

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18 มีนาคม 2563

เรื่อง ขอใช้น้ำและทิ้งน้ำในทางน้ำชลประทาน

เรียน ผู้อำนวยการโครงการส่งน้ำและบำรุงรักษาท่ามะกา

อ้างถึง หนังสือโครงการส่งน้ำและบำรุงรักษาท่ามะกา ที่ กษ 0322.10/367 ลงวันที่ 8 พฤศจิกายน 2562

สิ่งที่แนบมาด้วย รายละเอียดแสดงการใช้น้ำและทิ้งน้ำ

บริษัท หินกองเพาเวอร์ จำกัด (“บริษัทฯ ”) ผู้ประกอบกิจการโรงไฟฟ้าหินกองเป็นโครงการโรงไฟฟ้าขนาดใหญ่กำลังการผลิตไฟฟ้า 1,400 เมกะวัตต์ตั้งอยู่ที่ตำบลหินกอง อำเภอเมือง จังหวัดราชบุรี ซึ่งใช้ก๊าซธรรมชาติเป็นเชื้อเพลิงหลัก (“โครงการฯ”) โดยได้รับการพิจารณาให้จำหน่ายไฟฟ้าให้แก่การไฟฟ้าฝ่ายผลิตแห่งประเทศไทย และบริษัทฯ ปัจจุบันอยู่ระหว่างเตรียมเอกสารเพื่อดำเนินการขออนุญาตขอวางท่อระบายน้ำดิบขนาดประมาณ 24 นิ้ว และท่อระบายน้ำทิ้งขนาดประมาณ 12 นิ้ว ตามหนังสือที่อ้างถึง

ทั้งนี้ในการก่อสร้างวางท่อระบายน้ำดิบ และท่อระบายน้ำทิ้งดังกล่าวนี้ จะมีการนำน้ำจากทางน้ำชลประทานมาทำการทดสอบด้วยแรงดันน้ำ(Hydrostatic test) ดังรายละเอียดตามสิ่งที่แนบมาด้วย บริษัทฯ ยินดีที่จะปฏิบัติตามระเบียบขั้นตอนของหน่วยงานของท่านทุกประการ

บริษัทฯ หวังเป็นอย่างยิ่งว่าจะได้รับการพิจารณา เพื่อให้โรงไฟฟ้าสามารถดำเนินการได้อันจะก่อประโยชน์ในด้านความมั่นคงของระบบไฟฟ้าของประเทศ และเพื่อความเจริญของท้องถิ่น ทั้งนี้ใคร่ขอความอนุเคราะห์ส่งหนังสือตอบกลับมาที่ บริษัทฯ จักเป็นพระคุณยิ่ง

จึงเรียนมาเพื่อโปรดพิจารณา

ขอแสดงความนับถือ

(นายจตุพร โสภารักษ์)
หัวหน้าโครงการฯ

นายณิชชานน บุญญาภาส
ผู้ประสานงาน
โทร 094-054-6445

ได้รับเอกสารแล้ว
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Figure 5.8.3-3 Copy of permission permit from Thamaka Operation and Maintenance Project on water utilization and releasing water from testing pipelines onto Irrigation canals

5.8.4 Wastewater management

(1) Waste from the construction office

Solid waste arising from consumption of construction workers, such as food waste, plastic bags, etc., has the maximum amount is 3,000 kilograms per day (calculated from the rate of 1 kilogram of solid waste per person per day) from 3,000 workers (power plant and pipeline construction workers). The Project will provide 200-liter waste containers with closed lids to accommodate the solid waste that occurred before being disposed of to a licensed agency.

(2) Dismantled raw water and wastewater pipes and material from connecting pipes

The original pipe to be demolished consisted of a 24-inch diameter raw water pipe, a total length of approximately 13 kilometers and a 12-inch wastewater pipe, a total length of approximately 13 kilometers. The Project shall return to TECO for further management because it is TECO ownership.

Small amount of scrap and material from connecting pipes are recyclable material. Therefore, there is no impact on waste management.

(3) Soil residual from excavation

Because the pipeline of the Project will use the open cut and HDD construction techniques, the excavated soil will be used to cover the pipe by compaction to meet the standards. Therefore, the impact is low.

(4) Sodium bentonite residue left from HDD

The project uses sodium bentonite for the horizontal direction drilling (HDD) piping process. Sufficient sodium bentonite will be mixed for each drilling process. There will be not much sodium bentonite left from the hole. The amount of sodium bentonite used depends on the reamer, pipe size, and drilling distance. The construction of the Project will use a 30 inches diameter reamer for the raw water pipes and a 24 inches and a 16 inches reamer for the wastewater pipe with diameter of 12 inches. The length of the HDD is approximately 825 meters. The amount of sodium bentonite to be used are as follows:

<u>**Raw water pipeline**</u>

The amount of sodium bentonite $= \dfrac{\pi(d_1^2 - d_2^2) \times L}{4}$

Where: d_1 = Diameter of the Reamer, 30 inches (0.762 meter)

d_2 = Outside Diameter (inch) (24 inch or 0.610 meter)

L = Length of HDD (825 meters)

Therefore, the amount of sodium bentonite for the HDD is:

$$= \frac{3.14 \times (0.762^{2} - 0.610^{2}) \times 825)}{4}$$

= 136 cubic meters

<u>**Wastewater pipeline**</u>

The amount of sodium bentonite $= \dfrac{\pi(d_1^2 - d_2^2) \times L}{4}$

Where: d_1 = Diameter of the Reamer, 16 inches (0.4064 meter)

d_2 = Outside Diameter (inch) (12 inches or 0.3048 meter)

L = Length of HDD (825 meters)

Therefore, the amount of sodium bentonite for the HDD is:

$$= \frac{3.14 \times (0.4064^{2} - 0.3048^{2}) \times 825)}{4}$$

= 47 cubic meters

The project used 183 cubic meters of bentonite for HDD, with a sodium bentonite powder mixing ratio, where expansion in solution state of 20 kilograms per cubic meter of sodium bentonite solution. The amount of sodium bentonite powder required is 3,660 kilograms. The proportion of use may vary according to the area conditions and recommendations of each manufacturer.

However, it the operation, the Project requires that sodium bentonite is mixed for HDD to be suitable for the workload by considering the proportions of the sodium bentonite composite This will reduce the residual sodium bentonite that must be disposed of. The Project will fill the remaining bentonite mud in the area that is authorized by the owner of the area only. The bentonite MSDS details will be given to the owner of the area.

In addition, The project plans to maximize the use of sodium bentonite by recycling the sodium bentonite during HDD. The recycling process will reduce the sodium bentonite content. The use of such substances in the right amount will not be toxic to the environment. From the safety data of sodium bentonite, it is a muddy soil made from natural soil and has non-flammable properties. It is not toxic to the environment and there is no danger of residuals. However, since the sodium bentonite substance used in the Project is a dust-like powder, the method of protection for the user when mixing sodium bentonite powder with water is: wear a dust mask, goggles, and gloves to avoid the inhalation of dust to the lungs. From the properties of sodium bentonite mentioned above. First aids for operators who exposed to sodium bentonite powder are as follows:

- Inhalation: Immediately move from dusty areas
- Dermal contact: Wash with soap and water to remove dust
- Eyes contact: Wash with plenty of clean water
- Oral: Rinse mouth with water several times

The Project has set guidelines for the prevention and mitigation of the residual sodium bentonite for contractors to be implemented as follows:

- Operators who in charge in mixing sodium bentonite powder must wear protective equipment such as a dust mask, glasses, and gloves, etc. to prevent exposure to sodium bentonite powder
- Provide a responsible worker to monitor and take care with a barrier device such as a sandbag to prevent sodium bentonite from spreading out into the surrounding area during the entire processing period (**Figure 5.8.4-1**)


Surveillance team and their


Mud sunction truck


Controlling leakage area

Figure 5.8.4-1 Surveillance team for all distances of drilling and HDD

-In the cases of sodium bentonite spills, must collect by using a suction (vacuum) along the line with the spill. If there is a large spill, stop the machine temporarily to complete the storage before continue the operation by adjusting the amount of sodium bentonite to prevent overflow, such as adjusting the drilling pressure to suit the area conditions (**Figure 5.8.4-2**).


Surround with sand bags


Notify Inspectors


Let the Vacuum Truck/Sunction Truck and water truck clean up the area

Figure 5.8.4-2 Example of ways and methods to deal with sodium bentonite leakage

(5) Impact of sodium bentonite on area subsidence

Construction activities of the natural gas pipeline of the Project may be some sodium bentonite remaining between the drill groove and the pipeline. By the mechanism of action of sodium bentonite while drilling through, sodium particles have a positive charge (Na +) and bentonite have a negative charge. It is mixed with water to form large sodium particles. When it binds with sodium bentonite, the anion of sodium bentonite remains. This causing the particles of bentonite to repel together. As a result, sodium bentonite has a dense, fluid appearance, suitable for use. Later, sodium bentonite remained in the soil. It may react with cation exchange with calcium, iron, aluminum and manganese, etc. contained in natural soils. Thus, a cation exchange occurs between sodium and bentonite and calcium, iron, aluminum, and manganese in the soil. Since calcium, iron, aluminum, and manganese are more charged and, when combined with water, they are larger. Sodium is converted from sodium bentonite to calcium bentonite, etc. Over time, the negative charge of bentonite is captured by the cation of calcium until its total charge becomes zero. When this condition occurs, no negative ions are left to repel the bentonite particles. This may result in the soil around the natural gas pipeline to collapse slowly if the pipe is subjected to pressure from the top, for example traffic hitting may cause the soil to subsidence.

The maximum amount of sodium bentonite used is 189 cubic meters. The residual sodium bentonite in the soil is expected to be low. In addition, after the pipeline is completed, it is expected that the cation exchange in the soil due to the sodium associated with bentonite will be low.

In addition, the implementation of the pipeline installation, a maintenance plan has been set in accordance with ASME B31.8 to ensure that the Project operations are not affected by soil subsidence factors and site safety such as natural gas pipeline laying surveys to comply with ASME B31.8 standard, natural gas pipeline subsidence survey, and observation of erosion of the soil covering the natural gas pipeline, water flow, or steep slope, etc.

The Project has set measures for the management of sodium bentonite in the construction period as follows:

1) Mix sodium bentonite for HDD to fit the throughput by considering the proportions of the sodium bentonite composite. This will reduce the residual sodium bentonite that must be disposed of.

2) The construction of receiving holes must be partitioned by placing sandbags or creating bays around them to prevent sodium bentonite contamination caused by construction to neighboring areas.

3) In case of overflow/leakage of sodium bentonite into neighboring areas, proceed as follows:

(a) Handling in the case of sodium bentonite overflows or leaks to nearby areas by using a suction (vacuum) along the line with the spill. If there is a large spill, stop the machine temporarily to complete the storage before continuing the operation by adjusting the amount of sodium bentonite to prevent overflow, such as adjusting the drilling pressure to suit the area conditions

(b) The operation team is prepared to monitor in sensitive areas nearby in case of leakage of sodium bentonite during the HDD operation to be able to take action as soon as there is a leak until there is no leak along the line.

4) The construction of receiving holes must be partitioned by placing sandbags or creating bays around them to prevent sodium bentonite contamination caused by construction to neighboring areas.

5) In the case of overflow/leakage of sodium bentonite, block the affected area by using sandbags to prevent further spread and proceed to pump out and eliminate in accordance with academic principles.

6) In case of overflow/leakage of sodium bentonite and affecting the property or agricultural products of the people, the Project is responsible for any damage incurred. The Project shall coordinate to assist and resolve the impact or damage that has occurred as soon as possible as well as negotiate an agreement to compensate for damages appropriately with the value of the damage incurred.

7) Provide suitable sodium bentonite disposal area without being an agricultural area and comply with the landfill area selection guideline of the Pollution Control Department.

8) In the event that someone is affected by sodium bentonite that the Project takes to a landfill, the Project is responsible for any damage incurred and shall coordinate to help and resolve the impact or damage that has occurred as soon as possible including negotiation for damages appropriately with the value of the damage incurred.

From the impact assessment of waste management during the construction period of the Project including strict measures, therefore, the impact that is expected to occur in the construction period is low.

Conclusion	Size	Scope	Duration	Severity	Importance	Order of Importance	
	1	1	1	(3) = 1	3	3	low

Chapter 6

Health impact assessment

Chapter 6
Health Impact Assessment

6.1 Concept of health impact assessment

Health impact assessment will be conducted under the concept that human health is linked and inseparable from environmental components and development. Therefore, in this study, the health impact assessment view was added to the EIA report by applying guidelines according to the laws and regulations that have been adopted at the present t expand the health dimension under the topic "Public health and occupational health" to be more discreet and cover all aspects. The content would show the link between health information and environmental changes, natural resources including other effects such as the value of human use and socio-economic conditions. Analysis will be done to identify the risk groups and risk areas that may receiving health impacts. For the provisions, laws and regulations which were applied consisted of following details.

(1) Guidelines for health impact assessment in the guidelines for the EIA report of thermal power plant projects, Office of Natural Resources and Environmental Policy and Planning, Ministry of Natural Resources and Environment, October B.E.2561.

(2) Guidelines for the health impact assessment of power plant projects, Health Impact Assessment Division, Department of Health, Ministry of Public Health, July, B.E.2555

For concepts and criteria used in health impact assessment, it was considered from the following related definitions.

Health as defined by the National Health Act, B.E.2550, meaning the complete human condition in terms of physical, mental, intellectual and social aspects which linked in a balanced holistic manner. The World Health Organization (WHO, B.E.2541) has defined that health refers to the complete state of the body, mind, and live normally in society. It does not mean only the absence of disease and disability.

Health impact assessment means that the process of collaborative learning of society in analyzing and forecasting both positive and negative impacts to public health that may arise from one or more policies, projects or activities if performed in the same time and the same area. A variety of tools and appropriate participation processes will be applied to support decisions that will benefit public health in both the short and long term (Announcement of the National Health Commission, B.E. 2559).

From the above definition led to the study conceptual framework as an additional study of impacts from the 4 environmental impact assessments, such as, physical resources, biological resources, human use value and value of quality of life. The details of the study described in **Chapter 5.** Additional studies were conducted in the affected person-centered perspective and assessed the impact under the environmental factors of the affected person or the risk group. The consulting company have done the analysis on impacts/changes that were factors **determining the health** of the people in the area based on 5 health issues as the attachment of the Announcement of National Health Commission, No.2, B.E.2559 as the framework. If those factors affected health in any dimension (physical, mental, social and intellectual), measures must be established to prevent and reduce effects to an acceptable level. The established measures had 3 levels, which were (1) prevention measures at the source, (2) exposure prevention and monitoring measures for risk groups, and (3) related measures for local public health agencies. The conceptual framework for the study of health impact of the project could be seen in **Figure 6.1-1.**

6.2 Objectives of Health Impact Assessment

To find health threat factors arising from the project development and anticipate the potential health effects to decide whether the existing prevention and measures were sufficient or not. This led to the establishment of prevention and measures for health, including measures to monitor health impacts before their occurrences to workers or surrounding people.

6.3 Health Impact Assessment Process

This health impact study process consists of 5 steps, as seen in **Figure 6.3-1.**

6.3.1 Screening the project for determining scope of study

From studying the project details in **Chapter 2**, the scope of the project construction and operation periods could be determined as follows.

(1) Construction phase : activities during the construction phase were such as land adjustment and foundation work, civil and building work, machine installation and equipment testing, including the transportation of construction materials. The construction phase took approximately 33-42 months. In addition, accommodation for construction workers, locating outside of the area, were also considered. At the construction phase, the maximum of construction workers were 3,000 persons. Each activity posed a different health threat, with preliminary screening results described in **Table 6.3.1-1 on factors on health impacts of the project.**

(2) Operation phase : activities during the operation phase were such as, fuel combustion, power generation, wastewater management and solid waste management. The results of the screening for health threats of each activity were summarized in **Table 6.3.1-2.**

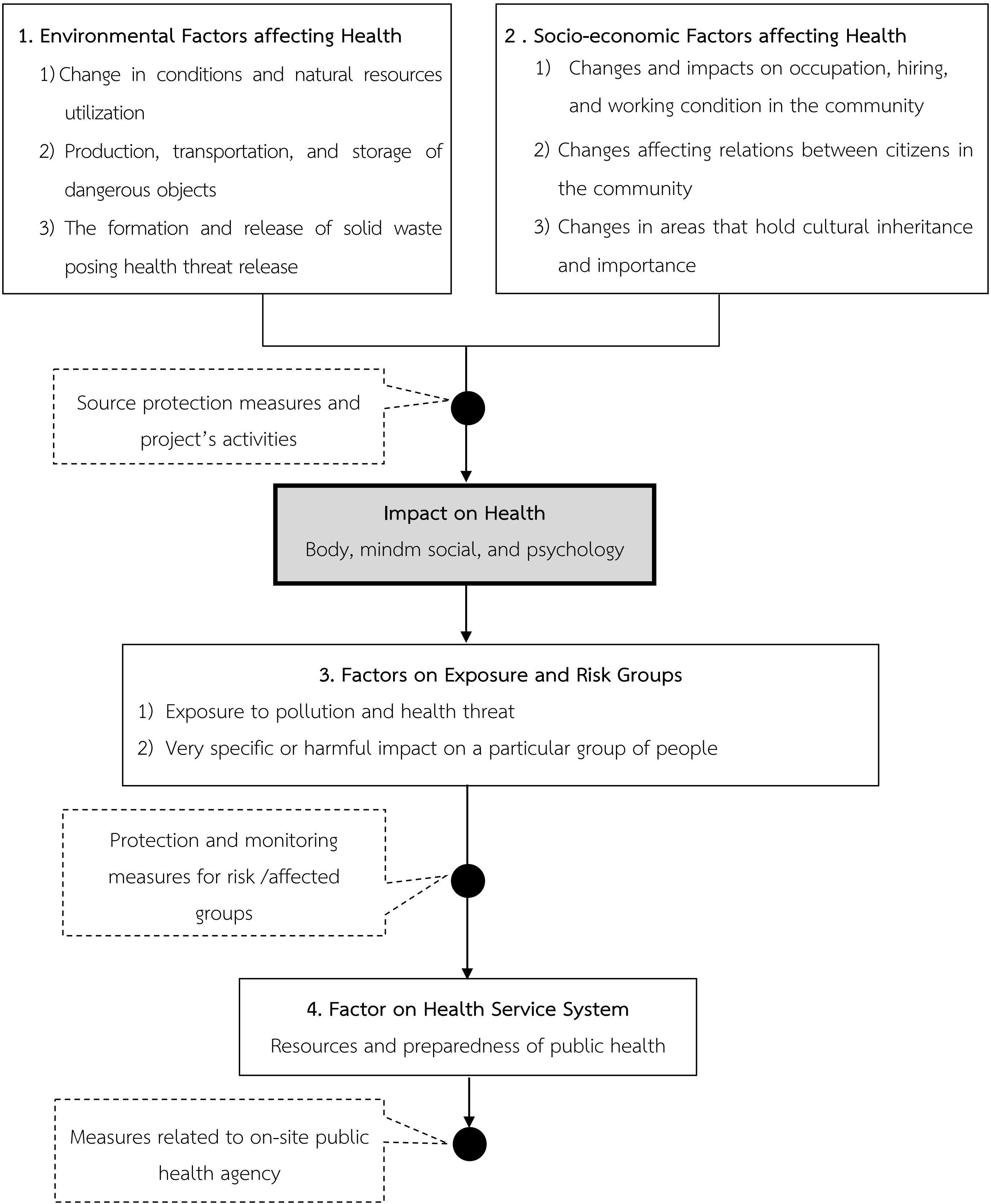

Figure 6.1-1 Conceptial framework and the study on impacts of the project

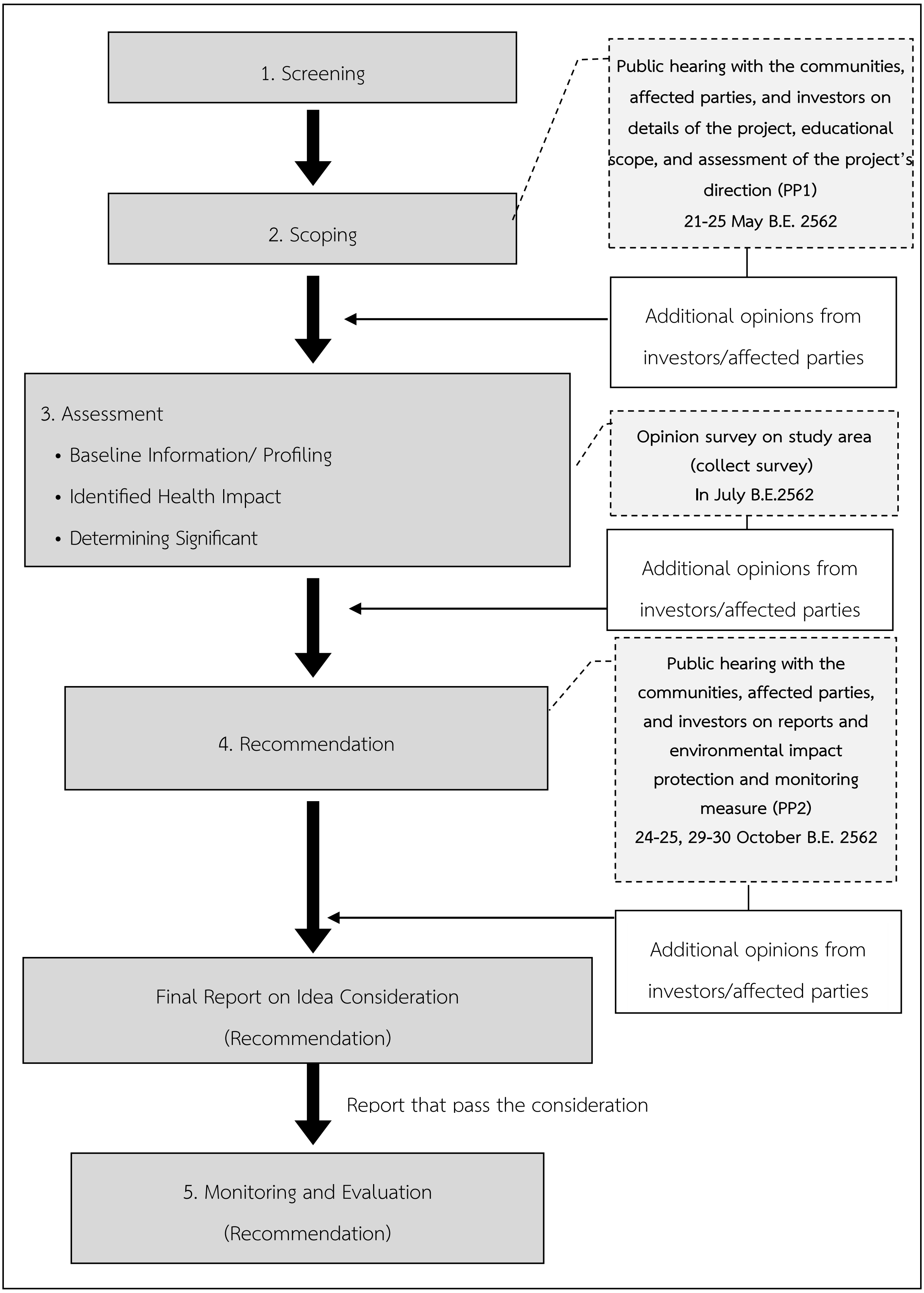

Figure 6.3-1 Steps to evaluate impact on health

Table 6.3.1-1

Factos on Health Impacts of the Project during Construciton

Factors on Health Impact			Activitites during Construction				
			Project Area			Area Outside the Project's Site	
			Changes on Area and Foundation	Civil Work and Building	Machine Installation and Equipment Testing	Construction Materials Transportation	Accomodation for workers/employees
1. Changes of condition and natural resource utilization							
1.1 Topography and soil resources			-	-	-	-	-
1.2 Water resources			-	-	-	-	Community
1.3 Biological resources			-	-	-	-	-
2. Changes of determinant factors in an environmental health							
2.1 Air	Physical	- dust	Worker	Worker	-	Worker /community	-
		- noise	Worker /community	Worker	Worker	Worker /community	Community
		- vibration	Worker	-	-	Community	-
		- heat	Worker	Worker	-	-	-
		- bright light	-	Worker	Worker	-	-
	Chemical	- metal fume	-	Worker	Worker	-	-
2.2 Water	Physical	- Construction scrap /solid waste	-	-	-	-	-
	Chemical	- oil	-	-	-	-	-

Table 6.3.1-1 (cont.)

Factors on Health Impact			Activitites during Construction				
			Project Area			Area Outside the Project's Site	
			Changes on Area and Foundation	Civil Work and Building	Machine Installation and Equipment Testing	Construction Materials Transportation	Accomodation for workers/employees
	Biological	- pathogens (sewage and disease carriers)	-	-	-	-	Worker /community
2.3 Soil	Chemical	- oil	-	-	-	-	-
	Biological	- pathogens (sewage and disease carriers)	-	-	-	-	Worker /community
2.4 Others	Physical	- accident	Worker	Worker	Worker	Worker /community	-
	Chemical	- chemical exposure	-	-	-	-	-
	Biological	- communicable/non communicable diseases	-	-	-	-	Worker /community
3. Changes of factors determining the social health							
3.1 Occupation, employment and working conditions			Community				
3.2 Income / community economy			Community				
3.3 Education			-				
3.4 Community network, relationships among people in the community			Community				
3.5 Safety of life and property			Community				

Table 6.3.1-1 (cont.)

Factors on Health Impact	Activitites during Construction				
	Project Area			Area Outside the Project's Site	
	Changes on Area and Foundation	Civil Work and Building	Machine Installation and Equipment Testing	Construction Materials Transportation	Accomodation for workers/employees
3.6 History / Art and Culture	-				
3.7 Public service systems in the community					
- Utilities services (electricity, water supply)	Community				
- Social service (disaster relief)	Community				
- Public health service	Worker /community				

Remark : (-) means insignificant

Source : Consutants of Technology Company Limited, 2562

Table 6.3.1-2

Factors on Health Impacts of the Project during Operation

Table 6.3.1-2 (cont.)

Factors on Health Impact			Activitites during Construction				
			Electricity Production	Water Production/Supply	Cooling System	Wastewater Treatment	Wastes Disposal
1. Changes of condition and natural resource utilization							
1.1 Water Resources			community				
1.2 Electrcity Consuption			community				
1.3 Biological Resources			community				
2. Changes of determinant factors in an environmental health							
2.1 Air	physical	- dust	employee / community	-	-	-	employee / community
		- noise	employee / community	-	employee	-	-
		- heat	employee	-	-	-	-
	Chemical	- nitrogen oxide	employee / community	employee	-	-	-
		- sulfur dioxide	employee / community	-	-	-	-
2.2 Water	physical	- turbidity(sediment)	-	community	community	community	community
		- heat	-	-	community	-	-

Table 6.3.1-2 (cont.)

Factors on Health Impact			Activitites during Construction				
			Electricity Production	Water Production/Supply	Cooling System	Wastewater Treatment	Wastes Disposal
	Chemical	- BOD	-	-	-	community	community
		- oil	community	-	-	community	-
		- chemical substance	community	community	community	community	-
2.3 Soil	physical	- heavy ash/ fly ash	community	-	-	-	-
2.4 Others	Accident	- Fuel, chemical, and solid wastes transport vehicle	-	-	-	-	community
		- Chemical substance uses	employee	employee	employee	-	-
		- Highly dangerous	employee	-	-	-	-
3. Changes of factors determining the social health							
3.1 Occupation, employment and working conditions			employee				
3.2 Income / community economy			community				
3.3 Education			community				
3.4 Community network, relationships among people in the community			community				
3.5 Safety of life and property			community				
3.6 History / Art and Culture			community				
3.7 Public service systems in the community							

Table 6.3.1-2 (cont.)

Factors on Health Impact	Activitites during Construction				
	Electricity Production	Water Production/Supply	Cooling System	Wastewater Treatment	Wastes Disposal
- Utilities services (electricity, water supply)	community				
- Social service (disaster relief)	community				
- Public health service	employee / community				

Remark : (-) means insignificant

Source : Consutants of Technology Company Limited, 2562

6.3.2 Scoping of the study to screen issues for health impact assessment.

For determining the study scope, the consulting company considered changes/impacts from the assessment in Chapter 5 and compared to the baseline conditions prior to the project in Chapter 3, together with public hearings in the study area. The impacts were classified into 5 levels to show the importance of the issues for further studied, as seen in **Table 6.3.2-1.**

Table 6.3.2-1.

Criteria for Assessing Impact on Health

Environmental impacts occurring from the project (Chapter 5)	Trends of health impacts		further study on health impacts
	Symbol	Description	
Having a project posed positively impacts or changes the existing fundamentals or has a better direction.	+	Positive impacts	-
Having a project is not involved nor does not affect or change the existing fundamentals.	0	No health impact (acceptable)	-
Causing changes without reducing the value of natural resources and the environment. Impacts can be easily prevented and remedied with general actions or measures (scores 1-2).	-1	Low level of negative impact, insignificant	-
Causing changes that affected the value of natural resources and the environment. Further preventive and measures are needed from normal measures with monitoring (scores 3-4)	-2	Moderate level of negative impact - acceptable (investigation is required as it may affect the vulnerable or sensitive group, etc.)	✓
Causing high impact and other consequences without any prevention and measures, or too difficult or not worthwhile (scores 6-9).	-3	High level of negative impacts (definitely possible to cause health impacts)	✓

From screening factors determining the primary health in various fields for both during the construction and the operation phases (**Table 6.3.1-1** and **Table6.3.1-2**) and reviewing the EIA results in **Chapter 5**, together with concerns and suggestions on the project proposal draft, project details, study scope and the alternative assessment of the project (PP1) on 21-25 May, B.E.2562, including the further survey in the study area (collection of questionnaires) in July, B.E.2562, and from a public hearing meeting on the drafted report and environmental impact prevention and measures and environmental impact monitoring measures (PP2) on 24-25 and 29-30 October, B.E.2562 (details were shown in **Chapter 4**) as shown in **Table 6.3.2-2,** it was found that activities in construction and operational phases may affected or were relevant to changes in health determinants in various areas. Prevention measures at the source were already in place.

Table 6.3.2-2
Analysis of environmental impact issues to study the health impacts

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
1. Changes of condition and natural resource consumption						
1.1 **Water resource**	-1	most of the water used for the consumption of construction workers and for washing tools and equipment. The project required contractors to prepare water tanks for the sufficient consumption. As for drinking water, they usually bought commercially available bottled water or tanks. The consumption of such water caused no impact to the community water consumption in the study area. Thus, there was a	-1	the implementation of the project needed water. Water from Mae Klong River would be pumped to store in 1 raw water reservoir within the project, which had sufficient quantity for the consumption for at least 3 days with the improvement of the quality first. From the study of the water consumption of the Hin Kong power plant, a newly developed, the remaining water supply for ecological preservation to push out saltwater was reduced from the case of the future without	- the amount of water in Mae Klong River is variable each year. They concerned that in the dry season, the amount of water would not be sufficient for the consumption in the project. It may affect the water consumption in agriculture.	impacts of the project were in the low level but the public concerned. Therefore, it led to further study on the issue of water resources.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
		low level of impact on the community.		power plant development only approximately 0.02% - 3.54% of the runoff volume in that year. However, it did not effect on water for agriculture, livestock, consumption, travel and industry in any way. Thus, there was a low level impact.		
1.2 **Electrical consumption**	-1	the project required contractors to supply diesel backup generators, therefore, the impact on the community electricity consumption was in the low level.	+	the generated electricity was distributed to the Electricity Generating Authority of Thailand (EGAT) with the amount of electricity supplied to the network of EGAT under the Power Purchase Agreement at 1,400 MW. The remain electricity of the project supplied to machines/equipment within	- Not an issue	during the construction phase of the project, it had a low impact on the community with no concerns. Thus, this issue was excluded from the health impact assessment

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
				the project. Thus, the project had a positive impact on the community		
1.3 Air pollution	-2	most of pollutants occurred during construction were dust which was a heavy dust fell in surrounding areas of the construction area. The most affected group was the construction workers. Project had assigned the contractor to spray water within the construction area and the road using for the transportation of materials at least twice a day to reduce the impact. Therefore, the impact was the moderate level.	-2	the project used natural gas as fuel containing little dust from combustion. However, the project has nitrogen oxides gas ventilation which resulting in increased pollutants in the atmosphere. The values obtained from the mathematical models in all cases were within the environmental quality standard, so the impacts was in the moderate level.	how did nitrogen oxides contaminating the atmosphere affect the health? Did the diesel fuel used in the project cause oil stains on the roofs of households or agricultural areas?	impacts causing by the project was in the moderate level with the public concerned. Therefore, the further study on air pollution issues was conducted.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
1.4 Noise pollution and vibrancy	-2	the project had assigned the contractor to use construction equipment at high noise levels, such as pile driving only during 08.00-17.00 hours. For construction areas near the community or adjacent to the project fence, steel sheet must be installed or other materials with equal sound reduction properties and easy to move according to the construction location and around noisy devices. If construction activities cause more noise than usual, the project informed communities surrounding the project at least 7 days in	-2	sound sources from the power generation process were gas turbine, steam turbine, steam boiler, etc. The project had assigned the designer to design machines with the average noise level not exceed 85 dB (A) at a distance of 1 meter. The assessment of the total noise level between the noise level from the project activity and the noise level from the current measurement showed no difference to the current measurement. However, with the project establishment, it may result in increased noise levels in the community. Project activity causing the	there was a noise around 3-4 times a month within 1 km from the power plant and without prior notice. The noise from the power plant caused farmed livestock in panic and stepped into paddy field which damaged rice. Gas turbine generator, steam turbine machine and steam generator located near the community area causing impacts the neighboring	impacts from the project was in the moderate level with the public concerned. Therefore, the further study on noise pollution issues was conducted.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
		advance. However, the presence of the project only increased the noise level in the community during construction activities. In addition, the excavation for the foundation construction caused the vibration to nearby household structures. However, various drilling operations resulting impacts which occurring during the construction period. Therefore, impacts were expected to be a moderate level.		vibration, mostly came from large chemical trucks which had a frequency of transportation for once a month. Therefore, the impacts were expected to be a moderate level.	community. Could the sound barrier installation help reducing the noise impact?	
1.5 Water pollution	-1	most wastewater generating from construction workers. Wastewater arising from the consumption of workers was treated to the standard with	-1	wastewater from human consumption was collected into a fabricated Septic tank system (Septic tank) installing in building. Wastewater from	concerned in the management of rainwater and wastewater contaminated with	impacts of the project were in the low level with the public is concerned.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
		a fabricated septic tank before releasing to the authorized agencies for disposal. For wastewater from construction activities, the project had constructed temporary gutters in line with the gutters during the project. Ponds were periodically located along the drainage gutter to precipitate wastewater before using for road spraying and wheel washing. Some water continued releasing into the Mae Klong River. The project had a weekly check of the sedimentation pond to remove the sediment. Thus,		production processes was collected to the holding pond before using in the project area and reused in the cooling system. Wastewater from production auxiliary systems was checked for the water quality before being sent to the holding pond and being used in the project area. In the event of rain, rain water may be contaminated with oil, so that it was sent to the oil-water separator to separate the water and oil. The separated rainwater was then sent to the reservoir. As for the oil, the project contacted the authorized agencies for	chemicals since most of the surrounding areas were agricultural areas where leakage could damage it. The groundwater quality should be measured whether it has been affected or not.	Therefore, additional studies were conducted on the issue of water pollution.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
		the impacts were in the low level.		further disposal. The total volume of the project wastewater was 6,963 m^3/day. It was examined for pH, temperature, and electrical conductivity with automatic measurement tools, to check the quality of the effluent whether it met the standard or not. Some water were used to watering the green areas of the project. The remained water was drained into the Mae Klong River. Thus, the impacts were in the low level		
1.6 Pollution from solid waste and industrial waste	-2	solid waste arising from the consumption by construction workers, such as food waste, plastic bags, etc., would be	-1	two main types of waste generating from the project operation were general waste from employees, and	- Not an issue	Impacts of project was a moderate level. Therefore, further studies

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
		collected into a 200-liter waste containers, providing by the project, with a closed lid to accommodate the solid waste before sending it to the authorized agency for further disposal. The waste from construction activities, for recycled types such as scrap, wood and brick etc., the project collected them within the project area and contacted an outside company for selling and further recycling. However, wastewater, sewage and waste generated during construction activities without a good basic sanitation system could be a		industrial waste. The project sent those wastes to companies authorized by the Department of Industrial Works for further disposal. Therefore, the impact was low.		were conducted on issues of pollution from solid waste and industrial waste.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
		spreading source of insect and animal-borne pathogens, leading the disease to people. Thus, impact was moderate.				
1.7 Drainage and flood protection	-1	the drainage of the area around the power plant at present showed the various flows of canals with a direction from west to east and flows into the Mae Klong River. From the measurement of the current drainage of the TECO power plant and the Hin Kong Power Plant development area, it was found that the area was drained into the canal to the north of the power plant. The drainage	-1	the project has designed a rainwater drainage system in the project area to collect into two rainwater retarding ponds and manage the drainage without changing the flow rate of the drainage canal and within the capacity that canal can support. Therefore, the impact is low.	concerns on flooding in the community area around the south of the project. Proposing measures for the management, prevention and compensation in case of waterlogging in affected communities and agricultural areas.	Impacts of the project was low with the public concerns. Therefore, the further study was conducted.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
		ditch in the north will help drainage caused by rainfall in the catchment area. Therefore, the impact was low.				
2. Changes and impacts on careers, employment and local working conditions.						
2.1 Employment and income	+	project development increased local turnover. However, the construction period was only a short time. After the construction was completed, income generation from construction worker expenses was gone, so the, impacts on income generation of the community is a low positive level.	+	providing the Power Development Fund and a community development program. Moreover, the security of utilities would bring more income and employment in the province, which the power plant was only responsible for distributing to the fund. Rules and protocols for using the fund would be the responsible of the Energy Regulatory Commission	proposing to adjust rules for using new funds, in order to facilitate the budget from the fund to support community activities. Educational support was not yet comprehensive, should established a separate fund from the power plant fund to solve problems for the people at the	the project had a positive impact despite public concern. Nevertheless, rules and protocols had not been changed. Therefore, this issue had been screened out from the health impact assessment.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
				(Central) for further acknowledgment. Therefore, there was a positive impact.	sub-district level. In the past, the community had often faced problems using money from the Power Development Fund.	
2.2 Occupation	+	the project was established in the area for a long time. Therefore, it does not affect the occupation of the community. In addition, the study area was an agricultural society. Therefore, having a project would increase the expenditure and purchase of products in the community. Thus, there was a positive impact.	+	the project operation was a complementary dependence between the project and the community in terms of income generation and employment. The problem of unemployment in the community, social and commercial were decreases. Thus, there was a positive impact.	- Not an issue	the project had a positive impact and the public was not concerned. Therefore, this issue was screened out from the health impact assessment.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
3. Changes and impacts on people relationships and communities						
3.1 Relationships of people in the community and social support Environmental impact during construction phase	-1	the construction phase of the project took a total of 33-42 months. It was expected that a maximum of 3,000 construction workers were used. Residents were not allowed to stay in the project area. The construction workers who were foreign workers may reduce the relationship of the people in the community. However, the project had put in place a measure of recruiting local workers as a priority. Thus, the impact was low.	+/-1	establishment of the project had positive and negative impacts which were, the project supported activities promoting relationships of people in the community as a positive impact. Projects may employed foreign workers leading of strangers in the community which could reduce the relationship of the people in the community due to the distrustfulness. Thus, the impact was low.	the project should clearly clarify the benefits for community from the project, including impacts which may occur. The project should clarify about money to the community on how much would the community get from the power plant development fund of the project? And must establish a committee to participate in the supervision and	psychological impacts (a concern).

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
					inspection of the project.	
3.2 Safety of life and property	-2	during the construction, the maximum construction workers were 3,000 persons. These migrant workers caused alienation in the community. People in the community concerned about crime, controversy, burglary and drugs, etc. However, the project had established measures for recruiting local workers as the first priority. In addition, the contractor must have measures to supervise these workers to comply with the regulations as specified by the project, in order to prevent impacts	-1	during the operation phase, the project had 60 employees with a policy of recruiting local employees as the first priority. This was expected not to cause any impacts.	Not an issue	impact was moderate. Therefore, further study on the issue of safety in life and property were conducted.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
		on the safety of life and property in the surrounding communities. Thus, the impact was moderate.				
4. Changes in significance and cultural heritage areas						
	0	there was no activities that affect arts, culture and traditions.	0	there was no activities that affect arts, culture and traditions.	Not an issue	the project had no activities that affect arts, culture and traditions. The public was not concerned. Therefore, this issue was screened out from the health impact assessment.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
5. Resources and readiness of the public health sector						
5.1 Public utility and environmental health services	-1	projects may employed foreign workers which could indirectly affect the community on the consumption of public utilities such as the garbage collection service. However, the project established measures for recruiting local workers as the first priority. Therefore, the impact was low.	-1	the project had a policy of recruiting local employees as the first priority. Therefore, it did not affect the use of social services among people in the community, such as education services. Thus, the impact was low.	the project should supported community activities such as public utilities, education and career with people in the community.	project provided a low impact with the public concerned. Therefore, the further study of this issue was conducted.
5.2 Social service in the community	-1	projects may employed foreign workers. This may cause indirectly impact on the use of social services of the community, such as education services. The project had a policy of recruiting local	-1	the project had a policy of recruiting local employees as the first priority. Therefore, no competition occurred for the social services of the people in the community such as education. Thus, the impact is low.	Not an issue	project caused a low impact and the public had no concern. Therefore, this issue was screened out of the health impact assessment.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
		employees as the first priority. Therefore, the impact is low.				
5.3 Public health service	-2	during the construction phase, a maximum of 3,000 construction workers may affected the community access to public health services or increased the health burden of the service agencies. This was due to the insufficient rate of medical and public health personnel in Ratchaburi to serve the people in the area. If foreign workers entered the area, it would affected the health service system. However, the project established measures for recruiting local workers as the first priority. In addition, the	-2	the project had a policy of recruiting local employees and 60 employees were hiring. In the event of illness and injury, it may resulting in competition for the public health services of the people in the community. However, the project had the social security covering private health care groups which could reducing the number of hospital services in the area. Therefore, the impact was moderate.	there should be an annual health checkup for the people due to in the future there will be more elderly people. Therefore, the community proposed the project to address this issue as a project to promote and encourage the elderly, to taking care, visiting and monitoring the elderly.	impact was moderate and the public was concerned. Therefore, additional studies were conducted on impacts of the project operation, in particularly, on the population of health personnel in health service agencies in the area.

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
		project had measures to support public health agencies in various areas. Thus, impacts was moderate.				
6. Production, transportation and storage of hazardous materials						
6.1 Transportation (accident)	-2	project activities included the transportation of materials and equipment, including construction workers. Impacts which expected to occur were an accident and higher traffic volume. Therefore, the impact was moderate.	-2	After the project operation, more transportation would occurred from the original. However, from the evaluation of the project, the operation phase did not change the level of road service. Therefore, the impact was moderate.	the transportation during the construction phase, the project should considered selecting the least route that passes through the community area to prevent traffic jams and accidents.	the impact was moderate. Therefore, it led to the further study on transportation issues (accidents).
6.2 Severe dangers and emergencies	0	project construction activities did not post serious hazards and emergencies.	-1	project activities could cause serious events. The affected area would be within the project area. For chemicals,	if there was an impact on the villagers, how would the project be corrected? The	impact was low and the public had concerned. Therefore, the

Issue	Environmental impact during construction phase		Environmental impact during operation phase		Issues from public hearing to determine the study scope	Determining the scope of health impact studies
	Impact Level	Impact characteristics	Impact Level	Impact characteristics		
				the project had a measure to control the storage from the place of origin, in order to prevent leakage or diffuse outward. Thus, the impact was low.	project should arranged an officer to coordinate the complaint and performed various actions when people were affected or in trouble. If a chemical leak occurred, what were preventive measures of the project? Which chemicals did the project use? And what kind of effect would be occurred?	further study in serious hazards and emergencies was conducted.

<u>Source</u> :, 2562 Consutants of Technology Company Limited, 2562

However, the consulting company further studied the issue using a view that based on the risk group (those who may be affected) as a center. Therefore, the health impact study scope would take into account on areas with moderate and greater negative impacts (-2 and -3) obtained from the EIA in **Chapter 5**, in order to examine the impact or change that may occurred the exposed person or certain population in the affected area, even though, the environmental impact study results had met the standard. For issues that were screened out according to the above criteria (+, 0, -1) with sufficient supporting information that such issues would not cause health impacts, if people and stakeholders in the area still had opinions and concerns, the consulting company had already included an overall psychological impact assessment. Issues for the health impact assessment on both construction and the operation phases were summarized in **Table 6.3.2-3.**

<u>Table 6.3.2-3</u>

<u>Issue used in Health Impact Study (Community)</u>

Impact Level	Issue used in Health Impact Study	
	Construction Phase	Operation Phase
High level negative impact (-3)	None	None
Moderate level negative impact (-2)	- air pollution - noise pollution and vibration - Solid and Industrial wastes pollution - Safety of life and property - Public health service - Transportationtion(accident)	- air pollution - noise pollution and vibration - Solid and Industrial wastes pollution - Transportationtion(accident)
Concerning Issue	- noise pollution - Public health service (relations between people in the community and social support, health utility service and environmental sanity, dangerous and emergency cases)	- Water resources - air pollution - noise pollution and vibration - Water pollution - drainage and flood protection - Public health service - psychology (relations between people in the community and social support, health utility service and environmental sanity, dangerous and emergency cases)

For studying the environmental impact on workers/employees, the consulting company determined factors affecting workers/employee health, classifying them as physical, chemical and biological threats. The identification of the study scope was shown in **Table 6.3.2-4** as follows.

<u>Table 6.3.2-4</u>

<u>Issue used to study Impact on workers/employees</u>

Health threat	Issue used to study Impact on workers/employees	
	Construction phase	Operation phase
1.Physical threat to health	- dust - noise - vibration - heat - bright light - accident	- noise - heat - accident (dangerous and emegency)
2. Chemical threat to health	- metal fume	- chemical substance
3. Biological threat to health	-pathogens from disease carrying wastes - communicable/non communicable diseases	none

In the overall picture of this health impact study, impacts were classified into 2 parts, health impacts occurring within and outside the project area as follows.

(1) Health impacts occurring within the project area: health impact assessment of project workers.

- Target population: workers operating in the project area
- Study guidelines: applied principles of occupational health and safety assessment, in order to identify risks and manage health risks
- Assessment tools: reviewed secondary data from similar projects.

(2) Health impacts occurring outside of the project area: health impact assessment of community within the study area.

- Study scope and target population: referred to the environmental impact assessment results in **Chapter 5**, the population at risk was varied according to the impact issue. The study focused on people in areas with special risks.

- Study guidelines: applied the health impact assessment guidelines from various agencies by studying both quantitative and qualitative.
- Assessment tools: questionnaires, interviews, data reviews and study reports, using of mathematical models to predict exposure. The descriptive explanation was done for issues that could not be quantitatively assessed.

6.3.3 The impact assessment

(1) Characteristics of health impacts

For health impact or health issues as outcomes from exposure to health threats or changes in health determinants, the health impact assessment must be considered to cover all 4 dimensions of health issues, which were summarized as follows:

1) **Physical Health** meaning that the health of the body without disease, illness and disability, the physiology of the body and organs was in perfect health. They work normally and are in good relationship with all parts. Health impacts or changes in physical health factors included;

- Communicable Disease
- Non Communicable Disease
- Accidents and Injuries
- Malnutrition

2) **Mental Health** meaning that a condition in which a person was free from mental illness, happy mentally (able to control emotions, cheerful without stress, frustration, and conflict within the mind and able to happily adapt to society and the environment). Health impacts or changes determining factors of mental health were included;

- Factors affected a happy life were negative emotions (stress, anxiety, annoyance), life satisfaction, anchor and social support.
- Factors related to mental illness such as mental illness, prevalence of mental retardation and suicide.

3) **Social Health** meaning that the ability to live well in society due to the absence of illnesses or factors/conditions causing severe restrictions on their functioning in society, including antisocial pathologies. The related factors consist of following items.

- Sufficient living factors: income, occupation
- Environment free of pollution
- A good society with adequate social services and equal access. Having a good relationship in both family and community levels.
- Health services (adequacy, quality, potentiality and capacity of the service)

4) Health on cognitive knowledge (spiritual) meaning that understanding or living skill as an important dimension to integrate and link other dimensions of the individual and the community, including physical, mental and social adaptation leading to a good health or well-being, including education and learning, opportunities to access information resources and develop appropriate living skills, to obtain media and access to information.

(2) Health impact assessment process

Health risk analysis was a significant analysis of results of project activities affecting the health determinants. It aimed to demonstrate the link between these effects on changes in health status. It showed the nature of effects in both the opportunity and the magnitude of the impacts on the risk group which consisted of 3 following steps.

1) Baseline Information/ Profiling

The consulting company collected basic information, including environmental quality data and health status information of people who may be affected in the area which related to the issues identified in the study scoping process. These data were used to assess health impacts. Surveillance and monitoring of changes in health from the implementation of project in each dimension.

2) Identified Health Impacts

Identifying and categorizing the nature of the health impacts occurring as a result of the project operation were classified into 2 parts as follows:

(A) Health impact assessment of project workers, it consisted of the health impact assessment on employee both during construction and operation phases. Details were shown in **item 6.4**. The project used the principles of occupational health and safety assessment to identify risks and manage health risks of workers / employees.

(B) Health impact assessment of people in the study area it consisted of the health impact assessment on employee both during construction and operation phases. Details were shown in 6.5, the health impact assessment on surrounding communities. Tools for the assessment consisted of review of study reports, mathematical modeling to predict exposure quantity and descriptive explanations for issues that could not be quantitatively assessed. In order to provide the clarity of assessment as much as possible, the consulting company established a scorecard for each issue and quantitatively defined it to determine the priority of health impacts and the urgent needed to manage or establish additional health measures.

For methods for identifying and assessing the health risks assessment, methods were divided into 2 types which were**;**

(A) Qualitative assessment was a study to explain social and anthropological phenomena by using qualitative data collection methods such as in-depth interviews, group chat. It did not focus on collecting data through scientific measurements or using statistics for data analysis.

(B) Quantitative assessment was a study using scientific principles with various variables were measured, including laboratory analysis. It could be explained for scientific reasons. It was used on the types of pollutants that may cause diseases, risk assessments which based on exposure routes. There were two aspects of the quantitative risk assessment: non-carcinogenicity and carcinogenicity.

(3) The risk assessment and impact prioritization

The appropriate assessment of significance level of the impact, methods and criteria to the project must be selected. Therefore, the consulting company conducted a qualitative health risk assessment to identify potential and significant impacts on the health of nearby communities and impacts on health of project staff. The potential and significance of the impact assessment were determined by the product of the Likelihood and the severity of the consequences (Severity of Consequence) as referred to the "Guidelines for the health impact assessment of the power plant project (pages 42-45), Department of Health, Ministry of Public Health, September, B.E.2555", which has been adapted from the Department of Health, Philippine (2009). The risk matrix using in this project for the evaluation was a 5 x 5 table, while the guidelines for preparing the EIA report for thermal power plant projects of the Office of Natural Resources and Environmental Policy and Planning stated that the risk matrix used in the assessment was a 4 x 3 table. However, the consulting company had reviewed the health impact assessment in accordance with the guidelines for preparing the EIA report of thermal power plant projects of the Office of Natural Resources and Environmental Policy and Planning. Results of the assessment showed that there was no change in the level of health risk. Evaluation results were as follows.

To assess the level of significance of impact, the appropriate method and criteria must be selected for the project. The consulting company performed a qualitative health risk assessment using the health risk matrix method to identify the significance of expected potential and significant impacts on the health of the nearby community and health of project staff. The potential and significance of the impact assessment were determined by the multiple result of likelihood and the severity of the consequences.

Significance	=	Likelihood	X	Severityof Consequence

Therefore, in the process of health impact assessment, background information, identification and characterization of impacts must be able to explain *the degree of likelihood of the impact*. It is determined by the probability of that event and *the severity of the consequences* by considering the main issues of vulnerable populations that were sensitive or susceptible to impact. In addition*, the loss and damage*, which were health impacts of all 4 dimensions, such as morbidity/morbidity rate, number of injuries and the severity of the injury, physical damage, such as numbers and degree of damage done to utilities, emergency care needs, community safety and environmental health impact in the community, etc, were taken into account as well.

Likelihood of impact was determined by the likelihood of that event in the neighborhood or type of business. The criteria for determining the analysis score of the possibility of impact were summarized **Table 6.3.3-1.**

The severity of the consequences was determined by the severity of the health impact that may be experienced on the affected person in the worst case scenario. The criteria for determining the analysis score criteria for determining the analysis score was summarized in **Table 6.3.3-2**.

The impact level considered the sum of scores between the likelihood of occurrence and the severity of the consequences by using a risk matrix to assess the impact of the project as shown in **Table 6.3.3-3.** The definition of the impact level was described in **Table 6.3.3-4.**

Table 6.3.3-1
Criteria for Likelihood of Health Impact

Score	Likelihood of health impacts	The definition
1	Very low	There is a very less possibility with never had a statistic of occurrence. There are measures to prevent and resolve impacts.
2	Low	There is a less possibility with information on the trend but still a lack of clear statistics from the available data. There are measures to prevent and resolve impacts.
3	Moderate	There is a moderate possibility or has a statistic from the available data to support the estimation of the possibility. There are no prevention or measures or existing measures do not cover the occurrence of the incident, or it is a concern of stakeholders.
4	High	The event has happened before with no measure to prevent and mitigate impacts, or existing measures are inadequate.

Source:Guidelines for preparing an environmental impact assessment report for thermal power plant projects of the Office of Natural Resources and Environmental Policy and Planning, B.E.2561.

Table 6.3.3-2
Criteria for assessing Consequences

Score	Impact level	The definition
1	Low	- Minor injury or injury occurred: no impact on work or daily activities, no injuries occurred in the community. - The causative agent is not harmful to the body.
2	Moderate	- Moderate injury or illness occurred: impacts on work or daily activities to vulnerable groups in the community for a long time. - The causative agent of the disease causes a non-severe health impact. The sickness rate increases. There are injuries and accumulation of risk groups.
3	High	- Causing permanent injury - The causative agent of the disease causes severe impacts. This can cause loss or death among workers and vulnerable groups in the community. - There has been a death with rehabilitation expenses. Risk groups are accumulated. Impact on the community both in the area/nearby area.

Table 6.3.3-3
Risk Matrix for Assessing Health Impact

Severity of Consequence		Likelihood			
Consequence Rating	**Harm to health**	**Very low 1**	**Low 2**	**Moderate 3**	**High 4**
1	A little injury or illness	1	2	3	4
2	Moderate injury or illness	2	4	6	8
3	Permanent injury	3	6	9	12
		Significnace of the risk			

Source : Guidelines for preparing an environmental impact assessment report for thermal power plant projects of the Office of Natural Resources and Environmental Policy and Planning, B.E.2561.

Table 6.3.3-4
Sorting out Impacts through their Significances/Importances

Risk level	Score	The definition
Very low	1	It causes no adverse effects on the health status. It does not increase the sickness/death rate. It does not affect the budget. It does not affect the production nor the need for prevention and measures.
Low	2-4	There is no need for additional environmental impacts prevention and measures. It may consider improving the existing measures to be more appropriate, without having to add expenses. If monitoring is necessary, the need and possibility are considered together.
Moderate	5-9	Increasing the incidence of injuries, injuries occurred, it can have an impact on the budget. It needs to be monitored and verified that the existing preventive and measures are adequate and appropriate. If necessary, additional measures may be established or improve existing measures to be in line with the impacts.
High	10-12	It affects the broader health status, death occurred, need more budget. Additional environmental impacts prevention and measures must be established. If this could not be avoided, the method of operation may need to be adjusted.

6.4 The occupational health and safety impact assessment

The health impact assessment on employee during construction and operation phases of the project was done based on the principles of occupational health and safety assessment, to identify risks and manage health risks of employees. The potential threats to health from the source, such as, the production processes and activities of the project was considered. Health threats divided into physical danger, chemical dangers and biological hazards as described as follows.

6.4.1 The health impact assessment on *workers* during the construction phase

The study of threats to the health of workers was a study of health threats during the construction phase from project details in **Chapter 2** and from reviewing relevant information. Important hazards that should be monitored were summarized in **Table 6.4.1-1**

(1) Physical hazard

1) Air pollution impacts

Activities generated dust such as, site preparation and transportation of construction materials. Most of the dust generated from construction activities in the construction area was large dust, easily causing impacts on construction workers in the area. The dispersed dust was limited to the construction area, thus, the most likely to be exposed were construction workers. *The exposure opportunity was high* which the exposure can be found by inhaling with approximately 8 hours. Large dust only reaching the upper respiratory system and the body could be eliminated by coughing, sneezing or secretion of mucus. *The severity was moderate*. Therefore, the risk of impacts *was moderate*.

Likelihood	Severity	Impact Level (likelihood x severity)
high (4)	moderate (2)	**moderate (8)**

Therefore, working in such areas required a measure to prevent and reduce the environmental impact that would occur by providing water spraying around the construction area at least 2 times a day and providing a canvas to cover , in order to prevent the spread of dust during the transportation of equipment into the project area. Dust masks were provided for construction workers.

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Table 6.4.1-1

Threat to Construction Worker's Health Classified through Operational Area

Location/Activity	Significant threats to health			
	Physical	Chemical	Biological	Working accident
Laying foundation	- dust - loud noise (Bumping/pounding type) - vibration - Heat from the sun	-	-	- items falling from high places - Items or equipments getting destroyed for falling over
Construction of structure or building	- dust - loud noise - bright lights - Heat from the sun	Metal fume	-	- items falling from high places - Items or equipments getting destroyed for falling over - sharp items cutting or piecing
Construction equipment and resources transportation	- dust - loud noise	-	-	Road accident
Shelter or accommodation for construction workers	-	-	- disease (pathogens) - contagious disease	-

Remark : " – " means pose no threat to health

2) Noise impacts

The construction activity of the project with the highest noise level were drilling / foundation work. The group with a directly exposure to the voice were workers, so the *likelihood of exposure was high*. Long-term exposure to loud noises caused ear problems and hearing loss, however, the noise during the construction of the project would only occur during the working period (08.00-17.00 hrs.). Such activities was performed exclusively. The construction workers therefore had not been exposed to the noise continuously. *Thus, the severity was moderate*, so that, the *risk of impact is moderate*.

Likelihood	**Severity**	**Impact Level (likelihood x severity)**
high (4)	moderate (2)	**moderate (8)**

Therefore, working in such areas requires a measure to prevent and reduce the environmental impact that will occur by providing personal protective equipment such as ear plugs or ear muffs for construction workers working in the area. Workers must require to use protective equipment in the event of working in noisy areas as well, including the selection of construction equipment and machinery that has a low noise level and always perform maintenance to be effective for reducing the noise level.

3) Vibration impacts

During the construction period, it was found that piling caused the most vibration to the structures of the nearby accommodation. The vibration had a direct impact on construction workers working with tools, machines with high vibration. There were two types of vibrations: Hand Arm Vibration (HAV), which was the impacts occurring on the hands and arms of the operator when exposed to vibration from activities, such as using a drill in construction and Whole Body Vibration (WBA), which impacts occurred throughout the body of the operator in performing activities such as driving various vehicles or standing in control of a vibrating machine. *The exposure likelihood was moderate*. The danger of touch vibration in the hands and arms of the operator causing disorders of the circulatory, nervous, bone, joint and muscular systems. Using the tool for a long time or tightly holding the tool would decrease the blood supply to the end of the tissue. In the event of one time exposure, it caused the muscle death. The symptoms would be more and faster if working in a cold environment*. The severity is moderate*, *so that, the risk of impact is moderate*.

Likelihood	Severity	Impact Level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

Therefore, the contractor had to manage on the engineering control, management controls and the use of personal protective equipment.

4) Heat impacts

Activities that pose a health threat such as, working in open spaces and/or high heat. The most construction activities occurred in the open air and in the hot weather. *The exposure likelihood was then moderate*. Heat is dangerous to the health of construction workers. It caused fainting, fatigue, or exhaustion because the body tries to maintain a normal temperature all the time. Therefore, it need to remove heat from the body. When the body cannot remove heat, there will be a *health impact with in moderate level*. Thus, the impact risk was *a moderate.*

Likelihood	Severity	Impact Level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

Therefore, the contractor must provide adequate clean drinking water for construction workers in the resting points in the construction area to minimize the impact on the health from construction workers.

5) The welding glare impacts

Activities posing a health threat were welding where the metal welding would cause welding sparks to splash on, including the bright light, which can damage the cornea or conjunctiva causing inflammation of the conjunctiva. *The severity of impact was moderate.* However, the project required contractors to supply a dimming shield or dimming glasses for welding work. *The exposure likelihood was moderate*, so that, *the risk of impact was moderate*.

Likelihood	Severity	Impact Level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

Therefore, the construction contractor must provide a dimming shield or dimming glasses, cloth or leather gloves, rubber soles or safety shoes and sparkly protective chest pads, including strictly controlling the use of safety devices.

6) Work accident impacts

Activities posing a health threat were working in unsafe conditions. The construction activities at risk of occupational accidents were foundations activities and civil works, including buildings. *The likelihood of exposure was low*. Work-related accidents could happened on a mild to very serious scale. In most cases, they arise from the negligence of workers, such as not wearing personal protective equipment while working, etc. If such an accident occurred, it may result in life. *The severity is high*, so that, the risk of impact *was moderate*.

Likelihood	Severity	Impact Level (likelihood x severity)
low (2)	high (3)	**moderate (6)**

Therefore, the project established additional measures to minimize the impact that may occurred, such as training for foreman/supervisors and workers on the safety of work related to construction, as well as other relevant parties. Providing personal protective equipment for workers by using suitable equipment for working conditions and potential hazards. Providing a safety inspection system from time to time by assigning staff with clear duties, responsibilities and powers, etc.

(2) Chemical hazards

Activities posing a health threat were the welding which caused heat of the metal. Welding fumes contained metal oxides and coatings on the electrodes. There were many types of fumes depending on the metal being welded, such as chromium, nickel, arsenic, manganese, beryl, cadmium, cobalt, copper, lead, zinc, etc., These may cause metal fume fever. Welding also produced gases from the combustion affecting many body systems, in particularly, the respiratory system, such as;

1) Nitrogen oxides, usually occurs in the atmosphere, but can occur while welding. It causes irritation to eyes, nose and throat and may cause unconsciousness. Therefore, the ventilation system should be installed.

2) Ozone gas (caused by ultraviolet rays reacted with oxygen), usually occurred with argon-based welding which is a gas used to cut steel. In welding, fumes from tungsten welding or gas welding is ozone which irritating eyes and mucous membranes and can lead to pulmonary edema, a chronic respiratory disease.

3) Carbon Monoxide caused by the use of carbon dioxide as a welding gas or caused by incomplete combustion of some substances, such as paint or wax which may be dangerous. Exposure to this gas caused drowsiness, dizziness or loss of consciousness and death, etc.

Workers in the primary function of welding may have a chance of being exposed to fumes from welding. *The exposure likelihood was moderate*. The important component was a particle of zinc compound which often found in combination with cadmium, iron, lead and arsenic. Exposure to high concentrations of welding fume particles for a short period within 4-12 hours, symptoms of metal cough may occurred to staff. This was caused by metal oxide particles, reacting with gram-negative bacteria presenting in the lungs and releasing endotoxin. Symptoms like fever, chills would disappeared within 1 day and can resumed to work normally because the body had the immunity. However, the immunity was not permanent. If the exposure had been stopped for a long time, such as on weekends, symptoms would reappear when exposed. *The severity was moderate*. Thus, the risk of impact *was moderate*.

Likelihood	Severity	Impact Level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

Therefore, the project must specified in the contract that the hired contractor must provide suitable and adequate metal fume mask.

(3) Biological hazards

1) Pathogen from sewage

Activities posing a health threat were wastewater and sewage drained from the worker accommodation, sewage generating from the excretion of construction workers, including solid waste. Without a good basic sanitation system, it may be a spreading source of pathogens carrying by insects and animals which could infected to humans, especially, gastrointestinal diseases. The severity was moderate. The main risk groups consisted of construction workers whose live closest to the source of waste and the morning-to-evening workers who were carriers of the disease back to the community where they live. *The exposure likelihood was moderate*, so that, the risk of impact *was moderate*.

Likelihood	Severity	Impact Level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

Therefore, the project required the contractor to provide a good sanitation system for worker accommodations, in particularly, providing hygienic bathrooms and toilets, garbage collection, providing health education about excretory sanitation to construction workers in order to perform properly. This would cut the cycle of disease and reduce the risk of disease spreading.

2) Communicable / non-communicable diseases

The accommodation of construction workers was a temporary housing for construction workers during 17 months. The coexistence of approximately 1,500 people resulted in a collection of garbage and sewage which were all sources of infectious disease transmitter and vectors, such as flies, mosquitoes, black mosquitoes, cockroaches, rats, dogs and cats, etc. The communicable and non-communicable diseases that may occurred including cholera, dengue fever, filariasis, allergies from cockroaches and plague. Coexistence in a limited location could lead to the risk of exposure to communicable and non-communicable diseases caused by human to human, including leprosy, hepatitis A, syphilis, AIDS, tuberculosis. Thus, *the severity is moderate.* However, construction workers worked in the morning and left in the evening, so that, this was only temporarily impact to their health. *The exposure likelihood was moderate*, so that, the risk of impact was *moderate.*

Likelihood	Severity	Impact Level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

Therefore, the project should provide a cover around the holding pond or sedimentation tank, as not to be a breeding ground for mosquitoes. A brief knowledge and understanding on the prevention of communicable and non-communicable diseases should be provided to workers. Health checkup for workers should be provide as well as a medical treatment by contacting and coordinating with hospitals for health checkup, especially, for 7 prohibited diseases. These 7 diseases has been prevented and surveillance from foreign workers by the Ministry of Public Health (the Announcement of the Ministry of Public Health on health inspection and health insurance for Foreign Workers, B.E.2558).

6.4.2 Health impact assessment on *employees* during the operation phase

(1) Physical health threats

1) Noise impact

The noise sources of the project were gas turbine generators, steam turbine, generator, steam generating unit, condenser. All kinds of machines were designed for the average noise level does not exceed 85 dB (A) at a distance of 1 meter. However, if any machines cannot reduce the noise level, the project would provide sound absorbing materials to control the noise level not exceeding the above limit, for example, building covering the sound source or installing a silencer at the safety valve. *Thus, the severity was moderate.* Workers usually entered the area of such process for a short period of time only, as the entry to check the availability and malfunction of machines and equipment. Therefore, the risk of impact was *moderate*.

However, the company has established measures minimize the impact of noise in areas with high noise levels by providing hearing protection, along with installing a clear warning sign. Therefore, the impact was a low. Moreover, the plan for inspection and maintenance of machines was scheduled and operated at specified frequencies to minimize the noise impact.

Likelihood	Severity	Impact Level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

2) Heat impact

Most of the high heat work areas of the projects have no employee. Control of various machinery is a closed system and employees work in the control room. The heat exposure in the area only occurred to check for the availability and malfunction of machines and equipment during operation from time to time and for only short periods of time. *An exposure likelihood was then moderate.* Heat is harmful to employees health, which causing various body systems to work malfunctions, heat stroke, heat exhaustion, water deficiency, dehydration, salt deficiency and heat cramps, including fatigue in work, decrease of work efficiency, loss of appetite and stress while working. *The severity was moderate*, so the risk of impact was *moderate.*

Likelihood	Severity	Impact Level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

In this regard, the project has established measures to prevent and minimize impacts such as providing training on occupational health and safety appropriately and sufficiently for the nature of the work, providing adequate and appropriate personal protective equipment for employees and providing a system for asking for permission to work, etc.

4) The impact of the accident (severe danger and emergency)

Activities with serious risks of the project are explosions of boiler, generator, steam turbine, transformer and chemical spills. Results of the risk assessment in each case showed that in explosion cases of boiler, generator, steam turbine, transformer, the risk level was 3, which requires a risk control plan and a risk mitigation plan. In case of chemical spills, the risk level was 2, which requires a risk control plan. Therefore, the project had already developed a risk mitigation plan and a risk control plan in each case. *The exposure likelihood was low*. However, in the serious event such as explosions of boiler, generator, steam turbine, transformer, the potential impact on employees may affect their lives. Thus, *the severity was high*. The risk of impact was *moderate.*

Likelihood	Severity	Impact Level (likelihood x severity)
น้อย (2)	สูง (3)	**moderate (6)**

(2) Chemical threats

1) Activities with the risk of chemical exposure

Chemical exposure is likely due to chemical storage and usage activities. The activities with risk were usage of chemicals within the project. The reason that may cause an incident leading to a chemical leak would occur in the event of an operation failure, such as the transfer of the chemical, use and then leak and storage leaks.

2) Hazards of exposure to the chemicals used in the project

The chemicals and additives used in the project are the chemicals for the water quality improvement system. They are liquid when they leak and may have a broader impact. For details on the hazards of chemicals used in the project were shown in **Table 6.4.2-1**. Project chemical usage can be harmful to employees health. From the chemical data used in the project, it was found that no carcinogenic substances. Most chemicals were corrosive substances. Thus, it will cause respiratory and skin irritation when the exposure occurred.

3) Risk grouping

Risk activities causing a chemical spill are the transferring chemicals, using chemical and then leak and storage leaks. The operator will expose to chemicals through skin and respiratory system. From the risk assessment results due to the chemical spill, it was found that the level of hazard risk was 2, which a risk control plan was needed. The project had already developed a risk mitigation plan and a risk control plan in each case. Therefore, *there is a moderate risk of exposure*. Because most of the chemicals and additives used in the project are those used for boilers and cooling tower systems, causing respiratory and skin irritation and from the chemical data used in the project, it was found that there was no carcinogenic substances. *The severity of the impacts was moderate*. Thus, the impact risk level was *moderate*.

Table 6.4.2-1

Danger from Exposure to Chemicals used in the Project

Order	Chemical substanace	State	Dangerous characteristics				Health Hazard	First Aid Method
			symbol	health	inflammable	reaction		
1.	Oxygen Scavenger, 25%	liquid		2	0	0	- Eye exposure causes serious eye irritation - skin exposure to dust particles form causes moderate irration and skin inflmammation for those who are allergic - Inhalation exposure casues tissue irration and continuous exposure can cause respiratory allergies - Ingestion or swallow exposure can cause stomach irration, diarrhea, depression, colic, severe allergy, and possibly death	- Eye exposure: immediately rinse with large amount of rinse water for at least 15 minutes and see a doctor immediately - Skin exposure immediately wash with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Apply a moisturizing agent to the exposed skin and see a doctor immediately. - Inhalation exposure transfer the patient to fresh air. If the patient is not breathing, give a CPR. If the patient has difficulty breathing, give oxygen and transfer to the doctor immediately - Ingestion or swallow exposure do not induce vomiting, let the patient drink plenty of water and take the patient to the doctor immediately. In the event of an unconscious patient, do not give the patient anything by oral.
2.	Aqueous Ammonia, 25%	liquid		3	1	0	- Eye exposure causes serious eye irritation, eye corrosion, and corneal burns and can cause a permanent injury. - Skin exposure causes severe irritation, skin corrosion - may cause burns. - Inhalation exposure aerosol causes respiratory irritation, shortness of breath, chest pain, severe headache and lung damage including pulmonary edema. - Ingestion or swallow exposure causes nausea, vomiting, diarrhea, abdominal pain and gastrointestinal burns.	- Eye exposure immediately rinse with large amount of rinse water for at least 15 minutes and see a doctor immediately. - Skin exposure wash the exposed area with soap and water, along with removing contaminated clothes and shoes. If irritation persists, meet the doctor. - Inhalation exposure transfer the patient to fresh air. If the patient is not breathing, give a CPR. If the patient has difficulty breathing, give oxygen and transfer to the doctor immediately - Ingestion or swallow exposure do not induce vomiting, let the patient drink plenty of water and take the patient to the doctor immediately. In the event of an unconscious patient, do not give the patient anything by oral.
3.	Trisodium Phosphate, 25%	liquid		3	0	0	- Eye exposure causes serious eye irritation and damages around contact area - Skin exposure from dust partucles form causes irritation)and exposure to liquid form can cause burns	- Eye exposure immediately rinse with large amount of rinse water for at least 15 minutes and see a doctor immediately - Skin exposure immediately wash with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Apply a moisturizing agent to the exposed skin and see a doctor immediately.

Table 6.4.2-1

Order	Chemical substanace	State	Dangerous characteristics				Health Hazard	First Aid Method
			symbol	health	inflammable	reaction		
							- Inhalation exposure can cause nose and throat irritation. Exposure in large amount can cause muscus membrane damages/destruction. - Ingestion or swallow exposure can cause nausea, vomit, gastrointestinal burns	Inhalation exposure transfer the patient to fresh air. If the patient is not breathing, give a CPR. If the patient has difficulty breathing, give oxygen and transfer to the doctor immediately - Ingestion or swallow exposure Give water to rinse the mouth. Do not induce vomiting. In case of conscious patient let the patient drink plenty of water and take the patient to the doctor immediately.
4.	Corrosion Inhibitor	liquid		3	3	0	- Eye exposure causes serious eye irritation - Skin exposure causes burn with the severity according to the chemical concentration and the time period in contact. Zinc chloride also cause skin allergy called eczematoid - Inhalation exposure to vaporized form of phosphoric acid causes respiratory system irration - Ingestion or swallow exposure causes severe irritation or burn wounds inside the mouth, throat, and stomach	- Eye exposure: immediately rinse with large amount of rinse water for at least 15 minutes and see a doctor immediately - Skin exposure immediately wash with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Apply a moisturizing agent to the exposed skin and see a doctor immediately. - Inhalation exposure transfer the patient to fresh air and transfer to the doctor immediately - Ingestion or swallow exposure Give water to rinse the mouth. Do not induce vomiting, let the patient drink plenty of water and take the patient to the doctor immediately. In the event of an unconscious patient, do not give the patient anything by oral.
5.	Scale Inhibitor	liquid		3	0	0	- Eye exposure causes serious eye irritation - Skin exposure causes severe irritation, skin corrosion - may cause burns if not immediately washed off. - Inhalation exposure does not cause any danger but the vaporized form can still cause irritation - Ingestion or swallow exposure causes severe irritation or burn wounds inside the mouth, throat, and stomach	- Eye exposure: immediately rinse with large amount of rinse water for at least 15 minutes and see a doctor immediately - Skin exposure immediately wash with water and soap. If the irritation persists, go see a doctor. - Inhalation exposure transfer the patient to fresh air. If the patient have difficulties breathing, immediately give oxygen and transfer to the doctor immediately - Ingestion or swallow exposure do not induce vomiting, let the patient drink plenty of water and take the patient to the doctor immediately. In the event of an unconscious patient, do not give the patient anything by oral.
6.	Sodium Hypochlorite ; NaOCl 10%	liquid		3	0	2	- Eye exposure causes serious eye irritation and burns and/or corrosion - Skin exposure causes severe irritation and burns	- Eye exposure: immediately rinse with large amount of rinse water for at least 15 minutes and see a doctor immediately - Skin exposure immediately wash with water and remove contaminated clothing and shoes

Table 6.4.2-1

Order	Chemical substanace	State	Dangerous characteristics				Health Hazard	First Aid Method
			symbol	health	inflammable	reaction		
							- Inhalation exposure causes respiratory irritation and pulmonary edema. - Ingestion or swallow exposure causes pain and infection inside of the mouth and gastrointestinal system, burns and holes inside gastrointestinal orgnas, vomit, rave, and coma state.	- Inhalation exposure transfer the patient to fresh air. If the patient is not breathing, give a CPR. If the patient has difficulty breathing, give oxygen and transfer to the doctor immediately - Inhalation exposure Do not induce vomiting. In the event of unconscious patient, do not give the patient anything by oral. If the patient is conscious, let the patient drink milk or dissolved gelatin if there are not water available and take the patient to the doctor immediately.
7.	Sulfuric Acid ; H_2SO_4 98%	liquid		3	0	2	- Eye exposure corrosive to eyes, red eyes, severe burns, blindness - Skin exposure severe burns, blisters - Inhalation exposure cause irritation, symptoms of pulmonary edema, sore throat, cough, and shortness of breath. Breathing in high concentrations can lead to death. - Ingestion or swallow exposure corrosive to the digestive tract. Ingestion can cause choking, which can lead to pneumonia, heavy bleeding in the lungs and possibly death.	- Eye exposure if wearing contact lenses, remove them immediately. Then wash your eyes with clean water for at least 15 minutes and see a doctor immediately. - Skin exposure immediately wash with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Apply a moisturizing agent to the exposed skin and see a doctor immediately. - Inhalation exposure transfer the patient to fresh air. If the patient is not breathing, give a CPR. If the patient has difficulty breathing, give oxygen and transfer to the doctor immediately. - Ingestion or swallow exposure do not induce vomiting. In the case of an unconscious patient, do not give the patient anything by oral and transfer to the doctor immediately.
8.	Poly Aluminium Chloride (PAC), 10%	solid		1	0	0	- Eye exposure causes irritation, red eyes, and swollen eyes. - Skin exposure causes irritation - Inhalation exposure causes muscus membranes irritation - Ingestion or swallow exposure causes mouth and gastrointestinal orgnas irritation.	- Eye exposure: immediately rinse with large amount of rinse water for at least 15 minutes and see a doctor immediately - Skin exposure immediately wash with water and soap for at least 15 minutes. If the irritation persists, go see a doctor. Inhalation exposure transfer the patient to fresh air. If the patient is not breathing, give a CPR. If the patient has difficulty breathing, give oxygen and transfer to the doctor immediately - Ingestion or swallow exposure do not induce vomiting, let the patient drink plenty of water and take the patient to the doctor immediately. In the event of an unconscious patient, do not give the patient anything by oral.

Table 6.4.2-1

Order	Chemical substanace	State	Dangerous characteristics				Health Hazard	First Aid Method
			symbol	health	inflammable	reaction		
9.	Polymer	solid		1	1	0	- <u>Eye and skin exposure</u> can cause moderate eye irritation and small skin irritation. - <u>Inhalation exposure</u> causes irritation to upper parts of the respiratory system - <u>Ingestion or swallow exposure</u> can cause small irritation to gastrointestinal system.	- <u>Eye exposure</u>: immediately rinse with large amount of rinse water for at least 15 minutes and see a doctor immediately - <u>Skin exposure</u> immediately wash with water and soap for at least 15 minutes. If the irritation persists, go see a doctor. <u>Inhalation exposure</u> If condisitons show, transfer the patient to fresh air and transfer to the doctor. - <u>Ingestion or swallow exposure</u> dilute the toxic in the stomach with 60-240ml of water or milk. In the event of unconscious patient, do not give the patient anything by oral. Do not induce vomiting and take the patient to the doctor immediately.
10.	Sodium Hydroxide ; NaOH	liquid		3	0	1	- <u>Eye exposure</u> corrosive to eyes, red eyes, severe burns, blindness - <u>Skin exposure</u> causes skin corrosion, red rash, and burns. - <u>Inhalation exposure</u> causes nose, throat, and lung irritation, sore throat, cough, and shortness of breath - <u>Ingestion or swallow exposure</u> causes sore/stinging throat and chest, stomach pain, diarrhea, nausea, vomit, weakness, shock, black out, or death	- <u>Eye exposure</u>: immediately rinse with large amount of rinse water for at least 15 minutes - <u>Skin exposure</u> immediately wash with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. - <u>Inhalation exposure</u> transfer the patient to fresh air. If the patient is not breathing, give a CPR. If the patient has difficulty breathing, give oxygen and transfer to the doctor immediately - <u>Ingestion or swallow exposure</u>. Do not induce vomiting. In case of conscious patient let the patient drink plenty of water and take the patient to the doctor immediately.
11.	Hydrochloric acid ; HCl	liquid		3	1	0	- <u>Eye exposure</u> causes severe burn, dameges to eye sight, or blindness. - <u>Skin exposure</u> causes severe burn - <u>Inhalation exposure</u> can causes damages to muscus membranes inside the nose, throat, and lungs. - <u>Ingestion or swallow exposure</u> can cause burn wound around the mouth, inside the mouth, upper parts of respiratory system, and gastrointestinal organs and system.	- <u>Eye exposure</u> if wearing contact lenses, remove them immediately. Then wash your eyes with clean water for at least 15 minutes and see a doctor immediately. - <u>Skin exposure</u> immediately wash with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Apply a moisturizing agent to the exposed skin and see a doctor immediately. <u>Inhalation exposure</u> transfer the patient to fresh air. If the patient is not breathing, give a CPR. If the patient has difficulty breathing, give oxygen and transfer to the doctor immediately - <u>Ingestion or swallow exposure</u> do not induce vomiting and take the patient to the doctor immediately. In the event of an unconscious patient, do not give the patient anything by oral.

Table 6.4.2-1

Order	Chemical substanace	State	Dangerous characteristics				Health Hazard	First Aid Method
			symbol	health	inflammable	reaction		
12.	Sodium bisulfite	solid		2	0	2	- Eye exposure can cause eye irritation. - Skin exposure can cause skin irritation. In the case that the skin absorbs the chemical, there are risk of allergies. - Inhalation exposure casuses respiratory irritation and allergy - Ingestion or swallow exposure can causes gastrointestinal irritation	- Eye exposure: immediately rinse with large amount of rinse water for at least 15 minutes and see a doctor immediately - Skin exposure immediately wash with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Apply a moisturizing agent to the exposed skin and see a doctor immediately. - Inhalation exposure transfer the patient to fresh air. If the patient is not breathing, give a CPR. If the patient has difficulty breathing, give oxygen and transfer to the doctor immediately - Ingestion or swallow exposure do not induce vomiting and take the patient to the doctor immediately
14.	Antiscalant	liquid		1	1	0	- Eye exposure can cause eye irritation. - Skin exposure can cause skin irritation. - Inhalation exposure causes danger when inhale. - Ingestion or swallow exposure can cause danger when ingest.	- Eye exposure: carefully rinse eyes with rinse water for several minutes then ask for a doctor. - Skin exposure immediately wash with water and soap for at least 15 minutes. If the irritation persists, go see a doctor. - Inhalation exposure transfer the patient to fresh air. If the patient have difficulties breathing, immediately give oxygen and transfer to the doctor immediately - Ingestion or swallow exposure do not induce vomiting and take the patient to the doctor immediately
15.	Biocide	liquid		3	0	0	- Eye exposure can cause severe eye irritation. - Skin exposure causes skin irritation. This product also causes allergies to specific group of people. - Inhalation exposure can cause respiratory system irritation. - Ingestion or swallow exposure can cause danger when ingest.	- Eye exposure: immediately rinse with large amount of rinse water for at least 15 minutes and see a doctor immediately - Skin exposure immediately wash with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Apply a moisturizing agent to the exposed skin and see a doctor immediately. - Inhalation exposure transfer the patient to fresh air. Wash nose and mouth with water. If sypmtoms persisted, transfer to the doctor. - Ingestion or swallow exposure. Do not induce vomiting. In case of conscious patient let the patient drink plenty of water and take the patient to the doctor immediately.

Source: Hin Kong Power Company Limited, 2562

6.5 The health impact assessment on surrounding communities

From the determination of the issues to be studied in the health impact in **Section 6.3.2**, it was found that there were five main issues for both during the construction and the operational period as shown in **Table 6.5-1.**

Table 6.5-1
Issue used in the Study of Health Impact on the Community during Construction Period and Operation Period

Issue studied	Construction Phase	Operation Phase
1. Water resources	-	X
2. Air pollution	X	X
3. Noise pollution and vibration	X	X
4. Water pollution	-	X
5. Pollution from solid waste and industrial waste	X	-
6. Safety in life and property	X	-
7. Transportation(accident)	X	X
8. Public Health Survice	X	X

Remark : x means Impact Assessment on the community

6.5.1 Health impacts from water resources

(1) Related operational activities of the project

During the operation phase, the project pumped water from the Mae Klong River. The pumping point was located along the Mae Klong River, in the area of Ban Lum Din, Lum Din Subdistrict which far from the project on the east with the distance of approximately 13 kilometers. The project had the maximum water demand of approximately 30,946 m^3/day.

In the study of water balance, the study covered the case of current water demand, the future water demand for water that has not yet been delivered to the power plant, as well as the case of future demand for water and the water consumption of power plants.

From the analysis of the water balance, it was found that the Mae Klong River downstream from the Mae Klong Dam to the Gulf of Thailand had an average annual volume of 7,004 million m^3 per year. This is the water consumption in the current state, although there is no development of the Hin Kong Power Plant. In the year of drought, the remaining water supply for ecological preservation was lower than the criteria set by the Royal Irrigation Department because less water was released from the Mae Klong Dam than the amount of ecological preservation water to push up the saltwater according to the measure of the Royal Irrigation Department. However, there was no effect on water consumption for other activities. When developing the Hin Kong Power Plant, which used 11.54 million m^3 of water from Mae Klong River per year (0.16% of the annual average water volume), it was found that newly developed Hin Kong Power Plant water consumption reduced the remaining water supply for ecological preservation to push out saltwater for only about 0.02% - 3.54% of the runoff volume in that year when compared to the future case where the power plant has not yet been developed. This water consumption still had not affected water for agriculture, livestock consumption, travel and industry in any way.

Even though remaining water volumes for ecological preservation was lower than the criteria set by the Royal Irrigation Department. However, the inspection found that the salinity values in Mae Klong River did not exceed the standard for agricultural water. Therefore, the development of Hin Kong Power Plant had no impacts on the water for agriculture, livestock, consumption, travel and industry in the Mae Klong River Basin.

(2) Health threats and their health impacts

The shortage of water resources is caused by the absence or lack of good quality water for various activities including consumption, agriculture, livestock, aquaculture, industry water transport, etc. It may had directly and indirectly impact on livelihood of people. Water resources are an important factor in human life. If water is insufficient or water quality is not good enough for human consumption, unclean water can lead to infection, whether eczema, wound infection, eye infection, or gastrointestinal infection. Moreover, it also has effect on the mind which anxiety and stress could occur.

(3) Data from the household representative questionnaire

From the socio-economic study by interviewing the heads of households of the communities in the study area together with the secondary data collection, it was found that for water sources were used for community consumption in the study area, most people consume drinking water from purchasing. As for the water for consumption, most communities use ground water. If there was insufficient groundwater, the local administration organization would provide water to people in the village.

(4) Summary of health impacts

The likelihood of impacts may arise from the lack of water resources for consumption which caused by many reasons such as climate change, increases in water demand as the population increases, insufficient natural and built reservoirs for water consumption and improper water management. Therefore, *the risk of impact is moderate*. According to the socio-economic study by interviewing the heads of the households of the community in the study area together with the secondary data collection, it was found that most people bought water for consumption as water source of the community in the study area.

Therefore, *the severity was moderate*. The risk of impacts was *moderate.*

Likelihood	Severity	Impact Level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

6.5.2 Health impacts from air pollution

(1) Health threats and their origins

1) The construction phase

Major sources of air pollution during the construction phase are dust from the area adjustment and transportation of construction materials and construction workers, including the use of various mechanical tools in construction work, all of which are diesel engines. Therefore, the combustion of engines will produce pollutants such as total suspended particulate (TSP), Particulate matter less than 10 microns (PM-10), sulfur dioxide (SO_2) and nitrogen gas. Oxides (NO_2).

2) The operation phase

When the project starts the operation for the power production, there will be a major source of air pollution which is two HRSG stacks from the steam generator, at a height of 60 meters.

Air pollution during the operation phase caused by burning natural gas fuel to drive a gas turbine. In normal conditions, the exhaust will be emitted from the individual

HRSG stack. The main pollutants contaminating with the exhaust are nitrogen oxides (NOx), sulfur dioxide (SO_2) and particulate matter (TSP).

(2) Review of health threat information

1) Dust

Air pollution arising from processes would cause health impacts due to dust. It depends on the exposure channel and particle size which can be summarized as follows.

(A) Particulate matter less than 10 microns (PM_{10}) can be suspended in the atmosphere for a long time and can penetrate deeper into the respiratory system causing irritation of the larynx and pharynx, throat itching, coughing, hoarseness. If the long term exposures had been occurred, it led to chronic inflammation. (Environmental medicine textbook, Environmental Medicine Center, Metta Pracharak Hospital).

(B) Particulate matter more than 10 microns usually can access only to the nose and throat, especially pharynx, which is the first part for dust exposure. Therefore, it causing frequent irritation, sneezing and sore throat. Most of the dust is captured by the nasal hairs and the intricacies of the nasal passages and then expelled with the mucus. People who are regularly exposed to dust may develop an overactive or allergic reaction. (Environmental medicine textbook, Environmental Medicine Center, Metta Pracharak Hospital).

For the hazard of dust, it depends on 2 factors: the size and elements containing in dust. When considering only the size of dust particle, it was found that smaller dust particles were more dangerous than the larger one because it could easily entered the body through the respiratory system and then entered the lower respiratory tract. On the other hand, approximately 99% of large particulate matter is filtered in the nasal passages. Then it was excreted out from the body by coughing or sneezing or mixing with mucus. Therefore, it is impossible to get into the deep airways. For small particles that can enter the respiratory tract, especially very small dust, it will be able to reach the level of the alveoli. The size of the particulate matter that must be considered as hazardous to health is particulate matter less than 10 microns (PM-10).This size of dust causes irritation, burning nose, coughing, sneezing. It could enters the human respiratory system causing the accumulation of dust in the alveoli resulting in less air exchange, shorten of breath and the heart works harder to replace the decreasing of gas exchange. People with respiratory problems such as asthma, emphysema, and heart disease would receive the higher impact. In addition, these microscopic particles are directly toxic to organs such as lungs, liver or kidneys, especially causing irritation and damaging lung tissue.

When long terms exposure or large quantity exposure has been occurred, it can accumulated in the lung tissue. A fibrosis or wound can occur and impair the efficiency of the lung function leading to bronchitis, asthma, emphysema, increase the chance of developing respiratory disease due to infection. Besides, these small dust, there are also acid particles such as sulfur dioxide particles, when entering the respiratory system, those acid particles combine with the moisture in the respiratory tract to form sulfates and sulfuric acid that is corrosive and irritate the respiratory system. This reduces the body ability to manage bacteria and easily to cause respiratory tract infections. Long-term exposure to particulate matter was associated with increased rates of patients with heart disease and lung disease and associated with premature death. Elderly patients, patients with heart disease, asthma and children are at higher risk than normal population.

2) Nitrogen dioxide (NO_2)

Nitrogen dioxide is produced by combustion of fuel at high temperatures (1000 ° C and above) and with sufficient oxygen. It is a brown gas with pungent odor and has a corrosive effect. This causes plants to reduce the rate of photosynthesis and can react with water vapor in the air causing nitric acid which is harmful to the respiratory system. Nitric acid can cause bronchitis, pneumonia. Health effects can be summarized as follows.

(A) Short term exposure

The effects of exposure to high nitrogen dioxide gas over a period of 1 hour have been studied. It was found that the concentration that exceeds 500 micrograms/m^3 will cause acute health effects. The study in people with congenital asthma found that the concentration greater than 560 micrograms/m^3 reduced the lung function. The concentration excess of 200 micrograms/m^3, the body was starting to respond to nitrogen dioxide. The World Health Organization (WHO) has established a 1-hour recommended value for nitrogen dioxide concentrations not more than 200 micrograms/m^3.

(B) Long exposure

The World Health Organization (WHO) has recommended a 1-year concentration of nitrogen dioxide not more than 40 micrograms/m^3. Such level is able to protect the public health. Epidemiologists have found that one-year exposure to nitrogen dioxide was associated with increased asthma in children and reduced development of lung function in children. Several studies had found that the increase in nitrogen dioxide concentration was related to traffic-related pollution, such as small particles of dust, and related to the health conditions of children living in urban communities.

3) Sulfur dioxide (SO_2)

Inhalation of sulfur dioxide is toxic causing edema in the respiratory airways. Its vapor irritates the respiratory tract causing symptoms of pulmonary edema. This symptom can occur from exposure to the substance 1-2 hours and can cause death. Skin exposure with the high concentration of sulfur dioxide vapors causes burns. Ingestion or swallow exposure of sulfur dioxide can cause burns in the esophagus and stomach. Eye exposure can cause irritation, burns and possibly damage the eyes. It is also suppressing the breathing, restless and uncomfortable.

(3) Baseline information of the impact zone and population at risk.

1) Environmental data: results of air quality measurements in the study area

The consulting company had measured the air quality in 4 stations in the surrounding area: Wat Hin Kong, Huai Phai Temple, Wat Huai Pladuk School, and Ban Huai Moo Health Promoting Hospital for 7 consecutive days, both during the dry season (on 12-19 February, B.E.2562) and the rainy season (on 8-14 July, B.E.2562). Total suspended particulate (TSP), particulate matter less than 10 microns (PM-10), particulate matter less than 2.5 microns (PM-2.5), sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) were measured. Results were shown in **Table 6.5.2-1.** It was found that, all measurement results were within the standard as required by law, except for total suspended particulate (TSP) and particulate matter less than 10 microns (PM-10) at the Huai Mu Health Promoting Hospital and particulate matter less than 2.5 microns (PM-2.5) around every monitoring station. The excess value was found in the measurement during the dry season (on 12-18 February, B.E.2562). During this period from the measurement data by the Pollution Control Department in the area around Na Muang station in Mueang Ratchaburi District, it showed the exceed value from the standard which required by law as well. With the situation information from meteorological conditions during January to February, the weather was less buoyant, calm wind. These conditions caused dust accumulation, resulting in the increase of particulate matter less than 2.5 microns (PM-2.5) in the central, northern, western and northeast regions.

Table 6.5.2-1

Air Quality Result in the Study Area

Measuring Station	Session	Concentration period (micrograms / m^3)						
		Total suspended particles (TSP) 24 hour average	Particulate matter less than 10 mircon (PM-10) 24 hour average	Particulate matter less than 2.5 micron (PM 2.5) 24 hour average	Sulfur dioxide		Nitrogen dioxide	
					1 hour average	24 hour average	1 hour average	24 hour average
Hin Kong Temple (A1)	1/2562	50-185	28-95	16-61	0-<2.62	0-<2.62	15.05-24.46	7.53-13.17
	2/2562	25-68	12-33	<5-15	5.24-10.48	2.62-7.86	2.62-5.24	2.62
Huai Phai Temple (A2)	1/2562	58-170	26-87	17-62	5.24	2.62-5.24	15.05-35.75	9.41-16.94
	2/2562	28-84	14-49	7-32	2.62-5.24	2.62	7.86-23.58	5.24-7.86
Wat Pladuk School (A3)	1/2562	81-140	42-85	27-58	2.62-5.24	2.62-5.24	15.05-28.23	7.53-16.94
	2/2562	19-47	12-29	5-12	5.24-7.86	5.24	5.24-10.48	5.24
Ban Huay Moo Private Hospital (A4)	1/2562	48-433	31-198	16-57	5.24-13.10	2.62-5.24	18.82-31.99	11.29-16.94
	2/2562	17-48	9-26	6-15	5.24-7.86	2.62-5.24	10.48-15.72	5.24-7.86
Standard Value[1/]		**330**	**120**	**50**	**300**	**120**	**170**	-

Remark : [1/] Notification of National Environment Board No.24(B.E.2547)on regulating ambient standard air quality in normal atmosphere.
[2/] Notification of National Environment Board No.21 (B.E.2544) on regulating standard ambient value of sulfur dioxide gas in normal atmosphere within 1 hour
[3/] Notification of National Environment Board No.33(B.E.2552) on regulating standard ambient value of nitrogen dioxide gas in normal atmosphere

Source : Measured by ALS Labatory Group(Thailand) Co.,Ltd and complied by Consultatns of Technology Co.,Ltd, 2562

2) Data from the household representative questionnaire

According to public opinion in the study area, it was found that some of the household representatives in the study area had suffered/annoyed from the environmental impact of dust. Most of them did not specify the source of dust. The followed by traffic and industrial factories, respectively. If there was a project, some of them concerned about air pollution/dust, followed by odors and water consumption, respectively.

3) Health results

Health impacts from exposure to air pollution have an effect on the respiratory system and lung function. The review of the statistics of respiratory disease patients in Ratchaburi found that respiratory disease was one of the top 3 groups of disease. In addition, the consulting company collected statistics of respiratory disease patients of district hospitals in the study area in B.E.2559-2561, it was found the respiratory disease tended to decrease.

However, it was difficult to identify or pinpoint the clear cause or main factor. Since the illness due to mentioned causes will include patients with cold symptoms. There may be other external causes or factors that can lead to the illness, such as local weather variation, lack of exercise or not getting enough rest, including personal health behavior, etc.

(4) Impact level and areas within the impact zone.

The consulting company had assessed the impact on air quality arising from the project by assessing the diffusion of air pollution during the construction and operation phases as follows.

1) The construction phase

Most of the dust generated from the area adjustment and transportation of construction equipment which can easily land on the site. As a result, the dispersed dust was limited to the construction area only. The project must provide a cover material to cover the soil and trucks. Spraying water at an open area and construction area was done at least twice a day which could reduce the amount of dust that diffuses into the air by approximately 50%. For pollutants from the use of various machines in construction activities and from the use of vehicles such as particulate matter less than 10 microns, nitrogen dioxide, and sulfur dioxide, the project had to turn off the engine/machine whenever they were idle. Inspection and maintenance of construction equipment / machines would be done to ensure their efficiency of the usage for every use.

Results of the mathematical model assessment showed that the maximum concentrations of total suspended particulate, particulate matter less than 10 microns, nitrogen dioxide and sulfur dioxide obtaining from the mathematical model were within atmospheric air quality standards. This was shown in **Chapter 5, section 5.3.1.2, impacts on air quality**.

2) Operation phase

The consulting company assessed the air quality impacts arising from the air pollution emission from two air pollution stacks of the project. In this study, the consulting company used AERMOD as the mathematical modelling to assess the dispersion of total suspended particulate (TSP), particulate matter less than 10 microns (PM_{10}), sulfur dioxide (SO_2) and nitrogen dioxide (NO_2). It was found that concentrations of all parameters obtained from the models were in atmospheric air quality standards. Results were shown in **Chapter 5, section 5.3.1.2 on impacts on air quality.**

(5) Qualitative impact assessment

1) The assessment concept

When considering the operation of the project, it was found that the main health impact factors was primary air emission which were, total suspended particulate (TSP), particulate matter less than 10 microns (PM-10), nitrogen dioxide (NO2) and sulfur dioxide (SO2). Therefore, the consulting company assessed the qualitative impacts of exposure to such substances. The conceptual framework for forecasting impacts was done by calculating the hazard quotient. It was the ratio between the projected results of pollutant concentrations in different areas by mathematical models and the acceptable exposure concentration of pollutants (reference concentration) as equation

Hazard quotient =	Predictive results of pollutant concentration/ reference concentration

For the reference concentrations, the concentration values were referred to the Ambient Air Quality Standard of Thailand, the World Health Organization (WHO) (WHO Air quality guideline (2005)) and the Occupational Health and Safety Authority. The reference values were based on principles that sensitivity groups as children and the elderly and appropriate long-term exposure were taken into account. In summary, the reference concentrations were shown in **Table 6.5.2-2.**

For the calculation of Hazard quotient (HQ), it was classified into 2 cases, which were;

Case 1 HQ less than 1 (HQ<1), means that the exposure level or the volume was less than the reference level. It represents a low risk or possibly no impacts to those who exposed.

Case 2 HQ equal to 1 or more (HQ≥1), means that the level of exposure or the volume was more than the reference level. It represents a high risk and is likely to affect those who had initial exposure.

Table 6.5.2-2

Reference Concentration

Impact Characteristic	Exposure duration	Reference concentration (microgram/m^3)
Total Suspended Particlate		
Acute impact	24 hour	330 [1/]
Chronic impact	1 year	100 [1/]
Particulate matter less than 10 microns		
Acute impact	24 hour	50 [2/]
Chronic impact	1 year	20 [2/]
Nitrogen dioxide gas		
Acute impact	24 hour	200 [2/]
Chronic impact	1 year	40 [2/]
Sulfur dioxide gas		
Acute impact	24 hour	20 [2/]
Chronic impact	>1 year	10 [3/]

Remark : [1/] Standard value according to National Environmental Board Notification No. 24(B.E.2547)
[2/] Standard value according to WHO Air quality guideline (2005)
[3/] Standard value according to ECE critical value (European Community Directive,1980)

2) Assessment results

(A) The construction phase

When considering the hazard classification according to the assessment framework and guidelines for the quantitative chemical impact as mentioned above, it was found that from project details, there were four types of pollutants to be quantitatively assessed during the construction period, such as total suspended particulate (TSP), particulate matter less than 10 microns (PM-10), nitrogen dioxide (NO_2) and Sulfur dioxide (SO_2). The consulting company evaluated the four pollutants in the construction phase. Assessment results were shown in **Table 6.5.2-3** to **Table 6.5.2-4.** The summary are as follows.

A) Total suspended particulate (TSP)

Results of the total suspended particulate exposure (TSP) from the project construction activities showed the hazard quotient of total suspended particulate impact, which was assessed in both acute (short-term) cases and the baseline values from the on-site and chronic (long-term) impacts (**Table 6.5.2-3**). It was predicted for the total suspended particulate concentration for the *acute impacts* as a total suspended particulate average concentration at 24-hour. It was found that the hazard quotient (HQ) was 0.78 in the project area. For *chronic impacts*, total suspended particulate concentration was used at a 1-year average concentration. It was found that the hazard quotient (HQ) was 0.21 in the project area. It could be seen that HQ values were less than 1, meaning all predictive areas had a concentration of that substance below the reference concentration. It could be said that the HQ value was at a level of no risk of impact on the health of the community during the construction period. Thus, the likelihood of impact on the health of the community was at an acceptable level.

Table 6.5.2-3

Risk Assessment(Hazard Quotient) from Air pollution Exposure(during Construction Period)

Total Suspended Particulate (TSP) and Particulate Matter less than 10 microns (PM-10)

Studied Area	Hazard Quotient : HQ			
	Total Suspended Particulate (TSP)		Particulate Matter less than 10 Microns (PM-10)	
	Acute Impact (24 hour average)	Chronic Impact (1 year average)	Acute Impact (24 hour average)	Chronic Impact (1 year average)
Highest Value	0.78	0.21	0.32	0.02
Time period with the highest concentration	January	-	December	-
Coordinates	(580200E, 1496400N)	(580200E, 1496500N)	(580100E, 1496500N)	(580200E, 1496400N)
Location	Project Area	Project Area	Project Area	Project Area
Studied Area				
1. Wat Huai Moo School	0.44	0.0001	0.26	0.00001
2. Wat Nong Taluang School	0.44	0.0001	0.25	0.00001
3. Wat Huai Pladuk School	0.44	0.0002	0.26	0.00002
4. Wat Na Nong School	0.44	0.0001	0.25	0.00001
5. Wat Kor Loi School	0.44	0.0000	0.25	0.00000
6. Wat Kao Gruad School	0.44	0.0001	0.26	0.00001
7. Wat Huai Phai School	0.44	0.0001	0.26	0.00001
8. Chedi Hak Private Hospital	0.44	0.0000	0.25	0.00000
9. Kor PlubPla Private Hospital	0.44	0.0000	0.25	0.00000
10. Huai Phai Private Hospital	0.45	0.0001	0.26	0.00001
11. Hin Kong Private Hospital	0.44	0.0001	0.25	0.00001
12. Kao Gruad Temple	0.44	0.0001	0.26	0.00001

Studied Area	Hazard Quotient : HQ			
	Total Suspended Particulate (TSP)		Particulate Matter less than 10 Microns (PM-10)	
	Acute Impact (24 hour average)	Chronic Impact (1 year average)	Acute Impact (24 hour average)	Chronic Impact (1 year average)
13. Aroon Ratanasiri Temple	0.44	0.0002	0.25	0.00002
14. Huai Phai Temple	0.45	0.0001	0.26	0.00001
15. Nong Num Khun Temple	0.44	0.0001	0.26	0.00002
16. Nong Luang Temple	0.44	0.0001	0.25	0.00001
17. Hin Kong Temple	0.44	0.0002	0.25	0.00001
18. Huai Phai Community	0.44	0.0002	0.25	0.00001
19. Nong Karm House	0.45	0.0002	0.26	0.00003
20. Nong Song Hong House	0.44	0.0000	0.25	0.00000
21. Nong Gratoom Temple	0.45	0.0002	0.25	0.00002
Acceptable Hazard Quotient	< 1.0			

Remark : Acute Impact Assessment using the modellled concentration and standard concentration of air quality measures from National Environment Board No.21 (B.E.2544), No.24(2547), and No.33 (B.E.2552).

Source : Consultants of Technology Co.,Ltd, 2562

Table 6.5.2-4

Risk Assessment(Hazard Quotient) from Air pollution Exposure (during Construction Period)

Nitrogen dioxide gas (NO_2) Sulfur dioxide gas (SO_2)

Table 6.5.2-4

Studied Area	Hazard Quotient : HQ			
	Nitrogen Dioxide gas (NO_2)		Sulfur dioxide gas (SO_2)	
	Acute Impact (1 hour average)	Chronic Impact (1 year average)	Acute Impact (24 hour average)	Chronic Impact (1 year average)
Highest Value	0.24	0.14	0.03	0.0005
Time period with the highest concentration	September	-	December	-
Coordinates	(580100E, 1496500N)	(580200E, 1496400N)	(580100E, 1496500N)	(580200E, 1496400N)
Location	Project Area	0.000	Project Area	Project Area
Studied Area				
1. Wat Huai Moo School	0.11	0.00007	0.02	0.0000003
2. Wat Nong Taluang School	0.11	0.00004	0.02	0.0000002
3. Wat Huai Pladuk School	0.12	0.00007	0.02	0.0000003
4. Wat Na Nong School	0.11	0.00004	0.02	0.0000002
5. Wat Kor Loi School	0.11	0.00002	0.02	0.0000000
6. Wat Kao Gruad School	0.12	0.00004	0.02	0.0000002
7. Wat Huai Phai School	0.11	0.00004	0.02	0.0000002
8. Chedi Hak Private Hospital	0.11	0.00004	0.02	0.0000001
9. Kor PlubPla Private Hospital	0.11	0.00002	0.02	0.0000001
10. Huai Phai Private Hospital	0.12	0.00004	0.02	0.0000002
11. Hin Kong Private Hospital	0.12	0.00005	0.02	0.0000002
12. Kao Gruad Temple	0.12	0.00004	0.02	0.0000001

Table 6.5.2-4

Studied Area	Hazard Quotient : HQ			
	Nitrogen Dioxide gas (NO_2)		Sulfur dioxide gas (SO_2)	
	Acute Impact (1 hour average)	Chronic Impact (1 year average)	Acute Impact (24 hour average)	Chronic Impact (1 year average)
13. Aroon Ratanasiri Temple	0.12	0.00007	0.02	0.0000004
14. Huai Phai Temple	0.12	0.00005	0.02	0.0000003
15. Nong Num Khun Temple	0.12	0.00004	0.02	0.0000003
16. Nong Luang Temple	0.12	0.00004	0.02	0.0000001
17. Hin Kong Temple	0.12	0.00004	0.02	0.0000003
18. Huai Phai Community	0.12	0.00007	0.02	0.0000003
19. Nong Karm House	0.11	0.00009	0.02	0.0000007
20. Nong Song Hong House	0.12	0.00002	0.02	0.0000001
21. Nong Gratoom Temple	0.12	0.00009	0.02	0.0000004
Acceptable Hazard Quotient	< 1.0			

Remark : Acute Impact Assessment using the modellled concentration and standard concentration of air quality measures from National Environment Board No.21 (B.E.2544), No.24(2547), and No.33(B.E.2552).

Source : Consultants of Technology Co.,Ltd, 2562

B) Particulate matter less than 10 microns (PM-10)

The results of the exposure assessment for particulate matter less than 10 microns from the construction activity of the project were found that the hazard quotient assessment of particulate matter less than 10 microns was assessed in both cases of acute effects (short-term), including baseline values from local and chronic (long-term) impacts (**Table 6.5.2-3**). Results of predicting concentrations of particulate matter less than 10 microns were evaluated *for acute impacts* as results of the predicted total dust concentration at 24 hours. It was found that the highest hazard quotient (HQ) was 0.32 in the project area. For *chronic impacts,* total suspended particulate concentrations were used at the 1-year average concentration. It was found that the HQ result was less than 1, meaning that all areas had a concentration of that substance below the reference concentration. It can be said that the HQ value was at a level of no risk of impact on the health of the community during the construction period. Thus, the likelihood of health impact on the community was at an acceptable level.

C) Sulfur dioxide

Sulfur dioxide exposure assessment results from the construction activities of the project showed that results of the assessment of the hazard quotient of sulfur dioxide exposure on both acute (short-term) effect, including baseline values from local measurements and chronic (long-term) effects (**Table 6.5.2-4**). Results for predicting the concentration of sulfur dioxide assessed for *acute impact* was the predictive effect of sulfur dioxide at an average concentration of 1 hour, the maximum hazard quotient (HQ) was 0.03 in the project area. For *chronic impacts,* the concentration of sulfur dioxide at the average concentration of 1 year showed that the highest hazard quotient (HQ) was 0.0005 in the project area. It can be seen that the resulting HQ was less than 1, meaning all areas had a concentration of that substance below the reference concentration. It can be said that the HQ value was at a level of no risk of impact on the community health during the construction period. Thus, the likelihood of health impact on the community was at an acceptable level.

C) Nitrogen oxides

Nitrogen oxides exposure assessment results from the construction activities of the project showed that results of the assessment of the hazard quotient of nitrogen oxides both acute (short-term) effect, including baseline values from local measurements and chronic (long-term) effects (**Table 6.5.2-4**). Results for predicting the concentration of nitrogen oxides assessed for *acute impact* was the predictive effect of nitrogen oxides at the average concentration of 1 hour the highest hazard quotient was 0.24 in the project area. For *chronic impacts,* the concentration of nitrogen oxides at the average concentration of 1 year showed that the highest hazard quotient (HQ) was 0.14 in the project area. It can be seen that the resulting HQ was less than 1, meaning all areas had a concentration of that substance below the reference concentration. It can be said that the HQ value was at a level of no risk of impact on the community health during the construction period. Thus, the likelihood of health impact on the community was at an acceptable level.

(B) The operation phase

When considering the hazard classification according to the assessment framework and guidelines, the quantitative chemical impact as mentioned above showed that from the project description, there were four main pollutants resulting from the operation of the project. These were total suspended particulate (TSP), particulate matter less than 10 microns (PM10), nitrogen dioxide (NO_2 and sulfur dioxide (SO_2). The consulting company considered selecting results of the highest impact to assess the health impact, such as in the event of running 100% of the power generation using natural gas (**Table 6.5.2-5** and **Table 6.5.2-6**) and diesel fuel. (**Table 6.5.2-7** and **Table 6.5.2-8**). Results shown in summarized as follows.

In case of using natural gas as fuel

A) Total suspended particulate (TSP)

Exposure assessment results of total suspended particulate (TSP) from the project activities showed that the hazard quotient of total suspended particulate had been assessed for both acute (short-term) impacts, including baseline values from local measurements, and chronic (long-term) impacts (**Table6.5.2-5**). Predictived concentration of total suspended particulate used to assess for *acute impacts* was an average concentration of total suspended particulate for 24 hours. It was found that the highest hazard quotient (HQ) was 0.46 in the foothills of Khao Ngam area, approximately 3.4 kilometers to the southeast of the project. For *chronic impacts*, it used an average concentration of total suspended particulate for 1 year and found that the highest hazard quotient (HQ) was 0.007 in the foothills of Khao Ngam area, approximately 3.4 kilometers to the southeast of the project. It can be seen that the HQ was less than 1, meaning all areas had a concentration of that substance below the reference concentration. It can be said that the HQ value was at a level of no risk of impact on the community health during the construction period. Thus, the likelihood of health impact on the community was at an acceptable level.

Table 6.5.2-5

Risk Assessment(Hazard Quotient) from Air pollution Exposure in case of Using Natural Gas as Fuel(during Operation Period)

Total Suspended Particulate (TSP) and Particulate Matter less than 10 Micron (PM-10)

Table 6.5.2-5

Studied Area	Hazard Quotient : HQ			
	Total suspended particulate (TSP)		Particulate matter less than 10 microns (PM-10)	
	Acute Impact (24 hour average)	Chronic Impact (1 year average)	Acute Impact (24 hour average)	Chronic Impact (1 year average)
Highest Value	**0.46**	**0.007**	**0.71**	**0.002**
Occuring month	November	-	November	-
Coordinates	(583250E , 1493500N)	(583250E , 1493500N)	(583250E , 1493500N)	(583250E , 1493500N)
Location	Khao Ngam(Ngam mountain) area, 3.4km southeast of the project area	Khao Ngam(Ngam mountain) area, 3.4km southeast of the project area	Khao Ngam(Ngam mountain) area, 3.4km southeast of the project area	Khao Ngam(Ngam mountain) area, 3.4km southeast of the project area
Studied area				
1. Wat Huai Moo School	0.444	0.002	0.70	0.001
2. Wat Nong Taluang School	0.446	0.002	0.70	0.001
3. Wat Huai Pladuk School	0.445	0.003	0.70	0.001
4. Wat Na Nong School	0.444	0.002	0.70	0.001
5. Wat Kor Loi School	0.442	0.001	0.70	0.000
6. Wat Kao Gruad School	0.443	0.001	0.70	0.000
7. Wat Huai Phai School	0.444	0.002	0.70	0.000
8. Chedi Hak Private Hospital	0.444	0.001	0.70	0.000
9. Kor PlubPla Private Hospital	0.443	0.001	0.70	0.000
10. Huai Phai Private Hospital	0.444	0.001	0.70	0.000

Table 6.5.2-5

Studied Area	Hazard Quotient : HQ			
	Total suspended particulate (TSP)		Particulate matter less than 10 microns (PM-10)	
	Acute Impact (24 hour average)	Chronic Impact (1 year average)	Acute Impact (24 hour average)	Chronic Impact (1 year average)
11. Hin Kong Private Hospital	0.444	0.002	0.70	0.001
12. Kao Gruad Temple	0.443	0.001	0.70	0.000
13. Aroon Ratanasiri Temple	0.444	0.002	0.70	0.001
14. Huai Phai Temple	0.444	0.002	0.70	0.001
15. Nong Num Khun Temple	0.444	0.002	0.70	0.001
16. Nong Luang Temple	0.443	0.001	0.70	0.000
17. Hin Kong Temple	0.444	0.002	0.70	0.001
18. Huai Phai Community	0.444	0.002	0.70	0.001
19. Nong Karm House	0.446	0.003	0.70	0.001
20. Nong Song Hong House	0.443	0.001	0.70	0.000
21. Nong Gratoom Temple	0.445	0.002	0.70	0.001
Acceptable Hazard Quotient	< 1.0			

Remark : Acute Impact Assessment using the modellled concentration and standard concentration of air quality measures from National Environment Board No.21 (B.E.2544), No.24(2547), and No.33(B.E.2552).

Source : Consultants of Technology Co.,Ltd, 256

Table 6.5.2-6

Risk Assessment(Hazard Quotient) from Air pollution Exposure in case of Using Natural Gas as Fuel(during Operation Period)

Nitrogen dioxide gas (NO_2) Sulfur dioxide gas (SO_2)

Table 6.5.2-6

Studied Area	Hazard Quotient : HQ			
	Nitrogen Dioxide (NO_2)		Sulfur dioxide (SO_2)	
	Acute Impact 1 hour average	Chronic Impact 1 year average	Acute Impact 1 hour average	Chronic Impact 1 year average
Highest Value	**0.99**	**0.06**	**0.123**	**0.0101**
Occuring month	April	-	April	-
coordinates	(576000E , 1496500N)	(583250E , 1493500N)	(576000E , 1496500N)	(583250E , 1493500N)
Location	Khao Khrok (Khrok Mountain) 3.5km west of the project area	Khao Ngam (Ngam mountain) area, 3.4km southeast of the project area	Khao Khrok (Khrok Mountain) 3.5km west of the project area	Khao Ngam (Ngam mountain) area, 3.4km southeast of the project area
Studied Area				
1. Wat Huai Moo School	0.21	0.014	0.029	0.003
2. Wat Nong Taluang School	0.20	0.014	0.027	0.003
3. Wat Huai Pladuk School	0.21	0.021	0.029	0.004
4. Wat Na Nong School	0.20	0.014	0.027	0.003
5. Wat Kor Loi School	0.18	0.006	0.025	0.001
6. Wat Kao Gruad School	0.21	0.011	0.028	0.002
7. Wat Huai Phai School	0.21	0.013	0.028	0.002
8. Chedi Hak Private Hospital	0.19	0.009	0.026	0.002
9. Kor PlubPla Private Hospital	0.18	0.007	0.025	0.001
10. Huai Phai Private Hospital	0.20	0.011	0.028	0.002

Table 6.5.2-6

Studied Area	Hazard Quotient : HQ			
	Nitrogen Dioxide (NO_2)		Sulfur dioxide (SO_2)	
	Acute Impact 1 hour average	Chronic Impact 1 year average	Acute Impact 1 hour average	Chronic Impact 1 year average
11. Hin Kong Private Hospital	0.21	0.014	0.029	0.002
12. Kao Gruad Temple	0.21	0.011	0.028	0.002
13. Aroon Ratanasiri Temple	0.23	0.018	0.031	0.003
14. Huai Phai Temple	0.21	0.017	0.028	0.003
15. Nong Num Khun Temple	0.20	0.014	0.027	0.003
16. Nong Luang Temple	0.20	0.011	0.028	0.002
17. Hin Kong Temple	0.20	0.015	0.028	0.003
18. Huai Phai Community	0.21	0.019	0.028	0.003
19. Nong Karm House	0.19	0.024	0.027	0.004
20. Nong Song Hong House	0.20	0.009	0.028	0.002
21. Nong Gratoom Temple	0.21	0.014	0.029	0.003
Acceptable Hazard Quotient	< 1.0			

Remark : Acute Impact Assessment using the modellled concentration and standard concentration of air quality measures from National Environment Board No.21 (B.E.2544), No.24(2547), and No.33(B.E.2552).

Source : Consultants of Technology Co.,Ltd, 256

B) Particulate matter less than 10 microns (PM-10)

Exposure assessment results of particulate matter less than 10 microns from the project activities showed that the hazard quotient of particulate matter less than 10 microns had been assessed for both acute (short-term) impacts, including baseline values from local measurements, and chronic (long-term) impacts (**Table6.5.2-5**). Predictive concentration of particulate matter less than 10 microns used to assess for *acute impacts* was an average concentration of particulate matter less than 10 microns for 24 hours. It was found that the highest hazard quotient (HQ) was 0.71 in the foothills of Khao Ngam area, approximately 3.4 kilometers to the southeast of the project. For *chronic impacts*, it used an average concentration of particulate matter less than 10 microns for 1 year and found that the highest hazard quotient (HQ) was 0.002 the foothills of Khao Ngam area, approximately 3.4 kilometers to the southeast of the project. It can be seen that the HQ was less than 1, meaning all areas had a concentration of that substance below the reference concentration. It can be said that the HQ value was at a level of no risk of impact on the community health during the construction period. Thus, the likelihood of health impact on the community was at an acceptable level.

C) Sulfur dioxide

Exposure assessment results of sulfur dioxide from the construction activity of the project showed that the hazard quotient of sulfur dioxide had been assessed for both acute (short-term) impacts, including baseline values from local measurements, and chronic (long-term) impacts (**Table6.5.2-6**). Predictive concentration of sulfur dioxide used to assess for *acute impacts* was an average concentration of sulfur dioxide for 1 hour. It was found that the highest hazard quotient (HQ) was 0.123 in the area of Khao Khrok, about 3.5 kilometers from the project to the west. For *chronic impacts*, it used an average concentration of sulfur dioxide for 1 year and found that the highest hazard quotient (HQ) was 0.0101 in the foothills of Khao Ngam area, approximately 3.4 kilometers to the southeast of the project. It can be seen that the HQ was less than 1, meaning all areas had a concentration of that substance below the reference concentration. It can be said that the HQ value was at a level of no risk of impact on the community health during the construction period. Thus, the likelihood of health impact on the community was at an acceptable level.

C) Nitrogen oxides

Exposure assessment results of nitrogen oxides from the project activities showed that the hazard quotient of nitrogen oxides had been assessed for both acute (short-term) impacts, including baseline values from local measurements, and chronic (long-term) impacts (**Table 6.5.2-6**).Predictive concentration of nitrogen oxides used to assess for *acute* *impacts* was an average concentration of Nitrogen oxides for 1 hour. It was found that the highest hazard quotient (HQ) was 0.99 in the area of Khao Khrok, about 3.5 kilometers from the project to the west. For *chronic impacts*, it used an average concentration of nitrogen oxides for 1 year and found that the highest hazard quotient (HQ) was 0.06 in the foothills of Khao Ngam area, approximately 3.4 kilometers to the southeast of the project. It can be seen that the HQ was less than 1, meaning all areas had a concentration of that substance below the reference concentration. It can be said that the HQ value was at a level of no risk of impact on the community health during the construction period. Thus, the likelihood of health impact on the community was at an acceptable level.

In case of using diesel as fuel

A) Total Suspended Particulate (TSP)

Exposure assessment results of total suspended particulate (TSP) from the project activities showed that the hazard quotient of total suspended particulate had been assessed for both acute (short-term) impacts, including baseline values from local measurements, and chronic (long-term) impacts (**Table 6.5.2-7**). Predictive concentration of total suspended particulate used to assess for *acute impacts* was an average concentration of 24 hour. It was found that the highest hazard quotient (HQ) was 0.465 in the Khao Raeng area, approximately 8 kilometers away from the north of the project. For *chronic impacts*, it used an average concentration of total suspended particulate for 1 year and found that the highest hazard quotient (HQ) was 0.006 in the foothills of Khao Ngam area, approximately 3.4 kilometers to the southeast of the project It can be seen that the HQ was less than 1, meaning all areas had a concentration of that substance below the reference concentration. It can be said that the HQ value was at a level of no risk of impact on the community health during the construction period. Thus, the likelihood of health impact on the community was at an acceptable level.

B) Particulate matter less than 10 microns (PM-10)

Exposure assessment results of particulate matter less than 10 microns from the project activities showed that the hazard quotient of particulate matter less than 10 microns had been assessed for both acute (short-term) impacts, including baseline values from local measurements, and chronic (long-term) impacts (**Table 6.5.2-7**). Predictive concentration of particulate matter less than 10 microns used to assess for *acute impacts* was an average concentration of particulate matter less than 10 microns for 24 hour. It was found that the highest hazard quotient (HQ) was 0.76 in the Khao Raeng area, approximately 8 kilometers away from the north of the project. For *chronic impacts*, it used an average concentration of particulate matter less than 10 microns for 1 year and found that the highest hazard quotient (HQ) was 0.0012 in the foothills of Khao Ngam area, approximately 3.4 kilometers to the southeast of the project. It can be seen that the HQ was less than 1, meaning all areas had a concentration of that substance below the reference concentration. It can be said that the HQ value was at a level of no risk of impact on the community health during the construction period. Thus, the likelihood of health impact on the community was at an acceptable level.

C) Sulfur dioxide

Exposure assessment results of sulfur dioxide from the project activities showed that the hazard quotient of sulfur dioxide had been assessed for both acute (short-term) impacts, including baseline values from local measurements, and chronic (long-term) impacts (**Table6.5.2-8**). Predictive concentration of sulfur dioxide used to assess for *acute impacts* was an average concentration of sulfur dioxide for 1. It was found that the highest hazard quotient (HQ) was 0.110 around Khao Chang Kam, approximately 4.5 kilometers away from the northeast of the project. For *chronic impacts*, it used an average concentration of sulfur dioxide for 1 year and found that the highest hazard quotient (HQ) was 0.010 in the foothills of Khao Ngam area, approximately 3.4 kilometers to the southeast of the project. It can be seen that the HQ was less than 1, meaning all areas had a concentration of that substance below the reference concentration. It can be said that the HQ value was at a level of no risk of impact on the community health during the construction period. Thus, the likelihood of health impact on the community was at an acceptable level.

D) Nitrogen oxides

Exposure assessment results of nitrogen oxides the construction activity of the project showed that the hazard quotient of nitrogen oxides had been assessed for both acute (short-term) impacts, including baseline values from local measurements, and chronic (long-term) impacts (**Table6.5.2-8**). Predictive concentration of nitrogen oxides used to assess for *acute impacts* was an average concentration of nitrogen oxides for 1 hour. It was found that the highest hazard quotient (HQ) was 0.755 around Khao Chang Kam, approximately 4.5 kilometers away from the northeast of the project. For *chronic impacts*, it used an average concentration of nitrogen oxides for 1 year and found that the highest hazard quotient (HQ) was 0.048 in the foothills of Khao Ngam area, approximately 3.4 kilometers to the southeast of the project. It can be seen that the HQ was less than 1, meaning all areas had a concentration of that substance below the reference concentration. It can be said that the HQ value was at a level of no risk of impact on the community health during the construction period. Thus, the likelihood of health impact on the community was at an acceptable level.

Table 6.5.2-7

Risk Assessment(Hazard Quotient) from Air pollution Exposure in case of Using Diesel as Fuel(during Operation Period)

Total Suspended Particulate (TSP) and Particulate Matter less than 10 Micron (PM-10)

Table 6.5.2-7

Studied Area	Hazard Quotient : HQ			
	Total suspended particulate (TSP)		Particulate matter less than 10 microns (PM-10)	
	Acute Impact (24 hour average)	Chronic Impact (1 year average)	Acute Impact (24 hour average)	Chronic Impact (1 year average)
Highest Value	**0.465**	**0.006**	**0.76**	**0.012**
Occuring Month	April	-	April	-
Coordinates	(579500E , 1505500N)	(583250E , 1493500N)	(579500E , 1505500N)	(583250E , 1493500N)
Location	Khao Rang(Rang mountain) 8km north of the project area	Khao Ngam(Ngam mountain) area, 3.4km southeast of the project area	Khao Rang(Rang mountain) 8km north of the project area	Khao Gnam(Ngam mountain) area, 3.4km southeast of the project area
Studied Area				
1. Wat Huai Moo School	0.445	0.002	0.71	0.004
2. Wat Nong Taluang School	0.446	0.002	0.71	0.004
3. Wat Huai Pladuk School	0.445	0.003	0.71	0.006
4. Wat Na Nong School	0.444	0.002	0.71	0.004
5. Wat Kor Loi School	0.443	0.001	0.71	0.002
6. Wat Kao Gruad School	0.444	0.002	0.71	0.003
7. Wat Huai Phai School	0.444	0.002	0.71	0.004
8. Chedi Hak Private Hospital	0.444	0.001	0.71	0.003
9. Kor PlubPla Private Hospital	0.443	0.001	0.71	0.002
10. Huai Phai Private Hospital	0.444	0.002	0.71	0.003

Table 6.5.2-7

Studied Area	Hazard Quotient : HQ			
	Total suspended particulate (TSP)		Particulate matter less than 10 microns (PM-10)	
	Acute Impact (24 hour average)	Chronic Impact (1 year average)	Acute Impact (24 hour average)	Chronic Impact (1 year average)
11. Hin Kong Private Hospital	0.444	0.002	0.71	0.004
12. Kao Gruad Temple	0.443	0.002	0.71	0.003
13. Aroon Ratanasiri Temple	0.445	0.003	0.71	0.005
14. Huai Phai Temple	0.444	0.003	0.71	0.005
15. Nong Num Khun Temple	0.444	0.002	0.71	0.004
16. Nong Luang Temple	0.444	0.002	0.71	0.003
17. Hin Kong Temple	0.444	0.002	0.71	0.004
18. Huai Phai Community	0.445	0.003	0.71	0.005
19. Nong Karm House	0.447	0.003	0.72	0.006
20. Nong Song Hong House	0.443	0.001	0.71	0.003
21. Nong Gratoom Temple	0.445	0.002	0.71	0.004
Acceptable Hazard Quotient	< 1.0			

Remark : Acute Impact Assessment using the modellled concentration and standard concentration of air quality measures from National Environment Board No.21 (B.E.2544), No.24(2547), and No.33 (B.E.2552).

Source : Consultants of Technology Co.,Ltd, 256

Table 6.5.2-8

Risk Assessment(Hazard Quotient) from Air pollution Exposure in case of Using Diesel as Fuel(during Operation Period)

Nitrogen dioxide gas (NO_2) Sulfur dioxide gas (SO_2)

Table 6.5.2-8

Studied Area	Hazard Quotient : HQ			
	Nitrogen Dioxide (NO_2)		Sulfur dioxide (SO_2)	
	Acute Impact 1 hour average	Chronic Impact 1 yaer average	Acute Impact 1 hour average	Chronic Impact 1 yaer average
Highest Value	0.755	0.048	0.110	0.010
Occuring Month	December	-	December	-
Coordinates	(583000E , 1501000N)	(583250E , 1493500N)	(583000E , 1501000N)	(583250E , 1493500N)
Location	Khao Chang Kam (Chang Kam mountain) area, 4.5 km northeast of the project area	Khao Ngam(Ngam mountain) area, 3.4km southeast of the project area	Khao Chang Kam (Chang Kam mountain) area, 4.5 km northeast of the project area	Khao Ngam(Ngam mountain) area, 3.4km southeast of the project area
Studied Area				
1. Wat Huai Moo School	0.225	0.016	0.033	0.003
2. Wat Nong Taluang School	0.204	0.015	0.030	0.003
3. Wat Huai Pladuk School	0.208	0.022	0.031	0.005
4. Wat Na Nong School	0.202	0.016	0.030	0.004
5. Wat Kor Loi School	0.180	0.007	0.027	0.002
6. Wat Kao Gruad School	0.213	0.013	0.031	0.003
7. Wat Huai Phai School	0.206	0.014	0.030	0.003
8. Chedi Hak Private Hospital	0.193	0.011	0.028	0.002
9. Kor PlubPla Private Hospital	0.188	0.008	0.028	0.002
10. Huai Phai Private Hospital	0.212	0.013	0.031	0.003

Table 6.5.2-8

Studied Area	Hazard Quotient : HQ			
	Nitrogen Dioxide (NO_2)		Sulfur dioxide (SO_2)	
	Acute Impact 1 hour average	Chronic Impact 1 yaer average	Acute Impact 1 hour average	Chronic Impact 1 yaer average
11. Hin Kong Private Hospital	0.211	0.015	0.031	0.003
12. Kao Gruad Temple	0.214	0.012	0.031	0.003
13. Aroon Ratanasiri Temple	0.233	0.019	0.034	0.004
14. Huai Phai Temple	0.203	0.019	0.030	0.004
15. Nong Num Khun Temple	0.190	0.015	0.028	0.003
16. Nong Luang Temple	0.207	0.013	0.031	0.003
17. Hin Kong Temple	0.202	0.016	0.030	0.003
18. Huai Phai Community	0.202	0.019	0.030	0.004
19. Nong Karm House	0.206	0.025	0.030	0.005
20. Nong Song Hong House	0.200	0.010	0.030	0.002
21. Nong Gratoom Temple	0.225	0.017	0.033	0.004
Acceptable Hazard Quotient	< 1.0			

Remark : Acute Impact Assessment using the modellled concentration and standard concentration of air quality measures from National Environment Board No.21 (B.E.2544), No.24(2547), and No.33(B.E.2552).

Source : Consultants of Technology Co.,Ltd, 2562

Based on results of the exposure assessment of total suspended particulate (TSP), particulate matter less than 10 microns (PM-10), Nitrogen dioxide (NO_2) and Sulfur dioxide (SO_2), both acute (short-term) and chronic (long-term) impact from project activities, it was found that the hazard quotient (HQ) was less than 1, meaning that the exposure level was less than the reference level. This indicated an acceptable health impacts and the likelihood that the communities surrounding the project area will experience a low level of health impact from air pollution.

(6) Summary of health impacts

The project had emitted air pollutants throughout the operation period, however, the project had controlled the emission rate from stacks not to exceed those specified in the EIA report. Therefore, *the likelihood of impact from the air pollution was considered as moderate*. A qualitative impact assessment from exposure to air pollution, both acute (short-term) and chronic (long-term) impacts showed the hazard quotient (HQ) value less than 1, for both short-term and long-term. Meaning that all expected areas had concentrations of substances below all reference concentrations. Therefore, *the severity was moderate*. Thus, the risk of impact was *moderate*.

Likelihood	**Severity**	**Impact Level (likelihood x severity)**
Moderate (3)	Moderate (2)	**moderate (6)**

6.5.3 Health impacts from noise and vibration pollutions

(1) Health threats and their origins

1) The construction phase

Project construction activities will be carried out in each activity not simultaneously. The consulting company therefore selected to assess activities that were expected to generate the highest noise, such as drilling and foundation activities which had a sound level of 88.0 dB (A) at a distance of 15 meters. The construction phase run approximately 33-42 months. In addition, from activities of the project during the construction phase, the project set measures to prevent and resolve impacts during the construction period to the neighboring communities. As the contractor required to use machines and equipment generating low levels of noise. A sound barrier must be installed at the location where the pile was being hammered for 10 meters away from the source of machines and equipment that cause noise on the north side of Moo.5, Ban Nong Rak and on the south side of Moo.8, Ban Nong Kham and the house behind the power plant. Initially, the material with a thickness of 0.64 mm (Steel 24 ga) or more was selected as sheet metal, with a transmission loss (TL) of 18 dB (A).

When considering the vibration arising from the construction activities of the project, it was found that the excavation for the foundation construction was able to cause the most vibration to the structures of the nearby community. The maximum particle velocity of 25 feet was 0.734 inches /second. Comparing the calculated vibration levels with the Whiffin and Leonand criteria, it was found that the vibration level in the residential area on the south side of the project was at a level that humans could feel the vibrations, and the higher the level of vibration affected the destruction or damage to the archaeological site. For the impact on structures compared to DIN 4150 requirements, it was found to be close to 2.0 mm/second. This level was not dangerous, even to the old buildings (Ancient Building). However, various drilling operations resulting impacts would only occur during the construction period.

2) The operation phase

The noise sources of the project were gas turbines, steam generators, steam turbine generator, coolant circulation pump, pumps for water feeding to the steam generation system, electric motor, air compressor, control valve and piping system, gas compressor and cooling fans for transformers, etc. The project has assigned the designer to design all kinds of machines, so that, the average noise level does not exceed 85 dB (A) at a distance of 1 meter.

Most of the project activities causing vibration were transportation of only large chemical trucks with a frequency of transportation approximately once a month. The project avoided the transportation in the route that passes through the community which had the most impact on the structures of the neighboring household structure.

However, throughout the operation period, staff from the project have been arranged to meet with communities surrounding the project on a regular basis. Throughout the construction and operation period to inquire about impacts of the project implementation. If any problems arisen, the project must find a solution urgently.

(2) Review of health threat information

Noise is the sound that can be heard and it causes both physically and mentally annoying and obstructs the performance of our work. Excessive noise is a major problem these days and even more dangerous. Noise can cause stress and anxiety and it interferes with daily habits, resulting in stressful contractions. If it happened frequently, it could lead to mental health problems. For the interference with sleep, it is the most serious problem due to mental and health aspects can deteriorate when the person does not have enough sleep. However, some people are able to adjust to noise so well that they get used to it and there were no sleeping problems. Annoyance that causing frustration, uneasy, has no direct nuisance measurement. But an indication of the cause of the annoyance is known by asking or observing the reaction to sound. The World Health Organization (WHO) has set the general noise level for urban residential communities during the day at an average noise level of no more than 55 dB (A) and during the night, not exceed 45 dB (A). Impact groups were persons living close to the source of noise. This may be obtained frequently and cause psychological disturbances, work, and rest, causing stress. Noise problems that arise will be less or more dangerous depending on the level of noise produced by the source, noise level at each frequency, the duration of noise exposure, individual life experiences and tolerability conditions.

For direct exposure to vibrations of the body, parts of the body that are exposed to vibrations and then passed on to other parts of the body, composition of the vibration affecting the body are frequency, strength (magnitude), direction and duration. The acute effect of vibration throughout the body cause discomfort, and interfering with the activities that are carried out at that time. Exposure to the vibration at 6.5-8 kHz in the downward direction resulting in increased pressure on the spinal cord. For the effects of partial tremors of the hand and arm, it causes disturbances of blood flow, resulting in stenosis and pale fingers, effects on the sensory and motor nerves, numbness and loss of coordination between the fingers, resulting in a lack of mobility in the hand, including causing disorders of the musculoskeletal system. Chronic effects of prolonged exposure of the vibration have negative effects on the spinal cord and increase the risk of lumbar and thoracic spinal pain. The vibration at 40 kHz causing disturbances of the nervous system. When considering the vibrations generated from the excavation for the foundation construction, it was found that the vibration level in the residential area on the south side of the project was at a level that humans can feel the vibrations. The higher the level of vibration will affect the destruction or damage to the archaeological site. For impact on buildings, it was found to be in a level of no dangerous even to the old buildings (Ancient Building). However, various drilling operations resulting impacts will only occur during the construction period.

(3) Baseline information of the impact zone and population at risk

1) Environmental data: results of noise level measurements in the study area

The consulting company measured the noise level in the study area for 7 consecutive days (during 12-18 February, B.E.2562) at 2 stations, the residential area on the north of the project, Moo.5, Ban Nong Rak (N1) and the residential area on the south side of Moo.8, Ban Nong Kham (N2) and the community behind the power plant (N3), in order to represent the general noise level in the study area. The measuring index were consisting of 24-hour average noise level (Leq 24 hr.) and maximum noise level (Lmax). When comparing the sound level measurement results with the standard values according to the National Environment Board Announcement, No.15 (B.E.2540) on the determination of noise level standards in general, it was found that measurement results were within the standard **Table 6.5.3-1.**

<u>Table 6.5.3-1</u>

<u>Noise Level Measuring Result in Project Area</u>

Measuring Station	Noise Level REsult (decibel (A))	
	24 hour average noise level	Highest level noise level
N1 : Ban Nong Ruk Moo.5	51.2- 54.4	82.6-91.4
N2 : Ban Nong Kam Moo 8	52.2-55.4	78.5-89.0
N3 : House area behind power plant	51.2- 54.4	82.6-91.4
Standard1/	**70.0**	**115.0**

<u>Remark</u> : Notification of Ministry of Industry on regulating noise disturbance and noise level from industry B.E.2548. Standard from notification of National Environment Board No. 15(B.E.2540) on regulating standard normal noise level.

2) Data from the household representative questionnaire

According to public opinion survey in the study area, it was found that some of the household representatives in the study area had suffered from noise impact. For the source of noise, most of them did not identified the noise source. Then followed by traffic and industrial factories, respectively.

(4) Summary of health impacts

During construction phase, noise source activities are drilling and foundation activities. Which has a sound level of 88.0 dB (A) at a distance of 15 meters. During the operation, there are machines that are noise sources, such as gas turbines, steam generators, steam turbine, generator, coolant circulating pump, pumps for feeding water to the steam generation system, electric motor, air compressor, control valve and piping system, gas compressor and cooling fans for transformers, etc. The project has assigned the designer to design all kinds of machines to generate an average noise level does not exceed 85 dB (A) at a distance of 1 meter. When considering the vibrations from the excavation for the foundation construction, it was found that residential areas on the south side of the project had a level that humans can feel the vibrations. The higher level of vibration will affect the destruction or damage to the archaeological site. For the impact on the buildings, it was found to be in a level with no dangerous even to the ancient buildings (Ancient Building). Various drilling operations resulting impact will only occur during the construction period. Most of the activities of the projects that caused the vibration were during the transportation of large chemical trucks only. The frequency of transportation was approximately once a month. Thus, there *was a moderate risk of exposure to noise*. From results of the measurement of noise in the atmosphere of 3 stations, when comparing results of the noise level measurement with the standard values according to the Announcement of the National Environment Board, No.15 (B.E.2540) on the determination of noise level standards in general, it was found that measurement results had values within the standard.

From the noise impact assessment done by assessing the general noise and noise level arising from the construction and operation phases, it was found that the average noise level of 24 hours was within the standard criteria, according to the Announcement of National Environment Board, No.15 (B.E.2540) on the determination of noise level standards in general. It was given that the average 24-hour noise level in the environment was not more than 70 dB (A).

Noise level when considering the time interval with noise value higher than 10 dB (A), it was found that the total noise level from the noise from the project activity and the current measurement noise level was equal to the current measurement. According to the Announcement of the National Environment Board, No. 29 (B.E.2550) on the noise level, it has set the noise level of 10 dB (A) respectively. Therefore, *the severity was moderate*. Thus, the risk of impact was *moderate*.

Likelihood	Severity	Impact Level (likelihood x severity)
moderate (3)	Moderate (2)	**moderate (6)**

Therefore, the project must strictly adhere to the prevention and measures of the noise impact.

6.5.4 Health impacts from the effluent management

(1) Health threats and their origins

Wastewater generating during the project operation can be classified into 3 parts: wastewater from employee consumption, wastewater from production processes and rainwater that may be contaminated with oil. Wastewater will be collected and sent to a pond where automatic water quality measurement instruments are installed, in order to check the quality of the effluent to meet the standard. Quality wastewater according to the standard criteria will be managed and divided into 2 parts: the project will bring water to the green area of the project and will drain water into the Mae Klong River. In the event that the effluent does not meet the specified standards, automatic water quality monitor will send a signal to switch the drain valve to the emergency holding pond before sending for further disposal by an authorized agency.

(2) Review of health threat information

The qualitative change of water source occurring from the contamination of the water supply and makes it unsafe for the consumption. Drinking water must be clean water, free from contamination or toxic substances including germs and chemicals which could cause illness, gastrointestinal disease regards to the nature of the pathogen and the type of toxins contaminated in the water, such as bacteria causing severe diarrhea, dysentery, typhoid. Viral infections causing hepatitis A and B. Then helminthiasis, parasites that infect humans are blood flukes, tapeworms, roundworms, which all affect health for both acute and chronic effects.

Because of concerns from people in the study area that project drainage may lead to the contamination of hazardous substances into the water supply. This would make people dependent on water resources feeling insecure. Therefore, providing information and operating methods of the project to those involved, not only as relieving public anxiety on such matters but it also provides the public with a more accurate understanding of the impacts of the project.

(3) Baseline information of the impact zone and population at risk

1) Environmental data: Results of surface water quality measurements in the study area

The consultant company measured the water quality in Mae Klong River by measuring 2 seasons: the dry season on 18th February, B.E.2562 and the rainy season on 18th July, B.E.2562, at 3 stations around the pumping and discharge station of the project which were Wat Bang Li T (SW1), Wat Khok Mo (SW2) and Sirilak Bridge (SW3). It was found that most of water quality at every station was within the surface water quality standards of type 3 and type 4, according to the Announcement of the National Environment Board, No.8 (B.E.2537) on requirements for surface water quality. In exceptional, all coliform bacteria and phytocoliform bacteria in the area of Sirilak Bridge Station (SW3) were exceeded the standard according to the announcement.

2) Data from the household representative questionnaire

According to public opinion survey in the study area, it was found that some of the household representatives in the study area were suffered/annoyed from the environmental impact of wastewater. Most of them did not specify the source. Then followed by industrial factories and tap water/ground water, respectively. For wastewater arising from various activities within the households, they were mostly said that they used water for the plantation, followed by leaving in open air/draining on the ground and dumped into public sewers, respectively.

(4) Summary of health impacts

Wastewater generated during the operation can be classified into 3 parts: waste water from employee consumption, wastewater from production processes and rainwater that may be contaminated with oil. The said wastewater will be collected and sent to the holding pond which was equipped with automatic water quality measurement instruments to check the quality of the effluent whether it meets the standard. In case the effluent does not meet the specified standards, automatic water quality monitor will send a signal to switch the drain valve to the emergency holding pond. Therefore, *the risk of water pollution was moderate*. People in the study area were concerned that project drainage may lead to contamination of hazardous substances into the water supply. However, the project would treat the wastewater to the standard before draining into Huai Takian and treated wastewater will be used the green area of the project. *The severity was moderate*. Thus, the risk of impact was *moderate*.

Likelihood	Severity	Impact level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

6.5.5 Health impacts of solid waste and industrial waste

(1) Health threats and their origins

Waste and solid waste generating during the construction phase can be classified into 2 types which are,

1) Solid waste arising from the consumption of construction workers, such as food waste, plastic bags, etc., had the maximum amount of 3,000 kilograms per day (based on the incidence of 1 kg of solid waste/person/day). The project will provide a 200-liter waste container with a closed lid to accommodate the solid waste that occurred before sending for further disposal by a licensed legal agency.

2) Waste and solid waste from construction activities as a recycled type are scrap, wood and brick etc. The project will be collected in the project area and contact an outside company for selling and further recycling.

Each type of solid waste and wastes, the project has provided the area for the storage. There are adequate containers for all types of waste generated in the construction project the waste separation container is collected once a day. The contractor company is responsible for the quantity and solid waste management.

(2) Review of health threat information

Unhygienic or incorrectly technical sewage and solid waste management can cause a number of effects on the environment and human health, for example being the source of disease, a breeding ground for pathogens and vectors of disease such as flies, rats, cockroaches, etc. Collecting and eliminating bad waste or leftover waste in the community causing pathogens such as hepatitis and typhoid, etc. Improperly management and leftover waste in the community area will cause pollution to the environment. It is the leading cause of water pollution, soil pollution and air pollution. It also causes an annoyance. The uncollected garbage causes disturbing odor throughout the community. In addition, inefficient waste management poses a number of risks and hazards to health. Hazardous wastes from projects leading to health impacts, such as the exposure of toxins contaminated with flies or gastrointestinal diseases caused by flies-borne bacteria, etc. However, the project has already determined measures to reduce the impact of waste management.

(3) Baseline information of the impact zone and population at risk.

1) Environmental information

Information from the environmental situation report of B.E.2561 of the Environment Office Region 8, Ratchaburi, Office of the Permanent Secretary, Ministry of Natural Resources and Environment. Ministry of Natural Resources and Environment, June issue, B.E.2562, it was concluded that Ratchaburi has 16 waste disposal sites in the area, 1 site was closed and 15 sites is still operating at present. Eleven sites are belonged to and managed by the local government organization and 4 sites are belonged to the private sector. There are 6 legitimate waste disposal sites in the area, operating with the separation system, sanitary landfill and control dump. There are 2 stations of the waste transfer system. For the management of the waste disposal facility of the local government, due to the limited budget and the local government has no machines for plowing, improving or covering, therefore, the landfill will be adjusted from time to time approximately 1-2 times a year depending on the amount of solid waste and the size of each site. The surrounding area of the project has waste disposal facilities belong to both government and private sectors. The project can contact them for disposal. For the government waste disposal facility nearby in the project area, it is Ang Hin Subdistrict Administrative Organization, which is located approximately 17 kilometers from the project area and with approximately 24 minutes for traveling to the project.

2) Data from the household representative questionnaire

According to the public opinion survey in the study area, it was found that most of the household representatives in the study area had disposed of solid waste by putting it in a trash bin waiting for the garbage collection truck of the responsible agency to collect, followed by incineration and general disposal/piling up on the open area, respectively. For the disposal of wastewater generating from various activities of households, it was found that most of wastewater were drained to the pipe, followed by disposal on open air /let it flow along the ground and watering the trees, respectively. However, a small number of people had been suffered/annoyed from the environmental impact of wastewater. Most of them were unidentified the source of wastewater, then followed by industrial factories and communities, respectively.

(4) Summary of health impacts

Waste and solid waste generating from the consumption of construction workers, such as food waste, plastic bags, etc., had the maximum amount is approximately 3,000 kilograms per day, including waste and solid waste from construction activities which its types as a recycled type, such as scrap, wood and brick, etc, the project will be collected in the project area and contact an outside company for selling and further recycling. The surrounding area of the project has waste disposal facilities belonging to both government and private sectors. The project can contact them to collect general solid waste for disposal. Therefore, *the risk of impact from solid waste and industrial waste was moderate*. The improperly waste management and leftover waste in the community area will cause environmental pollution. It is the leading cause of water pollution, soil pollution and air pollution. It also causes an annoyance. The uncollected garbage will cause a disturbing odor throughout the community. However, the project has provided the area for the storage area to organize waste in order and with adequate containers for all types of waste generated in the construction project. The waste separation container is collected once a day. The contractor company is responsible for the quantity and solid waste management. Therefore, *the severity of impact was moderate*. Thus, risk of impact level was *moderate.*

Likelihood	Severity	Impact level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

6.5.6 Health impacts from the safety of life and property

(1) Baseline information of the impact zone and population at risk.

1) Environmental information

The consulting company collected the statistic of the safety of life and property. crime and traffic accident statistics during B.E.2559-2561 from Provincial Police Region 7 and the Royal Thai Police, responsible for the project and nearby area. It was summarized as follows.

In B.E.2559, the top 3 notified cases were offences that the state was the victim, offences against property and offences affecting life, body and sexuality, as of 26,236 5,666 and 1,889 cases, respectively. In B.E.2560, the top 3 notified cases were offences that the state was the victim, offences against property and offences affecting life, body and sexuality, as of 40,974 5,737 and 2,236 cases, respectively. In B.E. 2561, the top 3 notified cases were offences that the state was the victim, offences against property and offences affecting life, body and sexuality, as of 46,817 5,738 และ 2,061 cases, respectively. Data showed that offences that the state was the victim were increased

Based on background information on the safety of life and property, statistics of such criminal cases showed that offences that the state was the victim was the highest. Most of them were drug cases, followed by gambling cases, firearms and explosives and offences relating to the Immigration Act, respectively.

2) Data from the household representative questionnaire

According to the public opinion survey in the study area, most of them did not have any accidents in the community, followed by car accidents and fires, respectively. There were some concerns on accident from natural gas pipelines and burglary/crime.

(2) Summary of health impacts

During the construction phase of the project, there will be a maximum of 3,000 construction workers, possibly causing changes in the population structure with an increase in the labor age (15-59 years). The entry into the community of migrant workers caused alienation in the community and may affected people in the community concerning on crime, controversy, burglary and drugs, etc. The entry of migrant workers will only take place during the construction period. Therefore, *the risk of health impacts from the safety of life and property was moderate*. Based on background information on the safety of life and property, statistics of such criminal cases showed that offences that the state was the victim was the highest. Most of them were drug cases, followed by gambling cases, firearms and explosives and offences relating to the Immigration Act, respectively. However, the project has established the measure for recruiting local workers as the first priority. In addition, the contractor must have measures to supervise these workers to comply with the regulations as specified by the project, in order to prevent impacts on the safety of life and property to the surrounding communities. Therefore, *the severity was moderate*. Thus, the risk of impact was *moderate*.

Likelihood	Severity	Impact level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

6.5.7 Health impacts on the transportation (accidents)

(1) Health threats to and their origins

1) Construction phase

The construction phase of the project will take approximately 35-42 months, expected to start construction in January, B.E.2564 and finish around December ,B.E.2566. The transportation during the first phase of construction will be the soil transportation to fill the area, transportation of construction equipment, machines using in the production process and construction workers. Trucks and trailers will be used for transportation. For the traffic volume during construction, it is expected that adjusting the land will use a 10-wheel truck, the maximum number of 120 trips/day. For the transportation of construction materials and machines using in the production process will use a truck with a maximum of 90 trips/day. In normal cases, there will be approximately 74 trips a day. The main routes will be Rural Highway No.4031 and Rural Highway No.4004 to the project area. Trucks transporting machines, equipment and production units must use the specified main route only and must avoid the route that passes through the community area. For the transportation of construction workers, it is expected to have a maximum of 134 trips/day and in normal cases, approximately 110 trips/ day (motorcycles is excluded). Some local construction workers may travel to the project by motorcycles, using Rural Highway No.4004. Accommodations for construction workers will be located outside the project area. The project has assigned the construction company to be responsible for arranging the accommodation. The operation of the construction company must strictly comply with the labor law.

2) Operation phase

From the nature of the project, during the operation phase, there will be a number of trips of fuel, chemical, ash and employee transportation. These transportation will take Rural Highway No.4031 and Rural Highway No.4004 as mainly routes to the project area. The transported vehicles must use specified main routes only. There will be 1 chemical vehicle/ day, 1 vehicle for collecting of solid waste/sludge from water quality improvement system/day, and employees and visitors for 50 vehicles/day. Therefore, there will be totally 52 cars/day.

(2) Review of health threat information

Regarding the World Health Organization and the World Bank provided a report on the prevention of injury from the road accident and related reports has been published since B.E.2547. They indicated that road traffic injuries were a critical public health concern. As it was the cause of 1.2 million deaths among the world population in each year, with over 50 million injuries and disabilities a year. It was also the number one cause of death among juveniles aged 5-29 with 90% of the losses occurred in poor or middle-income developing countries. The vulnerable or risk populations were pedestrians, cyclists, motorcyclists and passengers in unsafe vehicles. Besides the suffering resulting from the injuries and deaths that occur to patients and their families, it caused economic losses which had the direct impact on the sustainability of the national development (Office of the Accident Reduction Network, B.E.2553).

Major causes of road accidents, according to statistics of road traffic accidents, classified by 3 main factors: people, cars, roads and environment, showed that 77.5 % of accidents caused by "human", 1.3% caused by car and 0.4 % caused by "environment" (animals running across) without any causes from "road" factor. This information indicated that roads in Thailand were in good condition, safe, do not affect accidents, but it may be different from real conditions in some areas (Yodpol Thanabiboon *et al*. "Road Accident Situation", Journal of Health Situation, Vol.2, No.9, February, B.E.2549, page 2).

(3) Baseline information of the impact zone and population at risk.

1) Environmental information

Results from the calculated traffic index and traffic congestion for each route based on current conditions from a survey of a consulting company are as follows.

(A) Traffic volume during weekdays (on Friday 12 July, B.E.2562) and (on Monday 28 October, B.E.2562)

A) Rural Highway No.KorJor 4004, results of calculated traffic index (V/C Ratio) and traffic density were 0.30, 0.26 and 0.39, respectively.

B) The road in front of the power plant, results of calculated traffic index (V/C Ratio) and traffic density were 0.09, 0.07 and 0.08, respectively.

C) Road in front of Big Food Group Co.,Ltd., results of calculated traffic index (V/C Ratio) and traffic density were 0.22, 0.18 and 0.27, respectively.

When comparing results to the criteria for the level of service of Transportation Research Board, it was found that the service level was in A level, meaning that the traffic is flow and vehicles can freely move. There was no limitation in maneuvering. Delays caused by car stopping at the intersection are less.

(B) Traffic volume during weekend (on Saturday 13July, B.E.2562) and (on Sunday 27 October, B.E.2562)

A) Rural Highway No.KorJor 4004, results of calculated traffic index (V/C Ratio) and traffic density were 0.27, 0.18 and 0.29, respectively.

B) The road in front of the power plant, results of calculated traffic index (V/C Ratio) and traffic density were 0.10, 0.06 and 0.10, respectively.

C) Road in front of Big Food Group Co., Ltd., results of calculated traffic index (V/C Ratio) and traffic density were 0.14, 0.21 and 0.24, respectively.

When comparing results to the criteria for the level of service of Transportation Research Board, it was found that the service level was in A level, meaning that the traffic is flow and vehicles can freely move. Delays caused by car stopping at the intersection are less.

2) Data from the household representative questionnaire

According to the public opinion survey in the study area, most people did not have any accidents in the community, followed by car accidents and fires, respectively. Some people concerned about accidents from natural gas pipeline.

(4) Summary of health impacts

Project activities during construction phase were transportation of materials and equipment, including construction workers. The expected impacts were accidents and the higher traffic volume. After the project operation, there will be an increase in the transportation due to the number of trips of transportation of fuel, chemicals, ash and employee. Therefore, *the risk of health impacts from transportation (accidents) was moderate*. The impact assessment of the traffic of the project during construction and operation periods, it was found that the rural highway No.KorJor 4004, the road in front of the power plant and the road in front of Big Food Group Co., Ltd., had a traffic index (V / C) at level A. This level meaning that the vehicles can move with free-flow speed, without changing any of the road service level. Thus, the risk of impacts was *moderate*.

Likelihood	Severity	Impact level (likelihood x severity)
moderate (3)	moderate (2)	**moderate (6)**

6.5.8 Health impacts from the public health service system

(1) Health determinants

Public health services are as part of the health system. The efficiency of the organization of public health services depends on;

- Providing quality health services (Quality)
- Providing comprehensive public health services that everyone has easy access to public health services (Access), which includes providing equitable and fair services. Generally, the population per bed is used as an index.
- Providing services with an efficient resource management (Cost)
- Providing services to achieve the effectiveness of public health services.

The health service system is classified into 4 aspects as follows:

1) Health Promotion, to keep body strong, to have a good quality of life and reduce the likelihood of disease. Health promotion is not only about the knowledge of disease, but also related to changing the life style. Health Promotion service is a proactive service targeting a general population of all genders, all ages and every place.

2) Disease, Conditions Prevention, done by reducing the severity of the pathogen or by enhancing the immune system of the body or making it less likely to interact between the pathogen and the body. Prevention service is the proactive service targeting specific target groups depending on the problem in each area.

3) Curative, focusing on changing the disorder or disease to return to normal, without causing the abnormality or disease to become severe until disability or death. The service for medical treatment covers a specific target group or when a disease occurs.

4) Rehabilitation, when a disorder or disease is causing disability, either temporarily or permanently, this requires rehabilitation to bring the body and mind back to normal or for patients to be able to help themselves. Rehabilitation services will cover specific target groups with specific needs.

Environmental factors affecting public health services are linked to the environment, individuals and lead to the health impact of the individual. The factors affecting the provision of public health services are consisted of;

1) Demographic change, changing the population structure has changed the public health services. When elderly population increases, specific health services must be

provided to accommodate problems and diseases of the elderly. In addition, the required health resources must increase as the number of elderly increases, etc.

2) Problem and demand, changing problems and demands occurred due to the interaction between agent, host and environment with various factors such as behavior, beliefs, and way of life, environment that facilitates disease or abnormal conditions, or diseases requiring public health services. Therefore, WHO has divided diseases into 3 major groups as follows:

- Communicable Disease, Maternal and Child Conditions, Nutritional Conditions, which the size and scope of problems are not large in developed countries but still a serious problem in developing countries.
- Non Communicable Disease, this problem is large in scale and scope and it is likely to increase in every country.
- Injuries, tends to rise, especially in developing countries. However, at the present, there is a tendency for new problems spreading throughout the world very quickly such as, viral infectious diseases in animals, for example; avian influenza, terrorism. These problems resulting in more casualties than accidents and the solution was different from the original infectious disease and the original accident injury. It caused impacts on public health management to address these various problems.

3) Medical technology and other technologies, technology change, is the most impact on public health services. This is a factor that may not be able to directly identify the impact. Some technologies are not intended for public health services but there are side effects to the provision of public health services such as advances in information technology, advances in developing vaccines and drug-based cancer prevention, genetics and nanotechnology, etc.

Health services focused on health promotion and disease prevention. It affects the public health status in a good way. These services include maternal and child health services, prenatal health care, enhancing immunity, early diagnosis, providing health education about health risk factors and options for the good health.

(2) Related operational activities of the project

Dimension 1: increase in workers/employees and their families living as part of the community and as part of the existing public health service users.

Dimension 2: the project operation poses a health threat which affects the occurrence of health problems for people in the area. This is an increase in health problems that are burdensome of the health service agencies.

(3) Baseline information of the impact zone and population at risk

1) Information from local authorities

The study area and nearby the project have public health service units. In case of patient is injured in a severe case or is considered to be beyond the capability of the Tambon Health Promoting Hospital. Patients or injured persons will be transferred to public hospitals in the vicinity of the project area. The closest hospital to the project is Ratchaburi Hospital. This is an 855-bed community hospital located about 12 kilometers from the project and takes approximately 15 minutes by car from the project.

However, when considering physicians of the Ratchaburi Hospital, Ban Pong Hospital, Photharam Hospital, it was found that numbers of physicians have been exceeded the criteria as seen in **Table 6.5.8-1**.

In addition, when considering the sufficiency of the number of beds to the demand of the community for medical services, it was found that the hospital in the study area had sufficient beds for the population of the area, as seen in **Table 6.5.8-2**, however, the project provides for the necessary first aid and adequate medical care in accordance with the Ministerial Regulation of Labor on the welfare in the workplace, B.E.2548.

Table 6.5.8-1

Recommended Amount of Medical Personnel and Actual amount of Medical Personnel of Public Health Service in the Studied Area

Public Health Personnel	Amount of Medical Personnel (people)											
	Ratchaburi Hospital			Baan Pong Hospital			Potalarm Hospital			Dumnern Hospital		
	recommended	Actual	Lacking /in excess	recommended	Actual	Lacking /in excess	recommended	Actual	Lacking /in excess	recommended	Actual	Lacking /in excess
Doctor	89	204	+115	34	40	+6	33	32	-1	23	27	+4
Dentist	31	25	-6	20	12	-8	16	11	-5	11	10	-1
Pharmacist	31	35	+4	18	18	0	15	14	-1	11	13	+2
Nurse	656	585	-71	265	301	+36	219	245	+26	153	180	+27

Table 6.5.8-2

Bed per Poppulation Ratio in the Studied Area

Hosital	Amount of Bed	Poppulation	Bed per Population Ratio				
			Current	Construction Period	Operation Period	Standard Value	Compared to Standard Value
Ratchaburi hospital	855	98,779	1 : 116	1 : 234	1 : 116	1 : 10,000	Pass

Remark : [1/] The population in the area responsible for the health service system includes health insurance rights. Social Security rights Civil servants / state enterprises rights And other permissions

[2/] Employees/worker during construction phase : 3,000 people

[3/] Employees during operation phase : 60 people

[4/] Bed Ratio according to the tertiary levels of the Hospital (GIS standard)

- Bed for tertiary service ratio is 1 : 5,000
- Bed for medium tertiary service ratio is 1 : 2,500
- Bed for top tertiary service ratio 1 : 1,333

The project has schedule annual emergency drills to prepare for emergency response with relevant agencies in the area, at least once a year. In case of severe injuries and found that it exceeds the capability of the project. The sick or injured person will be transferred to receive treatment at Ratchaburi Hospital. This is an 855-bed community hospital located about 12 kilometers and takes approximately 15 minutes by using project cars or Ratchaburi Hospital Ambulance (depends on each situation).

However, if considering the information of Ratchaburi Hospital and found that it was beyond the capacity, patient will be referred to the local private hospital or hospitals in Bangkok (depends on the situation). These hospitals have the potential to support the injured from the accident and have a team of specialists in the accident. An emergency coordination diagram and the referral system network can be seen in **Figure 6.5.8-1** and **Figure 6.5.8-2.**

2) Data from the household representative questionnaire

From the public opinion survey for people in the study area, it was found that the majority of people when suffering from illness, they would admitted to the public hospital. Then, followed by treatment at a private hospital, buy self-medication and by Tambon Health Promoting Hospital, respectively. However, from the survey they said no household member was sick in the past year and stated that there were no patients with congenital disease in the household, respectively.

Flowchart showing employee emergency coordination procedures

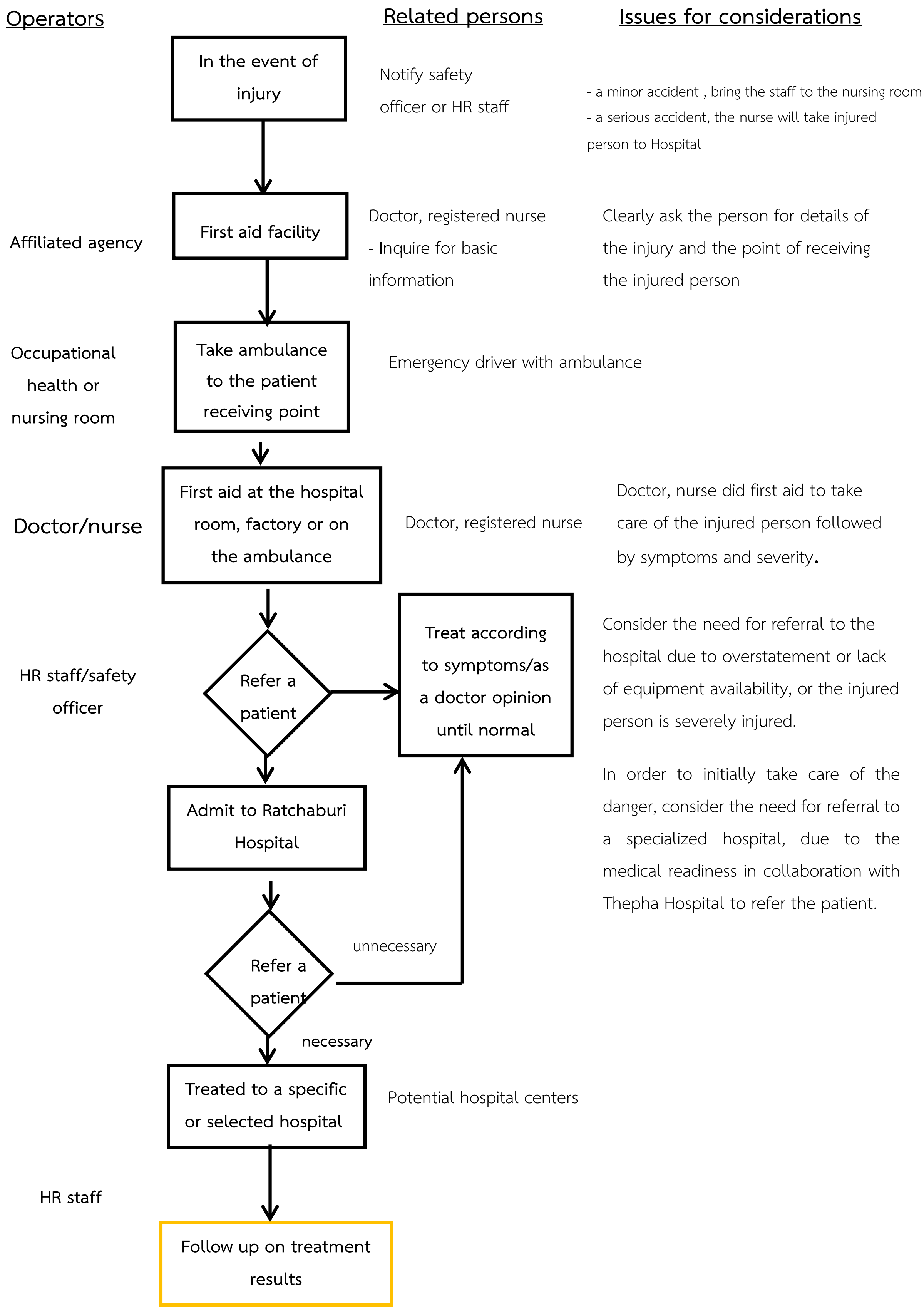

Figure 6.5.8-1 Chart showing coordination between staffs in case of emergency

Emergency Case in the Project Area

Normal Emergency Case/ Lack Severity

1. The project's nurse office
2. Outside Project's contacts
   - dial 1669
   - local authorities (Subdistrict Administration Organization., Local Government)
   - Ratchaburi Hospital (0-3271-9600)

- First Aid Medical Operation Unit
  (local government, Subdistrict Administration Organization)
  Project's ambulance car
- First-level Hospital (Ratchaburi Hospital)

Deliver Patient within 10 minutes

Serious Emergency Case

Emergency cse contacts
1. dial 1669
2. Ratchaburi Hospital

High-level Hospital

* **Ratchaburi Hospital** : outpatient department, inpatient department, emergency department, birth operating room, operating room, diabetes clinic, dental clinic

Personnel Information : consists of 159 doctors, 17 dentists, 41 pharmacist, 602 nurses, 1 detal public health officer, 3 pharmacy officer, 1 technical nurse, 8 physical therapist, 23 medical technician, 10 medical radiologist.

Medical Equipments : 855 inpatient beds, 45 I.C.U beds, 8 special room beds, 193 special single rooms, 16 operation rooms, 41 outpatient rooms.

Medical Electronic Equipments : 1 CT SCAN 21 Ultrasound scan and 7 ambulance vehicles.

Figure 6.5.8-2 Process of transferring patient in case of emergency

(4) Summary of health impacts

During the construction of the project, there are a maximum of 3,000 construction workers with a maximum construction time of 33-42 months, possibly causing changes in the population structure with increasing labor age (15-59 years). This only happens during the construction phase. Therefore, there are changes in the population of labor specific age. During the operation phase, there are 60 employees, which is likely to affect the access to the health service system. In addition, the project has measures to support public health agencies in the area. Therefore, the *risk of impact on the health system was considered at a moderate level* and when considering details of the health personnel working in Ratchaburi Hospital, according to the number of medical personnel that should have and the actual number of physical medical personnel in Ratchaburi, it was found that most of health services still lacked important medical personnel, especially, registered nurses during construction and operation phases. The project has the number of workers and employees that may be a burden to local health service agencies. However, the project has a policy to recruit local employees as the first priority. There are benefits such as social security covering private health care groups which can reduce the number of hospital services in the area.

Likelihood	Severity	Impact Level (likelihood x severity)
Moderate (3)	Moderate (2)	**moderate (6)**

Therefore, the operation of the project has an impact on the quality of services and the access to services of the people but may only make a slight increase. Therefore, *the severity of impact had been assessed at a moderate level*. Thus, *the impact was moderate*.

6.5.9 Mental impacts

(1) Health threats and their health impacts

From the definition of good human health, this includes having good mental health The meaning of mental health, according to the World Health Organization definition (Mental Health, 2001), refers to the normal state of health in which individuals have an understanding of their potential, able to deal with general stress problems appropriately, operate their businesses effectively, benefit themselves and social. For the Thai public health, Dr.Apichaimongkol and his team conducted a review study on happiness and mental health in the context of Thai society, which consisted of 4 components:

- ***Mental state,*** means a condition of perception of one's own state as being happy or unhappy

- ***Mental capacity***, means the ability of the mind to build a relationship with others and to deal with various problems.
- ***Quality of mind,*** means different features which are good in the mind for the benefit of oneself and society.
- ***Supporting factors,*** means various related factors contributing to a good mental health.

From the approach to assessing the health impact: social and psychological aspects in the environmental impact analysis report done by the advisory group of the Department of Mental Health (September, B.E.2553), it mentioned the conceptual framework for health impact assessment: mental well-being was divided into 4 parts as follows:

1) Factors that increase the ability to control and manage matters by themselves, self-controls, financial controls and management controls, living environmental control, influence on decisions related to neighbors, work/work environment controls, etc.
2) Factors that reduce anxiety are having knowledge and understanding of service systems and social support resources, clear access to project resources, and information communication at all stages, including reliability of information, risk communication, a sense of security (e.g, crime, group opinion).
3) Public participation factors such as feeling of belonging to society, having a valuable role that one would be proud.
4) Factors promoting social and equality network in the community, community participation, promotion of community integration and networking.

When comparing the view of Buddhism, scholars and the general public, according to the definition that many parts have defined, it was found that "mental health" and "happiness" have the same meaning in the Thai social context. However, mental health has a broader meaning than psychiatry because mental health work includes non-sick population to sick or previously sick person, mentally ill. In normal way of life, in general society has changed back and forth between a normal person who may have problems and a mentally ill person who may recover to a normal person.

(2) Baseline information in the field of impact

From the public hearing and stakeholders in the PP1 and PP2 process, it was found that there were still concerns of the public from the 2nd public hearing meeting as summarized in **Chapter 4**. The project has already established environmental impact prevention and measures along with measures for monitoring and examining environmental impacts.

(3) The magnitude of risks and health impacts occurring from the project

Issues of concern with environmental impacts were community relations and social support, public utility services, environmental health, drainage and flood protection and serious dangers and emergencies. If the information was not clarified, it could cause psychological and stress consequences for people who were worry that they were at risk. Therefore, in environmental and safety management issues related to the project operation, building a detailed understanding of the project, and clearly informed the public could reduce the anxiety and stress of people.

The project has established clear environmental impact prevention and measures to cover all issues that may cause impacts from the project and present results of environmental quality measurement to the community with the simplify conversion, so that, villagers can understand easily in the community center. The project coordinated with community leaders or local government organizations on a regular basis every 6 months to relieve public anxiety about the project operation that may cause environmental impacts as detailed in **Chapter 7**. Therefore, the risk of the health impact on *system was considered at a moderate level*. Regarding the environmental management and safety issues related to the project operation, building a detailed understanding of the project and clearly informed to the public would able to reduce the anxiety and stress of the people. *Therefore, the severity of the impact was moderate*. Therefore, the risk of impact *was moderate*.

Likelihood	Severity	Impact Level (likelihood x severity)
Moderate (3)	Moderate (2)	**moderate (6)**

Therefore, the project must implement environmental impact prevention and measures by working together with the public relations activities of the project

6.6 Summary of the qualitative health risk assessment

From results of the health impact assessment as described above both in terms of construction workers, project staff and communities in the study area, a qualitative health risk assessment using the Health Risk Matrix method was done to identify the potential and significant impact on the health of construction workers, project staff and the health of the community in the neighborhood, in order to formulate additional health measure. They were summarized in **Table 6.6-1** to **Table 6.6-4**, respectively.

Table 6.6-1

Summary of qualitative risk assessment for the health of construction workers (during Construction Perod)

Table 6.6-1 Summary of qualitative risk assessment for the health of construction workers (During Construction Phase)

Impact	Impact Characteristics	Health Risk Matrix			Additional Health Measures (construction health during construction)
		Likelihood	Severity	Impact Level	
Air pollution	Physical Impacts : The risk of developing respiratory disease increases. Psychological Impacts : stress, anxiety, insecurity in the air they breathe and trouble and annoyed by dust and dirt.	High (4) : activities generating dust included site preparation and transportation of construction materials. Most of the dust generating from construction activities in the construction area was large dust. Impacts on construction workers could easily fall into the area. As a result, the dispersed dust was limited to the construction area. The most likely to be exposed were construction workers. The exposure likelihood was high.	Moderate (2) : the exposure occurred by breathing. The exposure time was approximately 8 hours, with large dust reaching the upper respiratory system only and the body could eliminated them by coughing, sneezing, or secreting mucus. The severity was moderate.	Moderate (8)	-Spray water onto the construction area to stop and reduce the dust and particulate matters. - Completely cover the construction equipment on the truck with cloth all throughout the transportation phase. - Clean the truck's wheels before leaving the construction site. - Limit truck speed to reduce dust
Noise	Physical Impacts : Hearing Impairment	High (4) : activities causing noise during construction were site preparation and drilling activities.	Moderate (2) : the long-term exposure to loud noises causes hearing damage and may result	Moderate (8)	- Only use noisy construction equipments during the day

Table 6.6-1 Summary of qualitative risk assessment for the health of construction workers (During Construction Phase)

Impact	Impact Characteristics	Health Risk Matrix			Additional Health Measures (construction health during construction)
		Likelihood	Severity	Impact Level	
	Psychological Impacts : Annoyance from contnious exposure	Activities with the highest noise level were drilling/foundation work. The people who have been exposed directly to the voice were workers, so the likelihood of exposure was high.	in hearing loss. However, the noise during the construction of the project would only occur during the working period (08.00-17.00). The construction workers therefore had not been exposed to the noise continuously. The severity was moderate.		- Let the contractor use appropriate equipments with low risk during the construction and do a regular equipment checkup. - Have personal safety equipments such as ear plugs for the construction workers in loud working area (higher than 85 decibel (A))
Vibration	Physicsal Impacts : May be dangerous due to the vibration Psychological Impact	Moderate (3) : piling caused the most vibration to the structure of a nearby residence. The vibration had a direct impact on construction workers working with tools, machines with high vibration. This impacts occurred throughout the body of the operator during	Moderate (2) : an exposure to hazards vibration of operator hands and arms leading to disorders of the circulatory, nervous, bone, joint and muscular systems. Using the tool for a long time or tightly holding the tool would decreased the	Moderate (6)	- Have break at intervals and rotations of workers and machines/ equipments - Find safety equipments for personnels such as gloves and etc

Table 6.6-1 Summary of qualitative risk assessment for the health of construction workers (During Construction Phase)

Impact	Impact Characteristics	Health Risk Matrix			Additional Health Measures (construction health during construction)
		Likelihood	Severity	Impact Level	
	: Annoyance from continuous exposure	activities such as driving or standing to control the vibration of machinery. The exposure likelihood was moderate.	blood supply to the end of the tissue. In the event of continuously exposed, it would cause a muscle death and the symptoms would get worse and faster when working in a cold environment. The severity was moderate.		
Heat	Physical Impacts : Get rashes, feel faint or weak Psychological Impact : Discomfort	Moderate (3) : activities posing a health threat were working in open spaces and/or extreme heat. Most construction activities operated in the open air and with hot weather. The exposure likelihood was moderate.	Moderate (2) : heat was dangerous to the health of construction workers. Fainting, fatigue, or exhaustion could occurred due to the body tried to keep the temperature as normal all the time. Therefore, it need to find a way to remove heat from the body. If the body was unable to remove the heat immediately, it will have a	Moderate (6)	- Set up resting area with shades and provide cold water to compensate from sweating - Strictly follow rules and regulations to reduce risk on construction worker's healths

Table 6.6-1 Summary of qualitative risk assessment for the health of construction workers (During Construction Phase)

Impact	Impact Characteristics	Health Risk Matrix			Additional Health Measures (construction health during construction)
		Likelihood	Severity	Impact Level	
			negative impact on the body. The severity was moderate.		
Bright light	Physical Impact : damage the cornea and the conjuctiva Psychological Impact : Stress from prolong exposure	Moderate (3) : construction workers were on site workers and therefore are at risk of direct exposure to bright light. The project required contractors to supply dimming shields/dimming glasses for welding work. The exposure likelihood was moderate	Moderate (2) : Welding would cause welding sparks, including bright light, which could damage the cornea or conjunctiva causing inflammation of the conjunctiva. The severity was moderate.	Moderate (6)	- Find safety equipments such as shades or sunglasses for personnels and staffs
Work related accident	Physical Impact : wound and physical pain Psychological Impact : anxiety	Low (2) : it posed a health threat, including working in unsafe conditions. The construction activities that were at risk of occupational accidents were foundations activities, civil works and buildings. The likelihood of the exposure was low.	High (3) : Work-related accidents could happen in mild to very severe levels. In most cases, the accident arises from the negligence of workers, such as not wearing personal protective equipment while working, etc. If such an accident occurs, it may result in life. The severity was high.	Moderate (6)	- Organize trainings/sessions for supervisors and workers on safety in construction site - Have safety equipments in good shape and in the appropriate place in case of urgent uses or emergency - Do regular safety inspection and give clear supervising rights to the appropriate personnel.

Table 6.6-1 Summary of qualitative risk assessment for the health of construction workers (During Construction Phase)

Impact	Impact Characteristics	Health Risk Matrix			Additional Health Measures (construction health during construction)
		Likelihood	Severity	Impact Level	
Metal fume	Physical Impact : metal fume fever : Respiratory disease Psychological Impact : anxiety	Moderate (3) : workers performing the primary function of welding would had the opportunity to expose fumes from welding. The exposure likelihood was moderate.	Moderate (2) : resuming to work normally because the body had immunity, but it was not permanent. If the exposure had been stopped for a long time, such as on weekends symptoms would reappear when re-exposed. The severity was moderate.	Moderate (6)	- Provide anti metal fume masks for the construction workers
Pathogen from sewage	Physical Impact : gastrointestinal disease Psychological Impact : troubled mind	Moderate (3) : Main risk groups consisted of construction workers who were closest to the source of the waste and those working on the day-to-day basis. They were carriers of the disease back to spread in the community where they live. The exposure likelihood was moderate.	Moderate (2) : activities posing a threat to health were sewage and sewage drained from workers' accommodations and solid waste. In the event of no good sanitation system, it may be a spreading source of pathogens that were carried by insects and disease-carrier animals, especially, gastrointestinal disease. The severity was moderate.	Moderate (6)	- Make sure the contracted agency provide clean housing for the workers including clean and sanitize washroom and toilets. Make sure the wastes are properly taken care of, and the clean water are properly stored and sorted out so that the water will not be contaminated.

Table 6.6-1 Summary of qualitative risk assessment for the health of construction workers (During Construction Phase)

Impact	Impact Characteristics	Health Risk Matrix			Additional Health Measures (construction health during construction)
		Likelihood	Severity	Impact Level	
Contagious/ non-contagious disease	Physical Impact : physical unwell and pain Psychological : : troubled mind	Moderate (3) : construction workers had worked from morning to evening. Therefore, health impacts may occurred only temporarily. The exposure likelihood was moderate.	Moderate (2) : the accommodation for construction workers was temporary for the 33-42 months. The coexistence of approximately 3,000 people created a collection of waste and sewage which were all sources of infectious transmitter and vectors, such as flies, mosquitoes, black mosquitoes, cockroaches, including rats, dogs and cats, etc. The communicable and non-communicable diseases may occurred such as cholera, dengue fever, filariasis, allergies from cockroaches and plague. In addition, their inclusion in a limited location leading to the risk of exposure to communicable and non-	Moderate (6)	- Look after the construction workers' housings to make sure they stay in good shape and protect them from pathogens and contagious disease. - Cover the pond and water tank carefully so they cannot become breeding site for insects or mosquitos. - Provide knowledge on how to prevent contagious/ non contagious disease from spreading to every construction workers

Table 6.6-1 Summary of qualitative risk assessment for the health of construction workers (During Construction Phase)

Impact	Impact Characteristics	Health Risk Matrix			Additional Health Measures (construction health during construction)
		Likelihood	Severity	Impact Level	
			communicable diseases caused by human to human, such as leprosy, hepatitis A, syphilis, AIDS, tuberculosis. Therefore, the severity was moderate.		

Table 6.6-2

Summary of qualitative risk assessment on employee health (operation period)

Impact	Impact Characteristics	Health Risk Metrix (operation phase)			Health Measures
		Likelihood	Severity	Impact Level	
Loud noise	Physical Impact : Hearing Impariment Psychological Impact : : troubled mind	Moderate (3) : machines making noise during operation were a gas turbine generator, steam turbine power generator, steam generating unit, condenser and cooling tower. To control the operation of various machines, an automatic system was used with the supervisor worked in the control room. There was only occasional exposure to the noise level in the area. The risk of exposure was moderate.	Moderate (3) : project activities posed the risk of hearing loss to employee, but not severe. Due to the noisy areas, employees only entered occasionally. Therefore, the severity was moderate.	Moderate (9)	- Regular check up and fixation for the equipments to not become a loud noise source - Put the loud noise creating machine such as steam turbine engine and gas turbine engine in closed building - Area with noise louder than 85 decibel (A) should not have any permanent-stationed workers. The area should also have signboards indicating for loud noises

Table 6.6-2 Summary of qualitative risk assessment on employee health (operation phase)

Impact	Impact Characteristics	Health Risk Metrix (operation phase)			Health Measures
		Likelihood	Severity	Impact Level	
					sound-proof door for the Operation Room locating in the production department. - Area with noise louder than 85 decibel(A) must have a loud noise permit and signboards indicating for the need of safety equipments such as earplug and ear muff - Install a noise reduction equipment onto the machine that produce noise louder than 85 decibel(A). Also, provide noise protection measures in area with regular personnels with

Table 6.6-2 Summary of qualitative risk assessment on employee health (operation phase)

Impact	Impact Characteristics	Health Risk Metrix (operation phase)			Health Measures
		Likelihood	Severity	Impact Level	
					noise louder than 85 decibel(A). - Provide health check-up for newcomers and yearly health check-ups such as lung x ray, hearing ability, eye sight, general health, blood concentration, and etc.
Heat	Physical Impact : Danger from heat Psychological Impact: Troubled mind	Moderate (3): most of the high heat working areas of the project did not have staff to control the work of the machines due to they were automated systems and employees worked in the control room. The exposure to the heat would be from time to time during the maintenance of availability and malfunction of machinery and equipment in	Moderate (3): heat is harmful to employees health which causing various body systems to work malfunctions, heat stroke, heat exhaustion. However, due to heat exposure during the operation of employees would be occasionally and for a short period of time, so the severity of impact was moderate.	Moderate (9)	- Require permit before entering area with heat risks and provide safety equipments for those entering the area.

Table 6.6-2 Summary of qualitative risk assessment on employee health (operation phase)

Impact	Impact Characteristics	Health Risk Metrix (operation phase)			Health Measures
		Likelihood	Severity	Impact Level	
		occasional. It was a short-time operation. Therefore, there was moderate risk of exposure to heat.			
Chemical exposure	Physical Impact : skin irritation ; harm to respiratory system Psychological Impact: stress and anxiety related to safety	Moderate (3): impacts of exposure to chemicals likely arising from chemical storage and usage. Risk activities were included the use within the project causing an incident that could cause a chemical leak. It usually occurred in the event of an operation failure, such as the transfer of the chemical, usage and then leak and storage leaks. The operator then exposed to chemicals during such activities through skin and respiratory. Therefore, it had a moderate risk of exposure to chemicals.	Moderate (3): most chemicals and additives used in the project were chemicals for the water quality improvement system. The use of project chemicals may cause harm to employees' health. From the data of the chemicals used in the project, it was found that they did not contain carcinogens. The severity of the impact was moderate.	Moderate (9)	- Wear personal protective equipment (PPE) as indicated in the MSDS of each specific chemicals with required equipment of googles and chemical gloves. - In case of chemical transportation for usage, production unit supervisor and personnel must be careful to not let there be any chemical spills or leakages. They have to look after and check the transferring container. In

Table 6.6-2 Summary of qualitative risk assessment on employee health (operation phase)

Impact	Impact Characteristics	Health Risk Metrix (operation phase)			Health Measures
		Likelihood	Severity	Impact Level	
					case of spills and leakages, follow the predetermined procedure and regulations. Afterwards, the production unit supervisor must check the storage area before and after uses.

Table 6.6-3

Summary of the qualitative risk assessment to the community in the study area "The construction period"

Impact	Possible Impact characteristics	Health Risk on the community Metrix (construction phase)		Impact Level	Health Measures
		Likelihood	Severity		
Air pollution	Physical Impact People living in the area were at increased risk of developing respiratory disease .Psychological Impact stress, anxiety, insecurity in the air they breathe, nuisance from dust and dirt.	Moderate (3): the project had activities generating more dust, however, most of the dust generated from the adjustment and transportation of construction materials which easily fell into the area. As a result, the dispersed dust was limited to the construction area and construction workers were directly affected. Therefore, the risk of impact from air pollution was considered at a moderate level.	Moderate (2) : most construction phase dust with their particle sizes were more than 10 microns (TSP) were usually only accessible to the nose and throat. Especially, the throat part of the nose which was the first part that must be exposed to dust. Therefore it causing frequent irritation, sneezing and sore throat. Most of the dust was captured by the nasal hairs and the complex of the nasal passages and then excreted with the mucus. Therefore, the severity was assessed at a moderate level.	Moderate (6)	- Regularly spray water in the construction area and the transportation road (at least twice a day) - Cover the dirt pile and truck to prevent the creation and spread of dust during transportation.
Noise pollution and vibration	Physical Impact people living in the area were at risk of hearing damage. Psychological Impact nuisance and annoying from noise	Moderate (3): construction phase noise source activities were drilling and foundation activities. It had a sound level of 83.0 decibels (A) at a distance of 15 meters and was performed only during daytime (7: 00-17: 00 hrs.). When considering the	Moderate (2) : from the evaluation of the noise impact by assessing the general noise level and the noise generated during the construction period, it was found that the average noise level of 24 hours was within the specified standard. It was found that	Moderate (6)	- Only allow the usage of loud noise equipments during the day 7.00-17.00. - Choose to use equipments and machine with low noise output during the construction

Table 6.6-3(cont.) Summary of the qualitative risk assessment to the community in the study area "construction phase"

Impact	Possible Impact characteristics	Health Risk on the community Metrix (construction phase)		Impact Level	Health Measures
		Likelihood	Severity		
	and vibrations that occur during construction.	vibrations caused by construction excavation and foundations, it was found that the vibration level in the housing area on the south side of the project at a level that humans can feel the vibrations and the higher the level of vibration affected the destruction or damage to the archaeological site. As for the impact on the buildings, it was found to not be a dangerous even the ancient building. However, the impact only occurred during the construction period, therefore there was a moderate exposure risk	there were times when the noise level was close to 10 decibels (A). However, the project installed a temporary sound barrier. Therefore, the project activities did not cause disturbance levels. Therefore, the severity was moderate.		
Pollution from solid waste and industrial waste	Physical Impact the development of various diseases. Psychological Impact stress and anxiety that solid waste and industrial waste would	Moderate (3): wastes and solid waste were generated from the consumption of construction workers, such as food waste, plastic bags, etc., with a maximum amount of approximately 3,000 kilograms per day, including waste and solid waste from construction activities. For types of	Moderate (2) : If the waste management was improperly managed and left in the community area, it would cause environmental pollution. It was the leading cause of water pollution, soil pollution and air pollution. It also caused a nuisance. The left over garbage would cause odor throughout the	Moderate (6)	- Sort out trashes and garbages from activities and construction. Provide adequate amount of trash bins with lids in the area. Have people pick up the trashes daily and send

Table 6.6-3(cont.) Summary of the qualitative risk assessment to the community in the study area "construction phase"

Impact	Possible Impact characteristics	Health Risk on the community Metrix (construction phase)		Impact Level	Health Measures
		Likelihood	Severity		
	become contaminated.	wastes that can be recycled such as scrap, wood and brick etc., the project collected in the project area and contacted an outside company for sell and further recycling. The surrounding area of the project has a waste disposal facility for both government and private sectors which the project would contacted them to collect the general solid waste for disposal. Therefore, the risk of impact from solid waste and industrial waste was moderate.	community. However, the project provided the storage area organizing in order with adequate containers for all types of waste generated in the construction project. The waste separation container was collected once a day. The contractor company was responsible for the quantity and waste management. The severity was moderate.		them to certified agencies to further dispose of them. - Gather and sort trashes so that as many of them as possible can be reused, recycled, or sold to certified organization. - Infrom the workers to not throw trashes into the drain
Safety of life and property	Physical Impact people in the area are at risk of crime. Psychological Impact feeling insecure	Moderate (3): during the construction phase of the project, there will be a maximum of 3,000 construction workers, which could lead to a change in the population structure with an increase in labor age (15-59 years). Entering into the community of migrant workers creates community alienation. It may make people in the community worry about crime,	Moderate (2) : based on basic information on the safety of life and property statistics, the number of criminal cases in the study area, it was found that numbers of state cases were the highest number of victims. Most of them were drug cases, followed by gambling cases, firearms and explosives, and offenses relating to the Immigration Act, respectively. The project had	Moderate (6)	- Consider to hire local workers with the right characteristics to help promote the local community's economy and help build relationships with the local community - Make sure the construction workers do not commit bad behavior such as

Table 6.6-3(cont.) Summary of the qualitative risk assessment to the community in the study area "construction phase"

Impact	Possible Impact characteristics	Health Risk on the community Metrix (construction phase)		Impact Level	Health Measures
		Likelihood	Severity		
		controversy, burglary and drugs, etc. The entry of workers will only take place during the construction period. Therefore, the risk of health impacts from the safety of life and property was moderate.	established measures for recruiting local workers as the first priority. In addition, the contractor must have measures to supervise these workers to comply with the regulations as specified by the project, in order to prevent impacts on life and property safety to the surrounding communities. The severity was moderate.		crime, stealing, gambling, and etc. Work with the local government to impose punishment in case of bad behaviors. - Closely monitor the construction worker behavior as to not cause incidents or annoyance for the nearby community. - Make sure the contracted organization and affiliated organization strictly follow the regulations via monitoring their working site, housing, and trash bins, and do random drug testing.
Transportation(accident)	Physical Impact people are at risk of death, injury and disability due to road accidents.	Moderate (3): project activities during construction phase such as the transportation of materials and equipment and construction workers, the expected impact was an accident.	Moderate (2) : from the assessment of the traffic impact of the project during the construction phase, it was found that the rural highway No.KorJor 4004, the road in front of the power plant and	Moderate (6)	- Indicate transportation area and set up guards infront of the entrance/exit. Also avoid traffic area for transportation.

Table 6.6-3(cont.) Summary of the qualitative risk assessment to the community in the study area "construction phase"

Impact	Possible Impact characteristics	Health Risk on the community Metrix (construction phase)		Impact Level	Health Measures
		Likelihood	Severity		
	Psychological Impact feeling insecure	It led to the higher traffic volume. Therefore, the risk of impact from transportation (accidents) was moderate.	in front of Big Food Group Co., Ltd., had a traffic index (V / C) at A level. This level was a service level that vehicles could move freely with free flow speed, without changing the service level of the road in any way. Thus, the severity was moderate.		- Plan the transportation route to avoid any community area as much as possible to avoid negatively impacting the community road system. - Make sure the contracted organization carefully control the transportation driver to strictly follow the traffic laws. - Make sure the driver transporting resources/ equipments to do not exceed the speed limit as instructed in the traffic laws.
Public Health Service System	Social Impact accessibility to local health services	Moderate (3): during project construction phase, there will be a maximum of 3,000 construction workers with a maximum construction time of 33-42 months, which could cause demographic changes with	Moderate (2) : during the construction of the project, it would temporarily increase the number of employees that may be a burden to the local health service units. Therefore, the project operation had an impact on the quality	Moderate (6)	- Cooperate with the health agencies in the area to monitor the health and safety of the community. - Cooperate with local health agencies on

Table 6.6-3(cont.) Summary of the qualitative risk assessment to the community in the study area "construction phase"

Impact	Possible Impact characteristics	Health Risk on the community Metrix (construction phase)		Impact Level	Health Measures
		Likelihood	Severity		
		increased labor age (15-59 years), occurring only during the construction period. Therefore, there are changes in the population of labor specific age. There is a possibility that it may affect the accessibility of the healthcare system. Therefore, the risk on the health system was moderate.	of services and the accessibility of services with only a slight increase. However, the project provided a first aid kit according to the Ministerial Regulations (Ministry of Labor) on welfare arrangements in establishments, B.E.2548. Therefore, the severity of the impact was moderate.		spreading knowledge on washroom sanity, pathogens, and contagious disease to the community citizens and the workers, - Cooperate with the local health agencies in protection measures against pathogens breeding ground such as pathogen-carrying mosquitos.
Psychological Impact	Psychological Impact feeling insecure and anxiety	Moderate (3): issues of concerns for people with environmental impacts such as community relations and social support, public utility services and environmental health, serious hazards and emergencies. When information were not clear, it could lead psychological and stressful consequences for people who worry that they were at risk. The project has	Moderate (2) : the project must have environmental and safety management related to its operations. Building a detailed understanding of the project for the public to be clearly informed would reduce the anxiety and stress of the people. Therefore the severity was moderate.	Moderate (6)	- strictly follow the regulations

Table 6.6-3(cont.) Summary of the qualitative risk assessment to the community in the study area "construction phase"

Impact	Possible Impact characteristics	Health Risk on the community Metrix (construction phase)		Impact Level	Health Measures
		Likelihood	Severity		
		established clear environmental impact prevention and measures to cover all issues that may cause impacts from the project. Results of environmental quality measurement would be presented to the community with the simplify conversion, so that, villagers can easily understand in the center of the community. The project coordinated with community leaders or local government organizations on a regular basis, in order to relieve public anxiety about the implementation of projects that may cause environmental impacts. Thus, the risk of impact on the health system was moderate.			

Table 6.6-4

Summary of the qualitative risk assessment to the community in the study area "Operation period"

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Impact	Possible Impact characteristics	Health Risk on the community Metrix (operation phase)			Health Measures
		Likelihood	Severity	Impact Level	
Water resources	Physical Impact water shortage for the consumption then people were at risk of illness. Psychological Impact anxiety and stress	Moderate (3): the likelihood of impacts may arise from the lack of water resources for the consumption. It could be caused by many reasons such as climate change, demand for water increases as the population increases, inadequate natural and built reservoirs and improper water management. Therefore, the risk of impacts was moderate.	Moderate (2) : from the socio-economic study by interviewing heads of households of communities in the study area, together with the secondary data collection, it was found that water sources were used for community consumption in the study area. Most people bought water for consumption. Thus, the severity was moderate.	Moderate (6)	- Set up 1 raw water basin sized 92,838 m^3 for substitution within the project area (can substitute for atleast 3 days) - Follow the regulations and restriction from the local government.
Air pollution	Physical Impact people in the area are at increased risk of developing respiratory disease. Psychological Impact stress, anxiety, insecurity in the air they breathe and	Moderate (3): the project has emitted airborne pollutants throughout the operation phase. However, air pollutants from the stack were controlled to meet standard values by the CEMs system. Thus, the likelihood of air pollution impacts was moderate.	Moderate (2) : during the operation phase, the main pollutants arising from the project activities were sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) gases. For an air pollution from the project in both acute (short-term) and chronic (long-term) cases, it was found that the impact risk ratio (HQ) was less than 1 for both short-term and long-term. The	Moderate (6)	- Control the air particulate matter released as to not exceed the predicted/ controlled amount as state in the environmental impact assessment report. - Hire employee with knowledge on air pollution control as indicated by

Table 6.6-4(cont.) Summary of the qualitative risk assessment to the community in the study area "Operation period

Impact	Possible Impact characteristics	Health Risk on the community Metrix (operation phase)			Health Measures
		Likelihood	Severity	Impact Level	
	annoyance from dust and dirt.		concentration of the said substance was below all reference concentrations. Therefore, the severity of the impact of air pollution was moderate.		Notification of the Ministry of Industry B.E.2545 - Install Continious Emission Monitoring System (CEMS)
Noiuse pollution and vibration	Physical Impact People in the area are at risk of hearing impairment Psychological Impact Annoyance	Moderate (3): the noisy sources of the project were a gas turbine generator, steam turbine power generator, steam generating unit, condenser. Gas turbine generators and a steam turbine generator were installed inside the building. The project has required the designer to design all kinds of machines with the average noise level does not exceed 85 decibels (A) at a distance of 1 meter. However, if any machines could not reduce the noise level, the project would control the noise level not to exceed the above limit, such as building a cover or installing a silencer around the safety	Moderate (2) : from the results of the 24-hour average noise level measurement around the project area, it was found that most of measurement results were within the general noise level standard, according to the Announcement of National Environment Board, No.15, B.E.2540, which sets the 24-hour noise level not exceed 70 decibels (A). Therefore, the severity was moderate.	Moderate (6)	- Machines that produce loud noises will be fixed at the core/source such as using lubrication or reduing vibration. - Create plans for regular equipment check-up and fix equipments/monitor equipment at regular intervals to reduce loud noises and their impacts.

Table 6.6-4(cont.) Summary of the qualitative risk assessment to the community in the study area "Operation period

Impact	Possible Impact characteristics	Health Risk on the community Metrix (operation phase) Likelihood	Severity	Impact Level	Health Measures
		valve, etc. The vibration, mainly occurred by the transportation of large chemical trucks only. A frequency of transportation was approximately once a month. The project would avoid the transportation in the route that passes through the community, so that there was no impacts on the structures of the neighboring residence. Thus, the likelihood of exposure was moderate.			
Wastewater management	Physical Impact people in the area are at risk of developing gastrointestinal disease. Psychological Impact stress and concerns that the project effluent reservoir might be contaminated.	Moderate (3): most of the effluent was from cooling system water, which was low in dirt. The project sent it to a water quality inspection pond to measure the water quality to meet the standard before draining into the Mae Klong River. If the wastewater was in the standard criteria, the project then sent it to the holding pond before releasing into the Mae Klong River. If the wastewater was not	Moderate (2) : people in the study area were concerned about the adequacy of the water supply pumping for the project, and the project effluent may affect aquatic life, Wastewater generated by workers consumption would be collected into the septic tank installing in every building. Wastewater from production processes (mainly from the cooling system) would be collected and sent to the holding pond before being	Moderate (6)	Employ an employee to check the pipeline system and wasteswater management system every month. In case of broken equipment or any technical difficulties, it will be fixed as soon as possible. - Regulate the amount of wastewater released from the power plant in

Table 6.6-4(cont.) Summary of the qualitative risk assessment to the community in the study area "Operation period

Impact	Possible Impact characteristics	Health Risk on the community Metrix (operation phase)			Health Measures
		Likelihood	Severity	Impact Level	
		within the standard criteria, it would be sent to the emergency holding pond and the authorized agencies would be contacted by the project for further disposal. Moreover, the project has also controlled the effluent according to the law. Therefore, the risk of impact from water pollution was moderate.	utilized within the project area and some part would be drained into the Mae Klong River. However, the project has continuously measured the water quality around the pond and the quality of the Mae Klong River every 6 months. Therefore, the severity was moderate.		accordance to the standard. - Install Continious Water Quality Tester at the wastewater release site.
Transportation (accident)	Physical Impact People in the area are at risk of death, injury, and disability due to traffic accidents. Psychological Impact feeling insecure	Moderate (3): after the operation of the project, increasing in the transportation would occurred due to the number of trips of chemical and employee transportation. Therefore, the likelihood of health effects from transport (accidents) was moderate.	Moderate (2) : from the evaluation of the traffic impacts of the project during the operation phase, it was found that the rural highway No. KorJor 4004, a road in front of the power plant and in front of Big Food Group Co., Ltd., had a traffic index (V / C) at A level. This level was a service level that vehicles can moved freely with free flow speed, without changing the service level of the road in any way. The severity was moderate.	Moderate (6)	-Hold trainings or recommendations for the power plant workers on traffic regulations. - Employ an employee/guard to monitor and regulate any entry and exit at all time.

Table 6.6-4(cont.) Summary of the qualitative risk assessment to the community in the study area "Operation period

Impact	Possible Impact characteristics	Health Risk on the community Metrix (operation phase)			Health Measures
		Likelihood	Severity	Impact Level	
Public health service system	Social Impact People in the area may not be able to acces the public health centers.	Moderate (3): during the project operation, there were 60 employees with a potential impact on access to the healthcare system. However, the project has established measures to recruit local workers as the first priority. In addition, the project has measures to support public health agencies in the area. Therefore, the likelihood of the impacts was moderate.	Moderate (2) : when considering the details of resources and readiness of the public health sector, it was found that for the real medical personnel of Ratchaburi Hospital, Panurangsi Camp Hospital, Muangrat Hospital and hospitals with doctors, some of them still lacked important medical personnel. During the operation, there were a number of employees that may be a burden to the health service agencies in the area. However, the project had a policy of recruiting local employees as the first priority. In addition, the project has provided a first aid kit according to the Ministerial Regulations. (Ministry of Labor) on welfare arrangements in establishments, B.E.2548. Moreover, there were benefits such as social security covering private	Moderate (6)	- Cooperate with the hospitals to promote health and do community service with public health agenices. Promote activities and health care for employees and people in the area. - Create and promote health projects/campaign for the community. - cooperate with the public health service personnel in protection against disease and pathogen breeding ground.

Table 6.6-4(cont.) Summary of the qualitative risk assessment to the community in the study area "Operation period

Impact	Possible Impact characteristics	Health Risk on the community Metrix (operation phase)			Health Measures
		Likelihood	Severity	Impact Level	
			health care groups which could reduce the number of hospital services in the area. Therefore, the project operation may affect the quality of services and the accessibility to services of the people by only slightly increased. Therefore, the severity was moderate.		
Psychological impact	Psychological Impact feeling insecure and stressed	Moderate (3): issues of concern for people with environmental impacts were community relations and social support, public utility services and environmental health, drainage and flood protection and serious hazards and emergencies. If information was not cleared, it could cause psychological and stressful consequences for people who worry that they were at risk. The project has	Moderate (2) : the project must have environmental and safety management related to its operations. Building a detailed understanding of the project for the public to be clearly informed can reduce the anxiety and stress. Therefore, the severity was moderate.	Moderate (6)	- Strictly follow the regulations

Table 6.6-4(cont.) Summary of the qualitative risk assessment to the community in the study area "Operation period

Impact	Possible Impact characteristics	Health Risk on the community Metrix (operation phase)			Health Measures
		Likelihood	Severity	Impact Level	
		established clear environmental impact prevention and measures to cover all issues that may cause impacts from the project. Results of environmental quality measurement would be presented to the community with the simplified conversion, so that, villagers can understand easily in the center of the community. The project has coordinated with community leaders or local government organizations on a regular basis every six months to relieve public anxiety about the project operation that may cause environmental impacts. Therefore, the likelihood of impact on the health system was moderate.			

Chapter 7

Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program

Chapter 7
Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program

Hin Kong Power Company Limited has a plan to establish Hin Kong Power Plant Project, hereinafter referred to as "the Project". The Project aims at replacing the power generation which was terminated from the system on 30 June 2020 of the 700 MW combined cycle power plant of Ratchaburi Electricity Generating Company Limited (Tri Energy Power Plant Branch) or so-called TECO Power Plant. The Project locates in the area of TECO Power Plant. Hence, the area is ready and suitable for the electricity transmission system as well as fuel and raw water systems.

The Hin Kong Power Plant Project is a combined cycle power plant. The main fuel is natural gas while using diesel as a reserve fuel in an emergency case. The Project has a total area of 188 rai 3 ngan and 18 wa^2 (302,073 square meters). The main machine consists of 2 sets of gas turbine generators, 2 sets of steam generators, 2 sets of gas turbine generators, and a cooling tower system. The Project has a maximum installed capacity of 1,540 megawatts, a gross capacity of 1,520 megawatts, and a net capacity of 1,400 megawatts. The amount of electricity supplied to EGAT's network system is under the power purchase agreement.

For operational, the Project shall use water from Mae Klong River. The maximum amount of water will be 30,946 cubic meter / day and drainage into the river with a volume of 6,913 cubic meter / day. The Project shall lay a new raw water pipeline and discharge pipeline. The total distance is approximately 13 kilometers. The raw water pipeline is 24 inches in diameter and the discharge pipeline is 12 inches in diameter. The pipeline will be laid along the road and irrigation canal which is the original line of TECO Power Plant. The raw water pipeline that extends into the Mae Klong River will be at the level of -0.70 m MSL with a length of approximately 30 meters (the Mae Klong River pumping point is about 165 meters wide). The discharge point is the same area as the pumping point. The project shall install a discharge pipeline at the level of +0.50 m MSL with a length of 10 meters extending into the Mae Klong River. The discharge pipeline is approximately 1.7 meters from the raw water pipeline.

From the environmental, social, and health impacts assessment of the Project during the construction and the operation periods covering four environmental and resources aspects i.e. physical resources, biological resources, human use values, and quality of life values, found that resources and environmental values in the study area will be positively and negatively affected at different levels.

Therefore, in order to minimize the negative impact on resources and environmental values the Consultant has set environmental impact prevention and mitigation measures to prevent expected impacts to arise from the operation of the Project. The Consultant also set environmental impacts prevention and mitigation measures for the project of raw water and discharge pipelines installation of the Project. There are 13 aspects of the environmental action plan that must be followed for the implementation of the Project and 7 aspects of the environmental action plan for the installation of raw water and discharge pipelines. Details are as follows:

There are 13 aspects of the environmental action plan that must be followed for the implementation of the Project. Details are as follows:

(1) General action plan
(2) Air quality action plan
(3) Noise action plan
(4) Water use action plan
(5) Water quality and wastewater action plan
(6) Waste management action plan
(7) Transportation action plan
(8) Drainage and flood prevention action plan
(9) Action plan on occupational health and safety
(10) Health action plan
(11) Social and Economic Action Plan
(12) Aesthetics action plan
(13) Action plan on heat monitoring

There are 7 aspects of the environmental action plan for the installation of raw water and discharge pipelines that must be followed for the implementation of the Project. Details are as follows:

(1) Air quality action plan
(2) Noise action plan
(3) Vibration action plan
(4) Water quality and wastewater action plan
(5) Soil resources and erosion action plan
(6) Transportation action plan
(7) Waste management action plan

7.1 General action plan

(1) Rationale

In order to operate the Project to have the least impact on the environment, it is necessary to define basic measures for the Project to be fully operational and able to control the environmental impacts properly. For the general action plan, it is the determination of overall measures or conditions in addition to the measures on pollution control or safety operation, such as measures for preparing the performance report, conditions when the Project changes its descriptions, etc.

Therefore, it is necessary to set basic measures for the Project to be able to operate effectively and to control environmental impacts properly.

(2) Objectives

1) To reduce impacts that may occur in the construction and operation periods.

2) To monitor the implementation results of the environmental action plan measures and to control the implementation of the plan effectively.

(3) Target area/ operation

The Project area

(4) Environmental impact prevention and mitigation measures

1) Strictly follow the environmental impact prevention and mitigation measures and environmental quality monitoring program in the form of an environmental action plan as proposed in the EIA report of Hin Kong Power Plant Project of Hin Kong Power Company Limited, locates at Hin Kong Subdistrict, Mueang Ratchaburi District, Ratchaburi Province. The Project shall use the measures as a guideline for the supervision, control, and monitoring of the organization, the people, and related organizations.

2) Hin Kong Power Company Limited shall embed details of measures in the environmental action plan as essential conditions in the contract for the contracting company to be strictly implemented in order to achieve effectiveness in practice.

3) Hin Kong Power Company Limited shall maintain the cooling system to be in good working condition on a regular basis and is safe for workers and people in the vicinity area.

4) Hin Kong Power Company Limited is required to engage a third party to inspect the implementation of environmental impact prevention and correction measures and environmental impact monitoring program of the Project. The report on the implementation of environmental impact prevention and correction measures and

environmental impact monitoring program shall be submitted to licensing agencies, namely the Energy Regulatory Commission Office, the Department of Industrial Works, Ratchaburi Province, and electronic systems of the Office of Natural Resources and Environmental Policy and Planning. In this regard, the preparation of the report on the results of the measures implementation and the frequency of submission of the report shall be in accordance with the notification on criteria and methods for preparing a report on the results of the measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare after receiving permission to operate the project or business B.E. 2561 (2018) and related laws.

5) In cases where the environmental quality monitoring results have shown environmental problems including in the case of complaints from the community caused by the Project implementation, Hin Kong Power Company Limited shall improve and correct such problems as soon as possible. The Project shall notify the Energy Regulatory Commission, Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning to acknowledge soon in order to coordinate and cooperate in solving such problems.

6) If Hin Kong Power Company Limited requires to change the Project details or environmental impacts prevention and mitigation measures or environmental impact monitoring program from those presented in the environmental impact assessment report which has been approved by the expert committee, it is the duty of agencies that have the authority to consider or approve as follows:

(a) In the case that changing of the Project details or environmental impacts prevention and mitigation measures or environmental impacts monitoring program does not affect the essence of the environmental impact assessment in the EIA report and it is a measure that is more beneficial to the environment or equivalent to the measures specified in the EIA report that has been considered and approved by the expert committee, the competent authority shall approve or accept the notification of such amendment to be in accordance with the rules and conditions stipulated in that regulation. The contracted agency or agency with premits shall prepare a copy of the improved environmental impact prevention and mitigation measures or environmental impact monitoring program that has been notified and send it to the Office of Natural Resources and Environmental Policy and Planning for acknowledgment.

(b) If the authority agency considers that revising the Project details or measures may affect the essence of the EIA report approved by the expert committee, the authorized agency shall submit the revision report on the Project details or environmental impacts prevention and mitigation measures or measures to environmental impact monitoring program to the Office of Natural Resources and Environmental Policy and Planning to propose to the expert committee. When the Project has changed details or improved the measures according to the expert committee comments, the authorized agency shall acknowledge the results of the changes to the Office of Natural Resources and Environmental Policy and Planning.

7) When the Project's operation is in the steady-state and the emission of an air pollutant is lower than the values set in the measures, the Project shall use that as a control level and notify the Office of Natural Resources and Environmental Policy and Planning as soon as possible.

8) Hin Kong Power Company Limited is required to obtain permission to use the area for pipeline installation from the landlord and the licensing agency before starting the construction of the Project.

9) Disclose details of the Project, advantages - disadvantages of the Project, and results of the implementation of the measures to the community to acknowledge in order to create a better understanding along with providing opportunities for the community to participate in the monitoring of the Project's operation throughout the project life span.

10) The Project shall provide a channel for receiving complaints, such as over the phone, and establish a clear procedure for receiving complaints both general and emergency cases. In the case that there is a complaint from the community against the operation of the project, the Project must promptly fix the problem and record it as a report as well.

11) If damage occurs due to the Project operation, Hin Kong Power Company Limited shall carry out urgent compensation payments to those affected for initial emergency relief. However, the process of paying compensation in normal cases is applied when the cause and the total cost of the damage are finalized. The insurance company will pay the victim directly in accordance with the compensation procedure of the insurance company.

12) The project shall not block, limit the right, refrain, or prohibit anyone from entering the public area.

13) Clear signboards and symbols to specify area boundaries shall be provided at the area of the Project where adjacent to the public areas.

(5) Environmental impact monitoring measure

-

(6) Implementation period

Before construction and throughout the construction and operation periods

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Pre-construction period :	all specified measures, the cost will be approximately 665,000 Baht
Construction period :	all specified measures, the cost will be approximately 1,330,000 Baht/year
Operation period :	all specified measures, the cost will be approximately 1,550,000

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.2 Air quality action plan

(1) Rationale

For the study of the impact on air quality of Projects during both the construction and operational period, the Consultant considered the use of the AERMOD mathematical model to assess the air quality impact. During the construction period, there will be an area source of pollution, while during the operation period there is a point source of pollution which will be from the air pollution stack.

The study of the impact on air quality of Projects during construction period considered the dispersion of total suspended particulate (TSP) and particulate matter with a diameter of 10 microns from the land opening activity and pollutants caused by combustion of engines in construction and from using vehicles i.e. nitrogen dioxide and sulfur dioxide. The project will clear the land surface to prepare the construction site, which will be gradually implemented. It is predicted that during the simultaneous operation there will be total suspended particulate (TSP), particulate matter smaller than 10 microns (PM-10), nitrogen dioxide, and sulfur dioxide. Both the case of the modeled value and the case of including the background value from monitoring results of the Project measurement, it was found that the highest value found to occur in the Project area. A comparison of the values with the atmospheric air quality standards according to the Notification of the National Environment Board found that all of the study values were within the standard criteria.

During the operation period, the Project shall use natural gas as the primary fuel. Natural gas is considered a clean fuel due to the low content of sulfur and ash. The project will use diesel as a reserve fuel (in the absence of natural gas only). In the Project operation, air pollution sources used in the modeling of air quality were two air emission stacks. The modeling by the AERMOD mathematical model was performed based on the worst-case scenario at full load operating conditions. From the results of the modeling based on both cases of using natural gas and diesel as fuel with the background concentration from the monitoring results of the Project, it was found that the concentration of total suspended particulate (TSP), particulate matter with a diameter of smaller than 10 microns (PM -10), particulate matter with a diameter of smaller than 2.5 microns (PM-2.5), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) meet with the ambient air quality standard according to the Notification of the National Environment Board.

(2) Objectives

1) To control the emission of air pollutants from the Project emission stack during the operation period to be in accordance with the control values

2) To monitor the implementation of the measures of the environmental action plan and ensure that the plan is completely implemented

(3) Target area/ operation

Pre-construction period : the Project and the study areas

Construction period : the Project and the study areas

Operation period : the Project and the study areas

(4) Environmental impact prevention and mitigation measures

1) Construction period

(a) Spray water around the Project construction area and the road to the entrance-exit at least twice a day (morning and afternoon), consider additional spray when the weather is dry and windy to prevent dust from spreading into the atmosphere and affecting adjacent communities

(b) Use canvas to cover the trucks or construction materials that may be diffused, such as soil, cement, etc. during transportation

(c) Before leaving the construction area and going onto public roads, clean the truck wheels so that dirt from the project will not spread and dirty areas outside the project.

(d) Limited truck speed within the construction area of the Project not more than 20 kilometers per hour to reduce the dispersion of dust

(e) Check the condition and maintain the vehicle/engine/machinery used in construction regularly according to the period specified in the engine/machinery maintenance manual to control the pollution emission to meet the design criteria

(f) Stop the engine/machine every time it is idle

(g) Do not burn materials or solid waste in the construction area

(h) Control the contractor to clean up debris in the construction and adjacent areas which may be washed down by rainwater down the drainage gutters such as debris, sand attached to truck wheels, plastic bags, paper waste, etc.

2) Operation period

(a) The project must control the air pollutants emission not to exceed those specified in the environmental impact assessment report at dry conditions, temperature of 25 °C, pressure of 1 atmosphere and excess oxygen volume of 7% as follows:

<u>In case of using natural gas as fuel</u>

Full load operation

Nitrogen dioxide	not exceed	59 ppm at 7% O_2
	and not exceed	59.00 grams per second per stack
Sulfur dioxide	not exceed	10 ppm at 7% O_2
	and not exceed	13.90 grams per second per stack
Total suspended particulate	not exceed	20 milligrams per m^3
	and not exceed	9.70 grams per second per stack

Minimum generation load operation

Nitrogen dioxide	not exceed	59 ppm at 7% O_2
	and not exceed	36.70 grams per second per stack
Sulfur dioxide	not exceed	10 ppm at 7% O_2
	and not exceed	8.60 grams per second per stack
Total suspended particulate	not exceed	20 milligrams per m^3
	and not exceed	6.10 grams per second per stack

<u>In case of using diesel as fuel</u>

Full load operation

Nitrogen dioxide	not exceed	99 ppm at 7% O_2
	and not exceed	81.40 grams per second per stack
Sulfur dioxide	not exceed	20 ppm at 7% O_2
	and not exceed	22.90 grams per second per stack
Total suspended particulate	not exceed	35 milligrams per m^3
	and not exceed	14.0 grams per second per stack

Minimum generation load operation

Nitrogen dioxide	not exceed	99 ppm at 7% O_2
	and not exceed	67.8 grams per second per stack
Sulfur dioxide	not exceed	20 ppm at 7% O_2
	and not exceed	19.10 grams per second per stack
Total suspended particulate	not exceed	35 milligrams per m^3
	and not exceed	11.70 grams per second per stack

(b) Provide a continuous emission monitoring system (CEMs) at 2 HRSG stacks to monitor gas velocity, exhaust temperature, excess oxygen, nitrogen oxide (NO_x), sulfur dioxide (SO_2), and total suspended particulate (TSP) and install a display monitor to show contents of nitrogen oxide (NO_x), sulfur dioxide (SO_2), and total suspended particulate (TSP) in front of the power plant throughout the operation period

(c) Set alarm configurations from CEMs based on nitrogen oxides (NO_X) control values, which are set to 59 ppm, set two alarm levels: high and very high level, actions upon hearing the warning alarm are as follows:

- In the event of a high alarm set at 85% of the controlled emission rate, the operator in the control room monitors the operation of the power generating unit and the emission control device of that unit along with urgent maintenance or correction of detected malfunctions
- In the event of a high alarm set at 95% of the controlled emission rate, the operator in the control room will reduce the excess air volume to return to normal. If still unable to fix, the Project will consider reducing production or stop producing electricity to improve the operation of the system to be able to work normally first before resume the production again.

(d) In case of using natural gas as fuel, control emission of nitrogen oxides (NO_x) by using the dry low NO_x (DLN) control system and in the case of using diesel as fuel, control the emission of nitrogen oxides (NO_x) by using the water injection control system

(e) Air pollution management

a) Set a guideline for the concentration of air pollutants (NOx) monitored from the CEMs not to exceed the alarm levels (excluding start up and shutdown) as follows:

- Check the relevant production process, e.g. tendency of the pollutant concentrations readings from CEMs, examine whether the measured concentrations are wrong, etc.
- Check the relevant equipment such as the CEMs system, if the fault is caused by the measuring device or caused by CEMs fails/error, find the cause and solution. If it cannot be fixed by the staffs, call CEMs service provider to fix it, etc
- Inspected the production process and maintenance areas, if it is found that the control value is still over, reduce the production capacity
- Record the cause of the problem and duration of each corrective action

b) Provide an air pollution control system controller according to the relevant regulations of the Ministry of Industry to control the operation of the treatment system effectively

c) Continuous check air quality monitoring instruments (CEMs) annually throughout the project life span

d) Provide a plan for inspection and maintenance of the air pollution emission system to work effectively in a normal condition regarding to the design criteria

(5) Environmental impact monitoring measure

1) Pre-construction period

Monitoring parameter : consist of the following :

1. Total suspended particulate (TSP), average 24 hours
2. Particulate matter with diameter smaller than 10 microns (PM-10), average 24 hours
3. Nitrogen dioxide (NO_2), average 1 hour
4. Sulfur dioxide (SO_2), average 1 hour
5. Sulfur dioxide (SO_2), average 24 hours
6. Wind direction and velocity (1 station)

Monitoring station: 5 stations (**Figure 7-1**) as follows:

1. The area of Hin Kong Temple
2. The area of Huai Phai Temple
3. The area of Huai Pladuk School
4. The area of Chedi Hak Health Promoting Hospital (Ban Huai Mu)
5. The Project area

Methodology : Install measuring instruments and submit analysis samples in accordance with the method prescribed by the Notification of the National Environment Board

Duration/frequency: Monitor one time, seven days continuously before starting the Project construction activities

2) Construction period

Monitoring parameter : consist of the following:

1. Total suspended particulate (TSP), average 24 hours
2. Particulate matter with diameter smaller than 10 microns (PM-10), average 24 hours
3. Nitrogen dioxide (NO_2), average 1 hour
4. Sulfur dioxide (SO_2), average 1 hour
5. Sulfur dioxide (SO_2), average 24 hours
6. Wind direction and velocity (1 station)

Monitoring station: 5 stations (**Figure 7-1**) as follows:

1. The area of Hin Kong Temple
2. The area of Huai Phai Temple
3. The area of Huai Pladuk School
4. The area of Chedi Hak Health Promoting Hospital (Ban Huai Mu)
5. The Project area

Methodology: Install measuring instruments and submit analysis samples in accordance with the method prescribed by the Notification of the National Environment Board

Duration/frequency : Monitor every six months (twice a year), seven days continuously

3) Operation period

(a) Air quality at source: stack sampling

Monitoring parameter : consist of the following:

1. Flow rate
2. Exhaust Temperature
3. Excess Oxygen
4. NOx
5. SO_2
6. TSP

Monitoring station : Two emission stacks of the power plant

Methodology : Collect air quality samples and analyze according to the Notification of the Ministry of Industry

Duration/frequency : Monitor every six months (twice a year) at the same period as the ambient air quality monitoring

(b) Air quality analysis by CEMs: continuous emission monitoring system; CEMs

Monitoring parameter: consist of the following:

1. Flow rate
2. Exhaust Temperature
3. Excess Oxygen
4. NOx
5. SO_2
6. TSP

Monitoring station : CEMs of the emission stacks

Methodology : Install continuous emission monitoring system (CEMs) at the stacks, continuously measuring throughout the time the power is generated

Duration/frequency : Continuously monitoring throughout the time the power is generated

(c) CEMs auditing

Monitoring parameter : CEMs of the emission stacks

Analysis method : Validate the CEMs operation to verify that the measurement data obtained from the CEMs is accurate, by using the audit in accordance with the requirements of the U.S.EPA or the method established by government agencies

Duration/frequency : At least once a year or as required by relevant government agencies

(d) Ambient air quality

Monitoring parameter: consist of the following:

1. Total suspended particulate (TSP), average 24 hours
2. Particulate matter with diameter smaller than 10 microns (PM10), average 24 hours
3. Nitrogen dioxide (NO_2), average 1 hour
4. Sulfur dioxide (SO_2), average 1 hour
5. Sulfur dioxide (SO_2), average 24 hours
6. Wind direction and velocity (1 station)

Monitoring station : 4 stations (**Figure 7-1**) as follows:

1. The area of Hin Kong Temple
2. The area of Huai Phai Temple
3. The area of Huai Pladuk School
4. The area of Chedi Hak Health Promoting Hospital (Ban Huai Mu)

Methodology : Install measuring instruments and submit analysis samples in accordance with the method prescribed by the Notification of the National Environment Board

Duration/frequency : Monitor every six months (twice a year), seven days continuously, throughout the operation period

(6) Implementation period

Pre-construction period : Pre-construction

Construction period : throughout the construction

Operation period : throughout the operation

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Pre-construction period : approximately 550,000 Baht/term

Construction period : approximately 550,000 Baht/term

Operation period : approximately 650,000 Baht/term

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.3 Noise action plan

(1) Rationale

The main activities that generate noise during the construction period of the Project are land adjustment, transportation activities, construction of structures and buildings, decoration/inspection, etc. Construction activities that generate noise will vary greatly. However, construction activities are usually not take place at the same time, so the Consultant selected to use the activities that cause noise and take the longest time to assess the impact. The selected activity is the land adjustment activities which has a sound level of 83 dB(A) at a distance of 15 meters. From the noise impact assessment during the construction period, it was found that the 24 hours average noise levels at the observation points, Moo 5 Ban Nong Rak, Moo 8 Ban Nong Kham, and the houses behind the power plant are within the standard.

For disturbing noise level, when the Project has installed soundproof walls around the house behind the power plant (Southside of the Project) by choosing steel material, 18 ga, which is a material that can be easily found and available in the market as well as easy to move while having construction activities. The material transmission loss (TL) value is equal to 25 dB(A). It will be installed for a height of 5 meters. From the assessment results, it was found that the impact on the disturbing noise level is not different from the current state.

Sources of noise from the power generation process are gas turbines, steam turbines, steam generators (HRSG), etc. The Project has assigned the designers to design machines with average noise levels of not higher than 85 dB(A) at a distance of 1 meter.

The Project has designed a gas turbine and a steam turbine to be installed in a closed building. Therefore, in taking action to prevent the impact on the community, it is necessary to strictly follow the measures by monitoring the noise levels both at source and in the ambient around the Project fence. In order to monitor the noise level at the Project fence not to be higher than 70 dB(A), the Project has set up an ambient noise level measurement to monitor the impact of the Project's operations.

(2) Objectives

1) To prevent and reduce the noise effects that arise due to various activities in the operation period to those who work in the Project area and surrounding communities

2) To monitor and evaluate the implementation of the measures of the environmental action plan and to ensure that the plan is completely implemented

(3) Target area/ operation

Project area and study area

(4) Environmental impact prevention and mitigation measures

1) Construction period

(a) Publicize construction plans and noise control measures to people in the community and the households surrounding the power plant

(b) There should not be noise-inducing construction activities during the period of 17.00 - 07.00 o'clock of the next day in order to reduce the impact on the community during the period. If there is a need for activities that cause loud noise, the Project must notify people in the community and the households surrounding the power plant at least seven days in advance

(c) Install a temporary soundproof wall around the house behind the power plant (Southside of the Project) by using steel material, 18 ga, with a height of 5 meters

(d) Choose construction equipment and machinery that has low noise levels and always perform maintenance checks to reduce the noise level

(e) Provide noise protection equipment such as earplugs or earmuffs to construction workers in the areas where the noise level is higher than 85 dB(A)

(f) Install signboards or symbols to wear personal protective equipment in the areas with high noise levels according to the hazardous area classification by the safety officer

(g) Provide the Project's staffs to visit the area to inquire of the communities and households surrounding the power plant about the noise impact from the Project's construction activities periodically throughout the construction period in order to find ways to mitigate such impacts

(h) Continuously coordinate with communities and households surrounding the power plant to build good relationships and find solutions to problems together as well as coordinating with community leaders and related agencies to provide assistance, support, and problem-solving for people affected by the operation of the Project. In the case that there is an impact that is directly caused by the operation of the Project, the project shall compensate for any damages as appropriate.

2) Operation period

(a) Install a device to reduce the noise level at a machine that generates noise such as installing silencer at HRSG

(b) Perform regular checks and audits the performance of the silencer

(c) Specify high noise level areas, provide signs or symbols to indicate such areas where the noise exceeds 85 dB(A) and people who will work in the area must wear noise protective equipment such as earplugs or earmuffs

(d) Provide personal protective equipment such as ear muffs or earplugs for employees working in areas with noise levels higher than 85 dB(A)

(e) Manage to prevent employees from being exposed to noise levels for a long time, such as setting the length of work to reduce the time that employees are exposed to noise, staff switching/working day switching in noisy areas, etc.

(f) Prepare noise contour around the Project area at least once within the first year of operation and revise every 3 years

(5) Environmental impact monitoring measure

1) Pre-construction period

Monitoring parameter : Monitoring parameters consist of the following:

1. 24 hours weighted equivalent continuous sound level (Leq 24 hr)
2. Background sound level (L90)
3. Maximum sound level (Lmax)
4. Day-night average sound level (Ldn)

Monitoring station : Three stations (**Figure 7-2**):

1. The area of Moo 5 Ban Nong Rak
2. The area of Moo 8 Ban Nong Kham
3. The area of the house behind the power plant (Southside of the Project)

Methodology : Install measuring instruments according to the standards announced by the National Environment Board, the calculation shall be in accordance with the Notification of the Pollution Control Department

Duration/frequency : Monitor one time, seven days continuously before starting the Project construction activity

2) Construction period

Monitoring parameter : Monitoring parameters consist of the following:

1. 24 hours weighted equivalent continuous sound level (Leq 24 hr)
2. Background sound level (L90)
3. Maximum sound level (Lmax)
4. Day-night average sound level (Ldn)

Monitoring station : Three stations (**Figure 7-2**):

1. The area of Moo 5 Ban Nong Rak
2. The area of Moo 8 Ban Nong Kham
3. The area of the house behind the power plant (South of the project)

Methodology : Install measuring instruments according to the standards announced by the National Environment Board, the calculation shall be in accordance with the Notification of the Pollution Control Department

Duration/frequency : Every six months (twice a year, seven days continuously each time) throughout the construction period

3) Operation period

Monitoring parameter : Monitoring parameters consist of the following:

1. 24 hours weighted equivalent continuous sound level (Leq 24 hr)
2. Background sound level (L90)
3. Maximum sound level (Lmax)
4. Day-night average sound level (Ldn)

Monitoring station : Three stations (**Figure 7-2**):

1. The area of Moo 5 Ban Nong Rak
2. The area of Moo 8 Ban Nong Kham
3. The area of the house behind the power plant (South of the project)

Methodology : Install measuring instruments according to the standards announced by the National Environment Board, the calculation shall be in accordance with the Notification of the Pollution Control Department

Duration/frequency: Every six months (twice a year, seven days continuously each time) throughout the operation period

(6) Implementation period

Pre-construction period : Pre-construction

Construction period : throughout the construction

Operation period : throughout the operation

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Pre-construction period : approximately 100,000 Baht/term

Construction period : approximately 100,000 Baht/term

Operation period : approximately 100,000 Baht/term

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.4 Water use action plan

(1) Rationale

The use of water during the construction period can be classified into two types of activities. 1) Water used for the consumption of construction workers which is estimated that there will be a maximum of approximately 3,000 construction workers round-trip. There is no outstanding stay in the Project area which will have approximately 300 cubic meter of water consumption per day (calculated from the water consumption rate of 100 liters/person/day x 3,000 people). With the said water, the Project requires the contractor company to provide adequate use. For drinking water, it is usually purchased bottled water or commercially available buckets. 2) Water for construction activities. It is water used for tools and equipment washing and used concrete mixing. However, the consumption for concrete mixing is low since the construction of the Project will mainly rely on ready-mixed concrete. It is estimated that water consumption in construction activities is about 50 m^3 per day. The water source for construction activities will be the same as the water used for consumption by construction workers.

Water used during the operation period of the Project has a maximum water demand of 30,946 cubic meter per day. Water will be pumped from the Mae Klong River. The pumping point of the Project is located on the Mae Klong River, at Ban Lum Din, Lum Din Subdistrict, East side of the Project with a distance of approximately 13 kilometers. The Project's water pumping will pump water from the Mae Klong River to store it in a raw water reservoir within the Project area. The Project shall expand the reservoir capacity up to 92,838 m^3 which will be sufficient for at least 3 days of use. From the analysis of the water balance in the Mae Klong River, it was found that downstream of the Mae Klong River to the Gulf of Thailand had an average annual water volume of 7,004 million cubic meter per year. With the current conditions without the presence of the Project, in the year that the remaining water volume for ecological preservation was lower than the criteria set by the Royal Irrigation Department because there is less water released from Mae Klong Dam than the amount of ecological preservation to push the saltwater according to the measure of the Royal Irrigation Department. However, this does not affect the use of water in other activities. After the development of the Hin Kong Power Plant, the Project shall use approximately 11.54 million cubic meter of water from the Mae Klong River per year (0.16% of the annual average water volume). As a result, the remaining water supply for ecological preservation to push saltwater is reduced from the absence of the Hin Kong power plant development, only approximately 0.02-3.54 percent of the runoff volume in that year without impact on water use for agriculture, livestock, consumption, tourism, and industry. Although there is remaining water to preserve the ecosystem in order to push the saltwater below the threshold set by the Royal Irrigation Department but the investigation found that this will not cause the saltwater value in Mae Klong River to exceed the standard set for agricultural purposes. Therefore, the development of the Hin Kong Power Plant Project does not affect the use of water for agriculture, livestock, consumption, tourism, and industrial operations in the Mae Klong River Basin. Therefore, it has a low impact on the community.

(2) Objectives

1) To prevent impacts that will occur to farmers downstream of the river
2) Manage, control, and mitigate environmental impacts related to water management

(3) Target area/ operation

Within the Project area and the Project's pumping station

(4) Environmental impact prevention and mitigation measures

1) Pre-construction period

(a) Require a contractor to supply sufficient water for construction activities

(b) Require a contractor to provide clean, hygienic, and sufficient drinking water for construction workers

2) Operation period

(a) Provide a raw water reservoir with a capacity of 92,838 cubic meter to reserve water for use within the Project (reservation valid for at least 3 days)

(b) Collect rainwater from the second rainwater retention pond into the raw water reservoir of the Project to be used during the dry season and reduce river water pumping in the rainy season

(c) Install a 6 mm mesh netting at the end of the pipeline to reduce the amount of fish attached to the water diverted from the Mae Klong River into the raw water reservoir of the Project and coordinate with the Provincial Fisheries Office or the local government organization to formulate an annual project for releasing aquatic animals into the Mae Klong River to maintain the condition of existing aquatic animals in the vicinity of the Project area

(d) Follow the conditions or requirements of the relevant government agencies and when there is a new issue announcement of the Department of Water

Resources on the permission to use water the Project must request for permission to use water in accordance with the relevant laws

(e) Make a record of daily water diversion and prepare a monthly water diversion report, this will bring good results to both the local government and the public sector related to the water use activities of the Project

(5) Environmental impact monitoring measure

Prepare a monthly summary of the amount of water pumped along with problems and obstacles in pumping water (if any)

(6) Implementation period

Construction period : throughout the construction

Operation period : throughout the operation

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Operation period : approximately 20,000 Baht/year

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.5 Water quality and wastewater action plan

(1) Rationale

The wastewater generated during the construction period of the Project can be classified into two categories, the wastewater generated from the consumption of construction workers and wastewater generated from construction activities. The wastewater generated in the construction period comes mainly from the consumption of construction workers. It is estimated that during a peak of 3,000 workers there will be approximately 240 cubic meter of wastewater produced per day (calculated based on the assumption that wastewater will be generated about 80% of the total water consumption). The Project shall assign a contractor company to provide toilets to be sufficient for the number of workers at each construction phase. Wastewater shall be treated in accordance with sanitation principles.

During the operation period, wastewater/effluent from activities of the Project consists of cooling water, discharge from the demineralized water production systems, wastewater from office buildings, and wastewater from floor and machinery cleaning. It is estimated that the amount of wastewater to be generated during the operation period is approximately 6,963 cubic meter per day. The project will have a water quality management system for each activity before sending it to two wastewater holding ponds. One of the holding ponds shall be served as an emergency pond. Nevertheless, the Project shall install a continuous water quality monitoring system (online monitoring) to check the temperature, pH, and electrical conductivity (to determine total dissolved solids) before discharging into the Mae Klong River.

However, in order to prevent and correct environmental impacts on water quality, the Project, therefore, set an action plan for water and wastewater management for both during the construction and the operation periods as well as for water quality monitoring before discharging the Mae Klong River.

(2) Objectives

1) To control the quality of the wastewater before discharging from the Project so that it does not affect the environment and surrounding communities

2) To monitor and determine the implementation of the measures of the environmental action plan and to ensure that the plan is completely implemented

(3) Target area/ operation

Within the Project area and the Project's pumping station

(4) Environmental impact prevention and mitigation measures

1) Construction period

(a) Provide adequate toilets that equipped with sewage storage tanks for the construction workers as required by law before contacting the authorized agencies to get rid of them

(b) Do not litter down the drainage gutter and require the contractor to clean up the sediment and construction debris such as cement, concrete, etc. that have fallen in the area to prevent the leaching of rainwater into the surrounding drainage gutters

(c) Store construction materials in an appropriate area without obstructing the drainage and provide workers to regularly clean the drainage gutter to prevent clogging

(d) Vehicle and all kinds of machines maintenance must be performed in a specified area or on a hard surface and has a leak-proof material to prevent leaks into the outside water source

2) Operation period

(a) Cooling water management of the Project

a) Before discharging wastewater from the power plant, it will be stored in wastewater holding pond. Wastewater holding pond No. 1 has the capacity to hold water for at least one day. Wastewater holding pond No. 2 will have the capacity to hold water for at least 1 day as well. In order to prevent leakage, each wastewater holding pond will be lined with HDPE or concrete. In normal operation, the second wastewater holding pond is kept dry for an emergency pond.

b) Install online monitoring systems to check the temperature, pH, and electrical conductivity (to determine total dissolved solids) in the area of the cooling tower basin and wastewater holding pond of the Project. Wastewater must meet the standard before discharging into the Mae Klong River.

(b) Wastewater management of the Project

a) Provide an oil separator to separate oil and grease from wastewater that is contaminated with oil

b) Provide adequate sanitary toilets for employees as required by law as well as providing a ready-made wastewater treatment system or a septic tank to treat wastewater from consumption of employees

c) Control the characteristics of the effluent according to the Notification of the Ministry of Industry B.E. 2560 (2017) on Effluent Standard

(5) Environmental impact monitoring measure

1) Pre-construction period

Surface water quality

Monitoring parameter : Monitoring parameters consist of the following:

1. Temperature
2. pH
3. Conductivity
4. Total dissolved solids (TDS)
5. Suspended solids (SS)
6. Oil & grease
7. BOD_5
8. COD

Monitoring station : 3 monitoring stations (**Figure 7-3**):

1. 500 meters above the discharging point of the Project
2. Discharging point of the Project
3. 500 meters down the river from the discharging point of the Project

Methodology : Collect samples and analyze according to the Notification of the National Environmental Board (No.8) B.E. 2537 (1994)

Duration/frequency: One time before starting construction activities

2) Construction period

Surface water quality

Monitoring parameter : Monitoring parameters consist of the following:

1. Temperature
2. pH
3. Conductivity
4. Total dissolved solids (TDS)
5. Suspended solids (SS)
6. Oil & grease
7. BOD_5
8. COD

Monitoring station : 3 monitoring stations (**Figure 7-3**):

1. 500 meters above the discharging point of the Project
2. Discharging point of the Project

3. 500 meters down the river from the discharging point of the Project

Methodology : Collect samples and analyze according to the Notification of the National Environmental Board (No.8) B.E. 2537 (1994)

Duration/frequency : Two times a year, one time in the rainy season and one time in the dry season

3) Operation period

Surface water quality

Monitoring parameter : Monitoring parameters consist of the following:

1. Temperature
2. pH
3. Conductivity
4. Total dissolved solids (TDS)
5. Suspended solids (SS)
6. Oil & grease
7. BOD_5
8. COD

Monitoring station : 3 monitoring stations (**Figure 7-3**):

1. 500 meters above the discharging point of the Project
2. Discharging point of the Project
3. 500 meters down the river from the discharging point of the Project

Methodology : Collect samples and analyze according to the Notification of the National Environmental Board (No.8) B.E. 2537 (1994)

Duration/frequency : Two times a year, one time in the rainy season and one time in the dry season

Aquatic biological resources

Monitoring parameter : Monitoring parameters consist of the following:

1. Phytoplankton
2. Zooplankton
3. Benthos
4. Aquatic animals
5. Aquatic plants

Monitoring station : 3 monitoring stations (**Figure 7.3**):

1. 500 meters above the discharging point of the Project
2. Discharging point of the Project
3. 500 meters down the river from the discharging point of the Project

Methodology : Collect and analyze samples according to academically acceptable methods

Duration/frequency : Two times a year, one time in rainy season and one time in dry season

Wastewater quality

Monitoring parameter : Monitoring parameters consist of the following:

1. Temperature
2. pH
3. Conductivity
4. Total dissolved solids (TDS)
5. Suspended solids (SS)
6. Oil & grease
7. BOD_5

Monitoring station : Wastewater holding pond

Analysis method : Collect and analyze samples according to methods specified by the Ministry of Industry

Duration/frequency : Once a month

(6) Implementation period

Pre-construction period : Before construction

Construction period : throughout the construction

Operation period : throughout the Operation

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Pre-construction period : approximately 5,000 Baht/ stations

Construction period : approximately 5,000 Baht/ stations

Operation period : approximately 5,000 Baht/ stations

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.6 Waste management action plan

(1) Rationale

Some solid waste generated from construction activities such as wood chips and cement can be sold or reused. Solid waste that cannot be sold will be collected for an agency authorized to be disposed of. Waste generated from consumption of the construction workers up to 3,000 people, is estimated to be approximately 300 kilogram per day. The contractor is required to provide adequate waste container with lid distributed at various points within the construction area. In addition, the contractor shall provide workers responsible for collecting solid waste in the designated area at least once a day before coordinating with the authorized agencies from local government organization to collect and further disposal of waste.

During the operation period, the Project will operate in accordance with the management of waste or unused materials guideline which must apply for permission to transport out of the power plant area according to the Notification of the Ministry of Industry on Disposal of Waste or Unused Materials, B.E. 2548 (2005). For general waste arising from consumption by employees, the Project shall provide separate containers (wet, dry, and hazardous wastes) and covered with enclosed lids. The containers shall be placed scattered at various points within the Project. Later, waste will be collected and transported to the storage point before contacting an agency to dispose of on sanitary manner.

(2) Objectives

1) To manage waste and solid waste of the Project in accordance with the relevant laws without affecting the environment and communities

2) To monitor the implementation of the measures of the environmental action plan and to ensure that the plan is completely implemented

(3) Target area/ operation

The Project area and nearby area

(4) Environmental impact prevention and mitigation measures

1) Construction period

The solid waste generated from construction and from workers' activities shall be separated by type. Recyclable waste shall be collected as much as possible. Waste containers shall be adequately provided. The contractor shall provide workers who are responsible for collecting the waste in the designated area at least once a day before coordinating with the waste disposer who is approved by a local government agency to collect the waste for further disposal.

2) Operation period

(a) Provide adequate waste containers with lids to collect waste generated within the Project area before transport to the storage point before coordinating with the waste disposer who is authorized by law to dispose of in a sanitary manner.

(b) Provide a preliminary waste storage area to store waste before sending it to dispose of by a waste disposer that has a license from the government agency

(c) General and office waste shall be managed properly, such as recyclable waste shall be sold to the purchaser who has been licensed by the government agency to reduce the amount of waste that must be disposed of

(d) Waste from production processes including the waste from the RO water production unit shall be strictly managed in accordance with the Ministry of Industry Notification B.E. 2548 (2005), on the Disposal of Waste and Unused Materials or other relevant laws. The waste generated from the Project must be sent to a waste disposer that has been approved by the government agency.

(5) Environmental impact monitoring measure

1) Construction period

Indicator : Prepare a summary report for each type of waste with information on types, volumes, collection, transportation, and management of the wastes that are generated from the operation of the Project, and attach a copy of the waste disposal permission in the report

Monitoring area : The Project's construction area

Methodology : Survey and record

Duration/frequency : Every time the waste is sent out for disposal throughout the construction period, a summary report shall be prepared every six months

2) Operation period

Indicators : consist of the following:

1. Type
2. Quantity
3. Waste management approach
4. Waste manifest

Monitoring area : Within the Project area

Methodology : Survey and record

Duration/frequency : Monthly and prepare a summary report every six months throughout the operation period

(6) Implementation period

Construction period : throughout the construction

Operation period : throughout the Operation

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Construction period : Included in the construction budget

Operation period : Included in the Operation budget

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.7 Transportation action plan

(1) Rationale

The Project will take approximately 33-42 months to construct the power plant which is expected to begin in 2021 and will be able to generate electricity in 2024. Most of the transportation is the transportation of construction materials, equipment and machinery, and construction workers. The maximum traffic volume during the construction period is expected to be 90 trips per day with an average of 74 trips per day. The transportation shall be performed mainly by 6-wheel and 10-wheel trucks, trailers, and semi-trailers. The main transportation route is Rural Highway No. 4031 and enters the Project area in front of the entrance to the former TECO power plant. In this regard, vehicles that transport construction materials, equipment, and machinery must take the specified main routes only. From the transportation impact assessment during the construction period, it was found that the traffic volume is in the service level A, meaning the traffic is free to flow. A vehicle can move at independent speed without limitation in maneuvering. Delays can be caused by car stops at intersections are minimal. Thus, the Project is expected to cause transportation impact at a low level.

During the operation period, the fuel is mainly transported via the pipeline. For chemical and employee transport, the Project will use Highway No. 3028 and Rural Highway No. 4004 into the Project area. From the assessment of the impact on the transport during operation period, it was found that the traffic volume is in the service level A, meaning the traffic is free to flow. A vehicle can move at independent speed without limitation in maneuvering. Delays can be caused by car stops at intersections are minimal. Thus, the Project is expected to cause transportation impact at a low level.

(2) Objectives

1) To prevent and mitigate the impacts of the transportation of construction materials and equipment on public transportation during the construction period of the Project

2) To prevent and mitigate the impacts of transportation in the power plant on the traffic conditions both inside and outside the power plant area during the operation period

3) To monitor the implementation of the measures of the action plan and to ensure that the plan is effectively implemented

(3) Target area/ operation

The Project area and nearby area

(4) Environmental impact prevention and mitigation measures

1) Construction period

(a) The Project shall request contractors to plan the use of transportation routes for construction machinery/equipment by avoiding the transport routes that pass through the community as much as possible and to use the speed not exceeding the strict legal limit. In addition, the speed of the vehicle in the construction area shall be limited to not more than 20 kilometers per hour by notifying the contractor and installing speed control sign in the construction area.

(b) The contractor company is required to train and control the drivers to strictly comply with the traffic rules along with placing name tags and telephone numbers on the workers' transport vehicles, construction materials and tools, and construction's wastes as a channel for receiving complaints to the Project.

(c) In the case of transportation of large machines, coordinate with the traffic police to plan transportation, and facilitate transportation to minimize impacts on the traffic.

(d) Manage the traffic systems in the construction area accordingly, during rush hours (7.00-8.00 o'clock and 16.00-17.00 o'clock) the Project must provide staff to assist in facilitating and organizing traffic around the entrance-exit area of the Project.

(e) Inspect the engine conditions of construction trucks and transport vehicles in accordance with the vehicle maintenance manual throughout the life span and check for readiness and safety before use.

(f) In the case of investigation and found that the road has been damaged from the operation of the Project, the contractor shall repair or improve the damaged road together with the responsible agency or local government organization.

2) Operation period

(a) General measures

a) Provide training and educate drivers about the transportation procedure, action in case of emergency, and other relevant regulations as well as requiring drivers to strictly abide by traffic rules

b) Limit the speed of the vehicle within the Project area not to exceed 20 kilometers/hour and install speed control signs and use speed as of law when passing through community areas

c) Avoid using commuter routes that pass through communities in the morning and evening which is the rush hour (7.00-8.00 o'clock and 16.00-17.00 o'clock) to reduce the impact from the transportation that may occur

(b) Safety measures in the transportation of chemicals

Transportation of hazardous substances to be safe for the community, property, and the environment the transportation operator must comply with the safety procedure and relevant laws and standards, such as the Hazardous Substance Transportation Manual of the Pollution Control Department, September 2011, Hazardous Substance Management Manual, July 2013, the Notification of the Department of Industrial Works on Hazardous Substances Storage Handbook B.E. 2550 (2007), and the Notification of the Department of Industrial Works on Transportation of Hazardous Substances B.E. 2558 (2015). For instance:

- Request a transport license
- Provide labels and signs on chemical transportation vehicles in accordance with the requirements of the Department of Land Transport
- Arrange and transfer chemicals correctly and safely
- Prepare chemical safety data sheet (SDS) about the hazard characteristics according to the properties of that substance both Thai and English
- Provide personal protective equipment and equipment for chemical transportation vehicles
- Provide training for drivers to have knowledge and understanding of the hazards of chemicals and to have the skills to drive vehicle safely as well as being able to fix basic problems when there is an emergency

(5) Environmental impact monitoring measure

1) Construction period

Indicators : consist of the following:

1) Record the number of transportations of material, equipment, and machines
2) Record statistics of accidents that occur from the transportation of the Project, including the cause, place, time period, and solutions to problems

Monitoring area : Construction area and transportation route of the Project

Methodology : Record daily traffic volume and accidents that occurred in the Project every time and provide a monthly summary report

Duration/frequency : Every day throughout the construction period and prepare a summary report every 6 months

2) **Operation period**

Indicator : Statistics of accidents that occur from the Project, including the cause, place, time period, and solutions to problems

Monitoring area : Withing the Project area

Methodology : Record daily traffic volume and accidents that occurred in the Project every time and provide a monthly summary report

Duration/frequency : Throughout the operation period

(5) **Environmental impact monitoring measure**

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(6) **Implementation period**

Construction period : throughout the construction

Operation period : throughout the Operation

(7) **Responsible person**

Hin Kong Power Company Limited

(8) **Estimated cost/ expenditure**

Construction period : Included in the construction budget

Operation period : Included in the Operation budget

(9) **Evaluation**

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.8 Action plan on drainage and flood prevention

(1) Rationale

The construction of the Hin Kong Power Plant reduced the seepage area by converting it to an area of approximately 113,000 m^2 of solid concrete which will be resulted in an increasing runoff. This may have an impact on the drainage in the Project and the surrounding areas. The Project requires contractors to dig ditches and manholes to receive the drain water from construction activities before discharging outside the area.

During the operation period, rainwater that falls in the Project area will be collected into the closed rain gutter around the Project area. After that, the Project will collect the water in two ponds with a total capacity of approximately 14,875 m^3 (excluding the freeboard), which can handle excess rainwater flowing from the current conditions. However, the Project has set appropriate drainage and flood prevention action plan and shall manage rainwater in the rain water retention pond for maximum benefit and to prevent and impacts arising from the drainage in the surrounding area during both the construction and operation periods.

(2) Objectives

1) To prevent flooding in the Project and adjacent areas

2) Manage, control, and supervise in accordance with the environmental impact prevention and mitigation measures related to wastewater management

3) To monitor the quality of effluent from the Project's operation

(3) Target area/ operation

The Project area / areas around the power plant

(4) Environmental impact prevention and mitigation measures

1) Construction period

(a) Construct a temporary drainage channel and a sedimentation pond to collect sediment from rainwater into the sedimentation pond before draining or using water in the area

(b) Check for clogging conditions and dredge the temporary drainage channel/gutter every month, in case of sediment and construction debris such as cement and concrete flows into the rain gutter, the contractor shall dredge sediment and debris immediately

(c) The contractor is required to control construction workers not to throw waste into the gutter

2) Operation period

(a) Provide a rain gutter around the building or production units to handle the uncontaminated rainwater before sending into the Project's rain gutter

(b) Provide a rain water retention pond with a total capacity of at least 14,875 m^3 (excluding freeboard) to control the drainage rate from the area

(c) Check the drainage system in the Project area to be in good condition at all times so that there are no obstacles in the water flow and if it is found to be damaged, fix immediately

(d) Clean drainage gutter during the dry season every year to maintain the drainage efficiency of the Project area

(6) Implementation period

Construction period : throughout the construction

Operation period : throughout the operation

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Construction period : Included in the construction budget

Operation period : Included in the operation budget

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.9 Action plan on occupational health and safety

(1) Rationale

The main impacts on occupational health and safety during major construction activities are classified as follows:

1) **Physical hazards** include air pollution, noise, vibration, heat, welding glare, and occupational accidents where construction workers are at risk of being directly injured, prolonged exposure may affect the health of the workers

2) **Chemical hazards** include exposure to fumes from welding. If exposure to high concentrations for a short period of 4-12 hours may cause the employee to have a metal fume fever. This will cause the employee to have working leave for one day and return to work normally because the body has immunity. However, the immune system is not permanent, if the exposure is stopped for a long time, the symptoms will appear again upon new exposure. In addition, it can have a chronic effect on the respiratory system.

3) **Biological hazards** include wastewater and sewage drained from the workers' camp, sewage generated from the excretion of construction workers, and solid waste without a good basic sanitation system. These could be a spreading source of pathogens that are carried by insects and animals that carry disease to humans, especially gastrointestinal diseases.

For the operation period, major occupational health and safety impacts are classified as follows:

1) **Physical hazards** include noise and accidents (serious danger and emergency). The noise source of the Project is mostly installed in closed buildings As for outdoor areas with noise control and areas with noise levels higher than 85 dB(A), there will be employees inspecting from time to time. Therefore, the chance of exposure is low.

2) **Chemical hazards** are chemicals, most of which are used in the water treatment system. Most of them are corrosive chemicals. When exposed, it can cause respiratory and skin irritation. From the data of the chemicals used in the Project, it was found that there are no carcinogenic substances. Therefore, the severity arising from chemical exposure is low.

To ensure that the surrounding communities and the Project employees will not be affected, it is necessary to take appropriate measures to mitigate the potential impacts. It is also imperative to conduct an occupational health and safety audit to help identify potential changes in the situation and be able to serve as a timely solution to problems.

(2) Objectives

1) To prevent and mitigate the impact of the Project construction activities on the health and safety of workers in the construction period

2) To prevent and mitigate the impact of the Project on the health and safety of workers in the operation period

3) To monitor the implementation of the measures of the action plan on occupational health and safety and ensure that the plan is effectively implemented

(3) Target area/ operation

The Project area

(4) Environmental impact prevention and mitigation measures

1) Construction period

<u>Contractor recruitment and basic construction regulations</u>

(a) The Projects must clearly state an agreement on occupational health and safety measures with the construction company in the contract of employment. It must include methods to protect the safety and health of the employees working in the Project.

(b) The safety officer of the Project with knowledge of occupational health and safety as required by law shall coordinate with the safety staff of the contractor company to supervise and monitor the working safety conditions of the employees.

(c) Clearly define the area boundary, make a fence line around the construction area, provide lighting in the case of night operation, and apply a work permit system in the construction area especially the work related to heat, electricity, and confined space.

(d) Specify the working period of employees in high noise level areas in accordance with the law, including arranging for temporary work breaks or there is a system to circulate employees working in high noise level areas to other areas.

(e) Provide warning signs in the construction area, dangerous area, and areas requiring personal protective equipment such as dust masks, ear muffs and/or earplugs, helmets, gloves, and safety shoes as appropriate to the nature of work performed and strictly control the use of personal protective equipment.

(f) Provide training for employees prior to work on occupational health and safety along with accidents prevention

(g) Provide proper and adequate utilities for workers, such as clean drinking water, toilets, and waste containers, in accordance with sanitation principles

Health measures and collaboration with local health agencies

(h) Supervise the contractor company to prepare the health examination data of the construction workers before work and comply with the labor laws and regulations and annual physical examination with risk-based health checks for construction workers in areas with risk determinants such as hazardous chemicals (if any)

(i) Set welfare measures to compensate for damages in the event of being affected by the construction of the Project to the affected people, including employees, contractors, and the public

(j) Provide medical supplies and first aid equipment in the case of injured and taken to the hospital as well as having a vehicle for immediately referring in an emergency

(k) Inform the number of construction workers to the relevant agencies and local health agencies to be prepared for an event of illness or in an emergency

2) Operation period

Implementation of legislation and design

(a) The Project must comply with all occupational health and safety laws and regulations related to the operational activities of the Project.

(b) Provide training and knowledge about safety and environment including practices for safety and the environment for all employees regarding characteristics of jobs

(c) Provide adequate fire fighting equipment as required by laws or international standards and established a fire brigade as well as to conduct a fire drill annually

General safety management

(d) Provide a work permit system before entering the work area

(e) Provide appropriate working space and environment, such as having adequate lighting, etc., and consider the safety of employees

(f) Put warning signs in potentially hazardous areas for employees to wear personal protective equipment as appropriate for the work

(g) Provide an emergency action plan (**Figure 7-4**) with the training of employees on emergency procedure

Chemical measures

(h) Prepare safety data sheet for each chemical and disclose in the working area

(i) The acid-base containment area must have a dike border and must be able to handle all of the largest containment tanks in the event of an emergency causing the material to leak out of the tank. Inside of the dike, there must be lined with fiberglass covered with another layer of concrete to prevent leakage of chemicals to the outside.

(j) Provide an eyewash and shower point in the area of chemical transportation or storage area

Personal protective equipment and employee health protection measures

(k) Provide adequate personal protective equipment for the number of employees, including helmets, safety shoes, goggles, and earplugs and/or earmuffs, and supervise workers to wear the equipment every time they work

(l) Provide adequate first aid equipment in proper conditions and provide first aid training to employees

(m) Provide annual health check-up programs for all employees

(5) Environmental impact monitoring measure

1) Construction period

Indicator : 1. Cause/characteristic of the accident
2. Damage/loss condition
3. Problem solving/suggestion

Monitoring area : Construction area of the Project

Methodology : Record every accident that occurs in the execution of the project and provide a monthly summary

Duration/frequency : Every time there is an accident throughout the construction period

2) Operation period

Intensity of light in working area

Indicator : lluminance

Monitoring area : Electrical and Control Building, Adminstation Building

Methodology : Lux Meter or use the method stipulated and/or approved by the relevant government agencies.

Duration/frequency : Four times a year

Noise level in working area

Indicator : - Leq 8 hours

Monitoring area : - Gas compressor
- Cooling tower
- Generator pumps

- Gas turbine
- Steam turbine

Methodology : Integrated sound level measurement or using the method specified and/or approved by the relevant government agency

Duration/frequency : Four times a year

Heat in working area

Indicator : Heat

Monitoring area : - Gas turbine
- Steam turbine
- Boiler drum

Methodology : Wet bulb globe temperature method or using the method specified and/or approved by the relevant government agency

Duration/frequency : Four times a year

Health check for new and general employees

Indicator : - Lung x-ray
- Visual function
- General physical examination by a doctor
- Blood test: Complete blood count, blood group, immune system, and hepatitis B

Person : All employees

Duration/frequency : Before starting to work 1 time and after that once a year

Investigations on accidents and emergency plans

Indicator : - Record the accident statistics along with the cause and damages to be used as basic information for defining safety measures
- Practice emergency operations within the power plant and join in practice with related external agencies

Monitoring area : Inside and outside the power plant area

Duration/frequency : At least once a year

(6) Implementation period

Construction period : throughout the construction

Operation period : throughout the Operation

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Construction period : Included in the construction budget

Operation period : Included in the Operation budget

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.10 Health action plan

(1) Rationale

Health impact assessment is a collaborative learning process for the society to analyze and forecast the positive and negative impacts on public health that may arise from one or more policies, projects, or activities. A variety of tools and a appropriate participatory process are applied in the assessment to support decisions that will benefit public health in both the short and long term.

Therefore, the Consultant assessed the impact/changes that are the determinants of the public health of people in the area. The assessment was performed based on the 9 health determinants as stated in the Notification of the National Health Commission, 2009 as a framework. If these factors affect health in any dimension (physical, mental, social and intellectual), measures must be taken to prevent and reduce the effects to an acceptable level, where the prescribed measures have 3 levels: (1) preventive measures at the source of origin, (2) exposure prevention and surveillance measures at-risk groups, and (3) relevant measures for local public health agencies.

(2) Objectives

To prevent and reduce health impacts of workers and employees during construction and operation periods

(3) Target area/ operation

Construction workers/Communities surrounding the project

(4) Environmental impact prevention and mitigation measures

1) Construction period

(a) Inform the number of construction workers as information in the preparation of public health facilities in the area before starting to work and in case of illness or accident

(b) Coordinate with local health agencies to provide personal hygiene education, communicable diseases, and personal care for construction workers of all levels

(c) Provide first aid units and basic medical supplies including an emergency shuttle in the construction area according to the Regulation of the Ministry of Labor on Welfare in Establishments B.E. 2548 (2005)

(d) In the case of providing accommodation for temporary workers, utilities must be provided with adequate infrastructure and must comply with relevant standards or laws such as the Notification of the Ministry of Public Health No. 7/2538 on the number of workers per area of a construction worker residence and the Notification of the Labor Welfare Board on measures on labor welfare for accommodation for workers in construction

(e) Supervise and control contractors to strictly adhere to agreements, such as monitoring camps, residences, random drug testing, waste separation in the worker's camp, and closely control the behavior of construction workers not to cause a nuisance on neighboring communities

2) Operation period

(a) Provide first aid kit in the Project for employees and provide first aid training

(b) Support local public health agencies in promoting, rehabilitation, prevention, and community health care such as funding, education, etc.

(5) Environmental impact monitoring measure

Collecting data on disease statistics of people in the area from the public health agencies in the study area of 5 kilometers radius from the Project area once a year. The information shall be used in conjunction with the data of changes in ambient air quality data such as allergic, respiratory disease, skin diseases, etc.

(6) Implementation period

Construction period : throughout the construction

Operation period : throughout the Operation

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Construction period : Included in the construction budget

Operation period : Included in the Operation budget

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.11 Social and Action Plan

(1) Rationale

The operation of the Project can have direct and indirect impacts on the environment and the livelihood of the people in the adjacent areas. Thus, creating the right attitude and understanding about the Project as well as being aware of concerns and suggestions from the community are necessary to create a good relationship between the Project and the surrounding communities. These will allow the Project to co-exist with the community sustainably without causing mass problems against future operations.

(2) Objectives

1) People in the surrounding areas of the Project have proper knowledge of the nature of the operations and the main impacts that may arise from the Project and confidence that the operation of the Project will not adversely affect the environment and the livelihood of the community.

2) To monitor the implementation of the measures of the environmental action plan and to ensure that the plan is completely implemented

(3) Target area/ operation

The main target groups for the Project operations are communities that are expected to be affected by the Project operation within a 5 kilometers radius of the Project location and the community where the project's environmental parameter samples were collected

(4) Environmental impact prevention and mitigation measures

1) Pre-construction period

(a) Provide appropriate support to activities within the community to build good relationships with communities such as:

- Public health, such as mobile medical units, the project of protection before solving, etc.
- Education, such as the development of a teacher network for development, etc.
- Sport, such as traditional community sport, etc.
- Public relations, such as visiting an affiliated power plant, etc.
- Community support, such as budget allocation for community development according to the objectives of each area, etc.

(b) Establish an environmental inspectorate which will complete the appointment before construction, details are as follows:

Structure of the environmental inspectorate

Consists of representatives from the community, government agencies, experts, and the power plant, details are as follows:

a) Representatives from the communities from subdistricts and administrative districts within a 5-kilometer radius around the power plant as specified in the environmental impact assessment (EIA) report (not less than one-half of the number of boards), consists of:

- Two representatives from the village where the power plant is located
    - Hin Kong Subdistrict: Moo 5
- One representative from each village in the study areas (32 people)
    - Hin Kong Subdistrict : Moo 1, Moo 2, Moo 3, Moo 4, Moo 6, Moo 7, Moo 8, Moo 9, and Moo 10
    - Huai Phai Subdistrict : Moo 1, Moo 3, Moo 4, Moo 5, Moo 6, Moo 7, Moo 8, and Moo 9
    - Chedi Hak Subdistrict : Moo 6, Moo 7, Moo 8, Moo 9, Moo 10, and Moo 12
    - Ko Phlappla Subdistrict : Moo 6, Moo 7, and Moo 15
    - Don Tako Subdistrict : Moo 8 and Moo 9
    - Don Rae Subdistrict : Moo 2 and Moo 3
    - Khaongu Subdistrict Municipality : Ban Ton Mamoung Pattana Community and Som Phum Pattana Community

b) 11 government representatives, consist of 1 district administrative representative, 7 local government representatives, and 3 relevant government representatives (provincial natural resources and environment, provincial industry office, and provincial energy office)

c) 2 experts who must have knowledge in environmental impact monitoring or those that the community agree

d) 1 representative from the power plant

Recruiting

a) Representatives from the community may be obtained from recruiting or election or nomination. The process starts from the power plant to prepare a courtesy letter to the agencies within a radius of 5 kilometers in order to nominate an appropriate person to be a representative of the community to the power plant. Later, each area shall select a representative in accordance with the board structure. This process shall be complete within 30 days after receiving the letter from the power plant. The representatives from the communities must have the following qualifications:

- The person's name must be listed in the house registration in that subdistrict area for at least one year before the date of recruitment or appointment
- At least 25 years of age on the day of recruiting or election or nomination
- Do not have the following qualifications:
    * Misconduct or malpractice
    * Bankruptcy or imprisonment except for petty offenses or an offense committed by negligence
    * Insanity or mental distress or was ordered by the court to be an incompetent person or as incompetent

b) Government representatives shall be nominated by relevant agencies, one person per organization, consist of 1 district administrative representative, 7 local government representatives, and 3 relevant government representatives (provincial natural resources and environment, provincial industry office, and provincial energy office)

c) Experts shall come from a joint recruiting between representatives from the community and from the power plant, they must be knowledgeable in environmental impact monitoring or those the communities agreed and suggest to the power plant to select 2 people

d) 1 representative from the power plant shall be from the appointment of the power plant

<u>Authorities of the board</u> are as follows:

a) Set a guideline for the inspection of environmental impacts according to the environmental impact prevention and mitigation measures and environmental impact monitoring program

b) Visit the Project and participate in the audit of the environmental quality measurement process and the environmental quality measurement results according to the environmental impact monitoring measures to show transparency in the environmental management of the Project
c) Receive complaints, considering, and ruling out complaints, as well as suggestions from the public about the environmental impact of the construction and operation of the power plant
d) Give opinions or suggestions for the power plant to improve or revise the construction and operation and formulate ways to prevent and solve problems together in accordance with those specified in the environmental impact assessment report
e) Publicize correct information of the power plant to the public
f) Consider exploring the needs of the people, fostering good understanding between the community and the Project, and coordinating with other agencies or stakeholders
g) Post a public complaint to the board and announce the decision of the board in the office area of government agencies or in public spaces for at least three places
h) Set rules for receiving complaints, rules on the appeal of the people, or other rules that are necessary for the operation
i) Jointly negotiate, meditate, and find a resolution in the event of a dispute on environmental problems between the Project and the community
j) Inspect and consider compensation for damages where the case can be proven that is caused by the operation of the Project

<u>Term and tenure</u>

a) Chairman of the board comes from the resolution of the board meeting and has a term of 4 years
b) Members of the board have a term of 4 years from the date of appointment and can serve up to 2 consecutive terms

<u>Meeting frequency</u>

In order to have the board meeting, the presence of the members must not less than one-half of the total number of members. The meeting frequency is at least twice a year, but if there is an urgent need, a meeting can be performed under the consideration of half of the members of the board.

2) Construction period

(a) Consider hiring qualified local workers who meet the Project criteria to help local people get jobs and to foster a positive attitude towards the community by disclosing information on the vacancy in the communities

(b) Inspect construction workers not to engage in illegal behavior such as burglary, gambling, etc., with clear regulations and penalties including procedures for coordinating with local officials

(c) Post announcements to present the Project information by specifying information related to the Project such as the Project name, construction plan, contractor company, the Project owner company, coordinator, telephone number, etc.

(d) Provide appropriate support to activities within the community to build good relationships with communities such as:

- Public health, such as mobile medical units, the project of protection before solving, etc.
- Education, such as the development of a teacher network for development, etc.
- Sport, such as traditional community sport, etc.
- Public relations, such as visiting an affiliated power plant, etc.
- Community support, such as budget allocation for community development according to the objectives of each area, etc.

(f) Provide a channel for receiving complaints, such as by telephone, and promoting such channels to the community, set a complaint handling procedure, and facilitate as a complaints center to give information and to answer questions of the people (**Figure 7-6**).

3) Operation period

(a) Consider hiring qualified local workers who meet the project criteria as first priority to help local people get jobs and to foster a positive attitude towards the community by disclosing information on vacant positions to the community

(b) Public relations to create understanding with the community and to reduce anxiety as follows:

- Public relations to create more knowledge and understanding about the Project by creating a network to work with the community especially information on effective power production and pollution control efficiency as well as action plans related to environmental impacts
- Prepare a document presenting details of the power plant and pollution prevention system in a readable manner to create a good image for the power plant
- Coordinate with community leaders to organize groups of villagers to visit the power plant from time to time to build understanding and good relationship with the community
- Coordinate and attend meetings with key local agencies or organizations to clarify the results of operations to resolve impacts and to disclose new policies and guidelines to be implemented

(c) Support the community in activities that help to build up the confidence of the community, such as:

- Public health, such as mobile medical units, the project of protection before solving, etc.
- Education, such as the development of a teacher network for development, etc.
- Sport, such as traditional community sport, etc.
- Public relations, such as visiting an affiliated power plant, etc.
- Community support, such as budget allocation for community development according to the objectives of each area, etc.
- Environmental support such as working with the Provincial Fisheries Office or Department of Local Administration to release aquatic animals onto the Mae Klong River to preserve the aquatic conditions, food web, and etc.

(d) Support the community in activities that help to build up the confidence of the community in case of impacts

- Disaster relief training program, first aid training program, information exchange (methods and channels) between the power plant and the people.

- Organize trees planting project to increase green areas in the community and adjacent areas to reduce the anxiety about heat.

(e) In the event that damage is found to be caused by the operation of the Project, the company will set up a compensation committee for further consideration of appropriate compensation guideline

(f) Emergency preparedness and operation in the case of emergency shall be prepared with a 24-hour emergency receiving system. The Project shall provide a list of telephone numbers of local authorities that need to coordinate in the event of an emergency such as municipalities/SAO, local police stations, disaster mitigation authority, hospital, etc.

(5) Environmental impact monitoring measure

1) Construction period

(a) Socio-economic conditions

Indicator : Conduct a survey of socio-economic conditions, household problems, and needs as well as public opinion of community leaders in the sensitive area, representatives of relevant government agencies, establishments around the Project area, and communities where the environmental quality monitoring points are located together with surveying on community satisfaction index. A distribution map for data collection shall be presented.

Monitoring area: Communities in the area within 5 kilometers radius of the Project location and community where the environmental sampling points are located (**Figure 7-5**)

Methodology: Opinion survey by using questionnaires

Duration/frequency: One time per year throughout the construction period (3 years)

(b) Complaints

Indicator :

1. Record any complaints raised by the community against the Project including corrective approach and time duration to solve such complaints

2. Perform follow-up and review of action plans in case of any community complaints as follows:

* Communicate results to the community through community leaders

* In the event that the cause of the problem is found to be directly from the Project, the project is responsible for all monitoring incurred expenses

Monitoring area : In the Project area and adjacent communities

Methodology : Record any complaints that arise in the operation of the Project

Duration/frequency: Every time there is a complaint and prepare a summary report every 6 months throughout the construction period

2) Operation period

(a) Socio-economic conditions

Indicator : Conduct a survey of socio-economic conditions, household problems, and needs as well as public opinion of community leaders in the sensitive area, representatives of relevant government agencies, establishments around the Project area, and communities where the environmental quality monitoring points are located together with surveying on community satisfaction index. A distribution map for data collection shall be presented.

Monitoring area : Communities in the area within 5 kilometers radius of the Project location and community where the environmental sampling points are located (**Figure 7-5**)

Methodology : Opinion survey by using questionnaires

Duration/frequency : One time per year throughout the operation period

(b) Complaints

Indicator :

1. Record any complaints raised by the community against the Project including corrective approach and time duration to solve such complaints

2. Perform follow-up and review of action plans in case of any community complaints as follows :

* Communicate results to the community through community leaders
* In the event that the cause of the problem is found to be directly from the Project, the project is responsible for all monitoring incurred expenses

Monitoring area : In the Project area and adjacent communities

Methodology : Record any complaints that arise in the operation of the Project

Duration/frequency : Every time there is a complaint and prepare a summary report every 6 months throughout the operation period

(6) Implementation period

Throughout the construction and operation periods of the Project

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Construction period : Included in the construction budget

Operation period : Included in the operation budget

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.12 Aesthetics action plan

(1) Rationale

The Project is located in the original empty area of the Tri Energy Power Plant. Therefore, there is no change in the original scenery. For the landscape architecture surrounding the project area, the Project shall provide green spaces. This will help keep the shade and reduce stress and provide recreation for employees and visitors. Hence, this will create good scenery for the outsiders. In addition, the operation of the Project has no activity that will have a direct impact on tourism, nature reserve, and historic sites. Therefore, the resulting impact on aesthetics is low.

(2) Objectives

To reduce the aesthetic impact arising from the Project

(3) Target area/ operation

The Project area

(4) Environmental impact prevention and mitigation measures

1) Provide a green area of 15,646 square meters, accounting for 5.18% of the Project area (**Figure 7-7**) by planting trees or plants that are suitable for narrow areas to help block the wind and act as shade. The plant's height can be controlled by top cutting and the fact that the trees characteristics are in pyramid shape with narrow thin top and evergreen.

2) Prepare a management plan for the Project's green area to cover the steps of soil improvement, fertilizing, pest control, and mowing as well as repair of green areas are as follows:

(a) Improve the soil, fertilize, and eradicate pest by plowing the soil around the roots and fertilize regularly. The use of soil stabilizers in green areas is specially supervised by staff. Organic matter will mainly be used together with organic pest control for a frequency of one time a year or according to the condition of the disease.

(b) Pruning, weeding, and mowing shall be performed regularly or when the canopies are close together to allow sunlight to pass through. Weed control and mowing shall be performed at a frequency of one time a year or according to the conditions.

3) Restore of green space if trees in green areas die or deteriorate, the Project will carry out replanting within 30 days, taking into account the size and age of similar trees without disrupting the specified planting plan

(5) Environmental impact monitoring measure

Check the area of the green spaces of the Project and the proportion of green area to the Project area

(6) Implementation period

Pre-construction period : Before construction

Construction period : throughout the construction

Operation period : throughout the operation

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Operation period : Included in the Operation budget

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.13 Action plan on heat monitoring

(1) Rationale

During the operation period of the Project, there may be an effect of heat diffusion arising from the power plant. From the data collection, it was found that the Ratchaburi Power Plant Project, a power plant in the group of the company which has been operational. There was a study of temperature changes in the power plant and nearby areas. The study was performed by using satellite images to compare temperatures both the rainy and dry seasons. In the rainy season, the temperature of the power plant's stacks is slightly higher than the surrounding area. For other areas such as agricultural areas and the area around the power plant, the color values shown are also normal temperatures in the general atmosphere. There was no characteristic of the heatwave distribution from the power plant. In the dry season, the ambient temperature is higher due to the burning of rice straw in the fields surrounding the power plant area. Therefore, the results vary mainly according to the utilization of the surrounding areas. However, the Project has set up monitoring measures to monitor the impacts that may arise from the Project's operation.

(2) Objectives

To investigate the potential heat diffusion radius from the Project's operation by collecting data from the pre-construction, construction (before commissioning), and operation periods

(3) Target area/ operation

Pre-construction period : Cover the Project construction area, air quality monitoring areas, and temperature at the Project

Construction period : Cover the Project construction area, air quality monitoring areas, and temperature at the Project

Operation period : Cover the Project area, air quality monitoring stations, and temperature at the Project

(4) Environmental impact prevention and mitigation measures

-

(5) Environmental impact monitoring measure

1) Pre-construction and construction periods

Indicator : Satellite images showing temperature data provided by Geo-Informatics and Space Technology Development Agency (Public Organization) or GISTDA or agencies/companies that can perform the study and analysis of satellite imagery by presenting surface temperature with satellites

Monitoring area : Cover the Project construction area and air quality monitoring stations of the Project

Duration/frequency : Three times prior to the commissioning to cover all seasons, summer season (mid-February to around mid-May), rainy season (mid-May To around mid-October), and winter season (mid-October to around mid-February), the Meteorological Department, www.tmd.go.th.

2) Operation period

Indicator : Satellite images showing temperature data provided by Geo-Informatics and Space Technology Development Agency (Public Organization) or GISTDA or agencies/companies that can perform the study and analysis of satellite imagery by presenting surface temperature with satellites

Monitoring area : Cover the Project construction area and air quality monitoring stations of the Project

Duration/frequency : Three times prior to the commissioning to cover all seasons, summer season (mid-February to around mid-May), rainy season (mid-May To around mid-October), and winter season (mid-October to around mid-February), the Meteorological Department, www.tmd.go.th.

(6) Implementation period

Pre-construction period : Pre-construction

Construction period : throughout the construction

Operation period : throughout the operation

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Pre-construction period : approximately 90,000 Baht/terms

Construction period : approximately 90,000 Baht/terms

Operation period : approximately 90,000 Baht/terms

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

The Consultant has summarized the environmental action plans by proposing environmental impact prevention and mitigation measures for the Project to be implemented as follows:

General measures are shown in **Table 7-1**

Environmental impact prevention and mitigation measures for pre-construction and construction periods are shown in **Table 7-2**

Environmental impact prevention and mitigation measures for the operation period are shown in **Table 7-3**

Environmental impact monitoring measures can be used as a guideline for monitoring changes to the environment. It also can be used for investigation of the efficiency of implemented environmental impact prevention and mitigation measures whether they are appropriate or not. Environmental impact monitoring measures consist of the following:

Environmental impact monitoring measures for the pre-construction period are shown in **Table 7-4**

Environmental impact monitoring measures for the construction period are shown in **Table 7-5**

Environmental impact monitoring measures for the operation period are shown in **Table 7-6**

Environmental action plans for raw water and wastewater discharging pipeline installation consist of seven aspects to be strictly implemented. Details are as follows:

(1) Air quality action plan
(2) Noise action plan
(3) Vibration action plan
(4) Water quality and wastewater action plan
(5) Soil resources and erosion action plan
(6) Transportation action plan
(7) Waste management action plan

Environmental action plans, environmental impacts prevention and mitigation measures, and environmental impacts monitoring program For raw water and wastewater discharging pipeline

7.14 Air quality action plan

(1) Rationale

From the assessment of the impact on air quality during the construction of the Project in the study area, it is expected that the concentrations of particulate matter arising from the main activities that cause dispersion of dust are the adjustment of the excavation area for pipelines and the use of vehicles for the transportation of pipeline and machinery as well as pipeline embedment. By assessing the dust dispersion effect during the construction period with mathematical models, it was found that the values obtained from the mathematical model were within the ambient air quality standard (24-hour average total suspended particulate (TSP) of less than 330 micrograms per m^3, 24-hour average particulate matter with a diameter of smaller than 10 microns (PM-10) of less than 120 micrograms per m^3, 24-hour average sulfur dioxide (SO_2) of less than 300 micrograms per m^3, and 1-hour average nitrogen dioxide (NO_2) of less than 320 micrograms per m^3, according to the Notification of the National Environment Board No. 24 B.E. 2547 (2004) and the Notification of the National Environment Board No. 33 B.E. 2552 (2009). Therefore, the impact on the adjacent communities is low. However, in order to minimize air quality impacts on the public and the workers, the Project set air quality impact mitigation measures to be strictly implemented.

(2) Objectives

To reduce the amount and control of dust emission caused by the construction of the Project as well as reducing the occurrence of air pollution from the exhaust of machinery and engines into the atmosphere to minimize the impact on the people and the workers

(3) Target area/ operation

The construction area along the raw water and wastewater discharging pipelines of the Project (**Figure 7-8**)

(4) Environmental impact prevention and mitigation measures

1) Do not open the land surface at the same time throughout the pipeline and when the raw water and wastewater discharging pipelines have been laid, carry out the embedment as soon as possible

2) Spray water at least twice a day around the construction area and increase the frequency if there is a large amount of dispersed dust

3) Cover construction materials that can diffuse or fall onto the traffic surface during transport to prevent scattering and falling of materials while being transported along the route

4) Always turn off the engine when idling or parking

(5) Implementation period

throughout the construction

(6) Responsible person

Hin Kong Power Company Limited

(7) Estimated cost/ expenditure

Included in construction budget

(8) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.15 Noise action plan

(1) Rationale

Activities of the Project that may have a noise impact during the construction period of construction are mainly from activity that uses machinery or equipment such as the use of backhoes to open the land surface, excavation, trenching, pipeline embedding, etc.

From field surveys in conjunction with checking maps of the Royal Thai Survey Department, satellite photos, and images from the unmanned aerial vehicle throughout the pipeline of the Project, it was found that the land use along the pipeline was concentrated on housing in some areas. For the pipeline installation by open-cut, the nearest house locates about 2 meters from the construction area. For the pipeline installation by HDD, the nearest house locates about 10 meters from the construction area. Therefore, the Consultant assessed the noise impact of Project construction activities by distance. The results were used in setting noise impact mitigation measures. From the results of the noise level projections, the pipeline installation by open-cut method within the distance of 2 meters from the noise source will generate 24-hour average noise level of more than the standard which is 70 dB(A) as in compliance with the ambient noise level standard according to the Notification of the National Environment Board. For the pipeline installation by the HDD method which the driving pit near will generate 24-hour average noise level of higher than 70 dB(A) which is higher than the ambient noise level standard according to the Notification of the National Environment Board.

The assessment of the disturbance noise caused by construction activities by the open-cut method during 08.00-17.00 o'clock found that the areas affected by disturbance noise are within 0-250 meters from the pipeline installation area. For pipeline installation by the HDD method which will be performed on a 24-hour basis found that that the areas affected by noise are within 0- 500 meters from the pipeline installation area. However, the Project has set measures to reduce the impact on residents of the areas follows:

(2) Objectives

To reduce the impact on people nearby and prevent the health impact of the workers

(3) Target area/ operation

The construction area along the raw water and wastewater discharging pipelines of the Project

(4) Environmental impact prevention and mitigation measures

1) Discuss with homeowners or shops located within the nearby area to minimize impact during the construction period

2) Notify the residents, local government agencies, community leaders, and establishments in the vicinity of the Project area about the construction plan at least 1 week in advance in precaution against traffics on the project routes. When there are construction activities near citizen's households, the construction and operation shall be closely monitored and done swiftly and effectively.

3) If there is a household within the distance of 0-250 meters from the raw water and wastewater discharging pipelines, install a temporary soundproof wall covering the whole noise source area, 18 ga steel, with transmission loss of 25 dB(A) and a height of 2.5 meters from the ground and the area of the driving pit.

4) Construction activities must be carried out during the daytime (8:00 -17.00 o'clock) only, except those that require ongoing operations. In such a case, the contractor must inform the construction plan and relevant impact prevention and mitigation measures to the local administration, contracted/responsible agencies, and residents in advance.

5) Running of the loud noise-generating machine shall be performed during daytime only and stop the engine immediately after use

6) Arrange compensation for damages as appropriate in the event that the Project construction activity causes damage to shops or houses located near the construction area

7) Coordinate with communities and people near the pipeline to build a good relationship and find solutions to problems together as well as coordinating with community leaders and related agencies to provide assistance and support. In the event that the impact is directly caused by the Project, the Project shall compensate for any damages incurred as appropriate.

(5) Implementation period

throughout the construction

(6) Responsible person

Hin Kong Power Company Limited

(7) Estimated cost/ expenditure

Included in construction budget

(8) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.16 Vibration action plan

(1) Rationale

Project construction activities can cause vibration. However, the degree of vibration impact depends on the type of equipment, machinery used, construction methods, and distance of the source of vibration. During the Project operation period, only raw water and wastewater are transported through the pipeline system. These activities do not use heavy equipment. Therefore, there will be no vibration impact during the operation period. The Consultant gathered the sensitive areas near the construction site and found that there are no sensitive areas along the pipeline for both cases of the open-cut method with the nearest distance of 2 meters and the HDD method with the nearest distance of 10 meters. However, the Project has set measures to be applied in case of damage to property from construction activities

(2) Objectives

To reduce the impact on people nearby and prevent the health impact of the workers

(3) Target area/ operation

The construction area along the raw water and wastewater discharging pipelines of the Project

(4) Environmental impact prevention and mitigation measures

1) When any damages are investigated and are clear to be caused by the Project, the contractor company shall compensate appropriately and report the case to the Company as well as record the case details to prevent the reoccurrence of such damages.

2) Coordinate with community leaders and relevant agencies to provide assistance, support, and resolve problems for people affected by the Project construction activities

(5) Implementation period

throughout the construction

(6) Responsible person

Hin Kong Power Company Limited

(7) Estimated cost/ expenditure

Included in construction budget

(8) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.17 Water quality and wastewater action plan

(1) Rationale

The project activities can be classified as follows:

1) To reduce impacts on water quality and aquatic ecosystem, the Project shall perform HDD and boring techniques for installation of raw water and wastewater discharging pipelines through irrigation canals

2) Hydrostatic tests may cause an impact on water quality. The Project shall have wastewater from the hydrostatic test two times. The first time is when complete the pipeline installation for a distance of 1,000 -4,000 meters. The test is divided into 5 phases. The amount of water use and wastewater is approximately 4,742 m^3 (the raw water pipeline has a diameter of 24 inches and requires 3,793 m^3 of water while the wastewater discharging pipeline has a diameter of 12 inches and requires 949 m^3 of water). The project shall use water from the Mae Klong River or irrigation canal. The nearest water source shall be considered to reduce the impact on the communities. The second time of testing is when the whole pipeline installation is completed. The amount of water required for the testing is approximately 4,742 m^3. The Project shall use water from the Mae Klong River. Wastewater from the testing shall be discharged into the Mae Klong River as well. In addition, the Project has requested permission from the Marine Department and the Royal Irrigation Department.

3) Impact of wastewater from construction workers, the Project request the contractor to provide toilets and installed septic tanks in the temporary office area to sufficiently support the workers

The Company, therefore, has set such measures in the environmental action plan to be strictly implemented.

(2) Objectives

To prevent and mitigate the impact of effluent/contaminated water occurring during the construction period and prevent the impact of drainage on the area along the pipeline

(3) Target area/ operation

The construction area along the raw water and wastewater pipelines of the Project and the area that drains the wastewater from the hydrostatic test

(4) Environmental impact prevention and mitigation measures

1) General measures

(a) Provide temporary toilets at temporary offices and worker camp that is sufficient for the number of employees and workers and must be located at least 15 meters away from the water source

(b) Do not wash/clean tools/machines and do not litter chemicals and used motor oils in water sources as well as prohibit to drain untreated waste into water sources

(c) Keep the soil as far as possible from surface water sources and must install a sediment fence to prevent leaching of sediment into water bodies

2) Measures for the hydrostatic test

In the event that the Project drains the water from the hydrostatic test into public waterways, the following measures must be followed.

a) Before draining the water from the hydrostatic test into the water source, consent must be obtained from local authorities or responsible agencies such as the SAO and related government agencies

b) Adjust the water pressure from the hydrostatic test before slowly open the valve to drain the water into the temporary gutters/drains to prevent erosion and reduce the increase in the amount of turbidity of the water source

c) Provide a sieve to trap solid contaminants at the end of the pipe that drains the wastewater from the hydrostatic test

d) Conduct an inspection of the effluent quality by analyzing the temperature, pH, and suspended solids to be in accordance with the effluent standards specified by the Royal Irrigation Department

(5) Environmental impact monitoring measures

Monitoring parameter: Monitoring parameters consist of the following:

1. Temperature
2. pH
3. Conductivity
4. Total dissolved solids (TDS)
5. Suspended solids (SS)
6. Oil & grease
7. BOD_5
8. COD

Monitoring area: Mea Klong River where the wastewater from the hydrostatic test is discharged

Methodology: Collect samples and analyze according to the Notification of the National Environmental Board (No.8) B.E. 2537 (1994)

Duration/frequency: When discharging wastewater from the hydrostatic test

(6) Implementation period

throughout the construction

(7) Responsible person

Hin Kong Power Company Limited

(8) Estimated cost/ expenditure

Included in construction budget

(9) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.18 Soil resources and erosion action plan

(1) Rationale

Project construction activities include digging and pile of soil may cause mixing between the soil layers. It is also possible to cause soil erosion. From the assessment of soil erosion in the construction site, it was found that the pipelines of the Project would have an acceptable low level of impact. However, to prevent and reduce the environmental impact on soil resources that may occur, measures must be put in place.

(2) Objectives

To reduce the impacts arising from soil erosion in the construction period

(3) Target area/ operation

The construction area along the raw water and wastewater discharging pipelines of the Project

(4) Environmental impact prevention and mitigation measures

1) Limit the cover crop area to the area to be construction area only

2) Separating the topsoil from the subsoil and when covering the soil, the bottom layer must be covered first, followed by the topsoil and avoid the accumulation of soil caused by digging in open-cut near irrigation canals or drainage ditches to prevent debris from falling off the drainage channel

3) During heavy rain, activities engage in excavation is forbidden to prevent sediment from being leached into a nearby drainage channel

4) Supervise the excavation operations to have appropriate measures to prevent landslides and ensure the safety of the operators, such as installing a sheet pile around the open-cut construction area or consider the slope of the hole to be appropriate. For pipeline embedment, the original soil must be spread around the pipeline and consider collapse or subsidence of the soil with soil crown.

5) Install tools or devices to prevent soil collapse such as sheet pile or use trench box appropriately based on conditions of the area

6) When the pipeline installation is finished, return the entrances to the houses or in the road area to the same or better conditions as soon as possible, any debris from the construction must be removed from the area completely.

(5) Implementation period

throughout the construction

(6) Responsible person

Hin Kong Power Company Limited

(7) Estimated cost/ expenditure

Included in construction budget

(8) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.19 Transportation action plan

(1) Rationale

Areas of raw water and wastewater discharging pipelines installation are mainly in the area of the Royal Irrigation Department. Most of the transport during construction will be the transportation of construction materials and machinery. Transportation shall use trucks. Transport of materials, construction equipment, and machinery must use the specified main routes only and must avoid the route that passes through the community area. For the shuttle bus for construction workers, the project assigns the construction company to be responsible for arranging accommodation. In the operation of the construction company, it is necessary to strictly comply with the labor laws in order to reduce the impact on the environment, society, and the utilization of the area of the community. Therefore, the Project chooses to use the HDD and boring techniques in case of intersection such as canal, road, or wide road with heavy traffic. Thus, there is no impact on traffic obstruction. Although the assessment of traffic congestion during construction found that there are no significant changes from the Project operation. However, some areas that are expected to be affected which is the road behind the power plant and around Lum Din Community in which the installation shall be done using the open-cut technique. The project will provide a bypass for the public and implement impact prevention measures as follows.

(2) Objectives

To reduce impacts on the traffic and promote safety on roads that is used as a transportation route as well as the area along the pipelines

(3) Target area/ operation

The construction area and the transportation route for construction material and equipment

(4) Environmental impact prevention and mitigation measures

1) Request the contractor to provide a concrete barrier, steel fence, or other materials to specify a safe distance along the construction area. In addition, the construction shall block only the outermost traffic surface of 1 lane and the length of the deviation route, as necessary.

2) Provide a signboard to show the name of the Project, the Project owner, duration of the construction, and the construction company name with a phone number to inform the road users at least 1 month in advance

3) There shall be clearly visible signs or alarms both during the day and at night

- Construction signs at least 350 meters before reaching the construction area

- Speed reduction signs and construction signs at least 200 meters before reaching the area
- Traffic cones at least 50 meters before reaching the construction area
- End of the construction ara signs at the end of the construction area
- If it is necessary to work at night, blinking and warning light must always be clearly visible

4) Bypass must be completed before performing construction or excavate and provide at least one lane for vehicles to pass through, however, the pipeline must be embedded and road surface must be adjusted/fixed as soon as possible to reduce transportation impacts.

5) Limits the speed of vehicles used to transport construction materials not to exceed 30 kilometers/hour when passing through community areas and 80 kilometers/hour in a general area, in accordance with the relevant laws of each area.

6) In the case of damages of the road caused by the construction, the contractor company shall repair it immediately.

7) Publicize details of the construction plans to community leaders and households along the pipelines as well as related agencies such as local authorities, at least 1 week in advance

(5) Implementation period

throughout the construction

(6) Responsible person

Hin Kong Power Company Limited

(7) Estimated cost/ expenditure

Included in construction budget

(8) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

7.20 Waste management action plan

(1) Rationale

Wastes to be generated from activities during the construction period consist of waste from consumption of workers such as food packaging, and residue from the construction such as pipe welding debris, sodium bentonite mud from the HDD, absorbent material used to clean up spilled oil. The project is responsible for coordinating with the responsible agency in the area to collect and dispose of properly in a sanitary manner. However, in order to minimize the impacts on the communities, the Project set a waste management action plan to be strictly implemented.

(2) Objectives

To enable the Project to manage the waste appropriately without affecting the environment

(3) Target area/ operation

Throughout the Project construction area and the temporary construction office of the Project

(4) Environmental impact prevention and mitigation measures

1) General measures

(a) The contractor must provide enclosed waste containers according to the type of waste and sort recyclable waste to achieve maximum utilization. Apart from recyclable waste, the Project shall collect before sending it to dispose of by a licensed waste disposer.

(b) Pile of soil from construction activities must not obstructing the entrance-exit and the drainage way, and after the pipeline is laid, cover with the dredged soil. Before returning the area, the remaining soil from the embedment shall be used for landfilling in permitted area, and the area shall be properly inspected.

2) Measure on sodium bentonite management

(a) Mix sodium bentonite for the HDD to fit the required amount by considering the proportions of sodium bentonite to reduce the residual sodium bentonite that must be disposed of

(b) In the event of overflow/leakage of sodium bentonite to adjacent areas, perform the following:

- Handling in the case of sodium bentonite leaking or spilling up, use a vacuum vehicle along the line of the spill. If there is a large spill, pause the machine to complete the clean up first before resume the operation and consideration to adjust the operating methods accordingly to limit or reduce the amount of sodium bentonite overflow, for example, by adjusting the penetration pressure to suit the area conditions, etc.

- Provide employees to monitor and respond to prevent sodium bentonite from spreading out by using containment equipment such as sandbags.

(c) In case of overflow/leakage of sodium bentonite and affecting the property or agricultural products of the people, the project is responsible for any damage incurred. The Project shall coordinate to assist and resolve the impact or damage that has occurred as soon as possible as well as negotiate an agreement to compensate for damages appropriately.

(d) In case of sodium bentonite residual, it must be disposed of in accordance with academic principles and must report safety data sheet and chemical property of sodium bentonite such as electrical conductivity (ECe), exchangeable sodium content, and exchangeable sodium percentage (ESP), etc., to the disposal agency or the owner of the area.

(5) Implementation period

throughout the construction

(6) Responsible person

Hin Kong Power Company Limited

(7) Estimated cost/ expenditure

Included in construction budget

(8) Evaluation

Hin Kong Power Company Limited shall present a report on the results of the implementation of the measures along with electronic files in accordance with the format of the Office of Natural Resources and Environmental Policy and Planning. The report shall be sent to licensing agencies i.e. the Energy Regulatory Commission, the Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning in accordance with the Notification of the Ministry of Natural Resources and Environment on the criteria and methods for preparing a report on the implementation results of measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare once the project or business has been granted permission on a regular basis every 6 months.

The Consultant has summarized the environmental action plans by proposing environmental impact prevention and mitigation measures for the Project to be implemented as follows:

Environmental impact prevention and mitigation measures for the construction period are shown in **Table 7-7**

Environmental impact monitoring measures for the construction period are shown in **Table 7-8**

Table 7-1

Environmental Impact Prevention and Mitigation Measures

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environmental Element	Environmental Impact Prevention and Mitigation Measures	Location	Implementation Period(Duration)	Responsible Party
1. General Measures	1. Strictly follow the environmental impact prevention and mitigation measures and environmental quality monitoring program in the form of an environmental action plan as proposed in the EIA report of Hin Kong Power Plant Project of Hin Kong Power Company Limited, locates at Hin Kong Subdistrict, Mueang Ratchaburi District, Ratchaburi Province. The Project shall use the measures as a guideline for the supervision, control, and monitoring of the organization, the people, and related organizations.	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd
	2. Hin Kong Power Company Limited shall embed details of measures in the environmental action plan as essential conditions in the contract for the contracting company to be strictly implemented in order to achieve effectiveness in practice.	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd
	3. Hin Kong Power Company Limited shall maintain the cooling system to be in good working condition on a regular basis and is safe for workers and people in the vicinity area.	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd

Table 7-1 (continue)

Environmental Impact Prevention and Mitigation Measures

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environmental Element	Environmental Impact Prevention and Mitigation Measures	Location	Implementation Period(Duration)	Responsible Party
1. General Measure(continue)	4. Hin Kong Power Company Limited is required to engage a third party to inspect the implementation of environmental impact prevention and correction measures and environmental impact monitoring program of the Project. The report on the implementation of environmental impact prevention and correction measures and environmental impact monitoring program shall be submitted to licensing agencies, namely the Energy Regulatory Commission Office, the Department of Industrial Works, Ratchaburi Province, and electronic systems of the Office of Natural Resources and Environmental Policy and Planning. In this regard, the preparation of the report on the results of the measures implementation and the frequency of submission of the report shall be in accordance with the notification on criteria and methods for preparing a report on the results of the measures prescribed in the environmental impact assessment report which the operator or the applicant must prepare after receiving permission to operate the project or business B.E. 2561 (2018) and related laws.	- Project Area	- Entire duration of the project period	Hin Kong Power Co.,Ltd

Table 7-1 (continue)

Environmental Impact Prevention and Mitigation Measures

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environmental Element	Environmental Impact Prevention and Mitigation Measures	Location	Implementation Period(Duration)	Responsible Party
1.General Measure (continue)	5. In cases where the environmental quality monitoring results have shown environmental problems including in the case of complaints from the community caused by the Project implementation, Hin Kong Power Company Limited shall improve and correct such problems as soon as possible. The Project shall notify the Energy Regulatory Commission, Department of Industrial Works, Ratchaburi Province, and the Office of Natural Resources and Environmental Policy and Planning to acknowledge soon in order to coordinate and cooperate in solving such problems.	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd
	6. If Hin Kong Power Company Limited requires to change the Project details or environmental impacts prevent and mitigation measures or environmental impact monitoring program from those presented in the environmental impact assessment report which has been approved by the expert committee, it is the duty of agencies that have the authority to consider or approve as follows: (a) In the case that changing of the Project details or environmental impacts prevention and mitigation measures or environmental impacts monitoring program does not affect the essence of the environmental impact assessment in the EIA report and it is a measure that is more beneficial to the environment or equivalent to the measures specified in the EIA report that has been considered and approved by the expert	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd

Table 7-1 (continue)

Environmental Impact Prevention and Mitigation Measures

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environmental Element	Environmental Impact Prevention and Mitigation Measures	Location	Implementation Period(Duration)	Responsible Party
1.General Measure (continue)	committee, the competent authority shall approve or accept the notification of such amendment to be in accordance with the rules and conditions stipulated in that regulation. The contracted agency or agency with premits shall prepare a copy of the improved environmental impact prevention and mitigation measures or environmental impact monitoring program that has been notified and send it to the Office of Natural Resources and Environmental Policy and Planning for acknowledgment.			
	(b) If the authority agency considers that revising the Project details or measures may affect the essence of the EIA report approved by the expert committee, the authorized agency shall submit the revision report on the Project details or environmental impacts prevention and mitigation measures or measures to environmental impact monitoring program to the Office of Natural Resources and Environmental Policy and Planning to propose to the expert committee. When the Project has changed details or improved the measures according to the expert committee comments, the authorized agency shall acknowledge the results of the changes to the Office of Natural Resources and Environmental Policy and Planning.			

Table 7-1 (continue)

Environmental Impact Prevention and Mitigation Measures

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environmental Element	Environmental Impact Prevention and Mitigation Measures	Location	Implementation Period(Duration)	Responsible Party
1. General Measure (continue)	7. When the Project's operation is in the steady-state and the emission of an air pollutant is lower than the values set in the measures, the Project shall use that as a control level and notify the Office of Natural Resources and Environmental Policy and Planning as soon as possible.	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd
	8. Hin Kong Power Company Limited is required to obtain permission to use the area for pipeline installation from the landlord and the licensing agency before starting the construction of the Project.	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd
	9. Disclose details of the Project, advantages - disadvantages of the Project, and results of the implementation of the measures to the community to acknowledge in order to create a better understanding along with providing opportunities for the community to participate in the monitoring of the Project's operation throughout the project life span.	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd
	10. The Project shall provide a channel for receiving complaints, such as over the phone, and establish a clear procedure for receiving complaints both general and emergency cases. In the case that there is a complaint from the community against the operation of the project, the Project must promptly fix the problem and record it as a report as well.	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd

Table 7-1 (continue)

Environmental Impact Prevention and Mitigation Measures

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environmental Element	Environmental Impact Prevention and Mitigation Measures	Location	Implementation Period(Duration)	Responsible Party
	11.If damage occurs due to the Project operation, Hin Kong Power Company Limited shall carry out urgent compensation payments to those affected for initial emergency relief. However, the process of paying compensation in normal cases is applied when the cause and the total cost of the damage are finalized. The insurance company will pay the victim directly in accordance with the compensation procedure of the insurance company.	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd
	12.The project shall not block, limit the right, refrain, or prohibit anyone from entering the public area.	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd
	13.Clear signboards and symbols to specify area boundaries shall be provided at the area of the Project where adjacent to the public areas.	- Project Area	- Entire duration of the project and construction period	Hin Kong Power Co.,Ltd

Table 7-2

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
1. Air Quality	- Spray water around the Project construction area and the road to the entrance-exit at least twice a day (morning and afternoon), consider additional spray when the weather is dry and windy to prevent dust from spreading into the atmosphere and affecting adjacent communities	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Use canvas to cover the trucks or construction materials that may be diffused, such as soil, cement, etc. during transportation	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Before leaving the construction area and going onto public roads, clean the truck wheels so that dirt from the project will not spread and dirty areas outside the project.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Limited truck speed within the construction area of the Project not more than 20 kilometers per hour to reduce the dispersion of dust	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Check the condition and maintain the vehicle/engine/machinery used in construction regularly according to the period specified in the engine/machinery maintenance manual to control the pollution emission to meet the design criteria	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
1. Air Quality (continue)	- Stop the engine/machine every time it is idle	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Do not burn materials or solid waste in the construction area	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Control the contractor to clean up debris in the construction and adjacent areas which may be washed down by rainwater down the drainage gutters such as debris, sand attached to truck wheels, plastic bags, paper waste, etc.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
2. Sound/Noise	- Publicize construction plans and noise control measures to people in the community and the households surrounding the power plant	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- There should not be noise-inducing construction activities during the period of 17.00 - 07.00 o'clock of the next day in order to reduce the impact on the community during the period. If there is a need for activities that cause loud noise, the Project must notify people in the community and the households surrounding the power plant at least seven days in advance	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Install a temporary soundproof wall around the house behind the power plant (Southside of the Project) by using steel material, 18 ga, with a height of 5 meters	Along the fence on the south side of the project	Entire duration of the construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
2. Sound/Noise (continue)	- Choose construction equipment and machinery that has low noise levels and always perform maintenance checks to reduce the noise level	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Provide noise protection equipment such as earplugs or earmuffs to construction workers in the areas where the noise level is higher than 85 dB(A)	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Install signboards or symbols to wear personal protective equipment in the areas with high noise levels according to the hazardous area classification by the safety officer	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Provide the Project's staffs to visit the area to inquire of the communities and households surrounding the power plant about the noise impact from the Project's construction activities periodically throughout the construction period in order to find ways to mitigate such impacts	Education Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Continuously coordinate with communities and households surrounding the power plant to build good relationships and find solutions to problems together as well as coordinating with community leaders and related agencies to provide assistance, support, and problem-solving for people affected by the operation of the Project. In the case that there is an impact that is directly	Education Area	Entire duration of the construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
2. Sound/Noise (continue)	caused by the operation of the Project, the project shall compensate for any damages as appropriate.			
3. Water Usage	- Require a contractor to supply sufficient water for construction activities	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Require a contractor to provide clean, hygienic, and sufficient drinking water for construction workers	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
4. Water quality and wastewater	- Provide adequate toilets that equipped with sewage storage tanks for the construction workers as required by law before contacting the authorized agencies to get rid of them	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Do not litter down the drainage gutter and require the contractor to clean up the sediment and construction debris such as cement, concrete, etc. that have fallen in the area to prevent the leaching of rainwater into the surrounding drainage gutters	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Store construction materials in an appropriate area without obstructing the drainage and provide workers to regularly clean the drainage gutter to prevent clogging	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Vehicle and all kinds of machines maintenance must be performed in a specified area or on a hard surface and has a leak-proof material to prevent leaks into the outside water source	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
5. Waste Disposal	- The solid waste generated from construction and from workers' activities shall be separated by type. Recyclable waste shall be collected as much as possible. Waste containers shall be adequately provided. The contractor shall provide workers who are responsible for collecting the waste in the designated area at least once a day before coordinating with the waste disposer who is approved by a local government agency to collect the waste for further disposal.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
6. Transportation	- The Project shall request contractors to plan the use of transportation routes for construction machinery/equipment by avoiding the transport routes that pass through the community as much as possible and to use the speed not exceeding the strict legal limit. In addition, the speed of the vehicle in the construction area shall be limited to not more than 20 kilometers per hour by notifying the contractor and installing speed control sign in the construction area.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- The contractor company is required to train and control the drivers to strictly comply with the traffic rules along with placing name tags and telephone numbers on the workers' transport vehicles, construction materials and tools, and construction's wastes as a channel for receiving complaints to the Project.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
6. Transportation (continue)	- In the case of transportation of large machines, coordinate with the traffic police to plan transportation, and facilitate transportation to minimize impacts on the traffic.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Manage the traffic systems in the construction area accordingly, during rush hours (7.00-8.00 o'clock and 16.00-17.00 o'clock) the Project must provide staff to assist in facilitating and organizing traffic around the entrance-exit area of the Project.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Inspect the engine conditions of construction trucks and transport vehicles in accordance with the vehicle maintenance manual throughout the life span and check for readiness and safety before use.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- In the case of investigation and found that the road has been damaged from the operation of the Project, the contractor shall repair or improve the damaged road together with the responsible agency or local government organization.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
7. Drainage and Flood Prevention	- Construct a temporary drainage channel and a sedimentation pond to collect sediment from rainwater into the sedimentation pond before draining or using water in the area	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
7. Drainage and Flood Prevention (continue)	- Check for clogging conditions and dredge the temporary drainage channel/gutter every month, in case of sediment and construction debris such as cement and concrete flows into the rain gutter, the contractor shall dredge sediment and debris immediately	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- The contractor is required to control construction workers not to throw waste into the gutter	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
8. Occupational Health and Safety	<u>Contractor recruitment and basic construction regulations</u> - The Projects must clearly state an agreement on occupational health and safety measures with the construction company in the contract of employment. It must include methods to protect the safety and health of the employees working in the Project.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- The safety officer of the Project with knowledge of occupational health and safety as required by law shall coordinate with the safety staff of the contractor company to supervise and monitor the working safety conditions of the employees.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Clearly define the area boundary, make a fence line around the construction area, provide lighting in the case of night operation, and	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
8. Occupational Health and Safety (continue)	apply a work permit system in the construction area especially the work related to heat, electricity, and confined space.			
	- Specify the working period of employees in high noise level areas in accordance with the law, including arranging for temporary work breaks or there is a system to circulate employees working in high noise level areas to other areas.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Provide warning signs in the construction area, dangerous area, and areas requiring personal protective equipment such as dust masks, ear muffs and/or earplugs, helmets, gloves, and safety shoes as appropriate to the nature of work performed and strictly control the use of personal protective equipment.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Provide training for employees prior to work on occupational health and safety along with accidents prevention	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Provide proper and adequate utilities for workers, such as clean drinking water, toilets, and waste containers, in accordance with sanitation principles	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	<u>Health measures and collaboration with local health agencies</u> - Supervise the contractor company to prepare the health examination data of the construction workers before work and comply with the	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
8. Occupational Health and Safety (continue)	labor laws and regulations and annual physical examination with risk-based health checks for construction workers in areas with risk determinants such as hazardous chemicals (if any)			
	- Set welfare measures to compensate for damages in the event of being affected by the construction of the Project to the affected people, including employees, contractors, and the public	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Provide medical supplies and first aid equipment in the case of injured and taken to the hospital as well as having a vehicle for immediately referring in an emergency	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Inform the number of construction workers to the relevant agencies and local health agencies to be prepared for an event of illness or in an emergency	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
9. Health	- Inform the number of construction workers as information in the preparation of public health facilities in the area before starting to work and in case of illness or accident	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Coordinate with local health agencies to provide personal hygiene education, communicable diseases, and personal care for construction workers of all levels	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
9. Health (continue)	- Provide first aid units and basic medical supplies including an emergency shuttle in the construction area according to the Regulation of the Ministry of Labor on Welfare in Establishments B.E. 2548 (2005)	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- In the case of providing accommodation for temporary workers, utilities must be provided with adequate infrastructure and must comply with relevant standards or laws such as the Notification of the Ministry of Public Health No. 7/2538 on the number of workers per area of a construction worker residence and the Notification of the Labor Welfare Board on measures on labor welfare for accommodation for workers in construction	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Supervise and control contractors to strictly adhere to agreements, such as monitoring camps, residences, random drug testing, waste separation in the worker's camp, and closely control the behavior of construction workers not to cause a nuisance on neighboring communities	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
10. Social and Economy	- Provide appropriate support to activities within the community to build good relationships with communities such as: - Public health, such as mobile medical units, the project of protection before solving, etc.	Education Area	Before construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
10. Social and Economy (continue)	- Education, such as the development of a teacher network for development, etc. - Sport, such as traditional community sport, etc. - Public relations, such as visiting an affiliated power plant, etc. - Community support, such as budget allocation for community development according to the objectives of each area, etc.			
	- Establish an environmental inspectorate which will complete the appointment before construction, details are as follows: Structure of the environmental inspectorate Consists of representatives from the community, government agencies, experts, and the power plant, details are as follows: a) Representatives from the communities from subdistricts and administrative districts within a 5-kilometer radius around the power plant as specified in the environmental impact assessment (EIA) report (not less than one-half of the number of boards), consists of: • Two representative from the village where the power plant is located	Education Area	Before construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
10. Social and Economy (continue)	-Hin Koong Subdistric : Moo 5 • One representative from each village in the study area (32 people) - Hin Kong Subdistrict : Moo 1, Moo 2, Moo 3, Moo 4, Moo 6, Moo 7, Moo 8, Moo 9, and Moo 10 - Huai Phai Subdistrict : Moo 1, Moo 3, Moo 4, Moo 5, Moo 6, Moo 7, Moo 8, and Moo 9 - Chedi Hak Subdistrict : Moo 6, Moo 7, Moo 8, Moo 9, Moo 10, and Moo 12 - Ko Phlappla Subdistrict : Moo 6, Moo 7, and Moo 15 - Don Tako Subdistrict : Moo 8 and Moo 9 - Don Rae Subdistrict : Moo 2 and Moo 3 - Khaongu Subdistrict Municipality : Ban Ton Mamoung Pattana Community and Som Phum Pattana Community b) 11 government representatives, consist of 1 district administrative representative, 7 local government representatives, and 3 relevant government representatives (provincial natural resources and environment, provincial industry office, and provincial energy office)			

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
10. Social and Economy (continue)	c) Two experts who must have knowledge in environmental impact monitoring or those that the community agree d) 1 representative form the power plant Recruiting a) Representatives from the community may be obtained from recruiting or election or nomination. The process starts from the power plant to prepare a courtesy letter to the agencies within a radius of 5 kilometers in order to nominate an appropriate person to be a representative of the community to the power plant. Later, each area shall select a representative in accordance with the board structure. This process shall be complete within 30 days after receiving the letter from the power plant. The representatives from the communities must have the following qualifications: - The person's name must be listed in the house registration in that subdistrict area for at least one year before the date of recruitment or appointment - At least 25 years of age on the day of recruiting or election or nomination - Do not have the following qualifications: * Misconduct or malpractice			

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
10. Social and Economy (continue)	* Bankruptcy or imprisonment except for petty offenses or an offense committed by negligence * Insanity or mental distress or was ordered by the court to be an incompetent person or as incompetent b) Government representatives shall be nominated by relevant agencies, one person per organization, consist of 1 district administrative representative, 7 local government representatives, and 3 relevant government representatives (provincial natural resources and environment, provincial industry office, and provincial energy office) c) Experts shall come from a joint recruiting between representatives from the community and from the power plant, they must be knowledgeable in environmental impact monitoring or those the communities agreed and suggest to the power plant to select 2 people e) 1 representative from the power plant shall be from the appointment of the power plant Authorities of the board are as follows:			

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
10. Social and Economy (continue)	a) Set a guideline for the inspection of environmental impacts according to the environmental impact prevention and mitigation measures and environmental impact monitoring program b) Visit the Project and participate in the audit of the environmental quality measurement process and the environmental quality measurement results according to the environmental impact monitoring measures to show transparency in the environmental management of the Project c) Receive complaints, considering, and ruling out complaints, as well as suggestions from the public about the environmental impact of the construction and operation of the power plant d) Give opinions or suggestions for the power plant to improve or revise the construction and operation and formulate ways to prevent and solve problems together in accordance with those specified in the environmental impact assessment report e) Publicize correct information of the power plant to the public f) Consider exploring the needs of the people, fostering good understanding between the community and the Project, and coordinating with other agencies or stakeholders			

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
10. Social and Economy (continue)	g) Post a public complaint to the board and announce the decision of the board in the office area of government agencies or in public spaces for at least three places h) Set rules for receiving complaints, rules on the appeal of the people, or other rules that are necessary for the operation i) Jointly negotiate, meditate, and find a resolution in the event of a dispute on environmental problems between the Project and the community j) Inspect and consider compensation for damages where the case can be proven that is caused by the operation of the Project Term and tenture a) Chairman of the board comes from the resolution of the board meeting and has a term of 4 years b) Members of the board have a term of 4 years from the date of appointment and can serve up to 2 consecutive terms Meeting Frequency In order to have the board meeting, the presence of the members must not less than one-half of the total number of members. The meeting frequency			

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
10. Social and Economy (continue)	is at least twice a year, but if there is an urgent need, a meeting can be performed under the consideration of half of the members of the board.			
	- Consider hiring qualified local workers who meet the Project criteria to help local people get jobs and to foster a positive attitude towards the community by disclosing information on the vacancy in the communities	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Inspect construction workers not to engage in illegal behavior such as burglary, gambling, etc., with clear regulations and penalties including procedures for coordinating with local officials	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Post announcements to present the Project information by specifying information related to the Project such as the Project name, construction plan, contractor company, the Project owner company, coordinator, telephone number, etc.	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd
	- Provide appropriate support to activities within the community to build good relationships with communities such as:	Education Area	Entire duration of the construction	Hin Kong Power Co.,Ltd

Table 7-2 (continue)

Environmental Impact Prevention and Mitigation Measures before Construction and During Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi District, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/ Frequency	Responsible Party
	- Public health, such as mobile medical units, the project of protection before solving, etc. - Education, such as the development of a teacher network for developing, etc. - sport, such as traditional community sport, etc. - Public relations, such as visiting an affiliated power plant, etc. - Community support, such as budget allocation for community development according to the objectives of each area, etc.			
	- Provide a channel for receiving complaints, such as by telephone, and promoting such channels to the community, set a complaint handling procedure, and facilitate as a complaints center to give information and to answer questions of the people (**Figure 7-6**).	Construction Area	Entire duration of the construction	Hin Kong Power Co.,Ltd

Table 7-3

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
1. Air Quality	- The project must control the air pollutants emission not to exceed those specified in the environmental impact assessment report at dry conditions, temperature of 25 °C, pressure of 1 atmosphere and excess oxygen volume of 7% as follows: In case of using natural gas as fuel **Full load operation** - Nitrogen dioxide not exceed 59 ppm at 7% O_2 and not exceed 59.00 grams per second per stack - Sulfur dioxide not exceed 10 ppm at 7% O_2 and not exceed 13.90 grams per second per stack - Total suspended particulate not exceed 20 milligrams per cubic meter and not exceed 9.70 grams per second per stack **Minimum generation load operation** - Nitrogen dioxide not exceed 59 ppm at 7% O_2 and not exceed 36.70 grams per second per stack - Sulfur dioxide not exceed 10 ppm at 7% O_2 and not exceed 8.60 grams per second per stack - Total suspended particulate not exceed 20 milligrams per cubic meter and not exceed6.10 grams per second per stack	- Steam Boilers chimney	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
1. Air Quality (continue)	In case of using diesel as fuel Full load operation - Nitrogen dioxide not exceed 99 ppm at 7% O_2 and not exceed 81.40 grams per second per stack - Sulfur dioxide not exceed 20 ppm at 7% O_2 and not exceed 22.90 grams per second per stack - Total suspended particulate not exceed 35 milligrams per cubic meter and not exceed 14.0 grams per second per stack **Minimum generation load operation** - Nitrogen dioxide not exceed 99 ppm at 7% O_2 and not exceed 67.8 grams per second per stack - Sulfur dioxide not exceed 20 ppm at 7% O_2 and not exceed 19.10 grams per second per stack - Total suspended particulate not exceed 35 milligrams per cubic meter and not exceed 11.70 grams per second per stack			

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
1. Air Quality (continue)	- Provide a continuous emission monitoring system (CEMs) at 2 HRSG stacks to monitor gas velocity, exhaust temperature, excess oxygen, nitrogen oxide (NO_x), sulfur dioxide (SO_2), and total suspended particulate (TSP) and install a display monitor to show contents of nitrogen oxide (NO_x), sulfur dioxide (SO_2), and total suspended particulate (TSP) in front of the power plant throughout the operation period	- Steam Boilers chimney - Area in front of the Power Plant	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Set alarm configurations from CEMs based on nitrogen oxides (NO_X) control values, which are set to 59 ppm, set two alarm levels: high and very high level, actions upon hearing the warning alarm are as follows: * In the event of a high alarm set at 85% of the controlled emission rate, the operator in the control room monitors the operation of the power generating unit and the emission control device of that unit along with urgent maintenance or correction of detected malfunctions * In the event of a high alarm set at 95% of the controlled emission rate, the operator in the control room will reduce the	- Steam Boilers chimney	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
1. Air Quality (continue)	excess air volume to return to normal. If still unable to fix, the Project will consider reducing production or stop producing electricity to improve the operation of the system to be able to work normally first before resume the production again.			
	- In case of using natural gas as fuel, control emission of nitrogen oxides (NO_x) by using the dry low NO_x (DLN) control system and in the case of using diesel as fuel, control the emission of nitrogen oxides (NO_x) by using the water injection control system			
	- Air pollution management (a) Set a guideline for the concentration of air pollutants (NOx) monitored from the CEMs not to exceed the alarm levels (excluding start up and shutdown) as follows: a) Check the relevant production process, e.g. tendency of the pollutant concentrations readings from CEMs, examine whether the measured concentrations are wrong, etc. b) Check the relevant equipment such as the CEMs system, if the fault is caused by the measuring device or caused by CEMs fails/error, find the cause and	- Steam Boilers chimney	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
1. Air Quality (continue)	solution. If it cannot be fixed by the staffs, call CEMs service provider to fix it, etc c) Inspected the production process and maintenance areas, if it is found that the control value is still over, reduce the production capacity. d) Record the cause of the problem and duration of each (b) Provide an air pollution control system controller according to the relevant regulations of the Ministry of Industry to control the operation of the treatment system effectively (c) Continuous check air quality monitoring instruments (CEMs) annually throughout the project life span (d) Provide a plan for inspection and maintenance of the air pollution emission system to work effectively in a normal condition regarding to the design criteria			
2. Sound/Noise	- Install a device to reduce the noise level at a machine that generates noise such as installing silencer at HRSG	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Perform regular checks and audits the performance of the silencer	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
2. Sound/Noise (continue)	- Specify high noise level areas, provide signs or symbols to indicate such areas where the noise exceeds 85 dB(A) and people who will work in the area must wear noise protective equipment such as earplugs or earmuffs	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Provide personal protective equipment such as ear muffs or earplugs for employees working in areas with noise levels higher than 85 dB(A)	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Manage to prevent employees from being exposed to noise levels for a long time, such as setting the length of work to reduce the time that employees are exposed to noise, staff switching/working day switching in noisy areas, etc.	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Prepare noise contour around the Project area at least once within the first year of operation and revise every 3 years	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
3. Water Usage	- Provide a raw water reservoir with a capacity of 92,838 m^3 to reserve water for use within the Project (reservation valid for at least 3 days)	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Collect rainwater from the second rainwater retention pond into the raw water reservoir of the Project to be used during	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
3. Water Usage (continue)	the dry season and reduce river water pumping in the rainy season			
	- Install a 6 mm mesh netting at the end of the pipeline to reduce the amount of fish attached to the water diverted from the Mae Klong River into the raw water reservoir of the Project and coordinate with the Provincial Fisheries Office or the local government organization to formulate an annual project for releasing aquatic animals into the Mae Klong River to maintain the condition of existing aquatic animals in the vicinity of the Project area	Water Pump Station	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Follow the conditions or requirements of the relevant government agencies and when there is a new issue announcement of the Department of Water Resources on the permission to use water the Project must request for permission to use water in accordance with the relevant laws	Project Site Water Pump Station	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Make a record of daily water diversion and prepare a monthly water diversion report, this will bring good results to both the local government and the public sector related to the water use activities of the Project	Project Site Water Pump Station	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
4. Water Quality and Wastewater	**Cooling water management of the Project** - Before discharging wastewater from the power plant, it will be stored in wastewater holding pond. Wastewater holding pond No. 1 has the capacity to hold water for at least one day. Wastewater holding pond No. 2 will have the capacity to hold water for at least 1 day as well. In order to prevent leakage, each wastewater holding pond will be lined with HDPE or concrete. In normal operation, the second wastewater holding pond is kept dry for an emergency pond.	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Install online monitoring systems to check the temperature, pH, and electrical conductivity (to determine total dissolved solids) in the area of the cooling tower basin and wastewater holding pond of the Project. Wastewater must meet the standard before discharging into the Mae Klong River.	Cooling Tower basin Waste water Pond	Entire duration of the project	Hin Kong Power Co.,Ltd
	Wastewater management of the Project - Provide an oil separator to separate oil and grease from wastewater that is contaminated with oil	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Provide adequate sanitary toilets for employees as required by law as well as providing a ready-made wastewater	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
4. Water Quality and Waste Water (continue)	treatment system or a septic tank to treat wastewater from consumption of employees			
	- Control the characteristics of the effluent according to the Notification of the Ministry of Industry B.E. 2560 (2017) on Effluent Standard	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
5. Waste Disposal	- Provide adequate waste containers with lids to collect waste generated within the Project area before transport to the storage point before coordinating with the waste disposer who is authorized by law to dispose of in a sanitary manner.	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Provide a preliminary waste storage area to store waste before sending it to dispose of by a waste disposer that has a license from the government agency	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- General and office waste shall be managed properly, such as recyclable waste shall be sold to the purchaser who has been licensed by the government agency to reduce the amount of waste that must be disposed of	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Waste from production processes including the waste from the RO water production unit shall be strictly managed in accordance with the Ministry of Industry Notification B.E. 2548 (2005), on the Disposal	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
5. Waste Disposal (continue)	of Waste and Unused Materials or other relevant laws. The waste generated from the Project must be sent to a waste disposer that has been approved by the government agency.			
6. Transportation	**General Measures** - Provide training and educate drivers about the transportation procedure, action in case of emergency, and other relevant regulations as well as requiring drivers to strictly abide by traffic rules	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Limit the speed of the vehicle within the Project area not to exceed 20 kilometers/hour and install speed control signs and use speed as of law when passing through community areas	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Avoid using commuter routes that pass through communities in the morning and evening which is the rush hour (7.00-8.00 o'clock and 16.00-17.00 o'clock) to reduce the impact from the transportation that may occur	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	Safety measures in the transportation of chemicals Transportation of hazardous substances to be safe for the community, property, and the environment the transportation operator must comply with the safety	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
6. Transportation (continue)	procedure and relevant laws and standards, such as the Hazardous Substance Transportation Manual of the Pollution Control Department, September 2011, Hazardous Substance Management Manual, July 2013, the Notification of the Department of Industrial Works on Hazardous Substances Storage Handbook B.E. 2550 (2007), and the Notification of the Department of Industrial Works on Transportation of Hazardous Substances B.E. 2558 (2015). For instance: - Request a transport license - Provide labels and signs on chemical transportation vehicles in accordance with the requirements of the Department of Land Transport - Arrange and transfer chemicals correctly and safely - Prepare chemical safety data sheet (SDS) about the hazard characteristics according to the properties of that substance both Thai and English - Provide personal protective equipment and equipment for chemical transportation vehicles - Provide training for drivers to have knowledge and understanding of the hazards of chemicals and to have the			

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
6. Transportation (continue)	skills to drive vehicle safely as well as being able to fix basic problems when there is an emergency			
7. Drainage and Flood Prevention	- Provide a rain gutter around the building or production units to handle the uncontaminated rainwater before sending into the Project's rain gutter	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Provide a rain water retention pond with a total capacity of at least 14,875 m^3 (excluding freeboard) to control the drainage rate from the area	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Check the drainage system in the Project area to be in good condition at all times so that there are no obstacles in the water flow and if it is found to be damaged, fix immediately	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Clean drainage gutter during the dry season every year to maintain the drainage efficiency of the Project area	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
8. Occupational Health and Safety	<u>Implementation of legislation and design</u> - The Project must comply with all occupational health and safety laws and regulations related to the operational activities of the Project.	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
8. Occupational Health and Safety(continue)	- Provide training and knowledge about safety and environment including practices for safety and the environment for all employees regarding characteristics of jobs	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Provide adequate firefighting equipment as required by laws or international standards and established a fire brigade as well as to conduct a fire drill annually	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	General safety management - Provide a work permit system before entering the work area	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Provide appropriate working space and environment, such as having adequate lighting, etc., and consider the safety of employees	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Put warning signs in potentially hazardous areas for employees to wear personal protective equipment as appropriate for the work	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Provide an emergency action plan (**Figure 7-4**) with the training of employees on emergency procedure	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
8. Occupational Health and Safety (continue)	Measures against Chemicals - Prepare safety data sheet for each chemical and disclose in the working area	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- The acid-base containment area must have a dike border and must be able to handle all of the largest containment tanks in the event of an emergency causing the material to leak out of the tank. Inside of the dike, there must be lined with fiberglass covered with another layer of concrete to prevent leakage of chemicals to the outside.	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Provide an eyewash and shower point in the area of chemical transportation or storage area	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	Personal protective equipment and employee health protection measures - Provide adequate personal protective equipment for the number of employees, including helmets, safety shoes, goggles, and earplugs and/or earmuffs, and supervise workers to wear the equipment every time they work	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
	- Provide adequate first aid equipment in proper conditions and provide first aid training to employees	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Provide annual health check-up programs for all employees	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
9. Health	- Provide first aid kit in the Project for employees and provide first aid training	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Support local public health agencies in promoting, rehabilitation, prevention, and community health care such as funding, education, etc.	Local Health Department	Entire duration of the project	Hin Kong Power Co.,Ltd
10. Social and Economy	- Consider hiring qualified local workers who meet the project criteria as first priority to help local people get jobs and to foster a positive attitude towards the community by disclosing information on vacant positions to the community	Communities around/surrounding the Power Plant	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Public relations to create understanding with the community and to reduce anxiety as follows: *Public relations to create more knowledge and understanding about the Project by creating a network to work with the	Public Area within 5km radius of the Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
10. Social and Economy (continue)	community especially information on effective power production and pollution control efficiency as well as action plans related to environmental impacts. *Prepare a document presenting details of the power plant and pollution prevention system in a readable manner to create a good image for the power plant. *Coordinate with community leaders to organize groups of villagers to visit the power plant from time to time to build understanding and good relationship with the community. *Coordinate and attend meetings with key local agencies or organizations to clarify the results of operations to resolve impacts and to disclose new policies and guidelines to be implemented.			

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
10. Social and Economy (continue)	- Provide appropriate support to activities within the community to build good relationships with communities such as: * Public health, such as mobile medical units, the project of protection before solving, etc. * Education, such as the development of a teacher network for development, etc. * Sport, such as traditional community sport, etc. * Public relations, such as visiting an affiliated power plant, etc. * Environmental support such as working with the Provincial Fisheries Office or Department of Local Administration to release aquatic animals onto the Mae Klong River to preserve the aquatic conditions, food web, and etc. * Community support, such as budget allocation for community development according to the objectives of each area, etc.	Public Area within 5km radius of the Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Support the community in activities that help to build up the confidence of the community, such as:	Public Area within 5km radius of the Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
10. Social and Economy (continue)	* Disaster relief training program, first aid training program, information exchange (methods and channels) between the power plant and the people * Organize a tree-planting project to increase green areas in the community and adjacent areas to reduces the anxiety about the heat			
	- In the event that damage is found to be caused by the operation of the Project, the company will set up a compensation committee for further consideration of appropriate compensation guideline	Public Area within 5km radius of the Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Emergency preparedness and operation in the case of emergency shall be prepared with a 24-hour emergency receiving system. The Project shall provide a list of telephone numbers of local authorities that need to coordinate in the event of an emergency such as municipalities/SAO, local police stations, disaster mitigation authority, hospital, etc.	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
11. Aesthetics	- Provide a green area of 15,646 m^2, accounting for 5.18% of the Project area (**Figure 7-7**) by planting trees or plants that are suitable for narrow areas to help block the wind and act	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-3 (continue)

Environmental Impact Prevention and Mitigation Measures during Implementing and Operating Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental impact prevention and mitigation measures	Location	Duration/Frequency	Responsible Party
11. Aesthetics (continue)	as shade. The plant's height can be controlled by top cutting and the fact that the trees characteristics are in pyramid shape with narrow thin top and evergreen.			
	- Prepare a management plan for the Project's green area to cover the steps of soil improvement, fertilizing, pest control, and mowing as well as repair of green areas are as follows: * Improve the soil, fertilize, and eradicate pest by plowing the soil around the roots and fertilize regularly. The use of soil stabilizers in green areas is specially supervised by staff. Organic matter will mainly be used together with organic pest control for a frequency of one time a year or according to the condition of the disease. * Pruning, weeding, and mowing shall be performed regularly or when the canopies are close together to allow sunlight to pass through. Weed control and mowing shall be performed at a frequency of one time a year or according to the conditions.	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd
	- Restore of green space if trees in green areas die or deteriorate, the Project will carry out replanting within 30 days, taking into account the size and age of similar trees without disrupting the specified planting plan	Project Site	Entire duration of the project	Hin Kong Power Co.,Ltd

Table 7-4

Environmental Impact Monitoring Measure before Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
1. Air Quality	1. Total suspended particulate (TSP), average 24 hours 2. Particulate matter with diameter smaller than 10 microns (PM-10), average 24 hours 3. Nitrogen dioxide (NO_2), average 1 hour 4. Sulfur dioxide (SO_2), average 1 hour 5. Sulfur dioxide (SO_2), average 24 hours 6. Wind direction and velocity (1 station)	Install measuring instruments and submit analysis samples in accordance with the method prescribed by the Notification of the National Environment Board	-Monitoring station: 5 stations (**Figure 7-1**) as follows: 1. The area of Hin Kong Temple 2. The area of Huai Phai Temple 3. The area of Huai Pladuk School 4. The area of Chedi Hak Health Promoting Hospital (Ban Huai Mu) 5. The Project area	- Monitor one time, seven days continuously before starting the Project construction activities	Hin Kong Power Co.,Ltd

Table 7-4 (continue)

Environmental Impact Monitoring Measure before Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
2. Sound/Noise	1. 24 hours weighted equivalent continuous sound level (Leq 24 hr) 2. Background sound level (L90) 3. Maximum sound level (Lmax) 4. Day-night average sound level (Ldn)	Install measuring instruments according to the standards announced by the National Environment Board, the calculation shall be in accordance with the Notification of the Pollution Control Department	Monitoring station : Three stations (**Figure 7-2**): 1. The area of Moo 5 Ban Nong Rak 2. The area of Moo 8 Ban Nong Kham 3. The area of the house behind the Power plant (Southernside of the project)	- Monitor one time, seven days continuously before starting the Project construction activity	Hin Kong Power Co.,Ltd
3. Surface Water Quality	1. Temperature 2. pH 3. Conductivity 4. Total dissolved solids (TDS) 5. Suspended solids (SS) 6. Oil & Grease	Collect samples and analyze according to the Notification of the National Environmental Board	3 monitoring stations (**Figure 7-3**) : - 500 meters above the discharging point of the Project	- One time before starting construction activities	Hin Kong Power Co.,Ltd

Table 7-4 (continue)

Environmental Impact Monitoring Measure before Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
3. Surface Water Quality (continue)	7. BOD_5 8. COD	(No.8) B.E. 2537 (1994)	- Discharging point of the Project - 500 meters down the river from the discharging point of the Project.		
4. Monitoring Heat from the Power Plant	- Satellite Images showing temperature data	- Satellite images showing temperature data provided by Geo-Informatics and Space Technology Development Agency (Public Organization) or GISTDA or agencies/companies that can	- Cover the Project construction area and air quality monitoring stations of the Project	- Three times prior to the commissioning to cover all seasons, summer season (mid-February to around mid-May), rainy season (mid-May To around mid-October), and winter season (mid-October to around mid-February), the Meteorological Department, www.tmd.go.th.	Hin Kong Power Co.,Ltd

Table 7-4 (continue)

Environmental Impact Monitoring Measure before Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
4. Monitoring Heat from the Power Plant (continue)		perform the study and analysis of satellite imagery by presenting surface temperature with satellites			
5. Social and Economy	- Set up environmental inspectorate		- Representatives from the communities from subdistricts and administrative districts within a 5-kilometer radius around the power plant as specified in the environmental impact assessment (EIA) report	Members of the board have a term of 4 years from the date of appointment and can serve up to 2 consecutive years	Hin Kong Power Co.,Ltd

Table 7-5

Environmental Impact Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
1. Air Quality	- Total suspended particulate (TSP), average 24 hours - Particulate matter with diameter smaller than 10 microns (PM-10), average 24 hours - Nitrogen dioxide (NO_2), average 1 hour - Sulfur dioxide (SO_2), average 1 hour - Sulfur dioxide (SO_2), average 24 hours - Wind direction and velocity (1 station)	-Install measuring instruments and submit analysis samples in accordance with the method prescribed by the Notification of the National Environment Board	5 stations (**Figure 7-1**) as follows: 1. The area of Hin Kong Temple 2. The area of Huai Phai Temple 3. The area of Huai Pladuk School 4. The area of Chedi Hak Health Promoting Hospital (Ban Huai Mu) 5. The Project area	Monitor every six months (twice a year), seven days continuously	Hin Kong Power Co.,Ltd

Table 7-5 (continue)

Environmental Impact Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	.Location	Duration/Frequency	Responsible Party
2. Sound/Noise	1. 24 hours weighted equivalent continuous sound level (Leq 24 hr) 2. Background sound level (L90) 3. Maximum sound level (Lmax) 4. Day-night average sound level (Ldn)	- Install measuring instruments according to the standards announced by the National Environment Board, the calculation shall be in accordance with the Notification of the Pollution Control Department	Monitoring station : Three stations (**Figure 7-2**): 1. The area of Moo 5 Ban Nong Rak 2. The area of Moo 8 Ban Nong Kham 3. The area of the house behind the Power plant (Southern side of the project)	- Every six months(twice a year, seven days continuously each time) throughout the construction period.	Hin Kong Power Co.,Ltd
3. Water Quality and Wastewater (surface water)	1. Temperature 2. pH 3. Conductivity 4. Total dissolved solids (TDS) 5. Suspended solids(SS) 6. Oil & Grease 7. BOD_5 8. COD	- Collect samples and analyze according to the Notification of the National Environmental Board (No.8) B.E. 2537 (1994)	3 monitoring stations (**Figure 7.3**): - 500 meters above the discharging point of the Project - Discharging point of the Project	- Two times a year, one time in the rainy season and one time in the dry season	Hin Kong Power Co.,Ltd

Table 7-5 (continue)

Environmental Impact Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
			-500 meters down the river from the discharging point of the Project.		
4.Waste Management/ Disposal	- Prepare a summary report for each type of waste with information on types, volumes, collection, transportation, and management of the wastes that are generated from the operation of the Project, and attach a copy of the waste disposal permission in the report	- Survey and Record	- Construction Site/Area	- Every time the waste is sent out for disposal throughout the construction period, a summary report shall be prepared every six months	Hin Kong Power Co.,Ltd
5. Transportation	- Record the number of transportations of material, equipment, and machines - Record statistics of accidents that occur from the transportation of the Project, including the cause, place,	- Record daily traffic volume and accidents that occurred in the Project every time and provide a monthly summary report	-Construction area and transportation route of the Project	- Every day throughout the construction period and prepare a summary report every 6 months	Hin Kong Power Co.,Ltd

Table 7-5 (continue)

Environmental Impact Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
	time period, and solutions to problems				
6. Occupational Health and Safety	- Cause/characteristic of the accident - Damage/loss condition - Problem solving/suggestion	- Record every accident that occurs in the execution of the project and provide a monthly summary	- Construction area of the Project	- Every time there is an accident throughout the construction period	Hin Kong Power Co.,Ltd
7. Social and Economy	**Socio-economic conditions** - Conduct a survey of socio-economic conditions, household problems, and needs as well as public opinion of community leaders in the sensitive area, representatives of relevant government agencies, establishments	-Opinion survey by using questionnaires	- Communities in the area within 5 kilometers radius of the Project location and community where the environmental sampling	- One time per year throughout the construction period (3 years)	Hin Kong Power Co.,Ltd

Table 7-5 (continue)

Environmental Impact Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
7. Social and Economy (continue)	around the Project area, and communities where the environmental quality monitoring points are located together with surveying on community satisfaction index. A distribution map for data collection shall be presented.		points are located **(Figure 7-5)**		
	- **Complaints** 1. Record any complaints raised by the community against the Project including corrective approach and time duration to solve such complaints 2. Perform follow-up and review of action plans in case of any community complaints as follows: * Communicate results to the community through community leaders	- Record any complaints that arise in the operation of the Project	- In the Project area and adjacent communities	- Every time there is a complaint and prepare a summary report every 6 months throughout the construction period	Hin Kong Power Co.,Ltd

Table 7-5 (continue)

Environmental Impact Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
7. Social and Economy (continue)	* In the event that the cause of the problem is found to be directly from the Project, the project is responsible for all monitoring incurred expenses				
8. Monitoring Heat from the Power Plant	- Satellite Images showing temperature data	- Satellite images showing temperature data provided by Geo-Informatics and Space Technology Development Agency (Public Organization) or GISTDA or agencies/companies that can perform the study and analysis of satellite imagery by presenting surface temperature with satellites	Cover the Project construction area and air quality monitoring stations of the Project	- Three times prior to the commissioning to cover all seasons, summer season (mid-February to around mid-May), rainy season (mid-May To around mid-October), and winter season (mid-October to around mid-February), the Meteorological Department, www.tmd.go.th.	Hin Kong Power Co.,Ltd

Table 7-6

Environmental Impact Monitoring Measure during Operation Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
1. Air Quality	1) **Air Quality at source: stack Sampling** - Flow rate - Exhaust Temperature - Excess Oxygen - NOx - SO_2 - TSP	- Collect air quality samples and analyze according to the Notification of the Ministry of Industry	- Two emission stacks of the power plant	-Monitor every six months (twice a year) at the same period as the ambient air quality monitoring	Hin Kong Power Co.,Ltd
	2) **Air quality analysis by CEMs: continuous emission monitoring system; CEMs** - Flow rate - Exhaust Temperature - Excess Oxygen - NOx - SO_2 - TSP	Install continuous emission monitoring system (CEMs) at the stacks, continuously measuring throughout the time the power is generated	- CEMs of the emission stacks	- Continuously monitoring throughout the time the power is generated	Hin Kong Power Co.,Ltd

Table 7-6 (continue)

Environmental Impact Monitoring Measure during Operation Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
1. Air Quality (continue)	**3) CEMs auditing**	- Validate the CEMs operation to verify that the measurement data obtained from the CEMs is accurate, by using the audit in accordance with the requirements of the U.S.EPA or the method established by government agencies	- CEMs of the emission stacks	- At least once a year or as required by relevant government agencies	Hin Kong Power Co.,Ltd
	4) Ambient Air Quality - Total suspended particulate (TSP), average 24 hours - Particulate matter with diameter smaller than 10 microns (PM10), average 24 hours - Nitrogen dioxide (NO_2), average 1 hour - Sulfur dioxide (SO_2), average 1 hour	-Install measuring instruments and submit analysis samples in accordance with the method prescribed by the Notification of the National Environment Board	- Monitoring station : 4 stations (**Figure 7-1**) as follows : 1. The area of Hin Kong Temple 2. The area of Huai Phai Temple 3. The area of Huai Pladuk School	- Monitor every six months (twice a year), seven days continuously, throughout the operation period	Hin Kong Power Co.,Ltd

Table 7-6 (continue)

Environmental Impact Monitoring Measure during Operation Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
1. Air Quality (continue)	- Sulfur dioxide (SO_2), average 24 hours - Wind direction and velocity (1 station)		4. The area of Chedi Hak Health Promoting Hospital (Ban Huai Mu)		
2. Sound/Noise	- 24 hours weighted equivalent continuous sound level (Leq 24 hr) - Background sound level (L90) - Maximum sound level (Lmax) - Day-night average sound level (Ldn)	- Install measuring instruments according to the standards announced by the National Environment Board, the calculation shall be in accordance with the Notification of the Pollution Control Department	- Three stations (**Figure 7-2**) : 1. The area of Moo 5 Ban Nong Rak 2 The area of Moo 8 Ban Nong Kham 3. The area of the house behind the power plant (South of the project)	Every six months (twice a year, seven days continuously each time) throughout the operation period	Hin Kong Power Co.,Ltd
3. Water Quality and Wastewater	**Surface Water Quality** - Temperature - pH - Conductivity - Total dissolved solids (TDS)	- Collect samples and analyze according to the Notification of the National Environmental	3 monitoring stations (**Figure 7-3**) : - 500 meters above the discharging point of the Project	- Two times a year, one time in the rainy season and one time in the dry season	Hin Kong Power Co.,Ltd

Table 7-6 (continue)

Environmental Impact Monitoring Measure during Operation Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
3. Water Quality and Wastewater (continue)	- Suspended solids(SS) - Oil & Grease - BOD_5 - COD	Board (No.8) B.E. 2537 (1994)	- Discharging point of the Project - 500 meters down the river from the discharging point of the Project.		
	Aquatic biological resources - Phytoplankton - Zooplankton - Benthos - Aquatic animals - Aquatic plants	- Collect and analyze samples according to academically acceptable methods	3 monitoring stations (**Figure 7.3**): - 500 meters above the discharging point of the Project - Discharging point of the Project - 500 meters down the river from the discharging point of the Project.	- Two times a year, one time in the rainy season and one time in the dry season	Hin Kong Power Co.,Ltd

Table 7-6 (continue)

Environmental Impact Monitoring Measure during Operation Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
	Wastewater quality - Temperature - pH - Conductivity - Total dissolved solids (TDS) - Suspended solids (SS) - Oil & Grease - BOD_5	- Collect and analyze samples according to methods specified by the Ministry of Industry	- Wastewater holding pond	- Once a month	Hin Kong Power Co.,Ltd
4. Water Usage	- Amount of water pumped	Prepare a monthly summary of the amount of water pumped along with problems and obstacles in pumping water (if any)	- Area of the project and water pumping station	-Every water pumping day and prepare a report summarizing the results of a 6-month time operating process.	Hin Kong Power Co.,Ltd

Table 7-6 (continue)

Environmental Impact Monitoring Measure during Operation Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
5. Waste Management/ Disposal	- Type - Quantity - Waste management approach - Waste manifest	- Survey and record	- Project Site	- Monthly and prepare a summary report every six months throughout the operation period	Hin Kong Power Co.,Ltd
6. Transportation	- Statistics of accidents that occur from the Project, including the cause, place, time period, and solutions to problems	- Record daily traffic volume and accidents that occurred in the Project every time and provide a monthly summary report	- Project Site	- Entire duration of the operation period	Hin Kong Power Co.,Ltd
7. Occupational Health and safety	**Intensity of light in working area** - llluminance	- Lux Meter or use the method stipulated and/or approved by the relevant government agencies.	- Electrical and Control Building, Adminstation Building	- Four times a year	Hin Kong Power Co.,Ltd
	Noise level in working area - Leq 8 hours	- Integrated sound level measurement or using the	- Gas Compressor - Cooling Tower	- Four times a year	Hin Kong Power Co.,Ltd

Table 7-6 (continue)

Environmental Impact Monitoring Measure during Operation Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
7. Occupational Health and safety (continue)		method specified and/or approved by the relevant government agency	- Generator Pumps - Gas Turbine -Steam Turbine - Chiller		
	Heat in working area - Heat	Wet bulb globe temperature method or using the method specified and/or approved by the relevant government agency	- Gas Turbine - Steam Turbine - Boiler Drum	- Four times a year	Hin Kong Power Co.,Ltd
	Health check for new and general employees - Lung x-ray - Visual function - General physical examination by a doctor - Blood test: Complete blood count, blood group, immune system, and hepatitis B		All employees	- Before starting to work 1 time and after that once a year	Hin Kong Power Co.,Ltd

Table 7-6 (continue)

Environmental Impact Monitoring Measure during Operation Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
7. Occupational Health and safety (continue)	**Investigations on accidents and emergency plans** - Record the accident statistics along with the cause and damages to be used as basic information for defining safety measures - Practice emergency operations within the power plant and join in practice with related external agencies		- Inside and outside the power plant area	- At least once a year	Hin Kong Power Co.,Ltd
8. Health	- Collecting data on disease statistics of people in the area from the public health agencies in the study area of 5 kilometers radius from the Project area once a year. The information shall be used in conjunction with the data of changes in ambient air quality data such as allergic, respiratory disease, skin diseases, etc.	Collect data on those that receive public health services and analyse the data	- Communities within 5km radius of the power plant	- From public health agent within 5km radius of the power plant - Once a year for the entire duration of the operation period	Hin Kong Power Co.,Ltd

Table 7-6 (continue)

Environmental Impact Monitoring Measure during Operation Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
9. Social and Economy	**1) Socio-economic conditions** - Conduct a survey of socio-economic conditions, household problems, and needs as well as public opinion of community leaders in the sensitive area, representatives of relevant government agencies, establishments around the Project area, and communities where the environmental quality monitoring points are located together with surveying on community satisfaction index. A distribution map for data collection shall be presented.	- Opinion survey by using questionnaires	- Communities in the area within 5 kilometers radius of the Project location and community where the environmental sampling points are located (**Figure 7-5**)	- One time per year throughout the construction period (3 years)	Hin Kong Power Co.,Ltd
	2) Complaints - Record any complaints raised by the community against the Project including corrective approach and	- Record any complaints that arise in the operation of the Project	- In the Project area and adjacent communities	- Every time there is a complaint and prepare a summary report every 6	Hin Kong Power Co.,Ltd

Table 7-6 (continue)

Environmental Impact Monitoring Measure during Operation Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
9.Social and Economy (continue)	time duration to solve such complaints - Perform follow-up and review of action plans in case of any community complaints as follows : * Communicate results to the community through community leaders * In the event that the cause of the problem is found to be directly from the Project, the project is responsible for all monitoring incurred expenses			months throughout the operation period	
10. Aesthetics	- Green spaces and green area	- Check the area of the green spaces of the Project and the proportion of green area to the Project area	Project Site	Entire duration of the operating period	Hin Kong Power Co.,Ltd

Table 7-6 (continue)

Environmental Impact Monitoring Measure during Operation Period

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
11. Monitoring Heat from the Power Plant	- Satellite Images showing temperature data	- Satellite images showing temperature data provided by Geo-Informatics and Space Technology Development Agency (Public Organization) or GISTDA or agencies/companies that can perform the study and analysis of satellite imagery by presenting surface temperature with satellites	- Cover the Project construction area and air quality monitoring stations of the Project	- Three times prior to the commissioning to cover all seasons, summer season (mid-February to around mid-May), rainy season (mid-May To around mid-October), and winter season (mid-October to around mid-February), the Meteorological Department, www.tmd.go.th.	Hin Kong Power Co.,Ltd

Table 7-7

Environmental Impact Prevention and Mitigation and Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental Impact Prevention and Mitigation Measure	Location	Duration/Frequency	Responsible Party
1. Air Quality	- Do not open the land surface at the same time throughout the pipeline and when the raw water and wastewater discharging pipelines have been laid, carry out the embedment as soon as possible	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Spray water at least twice a day around the construction area and increase the frequency if there is a large amount of dispersed dust	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Cover construction materials that can diffuse or fall onto the traffic surface during transport to prevent scattering and falling of materials while being transported along the route	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Always turn off the engine when idling or parking	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
2. Sound/Noise	- Discuss with homeowners or shops located within the nearby area to minimize impact during the construction period	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd

Table 7-7 (continue)

Environmental Impact Prevention and Mitigation and Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental Impact Prevention and Mitigation Measure	Location	Duration/Frequency	Responsible Party
2. Sound/Noise (continue)	- Notify the residents, local government agencies, community leaders, and establishments in the vicinity of the Project area about the construction plan at least 1 week in advance in precaution against traffics on the project routes. When there are construction activities near citizen's households, the construction and operation shall be closely monitored and done swiftly and effectively.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- If there is a household within the distance of 0-250 meters from the raw water and wastewater discharging pipelines, install a temporary soundproof wall covering the whole noise source area, 18 ga steel, with transmission loss of 25 dB(A) and a height of 2.5 meters from the ground and the area of the driving pit.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Construction activities must be carried out during the daytime (8:00 - 17.00 o'clock) only, except those that require ongoing operations. In such a case, the contractor must inform the construction plan and relevant impact prevention and mitigation measures to the local administration, contracted/responsible agencies, and residents in advance.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Running of the loud noise-generating machine shall be performed during daytime only and stop the engine immediately after use	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd

Table 7-7 (continue)

Environmental Impact Prevention and Mitigation and Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental Impact Prevention and Mitigation Measure	Location	Duration/Frequency	Responsible Party
2. Sound/Noise (continue)	- Arrange compensation for damages as appropriate in the event that the Project construction activity causes damage to shops or houses located near the construction area	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Coordinate with communities and people near the pipeline to build a good relationship and find solutions to problems together as well as coordinating with community leaders and related agencies to provide assistance and support. In the event that the impact is directly caused by the Project, the Project shall compensate for any damages incurred as appropriate.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
3. Vibration	- When any damages are investigated and are clear to be caused by the Project, the contractor company shall compensate appropriately and report the case to the Company as well as record the case details to prevent the reoccurrence of such damages.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Coordinate with community leaders and relevant agencies to provide assistance, support, and resolve problems for people affected by the Project construction activities	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
4. Water Quality and Wastewater	**General measures** - Provide temporary toilets at temporary offices and worker camp that is sufficient for the number of employees and workers and must be located at least 15 meters away from the water source	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd

Table 7-7 (continue)

Environmental Impact Prevention and Mitigation and Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental Impact Prevention and Mitigation Measure	Location	Duration/Frequency	Responsible Party
4. Water Quality and Wastewater (continue)	- Do not wash/clean tools/machines and do not litter chemicals and used motor oils in water sources as well as prohibit to drain untreated waste into water sources	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Keep the soil as far as possible from surface water sources and must install a sediment fence to prevent leaching of sediment into water bodies	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	Measures for the hydrostatic test - In the event that the Project drains the water from the hydrostatic test into public waterways, the following measures must be followed.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	* Before draining the water from the hydrostatic test into the water source, consent must be obtained from local authorities or responsible agencies such as the SAO and related government agencies	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	* Adjust the water pressure from the hydrostatic test before slowly open the valve to drain the water into the temporary gutters/drains to prevent erosion and reduce the increase in the amount of turbidity of the water source	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	* Provide a sieve to trap solid contaminants at the end of the pipe that drains the wastewater from the hydrostatic test	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	* Conduct an inspection of the effluent quality by analyzing the temperature, pH, and suspended solids to be in accordance with the effluent standards specified by the Royal Irrigation Department	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd

Table 7-7 (continue)

Environmental Impact Prevention and Mitigation and Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental Impact Prevention and Mitigation Measure	Location	Duration/Frequency	Responsible Party
5. Soil resources and erosion	- Limit the cover crop area to the area to be construction area only	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Separating the topsoil from the subsoil and when covering the soil, the bottom layer must be covered first, followed by the topsoil and avoid the accumulation of soil caused by digging in open-cut near irrigation canals or drainage ditches to prevent debris from falling off the drainage channel	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- During heavy rain, activities engage in excavation is forbidden to prevent sediment from being leached into a nearby drainage channel	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Supervise the excavation operations to have appropriate measures to prevent landslides and ensure the safety of the operators, such as installing a sheet pile around the open-cut construction area or consider the slope of the hole to be appropriate. For pipeline embedment, the original soil must be spread around the pipeline and consider collapse or subsidence of the soil with soil crown.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Install tools or devices to prevent soil collapse such as sheet pile or use trench box appropriately based on conditions of the area	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd

Table 7-7 (continue)

Environmental Impact Prevention and Mitigation and Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental Impact Prevention and Mitigation Measure	Location	Duration/Frequency	Responsible Party
5. Soil resources and erosion (continue)	- When the pipeline installation is finished, return the entrances to the houses or in the road area to the same or better conditions as soon as possible, any debris from the construction must be removed from the area completely.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
6. Transportation	- Request the contractor to provide a concrete barrier, steel fence, or other materials to specify a safe distance along the construction area. In addition, the construction shall block only the outermost traffic surface of 1 lane and the length of the deviation route, as necessary.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Provide a signboard to show the name of the Project, the Project owner, duration of the construction, and the construction company name with a phone number to inform the road users at least 1 month in advance	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd

Table 7-7 (continue)

Environmental Impact Prevention and Mitigation and Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental Impact Prevention and Mitigation Measure	Location	Duration/Frequency	Responsible Party
6. Transportation (continue)	- There shall be clearly visible signs or alarms both during the day and at night * Construction signs at least 350 meters before reaching the construction area * Speed reduction signs and construction signs at least 200 meters before reaching the area * Traffic cones at least 50 meters before reaching the construction area * End of the construction ara signs at the end of the construction area * If it is necessary to work at night, blinking and warning light must always be clearly visible	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Bypass must be completed before performing construction or excavate and provide at least one lane for vehicles to pass through, however, the pipeline must be embedded and road surface must be adjusted/fixed as soon as possible to reduce transportation impacts.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Limits the speed of vehicles used to transport construction materials not to exceed 30 kilometers/hour when passing through community areas and 80 kilometers/hour in a general area, in accordance with the relevant laws of each area.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- In the case of damages of the road caused by the construction, the contractor company shall repair it immediately.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd

Table 7-7 (continue)

Environmental Impact Prevention and Mitigation and Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

Impact on Environment	Environmental Impact Prevention and Mitigation Measure	Location	Duration/Frequency	Responsible Party
	- Publicize details of the construction plans to community leaders and households along the pipelines as well as related agencies such as local authorities, at least 1 week in advance	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
7. Waste Management/ Disposal	**General Measures** - The contractor must provide enclosed waste containers according to the type of waste and sort recyclable waste to achieve maximum utilization. Apart from recyclable waste, the Project shall collect before sending it to dispose of by a licensed waste disposer.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- Pile of soil from construction activities must not obstructing the entrance-exit and the drainage way, and after the pipeline is laid, cover with the dredged soil. Before returning the area, the remaining soil from the embedment shall be used for landfilling in permitted area, and the area shall be properly inspected.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	Measure on sodium bentonite management - Mix sodium bentonite for the HDD to fit the required amount by considering the proportions of sodium bentonite to reduce the residual sodium bentonite that must be disposed of	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- In the event of overflow/leakage of sodium bentonite to adjacent areas, perform the following: * Handling in the case of sodium bentonite leaking or spilling up, use a vacuum vehicle along the line of the spill. If there is a large spill,	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd

Table 7-7 (continue)

Environmental Impact Prevention and Mitigation and Monitoring Measure during Construction

Hin Kong Power Plant of Hin Kong Power Company Limited, located in Tam Bon Hin Kong Ratchaburi Distruct, Ratchaburi Province

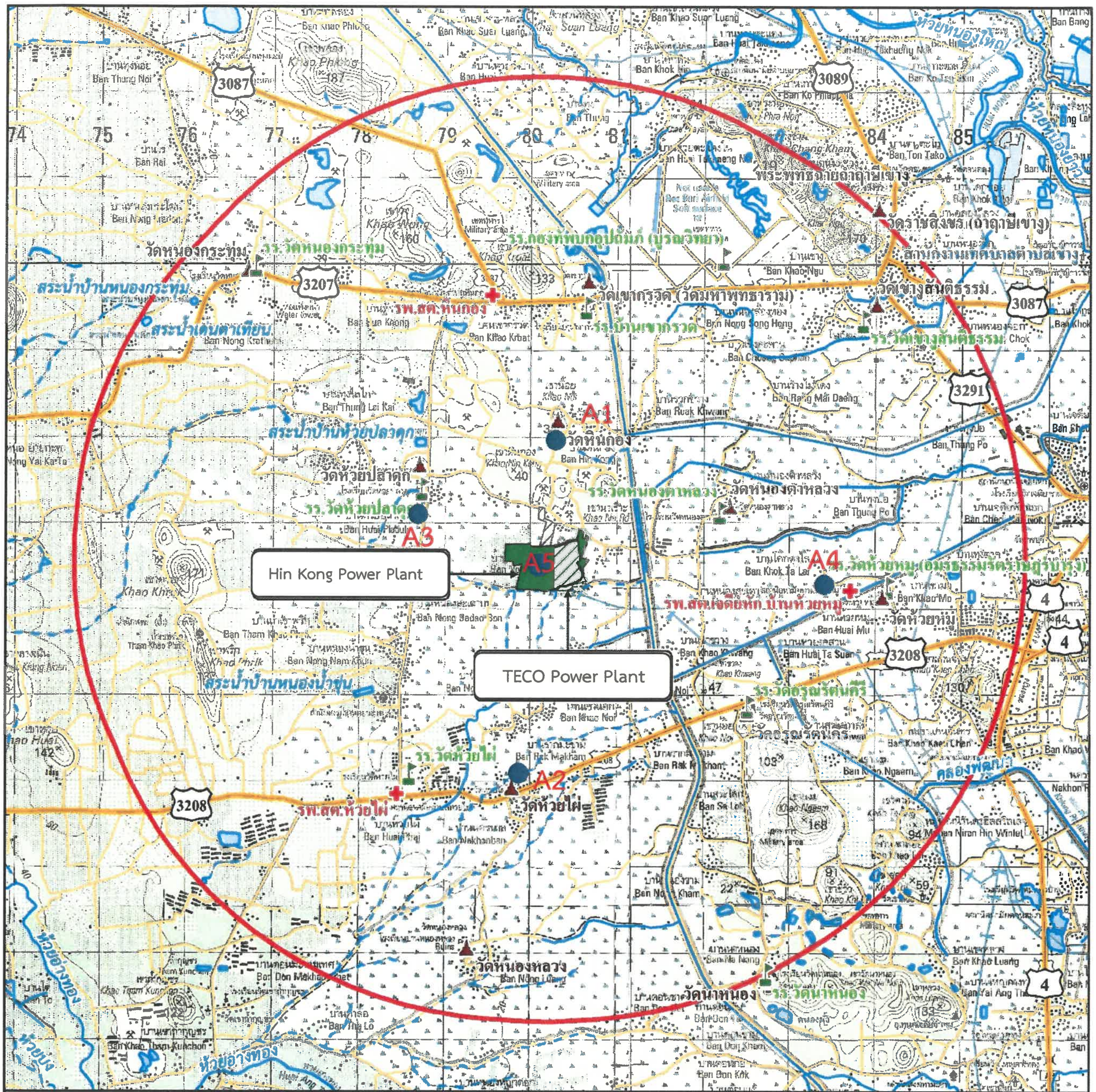
Impact on Environment	Environmental Impact Prevention and Mitigation Measure	Location	Duration/Frequency	Responsible Party
7. Waste Management/ Disposal (continue)	pause the machine to complete the clean up first before resume the operation and consideration to adjust the operating methods accordingly to limit or reduce the amount of sodium bentonite overflow, for example, by adjusting the penetration pressure to suit the area conditions, etc. * Provide employees to monitor and respond to prevent sodium bentonite from spreading out by using containment equipment such as sandbags.			
	- In case of overflow/leakage of sodium bentonite and affecting the property or agricultural products of the people, the project is responsible for any damage incurred. The Project shall coordinate to assist and resolve the impact or damage that has occurred as soon as possible as well as negotiate an agreement to compensate for damages appropriately.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd
	- In case of sodium bentonite residual, it must be disposed of in accordance with academic principles and must report safety data sheet and chemical property of sodium bentonite such as electrical conductivity (ECe), exchangeable sodium content, and exchangeable sodium percentage (ESP), etc., to the disposal agency or the owner of the area.	Construction Site	Entire Duration of Construction	Hin Kong Power Co.,Ltd

Table 7-8

Environmental Impact Monitoring Measure during Constrution Period

For Setting Pipeline for Raw and Waste Water of Hin Kong Power Plant Project of Hin Kong Power Co.,Ltd

Environment Aspects and their values	Measuring Index	Analysis and Methodology	Location	Duration/Frequency	Responsible Party
1. Water Quality and Wastewater	- Temperature - pH -Conductivity -Total dissolved solids (TDS) - Suspended solids(SS) - Oil & Grease - BOD_5 - COD	- Collect samples and analyze according to the Notification of the National Environmental Board (No.8) B.E. 2537 (1994)	Mae Klong River, Release through pipe by hydrostatic method	-When there are water released through the pipe by hydrostatic method	Hin Kong Power Co.,Ltd



Symbol

- Main road
- Minor road
- Perennial canal/water channel
- Non perennial canal/water channel
- Hospital
- School
- Temple
- Governmental agency
- TECO powerplant
- The project
- 5 km. radius from the project

● = Ambient air Monitoring station

A1 : The area of Hin Kong Temple

A2 : The area of Huai Phai Temple

A3 : The area of Huai Pladuk School

A4 : The area of Chedi Kak Health Promoting Hospital (Ban Huai Mu)

A5 : The Project area

N W E S

มาตราส่วน 1 : 70,000

0 .5 1 2 3 4 กม.

CONSULTANTS OF TECHNOLOGY CO., LTD.

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โทร. (66 2)9343233-47 โทรสาร (66 2)9343248

Internet Email : cot@cot.co.th

ที่มา : กรมแผนที่ทหาร, 2540

: กรมทางหลวง, 2540

Figure 7-1 Ambient air Monitoring station

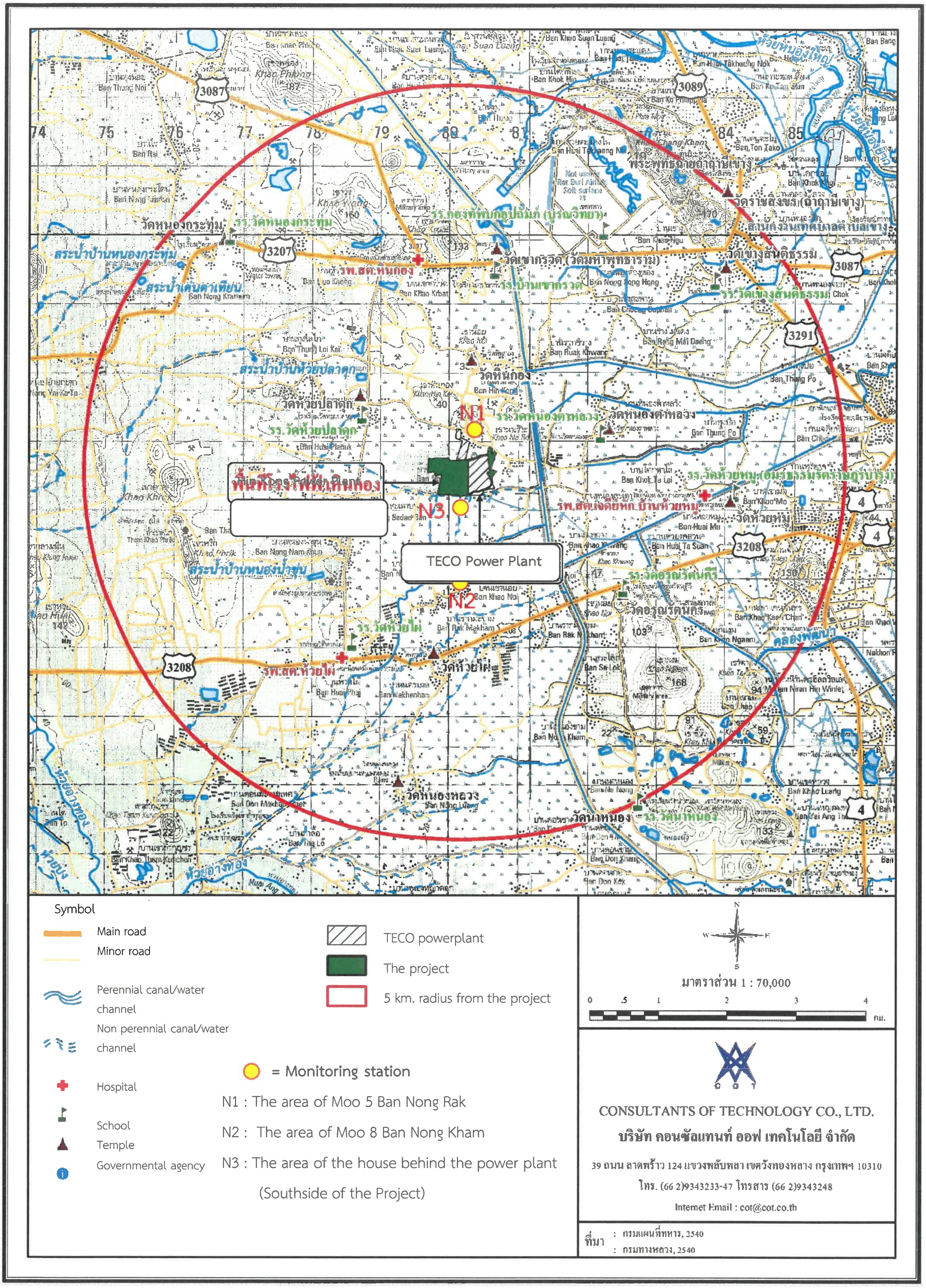
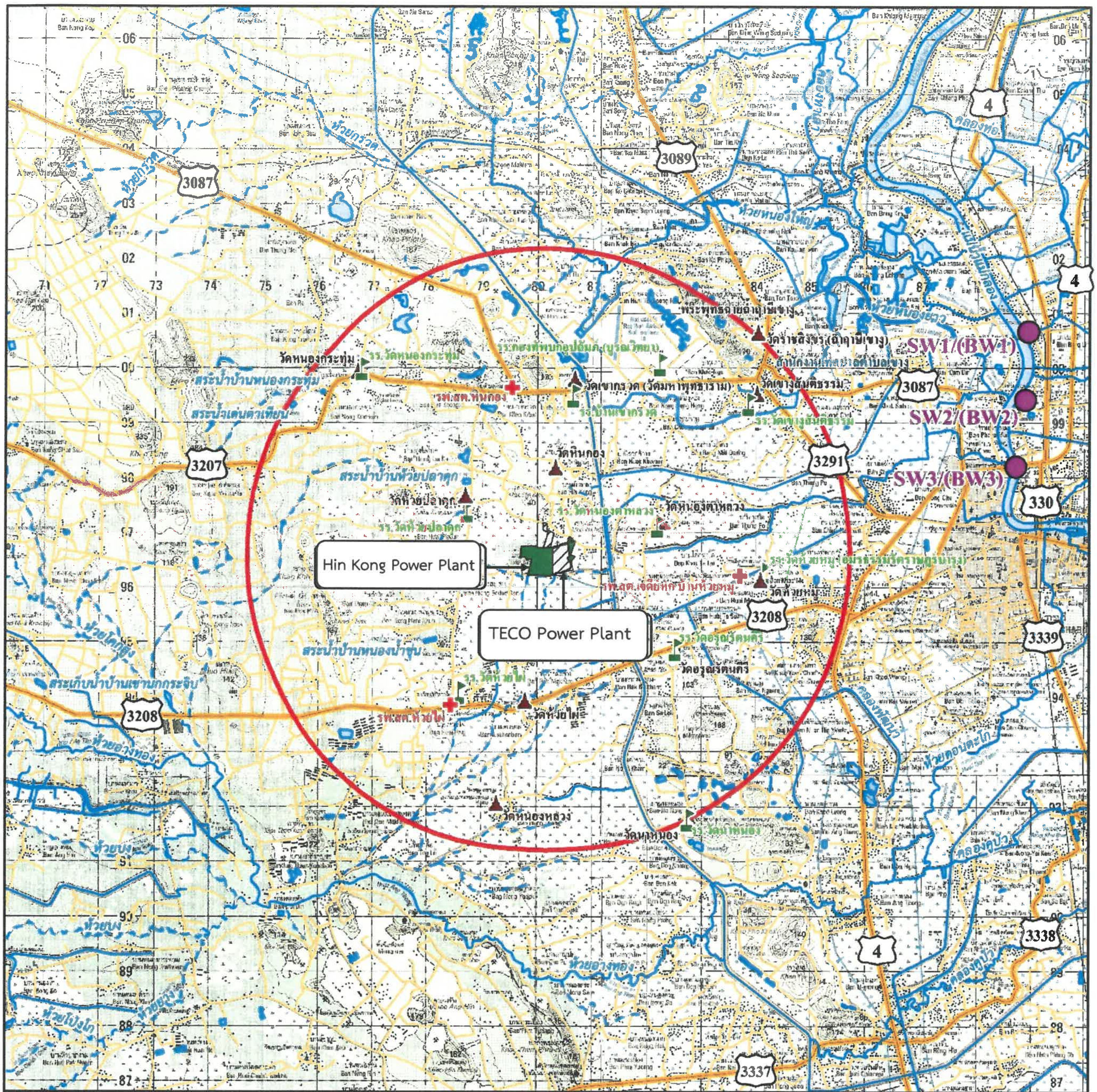


Figure 7-2 Noise Monitoring station



Symbol

Main road

Minor road

Perennial canal/water channel

Non perennial canal/water channel

Hospital

School

Temple

Governmental agency

TECO powerplant

The project

5 km. radius from the project

Surface water and Aquatic biological resources Monitoring station

SW1 (BW1) : 500 meters above the discharging point of the Project

SW2 (BW2) : Discharging point of the Project

SW3 (BW3) : 500 meters down the river from the discharging point of the Project

มาตราส่วน 1 : 110,000

0 .75 1.5 3 4.5 6 กม.

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ที่มา : กรมแผนที่ทหาร, 2540

Figure 7-3 Surface water and Aquatic biological resources Monitoring station

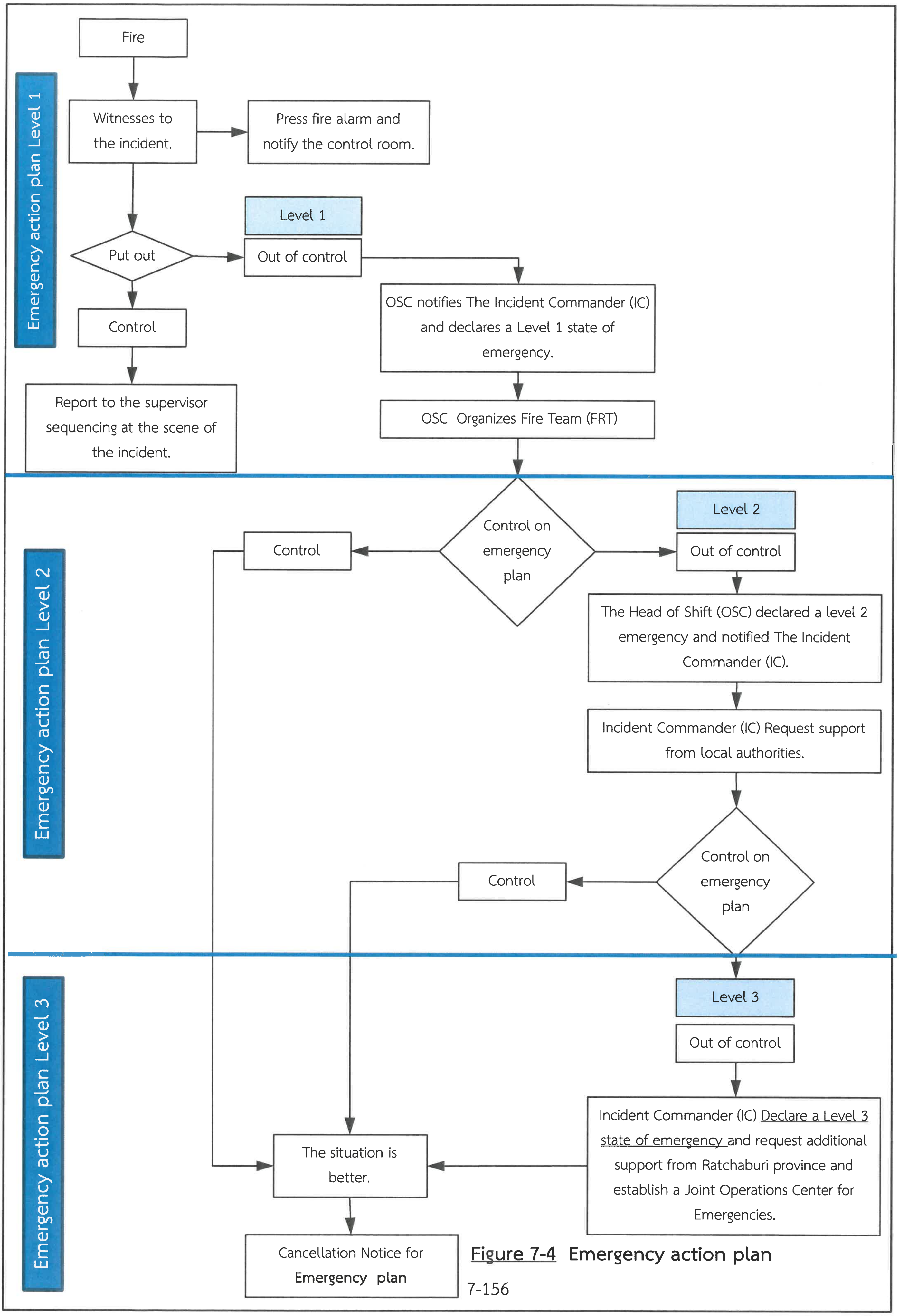


Figure 7-4 Emergency action plan

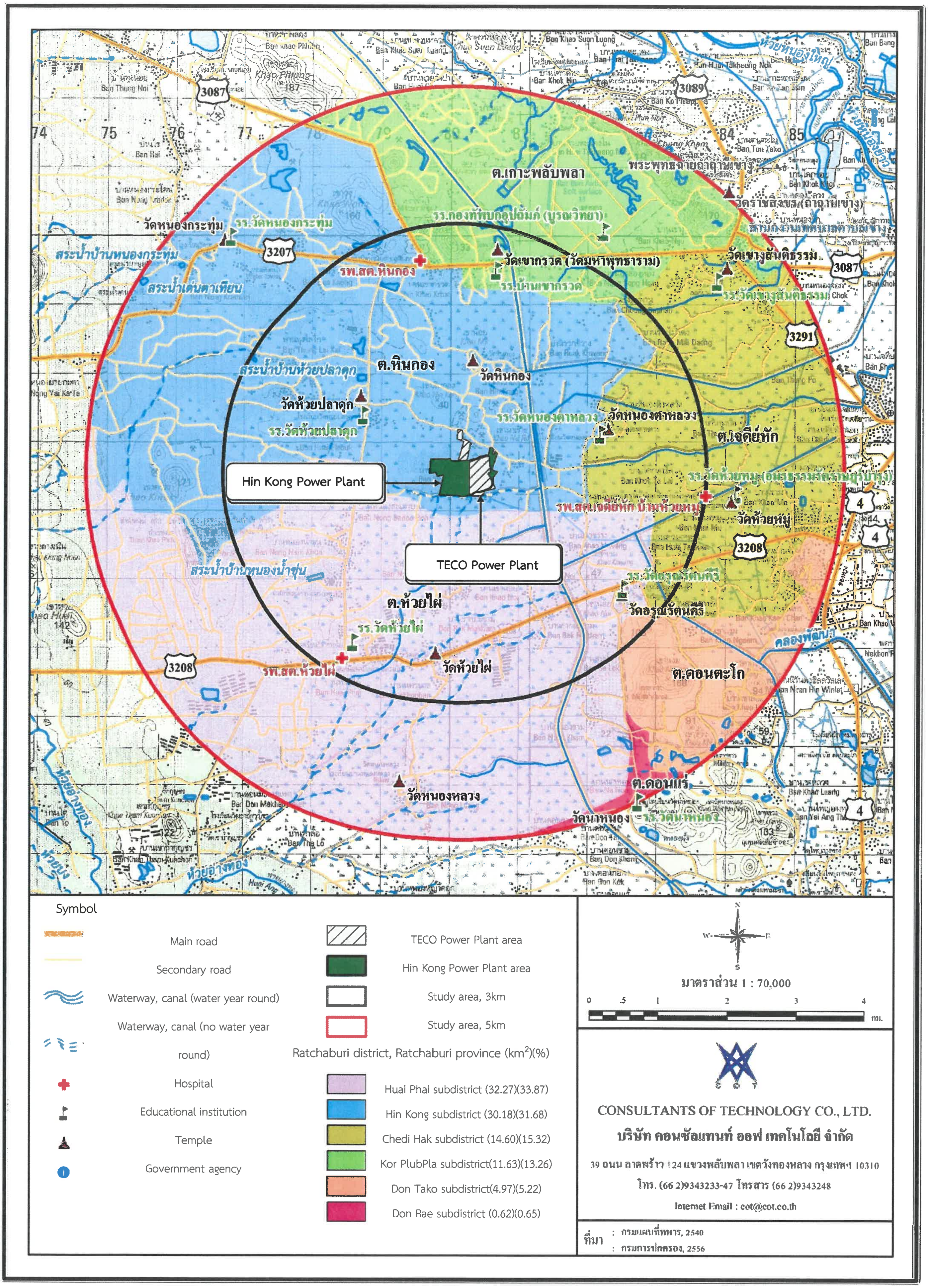
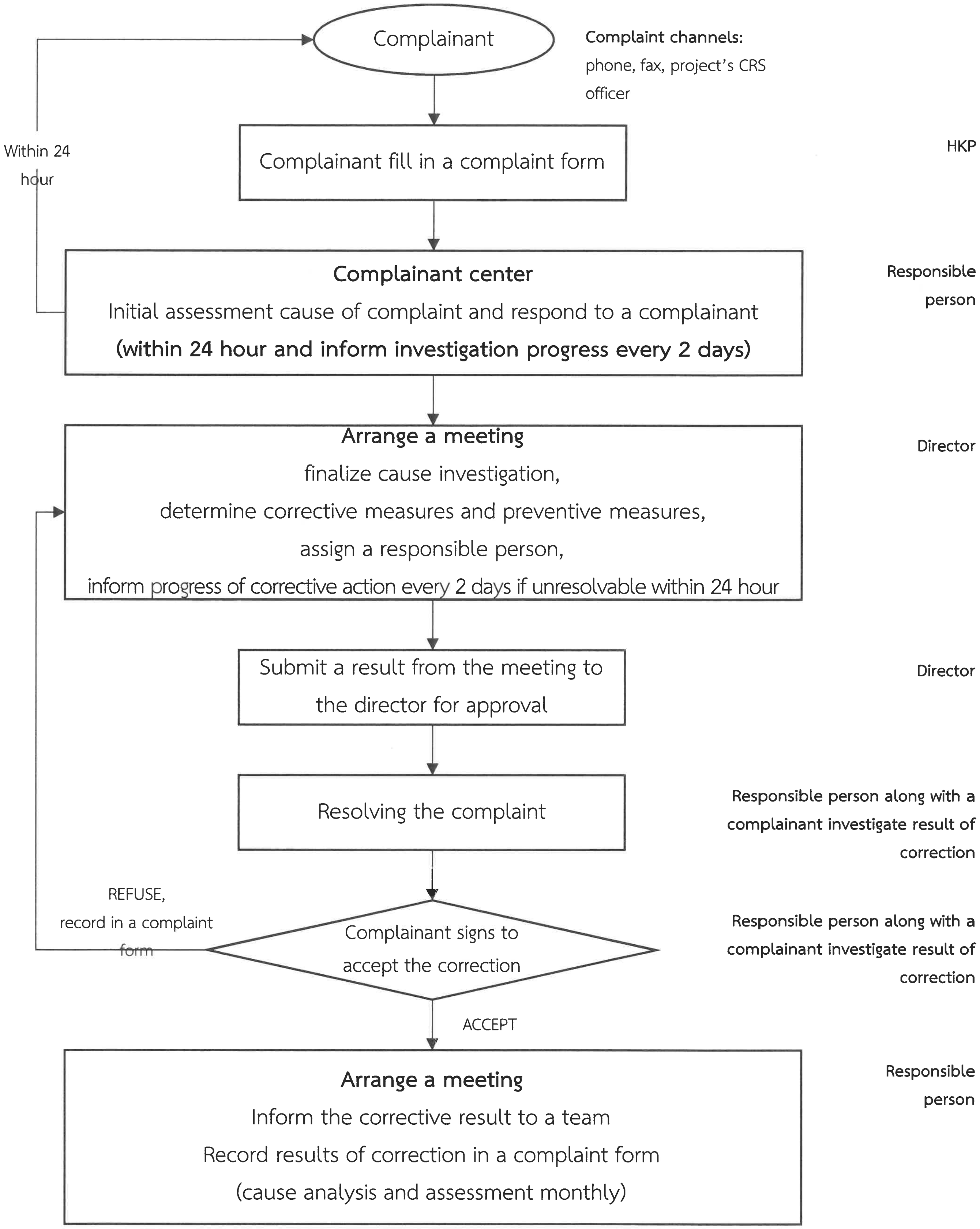


Figure 7-5 Socio-economic Locations

COMPLAINT PROCEDURE



Remark: complaint refer to complaint from people who live around the project location due to project operation that affect quality of live, health, occupational and safety, and environment

Figure 7-6 Complaint procedure Plan (General Cases)

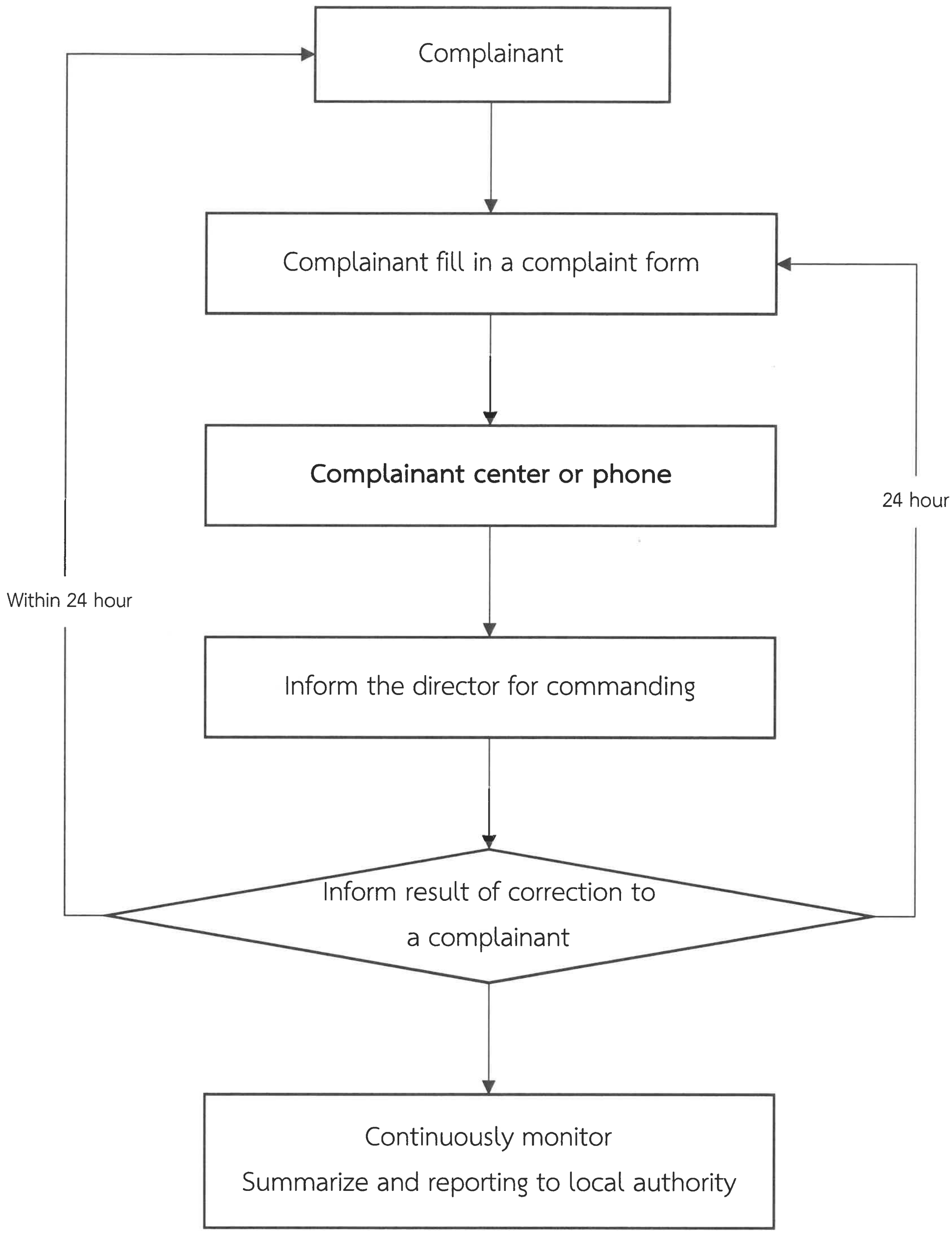


Figure 7-6 (conts) **Complaint procedure Plan (Urgent Cases)**

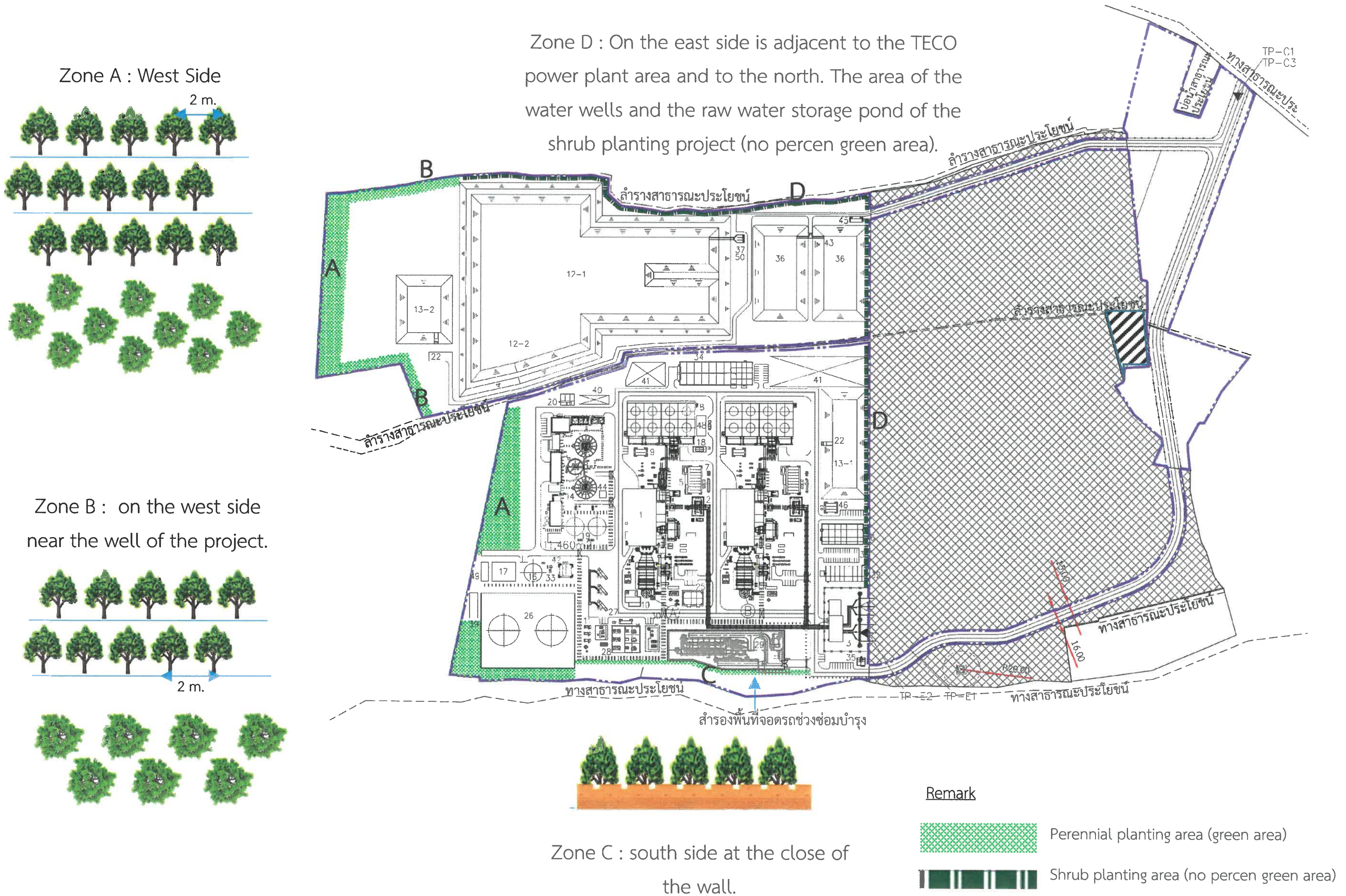
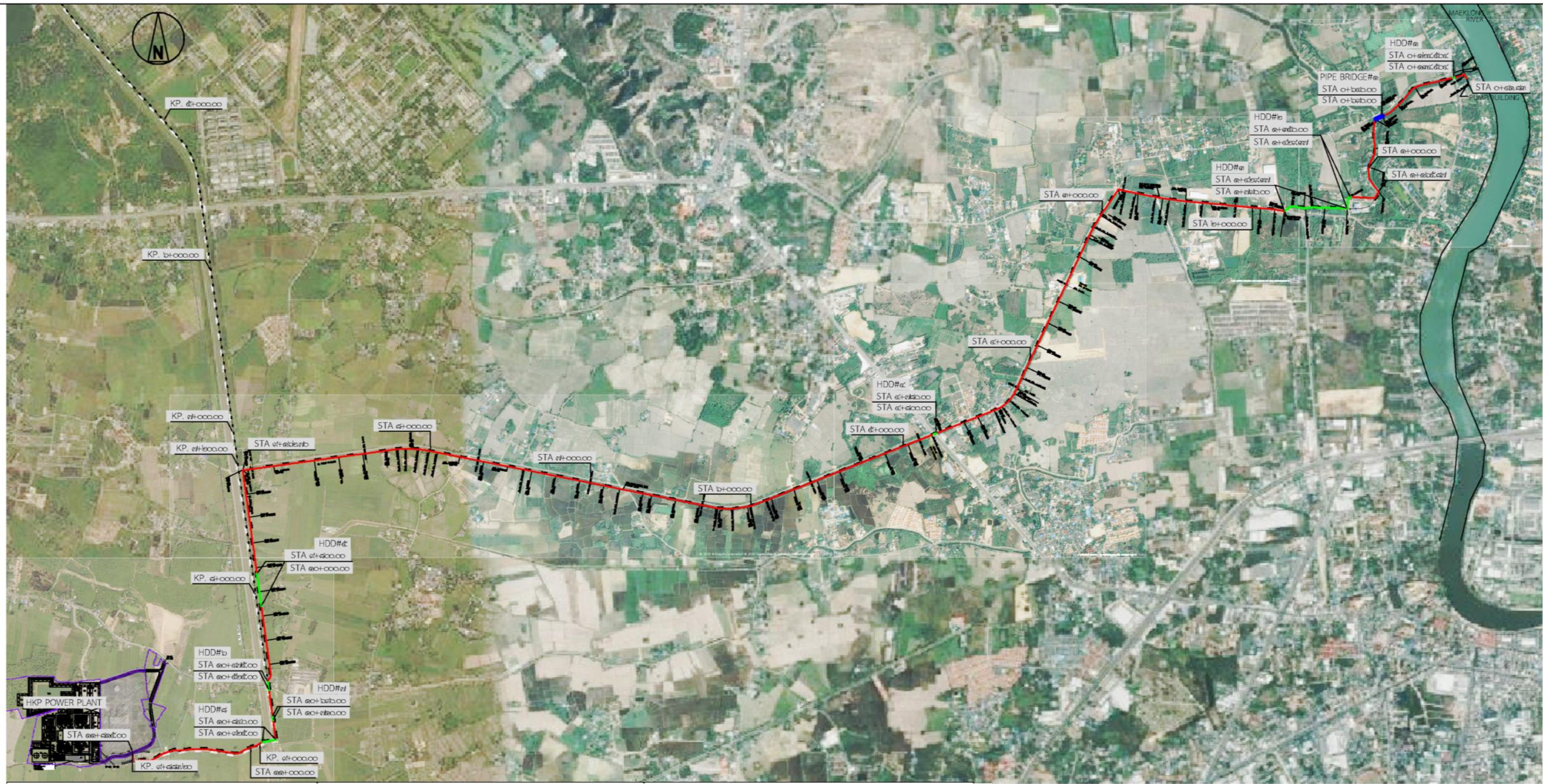


Figure 7-7 Green Area



OPEN CUT				HDD				Pipe Bridge			
STA			ระยะทาง (เมตร)	STA			ระยะทาง (เมตร)	STA			ระยะทาง (เมตร)
0+000	-	0+124.504	124.504	0+124.504	-	0+134.504	10	0+640.00	-	0+690.00	50
0+134.504	-	0+640.00	505.496	1+350.00	-	1+429.37	79.37				
0+690.00	-	1+350.00	660.000	1+429.37	-	1+790.00	360.63				
1+790.00	-	4+780.00	2990.000	4+780.00	-	4+800.00	20				
4+800.00	-	9+800.00	5000.000	9+800.00	-	10+000.00	200				
10+000.00	-	10+475.00	475.000	10+475.00	-	10+525.00	50				
10+525.00	-	10+690.00	165.000	10+690.00	-	10+710.00	20				
10+710.00	-	10+840.00	130.000	10+840.00	-	10+925.00	85				
10+925.00	-	11+815.00	890.000								
รวม			10940	รวม			825	รวม			50
รวมระยะทางทั้งหมดโดยประมาณ											11815

Symbol

Open cut

Pipe Bridge

HDD

Power Plant area

250 0 500 1000mm

SCALE 1:25

PRELIMINARY

Customer

HKP

บริษัท หินกองเพาเวอร์ จำกัด
HIN KONG POWER COMPANY LIMITED

Figure 7-8 Raw water and wastewater discharging pipeline