Turga
Pumped Storage Project
Preparatory Study
in India

Draft Final Report

March 2018

Japan International Cooperation Agency

Electric Power Development Co., Ltd.

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CRISIL	Credit Rating Information Services of India Limited
CSR	Corporate Social Responsibility
DAM	Day Ahead Market
Discom	Distribution Company
DFO	District Forest Officer
DF/R	Draft Final Report
DPR	Detailed Project Report
DSM	Deviation Settlement Mechanism
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Program
EOI	Expression of Interest
FIRR	Financial Internal Rate of Return
F/R	Final Report
GCC	General Conditions of Contract
GDP	Gross Domestic Product
GPO	Gram Panchayat Office
ICB	International Competitive Bidding
Ic/R	Inception Report
IEA	International Energy Agency
IMD	India Meteorological Department
IMF	International Monetary Fund
INR	Indian Rupee
IRR	Internal Rate of Return
It/R	Interim Report
JICA	Japan International Cooperation Agency
LCB	Local Competitive Bid
MoEFCC	Ministry of Environment, Forest and Climate Change
MOP	Ministry of Power
MU	Mega Unit
NEP	National Electricity Plan
OCCTO	Organization for Cross-regional Coordination of Transmission Operators, Japan
PGCIL	Power Grid Corporation of India Limited
PQ	Pre Qualification
QBS	Qualifications-Based Selection
RPO	Renewable Purchase Obligation
SIA	Social Impact Assessment
TOR	Terms of Reference
U	Unit
UDAY	Ujwal DISCOM Assurance Yojana
WBERC	West Bengal Electricity Regulatory Commission
WBPDCL	West Bengal Power Development Corporation Limited
WBSEDCL	West Bengal State Electricity Distribution Company Ltd.
WBSETCL	West Bengal State Electricity Transmission Company Ltd.

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INTRODUCTION

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CHAPTER 1 INTRODUCTION

Turga Pumped Storage Power Development Project (hereinafter referred as “the Project”) is to develop a 1,000 MW pumped storage power plant in Purulia district of West Bengal state, eastern state of India. The Project has been being promoted by West Bengal State Distribution Company Ltd., (WBSEDCL) through preparing DPR (Detailed Project Report) till present. In 2017, this was listed in a Rolling Plan of the Central government, India and Japanese government received the ODA request from DEA (Department of Economic Affairs), Ministry of Finance.

This Preparatory Study (the Study) is to conduct the necessary/required studies such as those of the Project cost, the required organization system in charge at development stage and that in operation & maintenance stage, environmental considerations, all of which are regulatory requirements for assessing the Project in the light of Japanese ODA loan.

The Indian government on 2014 has made the Renewable Energy Initiative to introduce 175 GW renewable energy (solar power and wind power) by 2022. Before that pumped storage power generation was not promoted by many states although its values in peaking power supply and its contribution to grid stabilization effects were acknowledged by them. It was because of its high cost of development together with political considerations of each state, in spite that they knew the large contributions of pumped storage power generators for stabilization of grid frequency and load control in middle-long term. West Bengal is one of the few states which has been promoting pumped storage projects from the past. But now that a certain RPO (Renewable Purchase Obligation) was imposed onto each state, some several new projects are not floating by states.

Central government consistently has maintained its firm stance for hydropower promotion. CEA announced to develop 10GW pumped storage power potential (August, 2016). Also in October 2016, then power minister released the comment to abolish capacity ceiling restriction on hydropower (25MW) to provide benefits coming from renewable energy category. It means a large hydropower project can be treated as one of renewable energy. Such policy increased the target of renewable energy target from 175GW up to 230GW, and expectation was arisen for hydro projects to enjoy several privileges as RPO, beneficial tariff regulations for renewables, appliance of governmental fund such as National Clean Energy Fund (NCEF), all of which may have stimulated the interests of state governments.

Furthermore, recently on December 2016 to January 2017 CEA published the Draft National Electricity Plan (DNEP 2016), and with power demand/load projection until 2036. It made an unexpected statement that no fresh coal thermal power generation projects are needed till 2027 other than the currently ongoing projects on track (50GW). It emphasized the promotion and supply of peaking power and provisions of control function of grid stability from hydro power generation and pumped storage power generation, and the integration of those with upcoming renewable energy.

Behind that DNEP 2016, the firm intention of central government (CEA and MOP) on steady promotion of renewable energy, and it seems each state has geared up its intention acquiring the opportunity.

West Bengal has commenced and kept operation of Purulia pumped storage plant (900 MW) since 2008. It also picked up next potential site, Turga pumped storage project of 1,000 MW and commenced the preparation of DPR (Detailed Project Report) on 2013 through its tender on its own state budget.

The West Bengal state sent the official application to central government on 2015 for utilization of external loan (enrollment of the project into the rolling plan).

Later on August 2016 the DPR was approved by CEA, and after TEC clearance (Techno-Economic Clearance) on October 2016, West Bengal state again sent the application to the central government for rolling plan enrollment on March 2017. It was listed on the plan on May 2017 and notified to Japanese government through governmental channel.

West Bengal is a proven leading state implementing pumped storage power projects in India. Turga pumped storage power project is one of the projects in advanced development stages.

The location of the project site is in the Figure below.

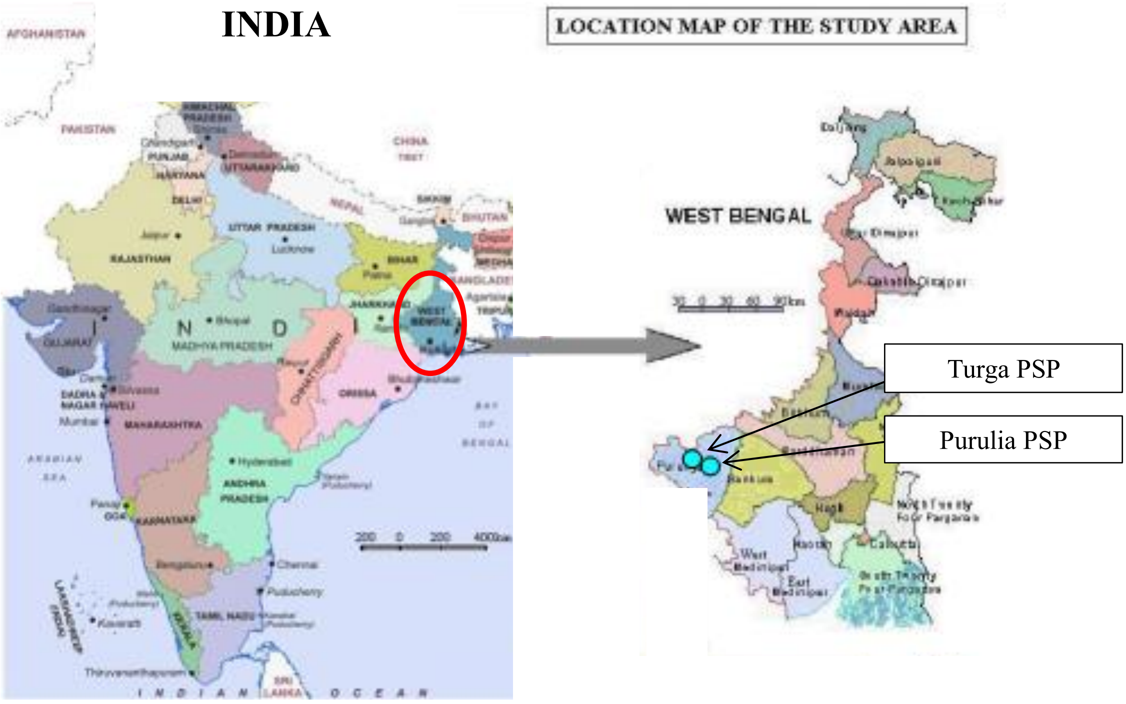

Figure 1-1 Location of Turga PSP

The salient features of the Turga pumped storage project and its layout is shown in the Table 1-1 and Figure 1-2.

Table 1-1 Salient Features of Turga Pumped Storage Plant

INSTALLED CAPACITY	4×250 MW
Peak Operating duration	5 hours daily
UPPER RESERVOIR	
FRL	EL 464.00 m
MDDL	EL 441.40 m (With Irrigation Storage depleted) EL 444.40 m (For Pumped Storage Generation)
Pondage at FRL	21.6 Mm^3
Pondage at MDDL (at 441.40m)	5.9 Mm^3
Pondage at MDDL (at 444.44m)	7.4 Mm^3
Live Pondage	14.2 Mm^3
LOWER RESERVOIR	
FRL	EL 316.5 m
MDDL	EL 280.4 m
Pondage at FRL	18 Mm^3
Pondage at MDDL	3.8 Mm^3
Live Pondage	14.2 Mm^3
UPPER DAM	
Type	Rock fill with Central impervious core
Top of Dam	EL 467.5 m
Foundation Elevation	EL 404 m
Length of Dam at top	732 m
Max. Height of Dam	63.5m
Top width of dam	10.00 m
MAIN LOWER DAM	
Type	Concrete Gravity
Top of Dam	EL 320m
Foundation Elevation	EL 256 m
Length of Dam at top	872 m
Max. Height of Dam	64 m
No. of “OF” blocks	4 nos, 18m wide each
No. “NoF” Blocks	40 nos, 20m wide each
Top width of dam	10.00 m
LOWER SADDLE DAM	
Type	Rock fill with central impervious core
Top of Dam	EL 320.0 m
Foundation Elevation	EL 270 m
Length of Dam at top	517.73 m
Max. Height of Dam	50.0 m (from Bed level)
Top width of dam	10.00 m
POWER INTAKE	
Type H × W × No. × Line	Horizontal Type 12.0m × 13.0m × 3 nos × 2 lines

HEADRACE TUNNEL (INTAKE TUNNEL)	
D × L × line	D 9.0 m × L 618.11 m × 2 lines
PENSTOCK (STEEL LINING)	
D × L × line	D 9.0 m × L 224.37m × 2 lines
After Bifurcation	D 6.4 m- D 4.4 m × L 73.73 m × 4 lines
TAILRACE TUNNEL	
Tailrace Tunnel No1	D 7.0 m × L 126.90 m × 1 line D 7.0 m × L 114.40 m × 1 line D 10.0 m × L 419.14 m × 1 line
Tailrace Tunnel No2	D 7.0 m × L 101.90 m × 1 line D 7.0 m × L 89.40 m × 1 line D 10.0 m × L 402.77 m × 1 line
POWER HOUSE	
Type Size	Underground Bullet shape L 160.00 × B 25.00 m × H 55.00 m (Two Variable Speed Pump/ Turbine units + Two Fixed Speed Pump/ Turbine units)
PUMP TURBINE	
Type	Francis type, vertical shaft reversible pump-turbine
Number of unit	Four (4) units
Effective head at normal static head	146.4 m
Maximum Turbine Output at normal effective head	255,500kW, 280,600kW (10% Overload)
Maximum Pump Input	285,000 kW
Maximum Turbine Discharge	197.0 m^3/s
Maximum Pump Discharge	196.7 m^3/s
Revolving Speed	187.5 rpm
GENERATOR- MOTOR	
Number of unit	Four (4) units [Two units Fixed Speed & Two units Variable Speed type]
Rated Capacity	Generator; 306MVA Motor ; 300 MW
Rated Revolving Speed	187.5 rpm (for Fixed Speed Machine)
Rated Revolving Speed of Variable Speed Machine	178.1 rpm to 196.9 rpm
Over Load Capacity	110 % rated capacity
TRANSMISSION LINE	
Type	Double Circuit, Quadruple Moose Conductor
Capacity Voltage Level	400kV
Length	1.7 km

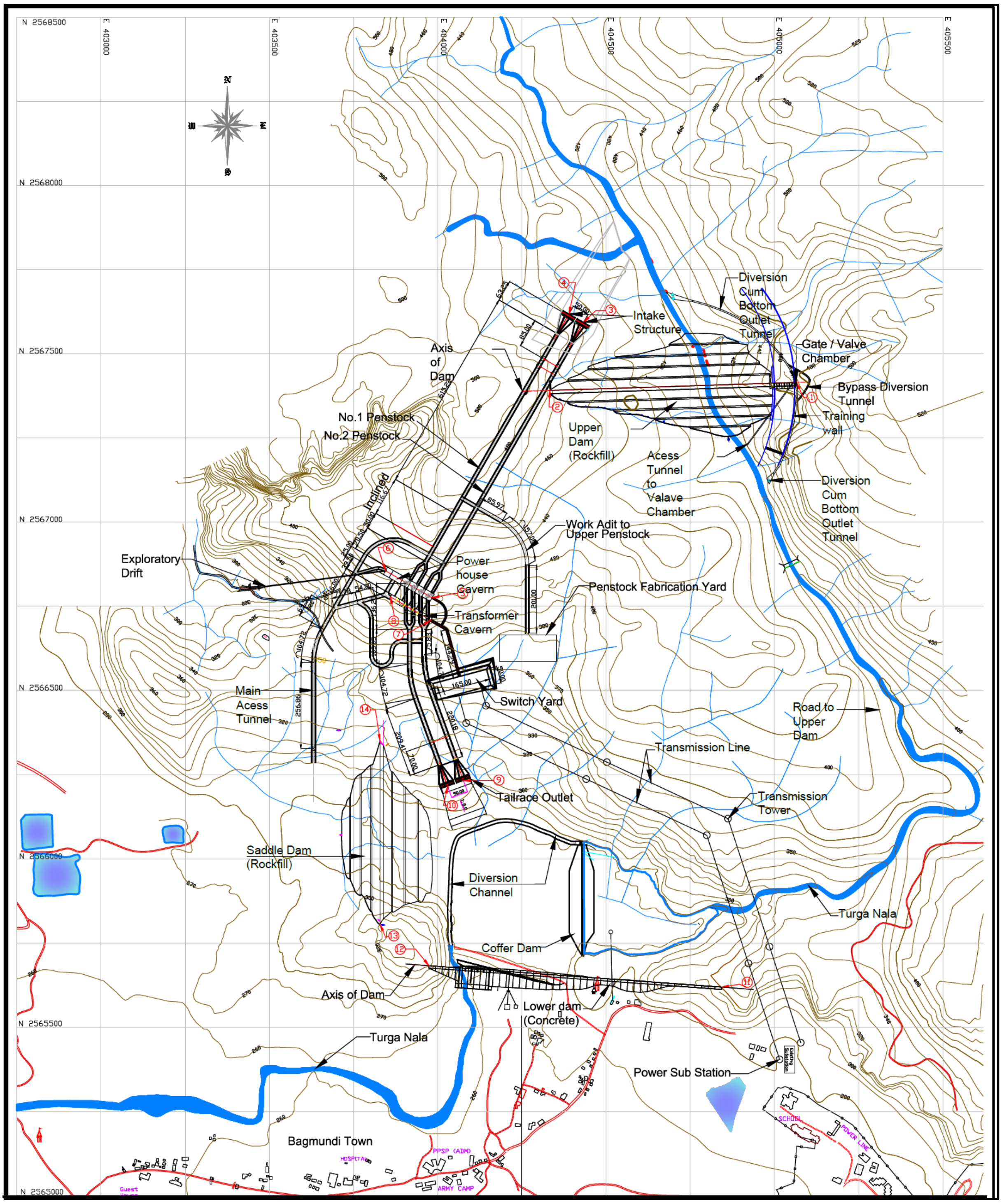

Figure 1-2 Layout of Turga PSP

1.1 PURPOSE AND SCOPE OF THE STUDY

1.1.1 Purpose

The Study conducts the necessary studies for regulatory requirements for assessing the Project in the light of Japanese ODA loan. Those cover the Project cost updating, identifying the required organization system in charge at both in development stage and in operation & maintenance stage, and especially environmental considerations.

1.1.2 Area

The Study aims to study Turga PSP in West Bengal, at Purulia province.

1.1.3 Counterpart

WBSEDCL. The governmental agency is Department of Power & Non-Conventional Energy source.

1.1.4 Scope

The Study conducts the following 3 stages in practically 6 months (note; contract formerly 10 months), The Study Team is composed of 3 teams/groups. 1) System/EM group, 2) Hydro planning group, 3) Environmental group.

- Confirmation and updating the site survey (local consultant's Detailed Design works), updation of power sector information such as power supply/demand, power development plans, etc. of West Bengal.
- DPR review and revision on the basis of practical/realistic cost/design.
- Utilization of existing Studies including the existing DPR, Data Collection Survey on Power Sector in India (JICA, 2016)
- Documentation requested by JICA for ODA process
- Strict surveillance from JICA environmental guideline ("GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS", April/2010) and revision of EIA
- Seminar in India and invitation of WBSEDCL and related personnel to Japan.

1.2 METHODLOGIES

The detailed work flow of the study is shown in the Figure 1.2.1-1.
The key considerations of assignments in the study are listed as below.

1. Confirmation of project background
    - Confirmation and data collection of electrical power policy, power supply and demand, etc.
    - Conduct the power system analysis confirming the stable operation of the power plant by the verification of power flow, short circuit capacity and dynamic stability, etc.

- Confirmation of Indian and West Bengal state government policy concerning utilization of adjustable speed pumping technology
- Activities of other donors

2. Review and Revise DPR
    - Review topographical, geological, hydrological and meteorological data which were studied in the DPR
    - Review and revise the planning factors and the elements of the design of the project.
3. Study on the project implementation system and operation and maintenance management system
4. Study on Implementation Schedule
5. Environmental and social consideration
    - Review the completed environmental impact assessment (EIA) associated with social impact assessment (SIA), conduct the environmental supplementary survey
    - Preparation of the revised EIA and EMP
    - Assist JICA finalize documents to submit to the 1st Advisory Committee Meeting on the Environmental and Social Considerations
6. Estimation of the approximate project cost and financial cash plan
7. Preparation of JICA's "Risk Management Framework"
8. Study on procurement and construction method
    - Situation of similar project contract
    - Preparation of the draft TOR (Term of Reference) on consulting services
    - Principle of contactors selection
    - Survey and analysis of the management over the contract
9. Study points of consideration for the project implementation
10. Project evaluation (qualitative effect and quantitative effect)
11. Holding the seminar on adjustable pumped storage technologies and invitation of the counterpart to Japan
12. Preparation of the Preparatory Study Report

1.2.1 Methodology

The study was carried out basically by the schedule of Figure 1.2.1-1. Each study is summarized below.

(1) 1st Work in Japan

1) Power system/Electromechanical group

Collection of the latest information on power sector (electrical power policy, power supply and demand, etc.), review of the existing DPR, specification of the power system analysis were studied. As for power system analysis it was confirmed that the WBSEDCL examined the stable operation of the power plant by the verification of power flow, short circuit capacity and dynamic stability which were included in the existing DPR. In this study conducted again was the power system analysis confirming the project contributing to stable supply of electricity, using expected system data at the time of completion of this project based on the latest system development plan, renewable energy development plan and situation change such as the power supply and demand, demand forecast and transmission network development situation after preparation of the DPR (2014 - 2015). It was concluded to subcontract the work to PGCIL as it was the only organization owing and managing the latest national power system data over India.

2) Hydropower planning group

Review of DPR and making plan and preparation of the site survey

3) Environmental group

Review of the existing EIA report and preparation of the TOR on the environmental and social supplemental survey

WBSEDCL completed already an environmental impact assessment (EIA) associated with social impact assessment (SIA), environmental management plan (EMP) and public hearing in compliance with relevant laws and regulations stipulated by the Government of India. As MoEFCC has given an Environmental Clearance (EC) with conditions in 2016, a revised EIA along with EMP based on the environmental and social supplemental survey was planned and was incorporated in the Preparatory Study Report, which will be part of the appraisal document for JICA and WBSEDCL.

4) Preparation of the Inception Report (IC/R)

(2) 1st Work in India

1) Presentation of the Inception Report (Ic/R) to WBSEDCL

2) Power system/Electromechanical group

The group reconfirmed the introduction of adjustable pumped storage plants into West Bengal which had been already approved by the state government and central government through the existing DPR. The group had the discussions with WBSEDCL. WBSETCL, and with PGCIL which conducted the system analysis in the existing DPR. Through discussion the group confirmed PGCIL has prepared the future transmission data for only 3-4 years ahead (as the uncertainties of the generation projects and power load projections). The discussion was made as to methodologies and TOR of the planned power system analysis (which continued until December 2017).

The power demand and supply data in West Bengal, and the operation data of the Purulia pumped storage power plant were obtained by the group.

3) Hydropower planning group

The reviewed cost of the project and the approved schedule by the state government (to establish a mile stone to start a part of open works in 2019) were obtained by the group from the WBSEDCL. The group initiated the collection and clarification the information of revised cost estimate details such as item by item rate and cost detail with the interaction with WBSEDCL to confirm the grounds of the above data. The discussion of the implementation schedule was also conducted with WBSEDCL for clarification. The group inspected and confirmed the progress, results and the geological condition in the exploratory adit, the hydro fracturing test, the construction material test, and hydrological data that had been continuously conducted after the submission of DPR. The group confirmed the validity of the current civil design and through discussions with WBSEDCL concluded additional geological investigation was not required.

4) Environmental group

The group conducted the site inspection and confirmed and agreed with WBSEDCL on the scoping of the study.

(3) 2nd Work in Japan

1) Power system/Electromechanical group

The group requested WBSEDCL to provide data on power sector that includes actual power supply and demand data, power load/demand projection, power generation development plan, grid development plan, etc. the data from the existing sources were collected. The interview was made with manufacturers for introductions of applicable technologies including adjustable pumped storage technologies.

2) Hydropower planning group

The discussion was made on cost estimate details, implementation schedule, etc. with the WBSEDCL as the implementation agency, WAPCOS Ltd., as the domestic consultant in charge of the existing DPR on its cost estimate. The assessment after the site inspection, the viability of the civil structure from the view point of technical, economical and natural environmental aspects was confirmed.

3) Environmental group

The 1st Advisory Committee Meeting on the Environmental and Social Considerations (27 October 2017) was assisted. The TOR on the environmental and social supplementary survey was studied consecutively and prepared.

(4) 2nd Work in India

1) Power system/Electromechanical group

Collection of the latest information on power sector (electrical power policy, power supply and demand, etc.) was continued. Regarding power transmission planning, transmission and substation equipment design were confirmed in the site inspection and no revisions were considered necessary.

2) Hydropower planning group

The discussion on cost estimate details, implementation schedule etc. was continued with the WBSEDCL as the implementation agency and WAPCOS Ltd., as the domestic consultant in charge of the existing DPR.

3) Environmental group

A stakeholder meeting and local consultations by WBSEDCL were assisted. The environmental and social supplementary survey was assigned to the subcontractor (WAPCOS Ltd.) and commenced after elaborating views and comments obtained in the 1st Advisory Committee Meeting on the Environmental and Social Considerations. The elephant survey was implemented into the supplementary survey.

(5) 3nd Work in Japan

1) Power system/Electromechanical group

Collection of the latest information on power sector (electrical power policy, power supply and demand, etc.) was continued in cooperation with WBSEDCL.

2) Hydropower planning group

The collection of the data on cost estimate details, implementation schedule etc. through discussion with the WBSEDCL as the implementation agency and WAPCOS Ltd., as the domestic consultant in charge of the existing DPR was continued.

3) Environmental group

The progress of supplementary survey conducted by the local consultant was monitored.

4) Preparation of Interim Report (It/R)

(6) 3rd Work in India

1) Power system/Electromechanical group

The agreement was made with PGCIL on the TOR and the contract conditions of the power system analysis.

2) Hydropower planning group

The discussion of the data on cost estimate details, implementation schedule etc. with the WBSEDCL as the implementation agency and WAPCOS Ltd., as the domestic consultant in charge of the existing DPR was continued. The financial data on the WBSEDCL and WBSETCL were collected. The data on the organizations on the companies were also collected.

The Study Team prepares the Interim Report to JICA, before 10 working days before the the explanation of it to WBSEDCL in the 3rd Work in India. The Study Team finalizes it reflecting the JICA's comments.

3) Environmental group

The progress of supplementary survey conducted by the local consultant was monitored.

(7) 4th Work in Japan

1) Power system/Electromechanical group

Collection of the latest information on power sector (electrical power policy, power supply and demand, etc.) was continued in cooperation with WBSEDCL. The contract was made with PGCIL and the work initiated. The interviews with manufacturers for introductions of applicable technologies in the Projects including, but not limited to, adjustable pumped storage technologies were conducted. The cost of electro-mechanical infrastructures was studied.

2) Hydropower planning group

Project cost estimation and cash planning as well as the project implementation schedule were prepared following with the evaluations and preparation of procurement and construction method and TOR of the consulting services.

3) Environmental group

The progress of supplementary survey conducted by the local consultant was monitored.

(8) 4th Work in India

1) Power system/Electromechanical group

Discussion for collection of the latest information on power sector (electrical power policy, power supply and demand, etc.) was continued with WBSEDCL. The plan and concept on implementing organization and organization in charge of maintenance & operation for the Turga project were interviewed with WBSEDCL and evaluated.

2) Hydropower planning group

Project cost estimation, as well as the project implementation schedule was discussed with WBSEDCL.

3) Environmental group

The progress of supplementary survey conducted by the local consultant was monitored.

4) Seminar on the APSPs

The seminar with scope focusing on adjustable pumped storage power technologies was held in Delhi on 2nd February, 2018 for the central agencies (MOP, CEA, etc.) and the state power utilities.

(9) 5th Work in Japan

1) Power system/Electromechanical group

Cost estimation on the electro-mechanical infrastructures was made. Draft Final Report (DFR) was drafted.

2) Hydropower planning group

Project cost estimation and cash planning as well as the project implementation schedule, the procurement and construction method and TOR of the consulting services were prepared. The project evaluation (B/C, IRR, operation index) was initiated. The DFR was drafted.

3) Environmental group

Draft Environmental management plan (EMP), draft abbreviated resettlement action plan (ARAP) were developed. DFR was drafted.

(10) 5th Work in India

1) Power system/Electromechanical group

Discussion was made with WBSEDCL on DFR. The collection and discussion on the latest information on power sector (electrical power policy, power supply and demand, etc.) was continued with WBSEDCL.

2) Hydropower planning group

Discussion was made with WBSEDCL on DFR.

3) Environmental group

The public consultation meeting held by WBSEDCL on 21st and 22nd February, 2018 was assisted.

(11) 6th Work in Japan

1) Power system/Electromechanical group

DFR was revised after discussion with WBSEDCL.

2) Hydropower planning group

Revisions were applied to project cost estimation, the project implementation schedule, the procurement and construction method, TOR of the consulting services, etc. after discussion with WBSEDCL.

3) Environmental group

The revisions were made to draft Environmental management plan (EMP), draft abbreviated resettlement action plan (ARAP), and DFR based on the result of the public consultation meeting on 21st and 22nd February, 2018.

(12) 6th Work in India

1) Explanation of the DFR.

The DFR was explained to the counterpart (WBSEDCL).

(13) 7th Work in Japan

1) Invitation of the counterpart to Japan

WBSEDCL and/or other relevant parties in West Bengal are to be invited to Japan for the further consultations with pumped storage power plant owners (JPOWER), adjustable storage plant manufacturers, trading companies.

2) Preparation of Final report (FR)

The Final Report is prepared and submitted after reflecting the comments received from WBSEDCL.

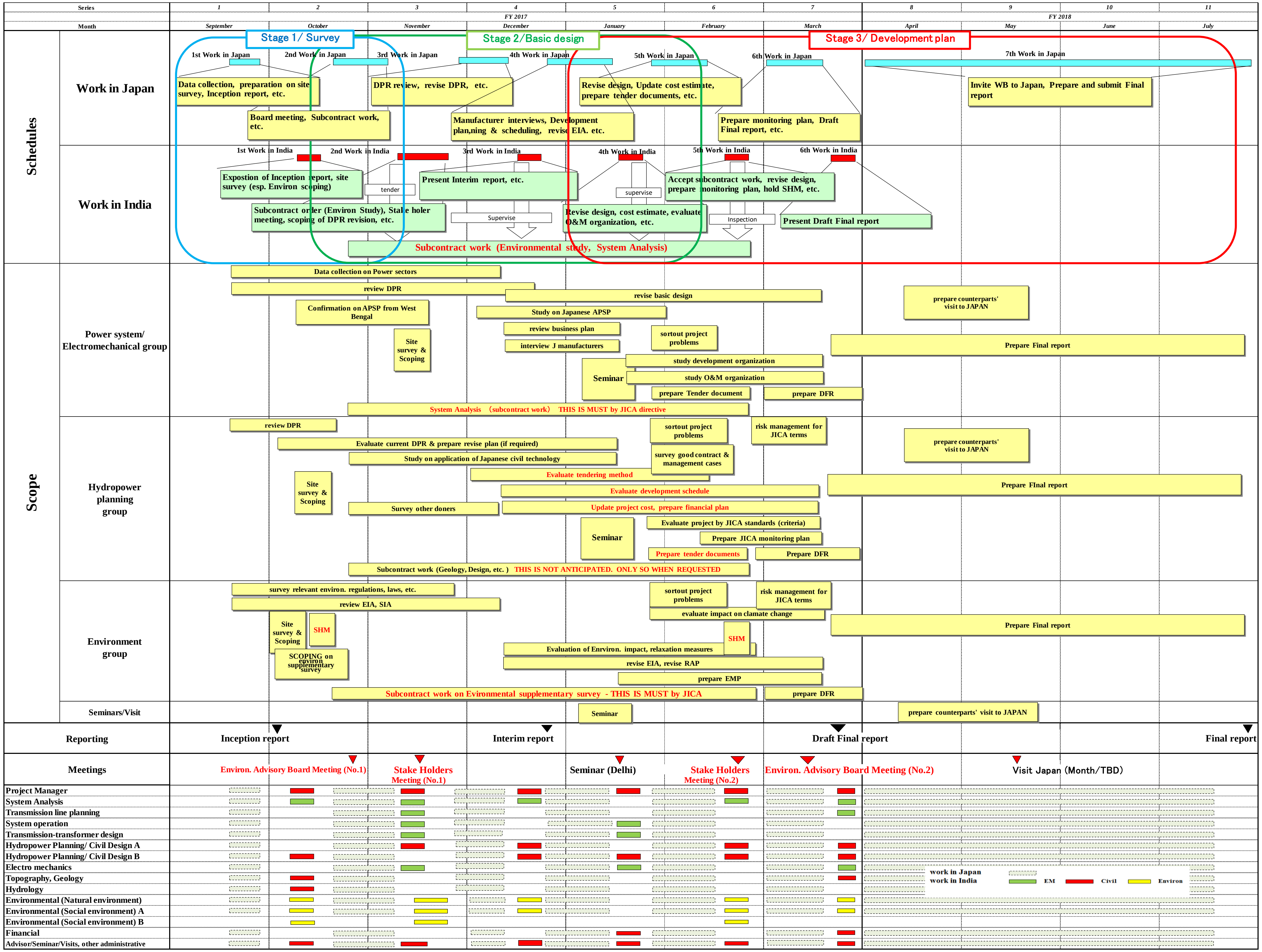

Figure 1.2.1-1 Turga Preparatory Study (JICA) Detailed Schedule

1.3 SURVEY ORGANIZATION STRUCTURE AND PERFORMANCE OF SURVEY

1.3.1 Composition of the Study Team

The survey organization is composed of 1) electrical group, 2) hydro planning group and 3) environmental group.

1) Electrical group is consisted of experts of power system analysist, electro-mechanics, transmission planning, system operation and transmission-transformer.
2) Hydro planning group is consisted of experts of hydropower planning/civil design, geology, and hydrology.
3) Environmental group is formed by experts of natural environment and social environment.

Each group is linked and managed through communications.

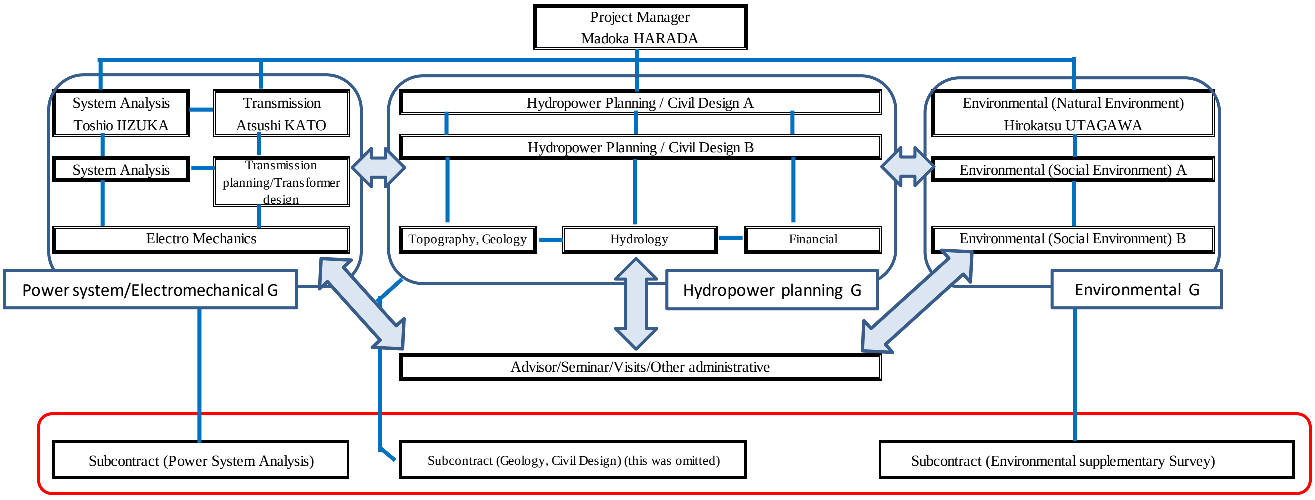

Figure 1.3.1-1 The Composition of the Study Team

The table below shows the composition of each expert.

Table 1.3.1-1 The list of members for the Study Team

Name	Task	Company
Madoka HARADA	Project Manager	JPOWER
Toshio IIZUKA	System Analysis	JPOWER
Atsuhi KATO	Transmission line planning	JPOWER
Shinji OMOTEYAMA	System operation	IEE, JAPAN (The Institure of Ebergy Economics,Japan)
Toshio AKI	Transmission-transformer design	YONDEN CONSULTANTS CO.,INC.
Tsuyoshi NAKAHATA	Hydropower Planning/ Civil Design A	J-POWER Generation Thailand
Gaku MATSUOKA	Hydropower Planning/ Civil Design B	JPOWER
Kozo UTSUMI	Electro mechanics	Senior Consultant, JPOWER
Nobuo HOSHINO	Topography, Geology	OPC Corporation
Tsuyoshi NAKAHATA	Hydrology	J-POWER Generation Thailand
Hirokatsu UTAGAWA	Environmental (Natural environment)	KOKUSAI KOGYO CO., LTD.
Junko KUWABARA (FUJIWARA)	Environmental (Social environment) A	OPMAC Corporation
Masami TAKAHATA	Environmental (Social environment) B	KOKUSAI KOGYO CO., LTD.
Tetsuya HIRAHARA	Financial	JPOWER
Shigeru KONDO	Advisor/Seminar/Visits, other administrative	Senior Consultant, JPOWER

1.3.2 Formation of the counterpart

The executing agency of West Bengal is the Pumped Storage Project Department of West Bengal State Electricity Distribution Co., Ltd. (PSPD, WBSEDCL).

The key personnel are shown below. CMD Mr. R. Pandey and the Board members are the key decision makers for the Turga project in WBSEDCL. The actual implementation/promotion of the project is headed by Director (Generation) Mr. S. Chakrabortty (he is a Board member), and managed by the Chief Engineer Mr. A. Kayal who collects expert staffs when necessary.

West Bengal State Electricity Distribution Co., Ltd. (WBSEDCL)	Chairman & Managing Director	Mr.Rajesh Pandey, I.A.S.
	Director (Generation)	Mr. Surajit Chakrabortty
	Chief Engineer, PSPD	Mr. Amitava Kayal
	Additional Chief Engineer, PSPD	Mr. Ashis Kumar Bhowmick
	Superintending Engineer, PSPD	Mr. Sourav Chakraborty

1.3.3 Record on dispatch of Study Team

JICA study team has launched the first survey in India in October 2017. Data collection and discussion with WBSEDCL and relevant organizations including WAPCOS, PGCIL etc. was conducted.

During its stay in India, the JICA Study Team researched the following technical subjects through cordial discussions with the counterparts and others.

First Survey	Major Research and Discussions
8 Oct. 2017 - 17 Oct. 2017	➢ Submittal of the inception report to WBSEDCL and explanation of the project overview. The JICA Study Team requested that WBSEDCL provide comments and information and data related to the project. ➢ Nomination of the counterpart personnel for the JICA Study Team ➢ Negotiations with local consultants as follows: ・ Power System Analysis：PGCIL ・ Environmental and Social supplemental investigation: WAPCOS Ltd. ➢ The discussions with WBSEDCL (power system analysis, power demand/supply, geology, hydrology, civil design, cost update, environmental study) ➢ The discussions with WAPCOS who was in charge of DPR preparation (civil design, cost update, hydrology) ➢ The site survey by JICA Study Team and WBSEDCL

Second Survey (2-1)	Major Research and Discussions
31 Oct. 2017 – 3 Nov. 2017	➢ Negotiation with survey consultant with the expansion of environmental survey (elephant survey) ➢ Collection and receipt of some relevant requested documents. ➢ Supplemental request on WBSEDCL for additional/lacking data and information

Second Survey (2-2)	Major Research and Discussions
8 Nov. 2017 – 2 Dec. 2017	➢ Commencement of environmental supplemental survey & supervision of the survey ➢ Negotiation with local consultants ・ Power System Analysis：PGCIL (continued) ・ Environmental and Social supplemental investigation: WAPCOS Ltd. (signed Agreement) ➢ The discussions with WBSEDCL (power system analysis, transmission, transformer, electro-mechanics, civil design, cost update, environmental study) ➢ The discussions with WAPCOS who was in charge of DPR preparation (civil design, cost update, hydrology) ➢ The site survey by JICA Study Team and WBSEDCL

Third Survey (3-1)	Major Research and Discussions
17 Dec. 2017 – 20 Dec. 2017	➢ Supervision of the environmental supplemental survey ➢ Negotiation with local consultants ・ Power System Analysis：PGCIL (continued) ➢ The discussions with WBSEDCL (civil design, cost update, financial analysis, environmental study) ➢ Preparation of the JICA seminar on February 2018.

Third Survey (3-2)	Major Research and Discussions
14 Jan. 2018 – 20 Jan. 2018	➢ Supervision of the environmental supplemental survey ➢ The discussions with WBSEDCL (environmental study)

Fourth Survey (4-1)	Major Research and Discussions
29 Jan. 2018 – 3 Feb. 2018	➢ Submittal of the interim report to WBSEDCL and explanation ➢ Collection of required information/data, discussions with WBSEDCL (Organization of project implementation and operation & maintenance, financial analysis, power demand and power supply, power demand projection, power generation development plan, etc.) ➢ Holding Seminar on the pumped storage power technology

Fourth Survey (4-2)	Major Research and Discussions
6 Feb. 2018 – 9 Feb. 2018	➢ Collection of required information/data, discussions with WBSEDCL (Organization of project implementation and operation & maintenance, financial analysis, power demand and power supply, power demand projection, power generation development plan, project cost estimate, project implementation schedule, consultancy services, etc.)

Fifth Survey (5-1)	Major Research and Discussions
13 Feb. 2018 – 26 Feb. 2018	➢ Holding and assisting the public consultation meeting on the project site ➢ Collection of required information/data, discussions with WBSEDCL (Organization of project implementation and operation & maintenance, financial analysis, power demand and power supply, power demand projection, power generation development plan, project cost estimate, project implementation schedule, consultancy services, etc.)

Fifth Survey (5-2)	Major Research and Discussions
7 Mar. 2018 – 10 Mar. 2018	➢ Collection of required information/data, discussions with WBSEDCL (Organization of project implementation and operation & maintenance, financial analysis, power demand and power supply, power demand projection, power generation development plan, project cost estimate, project implementation schedule, consultancy services, etc.)

Sixth Survey	Major Research and Discussions
26 Mar. 2018 – 31 Mar. 2018, 2 Apr. 2018 – 6 Apr. 2018	➢ Submittal of the draft final report (DFR) to WBSEDCL and explanation ➢ Discussions with WBSEDCL on DFR

CHAPTER 2

POWER SECTOR IN WEST BENGAL

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Regulations on power sector focusing on pumped storage power generation projects are described in this Chapter.

2.1 NATIONAL ENERGY POLICY

The Draft National Energy Policy was released by NITI Aayog, Government of India on June 27th, 2017. There are four key objectives of our energy policy: Access at affordable prices, Improved security and Independence, Greater Sustainability and Economic Growth. The National Energy Policy (NEP) aims to chart the way forward to meet the Government's recent bold announcements in the energy domain. All the Census villages are planned to be electrified by 2018, and universal electrification is to be achieved, with 24 × 7 electricity by 2022. The share of manufacturing in our GDP is to go up to 25% from the present level of 16%, while the Ministry of Petroleum is targeting reduction of oil imports by 10% from 2014-15 levels, both by 2022. The target defined by the Nationally Determining Contributions (NDCs) is the reduction of emissions intensity by 33%-35% by 2030 over 2005, achieving a 175 GW renewable energy capacity by 2022, and share of non-fossil fuel based capacity in the electricity mix is aimed at above 40% by 2030. In view of the fact that energy is handled by different ministries that have the primary responsibility of setting their own sectoral agenda, an omnibus policy is required to achieve the goal of energy security through coordination between these ministries' sources. This is also expected to mainstream emerging energy technologies, and provide consumer energy choices. The NEP expects to build, on the achievements of the earlier omnibus energy policy, the Integrated Energy Policy (IEP) and to set the new agenda consistent with the redefined role of emerging developments in the energy.

2.2 ELECTRICITY ACT (EA 2003)

Prior to India's independence from Great Britain, the country's electricity business was regulated by The Indian Electricity Act, 1910, which was a fundamental framework for the provision of electricity.

Following the independence of the Nation, the Electricity (Supply) Act was enacted in 1948. Based on the Act, the Central Electricity Authority (CEA) has been implementing electricity policies and formulating coordinations of activities of power sector in the central government, and the State Electricity Board (SEB) in which the steps from generation to distribution were vertically integrated has been controlling the state electricity industry. However various issues had been raised for the power sector.

- The monopoly of the state electricity board (SEB) in generation, transmission and distribution sector made the sector no longer financially viable. 40 years of public sector monopoly brought a huge accumulated financial deficit to SEBs and the unilluminated huge power deficit as well.

- There are numerous inefficiencies and redundancies in the power sector. As a result the power deficit put large negative affect on economic growth of India.
- Monopoly of public power sector had long time prevented the entry of private investors into the power sector.

The central government began to enforce reforms to the sector since 1991 in staged manners and newly enacted in 2003 the Electricity Act 2003 to regulate the electricity sector in India. It aims at the realization of accountable and transparent power market by deregulations and creation of competitive environment, and also at introduction of private sector vitalities. The comprehensive electricity act bill was approved in both the Rajya Sabha and the Lok Sabha to replace the former Act, and was released as the Electricity Act 2003. The Act provides the legal background to the reform of the electricity sector and is the comprehensive act dealing with wide range of power sector issues. The important issues are that the Act basically aims at SEB be legally dissolved or unbundled into generation, transmission, and distribution entities, while privatization of those entities is left to the independent decisions of each state government.

The act comprises: (1) generations except hydropower generation are free from licensing (requirement of TEC for non-hydro generation is done away with), (2) non-discriminatory open access to transmission lines is to be provided to distribution licensees, generating companies, (3) mutual entry guaranteed for distribution licensees free to take up generation & generating companies free to take up distribution licenses, (4) trading distinct activities permitted with licensing, (5) to endeavor to extend supplies of electricity to all villages/hamlets as rural electrification, (6) State Electricity Regulatory Commissions (SERC) to be constituted as compulsory, (7) metering made mandatory, (8) stricter penalties linked to the electricity theft, etc.

The Electricity Act 2003 (EA 2003) regulates the electricity business not only for the central government, but for state governments as well, and stipulates aspects such as the roles and authority of the central government, state governments, and government agencies. A main overview of Electricity Act 2003 is contained below.

1) Roles of Government
- Central Government to prepare National Electricity Policy and Tariff Policy.
- Central Govt. to notify a National Policy for rural areas permitting stand alone systems based on renewal and Non-Conventional energy sources in consultation with States.
- Central Govt. to formulate a National Policy in consultation with the concerned State Govts. for bulk purchase of power and management of local distribution through Users' Association, Cooperatives, Franchisees and Panchayat Institutions etc.

2) Rural Electrification
- Appropriate Govt to endeavor to extend supply of electricity to all villages/hamlets.
- Licence is required if a person intends to transmit and distribute power. (provided that a person generates and distributes power in rural area to be notified by state government, he shall not require any license.)

3) Licenses

a) Generation
  - Generation free from licensing.
  - Requirement of TEC for non-hydro generation done away with.[1]
  - Captive Generation is free from controls. Open access to Captive generating plants subject to availability of transmission facility.
  - Clearance of CEA for hydro projects required. Necessary due to concern of dam safety and inter-State issues.
  - Generation from Non-Conventional Sources / Co-generation to be promoted. Minimum percentage of purchase of power from renewables may be prescribed by Regulatory Commissions.

b) Transmission
  - Transmission companies to be licensed by the Appropriate Commission. The CERC issues licenses for companies that are owned or controlled by the Central Government and businesses engaged in the inter-state transmission of electricity, and the SERCs issue licenses for businesses that are only within a state.
  - There would be Transmission Utility at the Centre and in the States to undertake planning & development of transmission system.
  - Load despatch to be in the hands of a govt company/organisation. Flexibility regarding keeping Transmission Utility and load despatch together or separating them.
  - The Load Despatch Centre/Transmission Utility / Transmission Licensee not to trade in power. Facilitating genuine competition between generators.
  - Open access to the transmission lines to be provided to distribution licensees, generating companies.

c) Distribution
  - Distribution to be licensed by SERCs.
  - Distribution licensee free to take up generation & Generating co. free to take up distribution licence.
  - Retail tariff to be determined by the Regulatory Commission.
  - Metering made mandatory.
  - Open access in distribution to be allowed by SERC in phases.
  - In addition to the wheeling charges provision for surcharge if open access is allowed before elimination of cross subsidies.

4) Consumer Protection
- Every distribution licensee shall supply electricity to consumers within one month after the receipt of the application, or immediately after extension of distribution mains or commissioning new sub-stations.
- Penalty in the event of failure to give connection

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[1] Legal scheme defines no TEC required except Hydro power projects. However in actual operations, both thermal projects and transmission projects require the reviews of CEA. (This is due to technical inability of MoP)

5) Trading/ Market Development
- Trading distinct activity permitted with licencing.
- Regulatory Commission may fix ceiling on trading margin to avoid artificial price volatility.
- The Regulatory Commission to promote development of market including trading.

6) Regulatory Commissions/Appellate Tribunal
- State Electricity Regulatory Commission to be constituted within six months.
- Provision for Joint Commission by more than one State/UT.
- Provision for constitution of Appellate Tribunal consisting of Chairman and three Members.
- Appeal against the orders of Appellate Tribunal to lie before the Supreme Court.

7) Tariff Principles
- Regulatory Commission to determine tariff for supply of electricity by generating co. on long/medium term contracts.
- No tariff fixation by regulatory commission if tariff is determined through competitive bidding or where consumers, on being allowed open access enter into agreement with generators/traders.
- Consumer tariff should progressively reduce cross subsidies and move towards actual cost of supply.
- State Government may provide subsidy in advance through the budget for specified target groups if it requires the tariff to be lower than that determined by the Regulatory Commission.
- Regulatory Commissions may undertake regulation including determination of multi-year tariff principles, which rewards efficiency and is based on commercial principles.
- Regulatory Commission to look at the costs of generation, transmission and distribution separately.

8) Function of Central Electricity Authority (CEA)
- CEA to continue as the main technical Advisor of the Government of India/ State Government with the responsibility of overall planning.
- CEA to specify the technical standards for electrical plants and electrical lines.
- CEA to be technical adviser to CERC as well as SERCs.
- CEA to specify the safety standards.

9) Measures Against Theft of Electricity
- Focus on revenue realisation rather than criminal proceedings.
- Penalties linked to the connected load and quantum of energy and financial gain involved in theft.
- Provisions for compounding of offences.
- Assessment of electricity charges for unauthorised use of electricity by the assessing officer designated by the State Government.
- Theft punishable with imprisonment.
- Punishment provision for abetment of theft.
- Special Courts

10) Restructuring of SEBs
- Provision for transfer scheme to create one or more companies from SEB.
- States given flexibility to adopt reform model/path.
- In addition, the SEBs have been dissolved or unbundled in the majority of States and Union Territories, but as of the end of March 2018, the SEB still exists in only the state of Kerala.

The Electricity Act 2003 has been amended multiple times since 2003. The penalties related to Renewable Purchase Obligation (RPO) were proposed in 2013 but it became ambiguous due to the objections from debt suffering state distributing companies. The amendment in 2016 includes the enhancement of renewable energy, stricter implementation of RPO, and term "Ancillary services" be added. The Draft National Electricity Plan (DNEP, 2016) was released in the same year 2016, so the content of the Electricity Act amendment was considered to be coordinated with the DNEF 2016.

Table 2.2-1 Pumped Storage Projects planned in India

- "Ancillary services" shall be added to the term definitions.
- "National Renewable Energy Policy" shall be added to the policies (National Electricity Policy and Tariff Policy) formulated by the Central Government.
- The below items shall be added to the National Electricity Plan.
  - Optimal utilisation of resources
  - Promotion of Renewable Energy
  - "Solar power" shall be specified in stand alone systems.
- When establishing or expanding the capacity of a generating station, it shall be an obligation to submit a detailed project report.
- **When establishing a coal and lignite based thermal generating station, there shall be a requirement to establish a renewable energy generation capacity (not less than 10% of the thermal power installed capacity) under the Renewable Generation Obligation.**
- **Distribution utilities can face stiffer penalties for non-compliance of Renewable Purchase Obligations.**
- "Multipurpose hydro facilities with power generation" shall be added to the definition of "hydro generating station."
- "Supply of electricity to consumers" shall be added to businesses required to have licenses. In addition, a chapter related to the supply of electricity shall be added after "Distribution." Upon consulting with the Central Government within one year of the commencement of Electricity (Amendment) Act 2014, state governments shall have the ability to decide to separate distribution and the supply of electricity. The charges and prices for the supply licensees shall be calculated using a method stipulated by the SERCs and shall be publicly released, but these must be determined by looking at market trends.
- CERC/ SERCs shall not grant license to more than one distribution licensee in any area of distribution. Provided that where two or more distribution licensees within the same area of distribution are existing on the date of the commencement of the Electricity (Amendment) Act, 2014, they shall continue their operation till such period as specified in their licence. The Central Government in consultation with the Appropriate Commission may, in public interest, permit more than one distribution licensee to operate in any area, if it is considered necessary.

- SERCs shall introduce open access for use of distribution system in such phases and subject to such conditions, as may be specified within one year of the appointed date by it and in specifying the extent of open access in successive phases. The open access consumers procuring electricity from renewable energy sources shall not be required to pay the surcharge for open access for such period as may be prescribed by the Central Government. the open access consumer shall not switch over to any other supplier except by giving the notice of minimum time period as may be specified by the Appropriate Commission.
- All consumers having a connected load of 1 MW and above with the power system, may procure at their option electricity through open access under bilateral arrangement from any generating company, trading licensee, or from any other source. In this situation, the consumers may enter into an agreement with any person for supply or purchase of electricity on such terms and conditions (including tariff) as may be agreed upon by them.
- Electricity tariff determination must be at a level in which costs can be recovered. In cases in which there are deficits, state governments must resolve them by the time the bill comes into effect.
- Smart grids, ancillary services, and decentralized distributed generation shall be added to the regulations for inter-state transmission tariffs by the CERC.

Each state SERC (State Electricity Regulatory Commission) is in charge of formulating and approving actual state regulations. The issues like the frequency of Multi Year Tariff (MYT) revisions, observance of the Open Access (OA), respect of RPO (Renewable Purchase Obligation), complete elimination of state subsidies on electricity sector, are not completely resolved owing to the situations of each state.

2.3 NATIONAL ELECTRICITY POLICY 2005

Based on Electricity Act 2003 which defines CEA to renew National Electricity Policy every 5 years time, the CEA presented the National Electricity Policy (an MOP resolution) in February, 2005. The main issues and principles of the National Electricity Policy contain below.

- Access to Electricity -Available for all households in next five years;
- 44 % of households are not receiving power supply as at 2001;
- For that fulfilment, enhancing supply of power generate, transmission and distribution infrastructure are necessary and required;
- Electricity sector having large T&C losses is not commercially viable in solving these issues;
- Cross subsidy has reached too high and is no longer sustainable;
- Lack of distribution network prevents electricity supply to consumers;
- The Electricity Act 2003 aims at introduction of principle of competition thus expects the reduction of electricity price and higher effectivities in the power sector;

- The Electricity Act 2003 regulates the enactment of National Electricity Plan (NEP) based on the consultations of CEA with state governments. The central government enacts and revises as appropriate NEP and Tariff Policy;

2.4 NATIONAL ELECTRICITY PLAN 2005 (NEP 2005)

Based on Electricity Act 2003, CEA is set to prepare National Electricity Plan for a short-term framework of five years while it also gives a 15 year perspectives. The NEP 2005 is now under revision that Draft National Electricity Plan 2016 (DNEP 2016) has been released already (This remains as a draft as of March, 2018). Many items stipulated in NEP 2005 have been contained in the Tariff Policy amended in 2016. The main points of the NEP 2005 are contained below. Those are succeeded in DNEP 2016.

- Short-term and long-term demand forecast for each different regional grid;
- To suggest areas/locations for capacity additions in generation and transmission, keeping in view the economics of generation and transmission, losses in the system, load center requirements, grid stability, security of supply, quality of power including voltage profile etc., and environmental considerations including rehabilitation and resettlement (R&R);
- Integration of such possible locations with transmission system for development of national grid. It includes to create the transmission systems without redundant investments;
- Adoption of different various technologies available for efficient generation, transmission and distribution;
- Choice of fuels of generation based on economy, energy security and environmental considerations.
- Per capita availability of electricity to be increased to over 1,000kWh by 2012 and thus generation of 100 GW by 2012;
- Adequate reserve capacity margin at least 5% is to be accomplished by increasing generation;
- Maximum emphasis would be laid on the full development of the feasible hydro potential in the country. In order hydro potential would be speedily developed, central government be committed to review procedures for land acquisition, and other approvals/clearances, policies for speedy implementation of hydroelectric projects. National Policy on Rehabilitation and Resettlement (R&R) be implemented steadily;
- The Central Transmission Utility (CTU) and State Transmission Utility (STU) have the key responsibility of network planning and development. The Regulatory Commissions need to provide facilitative framework for non-discriminatory Open Access (OA);
- The financial support to reform distribution companies. The existing cross-subsidies would need to be reduced progressively and gradually;
- Necessary budget provision by State Government would be required to be made in advance so that the utility does not suffer financial problems that may affect its operations;

The rural electrification for agricultural villages became 97% in 2012 from 77% in 2005. Some states still face the power deficits. Per capita electricity demand arose 658 kWh in 2012 from 457 kWh in 2005 but did not reach the targeted rate.

The NEP 2005 dictates the role of PGCIL in planning of inter-state transmission line.

- The Central Transmission Utility (CTU) and State Transmission Utility (STU) have the key responsibility of network planning and development based on the National Electricity Plan by the CEA in coordination with all concerned agencies as provided in the Act. As the thermal generation sector has been de-licensed, the actual development may be at variance with respect to the program indicated in National Electricity Plan. The transmission development programs would accordingly need to be reworked from time to time. Therefore, in the long run there could be deviations from the National Electricity Plan. With the emergence of new generating stations, the variances of electricity transmission demands from utilizations of Open Accesses and power exchange markets by users necessitating the changes of transmission planning, the utilization the transmission system associated therewith would have to be quickly planned and executed. Thus, based on the perspective plan developed by CEA and depending upon as to which generations are likely to be available during the next 2-3 years and taking into account the load growth in particular areas, CTU prioritizes and firms up the inter-state transmission system requirements based on studies required for intermittent load generation scenarios after appraisals of the Regional Standing Committees for transmission system Planning.

The JICA Study Team has received the statement from PGCIL (November 2017) that they only cements plans and executes 2 - 3 years future transmission plan. This statement is confirmed by the above provision.

2.5 175GW RENEWABLE INITIATIVE

The central government announced the 175 GW renewable initiatives in 2014 placing the renewable energy as the center of prevention of global warming as well as the important tools to resolve deficit of electricity power supply and to enhance the rural electrification. The central government set the target of generation from renewable energy at 175 GW on 2022. The figure shows the tentative target of generation from each state below.

Table 2.5-1 Tentative State-wise break-up of Renewable Power Target

Unit: MW

State/UTs	Solar	Wind	Small hydro	Biomass
Delhi	2,762			
Haryana	4,142		25	209
Himachal Pradesh	776		1,500	
Jammu & Kashmir	1,155		150	
Punjab	4,772		50	244
Rajasthan	5,762	8,600		
Uttar Pradesh	10,697		25	3,499
Uttrakhand	900		700	197
Chandigarh	153			
Northern Region	31,120	8,600	2,450	4,149
Goa	358			
Gujarat	8,020	8,800	25	288
Chhattisgarh	1,783		25	
Madhya Pradesh	5,675	6,200	25	118
Maharashtra	11,926	7,600	50	2,469
D. & N. Haveli	449			
Daman & Diu	199			
Western Region	28,410	22,600	125	2,875
Andhra Pradesh	9,834	8,100		543
Telangana		2,000		
Karnataka	5,697	6,200	1,500	1,420
Kerala	1,870		100	
Tamil Nadu	8,884	11,900	75	649
Puducherry	246			
Southern Region	26,531	28,200	1,675	2,612
Bihar	2,493		25	244
Jharkhand	1,995		10	
Orissa	2,377			
West Bengal	5,336		50	
Sikkim	36		50	
Eastern Region	12,237		135	244
Assam	663		25	
Manipur	105			
Meghalaya	161		50	
Nagaland	61		15	
Tripura	105			
Arunachal Pradesh	39		500	
Mizoram	72		25	
North Eastern Region	1,205		615	
Andaman & Nicobar Islands	27			
Lakshadweep	4			
Other (New States)		600		120
All India	99,533	60,000	5,000	10,000

(source: Tentative State-wise break-up of Renewable Power target to be achieved by the year 2022, MNRE[2])

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[2] http://mnre.gov.in/file-manager/UserFiles/Tentative-State-wise-break-up-of-Renewable-Power-by-2022.pdf

The Feed in Tariff (FIT) was introduced for the renewable energy on 2009, and Renewable Purchase Obligation (RPO) was enacted in some states from 2010. The Tariff Policy amended on January 2016 has mandated the appliance of RPO in every state by 2022. Furthermore, Tariff Policy 2016 regulated the auctions be implemented in each state to procure renewable power sources so that that the cost of procurement from the renewable energy is controlled at lower level.

Currently as of March, 2018, the tendered tariff from solar PV and wind power generation has hit the record low as 2.47 INR/U (December 2017) from solar PV and 2.43 INR/U (December 2017).

2.6 (NATIONAL) TARIFF POLICY 2016

Based on Electricity Act 2003, the MOP publishes and keeps revising the Tariff Policy. The first Tariff Policy was published in January, 2006, and was amended in March, 2008, as well as in January and July, 2011. Most recently the Tariff Policy was amended in January, 2016. The amendment in January, 2016 made the following revisions under the focuses on renewable energy initiatives.

- 24×7 supply will be ensured to all consumers and state governments and regulators will devise a power supply trajectory for several years span to achieve this. (Upon this each state published “Power for All” report consecutively.)
- Renewable Power Obligation (RPO); In order to promote renewable energy and energy security, 8% of electricity consumption, excluding hydro power, shall be from solar energy by March 2022.
- Renewable Generation Obligation (RGO); New coal/lignite based thermal plants after specified date is mandatorily to establish/procure/purchase renewable capacity.
- For Hydro including pumped storage plants, the competitive bidding obligation by distribution licensees is exempted until 15th August 2022. In other words, Promotion of Hydro projects is enhanced (through certain conditions as the long term PPAs no less than 25 years with distribution companies, which exempt hydro from competitive bidding till 2022 and ERCs’ regulated tariff is allowed).
- Ancillary services to support grid operation for expansion of renewable energy.

2.7 TARIFF REGULATION 2014

CERC revises the Tariff Regulation from time to time when it considers necessary. The third amendment was released on 2013 in which a privileged provision on pumped storage plants was first inserted.

- The return on equity (ROE) for hydro power plants including pumped storage plants shall accept 16.5%, 1% higher than 15.5% applied for thermal power plants. Further, 0.5% additional ROE ratio shall be added for its completion within the approved development period for the plant and the completion within the permitted period for transmission lines. But 1% is deducted when plants are not operated in RGMO (restricted governor mode) nor FGMO (free GMO). The provision remained in the amendment made in 2014.

CERC published the notification “Terms and Conditions of Tariff Regulations, 2014” which stipulates the calculation method of electricity tariff from April 2014 to March 2019 on 21th February 2014. Energy charge of pumped storage plants is stipulated below according to this notification.

- The fixed charge is set as pro-rata rate of the annual fixed charge. In cases generated energy does not exceed 75% of pumping energy the fixed charge is deducted in proportion to the unaccomplished energy generated.
- The energy charge shall be payable for the total energy scheduled to be supplied to the beneficiary in excess of the design energy plus 75% of the energy utilized in pumping the water from the lower elevation reservoir to the higher elevation reservoir, at a flat rate equal to the average energy charge rate of 20 paise per kWh.
  The tariff of pumped storage plant is set very cheap at current regulation scheme.

CERC published the first amendment of “Terms and Conditions of Tariff Regulations, 2014” on 4th December 2015. There is no amendment for pumping storage plants charge.

2.8 RENEWABLE ENERGY SOURCES REGULATIONS 2012

CERC published the notification “Terms and Conditions for Tariff determination from Renewable Energy Sources Regulations, 2012” on 6th February 2012, which stipulates the calculation method of electricity tariff from renewable power generation with five year control or review period. Commercial operation period and tariff period are also stipulated. CERC published the first amendment of the notification on 18th March 2014, the second amendment of the notification on 5th January 2015 and the third amendment of the notification on 10th July 2015. The cost of biomass power generation was revised in these amendments. Municipal waste power generation was added in the fourth amendment on 7th October 2015. ROE of the renewable energy is prioritized as a) the 20% per annum for the first 10 years, and as b) the 24% per annum for 11th year onwards.

Operation and Maintenance (O&M) cost for solar PV generation of the final fiscal year of control period, FY2016, was reduced in the fifth amendment published on 30th March 2016.

2.9 MODEL REGULATIONS ON FORECASTING, SCHEDULING AND DEVIATION SETTLEMENT 2015

CERC developed “Model Regulations on Forecasting, Scheduling and Deviation Settlement of Wind and Solar Generating Stations at the State level, 2015” for Forum of Regulators in 2015 which indicates the regulation of deviation charge and spinning reserves. Consecutively on 12nd February 2016 CERC released draft notification “Draft Procedure for Implementation of the Framework on Forecasting, Scheduling and Imbalance Handling for Renewable Energy (RE) Generating Stations on

Wind and Solar Energy at Inter-State Level". It is the regulation which targets to mandate inter-state renewable energy generators to submit the generation forecast projections and imbalance regulation for variable renewable power generation was stipulated.

- The variable renewable power generators shall submit the forecasting their day ahead and week ahead power generation. Deviation commercial impact shall be borne by the variable renewable power generators.
- Deviation between scheduled day ahead power generation forecast and actual power generation is charged progressively. In case of under injection, progressive penalty shall be paid depending on deviation level. In case of injection, charge shall be reduced progressively depending on deviation level.
- The accounting shall be done by the SLDC. In case there is deficit in the overall pool at the end of the year, the SLDC may approach the National Funds such as PSDF or NCEF to cover such deficit.
- Deviation charge shall be payable/ receivable to/ from Regional Deviation Settlement Mechanism (DSM) Pool.

2.10 GRID CODE REGULATION 2010

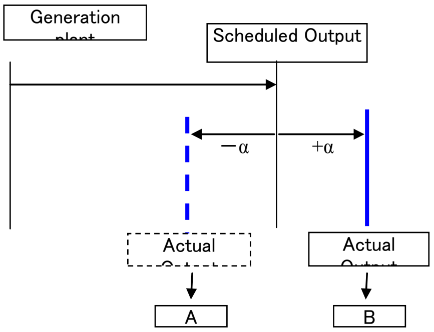
CERC published the notification "Indian Electricity Grid Code Regulations, 2010", which binds technical and commercial rules for utilities connected to inter-transmission system. Indian Electricity Grid Code (IEGC) stipulates grid frequency band to comply. SLDCs or distributors shall be bound to make load shedding in case that grid frequency decreases below stipulated number. IEGC has been amended four times by April 2016 and grid frequency band to comply has been tightened gradually.

The fourth amendment published on 6th April 2016 stipulates the technical minimum for operation in respect of a unit or units of a Central Generating Station of inter-State Generating Station shall be 55% of installed capacity of the unit of at generating station.

Grid Code mainly defines the frequency band to be compliance and its countermeasure method when it exceeds it. Meanwhile, there is a DSM described in the next section as a market mechanism to prevent deviation of frequency and absorb Deviation.

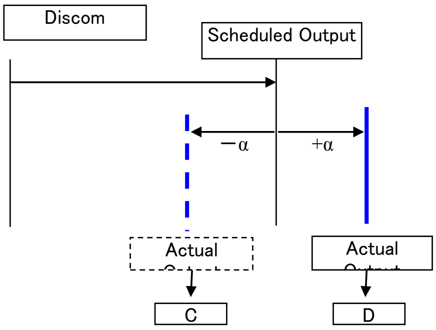
2.11 DEVIATION SETTLEMENT MECHANISM REGULATION 2015

CERC had been operating grid system and handling & controlling over drawl and over generation through incentives / penalties under Unscheduled Interchange (UI) mechanism (Unscheduled Interchange charges and related matters) Regulations, 2009, etc.).



Geneation Company

A	Actual supply < Scheduled supply (Undergeneration) 1） >50Hz→UI=0 （No penalty, Genaration compnany receivables are "all tariffs for scheduled output" No need to generate planned scheduled output. That triggers incentive for decreasing output. 2) <50Hz→UI cash （Penalty arises. Actual receivables are "all tariffs for scheduled output + UI* differential output (actual-shceduled)" Cash incentivises the increase of generation
B	Actual supply > Scheduled supply (Overgeneration) 1） >50Hz→UI=0 （No bonus, Genaration compnany receivables are "all tariffs for scheduled output" No need to generate excess planned scheduled output. That triggers incentive for decreasing output. 2) <50Hz→UI cash （bonus arises. Actual receivables are "all tariffs for scheduled output - UI* differential output (actual-shceduled)" Cash incentivises the increase of generation



Distribution company

C	Actual withdrawal < Scheduled drawal (Underdrawal) 1） >50Hz→UI=0 （No bonus, Distribution compnany payables are "all tariffs for scheduled input" No need to decrease planned scheduled input. That triggers incentive for increase input. 2) <50Hz→UI cash （bonus arises. Actual payables are "all tariffs for scheduled input - UI* differential input (actual-shceduled)" Cash incentivises the decrease of withdrawal
D	Actual withdrawal > Scheduled drawal (Overdrawal) 1） >50Hz→UI=0 （No penalty, Distribution compnany payables are "all tariffs for scheduled input" No need to decrease planned scheduled input. That triggers incentive for increase input. 2) <50Hz→UI cash （penalty arises. Actual payables are "all tariffs for scheduled input + UI* differential input (actual-shceduled)" Cash incentivises the decrease of withdrawal

(source: JPOWER, 2012)

Figure 2.11-1 UI Scheme mechanism

This UI regulation had been playing as the measures to control imbalance. But there were two major grid failures in India on consecutive days; one on 30th July 2012 and another on 31st July 2012 caused by over-drawals. There are overdrawing states and under drawing states in India. The grid failure has presented a case where these states were using the UI as a trading platform (as the speculative money gaming platform), which resulted in frequency variation in the specified range and at the same time making the grid unstable. In the wake of these grid disturbances, the government of India had constituted an enquiry committee under CEA. The enquiry committee in its report submitted to the government has identified the issues of inter-alia recommendations as under:

- Frequency band needs to be further tightened and brought closer to 50 Hz.
- Frequency control through UI may be phased out in a time bound manner and generation reserves/ancillary services may be used for frequency control.

With the report, DSM was created newly and CERC published the notification "Deviation Settlement Mechanism and related matters Regulations, 2014" on 7th January 2014, "Deviation settlement mechanism (DSM) regulations, 2015" on 7th August 2015, and "Deviation Settlement Mechanism, 2016" on 6th May 2016.

Main amendment from UI mechanism is showed below[52].

- Redefined frequency range and rates as 49.70-50.10 Hz.
- Volume limits and deviation limits for generator and buyer is added. Earlier in UI there wasn't any volume limits on the overall injection or drawl. Sellers would not receive any incentives when they sell beyond 12% of planned energy or 150MW whichever smaller. This DSM is recognized as the imbalance scheme to limit/control generation output, as the demand- supply control. It is considered as the penalized scheme to sellers/buyers when their actual performance is over outranged out of their declared injection or drawl. The penalty is calculated based on PPA price and varies depending on the frequency at the time. The basic concept of penalty is: 10% of PPA rate for 15-25% out scale, 20% of PPA rate for 25-35%, and 30% of PPA rate for >35%.

The details are shown below.

Table 2.11-1 Scheme of DSM

Additional Purchase by Buyer when >=49.70 Hz			
	when 12%<=150MW	when 12%>=150MW	additional charge
a	12%-15%	150MW to 200MW	+20%
b	15%-20%	200MW to 250MW	+40%
c	20% & above	250MW & above	+100%

Shortage of Supply by Buyer when >=49.70 Hz			
	when 12%<=150MW	when 12%>=150MW	additional charge
a	12%-15%	150MW to 200MW	+20%
b	15%-20%	200MW to 250MW	+40%
c	20% & above	250MW & above	+100%

Shortage of Supply by Buyer when >=49.70 Hz			
(generation by coal, gas, lignite based on Administered Price Mechanism)			
	when 12%<=150MW	when 12%>=150MW	additional charge
a	12%-15%	150MW to 200MW	+20% of 303.04 Paise/kWh or upon frequency
b	15%-20%	200MW to 250MW	+40% of 303.04 Paise/kWh or upon frequency
c	20% & above	250MW & above	+100% of 303.04 Paise/kWh or upon frequency

(source: Nomura Research Institute, 2019)

Main amendment in the second amendment of the notification (Appendix 2-136) published on 7th August 2015 is showed below.

- The wind or solar generators which are regional entities shall be paid deviation charge newly. This aimed to notify proactively for variable renewable power generator (assumed to be an inter-state generator mainly) which will enter the market in coming years.
- CERC admitted concerns that arbitration and false declaration cannot be eliminated completely under the current scheme but it is inevitable at present. CERC also applied PPA price instead of market price. They should be controlled by market mechanism in the future.
- LDC shall detect illegal players by monitoring scheduled generation plan. But issues addressed remain whether all participant comply with rules and whether LDC has an ability to implement

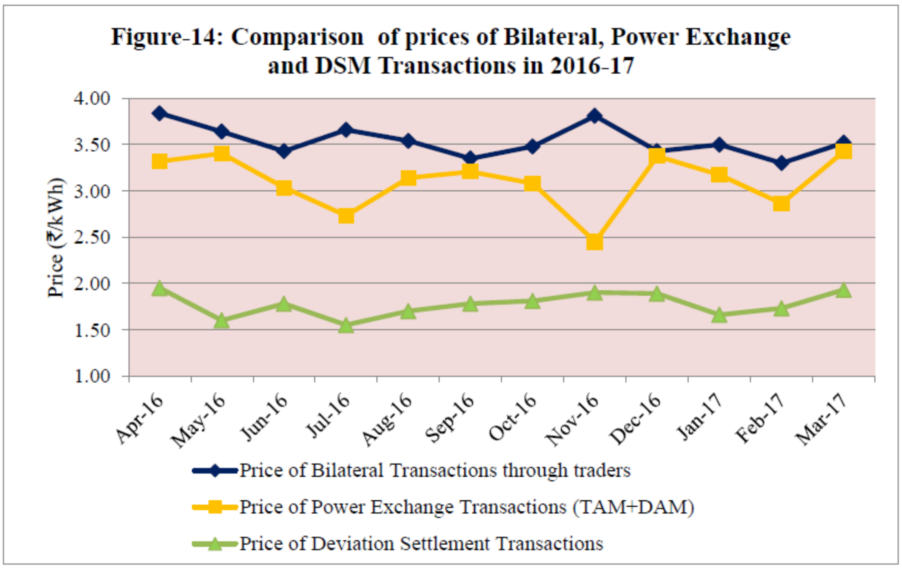
monitoring actual situations. Thus CERC stated that other regulations such as provision on spinning reserve or regulation on ancillary services must be prepared to stabilize grid.

Main amendment in the third amendment of the notification published on 6th May 2016 is showed below.

- A State whose minimum combined installed capacity of wind and solar power is 1,000 MW or more is defined as a Renewable Rich State. This aims to regulate large inter-state variable renewable power generation.
- Methodologies for the computation of Charges for Deviation and Additional Charges for Deviation applicable to Renewable Rich States for crossing the volume limits specified for the over-drawal/ under-injection is not a deviation from availability but MW as defined in the notification.

This regulation is an imbalance settlement regulation which enforces distributors/transmission operators to provide their purchase/transmission plan with higher accuracy, and by which incentives and penalties are given to them. This regulation has been in effect now and state generator WBPDCL has been participating.

However the incentive/penalty enforced remains low (<2 INR/U) at present (Figure 2.11-2).



(source: Report on Short-term Power Market in India: 2016-17, CERC)

Figure 2.11-2 DSM price

Generally speaking, there are only a few generators who have regulatory flexible power supply capability. Measures state distributors have are limited to load shedding and shutting down generation of renewable generations. Purulia pumped storage plant in West Bengal can be considered to contributes improving DSM account, but WBSEDCL states penalties may be reduced but no incentives gained. It implies the valuation of deviation control is not given sufficient value yet;

2.12 ANCILLARY SERVICES REGULATION 2015

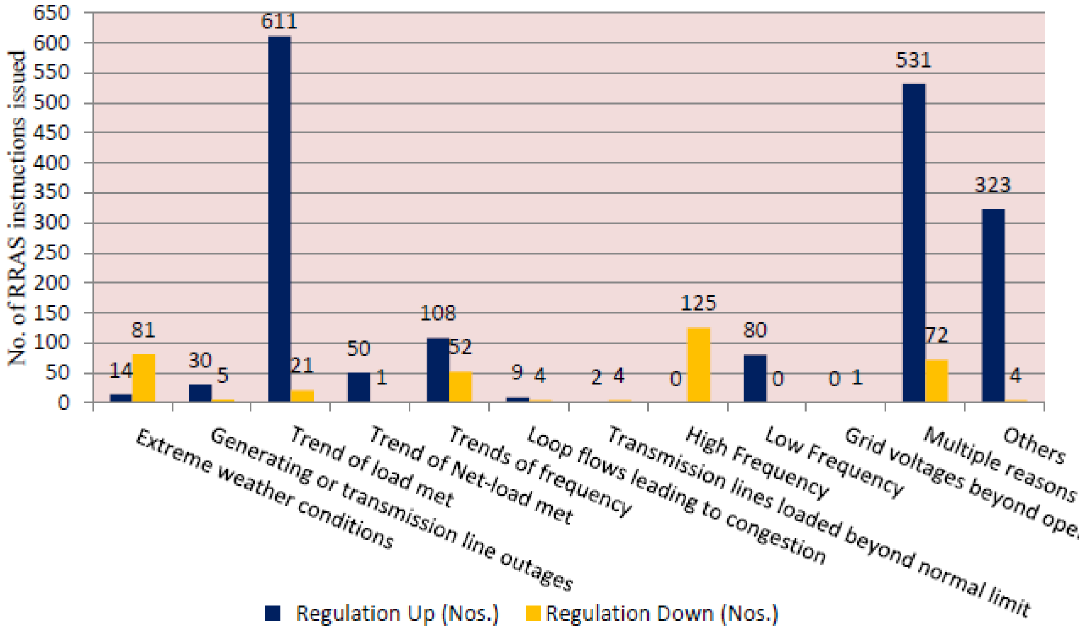
Grid Code in India mandates the maintenance of power system frequency within certain allowable range. However, there had been no mechanism to trade generator functions to control frequency either in PPA or in market. Under such circumstances in viewing the future growth of renewable energy in a large quantities, CERC published the staff paper “Introduction of Ancillary Services in Indian Electricity Market” in April 2013, the draft notification “Draft Ancillary Services Operations Regulations, 2015” on 1st May 2015, the notification “Ancillary Services Operations Regulations” on 13th August 2015, and “Framework on Ancillary Services Operations Regulations 2015: Statement of Reasons” on 17th September 2015. NLDC published “Detailed Procedure For Ancillary Services Operations” in exercise of powers conferred by the notification “Ancillary Services Operations Regulations, 2015”.

- The objective of Ancillary Services Regulations is to help in restoring the frequency level to the nominal level and to relieve the congestion in the inter-state transmission network.
- Inter-State Generating Stations (ISGSs) shall inject or back down the generation as per the instruction of RLDC as the Reserves Regulation Ancillary Services Provider (RRAS). RRAS shall on monthly basis submit details of fixed charge, variable charge and any other statutory charges to the Regional Power Committees (RPC) to account and obtain approvals.
- RLDC shall put in order the RRAS generators for merit order and dispatches those from cheaper ones in the phase of regulation up operation, controls those from expensive ones in the phase of regulation down operation.
- Each generation plants follows the dispatch/control order from RLDC either regulation up or down operation. In regulation up operation fixed charges and variable charges are applicable and provided to them, but in regulation down operation only variable charges are applicable for the RRAS Providers. Incentives or penalties are sourced from or pooled in the Deviation pool. Non obedience to the RLDC orders penalties are applicable to RRAS proiders.
- While renewable power generation is exempted from RRAS, renewable power generators have an obligation to submit generation forecasting by DSM regulation. Considering the situation of operation, it is to be determined whether RRAS is applicable to renewable power generation.
- Currently only tertiary frequency control is applicable. Primary and secondary controls are seemed to be premature. So this regulation intends to operate the generators in speed of 15 minutes or more response. Reserved coal thermal power generators must respond within 24hours and reserved gas thermal must respond within 3 hours.
- In the Draft Ancillary Services Operations Regulations, 2015 it was intended to include pumped storage generation as it included provision that “charges by Regulation down service is designed to provide incentives to pumped storage plants in pumping mode” But the pumping storage plants were excluded from RRAS in “Detailed Procedure For Ancillary Services Operations 2016 stating the pumped storage generation must function in full load to provide the maximum peaking power to the grid. In any case at current only central power utilities (CGU)

are the participants to this regulation. Let alone pumped storage plants. Only provision by CERC for charges of pumped storage generation is in the Terms and Conditions of Tariff Regulations, 2014.

The ancillary service regulation is the first regulation for its kind by CERC, but it only applies to tertiary control now, and there are few generators in India which have regulatory frequency control capability, this ancillary service has been utilized focusing on load frequency control (imbalance settlement) and not on frequency control itself.

The figure below shows the actual payment from the ancillary services for 2016/17. The amount of payment stocked for regulation up service was from load frequency control.



(source: Report on Short-term Power Market in India 2016-17, CERC)

Figure 2.12-1 Reasons for Ancillary services in 2016/17

No state generator is the member of RRAS as of March, 2018. No West Bengal providers is in the operation of RRAS. In the future CERC considers that RRAS shall be shifted to the market mechanism of ancillary service trade but it is not yet prepared. Ability of nodal agency (RLDCL) is the issue of concern whether it can control ancillary services in neutral fair position for every participant.

In any case the future when a large renewable generation is introduced inevitably mandates the grid operator to control frequency meeting the rapid changes of power injections (ramping up/down). Such regulation is required for power generators with sufficient capability of fast load control (frequency control) can be incentivized properly.

2.13 DRAFT NATIONAL ELECTRICITY PLAN 2016 (DNEP 2016)

Draft National Electricity Plan was prepared by CEA on the end of 2016 (7Th and 28th December, 2016) including the demand projection till 2022-36 with the (previous) 14th Plan (2022-2027), 15th Plan (2027-2032) and first three years of 16th (2032-2036) Plan. The brief content of the NEP is as follows but it is noticeable that;

1) **There will be no need for coal-based power generation capacity addition in the country from 2017 to 2022 from the projection made by CEA, except those projects currently on track.**
2) **Integration of renewable energy into the grid will be a focus area, and it promotes Hydroelectric Power generation including Pumped Storage Projects (PSP) to provide adequate peaking reserves, reliable grid operation and integration of variable renewable energy sources.**

The noticeable information in the 2016 NEP (in the “Highlight” of the document) is as follows.

- The projected Peak Demand is 235 GW and Energy requirement is 1,611 BU (after considering DSM measures) at the end of year 2021-22 which is around 17% and 15.4 % lower than the corresponding projections made by 18th Electric Power Survey (EPS) report.
- The projected Peak Demand is 317 GW and Energy requirement is 2,132 BU at the end of year 2026-27 which is around 20.7% and 21.3% lower than the corresponding projections made by 18th EPS report.
- Considering capacity addition from Gas - 4,340 MW, Hydro 15,330 MW, Nuclear -2800 MW and RES - 115,326 MW as committed capacity during 2017-22, the study reveals that no coal based capacity addition is required during the years 2017-22 as the total addition is 137,796MW without additional coal thermal generations. However, actually, a total capacity of 50,025 MW of coal based power projects is currently under different stages of construction and is likely to yield benefits during the period 2017-22. Thereby, the total capacity addition during 2017-22 is likely to be 187,821 MW.

  “That is, India may not see any new thermal power plants being installed after 2022 as MOP has set up 72 GW of conventional power capacity between 2017 and 2022 including 50,025 MW of coal-fired capacity.”
- For the period 2022-27, committed capacity addition is Nuclear - 4,800 MW, Hydro-12,000 MW and RES 100,000 MW. Considering the demand projections for the year 2026-27, study for the period 2022-27 reveals that a coal based capacity addition of 44,085 MW is required. However, as coal based capacity of 50,025 MW is already under construction which is likely to yield benefits during 2017-22, this coal based capacity would fulfil the capacity requirement for the years 2022-27. The Renewable Energy Generation will contribute about 20.3 % and 24.2 % of the total energy requirement in 2021-22 and 2026-27 respectively.

- There are several different Ancillary services or grid stabilizing services of hydropower, thus facilitating the integration of variable RES into the power system and providing a key tool to maintain a stable and balanced grid in terms of :
    - ✓ Quick-start capability
    - ✓ Black start capability
    - ✓ Regulation and frequency response
    - ✓ Voltage support
    - ✓ Spinning reserve

- It stresses Pumped Storage Plants as - BEST FRIEND OF ELECTRICITY GRID ;
  In view of infusion of high RES, Pump Storage Development has to be treated as a separate category. Separate Policy instrument is required to incentivize PSPs. While benefits of having pumped storage hydro power are known but current market structures and regulatory frameworks do not present an effective means of achieving this goal. There is need for regulatory mechanism/ market incentives and Regulatory Commissions may incentivize Tariff for PSPs and financial institutions should consider providing attractive terms for financing of PSPs.
- Hydro plants shall be considered for compensation for balancing the grid by implementing differential tariff for peak and off-peak power. Pump storage plants should be encouraged to operate in pump mode by providing incentive for its operation.
- Infrastructure cost from the Hydro project may be excluded for determining tariff. As the need for generation resources that can provide system flexibility increases with an increased proportional penetration of variable renewables, the value of hydropower and pumped storage will become more significant.

But still, pumped storage power generation has not been given prioritized benefits from regulations even though CEA published the document which promotes pumped storage generation such as in DNEP 2016. DNEP 2016 is still a draft as of March 2018.

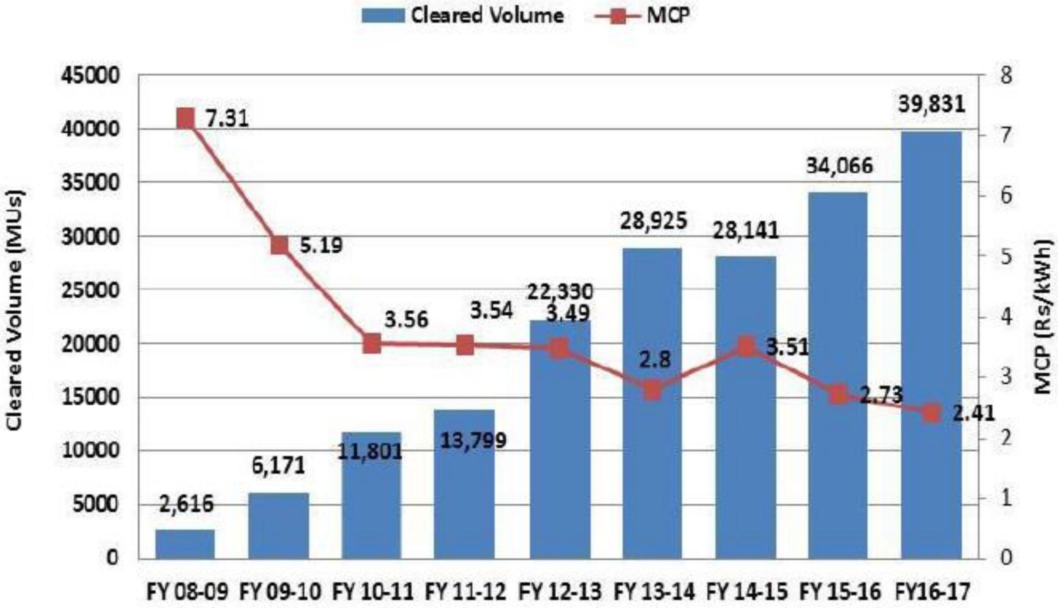
2.14 SHORT MARKET MECHANISM

Power exchange market was open in India on 2008. CERC published the notification "Power Market Regulations, 2010" on 20th January 2010, which stipulates electricity transaction procedure transacted through OTC and Power Exchange. CERC published the order "Extended Market Session on Power Exchanges" on 8th April 2015, ordered Power Exchanges to extend market session. Two Indian Power Exchanges extended market session from 20th July 2015, according to the CERC's order. The volume of market transaction in India still remains as low as 10% more or less, and the exchange price (Market Cleared Price) is kept very low on average showing that the market is governed by Buyer oriented transaction.

Table 2.14-1 Scheme of Short Market Contract

Contract Type		Duration	Trading Time	Delivery	Contract Period
Day Ahead Market (DAM)		24 Hrs of Next day	1000-1200 every day	Next day	15min time block
Term Ahead Market (TAM)	Intra Day Contract	24 Hrs of Same day	0030-2000 every day	0400-2400Hrs in Same day	Hourly
	Day Ahead Contingency	24 Hrs of Next day	1500-2300 every day	All Hrs of Next day	Hourly
	Daily Contract	All or block of Hrs in a day	1200-1500 every day	From +4 day to Next 7days	Fixed block Hrs
	Weekly Contract	All or block of Hrs in a week	1200-1600 every Wed. & Thurs.	Next week	Fixed block Hrs

(source: various sources, JICA Study Team)



(source: IEX Annual Report)

Figure 2.14-1 Market Cleared Prices (MCP) for DAM

In India, There is a possibility for more frequent market clearing in power exchanges such as real time markets, flexibility markets, capacity markets etc. for trading regulatory balancing power, where grid operators (RLDC or SLDC) procures such power through open tendering. The current Indian power market has not equipped such flexible functions for trading flexible balancing power. It is difficult to forecast when and how such market will be put in place. It is hard to quantify monetary values for balancing power.

CHAPTER 3

SITUATION OF POWER SUPPLY AND DEMAND

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CHAPTER 3 SITUATION OF POWER SUPPLY AND DEMAND

3.1 WHOLE INDIA

3.1.1 Supply and Demand

According to Annual Report FY 2014 issued by CEA, total amount of generation in India reached 1,048,673 GWh including IPP plants, of which thermal power plants generated 878,320 GWh (83.8%) followed by 129,244 GWh (12.3%) from hydro, 36,101 GWh (3.4%) from nuclear, and 5,008 GWh (0.5%) from Bhutan. Annual growth rate was 8.43%. However, according to Draft National Electricity Plan (NEP) and 19th Electric Power Survey of India (19th EPS) issued by CEA, total amount of generation in India in FY 2014 was 1,068,943 GWh. Moreover, according to Handbook of State Statistics issued by National Institution for Transforming India (NITI Aayog) and World Energy Statistics and Balances 2017 issued by International Energy Agency (IEA), total amount of generation in India in FY 2014 were 1,285,689 GWh and 1,287,398 GWh respectively. As seen from the above, it is noted that the figure is different by sources. Therefore, source for data and information is carefully shown in this chapter.

According to 19th EPS, total amount of generation in India increased from 122,287 MW in FY 2010 to 153,366 MW in FY 2015 at 5.3% of annual growth rate as shown in Table 3.1.1-1. On the other hand, peak demand increased from 861,591 GWh in FY 2010 to 1,114,408 GWh in FY 2015 at 4.6% of annual growth rate. Actual amount of generation from FY 2010 to FY 2015 was about 10% lower than projection of 18th Electric Power Survey of India. So, projection in 19th Electric Power Survey of India was revised downward.

Table 3.1.1-1 Trend of Power Generation and Peak Demand in India

	Power Generation		Peak Demand	
	GWh	G.R	MW	G.R
2010-11	861,591		122,287	
2011-12	937,199	8.8%	130,006	6.3%
2012-13	995,557	6.2%	135,453	4.2%
2013-14	1,002,257	0.7%	135,918	0.3%
2014-15	1,068,943	6.7%	148,166	9.0%
2015-16	1,114,408	4.3%	153,366	3.5%

(source: 19th Electric Power Survey of India, CEA, January 2017 (p9-10))

3.1.2 Power Development Plan

(1) Current Situation

As of January 2018, generation capacity in India reached 334 GW as shown in Table 3.1.2-1. Coal is major source for power generation, followed by renewable energy, hydro, gas, and nuclear.

Table 3.1.2-1 Installed Capacity of Power Plant in India as of January 2018

	MW	Share
Hydro	44,963	13.4%
Nuclear	6,780	2.0%
Gas	25,150	7.5%
Diesel	838	0.3%
Coal	193,822	58.0%
RES	62,847	18.8%
Total	334,400	100.0%

(source: CES portal site (http://www.cea.nic.in/reports/monthly/ installed capacity/2018/installed_capacity-01.pdf))

1) Hydro

Total hydro power potential in India was assessed as 84,044 MW. The total energy potential is assessed as 600 TWh per year. Hydropower is used to its maximum potential to meet peak loads. As of January 2018, the installed capacity of hydro power plants is 44,963 MW. This is about 53.5% of the total hydro potential in India.

2) Nuclear

Presently, Nuclear Power Corporation India Limited is operating 22 nuclear power plants with an installed capacity of 6,780 MW and generated 37,674 GWh in 2016-17. Out of these 22 plants, 2 plants are boiling water reactor type (BWR), 2 plants are pressurized water reactor type (PWR), and remainder 18 plants are pressurized heavy-water reactor type (PHWR) as shown in Table 3.1.2-2.

Table 3.1.2-2 Lists of Nuclear Power Plant in India

No	Plant	Unit	Type	Capacity (MW)	Date of Commercial Operation
1	Tarapur Atomic Power Station, Maharashtra	1	BWR	160	28-Oct-69
2	Tarapur Atomic Power Station, Maharashtra	2	BWR	160	28-Oct-69
3	Tarapur Atomic Power Station, Maharashtra	3	PHWR	540	18-Aug-06
4	Tarapur Atomic Power Station, Maharashtra	4	PHWR	540	12-Sep-05
5	Rajasthan Atomic Power Station, Rajasthan	1	PHWR	100	16-Dec-73
6	Rajasthan Atomic Power Station, Rajasthan	2	PHWR	200	1-Apr-81
7	Rajasthan Atomic Power Station, Rajasthan	3	PHWR	220	1-Jun-00
8	Rajasthan Atomic Power Station, Rajasthan	4	PHWR	220	23-Dec-00
9	Rajasthan Atomic Power Station, Rajasthan	5	PHWR	220	4-Feb-10
10	Rajasthan Atomic Power Station, Rajasthan	6	PHWR	220	31-Mar-10

No	Plant	Unit	Type	Capacity (MW)	Date of Commercial Operation
11	Madras Atomic Power Station, Tamilnadu	1	PHWR	220	27-Jan-84
12	Madras Atomic Power Station, Tamilnadu	2	PHWR	220	21-Mar-86
13	Kaiga Generating Station, Karnataka	1	PHWR	220	16-Nov-00
14	Kaiga Generating Station, Karnataka	2	PHWR	220	16-Mar-00
15	Kaiga Generating Station, Karnataka	3	PHWR	220	6-May-07
16	Kaiga Generating Station, Karnataka	4	PHWR	220	20-Jan-11
17	Kudankulam Nuclear Power Station, Tamilnadu	1	PWR	1,000	31-Dec-14
18	Kudankulam Nuclear Power Station, Tamilnadu	2	PWR	1,000	31-Mar-17
19	Narora Atomic Power Station, Uttarpradesh	1	PHWR	220	1-Jan-91
20	Narora Atomic Power Station, Uttarpradesh	2	PHWR	220	1-Jul-92
21	Kakrapar Atomic Power Station, Gujarat	1	PHWR	220	6-May-93
22	Kakrapar Atomic Power Station, Gujarat	2	PHWR	220	1-Sep-95
		53		6,780	

(source: NPCIL http://www.npcil.nic.in/content/302_1_AllPlants.aspx)

3) Gas

As of January 2018, the installed capacity of gas-fired power plants is 25,150 MW. Also a capacity of 4,340 MW is ready for commissioning or under construction but due to acute shortage of natural gas, is not in a position to commission. Production and supply of gas had not been keeping pace with the growing demand of natural gas in India, including power sector. The gas supply for gas-fired power plants is inadequate and India is facing huge generation loss. Presently, existing gas-fired power plants are operating at very low plant load factor (PLF) of about 23% and few gas-fired power plants are lying idle due to non-availability of natural gas.

4) Coal

Coal-fired power generation is backbone of Indian Power sector and will continue to dominate power generation. Due to environmental concerns, clean coal technologies such as supercritical technology have been adopted. Capacity totalling to about 33,500 MW based on supercritical technology has already been commissioned during 12th plan. The installed capacity of coal-fired power plants is 185,172.88 MW as of January 2018 which is almost 58% of the total installed capacity in India.

5) Generation from Renewable Energy Sources

The installed capacity from renewable energy sources is 62,847 MW as of January 2018. Share of renewable energy sources (RES) in the total installed capacity is about 19%. However, the share of renewables will substantially increase in coming years due to major thrust given by

Government of India in promoting renewable energy sources on account of these sources being clean and green. India is one of the best recipients of solar energy due to its location in the solar belt and has vast solar potential of 749 GW for power generation. Also, India has substantial wind potential of 103 GW due to its long coastline. Based on the availability of biomass, the potential of power generation from biomass has been assessed as around 25 GW[1]. Small hydro of capacity up to 25 MW has a power generation potential for 20 GW. However, generation from renewable energy sources especially solar and wind is variable in nature and therefore, requires huge balancing capacity in the system.

(2) Future Plan

According to Draft National Electricity Plan, scheduled additional capacity during FY 2016 reaches 33,480 MW. This includes 13,441 MW from thermal, hydro with 1,714 MW, nuclear with 1,500 MW, and renewable with 16,825 MW as shown in Table 3.1.2-3. As of January 2018, total capacity of power plants reached 334 GW. It is thought that additional power plants are developing on the schedule. Total additional capacity of conventional power plants from 2017 to 2022 reaches 72,495 MW, of which coal with 50,025 MW, gas with 4,340 MW, hydro with 15,330 MW, and nuclear with 2,800 MW. Projected install capacity for renewable energy as of March 2022 is classified into three category scenarios, namely 175,000 MW, 150,000 MW, 125,000 MW as shown Table 3.1.2-4.

Table 3.1.2-3 Additional Capacity during 2016-17

(MW)

	Installed Capacity as of March 2016	Likely addition during 2016-17	Likely Installed Capacity as of March 2017
Coal	185,173	13,315	198,488
Gas	25,502	126	25,628
Total Thermal	210,675	13,441	224,116
Hydro	42,784	1,714	44,498
Nuclear	5,780	1,500	7,280
Total Conventional	259,239	16,655	275,894
Solar	6,763	12,000	18,763
Wind	26,866	4,100	30,966
Others	9,220	725	9,945
Total Renewables	42,849	16,825	59,674
Total	302,088	33,480	335,568

(source: Draft National Electricity Plan (p5.17))

Only installed capacities of Solar and Wind are different among three scenarios. In the projected installed capacity by the end of 2021-22 in Table 3.1.2-4, hydro imports of 5,100 MW from Bhutan

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[1] Draft National Electricity Plan (page 5.3)

has been considered. The additional capacity of conventional power plants except renewable energy sources from 2017 to 2022 is 72,495 MW and total installed capacity of conventional power plants as of March 2022 reaches 348,389 MW as shown in Table 3.1.2-4.

Table 3.1.2-4 Projected Installed Capacity by the end of 2021-22

(MW)

Conventional Power Plants	Conventional Category	Conventional Installed Capacity as of March 2022	Likely Conventional Installed Capacity as of March 2017	Expected Conventional Capacity addition from 2017-22
	Coal	248,513	198,488	50,025
	Gas	29,968	25,628	4,340
	Total Thermal	278,481	224,116	54,365
	Hydro	59,828	44,498	15,330
	Nuclear	10,080	7,280	2,800
	Total Conventional	348,389	275,894	72,495
RES Scenario	RES Category	Target RES Installed Capacity as of March 2022	Likely RES Installed Capacity as of March 2017	Expected RES Capacity addition from 2017-22
Scenario 1	Solar	100,000	18,763	81,237
	Wind	60,000	30,967	29,033
	Biomass	10,000	5,446	4,554
	Small Hydro	5,000	4,498	502
	Total	175,000	59,674	115,326
Scenario 2	Solar	80,000	18,763	61,237
	Wind	55,000	30,967	24,033
	Biomass	10,000	5,446	4,554
	Small Hydro	5,000	4,498	502
	Total	150,000	59,674	90,326
Scenario 3	Solar	60,000	18,763	41,237
	Wind	50,000	30,967	19,033
	Biomass	10,000	5,446	4,554
	Small Hydro	5,000	4,498	502
	Total	125,000	59,674	65,326
Grand Total	Scenario 1	523,389	335,568	187,821
	Scenario 2	498,389	335,568	162,821
	Scenario 3	473,389	335,568	137,821

(source: Draft National Electricity Plan (p5.18-23))

Details Plan by each source are as follows.

1) Hydro

Considering the status of various hydro projects, about 15,330 MW of additional hydro power capacity is commissioned likely during the years 2017-22. This comprises of 11,788 MW of capacity which is under construction and 3,542 MW of capacity accorded concurrence by CEA, but to be taken up for construction. Details of hydro projects are shown in Table 3.1.2-5.

Table 3.1.2-5 List of Hydro Projects during 2017-2022

No	Project Name	State	Agency	No. of Units × MW	Likely Benefits during 2017-22 (MW)	Status
1	Kameng	Arunachal Pradesh	NEEPCO	4×150	300	Under construction
2	Subansiri Lower	Arunachal Pradesh	NHPC	8×250	2,000	Under construction
3	Parbati St. II	Himachal Pradesh	NHPC	4×200	800	Under construction
4	Kishanganga	Jammu & Kashmir	NHPC	3×110	330	Under construction
5	Tuirial	Mizoram	NEEPCO	2×30	60	Under construction
6	Tapovan Vishnugad	Uttarakhand	NTPC	4×130	520	Under construction
7	Tehri PSS	Uttarakhand	THDC	4×250	1,000	Under construction
8	Vishnugad Pipalkoti	Uttarakhand	THDC	4×111	444	Under construction
9	Lata Tapovan	Uttarakhand	NTPC	3×57	171	Under construction
10	Rammam - III	West Bengal	NTPC	3×40	120	Under construction
	Central Sector Total				5,745	
1	Indira Sagar (Pollavaram MPP)	Arunachal Pradesh	APID	12×80	960	Under construction
2	Kashang-II & III	Himachal Pradesh	HPPCL	1×65+1×65	130	Under construction
3	Shongtong Karcham	Himachal Pradesh	HPPCL	3×150	450	Under construction
4	Swara Kuddu	Himachal Pradesh	HPPCL	3×37	111	Under construction
5	Uhl-III	Himachal Pradesh	BVPC	3×33.3	100	Under construction
6	Pallivasal	Kerala	KSEB	2×30	60	Under construction
7	Thottiyar	Kerala	KSEB	1×30+1×10	40	Under construction
8	Koyna Left Bank PSS	Maharashtra	WRD, GO Mah.	2×40	80	Under construction
9	Shahpurkandi	Punjab	Irr. Deptt. & PSPCL	3×33+3×33+ 1×8	206	Under construction
10	Pulichintala	Telengana	TSGENCO	4×30	60	Under construction
11	Vyasi	Uttarakhand	UJVNL	2×60	120	Under construction
	State Sector Total				2,317	
1	Gongri	Arunachal Pradesh	DEPL	2×72	144	Under construction
2	Bajoli Holi	Himachal Pradesh	GMR	3×60	180	Under construction
3	Sorang	Himachal Pradesh	HSPL	2×50	100	Under construction
4	Tangnu Romai- I	Himachal Pradesh	TRPG	2×22	44	Under construction
5	Tidong-I	Himachal Pradesh	M/s NSL Tidong	2×50	100	Under construction
6	Ratle	Jammu & Kashmir	RHEPPL	4×205+1×30	850	Under construction
7	Maheshwar	Madhya Pradesh	SMHPCL	10×40	400	Under construction
8	Bhasmey	Sikkim	Gati Infrastructure	3×17	51	Under construction
9	Panan	Sikkim	HHEPL	4×75	300	Under construction
10	Rangit-II	Sikkim	SHPL	2×33	66	Under construction
11	Rangit-IV	Sikkim	Jal Power	3×40	120	Under construction
12	Rongnichu	Sikkim	MBPCL	2×48	96	Under construction
13	Teesta- VI	Sikkim	LANCO	4×125	500	Under construction
14	Teesta-III	Sikkim	Teesta Urja Ltd	6×200	600	Under construction

No	Project Name	State	Agency	No. of Units × MW	Likely Benefits during 2017-22 (MW)	Status
15	Phata Byung	Uttarakhand	LANCO	2×38	76	Under construction
16	Singoli Bhatwari	Uttarakhand	L&T	3×33	99	Under construction
	Private Sector Total				3,726	Under construction
I	Sub Total Under Construction				11,788	
1	Devsari	Uttarakhand	SJVNL	3×84	252	Concurred
2	Kotlibhel-St-1A	Uttarakhand	NHPC	3×65	195	Concurred
	Central Sector Total				447	
1	New Ganderbal	Jammu & Kashmir	JKPDC	3×31	93	Concurred
	State Sector Total				93	
1	Demwe Lower	Arunachal Pradesh	Athena Demwe	5×342+1×40	725	Concurred
2	Dibbin	Arunachal Pradesh	KSK	2×60	120	Concurred
3	Heo	Arunachal Pradesh	HHPPL	3×80	240	Concurred
4	Nafra	Arunachal Pradesh	SEW	2×60	120	Concurred
5	Nyamjangchhu	Arunachal Pradesh	Bhilwara Energy Ltd	6×130	780	Concurred
6	Talong Londa	Arunachal Pradesh	GMR	3×75	225	Concurred
7	Tato-I	Arunachal Pradesh	SHHPL	3×62	186	Concurred
8	Chango Yangthang	Himachal Pradesh	MPCL	3×60	180	Concurred
9	Kutehr	Himachal Pradesh	JSW	3×80	240	Concurred
10	Dikhu	Nagaland	Manu Energy	3×62	186	Concurred
	Private Sector Total				3,002	
II	Sub Total Concurred				3,542	
	Total (I+II)				15,330	

(source: Draft National Electricity Plan (p5.39-41))

2) Nuclear

Additional nuclear capacities for the period 2017-22 and 2022-2027 as per the information released by Department of Atomic Energy (DOAE) are 2,800 MW and 4,800 MW respectively as shown in Table 3.1.2-6 and Table 3.1.2-7.

Table 3.1.2-6 List of Nuclear Projects under Construction during 2017-2022

No	Project Name	State	Agency	No. of Units x MW	Likely Benefits during 2017-22 (MW)
1	Kakrapar Atomic Power Plant	Gujarat	NPCIL	2×700	1,400
2	Rajasthan Atomic Power Station	Rajasthan	NPCIL	2×700	1,400
	Total (2017-22)				2,800

(source: Draft National Electricity Plan (p5.42))

Table 3.1.2-7 List of Nuclear Projects under Construction during 2022-2027

No	Project Name	State	Agency	No. of Units x MW	Likely Benefits during 2022-27 (MW)
1	Kudankulam Nuclear Power Project (Expansion)	Tamil Nadu	NPCIL	2×1000	2,000
2	Gorakpur Haryana Anu Vidyut Pariyojana	Haryana	NPCIL	2×700	1,400
3	New PHWR	Madhya Pradesh*	NPCIL	2×700	1,400
	Total (2022-27)				4,800

(*note: Procurement of Land in advance stage)
(source: Draft National Electricity Plan (p5.43))

3) Gas

In view of acute shortage of natural gas in the country, many gas-fired power plants are running at very low Plant Load Factor. A capacity of around 4,340 MW is ready for commissioning/under construction but stranded due to non-availability of natural gas. These plants have been considered to be available during the year 2017-22. As the availability of gas is uncertain, no additional gas-fired projects have been considered during the year 2017-22. Details of gas-fired power plants are shown in Table 3.1.2-8.

Table 3.1.2-8 List of Gas Power Projects under Construction/Ready for Commissioning

No	Project Name	State	Sector	Agency	Capacity (MW)
1	Panduranga CCPP	Andhra Pradesh	Private	Panduranga Power Ltd	116
2	RVK Gas Engine	Andhra Pradesh	Private	RVK (Rajahmundry) Pvt.Ltd	76
3	RVKCCPP	Andhra Pradesh	Private	RVK (Rajahmundry) Pvt.Ltd	360
4	Samalkot CCPP-II	Andhra Pradesh	Private	Reliance Power	2,400
5	Mangaon CCPP	Maharashtra	Private	PGPL	388
6	Astha Gas Engines	Telangana	Private	Astha	35
7	Ind Barath Gas Project	Tamil Nadu	Private	Barath	65
8	Kashipur CCPP	Utrakhand	Private	Sravanthi Energy Pvt. Ltd	225
9	Beta CCPP	Utrakhand	Private	BIPL	225
10	Gama CCPP	Utrakhand	Private	GIPL	225
11	Kashipur CCPP-II	Utrakhand	Private	Sravanthi Energy Pvt. Ltd	225
	Total				4,340

(source: Draft National Electricity Plan (p2.37))

4) Coal

The balance capacity (after considering the committed capacity addition from hydro, nuclear, gas and RES) to meet the projected demand is proposed to be met from coal-fired power plants.

3.1.3 Electricity Demand Forecast

(1) Methodology

According to 19th EPS (page24), electricity demand in the future is forecasted by Partial End-Use

Method (PEUM). PEUM is a combination method of time series (regression) method and end-use method. Time series method has been used to derive growth indicators giving higher weight to the recent trends so as to consider the benefits of energy conservation and technological changes. End-use method considers the electricity consumption of appliances and equipments at the consumer premises and the projection is based on the increase in the number of appliances/equipments and their electricity consumption. The details of methodology are mentioned on page 25-29 in 19th EPS.

(2) Assumptions

According to 19th EPS (page30-31), major assumptions for demand forecast are as follows.

1) The projections of 19th EPS have been made considering FY 2015 as the base year.
2) The projection of electricity demand has been made for the demand incident on the utility system only. The projections do not include the portion of electricity demand od industries and other consumers that would be met from captive power plants.
3) Projection of 19th EPS takes into account the reduction in electricity demand on account of aggressive Demand Side Management (DMS), improvement of energy efficiency, and energy conservation measures. As per estimates made by Bureau of Energy Efficiency (BEE), the schemes for these measures would lead to savings of 95,000 GWh in FY 2016, 206,000 GWh in FY 2021, and 273,000 GWh in FY 2026.
4) The aggregate Technical & Commercial losses for Distribution Companies (Discoms) have been taken as per the trajectory of loss reduction given by the respective Discoms.
5) India has set its renewable energy capacity addition target to 175 GW by the year 2022 in view of the significant renewable energy potential. This includes 100 GW from solar, 60 GW from wind, 10 GW from biomass, and 5 GW from small hydro power. The 100 GW of solar includes 40 GW from solar roof-top. The roof-top solar installations would result in reduced demand on the utility grid.
6) Power for All (PFA) initiative of Government of India/State Governments, Make in India initiative, dedicated freight corridor, electric vehicles and other developmental activities envisaged by Central/State Governments have been factored in the electricity demand projection of States utilities.

(3) Results of PEUM

Table 3.1.3-1 shows the results of electricity demand forecast in India by using PEUM. Electricity demand is increasing from 920,837 GWh in FY 2016 to 1,743,036 GWh in FY 2026 at 6.6% of average annual growth rate. On the other hand, required electricity generation is also increasing from 1,160,429 GWh in FY 2016 to 2,047,434 GWh in FY 2026 at 5.8% of average annual growth rate. It is expected that transmission and distribution losses will be improved during the periods.

Peak electricity demand is also increasing from 161,834 MW in FY 2016 to 298,774 MW in FY 2026 at 6.3% of average annual growth rate. Load factor is gradually decreasing year by year. In case of Japan, load factor reached 69% in 1970. After that, load factor in Japan gradually decreased and recorded 55% in 1990. At present, load factor is keeping the range between 55-65%. High load factor means that the difference between maximum demand and minimum demand is small. When daily load fluctuation and/or seasonal load fluctuation are small, load factor gets higher.

Table 3.1.3-1 Results of Electricity Demand Forecast in India

	Electrical Energy Consumption (GWh)	Electrical Energy Requirement (GWh)	Peak Electricity Demand (MW)	T&D Losses	Load Factor
2016-17	920,837	1,160,429	161,834	20.65%	81.85%
2017-18	994,382	1,240,760	176,897	19.86%	80.07%
2018-19	1,066,989	1,317,962	188,360	19.04%	79.87%
2019-20	1,144,579	1,399,913	200,696	18.24%	79.63%
2020-21	1,222,286	1,483,257	213,244	17.59%	79.40%
2021-22	1,300,486	1,566,023	225,751	16.96%	79.19%
2022-23	1,380,197	1,650,594	238,899	16.38%	78.87%
2023-24	1,463,505	1,739,618	252,288	15.87%	78.71%
2024-25	1,551,066	1,836,001	266,844	15.52%	78.54%
2025-26	1,644,635	1,939,111	282,418	15.19%	78.38%
2026-27	1,743,036	2,047,434	298,774	14.87%	78.23%
2031-32	2,192,305	2,530,531	370,462	13.37%	77.98%
2036-37	2,672,302	3,049,478	447,702	12.37%	77.76%

(source: 19th EPS, CEA, January 2017 (p36, p301))

The above forecasts are estimated by PEMU. However, definition equations are not mentioned on the report of 19th EPS. Electricity demand in India shows close correlation with Gross Domestic Product (GDP). The coefficient of determination (R squared) between electricity demand and GDP during 1990 and 2014 showed very high at 0.997. Figure 3.1.3-1 shows actual electricity demand in the past (pink line) and electricity demand estimated by forecasting model equation (blue line). Both lines almost overlap each other and electricity demand can be explained by GDP. Model equation obtained by regression analysis is as follow.

$f = 0.40921\, x + 39.466$

f : electricity demand, x : GDP

During 1990 and 2014, elasticity of electricity demand to GDP[2] is 0.9. Therefore, to achieve electricity demand in FY 2026 in Table 3.1.3-2, 7.3% of average annual growth rate of GDP is required.

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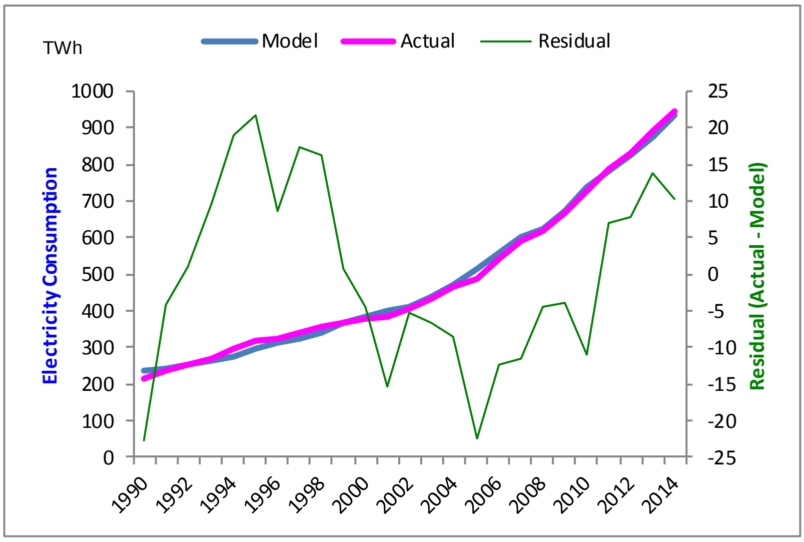
[2] Growth rate of electricity demand divided by growth rate of GDP



(source: JICA Study Team)

Figure 3.1.3-1 Comparison between Actual Demand and Demand from Model Equation

Table 3.1.3-2 Trend of Electricity Demand and GDP in India

	1990	1995	2000	2005	2010	2014
GDP billion $ 2010 price	485	621	834	1,154	1,702	2,193
Electricity Demand TWh	236	315	376	489	725	947

(source: Handbook of Japan's & World Energy & Economic Statistics, 2017, EDMC (p312)
World Energy Statistics and Balances 2017, IEA)

3.2 WEST BENGAL

3.2.1 Supply and Demand

(1) Electricity Demand

There are 5 distribution utilities operating in the State, with 2 being private licensees, 2 owned by State Government and one owned by Central Govt., as detailed below:

1) WBSEDCL - West Bengal State Electricity Distribution Company Limited is a State Govt. owned utility responsible for electricity distribution in the State with consumer base of about 1.53 Crore.

2) DVC - Damodar Valley Corporation is a Central Govt. owned utility, supplying power at 33kV level and above in the DVC command area spanning across the State of West Bengal and Jharkhand. Nearly 40% of sales of DVC are in the state of West Bengal.

3) DPL - Durgapur Projects Ltd. is a State Govt. owned integrated power utility responsible for supplying electricity in the limited geographical area of Durgapur, operating in area of 125 Sq. Km.

4) CESC - CESC Limited is a fully integrated private utility, owning and operating distribution

system with total area of 567Sq. Km in Kolkata and Howrah, serving over 29 lac consumers.

5) IPCL (Formerly DPSC) - India Power Co. Ltd. is a privately owned utility which owns and operates distribution system in region spread over 618 Sq. Km in coal rich Asansol and Raniganj area.

Out of the total energy sales of 41,065 GWh in FY2015 in West Bengal, WBSEDCL accounted for nearly 55% of total, followed by CESC at 22%, DVC at 17%, DPL at 4%, and DPSC at 2%.

Table 3.2.1-1 Electricity Sales in West Bengal by Utilities in FY2015

(GWh)

WBSEDCL	CESC	DVC	DPL	IPCL	Total
22,509	9,006	6,848	1,824	878	41,065
55%	22%	17%	4%	2%	100%

(source: Power for all-West Bengal (p8))

Actual power load data for 2016 is shown in Figure 3.2.1-1. The load duration curve shows certain peaking load which necessitates the introduction of peaking power generation at the current condition from the viewpoint of power generation mix. At present, as far as it is from the state's own generations, West Bengal has been managing peaking supply of power from coal thermal power generations except Purulia PSP (900MW).

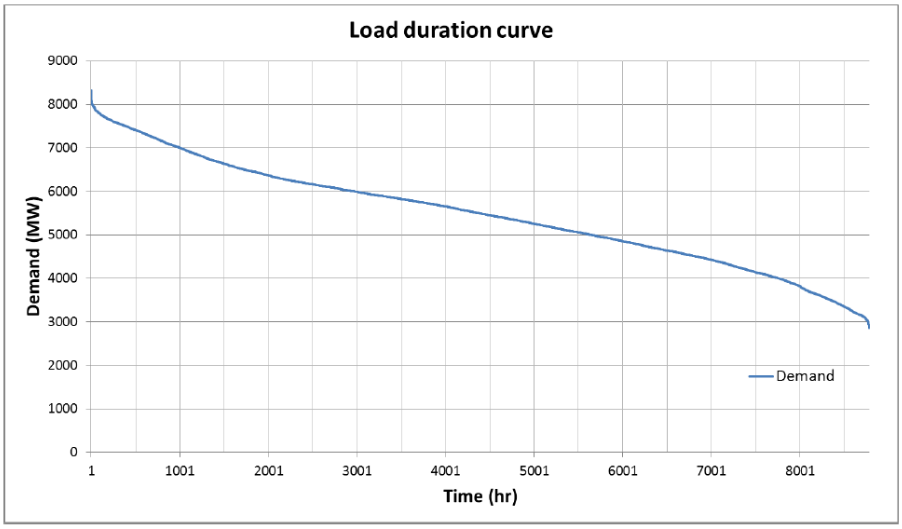


Figure 3.2.1-1 Load Duration Curve in West Bengal in 2016

(2) Power Supply

According to Handbook of State Statistics (page 510) issued by NITI Aayog, total electricity generation in West Bengal increased from 61,293 GWh in FY 2011 to 67,861 GWh in FY 2015 at 2.6% of average annual growth rate. On the other hand, according to Power for All West Bengal (p8), peak demand in West Bengal increased from 6,529 MW in FY 2012 to 7,544 MW in FY 2015 at 4.9% of average annual growth rate as shown in Table 3.2.1-2. Total electricity generation includes generation from captive power plants aside from utility companies.

Table 3.2.1-2 Trend of Electricity Generation and Peak Demand in West Bengal

	Electricity Generation		Peak Demand	
	GWh	G.R	MW	G.R
2011-12	61,293			
2012-13	67,067	9.4%	6,529	
2013-14	68,528	2.2%	7,322	12.1%
2014-15	71,418	4.2%	7,325	0.0%
2015-16	67,861	-5.0%	7,544	3.0%

(source: Generation: Handbook of State Statistics (p510), Peak: Power for All West Bengal (p8))

3.2.2 Electricity Demand Forecast

Table 3.2.2-1 shows the results of electricity demand forecast until FY2026 in West Bengal by using PEUM. Electricity demand is increasing from 44,710 GWh in FY 2016 to 72,848 GWh in FY 2026 at 5.0% of average annual growth rate. On the other hand, required electricity generation is also increasing from 57,342 GWh in FY 2016 to 85,890 GWh in FY 2026 at 4.1% of average annual growth rate. It is expected that transmission and distribution losses will be improved during the periods. The loss in FY 2016 in West Bengal is higher than that of average in India. However, the loss in FY 2026 is assumed to become an average level in India. Peak electricity demand is also increasing from 10,383 MW in FY 2016 to 15,680 MW in FY 2026 at 4.2% of average annual growth rate. It is assumed that load factor remains the same level during the period. Load factor in West Bengal is lower than that of average in India. It is considered that daily load and/or seasonal load have large fluctuation as well as Japan.

Table 3.2.2-2 shows electricity demand forecast by Power for All - West Bengal. The demand projection has been done separately for electrified and un-electrified rural and urban households. Whereas, for rest of the consumer categories a growth rate based on WBSEDCL’s estimation of the expected growth along with a review/ validation with the past trend has been considered. Regarding with electrified households, electricity consumption per households in urban and rural is assumed. Electricity consumption is calculated by number of households. Regarding with un-electrified households, electricity demand is estimated based on expected number of households from un-electrified to electrified.

Table 3.2.2-1 Results of Electricity Demand Forecast in West Bengal by 19th EPS

	Electrical Energy Consumption (GWh)	Electrical Energy Requirement (GWh)	Peak Electricity Demand (MW)	T&D Losses	Load Factor
2016-17	44,710	57,342	10,383	22.03%	62.61%
2017-18	46,572	59,148	10,817	21.26%	62.00%
2018-19	48,866	61,485	11,267	20.52%	61.87%
2019-20	51,334	63,979	11,724	19.76%	61.88%
2020-21	53,952	66,634	12,191	19.03%	61.97%
2021-22	56,644	69,361	12,688	18.33%	61.98%
2022-23	59,493	72,222	13,318	17.62%	61.48%
2023-24	62,516	75,264	13,873	16.94%	61.51%
2024-25	65,733	78,463	14,435	16.22%	61.63%
2025-26	69,176	81,915	15,065	15.55%	61.65%
2026-27	72,848	85,590	15,680	14.89%	61.89%
2031-32	89,315	103,722	18,827	13.89%	62.89%
2036-37	109,504	125,708	22,461	12.89%	63.89%

(source: 19th EPS, CEA, January 2017 (p40-49, p303-307)

Table 3.2.2-2 Results of Electricity Demand Forecast in West Bengal by PFA

	Electrical Energy Requirement (GWh)	Peak Electricity Demand (MW)	Load Factor
2015-16	52,358	7,544	79.23%
2016-17	56,035	9,842	64.99%
2017-18	59,403	10,258	66.11%
2018-19	60,662	10,687	64.80%
2019-20	62,926	11,172	64.30%

(note: Data in 2015-16 is actual)
(source: Power for All (PFA) ‐ West Bengal (p13))

The electricity demand projection exercise was carried out in consultation with Distribution Companies, Electricity Departments of States/Union Territories, and Transmission Companies of States/Union Territories. Therefore, the electricity demand projection does not include electricity demand from captive power plants in industry sector. With improvement in grid supply, the industries may shift to grid supply rather than consuming electricity from captive power plants. If 15% and 25% of the energy consumed by industries from captive power plants in all India is transferred to the utility grid in the year 2021-22 and 2026-27 respectively, it is estimated that additional electrical energy of about 41,000 GWh (2.6% of total) in the year 2021-22 and 97,000 GWh (4.7% of total) in the year

2026-27 would be required by the industries from the utility grid.

As per 2001 Census data, about 9 million households were unelectrified. West Bengal has provided electricity connections to about 8 million un-electrified households during the period FY 2011 to FY 2015. As on October 2015, a survey conducted by WBSEDCL has revealed that only about 0.75 million households remain as un-electrified in the State. Moreover, according to Handbook of State Statistics (page 514) issued by NITI Aayog, number of un-electrified households reduced to 127,581.

3.2.3 Generation Plan

The West Bengal Power Development Corporation Limited (WBPDCL), a company owned by the Government of West Bengal, is entrusted with the responsibility to carry on the business of thermal power generation. In addition to WBPDCL, remaining thermal power generating capacity is owned and operated by private players namely CESC, HEL, IPCL and central generating stations owned by NTPC, NHPC and DVC etc. and also some IPPs. The total power generation capacity available to the state (WBSEDCL), as on Sep 31, 2015, is 9,564 MW including allocation from Central Generating Stations. The share of thermal stations in the installed capacity stands at 85%. The State sources contribute to 67% of installed capacity, followed by the private sector which contribute to 21% of the installed capacity.

Table 3.2.3-1 Installed Capacity for WBSEDCL

(MW)

Sector	Thermal	Hydro	Renewables	Total
State	5,320	977	92	6,389
Private	1,941	0	40	1,981
Centaral	922	271	0	1,194
Total	8,183	1,248	132	9,564

(source: Power for All (PFA) ‐ West Bengal (p15))

During the period FY 2015 to FY 2019, the peak demand and energy requirement is expected to increase from 7,544 MW and 52,358 GWh to 11,172 MW and 62,926 GWh in FY 2019 as shown in Table 3.2.2-2. In order to meet the increase in electricity demand, the state needs to carefully plan for either developing its own generation capacity or tie up with central generating stations/ IPPs.

The State has been allocated a share of 993 MW from the upcoming Central Generating Stations and projects in Bhutan until FY 2019 as shown in Table 3.2.3-2. Further, regarding the Teesta Basin Investigation projects, Government of West Bengal has allotted four projects in West Bengal to NHPC namely Teesta Low dam V (80 MW), Teesta Low Dam I & II combined (81 MW), Teesta Intermediate (84 MW) and Rammam Stage I (48 MW) for which Memorandum of Agreement has been signed. Two additional units (Sagardighi 2X500 MW Unit III and IV) owned by the WBPDCL were commissioned in 2015 and 2016. Additionally, a total of 585 MW is expected from renewable energy sources until FY 2019. In the term of peak power requirement, West Bengal has performed significantly better than the national average, as the peak deficit has been below 1%[3]. Reserve margin of Indian target is 5% in the future.

Table 3.2.3-2 Upcoming Central Generating Stations

Name	Fuel	Owner	Capacity (MW)	Allocated Capacity for WBSEDCL (MW)	Expected Commercial Operation Date (COD)	Status
Teesta low Dam IV	Hydro	NHPC	160	160	Sep-16	Under construction One unit of 40 MW already commissioned and spinning of another unit done
Teesta IV	Hydro	NHPC	520	121	Aug-22	Under clearance
New Nabinagar	Thermal	NTPC	1,980	179	Jul-17	Under construction WBSEDCL has cancelled PPA
North Karanpura	Thermal	NTPC	1,320	99	Jul-17	Under construction WBSEDCL has cancelled PPA
Katwa	Thermal	NTPC	1,320	1,122	Beyond FY19	Under construction
Darlipalli	Thermal	NTPC	1,600	250	Jun-16	Under construction
Punatsangchhu-II HEP	Hydro	Bhutan	1,020	106	Jun-17	Under construction Expected slippage in COD
Mangdechhu HEP	Hydro	Bhutan	474	75	Sep-17	Under construction Expected slippage in COD
Punatsangchhu-I	Hydro	Bhutan	1,200	124	Dec-18	Under construction Expected slippage in COD
Total				2,236		
Total until FY19				993		

(source: Power for All (PFA) ‐ West Bengal (p17))

3.2.4 Transmission Plan

The planning and development of intra-state transmission system in the state is undertaken by West Bengal State Electricity Transmission Company Limited (WBSETCL). As on 31st March 2015, WBSETCL operates and maintains a transmission network of 12,042.54 ckt. kms of Extra High Voltage Transmission lines along with 113 sub-stations (400/220/132/66 kV) having total transformation capacity of 23,580.8 MVA, spread over the entire stretch of the State of West Bengal. The existing transformation capacity and line length (400 kV, 220 kV, 132 kV and 66 kV) of WBSETCL network is summarized in Table 3.2.4-1. The existing capacity of intra-state transmission system requires further strengthening for meeting the growing demand for power in the State. The availability of WBSETCL's transmission system is at par with other leading state transmission utilities in the country.

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[3] Source: Handbook of State Statistics, NITI, page509

Table 3.2.4-1 Intra-state Transmission System

Voltage	Transformation Capacity (MVA)	Line Length (ckt kms)
440 kV	3,780.0	1,644.70
220 kV	9,880.0	2,941.50
132 kV	9,674.5	7,035.34
66 kV	246.3	421.00
Total	23,580.8	12,042.54

(source: Power for All (PFA) ‑ West Bengal (p22))

In accordance with the 5 year long term rolling transmission system investment plan, WBSETCL is working on a number of transmission projects, without any financial assistance from the Government of West Bengal and Government of India, to improve the network infrastructure and to ensure reliability and quality of supply to end consumers. The projects are being funded from WBSETCL's internal accruals and domestic borrowings from financial institutions. The list of ongoing, approved and proposed capacity additions at various voltage levels is summarized in Table 3.2.4-2.

Out of total 42 planed substations, the ongoing schemes for 12 sub-stations and 1,025.5 kms of transmission lines are scheduled to be completed progressively by FY 2017. The approved schemes for 18 sub-stations and 399.6 kms of transmission lines are to be completed progressively from the year FY 2017 onwards. The remaining 12 substations and 569.5 kms of transmission lines will be reviewed annually and will be taken up for construction at the earliest. All those schemes are to be completed progressively by FY 2022.

Table 3.2.4-2 Ongoing, Approved and Proposed Schemes of WBSETCL

	Ongoing	Approved	Proposed	Total
No. of Substations	12	18	12	42
Transformation Capacity (MVA)	3,769	3,007	3,623	10,399
400/220 kV	1,260	315	1,260	2,835
220/132 kV	1,920	1,280	1,600	4,800
220/33 kV		160		160
132/33 kV	589	1,252	763	2,604
Lines (km)	1,026	400	570	1,996
400 kV	353	53	150	556
220 kV	201	82	153	436
132 kV	472	265	267	1,004

(source: Power for All (PFA) ‑ West Bengal (p25))

3.2.5 Renewable Energy Plan

West Bengal’s renewable energy sources comprise of small and mini hydro power generation sources in the North Bengal region. The state utility, WBSEDCL, is also procuring renewable energy from other sources to fulfill its Renewable Purchase Obligations (RPO) as mandated in ‘Cogeneration and Generation of Electricity from Renewable Sources of Energy Regulations’ notified in 2013. The share of RPO for the distribution licensees in the state are shown in Table 3.2.5-1.

West Bengal Renewable Energy Development Agency (WBREDA) formed in 1993, is the State Nodal Agency for implementation of Non - Conventional Energy Programs in the State of West Bengal. Further, West Bengal Green Energy Development Corporation Limited was formed in 1993 to promote different grid-connected renewable energy based power projects through Public-Private Partnerships (PPP) mode. The state has a renewable energy potential of 19,071 MW[4]. This includes 16,800 of Solar and 2,271 MW from other renewable energy sources. Renewable Energy (RE) Policy was notified by the State in 2012. The policy aims to attain 2,706 MW of generation capacity from renewable energy sources including co-generation by the year 2022. The targets under the RE Policy for the state are presented in Table 3.2.5-2. As a part of the MNRE’s 175 GW RE addition plan for the country, West Bengal has been provided a target of 5,386 MW by 2022. In this context, the State Government may have to revise the above targets.

Table 3.2.5-1 Share of RPO Targets for West Bengal

Year	Solar RPO	Non-Solar RPO
FY 2014	0.10%	4.0%
FY 2015	0.15%	4.5%
FY 2016	0.20%	5.0%
FY 2017	0.25%	5.5%
FY 2018	0.30%	6.0%

(source: Power for All (PFA) ‐ West Bengal (p39))

Table 3.2.5-2 RPO Targets for West Bengal

(MW)

Source	2017 Target	2022 Target
Wind Power	75	450
Mini & Small Hydro	220	394
Co-generation	355	600
Biomass	240	662
Waste to Energy	50	100
Solar	100	500
Total	1,040	2,706

(source: Power for All (PFA) ‐ West Bengal (p39))

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[4] Source: Power for All – West Bengal (page39)

WBSEDCL has 9 small hydro plants less than 25 MW with a total installed capacity of 89.55 MW as shown Table 3.2.5-3. The total generation from these plants in FY 2015 was 185.07 GWh. In addition to these stations, WBSEDCL has a quantum of 162.2 MW renewable energy from other sources as shown in Table 3.2.5-4.

Table 3.2.5-3 RPO Targets for West Bengal

Plant Name	Capacity (MW)
Jaldhaka Stage-II (2×4MW)	8
TCF-I (3×7.5MW)	22.5
TCF-II (3×7.5MW)	22.5
TCF-III (3×7.5MW)	22.5
Rinchington (2×1MW)	2
Little Rangit (2×1MW)	2
Mongpu Kalikhola (3×1MW)	3
Sidrapong (3×0.2 MW)	0.6
Fazi (2×0.4+1×0.448+1×1.2MW)	2.448
Massamijor	4
Total	89.548

(source: Power for All (PFA) - West Bengal (p39))

Table 3.2.5-4 RE Procurement by WBSEDCL (Other Sources)

Name of Entity	Type	Cap(MW)	COD/Status
Rashmi Cement Ltd.	Co-gen	18	Jan, 2011
Bengal Energy Ltd.	Co-gen	36	Apr, 2012
Himadri Chemicals and Industries Ltd.	Co-gen	12	Feb, 2012
M/s Tata Power Co. Ltd.	Co-gen	20	Jun, 2008
M/s Ennore Coke Ltd.	Co-gen	10.8	Dec, 2012
Electro Steel	Co-gen	10.8	in operation since 2006
CONCAST	Co-gen	4.8	Aug, 2013
Ramsarup Loha Udyog	Co-gen	20	Shutdown
Nippon Power Ltd.	Small Hydro	2.7	Mar, 2007
M/s Neora Hydro Ltd.	Small Hydro	2.7	Apr, 2006
WBREDA	Wind	2	Jul, 2001 and Apr, 2008
M/s Amrit Bio-Energy & Industries Ltd.	Biomass	9.1	Mar, 2010 (Shutdown)
M/s Kamarhati Co. Ltd.	Biomass	5.3	Jun, 2008 (Shutdown)
Himadri Chemicals and Industries Ltd.	Co-gen	8	in operation
Total		162.2	

(source: Power for All (PFA) - West Bengal (p40))

3.2.6 Electricity Tariff

According to the website of WBESDCL, the electricity tariff is categorized into two major categories, low & medium voltage customers and high and extra high voltage customers. Domestic electricity tariff for households consists of demand charge and energy charge. As shown in Table 3.2.6-1, energy charge per kWh is gradually rising as increase of electricity consumption for three months. Domestic electricity tariff of rural is slightly cheaper than that of urban. There is a prepaid system as an option and the energy charge of the prepaid system is fixed at 6.64 INR/kWh regardless of electricity consumption for three months as shown in Table 3.2.6-1. Moreover, electricity tariff for consumer less than 75 kWh for three months is very cheap as classified Life Line.

Table 3.2.6-1 Domestic Electricity Tariff in West Bengal

Type of Consumer	Quarterly consumption in kWh		Energy charge Paisa/kWh	Demand charge in INR/KVA/month
Life Line (Domestic)	0 to 75		356	5
Domestic (Rural)	First	102	526	15
	Next	78	586	
	Next	120	673	
	Next	300	723	
	Next	300	732	
	Above	900	899	
Domestic (Urban)	First	102	530	15
	Next	78	597	
	Next	120	697	
	Next	300	731	
	Next	300	758	
	Above	900	899	
Domestic (Rural-Prepaid)	All Unit		6.64	15
Domestic (Urban-Prepaid)	All Unit		6.64	15

(source: https://www.wbsedcl.in/irj/go/km/docs/internet/new_website/pdf/Tariff_Volumn/PDFsam_mergetariff2.pdf)

There are many categories for tariff such as commercial, public, industry, agriculture, and so on. Some categories have energy charge by three time zones. Energy charge from 17:00 to 23:00 is the highest, followed by 6:00-17:00, 23:00-6:00. For industrial consumer, load factor rebate is applicable.

According to Power for All - West Bengal (page 20), WBSEDCL's power purchase cost for the last few years has been varying between 3.83 Rs./kWh and 4.12 Rs./kWh from FY 2013 to FY 2015. The rise in average power purchase rate was partly driven by the rise in variable cost of generation. The utility has been able to reduce the cost by 26 paisa/kWh during FY 2015 with the following steps:

1) Increase in generation by state's own sources by 44.9% in FY 2015 over FY 2014. This helped in reducing the variable power purchase cost.

2) Restructuring of Long term procurement plan by avoiding costly PPA's.
3) Using the Day Ahead Market (DAM) to procure cheaper power. The utility increased the quantum of energy bought by about 34% in FY 2015.
4) Economic operation of Purulia Pumped Storage Station helped the utility to avoid peak power purchases.
5) The utility has focused on buying power from short-term market. Buying varying quantum of power instead of Round The Clock (RTC) purchases has enabled the utility to avoid fixed costs and reduction in back down charges

The short power exchange market shares 10-20% of total power transactions in India and it has on the rise. Basically power on sale exceeds power on purchase. CERC has introduced extension of transaction time, DAM (Day Ahead Market), TAC (Term Ahead Market) as Intra Day Contract, Day Ahead Contingency so that flexibility of power sale/purchase can be done. IEX (India Energy Exchange) transaction price for 2016 in E1 block is shown below. It should be remembered Discoms with financial deficits may show low interests in purchasing power from market to fulfil distribution needs and the price ranges 2-3 INR/U low prices. The highest peak price was 4.85 INR/U.

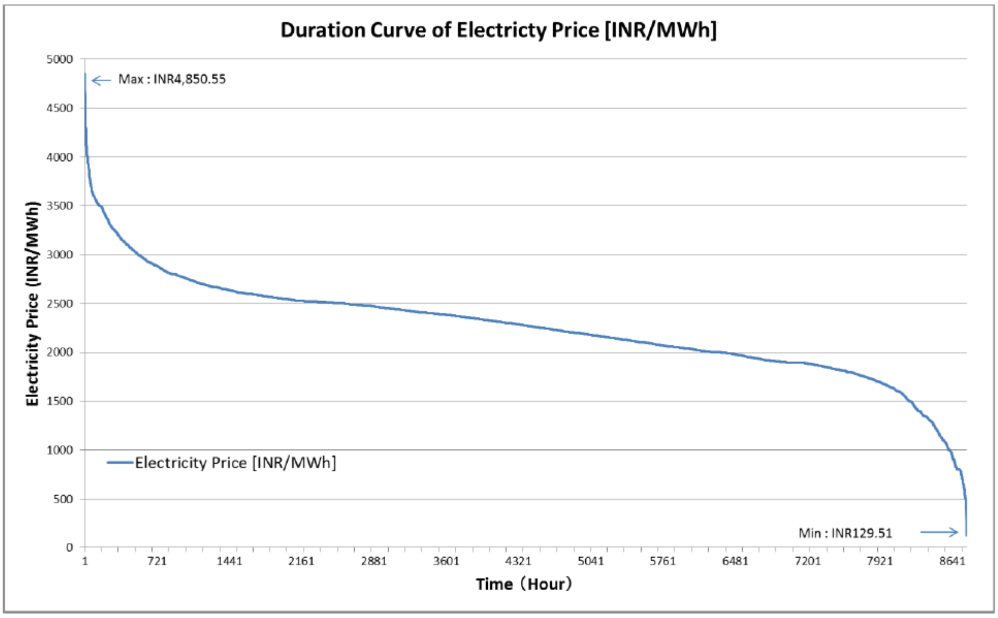

Figure 3.2.6-1 IEX Market Price in West Bengal in 2016

3.2.7 Operation record of WBSEDCL

Figure 3.2.7-1 and Figure 3.2.7-2 shows actual demand for 2016 as well as IEX price and Purulia PSP operation through one year.

It is confirmed Purulia PSP contributes as a peaking power for night time on-peak load in West Bengal. On the other hand, Purulia PSP purchase power on time zone where IEX price is low and generates power on the time zone when IEX price is high.

It is known that although it has flexibly utilizes short power market to reduce power purchase cost, the main source of power purchase has been from PPA (Table 3.2.7-1), and that the operation of Purulia PSP is done in line to the directives by ERLDC/WBSLDC. So far it is difficult to extract the financial competitiveness of Purulia PSP alone apart from whole WBSEDCL financial sheet.

(Not be disclosed per internal corporate information)

(source : JICA Team, from WBSEDCL)

Figure 3.2.7-1 Operation record of West Bengal in 2016 (excerpt)

(Not be disclosed per internal corporate information)

(source : JICA Team, from WBSEDCL)

Figure 3.2.7-2 Operation record of Purulia PSP in 2016 (excerpt)

Table 3.2.7-1 Purchase Volume of WBESDCL

WBSEDCL Power Purchase	2015-2016	2014-2015	2013-2014
1 Central Sectors (CGU; NTPC, NHPC, PTC, DVC, etc.)	8,988.3	9,647.1	9,151.1
2 State Sectors (WBPDCL, DPL)	17,910.5	21,670.0	18,605.8
3 Short Term Bilateral	3,948.6	753.7	693.9
4 Short Term Exchange (IEX, PXIL)	1,343.0	1,044.2	319.0
5 Swap Power	989.5	1,129.8	1,172.7
6 Private Sectors	3,387.1	3,136.5	4,432.2
7 Renewables (WBREDA)	0.2	0.2	0.2
8 Power Drawn under UI mode	258.2	431.3	777.4
Total Energy	36,825.3	37,812.8	35,152.4

(source : JICA Team, from WBSEDCL Annual Report 2014-15 (Dec. 2015), 2015-16 (Sep. 2016))

CHAPTER 4

PROJECT IMPLEMENTATION, MAINTENANCE AND MANAGEMENT SYSTEM

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List of Abbreviations

Abbreviation	**Full Form**
AE	Assistance Engineer
CE	Chief Engineer
CESC	Calcutta Electric Supply Corporation
CKM	Circuit Kilometers
CoD	Commercial Operation Date
CSR	Corporate Social Responsibility(
DE	Divisional Engineer
DDUGJY	Deendayal Upadhyaya Gram Jyoti Yojana
DPL	Durgapur Projects Ltd
DPSC	Dishergarh Power Supply Company Limited
DVC	Damodar Valley Corporation
DPR	Detailed Project Report
DSM	Demand Side Management
DT/ DTR	Distribution Transformer
EBIDTA	Earnings Before Interest Depreciation Taxes and Amortization
EE	Energy Efficiency
EPC	Engineering, Procurement and Construction
EPS	Electric Power Survey
ER	Eastern Region
FY	Financial Year
GIS	Gas Insulated Switchgear
GoI	Government of India
GSS	Grid Substation
GWp	Giga Watt Peak
HH	Household
HTLS	High Temperature Low Sag Conductor
HR	Human Resource
IPCL	India Power Co.、Ltd
IPDS	Integrated Power Development Scheme
IPP	Independent Power Producer
ISTS	Inter State Transmission System
LED	Light-emitting Diode
LT	Low Tension
MNRE	Ministry of New and Renewable Energy
MoC	Ministry of Coal
MoEF	Ministry of Environment & Forests, Government of India
MU	Million Unit of Electricity (in kWh)
MVA	Mega Volt Ampere

MW	Mega Watt
NESCL	NTPC Electric Supply Company Limited
NHPC	National Hydroelectric Power Corporation
NTPC	National Thermal Power Corporation
O&M	Operation & Maintenance
PAT	Profit After Taxes
PBT	Profit Before Taxes
PFA	Power For All
PFC	Power Finance Corporation
PGCIL	Power Grid Corporation Of India Limited
PLF	Plant Load Factor
PMA	Project Monitoring Agency
PPA	Power Purchase Agreement
PPP	Public–private Partnership
PSS	Power Sub-station
R&M	Renovation & Modernization
RE	Renewable Energy
REC	Rural Electrification Corporation
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
ROW	Right of Way
RPO	Renewable Energy Purchase Obligation
SCADA	Supervisory Control and Data Acquisition
SE	Superintending Engineer
SEB	State Electricity Board
SHR	Station Heat Rate
SLDC	State Load Dispatch Center
SPV	Special Purpose Vehicle
T&D	Transmission & Distribution
TBCB	Tariff Based Competitive Bidding
ToR	Terms of Reference
TPS	Thermal Power Station
UDAY	Ujwal Discom Assurance Yojana scheme
UMPP	Ultra Mega Power Project
USTDA	US Trade & Development Agency
WBERC	West Bengal Electricity Regulatory Commission
WBSEDCL	West Bengal State Electricity Distribution Company Limited
WBPDCL	West Bengal Power Development Corporation Limited
WBSETCL	West Bengal State Electricity Transmission Company Limited
WBREDA	West Bengal renewable Energy Development Agency

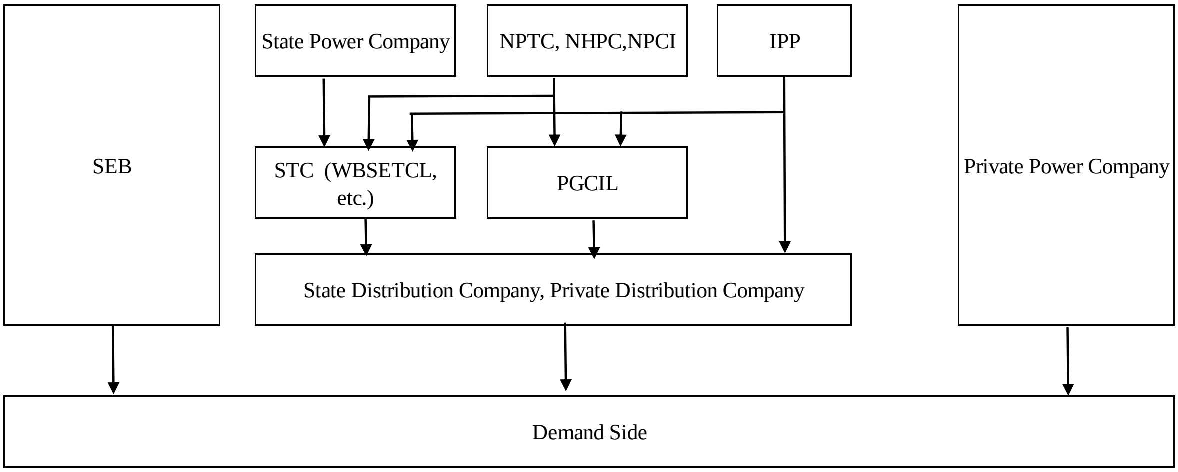
CHAPTER 4 PROJECT IMPLEMENTATION, MAINTENANCE AND MANAGEMENT SYSTEM

4.1 PROJECT IMPLEMENTATION, MAINTENANCE AND MANAGEMENT SYSTEM

4.1.1 Project Implementation System

Electric power supply in India Domestic power supply has been responsible for power supply mainly by large cities by Conglomerate electric power companies before independence (1950). Since independence, in order to be responsible for the provision of rural electricity, a provisionally-provincial state electric power bureau (SEB) that consistently carries out power generation, transmission and distribution as a state-owned electric power company has been established and has been responsible for the province's power supply. After that, the development of electric power infrastructure was advanced, the central government power generation corporation (NTPC, NHPC, NPCIL), and the Power Grid Corporation of India Limited (PGCIL) were established.

Currently, the Indian power supply system is composed of three sectors: the central government, the state government, and the private sector. Electric power reform in India has been promoted around 1990, and the "Electricity Act 2003" has been enforced to segregate SEBs, rationalize electricity rates, separate transmission and distribution, and approval system other than hydropower generation, Open access to the transmission and distribution system, etc. are permitted. Progress of electric power reform varies widely from state to state, some states have been aggressively implemented, and there are various states such as states that remain practically integrated. There are states coexisting with states where SEB is currently transmitting and distributing and those in which these companies are conducting (Figure 4.1.1-1).



(source: Collection Data by Japan Electric Power Information Center (JEPIC))

Figure 4.1.1-1 Electric Power Company Structure in India

4.1.2 Power Supply System in West Bengal State [1]

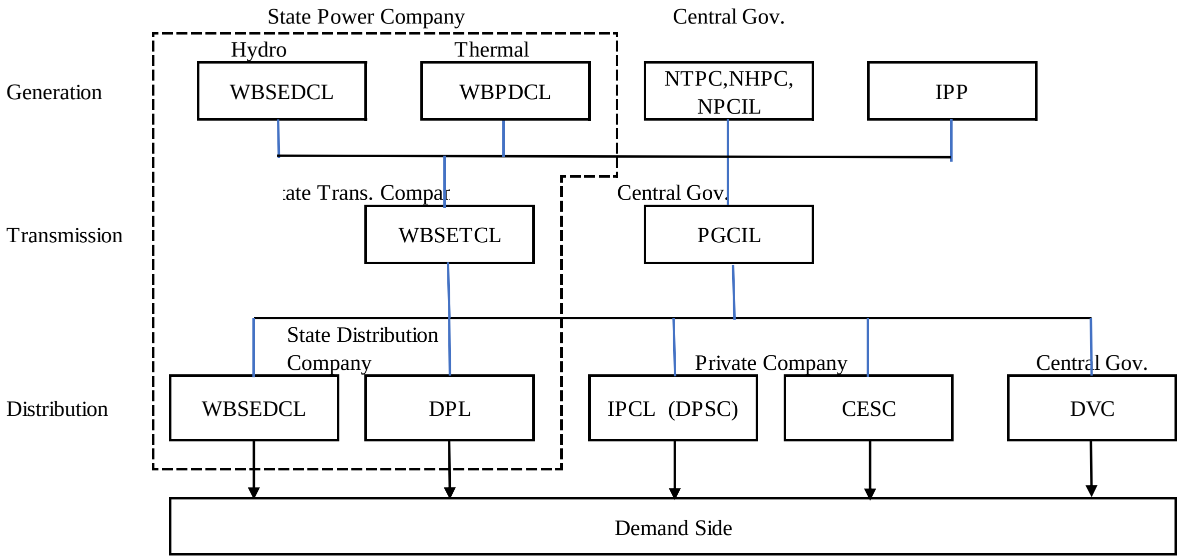
The West Bengal State located in the eastern part of India shares state boundaries with Jharkhand, Bihar, Odisha, Sikkim, Assam. As a nation, the state has the border line with Nepal, Bhutan and Bangladesh. It is the 14th state by region and is the fourth largest state in population.

West Bengal is the tenth largest power consumption state that accounts for about 4.4% of the total energy consumption in India. In the electricity supply, energy shortage in the state in 2015 is only 0.5%, which is considerably lower than the average energy shortage of 3.6% nationwide. Regarding peak power demand, West Bengal's power supply structure is superior to the national average because the peak deficit has fallen below 1% over the past four years.

At the state level, the overall energy demand is expected to increase from the existing 52,358 MU in 2015 to 62,926 MU in 2019, showing a 5% annual growth during this period. This leads to an increase in peak power demand from 7,544 MW in FY 2015 to 11,172 MW in FY2019.

In West Bengal State, the West Bengal State Electricity Board (WBSEB) is divided to the West Bengal State Electricity Transmission Company Ltd. (WBSETCL) and the West Bengal State Electricity Distribution Company Ltd .: WBSEDCL) in April 2007.

The power supply system in West Bengal State is shown in Figure 4.1.2-1. Within the dot line, the state government has a power company that operates power generation, transmission and distribution lines.



(source: Collection Data by Power for All West Bengal)

Figure 4.1.2-1 Electricity Supply Structure in West Bengal

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[1] Sources of (1) through (3) of 4.1.2 mainly from "Power for All West Bengal"

(1) Power Generation Plan

Established in 1985, West Bengal Power Development Corporation Ltd. (WBPDCL) is a state-owned company that owns and operates thermal power plants. In addition to the WBPDCL, the remaining thermal power capacity is owned and operated by private companies. In addition there are power plants owned by central government such as NTPC, NHPC, DVC.

Hydroelectric power generation is currently being conducted by WBSEDCL.

The power demand of West Bengal State is largely satisfied by the power plants operated by the state government, and the capacity of WBPDCL, WBSEDCL of the state government accounts for over 64% of the total installed capacity in the state. With capacity of 4,865 MW, the WBPDCL shares the most of state thermal power capacity. WBSEDCL owns eleven hydropower stations with 1,075.1 MW in total including Rammam (51 MW) and Purulia Pumped Storage Plant (900 MW).

In the power information of "Power for All West Bengal" issued by the West Bengal State Government, in 2015, the Peak power demand was 7,544 MW, however the supply capacity was 7,524 MW, 20 MW below peak demand. Peak power demand is expected to increase to 11,172 MW in FY 2019 and plans to supply the power by newly established thermal power generation plants and imported electricity. However, since it is expected that the tendency of supply shortage will continue even after 2019, it is expected that supply power of comparatively large capacity will be operated at an early stage.

Practical operation of Turga pumped storage power generation (1,000 MW) and the Bandu pumped power generation (900 MW) will increase the peak power supply capacity drastically in West Bengal State.

These plans are expected to respond to the peak demand of West Bengal State and to stabilize it to the power grid, thereby contributing to improvement of power quality within the state and regional power grid system.

(2) Power Transmission Plan

As of the end of March 2015, the West Bengal power supply area has expanded transmission lines along 113 substations (400/220/132/66 kV) with total transformer capacity of 23,580.8 MVA. WBSETCL is working on a number of power transmission projects based on a five-year long-term power transmission enhancement plan. 42 new substations to be added between FY 2016 and FY 2019, of which 12 substations and 1,025.5 km transmission lines are expected to be completed by FY 2016 and FY 2017. The 18 substation stations and the 399.6 km transmission line plan will be gradually completed after FY 2017. The remaining plans are planned for approval by WBSETCL and necessary financing.

In addition, transmission networks extending between West Bengal and the Eastern Region over the transboundary transmission lines and other states are expanding their transmission networks. The Power Grid Corporation of India Limited (PGCIL) added about 3,863 km (1,000 kV - 765 kV and

2,863 km - 400 kV) of the Inter State Transmission Line System (ISTS) line, and a new 765/400 kV substation (Jeerat - 3000 MVA and Medinipur - 3000 MVA) to increase the capacity of the 9,435 MVA transformer capacity. In West Bengal State, there are plans for two new 400/220 kV substations (Rajarhat - 1000 MVA and Alipurduar - 630 MVA). These power transmission capacity enhancement plans can sufficiently respond to the increase in supply and demand of electricity in West Bengal State.

(3) Power Distribution Plan

West Bengal has five licensed distribution companies.

They are WBSEDCL, CESC (Calcutta Electric Supply Corporation), DPL (Durgapur Projects Ltd), IPCL (India Power Co., Ltd), and DVC (Damodar Valley Corporation).

Two are owned by the state government, two are private companies and the other is owned by the central government.

1) WBSEDCL is a state-owned power distribution company and is responsible for the state's power distribution department, which has about 174.2 million consumer base at the end of FY2017.
2) CESC owns and operates a supply area with a total of 567 km^2, the largest private power distribution company in the state. Kolkata and Howrah are in the supply area.
3) IPCL (formerly DPSC) - India Power Co., Ltd is a private distribution company that owns and manages distribution systems in areas over 618 km^2. Coals-rich Asansol and Raniganj regions are the supply area.
4) DPL is a state-owned distribution company. It supplies electricity to Durgapur's limited area.
5) DVC is a distribution company operated by the central government. It supplies electricity of 33 kV or more in the Damodar Valley area crossing West Bengal State and Jharkhand State.

(4) Prospect of Power Liberalization in Indian government and West Bengal State[2]

After 1991, India steered up the line of economic liberalization, and economical innovation such as entering of private sector to the industry monopolized by the public sector and relaxing restrictions on foreign capital were done. With this economical innovation, the liberalization began in India's electric power sector as well.

In the power innovation conducted in the early 1990’s, West Bengal aggressively adopted deregulation measures focused on the electric power sector, such as the introduction of IPP, in response to the problem of power shortage due to the rapid economic growth. Furthermore, in the series of electric power business innovation in the latter half of the 1990s and the 2000s, the main focus was placed on improving the efficiency of the distribution system and the development of the

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[2] Including short extract from information of JEPIC (Japan Electric Power Information Center)

electricity tariff system. In 2003, following the revision of the Electric Law, which is the basis of power innovation, the division of the State Electricity Bureau and the separation of electricity transmission and generation part were carried out.

In the general election held in May 2014, the Indian People's Party (BJP) who pledged to nationwide families "to supply electricity without interrupting power for 24 hours a day for seven days a week" took the office. After taking office by pointing out the hindrance of vertical division administration as a factor that does not improve innovation, a new minister to oversee three portion of Power, Coal and New and Renewable Energy was appointed to promote the following power innovation:

1) Review of coal allocation method

Distribution of domestically produced coal to each business operator is carried out by a state-owned company India Coal Corporation (CIL). This coal allocation method was rejected as it was unfair being preferable for public enterprises. Especially considering power shortage and environmental problems, coal was preferentially allocated to efficient power plants.

2) Rural electrification (program name: DDUGJY)

The government will improve to be installed transformers, distribution transformers, conductors, meters, feeders and meters to proceed with meter reading in non-meter-ready households in order to electrify 18,452 villages of unelectrified villages and 50 million households un-electrified. The budget amount is Rs. 758.93 million.

3) Distribution efficiency improvement (program name: IPDS)

A program aimed mainly at lowering distribution loss in urban areas (including the prevention of theft). Establishment of smart meters and tamper-proof meters, strengthening of distribution infrastructure, undergrounding in densely populated areas, IT conversion, installation of solar panels. The budget amount is Rs. 654.24 million.

4) Promotion of diffusion of LED

By 2019 change the street lights and household lights nationwide to LEDs. To general households, sell cheaply. The government estimates that the energy conservation effect by changing to the LED light will be 243 million kWh and that household electricity bill will be saved at 162 rupees per year (about 308 yen) annually.

5) Eliminate debt of distribution company (program name: UDAY)

It was announced in November 2015. The state government takes over 75% of the liability amount as of the end of September 2015 from the distribution company, securitizes it over two years and sells it. The remaining 25% is allowed to be securitized and sold by the distribution company itself. Total debt of the distribution company nationwide is estimated to be Rs. 620 billion (about 1.15 trillion yen) (as of the end of March, 2015).

6) Scheduled plans in the future

On January 20, 2016, the Government of India approved a draft revision of "Tariff Policy" at the Cabinet meeting. The electricity price policy was a policy document showing the policy of innovation of the electric power business system based on the Electricity Act of 2003, the first full revision since the formulation in 2006. In the new electricity price policy such as,

(a) to spread electricity to the people.

(b) to promote efficiency of the electric power business to keep the electricity price at an appropriate level.

(c) to respond to environmental problems for a sustainable future.

(d) Improvement of the investment environment.

And to provide electricity to all consumers without power interruption for 24 hours, it is urgently given and requested to state governments and state regulatory agencies a path to realization.

In addition, such as spreading smart meters, to introduce renewable energy purchasing obligation system (RPO) by 2022, not to collect the consignment charge for solar and wind power generation are included in the Policy. When the tax system etc. is changed it is shown that it is acceptable to pass on to the price. The RPO system has already been introduced in West Bengal State.

In West Bengal State, following the measures of the Indian government, "24 × 7 Power For All West Bengal" (24 × 7 PFA) program was formulated in 2015. (24 × 7 PFA) program is a joint initiative of the Government of India (GoI) and the State government, and by the end of 2019, it is aimed to make electricity available for 7 days with reliable power to all households, industries, commerce and all other power consumers for 24 hours continuously, and it was summarized as a roadmap for achieving that purpose. This PFA road map carries various projects including power generation, transmission, distribution, renewable energy, energy efficiency / DSM measures implemented in FY 2016 to 2019.

The contents are based on the business plans of each generation, transmission and distribution power company listed in (1) power generation plan, (2) power transmission plan, and (3) power distribution plan shown in 4.1.2 Power Supply System in West Bengal State.

The state government is planning to provide all necessary support to electric utilities to achieve the various milestones and targets outlined in this PFA roadmap.

Also, Ministry of Power (MoP) complements corrective action on various problems handled at the Government of India (GoI) level, including those described in this document, MoP, GoI, have to make efforts to support the use of the loan system for the utilities.

In addition, the Gol and state governments will review and monitor the progress of the plan through regular meetings and improve to achieve the program's goals by taking necessary measures as envisioned in the PFA roadmap.

4.1.3 West Bengal State Electricity Distribution Company Ltd., (WBSEDCL)

(1) Organization

The organization of WBSEDCL is composed of six divisions, Human Resource, Generation, Regulatory & Trading, Projects & Procurement, Finance & Accounts, and Distribution, with Chairman being the lead, and they each have the following roles.

1) Human Resource (HR): It plays a central role in education and human resource development, and coordinates technical training for mid-level engineers, etc. with external organizations from vocational training of the initial employer. It also plays the role of Corporate Social Responsibility (CSR), making a great contribution in various fields such as education, sports and the social environment.

2) Generation: From renewable energy to large-scale hydropower development, construction and operation of existing and new power generation facilities. The Purulia PSP recorded energy generation watthours of 1,106 MU in 2016 - 2017, and Cycle Efficiency[3] 78.13% against design efficiency of 75.5%. Overhaul of Unit 3 and Unit 4 continued as in the previous year. For O & M expenses in 2016 - 2017, expenditure was 45.61 crore against budget 49, 32 crore.

1) Distribution: New substation design, specification review, 11 kV - 33 kV distribution line facility. It is responsible for operations related to operations. Currently, it is under consideration to introduce it to 33/11 kV substation of increased capacity low sag conductors (HTLS, High Temperature Low Sag Conductor), SCADA, GIS.

3) Regulatory & Trading: It is responsible for domestic and foreign power trading, purchasing based on renewable energy purchasing obligation.

4) Planning & Project: This department is responsible for purchasing power generation and substation equipment and distribution cables. In fiscal 2016-2017, this dpt. set goals aimed at contracts with appropriate prices from appropriate suppliers.

5) Finance & Accounts: Department responsible for accounting and financial management. Total Income in 1990 - 2017 is 19931.68 Crore, Total Expense is 19883.03 Crore, Income Tax 17.32 Crore, Total Comprehensive Income is 31.33 Crore surplus.

The organization chart is shown in Figure 4.1.3-1 Organization Chart of WBSEDCL.

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[3] Cycle Efficiency: Total efficiency including efficiency of motor, generator and pump turbine from motor input to Generator output.

(Disclosed per internal corporate information)

(source: Data from WBSEDCL Feb.13, 2018)

Figure 4.1.3-1 Organization Chart of WBSEDCL

The staffing structure of WBSEDCL is shown in Table 4.1.3-1.

Table 4.1.3-1 Employees of WBSEDCL

(Not be disclosed per internal corporate information)

(source: Data from WBSEDCL Feb.13, 2018)

(2) Turga Pumped Storage Power Plant (TPSP) Construction promotion system

With the separation of executing agencies, WBSEDCL will conduct power generation projects and WBSETCL will implement power transmission projects.

WBSEDCL is a state agency that has been delegated power distribution and hydroelectric power generation functions in the country alongside other agencies, and plans to operate new power generation facilities along with the operation of existing power generation facilities and distribution networks.

Construction works are carried out through contractors contracted with appropriate contract packages and are expected to be completed in nearly six years, including one year for construction of access roads.

Construction work of Turga PSP on WBSEDCL side is done by Pumped Storage Project Department. One person is assigned to each of the Civil & Hydro-Mechanical division and the electromechanical division of the chief engineer (CE) in the construction organization of TURGA PSP, respectively, and another additional CE is planned as the project manager. Furthermore, offices for F & A division and CE are established.

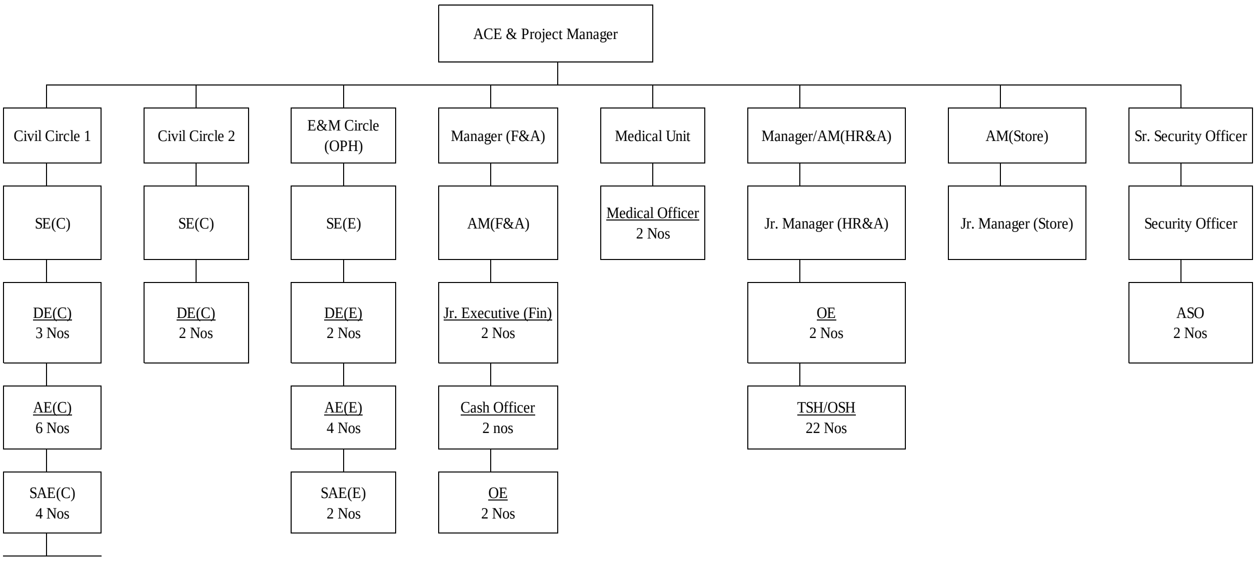
The structure of the organization detailed up to the department level considering the scale of various work is shown in the following two parts.

1) Organization of Pre-construction Stage (first two (2) years)
2) Organization of Peak-construction Stage (peak construction stage)

In the first two years of project implementation, construction of infrastructure such as access road will be carried out.

Therefore, during the first two years the need for staff is reduced compared to peak construction period.

The organization of the local office in Pre-construction Stage is shown in Figure 4.1.3-2.

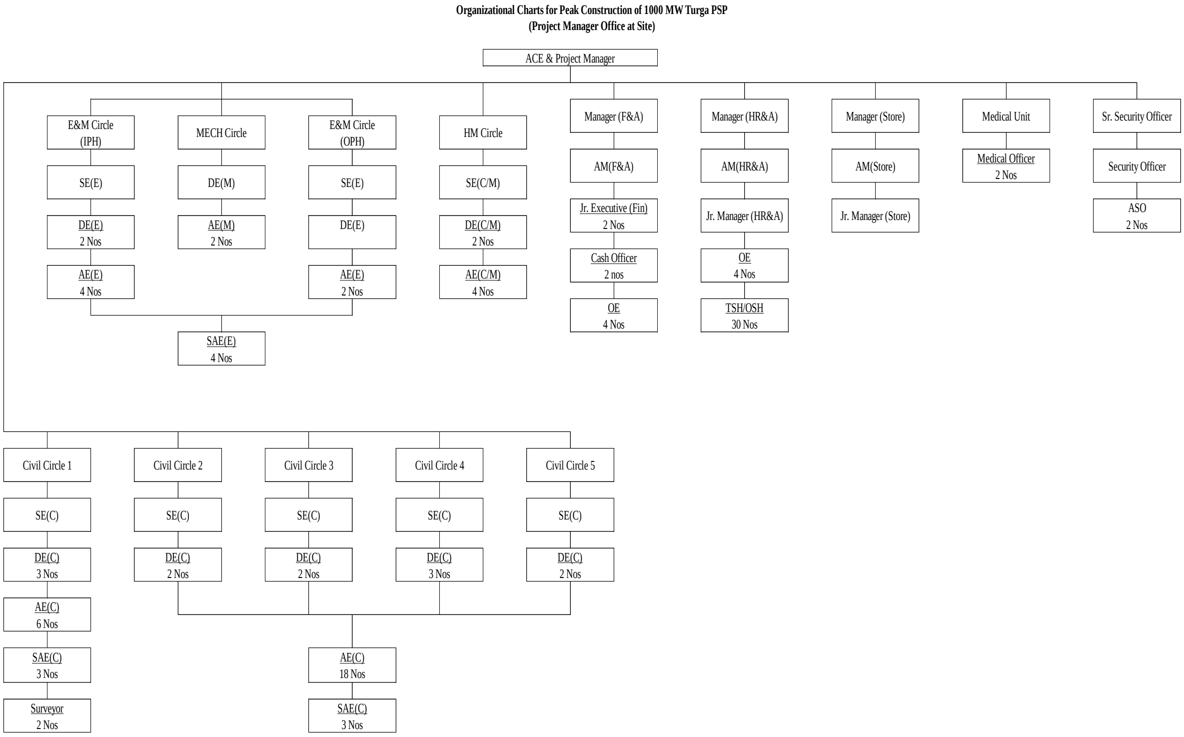


(source: Detailed Project Report of Turga Pumped Storage Power Plant, WBSEDCL 2016)

Figure 4.1.3-2 Organization Chart of Pre-construction Stage at Site Office

In addition, it is also responsible for securing the security of safe work environments inside or outside the power plant as a department that manages inventory and inventory records, as well as departments managing inventory and stock records, accepting power generating equipment, storing and distributing storage equipment, construction Monitor the entry and exit of related employees, contractors and other persons and take charge of business to prevent theft and damage of materials and equipment. In addition, facilities such as schools and hospitals are located near from the project area and collaboration with medical institutions is considered for emergency medical care and emergency situations.

Figure 4.1.3-3 shows the local organization in the event of a full-scale construction stage.

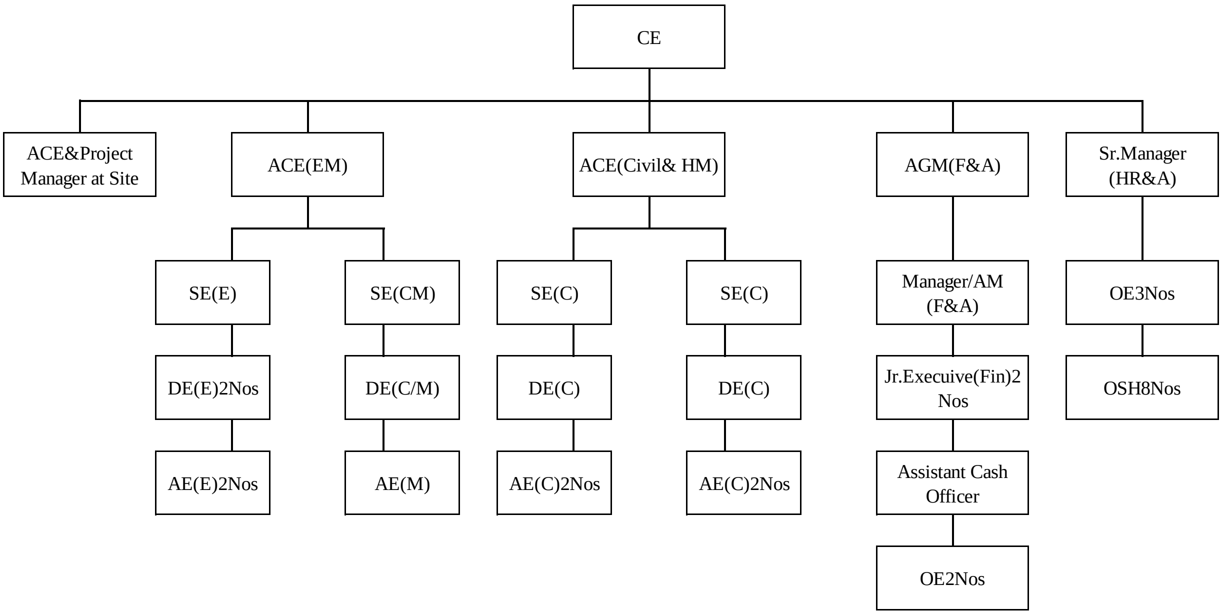


N.B: Security personnel for individual Project components will be arranged from outside agency.

(source: Detailed Project Report of Turga Pumped Storage Power Plant, WBSEDCL 2016)

Figure 4.1.3-3 Organization Chart of Construction Stage at Site Office

Figure 4.1.3-4 shows the organization of the head office during construction preparation and full-scale construction.



(source: Detailed Project Report of Turga Pumped Storage Power Plant, WBSEDCL 2016)

Figure 4.1.3-4 Organization Chart of Pre-construction and Construction Stage at Head Quarter

In order to promote this project during construction work and full-scale construction, we consider the personnel allocation of head office and field office under the organization shown above as follows:

Table 4.1.3-2 Manpower for Pre and Peak Construction period at Chief Engineer office in Head Quarters

Designation	Pre-Construction and Peak Construction Period
Chief Engineer	1
Addl. Chief Engineer	2
Addl. Gneral Manager (F&A)	1
Sr. Manager (HR&A)	1
Superintending Engineer (Civil)	2
Superintending Engineer (Elect.)	1
Superintending Engineer (C/M)	1
Divisional Engineer (Civil)	2
Divisional Engineer (Elect.)	2
Divisional Engineer (C/M)	1
Manager (F&A)/ Assistant Manager (F&A)	1
Assistant Engineer (Civil)	4
Assistant Engineer (Elect.)	2
Assistant Engineer (M)	1
Junior Executive (Finanace)	2
Assistant Cash Officer	1
Office Executive	5
Office Support Hand	8
Total	**38**

(source: Detailed Project Report of Turga Pumped Storage Power Plant, WBSEDCL 2016)

Table 4.1.3-3 Manpower for Pre and peak Construction period at Project Manager Office in Site

Designation	**Pre-Construction period**	**Peak Construction Period**
Addl. Chief Engineer and Project Manager	1	1
Superintending Engineer (Civil)	2	5
Superintending Engineer (Elect.)	1	2
Superintending Engineer (C/M)	0	1
Sr. Security Officer	1	1
Divisional Engineer (Civil)	5	12
Divisional Engineer (Elect.)	2	3
Divisional Engineer (Mech.)	0	1
Divisional Engineer (C/M)	0	2
Manager (HR&A)	0	1
Manager (HR&A)/AM(HR&A)	1	0
Manager (F&A)	1	1
Manager (Store)	0	1
Security Officer	1	1
Assistant Engineer (Civil)	6	24
Assistant Engineer (Elect.)	4	6
Assistant Engineer (Mech.)	0	2
Assistant Engineer (C/M)	0	4
Assistant Manager (F&A)	1	1
Assistant Manager (HR&A)	0	1
Assistant Manager (Store)	1	1
Assistant Security Officer	2	2
Medical Officer	2	2
Sub Assistant Engineer (Civil)	4	6
Sub Assistant Engineer (Elect.)	2	4
Junior Executive (Finance)	2	2
Junior Manager (HR&A)	1	1
Junior Manager (Store)	1	1
Cash Officer	2	2
Office Executive	4	8
Surveyor	2	2
Technical Support Hand/Office Suppo	22	30
Total	**71**	**131**

(source: Detailed Project Report of Turga Pumped Storage Power Plant, WBSEDCL 2016)

(3) Organizational structure after the start of Turga PSP operation

Regarding the maintenance and management system after the Turga PSP started operations, it seems that the operation and management system equivalent to that of the existing Purulia PSP are implemented.

(Not be disclosed per internal corporate information)

(source: Organization Structure & Manpower Setup, WBSEDCL 2011)

Figure 4.1.3-5 Organization Chart of Post-construction Stage at Head Quarter

(4) Technical aspects, background of the project

WBSEDCL, the main body of implementation of the Turga PSP, is an operating company of India's largest pumped-storage power plant Purulia, which began operation in 2007 (output 900 MW), and this project is scheduled for the nighttime peak zone after 2022 as an important supply capability to compensate for the power shortage.

The Purulia PSP has been operating for about 10 years since its inception in 2008, and during that time, based on the experience of maintaining and operating without major troubles, as a technical level and a operating experience of similar power stations, it is thought that it has sufficient experience.

In WBSEDCL's ANNUAL REPORT & ACCOUNTS 2016 - 2017, the total efficiency as a performance indicator of the power plant was recorded as the achievement of the Purulia power station, exceeding the design efficiency of 75.5%.

Turga PSP is equivalent to that of Purulia power plant with 1000 MW of power output and each 250 MW × 4 units, so WBSEDCL, which has experience in construction and maintenance operation of existing Purulia power plant, is a suitable business implementation company.

(5) Financial Aspect

1) Actual Situation

i) Energy Volume

WBSEDCL is a distribution company which supplies energy to the West Bengal State as a whole. In addition to the energy generated at hydropower plants owned and operated by the company, they purchase energy from the Central Sector (NTPC, NHPC, import from Bhutan, etc.), State Sector (WBPDCL, etc.) and Private Sector, which is necessary for distribution.

Table 4.1.3-4 indicates the transition of volume of energy sale, energy purchase and generation by WBSEDCL for the past five years. The amount for three years from 2011-12 shows a tendency of increase, but that for 2015-16 was decreased below the previous year due to the low demand.

Table 4.1.3-4 Transition of Energy Sale, Purchase and Generation

(Unit: MU)

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Sales	22,201.28	25,069.25	25,395.80	27,250.69	26,175.77	26,540.55
Purchase	30,794.48	34,111.65	35,152.39	37,812.72	36,825.27	37,576.52
Generation	1,180.74	1,250.30	1,314.63	1,902.81	1,565.14	1,620.23

(source: WBSEDCL Annual Report 2012-2017)

ii) Electricity Tariff

Electricity tariff of WBSEDCL is approved after scrutiny by WBERC annually through a tariff petition filed to WBERC, which is calculated from the actual amount in the previous year or a normative unit rate stipulated by WBERC. Recently tariff for three years are approved as Multi Year Tariff, however, annual performance review is made for adjustment of the tariff based on the actual amount of expenses. Table 4.1.3-5 shows average electricity tariff for the past five years.

Table 4.1.3-5 Average Electricity Tariff

(Unit: Rs/kWh)

FY	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Tariff	6.05	6.07	6.09	6.56	6.55	6.89
Date	01.12.2012	01.12.2012	26.12.2013	04.03.2015	10.08.2015	28.10.2016

(source: WBSEDCL)

iii) Distribution Loss Rate

Relatively high loss rate of distribution companies in India is considered as a national problem, and discussions have been made to decrease the rate also at the central level by Ministry of Power and CEA. Naturally WBSEDCL has been implementing various countermeasures to decrease the loss rate, however, any remarkable results have been obtained. Table 4.1.3-6 indicates the loss rate of WBSEDCL.

Table 4.1.3-6 AT&C Loss and Distribution Loss of WBSEDCL

	2012-13	2013-14	2014-15	2015-16	2016-17
AT&C loss	31.56%	30.51%	29.95%	29.84%	28.96%
Volume	8,817MU	8,844MU	9,392MU	9,564MU	9,787MU
Distrib. loss	25.40%	27.96%	27.60%	27.74%	27.47%

(source: WBSEDCL)

On the other hand, WBERC stipulates the normative distribution loss rate of distribution companies in its tariff regulation. Table 4.1.3-7 indicates the loss rates for WBSEDCL.

Table 4.1.3-7 Normative Distribution Loss of WBSEDCL

	2011-12	2012-13	2013-14	2015-16 onward
Loss rate	17.75%	17.50%	17.50%	17.50%

(source: The Kolkata Gazette, April 29, 2011 and July 30, 2013)

2) Financial Situation

Financial situation of WBSEDCL for the past five years is analyzed. Table 4.1.3-8 indicates Profit and Loss Statement, Table 4.1.3-9 Balance Sheet, and Table 4.1.3-10 Cash Flow Statement.

Financial statements of WBSEDCL has been made on GAAP (Generally accepted accounting principles in India) until FY2015-16, however, they are replaced with the Ind AS (Indian Accounting Standard) in FY 2016-17. This accompanies particulars and summation different from the previous standard, so it was found out that direct comparison with the amounts for the previous years is difficult. Therefore, the analysis has been made with the statements up to FY2015-16.

Table 4.1.3-8 Profit and Loss Statement of WBSEDCL

(Unit: Lakh Rs)

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1. (a) Revenue from operations	1,408,230	1,741,710	1,775,889	1,692,076	1,604,691	1,787,888
(b) Other Operating Revenue				51,958	44,666	47,267
(c) Amount Realisable through Regulatory Mechanism				199,752	205,436	
(d) Other income	9,055	8,275	12,103	14,548	6,337	33,624
Total Revenue	1,417,285	1,749,985	1,787,992	1,958,334	1,861,130	1,868,788
2. Expenses						
(a) Purchases of Power & Transmission Charges	1,156,768	1,449,530	1,431,565	1,552,893	1,417,230	1,496,926
(b) Employee benefits expenses	90,823	96,125	117,065	113,933	117,193	120,571
(c) Finance costs	68,724	81,271	107,804	136,202	145,157	171,885
(d) Depreciation	34,138	39,622	47,131	61,902	65,791	88,378
(e) Other expenses	56,569	72,601	81,466	90,400	112,241	105,078
Total Expenses	1,407,022	1,739,149	1,785,031	1,955,330	1,857,612	1,995,501
3. Profit before exceptional and extraordinary items						
and Tax (1-2)	10,263	10,836	2,961	3,004	3,518	
4. Exceptional items	0	0	0	0	0	
5. Profit before extraordinary items and Tax (3 - 4)	10,263	10,836	2,961	3,004	3,518	
6. Extraordinary items	0	0	0	0	0	
7. Profit (+) / Loss (-) before Tax (5 - 6)	10,263	10,836	2,961	3,004	3,518	
8. Tax expenses:						
(a) Current tax	2,915	2,664	1,054	1,022	1,360	196
(b) Deferred tax	0	0	0	0	0	0
Sub-Total	2,915	2,664	1,054	1,022	1,360	196
9. Net Profit (+) / Loss (-) for the period (7-8)	7,348	8,172	1,907	1,982	2,158	
10. Earning per equity share of face value of 10 each						
(a) Basic and diluted EPS before Extraordinary items - (in)	0.29	0.36	0.08	0.09	0.10	
(b) Basic and diluted EPS after Extraordinary items - (in)	0.29	0.36	0.08	0.09	0.10	

(source: WBSEDCL annual report 2011-2017)

Table 4.1.3-9 Balance Sheet of WBSEDCL

(Unit: Lakh Rs)

Particulars	2012/3/31	2013/3/1	2014/3/1	2015/3/31	2016/3/31	2017/3/31
I. EQUITY AND LIABILITIES						
1. Shareholders' funds						
(a) Share capital	255,840	225,674	225,674	225,674	225,674	225,674
(b) Reserves and surplus	275,814	345,132	366,895	496,927	636,360	13,500
Sub-Total	**531,654**	**570,806**	**592,569**	**722,601**	**862,034**	**239,174**
2. Share application money pending allotment	0	0	0	0	0	0
Sub-Total	**0**	**0**	**0**	**0**	**0**	**0**
3. Non-current liabilities						
(a) Long-term borrowings	564,459	609,754	767,474	759,665	849,105	
(b) Defered tax liabilities (Net)	0	0	0	0	0	
(c) Other long term liabilities	535,531	675,147	720,835	831,165	870,248	
(d) Long-term provisions	17,745	21,663	24,728	25,652	23,198	
Sub-Total	**1,117,735**	**1,306,564**	**1,513,037**	**1,616,482**	**1,742,551**	**2,058,073**
4. Current liabilities						
(a) Short-term borrowings	129,041	271,977	314,508	342,019	430,597	
(b) Trade payables	165,297	289,107	341,618	388,286	367,121	
(c) Other current liabilities	85,760	97,160	162,684	265,121	298,883	
(d) Short-term provisions	249,066	258,357	297,109	276,149	360,588	
Sub-Total	**629,164**	**916,601**	**1,115,919**	**1,271,575**	**1,457,189**	**1,785,540**
Total	**2,278,553**	**2,793,971**	**3,221,525**	**3,610,658**	**4,061,774**	***3,542,750**
II. ASSETS						
1. Non-current Assets						
(a) Fixed assets						
(i) Tangible assets	962,574	1,079,996	1,281,738	1,479,271	1,592,234	
(ii) Intangible assets	0	0	2,018	1,938	3,064	
(iii) Capital work-in-progress	192,172	218,670	179,257	138,520	141,326	
(iv) Intangibe assets under development	0	0	0	0	0	
Sub-Total (i+ii+iii+iv)	**1,154,746**	**1,298,666**	**1,463,013**	**1,619,729**	**1,736,624**	
(b) Non-current investments	801	1,190	1,190	1,069	894	
(c) Deferred tax assets (net)	0	0	0	0	0	
(d) Long-term loans and advances	30,298	53,587	34,073	38,564	81,712	
(e) Other non-current assets	208,714	534,696	392,482	616,111	443,929	
Sub-Total (b+c+d+e)	**239,813**	**589,473**	**427,745**	**655,744**	**526,535**	**1,964,433**
2. Current assets						
(a) Current investments	0	0	0	0	0	
(b) Inventories	50,820	57,005	66,142	54,309	54,002	
(c) Trade receivables (incl. Unbilled Revenue)	309,482	449,162	498,222	571,633	624,127	
(d) Cash and Bank Balances	130,704	130,938	141,130	149,369	214,963	
(e) Short-term loans and advances	15,247	7,686	8,316	13,132	35,700	
(f) Other current assets	377,741	261,041	616,957	546,742	869,823	
Sub-Total	**883,994**	**905,832**	**1,330,767**	**1,335,185**	**1,798,615**	**960,183**
Total	**2,278,553**	**2,793,971**	**3,221,525**	**3,610,658**	**4,061,774**	***3,542,750**
*Note: Total amounts for 2017/3/31 include those for other particulars.						

(source: WBSEDCL annual report 2011-2017)

Table 4.1.3-10 Cash Flow Statement of WBSEDCL

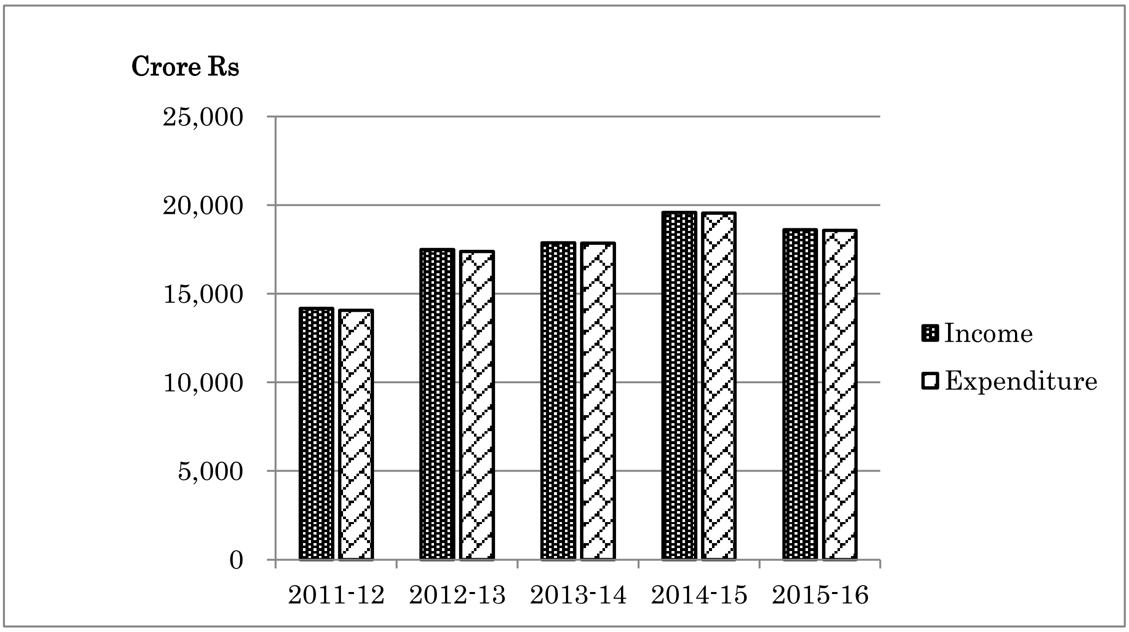
(Unit: Lakh Rs)

Particulars	2011-2012	2012-2013	2013-2014	2014-15	2015-16	2016-17*
A. CASH FLOW FROM OPERATING ACTIVITIES :						
Net Profit/(Loss) Before Taxation & Extraordinary items	10,263	10,836	2,961	3,004	3,518	4,865
Adjustment For :						
Depreciation	35,789	40,881	48,092	62,432	65,791	88,378
Interest & Financial Charges	68,724	81,271	107,804	126,515	134,900	140,999
Bad Debts & Provision	4,580	7,029	4,052	1,737	2,856	2,328
Excess provision written back				(1,949)	(126)	
Interest/Dividend etc. Income	(4,279)	(4,332)	(5,815)	(7,732)	(2,435)	
Sub-Total	115,077	135,685	157,094	184,007	204,504	
Operating Profit Before Working Capital Change						227,934
Adjustment For :						
Stores & Spares [Inventories]	16,718	6,185	9,152	(11,833)	807	(3,549)
Sundry Debtors [Trade Receivables]	150,895	141,206	50,772	75,148	54,236	31,421
Other Current Assets	222,606	209,281	213,702	151,664	151,606	10,835
Loan & Advances	(3,339)	15,728	(18,884)	4,816	22,393	(5,147)
Current Liabilities & Provision, etc	(286,207)	(288,035)	(208,889)	(142,560)	(108,430)	(42,673)
Sub-Total	100,673	84,365	45,853	77,235		(9,113)
Regulatory Deferral Account						(89,363)
Cash Generation from operation					83,892	326,410
Tax Paid (net)					1,394	2,143
NET CASH FROM OPERATING ACTIVITIES (A)	**14,404**	**51,320**	**111,241**	**106,772**	**82,498**	**324,267**
B. CASH FLOW FROM INVESTING ACTIVITIES						
Decrease (Increase) in Fixed Asets	(169,898)	(166,064)	(260,332)	(272,755)	(195,793)	(226,526)
Decrease (Increase) in Work in Progress	(39,575)	(26,498)	39,413	50,047	(45,920)	25,537
(Increase)/Decrease in Investments	(48,113)	(7,388)	(9,535)	(34,378)	1,121	(41,643)
Interest/Dividend Income	4,059	3,925	5,660	5,982	3,142	(231)
NET CASH GENERATED FROM INVESTING ACTIVITIES (B)	**(253,527)**	**(196,025)**	**(224,794)**	**(251,104)**	**(237,450)**	**(242,863)**
C. CASH FLOW FROM FINANCING ACTIVITIES						
Proceeds from Borrowing (Net)	175,507	188,231	200,251	81,341	182,724	(159,750)
Proceeds from Share Capital	0	(30,166)	0	0	0	0
Proceeds from Consumers contribution & capital subsidy						145,027
(Reserve & Surplus)	118,484	61,146	21,763	140,921	153,190	
Interest & Financial Charges	(68,724)	(81,271)	(107,804)	(104,069)	(114,247)	(123,973)
NET CASH GENERATED FROM FINANCING ACTIVITIES (C)	**225,267**	**137,940**	**114,210**	**118,193**	**221,667**	**(138,696)**
NET INCREASE (DECREASE) IN CASH & CASH EQUIV						
(A+B+C)	(13,856)	(6,765)	657	(26,139)	66,715	(57,292)
CASH & CASH EQUIV. AT THE BEGIN. OF THE YEAR	87,439	73,583	66,818	67,475	41,336	(270,346)
CASH & CASH EQUIV. AT THE END OF THE YEAR	73,583	66,818	67,475	41,336	108,051	(327,638)
Note: Amounts for FY 2016-17 are calculated based on Ind AS, which is different from the previous years.						

(source: WBSEDCL annual report 2011-2017)

i) Summary of Profit and Loss Statement

Figure 4.1.3-6 shows the summary of Profit and Loss Statement.



(source: JICA study team preparation)

Figure 4.1.3-6 Summary of Profit and Loss Statement

As stated above, the energy sales volume decreased due to decline of demand in FY2015-16 as compared with the previous year, and the income decreased from 19,583 Crore Rs to 18,611 Crore Rs.

On the other hand, decrease in the corresponding power purchase volume as well as unit cost of power purchase, the expenditure also decreased from 19,553 Crore Rs to 18,576 Crore Rs. As a result, in spite of the decrease in income, the net benefit increased slightly from 19 Crore Rs to 22 Crore Rs. It is usual for WBSEDCL to have much the same amount for income and expenditure, and obtained only a slight profit for years.

Table 4.1.3-11 indicates the percentage of expenditure against revenue.

Table 4.1.3-11 Percentage of Expenditure in Revenue

FY	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Revenue	14,173	17,500	17,880	19.583	18,611	19,932
Expenditure	14,070	17,391	17,850	19,553	18,576	19,883
Percentage	99.3%	99.4%	99.8%	99.8%	99.8%	99.8%

(source: JICA study team preparation)

Tariff regulation stipulated by WBERC, which is a regulatory authority of power sector in West Bengal State, is prepared based on a concept of cost-plus, and the return on equity of 16.5% for generation and 15.5% for distribution is admitted. Nevertheless, the net profit is less than one percent of revenue, which is too small for the revenue amount. One of the reasons is the distribution loss of some 30%, which is in the high side in India.

As seen in the above table, there is a ten-point difference between the normative level stipulated by WBERC and the actual level of the distribution loss. On the other hand, due to the fact that the loss rate has been stagnating, WBERC does not approve inclusion of power purchase cost corresponding to the energy amount calculated from the difference between normative rate and actual rate into electricity tariff rate. The disapproved cost amounts to 705 Crore Rs in FY2011-12.

Basically a lot of cost items are admitted to be included into electricity tariff based on its actual expenditure, therefore, the tariff tends to rise. On the other hand, reflecting the intension of the State Government to avoid sharp rise in tariff level, there have been such cases to keep the tariff level temporarily low by passing part of the cost on to the future tariff. This has created a Regulatory Asset, and it is considered as one of the financial problems in WBSEDCL. Table 4.1.3-12 shows the amount of Regulatory Asset.

Table 4.1.3-12 Amount of Regulatory Asset

(Unit: Crore Rs)

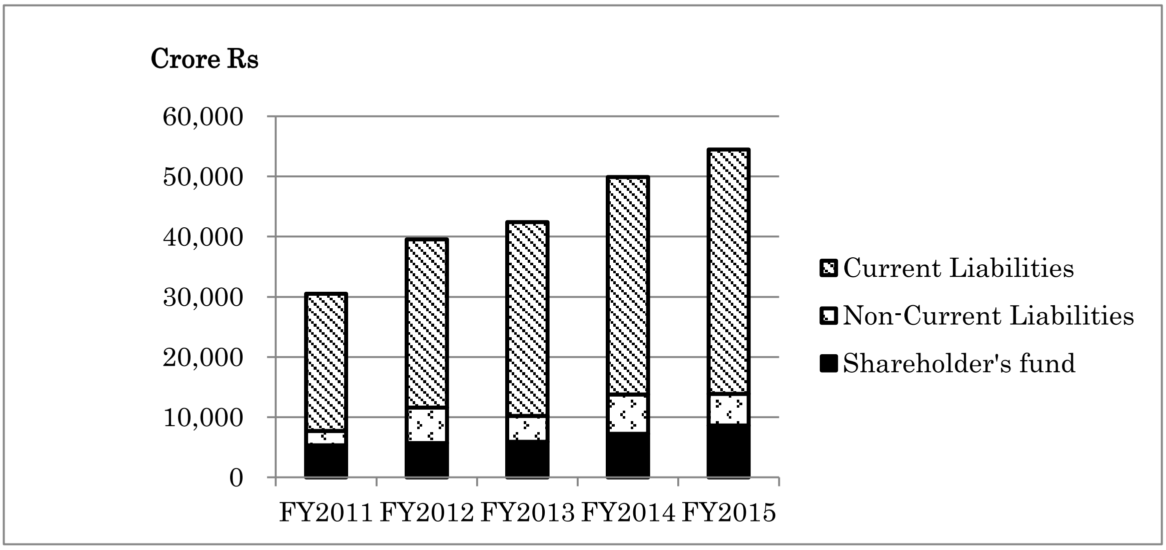
As of	Mar. 2012	Mar. 2013	Mar. 2014	Mar. 2015	Mar. 2016
Amount	5,396.7	6,132.7	8,895.3	10,892.8	12,947.2

(source: WBSEDCL Annual report 2011-2016)

A great attention on this problem had been paid by the State Government, and in order to partly solve the problem, and the Government supplied a grant to WBSEDCL and ABPDCL in September 2016 with a total amount of 4,563 Crore Rs. WBSEDCL received 2,647 Crore Rs and the amount of 1,655 Crore Rs was applied to set off the Regulatory Asset, and the rest is said to be used as an adjustment fund in the future.

ii) Summary of Balance Sheet

Figure 4.1.3-7 shows the Balance Sheet of WBSEDCL.



(source: JICA study team preparation)

Figure 4.1.3-7 Summary of Balance Sheet

The figure indicates that current liabilities occupy a large part and the amount of a short term borrowing has been increased year by year. The major reason would be that short term borrowing for working capital is necessary resulting from the time required for scrutiny by WBREC on annual performance review to reflect the actual expenses eligible for adjustment of electricity tariff.

iii) Summary of Cash flow statement

Cash flow statement indicates that there has been a trend of Cash flow from operating and financial activities are in surplus, while that for investing activities are in deficit. WBSEDCL has a surplus in profit before tax, and also in cash flow from operating activities. This indicates that the company has a sound cash flow. Deficit in investing activities have been continuing, however, this may be attributed to expenses mainly for rural electrification and/or reinforcement of distribution network, which will be a future source of income. The amount of cash flow from operating is not so large and it is not possible to cover the cash flow for investing activities; this requires borrowing, and the cash flow from financing activities has been large.

3) Financial indicators

Financial situation of WBSEDCL has been evaluated from the following three viewpoints: profitability, stability and debt service. Table 4.1.3-13 shows a list of financial indicators.

Table 4.1.3-13 Financial Indicators

	2011-12	2012-13	2013-14	2014-15	2015-16	Eval.
Return on Equity (%)	1.38	1.43	0.32	0.27	0.25	higher
Return on net worth (%)	1.36	1.47	0.33	0.28	1.01	higher
Current Ratio	1.41	0.99	1.18	1.05	1.23	1.3 <
Debt Equity Ratio	2.10	6.23	7.06	7.53	8.18	< 1.0
Debt Service Coverage Ratio	1.26	1.33	1.21	1.23	1.29	1.3 <
Interest Coverage Ratio	1.68	1.64	1.46	1.48	1.52	1.5 <

(source: WBSEDCL Annual Report 2011-2016)

i) Profitability

- Return on equity（ROE）＝ net profit / equity
- Profitability on sales ＝ net profit／revenue amount

These are the indicators which show how much is the profitability on equity or revenue amount, and the higher, the better.

The indicators for the profitability of WBSEDCL have been stagnating. Actually, although profit of WBSEDCL has continuously been in surplus, the amount is very small; therefore their profitability is very low.

ii) Stability

- Current ratio ＝ Current asset / Current liabilities

Current ratio is an indicator which shows the ability of payment in a short term. Desirable figure is considered to be 1.3 or more, and attention shall be paid in case of 1.0 or less. After FY2012-13, the figure has been less than 1.3.[4] As mentioned earlier, this is considered due to the increase in short term borrowing.

- Debt Equity Ratio ＝ (Fixed Asset + Current Liabilities) / equity

Debt Equity Ratio is an indicator to show how much is the liability against equity, and indicate the stability of the company. Desirable figure is less than 1, and the lower, the more stable. The figure for WBSEDCL has been increasing year by year, and reached to 8.18 in FY2015-16. This indicates that there ability for payment in short term is questionable.[5]

iii) Debt service

- Debt service coverage ratio (DSCR)

DSCR is an indicator to show the ability of debt service by evaluating how much cash flow is generated to cover the amount of debt service. The desirable figure is considered to be 1.2 - 1.3

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[4] Figures calculated under Ind AS are 1.38 for FY2015-16, and 1.19 for FY2016-17.

[5] Figures calculated under Ind AS are 5.50 for FY2015-16, and 4.65 for FY2016-17, thus decreasing tendency.

or more. WBSEDCL has the figures around 1.2 and 1.3.[6]

- Interest Coverage Ratio (ICR) ＝ Operating profit / Interest payment

ICR is an indicator to show how much the operating profit and financial revenue exceed the interest payment. The higher the more financially affordable. The desired figure is considered to be 1.5 or more. The figures for FY2013-14 and 2014-15 were below the acceptable level, but recovered to 1.52 in FY2015-16.[7] From this indicator, WBSEDCL barely has an ability for debt service.

According to the tariff regulation of WBERC, the expenses spent for principal repayment and interest payment are eligible for tariff calculation, therefore, sources for debt service are regarded to be secured.

4) Budget and Expenditures

WBSEDCL prepares annual budget for the next fiscal year in September, and it is revised in September in the fiscal year. Revision is made based on the actual amount for each quarter, as well increase/decrease of expenditure, additional works, etc. Revised budget is required to be approved by the board of directors of WBSEDCL.

As to the budget for Turga Pumped Storage Project, annual and phase-wise budgets are prepared after conclusion of the Loan Agreement, and they are reviews annually. The budget has to be approved by the board of directors, Department of Finance, and the State Cabinet.

15 % of the Project cost is secured as an equity portion, and it is managed by the Financial Department of Finance. If additional budget is required for equity portion, it will be borne by the Department of Finance. For this purpose, the necessity is discussed by the board of directors of WBSEDCL to be held one a month, and procedure is taken for approval of budget increase by the Department of Finance. The budget is reimbursed to WBSEDCL based on the amount of actual expenditure, WBSEDCL would be required to bear the cost temporarily until the reimbursement is made, though the period is short.

4.1.4 West Bengal State Electricity Transmission Company Ltd. (WBSETCL)

(1) Organization

As of 2017, WBSETCL employs 884 engineers, 956 technicians, 32 technical assistants, secretaries, 145 managers, 234 clerical workers, pharmacists, 139 assistants and so on.
At the end of 2017, the total number of employees is 2,390.
Figure 4.1.4-1 shows the organization chart of WBSTCL.

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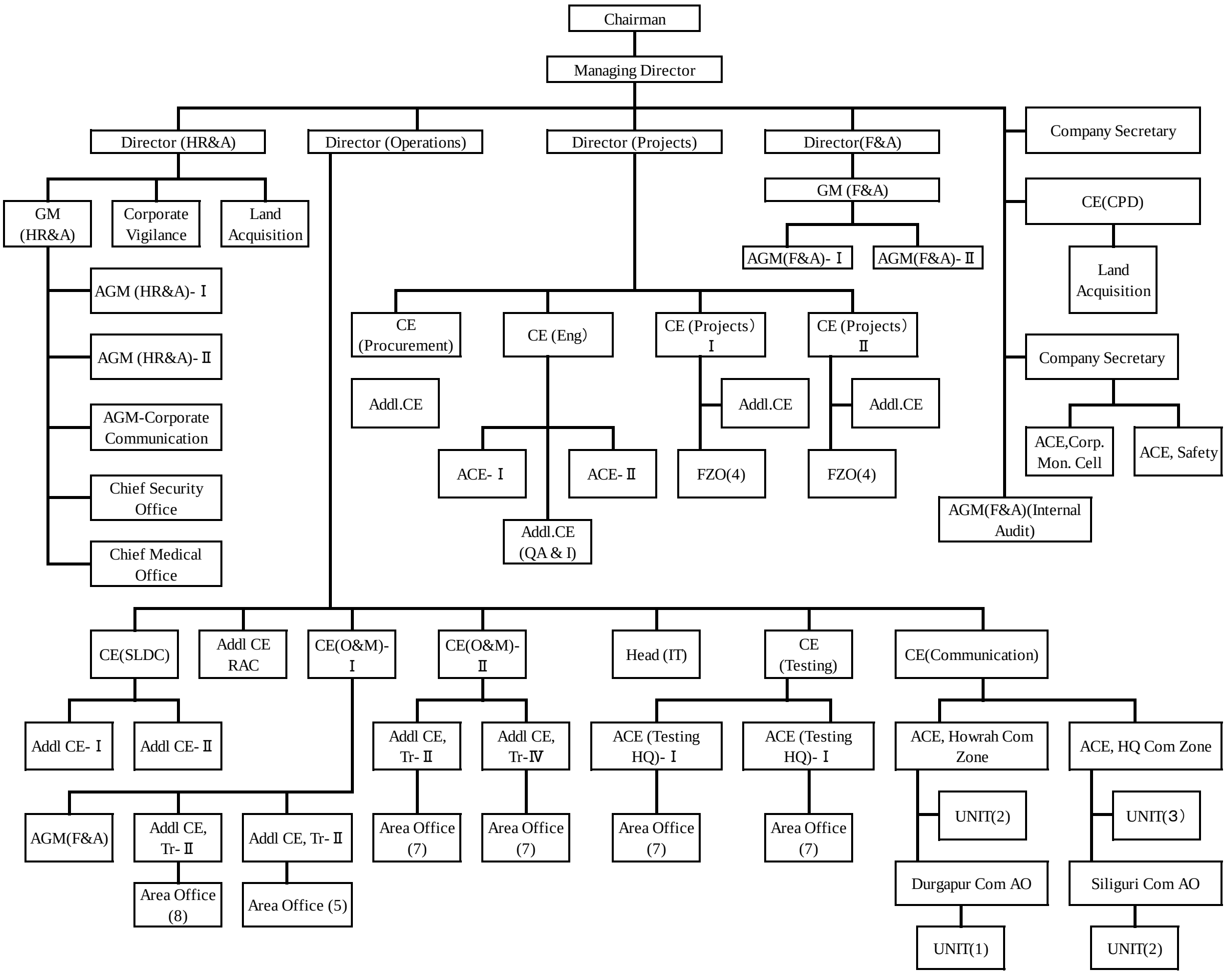
[6] Figures calculated under Ind AS are 1.36 for FY2015-16, and 1.45 for FY2016-17.

[7] Figures calculated under Ind AS are 1.56 for both FY2015-16, and FY2016-17.



(source: 2015-2016 Annual Report of WBSETCL)

Figure 4.1.4-1 Organization Chart of WBSETCL

(2) Technical aspects (background and so on)

Technical approach of WBSETCL, operation results of total substation equipment, plan etc. will be detailed in the project maintenance and management system.

In WBSETCL, internal regulations have been developed since the separation, and management improvements are being made. WBSETCL have introduced Quality Management System (QMS) in order to improve the quality of the work in the organization.

The QMS is a business system that can be certified if it is recognized that the series of processes are applied as a system together with documentation, clarification of business processes, grasping / managing interrelationships of the work, and management. It is considered to be the same system as ISO 9001.

Total Quality Management (TQM), which was started before separation, is carried out at each work organization after separation, and its results are also regarded as important in WBSETCL. In 2009, at 13 high voltage substations have acquired ISO 9001: 2000.

(3) Financial Aspects

1) Actual situation

i) Summary of the facilities and energy volume

WBSETCL is a transmission company covering the entire area of West Bengal State. Main services to supply energy purchased from the Central Sector (NTPC, NHPC, import from Bhutan, etc.), State Sector (WBSEDCL, WBPDCL, etc.) and Private Sector to distribution companies as WBSEDCL, CSCE, DLP through their transmission lines and substations. They also supply energy to outside the State.

Table 4.1.4-1 indicates the transformation capacity, transmission line length and volume of energy flow in the past five years. Transformation capacity increased by 33% from 19,236MVA to 24,550MVA, transmission line length increased by 13 % from 11,095c-km to 12,043c-km, and the volume of energy flow increased by 25 % from 34,750MU to 41,423MU in the period.

Table 4.1.4-1 Facilities and Energy Flow

Item	2011-12	2012-13	2013-14	2014-15	2015-16
Transformation Capacity (MVA)	19,236	21,670	23,290	24,550	25,661
Transmission Length (circuit-km)	11,095	11,445	11,951	12,043	12,584
Energy Flow in Grid (MU)	34,750	37,030	36,976	41,423	43,344

(source: WBSETC Annual Report 2015-16)

ii) Transmission tariff

Transmission tariff of WBSETCL is approved after scrutiny by WBERC annually through a tariff petition filed to WBERC, which is calculated from the actual amount in the previous year or a normative unit rate stipulated by WBERC. The tariff is basically established under the concept of "COST-PLUS", and a fee of 15.5% on equity is admitted.

iii) Transmission loss rate

Table 4.1.4-2 Technical Loss of WBSETCL

(Not be disclosed per internal corporate information)

(source: WBSETCL)

WBERC stipulates the loss rate of the transmission company in its tariff regulation. Table 4.1.4-3 indicates the normative loss rate for WBSETCL.

Table 4.1.4-3 Normative Transmission Loss of WBSETCL

	2011-12	2012-13	2013-14	2014-15 onward
Loss rate	3.60 %	3.50 %	3.40 %	3.40 %

(source The Kolkata Gazette, April 29, 2011 and July 30, 2013)

2) Financial situation

Financial situation of WBSETCL for the past five years is analyzed. Table 4.1.4-4 indicates Profit and Loss Statement, Table 4.1.4-5 Balance Sheet, and Table 4.1.4-6 Cash Flow Statement.

Table 4.1.4-4 Profit and Loss Statement of WBSETCL

(Unit: Lahk Rs)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17
1. Revenue from operations					
Income from Services	101,028	106,863	102,079	124,267	125,892
2. Other income	1,606	2,899	(65)	2,368	3,662
Total Revenue	**102,634**	**109,762**	**102,013**	**126,635**	**129,553**
2. Expenses					
(a) Employee benefits expenses	13,273	15,288	14,741	17,053	23,562
(b) Finance costs	18,834	20,007	23,254	22,157	23,856
(c) Depreciation and amortization expense	13,700	14,583	16,629	17,425	19,578
(d) Other expenses	15,194	14,134	13,323	14,428	15,370
Total Expenses	**61,001**	**64,012**	**67,946**	**71,063**	**82,366**
3. Profit before exceptional and extraordinary items and Tax (1-2)	**41,633**	**45,750**	**34,067**	**55,572**	**47,188**
4. Exceptional items	0	1,157	0	0	0
5. Profit before extraordinary items and Tax	41,633	46,907	34,067	55,572	47,188
6. Extraordinary items	0	(252)	0	0	0
7. Profit (+) / Loss (-) before Tax (5 - 6)	**41,633**	**46,655**	**34,067**	**55,572**	**47,188**
8. Tax expenses:					
(a) Current tax	8,330	9,779	7,141	11,860	10,071
(b) Deferred tax	0	0	0	0	0
Sub-Total	8,330	9,779	7,141	11,860	10,071
9. Net Profit (+) / Loss (-) for the period (7-8)	**33,302**	**36,876**	**26,926**	**43,712**	**37,117**
10. Earning per equity share					
(nominal value of share Rs.10)					
(a) Basic	3.01	3.34	2.44	3.95	3.36
(b) Diluted	3.01	3.34	2.44	3.95	3.36

(source: WBSETCL annual report 2012-2017)

Table 4.1.4-5 Balance Sheet of WBSETCL

(Unit: Lakh Rs)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17
I. EQUITY AND LIABILITIES					
1. Shareholders' funds					
(a) Share capital	110,552	110,552	110,552	110,552	110,552
(b) Reserves and surplus	96,309	133,185	160,761	205,577	246,749
Sub-Total	**206,861**	**243,737**	**271,313**	**316,129**	**357,301**
2. Non-current liabilities					
(a) Long-term borrowings	213,449	215,072	236,850	259,453	281,530
(b) Other long term liabilities	10,760	11,721	19,245	27,350	10,919
(c) Long-term provisions	459	830	1,253	5,738	7,330
Sub-Total	**224,668**	**227,622**	**257,348**	**292,540**	**299,779**
3. Current liabilities					
(a) Short-term borrowings	15,500	23,334	20,550	10,628	10,752
(b) Trade payables	4,962	3,783	4,508	5,668	6,465
(c) Other current liabilities	41,992	41,622	45,083	59,488	110,879
(d) Short-term provisions	113	75	59	743	773
Sub-Total	**62,568**	**68,814**	**70,201**	**76,527**	**128,868**
Total	**494,097**	**540,173**	**598,862**	**685,197**	**785,948**
II. ASSETS					
1. Non-current assets					
(a) Fixed assets					
(i) Tangible assets	357,246	382,685	416,211	456,661	504,016
(ii) Capital work-in-progress	75,788	74,548	95,706	123,351	178,168
(b) Long-term loans and advances	3,768	8,605	9,407	12,222	10,852
(c) Other non-current assets	0	11,176	4,471	4,471	4,076
Sub-Total	**436,802**	**477,015**	**525,796**	**596,704**	**697,112**
2. Current assets					
(a) Inventories	8,503	10,201	9,539	10,890	14,303
(b) Trade receivables	28,888	26,180	25,095	29,498	22,366
(c) Cash and bank balances	12,974	16,245	22,855	30,134	34,824
(d) Short-term loans and advances	4,307	5,855	8,966	8,917	2,070
(e) Other current assets	2,622	4,676	6,611	9,053	10,803
Sub-Total	**57,295**	**63,158**	**73,066**	**88,492**	**84,365**
					*** 4,471**
Total	**494,097**	**540,173**	**598,862**	**685,197**	**785,948**
* Regulatory deferral account debit balance					

(source: WBSETCL annual report 2012-2017)

Table 4.1.4-6 Cash Flow Sheet of WBSETCL

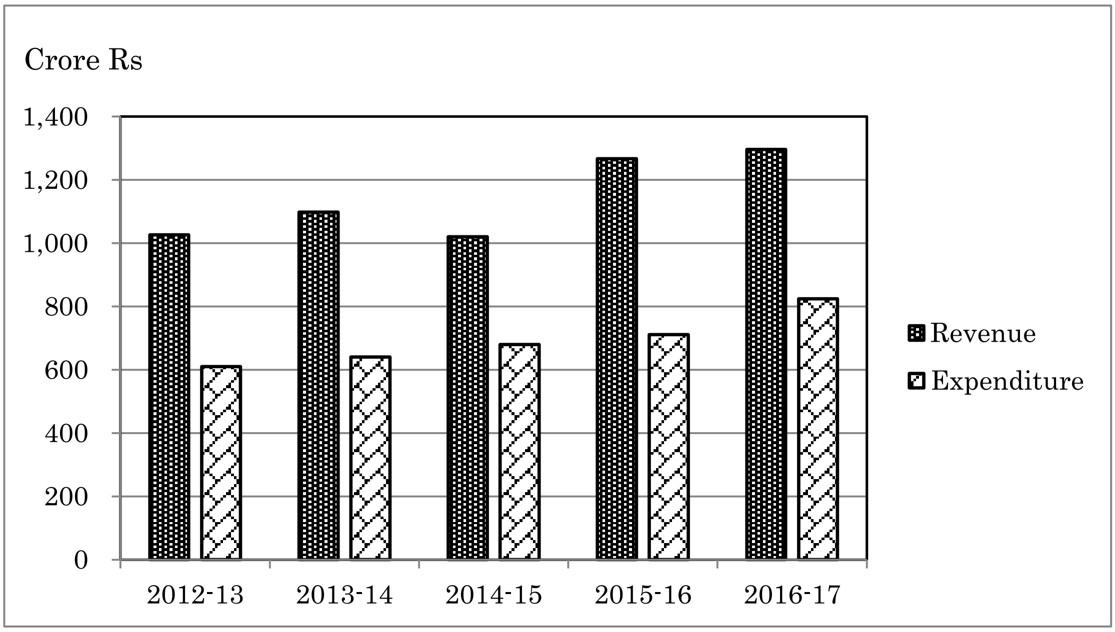
(Unit: Lahk Rs)

Particulars		2012-13	2013-14	2014-15	2015-16	2016-17
A	**A. CASH FLOW FROM OPERATING ACTIVITIES :**					
	Net Profit/(Loss) Before Taxation	41,633	46,655	34,067	55,572	47,188
	Adjustment For :					
	Depreciation	13,750	14,696	18,128	17,529	19,323
	Interest & Financial Charges	18,834	20,007	23,254	22,157	29,724
	Bad Debts & Provision					
	Excess provision written back					
	Interest/Dividend etc. Income	(1,006)	(970)	(1,909)	(1,996)	(2,741)
	Sub-Total	31,578	33,733	39,472	37,691	46,307
	Operating Profit Before Working Capital Change	73,211	80,388	73,539	93,263	93,494
	Adjustment For :					
	Stores & Spares	271	(1,699)	662	(1,351)	(3,413)
	Trade Receivables	(22,666)	(8,468)	7,790	(4,403)	7,132
	Other Current Assets	3,519	(2,096)	(1,975)	(2,360)	(834)
	Loan & Advances	17	(202)	(2,537)	(80)	0
	Current Liabilities & Provision, etc	8,819	2,953	11,680	23,307	33,647
	Sub-Total	(10,041)	(9,512)	15,620	15,113	36,533
	Cash Generation from operation	63,170	70,876	89,159	108,376	130,027
	Less: Tax Paid	(10,045)	(11,125)	(7,714)	(11,731)	(10,049)
	NET CASH FROM OPERATING ACTIVITIES (A)	**53,124**	**59,751**	**81,445**	**96,646**	**119,978**
B	**B. CASH FLOW FROM INVESTING ACTIVITIES**					
	Decrease (Increase) in Fixed Asets	(45,400)	(42,157)	(51,653)	(57,979)	(57,679)
	Decrease (Increase) in Work in Progress & Capital Advance	9,335	(3,597)	(21,960)	(30,459)	(58,081)
	Interest Incomes, etc.	1,006	970	1,909	1,996	2,957
	Grants Received from GoWB (DRS)	0	0	650	1,104	15
	NET CASH GENERATED FROM INVESTING ACTIVITIES (B)	**(35,059)**	**(44,785)**	**(71,054)**	**(85,338)**	**(112,788)**
C	**C. CASH FLOW FROM FINANCING ACTIVITIES**					
	Proceeds from Borrowing (Net)	(8,165)	8,311	19,473	18,129	22,494
	Interest & Financial Charges	(18,834)	(20,007)	(23,254)	(22,157)	(29,752)
	NET CASH GENERATED FROM FINANCING ACTIVITIES (C)	**(26,999)**	**(11,696)**	**(3,781)**	**(4,028)**	**(7,258)**
	NET INCREASE (DECREASE) IN CASH & CASH EQUIVALENTS					
	(A+B+C)	(8,933)	3,271	6,610	7,279	(69)
	CASH & CASH EQUIV. AT THE BEGINNING OF THE YEAR	21,908	12,974	16,245	22,855	30,134
	CASH & CASH EQUIVALENTS AT THE END OF THE YEAR	12,974	16,245	22,855	30,134	30,066

(source: WBSETCL annual report 2012-17)

i) Summary of Profit and Loss Statement

Figure 4.1.4-2 indicates the summary of Profit and Loss Statement.



(source: JICA study team preparation based on WBSETCL annual report)

Figure 4.1.4-2 Summary of Profit and Loss Statement

Total revenue for FY2014-15 decreased from 1,069 Crore Rs to 1,021 Crore Rs due to decrease in revenue from SLDC and short term open access. Except for this fiscal year, revenue amount has been annually increasing.

Table 4.1.4-7 indicates the percentage of expenses of WBSETCL against its revenue. The figure fluctuates from 71.5% in FY2011-12, but recently it has come to a level of around 60%. Annual average increase rate from FY2011to FY2016 is 13%, while that for expenditure remains around 9%; this indicates that the company has been managed properly.

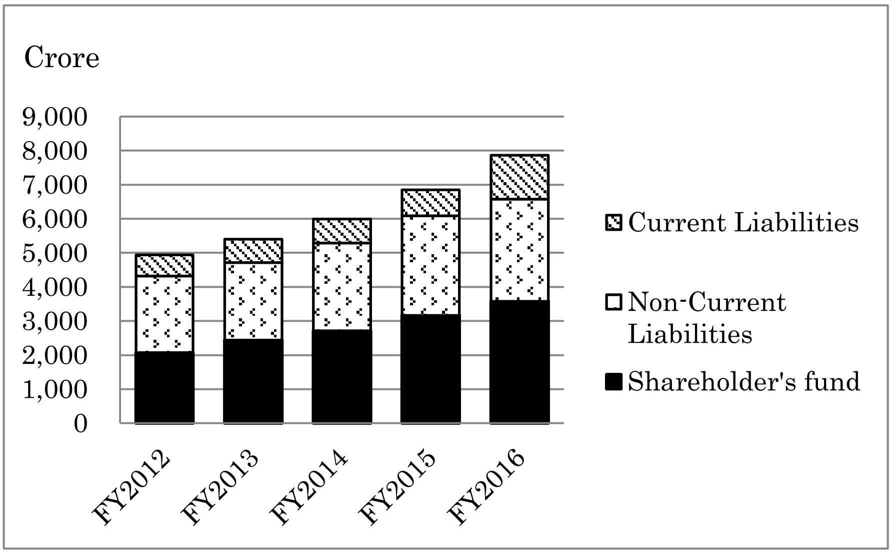
Table 4.1.4-7 Percentage of Expenditure in Revenue

FY	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Revenue	752	1,026	1,098	1,020	1,266	1,296
Expenditure	537	610	640	679	711	824
Percentage	71.5 %	59.4%	58.3 %	66.6 %	56.1 %	63.6 %

(source: WBSETCL annual report 2011-2017)

ii) Summary of Balance Sheet

Figure 4.1.4-3 indicate the summary of Balance Sheet.



(source: JICA study team preparation based on WBSETCL annual report)

Figure 4.1.4-3 Summary of Balance Sheet

Total assets of WBSETCL has been in an increasing trend, and marked some 160 % increase in the five years from FY2012 to FY2016. Equity has also increased by some 170 % in the same period. It is conspicuous that the current liabilities have increased by some 170% from FY2015 to FY2016.

iii) Summary of Cash Flow Statement

Cash flow statement shows that operating activities have been in surplus, while operating and financial activities in deficit. Due to the fact that WBSETCL earns profit before tax, and that operating activities maintains the surplus, the operation of the company is considered to be sound. Additionally, in spite of deficit in investing activities, the amount has been fully covered with the operating activities, thus their financial situation is judged as very sound.

3) Financial indicators

Financial situation of WBSEDCL has been evaluated from the following three viewpoints: profitability, stability and debt service. Table 4.1.4-8 shows a list of financial indicators.

Table 4.1.4-8 Financial Indicators

	2011-12	2012-13	2013-14	2014-15	2015-16	Eval.
Return on Equity (%)	16.1	15.1	9.9	13.8	10.4	higher
Return on Sales (%)	32.5	33.6	26.4	34.5	28.7	higher
Current Ratio	1.47	1.28	1.23	1.36	1.64	1.3 <
Debt Equity Ratio	1.49	1.18	1.00	0.99	0.95	< 1.0
Debt Service Coverage Ratio	1.19	1.81	1.90	1.69	2.21	1.0 <
Interest coverage Ratio	2.67	3.5	3.58	2.89	3.08	1.5 <

(source: WBSETCL Annual Report 2011-2016)

i) Profitability

- Return on equity (ROE) ＝ net profit / equity
- Profitability on sales ＝ net profit / revenue amount

These are the indicators which show how much is the profitability on equity or revenue amount, and the higher, the better.

The figures for ROE has been decreasing do to the fact that the reserves and surplus in shareholders' funds have increased annually by more than 20 %, The profitability has been fluctuating annually, however, generally high values have been maintained, and it is judged that they would not cause major problem.

ii) Stability

- Current ratio ＝ Current asset / Current liabilities

Current ratio is an indicator which shows the ability of payment in a short term. Desirable figure is considered to be 1.3 or more.

In FY2012 and FY2013, they recorded values under the standard, however, a recovery has been made afterwards attaining 1.36 in FY 2014 and 1.64 in FY2015. This indicate the financial soundness of WBSETCL.

- Debt Equity Ratio ＝ (Fixed Asset + Currrent Liabilities) / equity

Debt Equity Ratio is an indicator to show how much is the liability against equity, and indicate the stability of the company. Desirable figure is less than 1, and the lower, the more stable.

The figure for WBSETCL was low in FY2011 and FY2012, however, a recovery has been made afterwards attaining 0.95 in FY2015. This indicates that there is no problem in short term borrowing.

iii) Debt service

- Debt service coverage ratio (DSCR)

DSCR is an indicator to show the ability of debt service by evaluating how much cash flow is generated to cover the amount of debt service. The desirable figure is considered to be 1.2 – 1.3 or more. WBSETCL recorded a low figure of 1.19 in FY2015, however, a sharp recovery has been made afterwards, and attained 2.2 in FY2016. There is no problem in debt service with this level.

- Interest Coverage Ratio (ICR) ＝ Operating profit / Interest payment

ICR is an indicator to show how much the operating profit and financial revenue exceed the interest payment. The higher the more financially affordable. The desired figure is considered to be 1.5 or more.

WBSETCL maintains the figure over 2.5 after FY2011, therefore, it is judges that there is no problem from a viewpoint of cash earning for interest payment.

4) Budget and Expenditures

WBSETCL prepares annual budget for the next fiscal year in September, and it is revised in September in the fiscal year. Revision is made based on the actual amount for each quarter, as well increase/decrease of expenditure, additional works, etc. Revised budget is required to be approved by the board of directors of WBSETCL.

As to the budget for Turga Pumped Storage Project, annual and phase-wise budgets are prepared after conclusion of the L

4.2 PROJECT MAINTENANCE AND MANAGEMENT SYSTEM

4.2.1 West Bengal State Electricity Distribution Company Ltd.

(1) Operation plan

The existing hydropower plants of WBSEDCL are as follows.

1) Purulia Pumped Storage Project 4 × 225 MW (900 MW)
2) Teesta Canal Fall Hydro Project 3 × 3 × 7.5 MW (67.5 MW)
3) Rammam Hydro Project Stage II 4 × 12.75 MW (51 MW)
4) Jaldhaka Hydro Project Stage I 4 × 9 MW (36 MW)
5) Jaldhaka Hydro Project Stage II 2 × 4 MW (8 MW)
6) Massanjore Hydro Project 2 × 2 (4 MW)
7) Mini Hydro Power Project Total 9.6 MW

Operating results in 2016 - 2017 are shown below

Name of Power Stations	Generation Achieved in 2016-2017
Purulia Pumped Storage Project	1106.00 MU
Rammam Hydro Project Stage II	248.0678 MU
Jaldhaka Hydro Project	205.5084 MU
Teesta Canal Fall Hydro Project	46.6961 MU
Small Hydro	29.4514 MU
Total	1635.7237 MU

(source: 2016-2017 Annual Report of WBSEDCL)

Operating results in 2016 - 2017 1635.7237 MU exceeds the results of 2015 - 2016, 1588.377 MU.

As a big project following TURGA PSP, the Bandu Pumped Storage Project (BPSP) is planned. The planned construction site is the same Purulia district as TURGA PSP.

Currently, local consultants are preparing for re-bidding on implementation of Detail Project Report (DPR).

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In addition, in the Darjeeling district, the plan of Teesta Low Dam I & II Hydro Electric Project (84 MW), Teesta Low Dam V Hydro Electric Project (80 MW), Fammam Stage - I Hydro Electric Project (48 MW) was issued to NHPC Limited in July 2015 assigned based on agreement.

(2) Periodical Inspection Plan

(Not be disclosed per internal corporate information)

Table 4.2.1-1 Cost of repairing for major equipment at Purulia PSP

(source: Data from WBSEDCL, Nov.13, 2017)

(Not be disclosed per internal corporate information)

(3) Technical aspects (previous experience, etc.)

In West Bengal State, West Bengal State Electricity Board (WBSEB) of the time planned Purulia PSP as a large-scale pumped-storage power project, started feasibility survey from August 1990, detailed design through March 2002, it started full-scale construction into a Purulia PSP. Then in April 2007 WBSEB separated and independent from West Bengal State Electricity Transmission Company Ltd. (WBSETCL) and West Bengal State Electricity Distribution Company Ltd. (WBSEDCL), WBSEDCL took over the construction project, it was completed in January 2008 and started operation, it has reached today.

In large-scale pumped-storage power projects, it is necessary not only to construct the plant with high technical reliability but also to maintain the soundness of power supply and facility management continuously.

To that end, it is extremely important to develop and manage a system related to maintenance and management.

Regarding the maintenance and management system of the Turga PSP, WBSEDCL confirmed its soundness by looking at the maintenance performance of the existing Purulia pumped power plant in the vicinity.

1) Maintenance system of Purulia PSP

(Not be disclosed per internal corporate information)

Table 4.2.1-2 Directorate of Purulia PSP

(Not be disclosed per internal corporate information)

(source: Data from WBSEDCL, Nov.13, 2017)

2) Operating results of existing Purulia PSP

(Not be disclosed per internal corporate information)

Table 4.2.1-3 Availability Factor of Purulia PSP

(Not be disclosed per internal corporate information)

(source: Data from WBSEDCL, Nov.13, 2017)

Table 4.2.1-4 Capacity Factor of Purulia PSP

(Not be disclosed per internal corporate information)

(source: Data from WBSEDCL, Nov.13, 2017)

(4) Budget and Expenditure

Operation and Maintenance Expenditures of Turga PSP will consist of two particulars for tariff calculation: one is O&M cost and the other is Employee Cost. Currently, the expenses are arranged by power plants owned by WBSEDCL. The system will be applied to Turga PSPS.

Particulars included in O&M Cost are mentioned below:

- Cost of Outsourcing
- Repairs & Maintenance
- Administration & General Expenses
- Rent and lease charges
  - Legal charges
  - Auditor’s expenses
  - Consultancy charges
  - Others

Table 4.2.1-5 indicates the actual amount of O&M for WBSEDCL.

Table 4.2.1-5 Operation & Maintenance Expenses of WBSEDCL

(Unit: Lakh Rs)

Fiscal Year	Employee's Cost	Admin & General Expenses	Repair & Maintenance
2012-13	114,542	13,313	23,904
2013-14	139,370	19,027	27,241
2014-15	136,022	19,651	28,748
2015-16	139,079	21,414	33,990
2016-17	133,234	23,478	21,714

(source: WBSEDCL annual report 2012-2017.)

Normative unit rate of O&M cost is established for each existing power plant, therefore it is expected that the same will be applied for Turga PSP based on the actual cost to be incurred.

Normative O&M Expenses for Purulia PSP is indicated in Table 4.2.1-6 [10].

Table 4.2.1-6 Normative O&M Expenses for Purulia PSP

(Rs. in Lakh)

FY	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
unit rate/MW	3.94	4.09	4.26	2.15	2.26	2.37
amount	3,546	3,681	3,834	1,935	2,034	2,133
actual amount	n/a	n/a	n/a	2,059	1,206	2,508
difference	n/a	n/a	n/a	(124)	828	(375)

(source: The Kolkata Gazette, April 29, 2011 and July 30, 2013;
Annual Performance Review, 2015-17, WBSEDCL)

O&M cost is classified as “controllable” item in Tariff Regulation. The surplus amount in “controllable” items may be admitted, subject to the condition that the overall expenditure of such controllable item will be limited to the value that has been allowed in the tariff order.

On the other hand, personnel cost is classified as “uncontrollable” item which will be passed on to the tariff after scrutiny.

As to the amount for principal repayment and interest payment, they are admitted to be passed on to the tariff calculation and will be recovered from the electricity tariff. The tariff revenue is the only source of Turga PSP, and principally there is no provision from the West Bengal State Government.

According to the CERC tariff regulations, O&M cost in the first year of a newly commissioned power plant is stipulated as two percent of the initial project cost, and it is escalated with a rate of 6.04% afterward. The amount is replaced with the actual amount at the time of Annual Performance

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[10] Draft WBERC Tariff Regulations 2017 propose 3.99 Lakh/MW for FY2017-18 and annual increase of 5% thereafter.

Review. This amount is included in the tariff calculation, and the O&M cost is recovered from the electricity tariff.

Table 4.2.1-7 indicates the expected O&M cost under CERC regulations for three years from FY2017-18, which is calculated with a total cost of the Project and an annual escalation.[11]

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[11] WBSEDCL estimates 35 Crore Rs/year in line with the existing norms for Purulia PSP, not including those expenses for overhaul.

Table 4.2.1-7 Expected O&M Cost for Turga Project

(Not be disclosed per internal corporate information)

(source: JICA study team preparation)

4.2.2 West Bengal State Electricity Transmission Company Ltd.,

(1) Operation plan

WBSETCL maintains and operates power grid of EHV transmission lines of approximately 12,962 km throughout the year, maintains transformers with 117 Substations (400 kV to 66 kV) and a total of 27,752.23 MVA, average transmission loss is 3.4%, it was 3.1% against.

Regarding the use of land for the construction of new Substations and the construction of transmission lines, the population density is high in West Bengal province and the reliance on agriculture by the fertile nature of the land is high, so in order to reduce the necessity of land WBSETCL is considering adopting GIS.

In addition, the use of monopole, multi-circuit, narrow base tower is also under consideration for the purpose of reducing the installation area of transmission lines.

The underground cable is also used in all voltage classes when urban areas, semi-urban areas, and overhead lines can not be used.

In light of the steadily increasing demand for electricity by the rural electrification and the establishment of new power plants in the state or the expansion of existing power plants, the WBSETCL is expected to provide stable state power transmission that is the backbone of the power infrastructure in order to form a system, WBSETCL is constructing substations and transmission lines that often go over difficult terrain.

In 2015 - 2016, WBSETCL laid a 392.100 km EHV transmission line, added 2518.18 MVA substation equipment to the existing Substation, and built 5 EHV Substations.

As of March 31, 2017, the facilities of WBSETCL are as follows.

- EHV transmission line length (400 kV to 66 kV) about 12,962 km.
- Transformer capacity Approx. 27752.23 MVA annual utilization factor 99.91% or more.
- EHV Substation 117 locations.

In the past 10 years, the transmission loss of WBSETCL is about 3%, and various initiatives are being implemented to further reduce it.

Regarding the transmission line, WBSETCL plan to newly install a 403.17 kilometer transmission line in the future.

For substation equipment, WBSETCL are constructing 20 new substations including 2 of 400 kV substations, 7 of 220 kV substations and 11 of 132 kV substations. WBSETCL plan to add 4854

MVA to the existing system after completion of this substation.

Table 4.2.2-1 shows the new power transmission plan until 2021-22.

From 2017-18 to 2021-22, 10 of new EHV Substations, 18296 MVA expansion and 4894 km transmission line construction are being studied.

As a result, the entire transmission system of WBSETCL is as follows.

Table 4.2.2-1 WBSETCL, Plant Capacity FY2021-2022

	Nos. of Substation		Capacity in MVA		Line length in ckm	
Discription	2017.3.31	2022.3.31	2017.3.31	2022.3.31	2017.3.31	2022.3.31
440kV	5	9	6155	9990	1643	2714
220kV	22	36	12121	19431	33653604	33654492
132kV	82	113	9270	16623	7292	10227
66kV	8	2	204	2	421	140
Total						

(source: 2015-2016 Annual Report of WBSETCL)

As the development of transmission and substation equipment under construction and plan progresses as planned, the following targets will be achieved.

1) Improve reliability of power supply.
2) Improve system stability and reduce transmission loss.
3) Promotion of development in industrial and agricultural fields.
4) Overload reduction of transmission power from the power producer.
5) Enhancement of existing transmission grid and increase of transformer capacity corresponding to future load increase.

(2) Transmission and Substation Equipment Maintenance Management

The maintenance management system of WBSETCL is aimed at keeping the system in a stable state while minimizing the maintenance cost of facilities and personnel while increasing safety.

WBSETCL has a team of experts in substation equipment and transmission line engineering equipped with state-of-the-art technology, software functions, and computer-aided facilities for planning and designing transmission and transformation equipment, and the data fed back from the field based on the necessity, equipment renewal is carried out.

The expert team actively standardizes the state of the equipment and technical parameters in order to save costs and shorten the introduction period based on feedback data.

Also, in order to minimize sudden failures, WBSETCL is studying a system for predicting failure of substation equipment or transmission line from the viewpoint of preventive maintenance of transmission line and equipment.

For this purpose,

1) Exchanges over the full voltage of switchgears, current transformers and lightning arresters, residual life evaluation and maintenance.
2) Application of Thermo Scan in Substation to detect Hot spot on the equipment, preventive maintenance before repair work
3) Establishment of GIS to reduce land requirement of Substation.
4) Install underground XLPE cables at 400 kV, 220 kV and 132 kV level in congested urban areas.
5) Adoption of hybrid electric wires by combination of 400 kV, 220 kV and 400 kV OH conductors and UG cables.
6) Use of modern surveying techniques for route selection and length optimization.
7) Regularly re-conduct old lines;
8) Application of OPGW for digital communication between Substations.
9) Adoption of HTLS conductors for upgrading power flow in existing transmission lines.

In addition to standardizing inventory of all transmission lines, periodic inspections on all Substations.

In addition, an emergency restoration system (ERS) consisting of 10 sets of 1 circuit of 400 kV class that WBSETCL is procuring as part of disaster management.

Diagnostic tools are provided to shorten the recovery time in the case of the EHV tower and to improve the utilization of the transmission line.

(3) Corporate Social Responsibility

Measures concerning "corporate social responsibility" have been formulated from the viewpoint of the provisions of the Company Law and Regulations in 2013.

From April 1, 2014, WBSETCL 's CSR activities are applied regionally.

The main activities are as follows.

1) Prevention of hunger, poverty, malnutrition

   To promote preventive health care and hygiene, to provide safe drinking water.

2) Promotion of education including special education and employment promotion jobs

   Especially the skills of children, women, elderly people, differences in way of living and livelihood
   As an enhancement project

3) Promotion of gender equality, empowerment of women, establishment of dwelling and lodgings for women,

   Installation of nursing homes for the elderly people, orphans, nurseries and other elderly facilities
   Measures to reduce inequality faced socially and economically backwards groups,

4) Environmental sustainability, ecological balance, protection of animals and plants,

   Animal welfare, agricultural forestry, conservation of natural resources, maintenance of soil quality,

5) Protection of national heritage, arts and culture.

   Historical importance and art work. Establish public libraries. Promotion and development
   Traditional art and handicraft products;

6) Training to promote rural sports, nationally recognized sports, Paralympics, the Olympic Games

7) Contribution to the Fund established by the Prime Minister 's National Relief Fund or Central Government

8) Donation or funds provided to the technical incubator within the academic institution

   Those approved by central government.

9) Rural development project.

(4) Budget and Expenditure

Operation and Maintenance Expenditures of WBSETCL will consist of two particulars for tariff calculation: one is O&M cost and the other is Employee Cost. Particulars included in O&M Cost are mentioned below:

- Cost of Outsourcing
- Repairs & Maintenance
  - Plant & Machinery
  - Building
  - Others
- Administration & General Expenses
  - Rent and lease charges
  - Legal charges
  - Auditor’s expenses
  - Consultancy charges
  - Others

Table 4.2.2-2 Budget for Operation and Maintenance WBSETCL

(Not be disclosed per internal corporate information)

(Unit: Lakh Rs)

(source: WBSETCL)

Tariff regulation of WBERC only mentions that "The Commission shall accept Operation and Maintenance Expenditure subject to prudent check." On the other hand, Tariff Regulation 2014-19 of CERC stipulates normative O&M expenses according to the specification of substation and transmission line. Table 4.2.2-3 indicates the normative O&M expenses according to CERC.[12]

Table 4.2.2-3 Normative O&M Expenses

(Unit: Rs Lakh)

Item	2015-16	2016-17	2017-18	2018-19
400kV GIS Substation (per bay)	53.25	55.03	56.84	58.73
Double circuit (Bundled conductor with four or more sub-conductors) AC lines (per km)	1.097	1.133	1.171	1.210

(source: CERC Tariff Regulations 2014-19)

Table 4.2.2-4 indicates the expected normative O&M expenses corresponding to the facilities for Turga PSP, using the unit rate of FY2018-19. The similar amount will be included in tariff calculation and the O&M cost will be recovered from the transmission tariff.

Table 4.2.2-4 Normative Operation and Maintenance Cost

(Unit: Lakh Rs)

Item	Unit rate	Number	Amount
400kV GIS Substation (per bay)	58.73	13 bays	763.49
Double circuit (Bundled conductor with four more sub- conductors) AC lines (per km)	1.210	1.7 km	2.057
TOTAL			765.547

(source: JICA study team calculation)

O&M cost is classified as "controllable" item in Tariff Regulation. The surplus amount in "controllable" items may be admitted, subject to the condition that the overall expenditure of such controllable item will be limited to the value that has been allowed in the tariff order.

On the other hand, personnel cost is classified as "uncontrollable" item which will be passed on to the tariff after scrutiny.

The amount for principal repayment and interest payment are admitted to be passed on to the tariff

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[12] According to WBSETCL, WBERC has set the similar unit rate, however, WBSETCL is not in agree with this method due to various reasons, and they continue to report to WBERC with the actual amount of expenses in their Annual Performance Review.

calculation and will be recovered from the electricity tariff. The tariff revenue is the only source of Turga PSP, and principally there is no provision from the West Bengal State Government.

As to the transmission fee of WBSETCL, there exist the following risks as same as WBSEDCL: Costs are included into tariff calculation upon scrutiny of WBERC and a political consideration has been made to avoid sharp increase of the tariff. The portion of the Turga PSP facilities occupies a very small portion of the total ones of WBSETCL: 0.03% for transmission line (1.7km, 2 circuits) and 1.3% for transformation capacity (330MVA) , and that the company enjoys the sound financial situation. Considering these conditions, it is considered that there exists no major concern in securing the financial sources for operation and maintenance of the Project.

4.2.3 Human Resource Development, Human Resource Securing

In the Electricity Act of 2003, the Central Electricity Authority (CEA) to promote skills training for engineers engaged in the power industry, such as National Training Policy on power generation, transmission and distribution are doing. The contents of this education and training policy are outlined below

- Comprehensive training of each electric power company, formulation of training plan.
- Student assignment of training and training expenses.
- Building a network for educational infrastructure and intellectual property utilization.
- Training and training obligation similar to power generation workers of transmission and distribution (T & D) personnel.
- Development of an appropriate infrastructure for hydropower, transmission and distribution training.
- Obligations for simulator training at appropriate intervals of power plant management staff.

This policy emphasizes the necessity of training and training planning as an activity of comprehensive human resource development (HRD), because training and training expenses are human resources investment.

The National Power Training Institute (NPTI) is an organization established for trainings and human resources development in the power sector under the Ministry of Electric Power and supplies training and training services for over 40 years.

There are 382 staff members of the NPTI, of which 131 officials in Group A & B and 251 employees are active throughout India through nine laboratories across the country.

(1) Northern Region
  1) NPTI Corporate Office Faridabad
  2) NPTI (Northern Region) Badarpur
  3) NPTI (Hydro Power Training Centre) Nangal
(2) Southern Region
  1) NPTI (Power System Training Institute) Bangalore
  2) NPTI (Hot Line Training Centre) Bangalore
  3) NPTI (Southern Region) Neyveli
(3) Eastern & North Eastern Region
  1) NPTI (Eastern REgion) Durgapur
  2) NPTI (North Eastern REgion) Guwahati
(4) Western Region
  1) NPTI (Western Region) Nagpur

The NPTI laboratory has high-tech infrastructure facilities to implement various courses on technical and administrative themes covering the needs of India's electricity and energy sector thermal power, hydropower, transmission and distribution system, energy related fields. The Faridabad Institute has a 500 MW thermal training simulator, and the Nagpur Institute has a 210 MW thermal training simulator, which provides technology specialized for operation personnel nationwide. The high precision load dispatch operator simulator for the National Grid is planned to be installed at PSTI in Bangalore.

In addition, long-term, medium-term and short-term training programs in fields such as hydropower, thermal power, transmission and distribution and management, regulation work, etc. are implemented at various laboratories of NPTI, training programs for electric power engineers are also being held in the year.

- 2-years MBA in power management approved by the All India Council for Technical Education (AICTE)
- 4-years of power engineering approved by AICTE B.Tech./B.E degrees
- 1year Post-Graduate Diploma Course in Thermal Power Plant Engineering
- Thermal power plant engineering 1 year post diploma course
- 1 year postgraduate diploma for GIS and Remote Sensing (RS)
- 9-month Post Graduate Diploma Course for Hydropower Plant
- 6 months O & M of transmission and distribution system for engineers
- Acceptance of international trainees as international cooperation.

The Central Power Research Institute (CPRI) was established in 1960 by the Indian government with its headquarters in Bangalore. In 1978, it was reorganized into an autonomous organization under the Indian Electric Power Department. The main purpose of the establishment of the research institute is to function as an independent national test certification authority of electrical equipment and parts to secure the reliability of the electric power system and to innovate and develop the electric power engineering application research It is a national-level laboratory that conducts research.

And CPRI has Training Division and prepare Training Program for electric power sector, training from university training point of view for personnel training and human resources securing, and active vocational training of university students.

WBSEDCL actively utilizes the program, and in the period of 2017-2018, technical training for newly-appointed power engineers is conducted six times.

The implementation department related to WBSEDCL’s training is the Human Resource Department (HRD), which announces the actual value for the number of target participants for each year's training.

Participant’s target values and actual values in 2016 - 2017 are shown in Table 4.2.3-1.

Table 4.2.3-1 Target Vs Achievement For FY 2016-2017 i.r.o. Training

2016-2017 (Target Participants)	2016-2017 (Achievement Participants)
Class-I－950	Class-I－596
Class-II－500	Class-II－195
Class-III & IV－4500	Class- III & IV－3405
Other－4800	Other－2350
Total－10750	Total－6546

(source: 2016-2017 Annual Report of WBSEDCL)

Table 4.2.3-2 shows the contents of the training and the actual number of participants by class staff.

Table 4.2.3-2 Training Conducted HRD & TRG Dept. from 2016-2017

No.	Details of Training conducted by HRD & TRG Dept.	Class I	Class II	Class III&IV	Others(Contractor Laborer & Employees of other Organization)	Total No. of Participants
1	Induction/Orientation Training at Vidyut Bhavan for newly recruited employee	81	12	259	0	352
2	Electricity Employees Training Institute (EETI)-Burdwan	20	18	538	242	818
3	EETI-Kharagpur	27	0	329	309	665
4	EETI-Triberi	0	0	378	463	841
5	EETI-Berhampore	62	5	306	146	519
6	EETI-Kolkata	0	16	339	409	764
7	EETI-Coochbehar	31	0	93	0	124
8	KJTC	0	0	78	0	78
9	External Training by different Training Partner （CPI etc.,）	-	-	-	-	1604
10	Vocational Trauning	-	-	-	-	572
11	Internship Training for IIT/IISWBM/IIEST/JU as per approval of Hon’ble CMD	-	-	-	-	209
	Total	221	51	2320	1569	6546

(source: 2016-2017Annual Report of WBSEDCL)

Annual report 2015 - 16 issued by WBSETCL has reported that employees' work performance is improved and education for staff is keenly done according to the latest trend of business scenario.

In addition to training inside WBSETCL, many opportunities to participate in external training are given, and training necessary for staff is provided. A total of 631 participants attended the training program, of which 219 employees were trained from the outside at various training institutions. There are 391 graduate students and graduates in all of the first-time vocational training. Vocational training related to transmission and substation equipment is regularly implemented, and implementation reports such as issue of certificates to persons completing training are being made.

The role of WBSETCL in this project is the transmission line design and construction work from the switchyard of the Turga PSP to the new substation serving as the power receiving side, and it is assumed that it will be implemented by the project cost of WBSETCL.

Problems with the operation and maintenance system of new transmission line design / construction work are not recognized from the situation of human resource development, procurement implemented by WBSETCL.

CHAPTER 5

JUSTIFICATION OF PUMPED STORAGE PROJECT IN WEST BENGAL

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CHAPTER 5 JUSTIFICATION OF PUMPED STORAGE PROJECT IN WEST BENGAL

In this Chapter it is described and verified of the necessity which WBSEDCL (Implementing Agency) considers vital for introducing Pumped Storage Project in West Bengal State.

The quantitative evaluation for Turga Pumped Storage Power Development Project is described in Chapter 9.

5.1 VALIDITY OF PUMPED STORAGE PROJECT

Reflecting the Renewable Energy Initiative to develop 175GW renewable energy in 2022 released in 2014, both Indian central government and state governments have been showing keen interests in development of Pumped Storage plants. CEA released the power demand projections till 2036 in the Draft National Electricity Plan 2016 (NEP 2016). In the Plan CEA has made its stance clear to promote Pumped Storage projects in India by mentioning such as “Grid connected renewable energy will become important category in India, that peak power supply, stable power system control and integration with renewable energy by enhancement of hydropower generations including pumped storage generations turn to be essential”, “Pumped storage generation should be considered unique independent generation category and the incentives to pumped storage generations is necessary including power tariff, beneficial finance support must be provided”, or “hydropower tariff and pumped storage plant tariff should exempt recovery of capital costs as capacity charges shall be born separately by all beneficiaries considering needs for such flexible power generations become more and more important to meet the rapid growth of variable in nature renewable power generation”.

Under these circumstances currently more than 10 pumped storage projects have been progressing in various stages all over India as below[1].

Table 5.1-1 Pumped Storage Projects planned in India

State	PSP (Output)
Odisha	Upper Indravati (600MW)
Karnataka	Sharavathy (1,000MW, as maximum) Varahi (1,000MW) Kali (1,000MW)
Tamil Nadu	Kundha (500MW) Sillahalla (2,000MW, being reviewed) Mettur (500MW)
West Bengal	Bandhu (600MW)
Kerala	Pallivasari (600MW)
Maharashtra	Warasgaon (1,200MW) Panshet (1,600MW) Varandah Ghat (800MW)

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[1] Based on “Data Collection Survey on Power Sector in India, 2017, JICA”, the output of Bandhu is now at 900MW.

Compared to those, West Bengal state is one of the leading states as it has been operating Purulia pumped storage power plant since 2008 and has made Turga pumped storage project clear the DPR preparation, its approval by the central government and reach the Detailed Design stage.

West Bengal expects the increase of power demand up to 11,172 MW in 2019 from 7,544 MW in 2015, which necessitates the further implementation of power supply. The Central government regulates West Bengal to target renewable power generation (installed capacity) of 5,386 MW by 2022 from 193 MW as of 2012. It urges the introduction of regulating power generation which enables to adjust itself to the fluctuation of renewable generation by weather. Under such circumstances, West Bengal finds it necessary to enhance the development of pumped storage power projects as PSPs have advantages not only in supplying peaking power but also in provision of ancillary services such as in load-generation balance, in frequency regulation, etc.) Hydro power plants are in nature bound to geographical and geological site configurations that Turga PSP site was found suitable in close proximity to the existing Purulia PSP.

The merits recognized in India for pumped storage projects are listed like peak power generation (power shift to peak power), power storage, mitigation measures for renewable energy, frequency control, etc., and those merits for grid operation are well known. But the regulatory preparations realizing pumped storage competitive in power sector have not been made yet. Furthermore, it should be noted in West Begal the scheme that distributors (Discom) owns and operates pumped storage plants is unique and different from other states.

There are several advantages for pumped storage plant generations in India. All are benefits (all give benefits) to grid system operators. However merits differ depending on whether generators (Gencos) own pumped storage power plants or distributors (Discoms) own the same.

1. <u>Optimization of generation for peak power supply/power generation shift from off-peak to peak demand</u>

    Benefits for Gencos (to have pumped storage plants); avoidance of generation back down (restriction or shut down of generations in power surplus and relevant associated expenditures)

    Benefits for Discoms (to have pumped storage plants): sourcing pumping energy at lower cost in off-peak period, avoidance of purchasing peak power at expensive price. However it does not provide sufficient price gaps for pumped storage power plants to make themselves competitive in Indian power exchange market right now.

2. <u>Controlling intermittent generation from renewable power sources</u>

    Benefits for Gencos (to have pumped storage plants); Avoidance of power shutdown of renewable generation.

    Benefits for Discoms (to have pumped storage plants); to obtain low cost of pumping energy from renewable sources in future. Currently there is no incentive for pumped storage power generators to quickly absorb rapidly fluctuating renewable energy.

3. <u>Ancillary Services</u>

   The benefits belong to power system operator thus provide benefits to the state as a whole. Currently the incentives to Gencos or Discoms for their provision of this services are not materialized in regulations. The expectations for the same has been arising as the needs for ancillary service become very crucial in whole India at the time of large renewable energy come into the power supply market.

4. <u>Imbalance settlement, Minimize the deviation from schedule dispatch or drawal.</u>

   It gives certain benefits to power system operator. There introduced incentives and penalties already for Gencos and Discoms from Diviation Settlement Mechanism Regulations (DSM). Pumped storage plants play certain role in keeping incentives and avoiding penalties but the monetary valuation does not amount much to justify pumped storage project only by this.

5. <u>Storage of excess generation of grid by creating demand at the time of excess generation.</u>

   It gives benefits to power system operator by storing excess energy. It does not directly provides monetary benefits to Gencos and Discoms.

The benefits specifically provided for WBSEDCL to own pumped storage plants are summarized as below.

1. WBSEDCL has to bear the cost of power purchase at high price for peak power. It is especially the case when WBSEDCL purchase power from outside of the state (such as central power generators (CGU). By utilizing pumped storage power plants, WBSEDCL can avoid high cost of power purchase to certain extent.
2. The short term power market provides low price for off-peak power and high price for peak power. It gives certain basis for pumped storage plants being viable in economic power generation in the current power market. Purulia pumped storage plant operates in lune with current power market, ie., it sources (buy) energy when market is low price and generates (sell) energy when market is high price.
3. It is anticipated a large volume of energy from renewable sources in the near future leading to the phases a large volume of low cost of energy coming into the grid. However, well known difficulties are to control and maintain the stable power system at the time of large scale renewable energy integration to the grid which by nature is very rapidly fluctuating and hard to anticipate. One viable solution for this is power storage. There are several ways to store power as pumped storage plants, Compressed Air Energy Storage (CAES), or Litium-Ion Batteries, but only market competitive feasible storage system in West Bengal now is only

pumped storage power plants. Alternative means of power generation meeting to the rapid ramp up/down of renewable power generations could be a gas power generation. But in West Bengal there is no gas power plant now and no such projects exist reflecting scarce potential of natural gas resources.

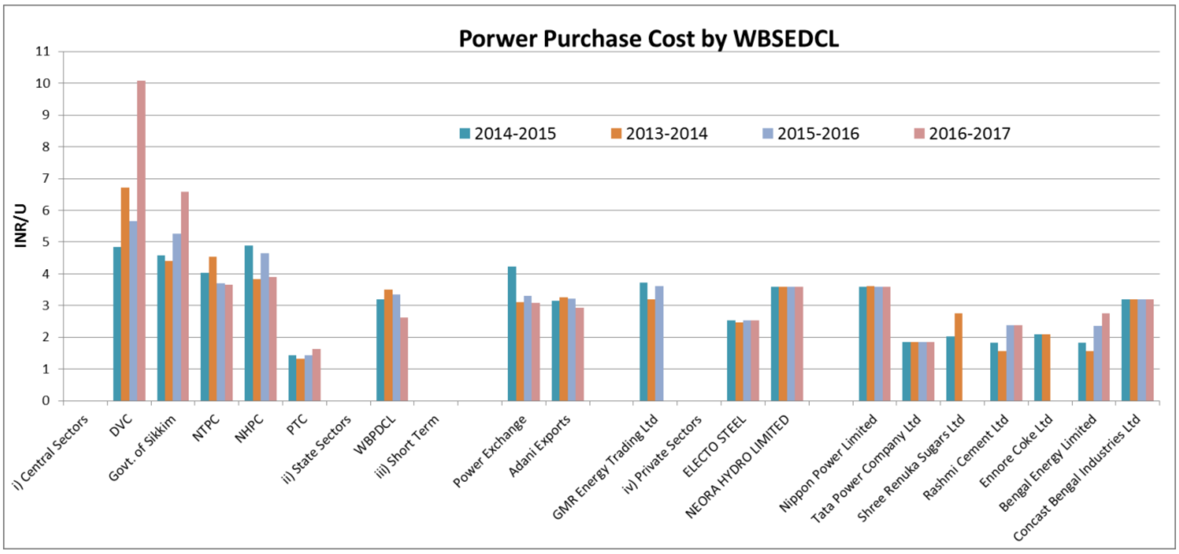
As for the point 1 above, no exact PPAs are open to the JICA Team, so the exact cost for power purchases are unknown. In order to provide estimate, the purchase cost by WBSEDCL has been examined from WBSEDCL annual reports by extracting power purchase volume and power purchase total expenditure. The cost and volume are shown in Table 5.1-2 and Figure 5.1-1.

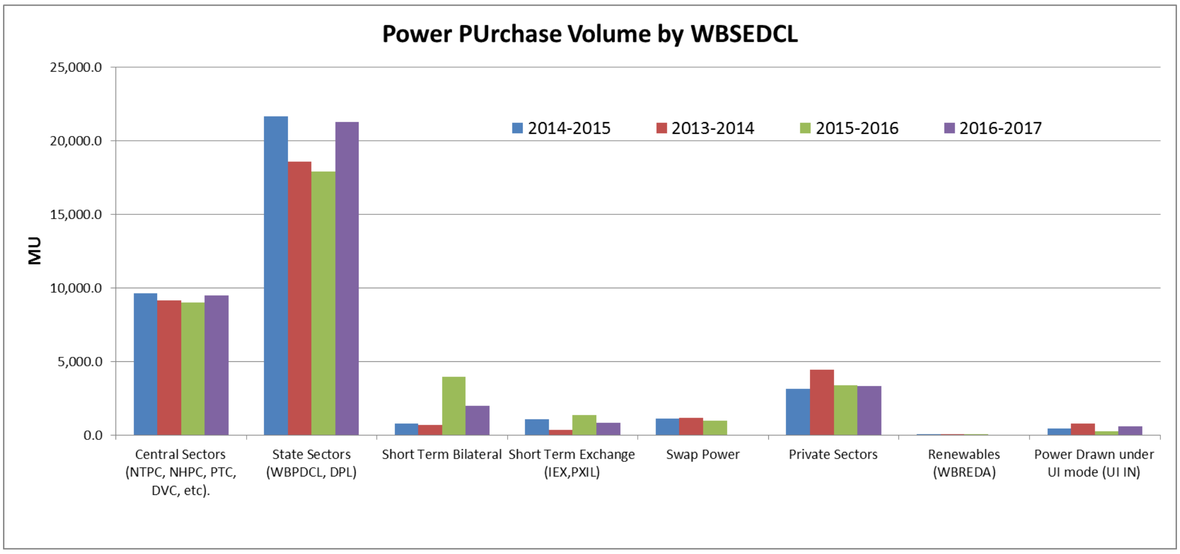
Table 5.1-2 Power Purchase Price and Volume by WBSEDCL

WBSEDCL Purchase Price	**2016-2017**	**2015-2016**	**2014-2015**	**2013-2014**
	INR/U	**INR/U**	**INR/U**	**INR/U**
i) Central Sectors				
DVC	10.1	5.7	4.8	6.7
Govt. of Sikkim	6.6	5.3	4.6	4.4
NTPC	3.7	3.7	4.0	4.5
NHPC	3.9	4.6	4.9	3.8
PTC	1.6	1.4	1.4	1.3
ii) State Sectors				
WBPDCL	**2.6**	**3.3**	**3.2**	**3.5**
iii) Short Term				
Power Exchange	3.1	3.3	4.2	3.1
Adani Exports	2.9	3.2	3.2	3.3
GMR Energy Trading Ltd		3.6	3.7	3.2
iv) Private Sectors				
ELECTO STEEL	2.5	2.5	2.5	2.5
NEORA HYDRO LIMITED	3.6	3.6	3.6	3.6
Nippon Power Limited	3.6	3.6	3.6	3.6
Tata Power Company Ltd	1.9	1.9	1.9	1.9
Shree Renuka Sugars Ltd	0.0	0.0	2.0	2.8
Rashmi Cement Ltd	2.4	2.4	1.8	1.6
Ennore Coke Ltd	0.0	0.0	2.1	2.1
Bengal Energy Limited	2.8	2.4	1.8	1.6
Concast Bengal Industries Ltd	3.2	3.2	3.2	3.2

WBSEDCL Power Purchase (MU)	**2016-2017**	**2015-2016**	**2014-2015**	**2013-2014**
1 Central Sectors (NTPC, NHPC, PTC, DVC, etc).	9,465.2	8,988.3	9,647.1	9,151.1
2 State Sectors (WBPDCL, DPL)	21,289.1	17,910.5	21,670.0	18,605.8
3 Short Term Bilateral	1,996.7	3,948.6	753.7	693.9
4 Short Term Exchange (IEX,PXIL)	844.0	1,343.0	1,044.2	319.0
5 Swap Power	0.0	989.5	1,129.8	1,172.7
6 Private Sectors	3,302.8	3,387.1	3,136.5	4,432.2
7 Renewables (WBREDA)	0.0	0.2	0.2	0.2
8 Power Drawn under UI mode (UI IN)	576.0	258.2	431.3	777.4
9 others	102.8			
Total Energy	37,576.6	36,825.3	37,812.8	35,152.4

(source: WBSEDCL Annual Report, 2016/17, 2015/16, 2014/15, 2014/13)





(souce: WBSEDCL Annual Report, 2016/17, 2015/16, 2014/15, 2014/13)

Figure 5.1-1 Power Purchase Price and Volume by WBSEDCL

WBSEDCL purchases about 65% of power supply for distribution so it is anticipated the above figures/tables represent the whole tendency of the state power purchase. Form this data, it is said 57% of whole power supply come from the state own power generations (ie. WBPDCL) but 25% must be sourced from outside of the state power generations (NTPC, NHPC, etc.). the price purchase from central power generations (CGU) are 4 - 7 INR/U, well above the average purchase price from WBPDCL. From this data it is understood that WBSEDCL, and West Bengal state would prefer to avoid the purchase from outside of state (CGU), and would benefit themselves if they secure energy from state power generations. The pumped storage power can benefit to the state in this regard.

The point 2 can be verified by evaluation the actual short power market price data and Purulia pumped storage plant operation.

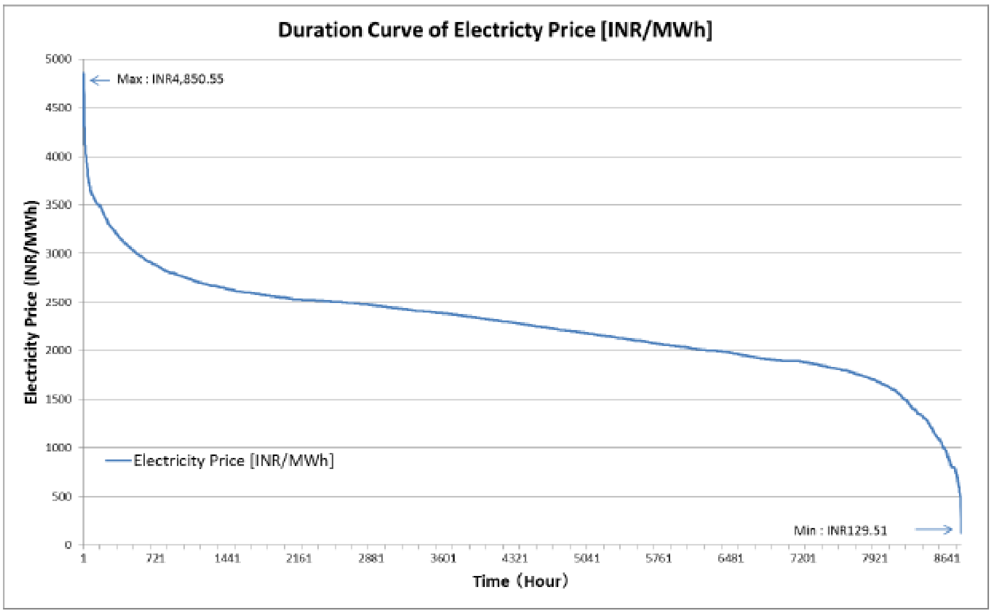
(Not be disclosed per internal corporate information)

(souce: supplied by WBSEDCL, Nov., 2017)

Figure 5.1-2 Short Market Price (IEX) and Purulia PSP Operation in 2016

Above figures show the trends on maximum peak season (April 2016) and minimum peak load season (December 2016). The both days illustrate the evening peak load time (18:00 - 20:00) are accompanied by the generation of Purulia pumped storage plants. In general the generation and pumping are in line with the fluctuation of market price.

The price duration for IEX is shown in Figure 5.1-3. It should be noted the actual price discrepancy between the peak price and off-peak price are only 2 INR/U (in the 10% maximum and 10% minimum zone) and 4.7INR/U for highest to lowest, which is hardly justifying the viability of price arbitrage operation of Purulia pumped storage plant alone in pure power market. Still, it can be said Purulia pumped storage plant can save cost for power supply to distribution market by reducing high cost power purchase at peak time thus it contribute the total cost reduction of WBSEDCL in power purchase.



(souce: supplied by WBSEDCL, Nov., 2017)

Figure 5.1-3 Short Market Price (IEX) Duration Curve in 2016

The price for renewable power generation are falling in India now, with 2.44 INR/U for solar PV tender price (May/2017) and 2.43 INR/U for wind power tender (December/2017). Those prices have become even lower than the current power purchase price for WBSEDCL from WBPDCL's coal thermal power generations. Considering the market trends which falls PV and wind tender prices even lower, the tendencies to procure much more power from renewable power sources are inevitable in coming future.

In West Bengal, Discoms bear obligations to procure certain amount of power from renewables by RPO, and which is to increase steadily in year on year. Such mandatory obligations will urge WBSEDCL and West Bengal state as a whole to look for opportunities to increase renewable power source procurement, and such increase inevitably encourages the calls for ancillary service regulations.

There are not power generations in West Bengal which play power output control in the range of minutes to 10s of minutes (so called “secondary frequency control”). West Bengal state has been doing “free rides” on such frequency control operations conducted by elsewhere outside of the state. But in the future when whole India bear the a large volume of renewable power generation, each state has to bear each responsibility to manage its own state frequency control. In case of West Bengal, it is only pumped storage power generations which can provide frequency control functions in the future.

It is to be advised that adequate regulatory frameworks to support pumped storage power generations must accompany since currently no such supports are available for Discoms to be incentivized to introduce pumped storage power plants.

- Ancillary service regulation has been introduced as a central government level (in CERC regulation) but the compatible West Bengal state regulation has not been ready yet.
- DSM (Deviation Settlement Mechanism) regulation has been introduced in the West Bengal state level. It replaced the UI (Unscheduled Interchange) system. It mainly focuses on the imbalance settlement and it is unknown how much effects it may have to accelerate regulated flexible power source such as pumped storage power plants.
- Grid Code defines the allowable range of frequency fluctuations and mandatory ratio for spinning or operation reserves. But currently those are not securely maintained. In future such regulatory regulations are anticipated to apply with penalties.
- Real time reserve power markets for regulatory flexible power supply (frequency control, load frequency control, etc.) are not likely to come soon in Indian short power trading platform. Long term PPAs are the major roles for trading power supply and short market trading are more or less 10-20% of whole trading.

In conclusion, Indian power market does not provide monetary valuation on the regulatory flexible power generation yet. There are no tariff regulations giving incentives to spinning, operating reserves, capacity values for peak power generation. It is not possible to evaluate quantitative (monetary) benefits of regulatory power generations for its functions including pumped storage power generations, and values for those generations must be evaluated in the current norms of regulations.

In the near future when 175 GW renewable generations come into the market with relaxing power supply demand situations of India as a whole, then the power sector must introduce much more regulating flexible power sources. In the course of that it is expected to materialize the regulations which put valuations to such power sources and CEA and MOP are heading to such treatments.

5.2 NECESSITY FOR PUMPED STORAGE POWERGENERATION FROM THE WBSEDCL

The JICA Study Team has collected the reasoning explanations from WBSEDCL and SLDC for the adaption of pumped storage power generations in West Bengal.

5.2.1 The necessity under the current power supply- demand circumstances of West Bengal

The explanation for necessity of pumped storage power plants has been provided as follows.

1) Power purchase cost (by PPA) from coal thermal power plants other than state power generations,

(Not be disclosed per internal corporate information)

2) Currently peak power demand of West Bengal is 8,500 MW whereas off-peak power demand is 3,500 MW.

3) Existing coal thermal power plants of WBPDCL cannot lower output below 70% due to their aging infrastructure.

4) The power purchase by West Bengal state from outside of state power utilities consists of various PPAs from long terms to short terms. It totals 2,500 MW to 3,000 MW. The issues are, the minimum purchase volume (Must Buy volume) amounts 2,300 MW.

5) The total coal thermal power plants' capacity available by WBPDCL is 4,860 MW. The total available power supply (ie. Available Running Capacity) from those are 3,000 MW due to aging infrastructures, restrictions of coal supply, auxiliary consumption, etc.

6) Under such circumstances, the power supply at off- peak demand period,

Off-Peak Demand	3,500 MW
Must Buy Thermal from outside	2,300 MW
Balance	1,200 MW

Since power supply from existing coal thermal plants from WBPDCL could be reduced as low as 2,100 MW only (3,000 MW × 70%), 900 MW (2,100 MW - 1,200 MW) turns to be redundant. If Purulia pumped storage power generation supplies power demand of 1,000 MW (250MW × 4) at off-peak load period, it could eliminate the risks to back down coal thermal power plants of WBPDCL, consequently save starting up-shutting down costs of coal thermal plants. It is beneficial for power system operator.

The above is the explanation provided.

Generally speaking it requires 3-5 times higher peak power price to off-peak price in order pumped storage power generation is economically viable in power market price arbitrage operation (economic operation).

The current daily power load curve in West Bengal is shown in Figure 5.2.1-1 and Annexure 5.1.

(Not be disclosed per internal corporate information)

(source: supplied by WBSEDCL, Nov., 2017)

Figure 5.2.1-1 Hourly Load Curve in West Bengal in 2016 (Monthly Average)

Thus the figures given by West Bengal for off-peak demand of 3,500 MW are adequate.

The existing operating power plants owned by West Bengal state are shown below. Some planning plants are also included. The central generation utilities (CGU) supplying power to West Bengal are presumed as the below table.

The PLF of WBPDCL is shown in the Figure 5.2.1-2.

Table 5.2.1-1 Current State Power Plants in West Bengal in 2017

	Plant	Owner	Capacity (MW)	Estimeated WBSEDCL allocation (MW)	status
State	Kolaghat (6x210 MW)	WBPDCL	1,260	1,260	In operation
	Bakreswar (5x210 MW)	WBPDCL	1,050	1,050	In operation
	Bakreswar (1x660 MW)	WBPDCL	*660*	—	proposed
	Bandel (4x60 MW+ 1x210 MW)	WBPDCL	*455*	*455*	Unit 5 capacity increased to 215 MW after R&M
	Santaldhi (2x250 MW), Unit-5&6	WBPDCL	500	500	In operation
	Santaldhi (2x500 MW), Unit-7&8	WBPDCL	*1,000*	—	No EC obtained, maybe abandoned
	Sagardighi (2x300 MW), Unit-1&2	WBPDCL	600	600	In operation
	Sagardighi (2X500 MW), Unit-3&4	WBPDCL	1,000	1,000	In operation
	Sagardighi (1X660 MW), Unit-5	WBPDCL	*660*	—	In April 2016 the company applied for Unit-5 to be 660 MW, Unti-6 received no permit thus shelved.
	Jaldhaka (3X9 MW)	WBSEDCL	27	27	In Operation
	Rammam (4 x 12.75 MW)	WBSEDCL	51	51	In operation
	PPSP (4 x 225 MW)	WBSEDCL	900	900	In operation
	Jaldhaka (2X4 MW)	WBSEDCL	8	8	In operation
	Massanjore (2X2 MW)	WBSEDCL	4	4	In operation
	Tista (9X7.5 MW)	WBSEDCL	67.5	67.5	In operation
	Micro Hydel	WBSEDCL	7.51	7.51	In operation
			5,930	5,930	

(souce: JICA Study Team, compiled from DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal, WBSEDCL, 2016,

Eastern Regional Load Despatch Center, Annual Grid Report 2015-16, ERLDC, 2016,

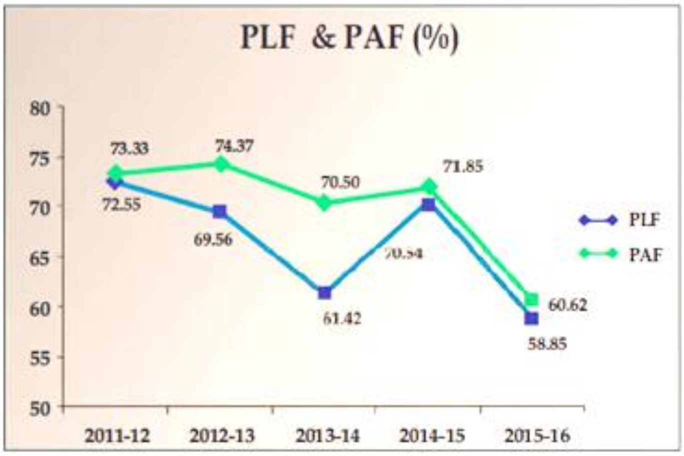
Power for All, Gov. of West Bengal, 2016, and various sources)

(note: Jaldhala (3×9MW), Micro Hydel 9.8 MW according to WBSEDCL Annual Report 2016-17)

Table 5.2.1-2 Current Central and Private Power Plants supplying Power to West Bengal in 2017

	Plant	Owner	Capacity (MW)	Estimeated WBSEDCL allocation (MW)	status
Central, Others	TLDP-III (4X33 MW)	NHPC	132	132	In operation
	TLDP-IV (2X40 MW)	NHPC	80	80	In operation
	Budge Budge Generating Station	CESC	750	0	In operation
	Titagarh generating Station	CESC	240	0	In operation
	Southern Generating Station	CESC	135	0	In operation
	Haldia	HEL	600	0	In operation
	Mejia Thermal Power Station	DVC	2,340	468	In operation
	Durgapur Thermal Power Station	DVC	350	350	In operation
	Maithon Hydel Station	DVC	63.2	63.2	In operation
	Durgapur Steel Thermal Power Station	DVC	1,000	1,000	In operation
	Durgapur Projects Limited	DPL	660	660	In operation
			6,350	2,753	

(source: same as above, including estimates)



(source: 31st Annaul Report, 2015-16, WBPDCL, 2017/March)

Figure 5.2.1-2 Plant Load Factor (PLF) and Plant Availability Factor (PAF) of WBPDCL Coal Thermal Plants

From these figures and table, the current power capacity available by West Bengal state utilities are 4,865 MW matching the above explanation 4,860MW. The PLF of the WBPDCL coal thermal plants are as low as 60% from Figure 5.2.1-2 that available power supply is estimated to be around 3,000 MW (4,865 MW × 60%) and it matches the explanation above. It is considered West Bengal must procure the rest of power supply to meet demand by sourcing it from CGU (NTPC, NHPC) or from private utilities. The amount of such procurement is not disclosed. But Figure 5.2.1-1 load curve or Table 5.2.1-1 indicate 2,500 - 3,000 MW power purchase would be reasonable.

There is no evidence for minimum procurement of 2,300 MW from CGU as PPA is not disclosed, but they would be reasonable conditions for CGU PPA on state Discoms.

In conclusion, the statement by West Bengal (WBSEDCL and SLDC) that power shift of at least 900 MW on off-peak load period by pumped storage power generation would provide smooth power system operation in addition to the peak power supply, provides a reasonable ground for the requirement of pumped storage power generation.

5.2.2 Justification of pumped storage plants in future

WBSEDCL and SLDC has provided the following explanations. WBSEDCL and SLDC has provided their visions for future pointing 2024 as an example. The situation from 2024 onwards is not expected to change and the necessity for pumped storage plants is considered to increase.

1) The power demand of West Bengal will grow as much as 5% per annum onwards. It will provide peak demand of 12,000 MW and off-peak demand of 5,000 MW at the time of 2024.

2) There are no new coal thermal power plants on track of operation at 2024. Thus another new power purchase from outside of state power utilities will become indispensable. It also increases the minimum power procurement obligation (Must Buy power). If no practical

counter measures are taken, the incremental additional power demand for 3,500 MW (12,000 MW - 8,500 MW) must be sourced from outside of state utilities. Assuming the same ratio of minimum power purchase at 2017 (75%) applies, then

1.	Off-Peak Demand	5,000 MW
2.	Must Buy Thermal from outside	4,900 MW (2,300 + 3,500 × 75%)
3.	Balance	100 MW

3) In short, almost all of state existing coal thermal power plants are forced to back down at off-peak demand period in order to satisfy the minimum purchase obligation from CGU, etc. Such extreme PPA may not be realized but it is true that West Bengal will face harder system operation in 2024.

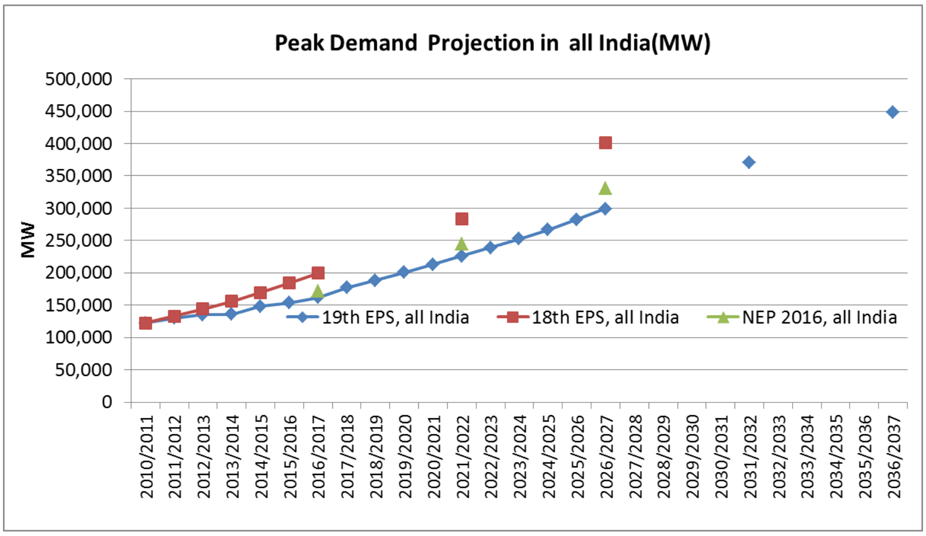
With Off Peak demand 5,000 MW and available supplies by WBPDCL's coal thermal 2,100 MW (3,000 MW×70%), renewables 2,700 MW (Solar 500 MW), Power purchase from CGU etc. 4,900 MW, then Purulia PSP (900 MW) and Turga PSP (1,000 MW) would not be sufficient. WBSEDCL considers to develop Bandhu PSP (600 MW) as well.

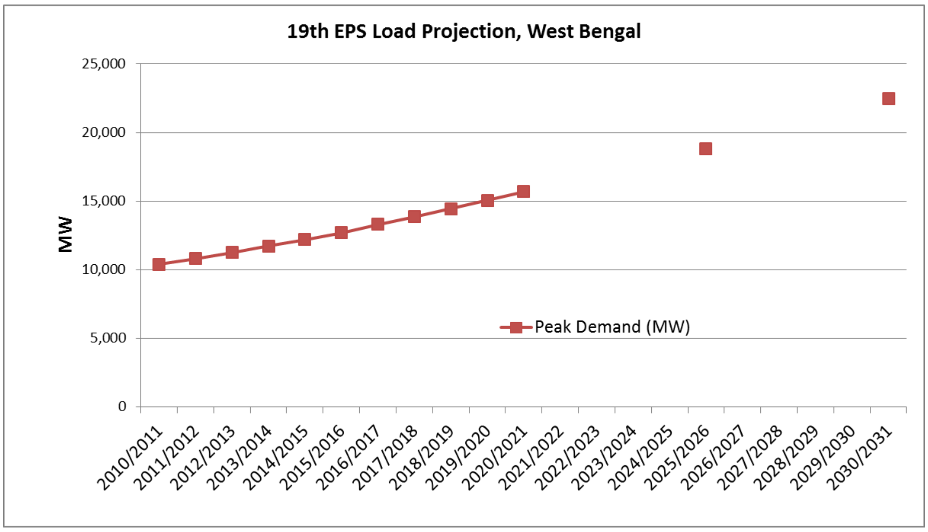
4) West Bengal state do not have many large renewable power generation projects. But the requirement from the Central government is high as 2,700 MW of RPO will become mandatory in 2022 in West Bengal (Table 3.2.5-2). In that situation West Bengal must try to keep load frequency control (LFC) in the defined range of output (MW) and frequency (Hz) at the same time in purchasing ramping up/down renewable energy. Coal thermal power generation needs 10 minutes time span to load frequency control, but adjustable pumped storage plants if introduced can adapt output in a very short period of time. Such adjustable pumped storage plants can provide benefits to power system grid operation in future when a large scale renewable energy will be installed over India.

The power demand increases from 2024 onwards from EPS 19th, and it is also planned to have renewable energy at 2026/27 targeted at 275 GW. Considering the growth of renewable energy especially solar PV, new coal thermal power generation projects are becoming difficult to anticipate. Thus, the necessity for pumped storage power generations is considered to increase from 2026 onwards.

Figure 5.2.2-1 shows the power demand growth all over the India by 6% per annum and in West Bengal 4 % per annum during 2016/17 and 2026/27 (from 19th EPS, CEA, Jan., 2017). This will bring the maximum peak demand in West Bengal in 2024/25 of 14,435 MW. The incremental power demand from 2016/17 will reach as much as 4,000MW. If it simply assumes the same 4-5 % ratio for minimum power (off-peak) demand growth, the off peak demand in 2024/25 will sum up to 4,800 to 5,200 MW.

Thus, the peak demand is even higher than above 2) explanation by SLDC & WBSEDCL, and the off peak demand will be around the same as 2) anticipation.





(source: 19th Electric Power Supply in India, CEA, 2017/1)

Figure 5.2.2-1 Peak Demand Projection (in India, in West Bengal)

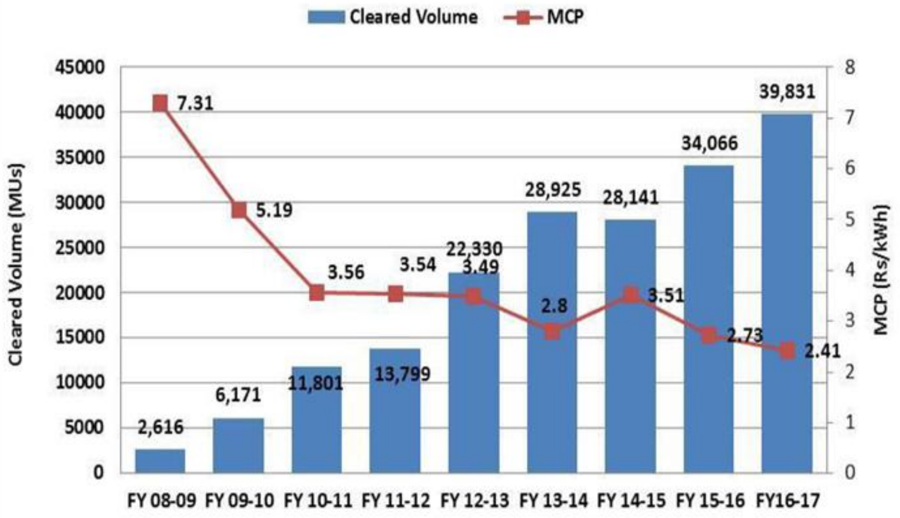
When we look at the supply side of power generation in West Bengal in 2024/25, as shown in Table5.2.1-1, there are no new practical coa thermal power generation projects by 2024/25, although it has plans of Bakreswar (1 × 660 MW), Unit-6, Santaldhi (2 × 500 MW), and Unit-7&8, Sagardighi (1 × 660 MW), Unit-5. Thus, as stated by WBSEDCL and SLDC above, West Bengal clearly must depend on the power purchase aside from state power utilities but from CGU or/and IPP generations. Those power would be sourced from power plants listed in Table 5.2.1-2 and Table 3.2.3-2 “Upcoming Central Generating Stations”. The situation estimated in 2) above will be coming out.

Therefore, as long as Back Down Charge and minimum power procurement oblgation from CGU etc. continue, it is reasonable to state that number of pumped storage power generation projects would effectively avoid backing down the existing coal thermal power generations and can source pumping energy at virtuary low cost, and help West Bengal powser system grid operation.

The renewable solar PV power price already has hit record low price of 2.44 INR/U in 2017, while it was 17 INR/U in 2010. This price already became lower than that of coal thermal power generation

(Table 5.1-2). The renewable solar PV projects in West Bengal state is summarized below. The progress seems not so smooth but it is progressing steadily. As shown in Chapter 3, 2,706 MW of renewable energy is required to be purchased in 2022 in West Bengal (solar by 500 MW and wind by 450 MW). It is presumed for the price for solar PV and wind keeps lowering, that West Bengal continues to increase such lower cost of energy from renewable sources. When renewable energy of 175 GW is introduced, Whole India grid needs much higher demand for regulating flexible power sources. There are no power generations with high speed (secondaray speed) load frequency control functions. West Bengal will not continue to keep a free ride in power grid stabilizing obligation in the future. West Bengal will need to provide load control and frequency control by operation of its pumped storage power plants in the future.

The large volume of renewable power in daytime will push down the power price at off-peak period as there would be abundant surplus power in the future. The current market price continues to lower from Figure 5.2.2-2 reflecting buyer oriented market. The future even lower price from renewables can provide very low cost of pumping energy for pumped storage power generations.



(source: IEX Annual Report)

Figure 5.2.2-2 Market Cleared Prices (MCP) for DAM (the same reshown of Figure 2.13-1)

For the states like West Bengal which have potentially favorable sites, development of pumped storage power projects can provide benefits to both whole state and development agencies. Adjustable pumped storage power generation systtem gives benefits to power system operator. Central government agency of CEA has emphasized that upcoming pumed storage power generations must be adjustable machines. Considering the requirement of regulating flexible power generations such as adjustable pumped storage power plants in future, these power projects will become major ones ialthough currently it is difficult to quantify the valuations for development agencies.

Table 5.2.2-1 Current State Solar Projects in West Bengal

Projects	Capacity (MW)	Status
Teesta Canal Bank Solar Power project	10	commissioned in 2016
Mejia Solar Power Project	10	commissioned in Dec 2017
Chharrah Solar Power Project	10	commissioned in Mar 2018
Santaldih Solar Power Project	10	expected commission in Nov 2018
Salboni Solar Power Project	10	expected commission in Dec 2018
Atna Solar Power Project	6	under tendering process
TCFHP Tailrace Canal Top Solar Power Project	10	order process & expected commission in Feb 2019
Kemasuli Solar Power Projcet	10	under tendering process
Koshangi Solar Power Project	4	under tendering process
Bagkhuar Solar Power Project	6	under tendering process
Asansol Solar Power Project	10	under tendering process
Raniganj Solar Power Project	10	under tendering process
Jhargram Solar Power Project	10	under tendering process
Nadia Solar Power Project by WBREDA	10	proposed
Near Teesta Canal Solar Power Project	10	proposed
	136	

All projects are conducted by WBSEDCL except Nadia Solar Power Project by WBREDA

Mega Solar Projects in West Bengal

Projects	Capacity	Status
Solar Park in Purba, Paschim Medinipur, Bankura districts	500 MW	DPR for 210MW completed
Solar Power Project	1,200 MW	preliminary study completed
	1,700 MW	

(source: website of Department of Power & Non Conventional Energy Sources, West Bengal, Annual Report and Accounts, 2015-16, WBSEDCL, 2016/Sep., website of WBSEDCL, Website of Solar Power Generation Dept., WBSEDCL)

Annexure 5-1

Hourly Power Load Curves in West Bengal for 2016

(Not be disclosed per internal corporate information)

Annexure 5-2

Comparison of alternatives of Pumped Power Storage generation

The consideration of alternatives to Pumped Power Storage generation in terms of the following merits are discussed below.

1. <u>Optimization of generation for peak power supply/power generation shift from off-peak to peak demand</u>

   Benefits for Gencos (to have pumped storage plants); avoidance of generation back down (restriction or shut down of generations in power surplus and relevant associated expenditures)

   Benefits for Discoms (to have pumped storage plants): sourcing pumping energy at lower cost in off-peak period, avoidance of purchasing peak power at expensive price. However it does not provide sufficient price gaps for pumped storage power plants to make themselves competitive in Indian power exchange market right now.

2. <u>Controlling intermittent generation from renewable power sources</u>

   Benefits for Gencos (to have pumped storage plants); Avoidance of power shutdown of renewable generation.

   Benefits for Discoms (to have pumped storage plants); to obtain low cost of pumping energy from renewable sources in future. Currently there is no incentive for pumped storage power generators to quickly absorb rapidly fluctuating renewable energy.

3. <u>Ancillary Services</u>

   The benefits belong to power system operator thus provide benefits to the state as a whole. Currently the incentives to Gencos or Discoms for their provision of this services are not materialized in regulations. The expectations for the same has been arising as the needs for ancillary service become very crucial in whole India at the time of large renewable energy come into the power supply market.

4. <u>Imbalance settlement, Minimize the deviation from schedule dispatch or drawal.</u>

   It gives certain benefits to power system operator. There introduced incentives and penalties already for Gencos and Discoms from Diviation Settlement Mechanism Regulations (DSM). Pumped storage plants play certain role in keeping incentives and avoiding penalties but the monetary valuation does not amount much to justify pumped storage project only by this.

5. <u>Storage of excess generation of grid by creating demand at the time of excess generation .</u>

   It gives benefits to power system operator by storing excess energy. It does not directly provides monetary benefits to Gencos and Discoms.

1. Optimization of generation for peak power supply/power generation shift from off-peak to peak demand

1) Gas power generation

Gas power generation is one generally accepted option as the peak power generation. However, there is no gas power generation plans in West Bengal and feasibility is low.

2) Reservoir hydro power generation

It is general conception that reservoir type hydro power generation is likely to have competitiveness against PSP for supplying peak power. The construction costs have been surveyed from CERC Tariff Orders as in the below table.

Order	Project	COD	Hard Cost (Crore)	cost as of	Capacity (MW)	Unit Cost (Crore/MW)	Unit Cost (Crore/MW) as of 2017
					(MW)		
Petition No. 107/GT/2015	Koldam Hydroelectric	2015	4,851.0	2015	800	6.06	6.58
Petition No. 249/GT/2016	Teesta III Hydroelectric Power Project	2017	6,832.1	2017	1,200	5.69	5.69
Petition No. 178/GT/2015	Tehri Hydroelectric Power Project (HPP), Stage-I	2007	7,041.2	2014	1,000	7.04	8.01
Petition No. 434/GT/2014	Karcham Wangtoo HEP	2011	6,382.0	2014	1,000	6.38	7.26
Petition No. 184/GT/2014	Rampur Hydroelectric Project	2014	4,097.7	2014	1,000	4.10	4.66
						average	6.44

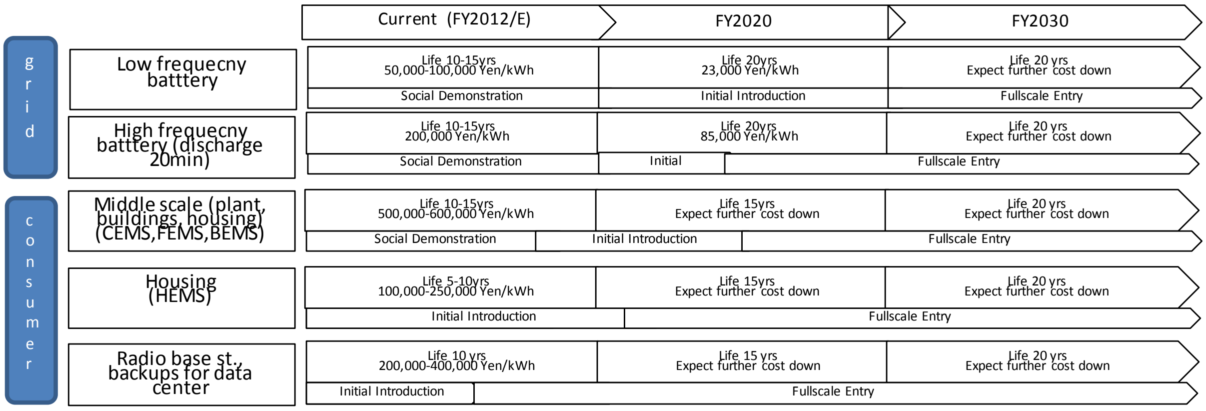
The cost of hydro power generation highly depends upon site geographic conditions so unit construction cost varies from 4.66 to 8.01 Cr/MW.

However, again there is no reservoir hydro power generation projects nor potential sites in West Bengal, which is just the same as gas power generation projects, that this option (reservoir hydro power development) is not feasible.

3) Battery

PSPs have an advantage in its larger power storage capabilities than other power storage facilities. On the contrary batteries have an advantage in less site restriction and shorter development period than PSPs.

(Unfortunately) it is not available of up to date operating battery cost in India, the cost of batteries with its projection available in Japan are collected. The stationary battery energy storage system categorizes itself into “batteries for low frequency grid operation” and “batteries for high frequency grid operation”. High frequency for grid means output variation of a period of a few to 20 minutes and low frequency battery means a larger period of grid output variation.



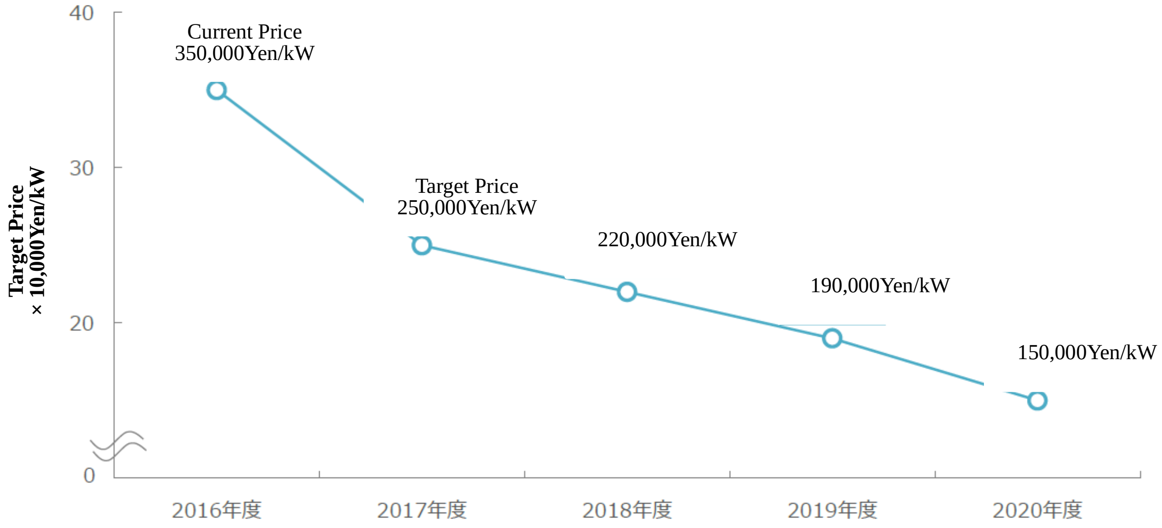
(source: NEDO 「Road map of technical development of secondary batteries 2013」,2013)

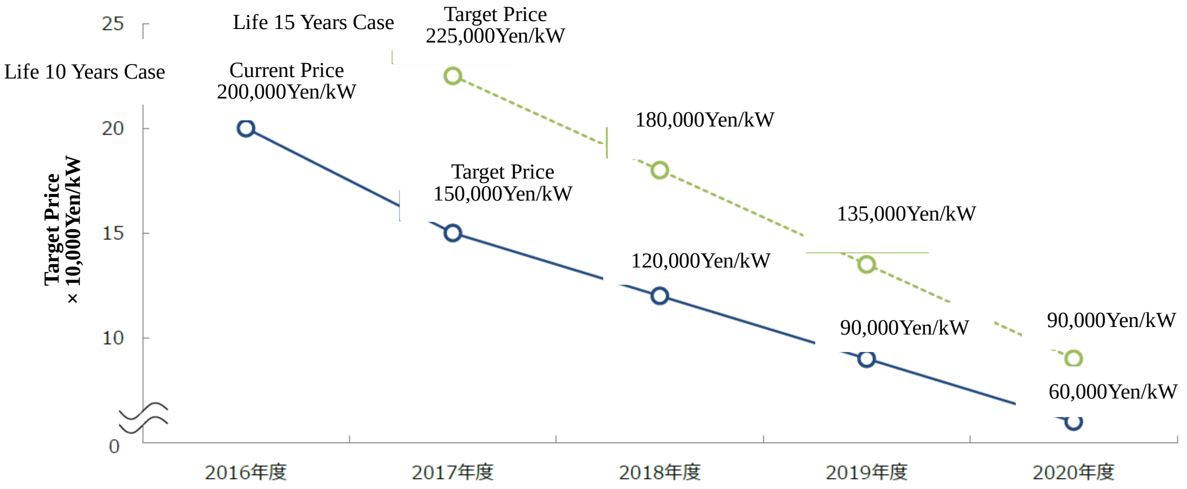
Item	Lead–acid battery	Nickel hydrogen battery	Sodium sulfur battery	Redox flow battery	Lithium-ion battery
Energy Density (Wh/kg)	35	60	100	10	200
Charge-Discharge Efficiency	75	90	75	70	95
Life- cycle	3,000	2,000	4,500	>=10,000	3,500
Life- year	17	5-7	15	6-10	6-10
Capacity Range	kWhs- MWhs	upto MWhs	above 100s kWh	above 100s kWh	kWhs-1MWh
Unit Cost (yen/kWh)	50,000	100,000	40,000	ND	200,000
Notes	inexpensive, many records	large current	high temperature	long cycle life	high efficiency, costly

(source; Research on Building Costs、Research Institute on Building Cost, 2013)

	Lead–acid battery	**Nickel hydrogen battery**	**Lithium Ion battery**	**NAS (Sodium sulfur) battery**	**Redox flow battery**	**Molten Salt battery**
Comapction	×	△	◎	○	×	◎
Energy Density (Wh/kg)	35	60	200	130	10	290
Cost (Yen/kWh))	50,000	100,000	200,000	40,000	ND	ND
Large Size Adaptability	○, -MW class	○, -MW class	○, upto 1MW	◎, above MW class	◎, above MW class	ND
Charge Accuracy	△	△	△	△	◎	△
Safety	○	○	△	△	◎	◎
Resources	○	△	○	◎	△	◎
Heating Requirement				Required (>=200deg)		Required (>=50deg)
Life-Yrs	17	5-7	6-10	15	6-10	ND
Life-Cicles	3,150	2,000	3,500	4,500	no limit	ND

(source: Battery Strategy, 2012, METI)





	Actual Price (FY2015) (yen/kWh)	Target Price (FY2020) (yen/kWh)	Notes
kWh Battery (mainly for Housing)	220,000	below 90,000	demand increase enables 15 years recovery
kW Battery (mainly for Industry)	360,000	below 150,000	decrease in PPA via peakcut enables 7 years recovery

(source: Price Decrease Scheme of Stationary Battery, METI, 2017)

	Manufacturer	Product Specification (example)		
		Output	Capacity	Size
Domestic Manufacturer	Toshiba	500 kW	24-3,840 kWh (1-16 parallel)	2.0W x 1.9H x 0.7D (m,PCS) 0.6W x 2.1H x 0.65D (m.unitwise)
	MHI	2 MW	816 kWh	40ft container x 3, (battery2, PCS1)
	Hitachi	1 MW	450 kWh	45ft container
	GS-Yuasa	250 kW	1 MWh	40ft container
	NEC	250 kW	250 kWh	-
Foreign Manufacturer	Samsung	1 MW	1 MWh	45ft container
	AI23	4 MW	4 MWh	53ft container
	SAFT	1.6 MW	420 kWh	20ft container

(source: MRI, 2014)

Domestic Battery Project on Grid Scale

	Site	Capacity
Hokkaido Electric Power	Minami hayakita SS	1.5MW- 4h, Redox flow battery
Tohoku Electric Power	Nishi Kawauchi SS	20MW- 1h,Lithium-ion battery
	Minami Souma SS	40MW- 1h,Lithium-ion battery
Kyushu Electric Power	Buzen SS	50MW-6h, Sodium sulfur battery

(source; JICA Study Team)

In case batteries are selected for the alternative peak supply facility, low frequency type battery must be chosen with a large scale capacity and long output duration period. Judging from the above document information, it is considered currently:

- Construction cost : 25,000 – 50,000 yen/kWh (at 2020 year)
- Current maximum capacity :50MW
- Current weight : 100Wh/kg

Thus, such battery with equivalent capability as Turga PSP of 1.000 MW capacity and 5 hour generation per day necessitates huge cost to establish, and is considered unrealistic. In addition it needs a huge weight/special area to put it in.

(1,000 MW with 1,825 hr/yr requires 25,000yen/kWh × 1,825 Million kWh/yr = 45 trillion yen/yr. Weight for 100kg/Wh × 5,000 MWh = 83,000t)

In conclusion, batteries for peak power storage is not competitive against PSPs for their large scale in terms of cost, no matter how much cost down can be anticipated in future.

4) Power purchase from outside of the state

West Bengal has been purchasing power from outside of the state till now, but it complies conditions of Back Down Charge payment so that West Bengal cannot purchase only peak power for its need but also must purchase firm off – peak power if it wishes to avoid Back Down Charge payment. Simply if it assumes power purchase other than 5 hr per day is of useless and cancelled, WBPDCL will have to bear huge cost burden to purchase power from outside in the future.

2. Controlling intermittent generation from renewable power sources

1) Battery

There are 2 different types of batteries in meeting the variation of renewable power generation such as battery for "low frequency grid operation for relatively long hours stabilization" and a battery for "high frequency grid operation" for a few to 20 minutes stabilization. Each type battery has different competitiveness.

The former type of low frequency type battery needs to be in operation for long hours per day to absorb renewable power fluctuation. It requires a huge cost as in above 1 "Optimization of generation for peak power supply/power generation shift from off-peak to peak demand Peak power" and is not feasible. High frequency battery may become feasible under a certain circumstances in the future.

(In West Bengal it projects 2,700 - 5,386MW of renewable energy in 2022. It will become all redundant considering Off Peak demand will be 5,000MW.

1) If such redundant power 500MW (assumed) is absorbed by battery for 3 hr/day, 50 days/yr, then 25,000 yen/kWh x 75 Million kWh = 19 Trillion yen/yr.

2) If such redundant power of 100 MW (assumed) is absorbed by battery for 0.25 hr/day, 50 days/yr, then 25,000 yen/kWh x 1.25 Million kWh = 310 Billion yen/yr

2) Supply demand control by power export/import to/from outside state

Nationwide control or several interstate control of trading power can manage power from intermittent generation by renewable energy. Such power control must be equipped with costing and time consuming investment on interstate transmission networks. Such trade is influenced by each state power supply-demand status. Regulations must be prepared first.

3. Ancillary Services

No duly intra state ancillary service is available in India, and only "Ancillary Services Operations Regulations, 2015" is available for interstate transmission of power. The actual demand for ancillary service in West Bengal therefore is unknown.

For reference, actual trade record for interstate ancillary service is shown below from "Report on Short-term Power Market in India 2016-17, CERC".

Figure-38: Energy Scheduled to/from Virtual Ancillary Entity under RRAS (MU), 2016-17

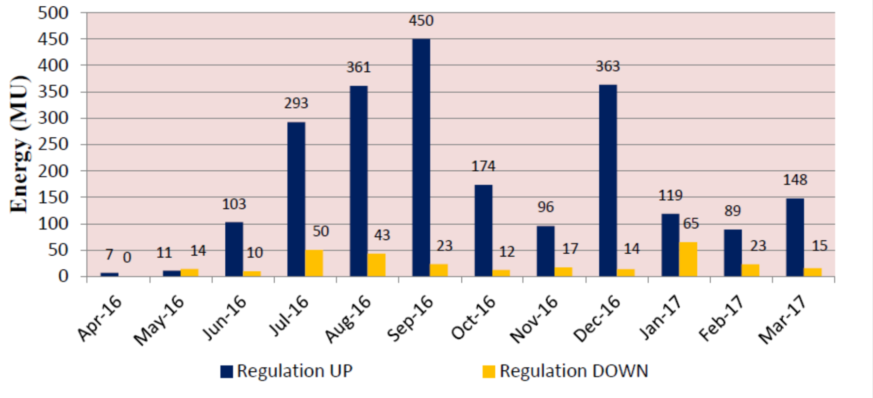
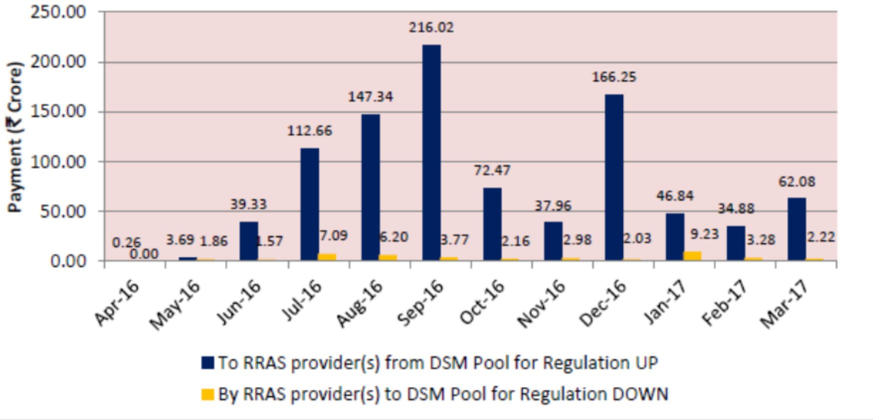


Figure-39: Payments made for Ancillary Services during 2016-17 (₹ Crore)



(source: Report on Short-term Power Market in India 2016-17 CERC)

This explains,

2,500 MU/yr for a whole year transaction volume of ancillary services.

1,001 Cr/yr for a whole year transaction cost of ancillary services.

It simply indicates on average ancillary service is traded 4 INR/kWh in 2016-17.

1) Battery

Ancillary service requires only a limited short time operation period and only a limited power energy transaction (kW). It is one order smaller to battery capacity for renewable absorption.

Currently the kW cost for battery is high as 150,000 yen/kW (2020) with unit cost of 19 yen/kW (in calculation below), and it is yet competitive cost to PSPs. However 19 yen/kW provides prospect of cost down to the feasible competitive range in the future.

(The required AGC volume in 2020 for West Bengal amounts 100 - 180MW from peak demand 12,000 MW and off-peak demand 5,000 MW using AGC formula in chapter 9. It is 10 % of Turga PSP. If a battery installation cost is assumed 150,000 yen/kW, it gives 15-27 Billion yen for 100- 180 MW battery. If 100 MkWh/yr is assumed as the transaction volume of ancillary service in West Bengal, Fixed cost for 10 yr recovery would be 15 yen/kWh. Variable cost would be around 4 INR (= power procured 3 INR/kwh/85% efficiency).

2) Spinning Reserve supply from conventional power generation
WBSEDCL requires 4-5 units of coal thermal plant if it tries to supply ancillary volume equivalent to Turga PSP (36.5MW). As WBSEDCL does not own coal thermal plants it needs to procure it from WBPEDCL etc. but WBPDCL does not have any incentive nor duty to at all times prepare spinning reserve from always running baseload coal thermal power supply.

3) Demand Response (DR)
Demand side management is to absorb and discharge intermittent fluctuated power by smart grid meter and electric vehicles (EV). This is being studied in India. But such management needs various infrastructures as automatic remote demand - supply control system on power generators, charging stations to EVs, regulatory and market designs, etc. It may take some time considering current Indian power sector with a large T&D loss and power theft.

4. <u>Imbalance settlement, Minimize the deviation from schedule dispatch or drawal.</u>

1) Battery
Same as 1) Battery for 3. “Ancillary Services”

2) Spinning Reserve supply from conventional power generation
Same as 2) for 3. “Ancillary Services”
Currently WBSEDCL handles imbalance by paying penalty (it may reduce paying penalties by its own hydropower generators).

3) Gas power generation
Same as 1) for 1. “Optimization of generation for peak power supply/power generation shift from off-peak to peak demand”.
There is no gas turbine power generation plan in West Bengal.

5. <u>Storage of excess generation of grid by creating demand at the time of excess generation.</u>

1) Battery
Same as 1) for 2. “Controlling intermittent generation from renewable power sources”
Battery is not competitive to PSPs.

2) Restriction of Renewable Power Generation
If PV generation of 1,000MW is to be shut down for 6 hrs then1.46 Cr/6 hrs will be lost in revenue (assuming 2.44INR/U for PV). It may be relatively realistic measures compared to other options.

3) Demand Response (DR)
Same as 3) for 3. “Ancillary Services” it is not practical in India yet.

CHAPTER 6

GEOLOGY

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CHAPTER 6 GEOLOGY

Based on review of the Detailed Report of the Turga Pumped Storage Project (DPR), field visit in October 2017 and the information after DPR, outline of geology and geotechnical evaluation of the Turga Pomped Storage Project is shown in this chapter.

6.1 TOPOGRAPHY AND GEOLOGY OF THE PROJECT AREA

6.1.1 Regional Geology

The project lies near Baghmundi village in the Purulia District, West Bengal.

Based on DPR Vol.1 Chapter 1 p 6, regional geology around the project area is as follows.

The project area constitutes mainly the crystalline rocks comprising quartzo-feldspathic gneiss belonging to the Chhotanagpur Gneissic Complex (CGC) of Archaean age. The Singhbum Shear Zone (SSZ) is located towards the south-eastern part of the project area. The border between CGC and SSZ are divided by the South Purulia Shear Zone. North Purulia Shear Zone is noted towards the north of the project area (Figure 6.1.1-1).

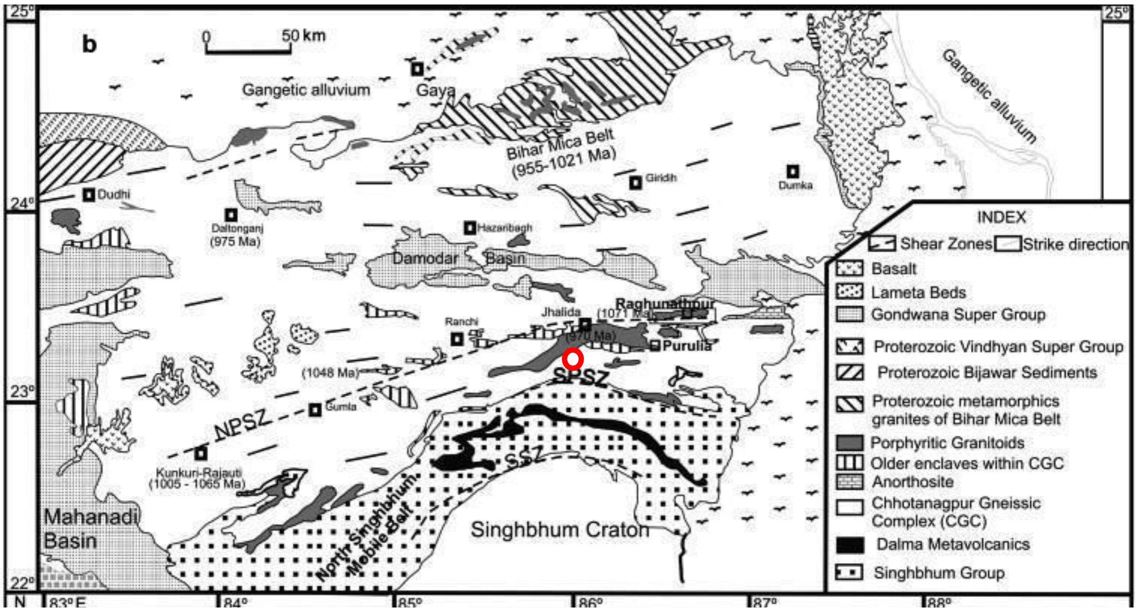


Figure 6.1.1-1 Regional Geological Map around the Project Area

○ : Project Area (Source: DPR Vol.5 p13 Figure 5.3.2)

6.1.2 Topography of the Project Area

The project area lies in the catchment area of Turga nala at the south-western fringe of the Ajodhya Hills.

The Turga nala rises on Ajodhya Hills and flows south-west for about 9 km and meets Kistobazar nala and then meets with the Subarnarekha River which in turns pours itself into the Bay of Bengal (DPR Vol.1 Chapter 1 p6).

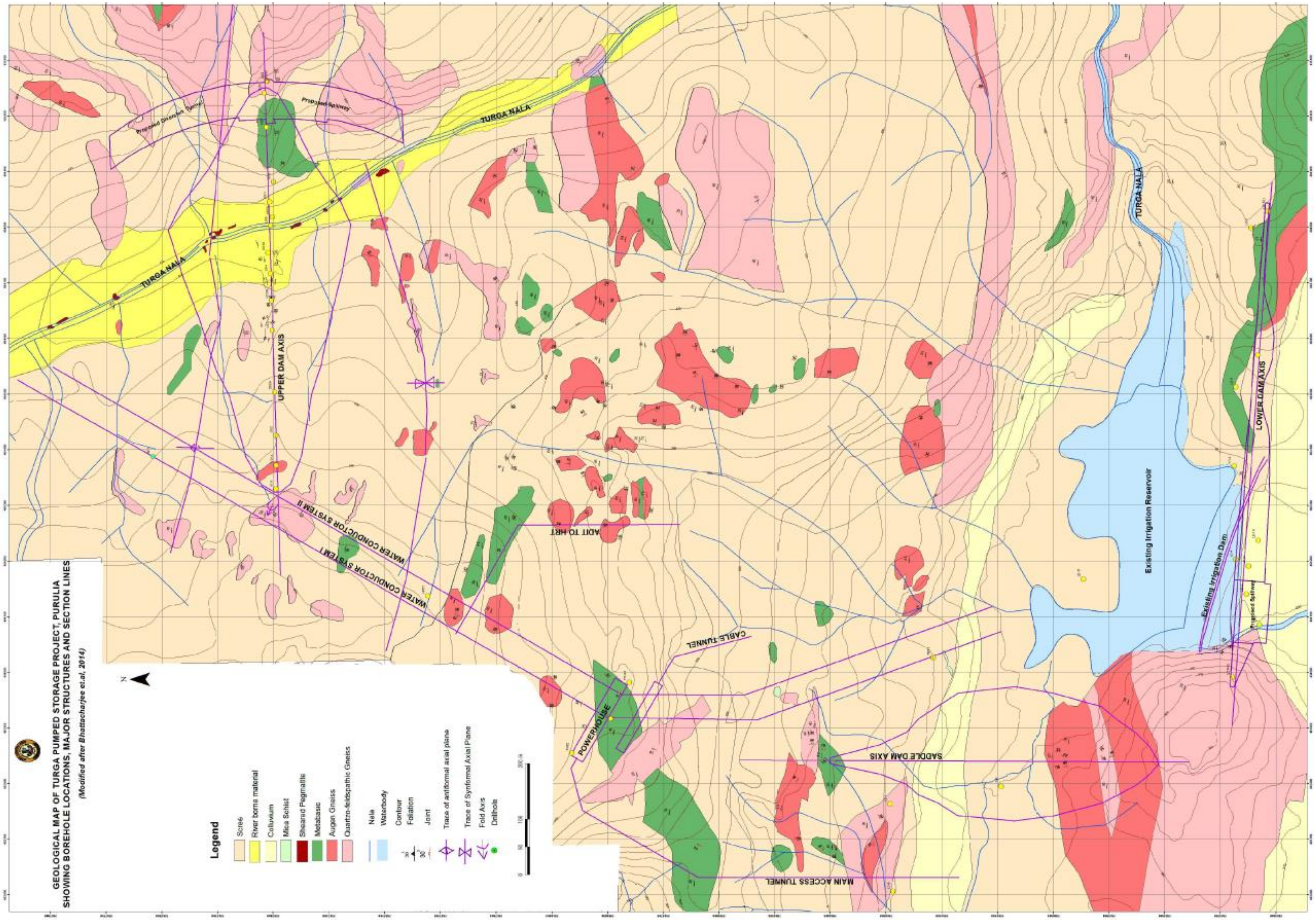
Ajodhya Hills is a plateau of 500 m - 600 m in elevation. The upper dam site is located in the valley of Turga nala where its bottom is about 410 m in elevation, and the lower dam site is located near its downstream end of the valley which bottom is about 260 m in elevation.

Near the upper dam site, Turga nala flows in a NW-SE valley which is a part of a NW-SE remarkable lineament recognized by aerial photograph interpretation (DPR Vol.5 Annexure 3 p4).

6.1.3 Geological Investigation

(1) Geological mapping

The project area has been mapped on scale 1:5000 and each project component sites have been mapped on 1:2000 scale. These works have been compiled in 1:5000 geological map (Figure 6.1.3-1).



(source: DPR Vol.5 Plate 1)

Figure 6.1.3-1 Geological Map of the Project area

(2) Core boring

The quantity of core borings is shown in Table 6.1.3-1. In boreholes, permeability tests (Lugeon tests) have been conducted.

Table 6.1.3-1 Core Borings in the Project area

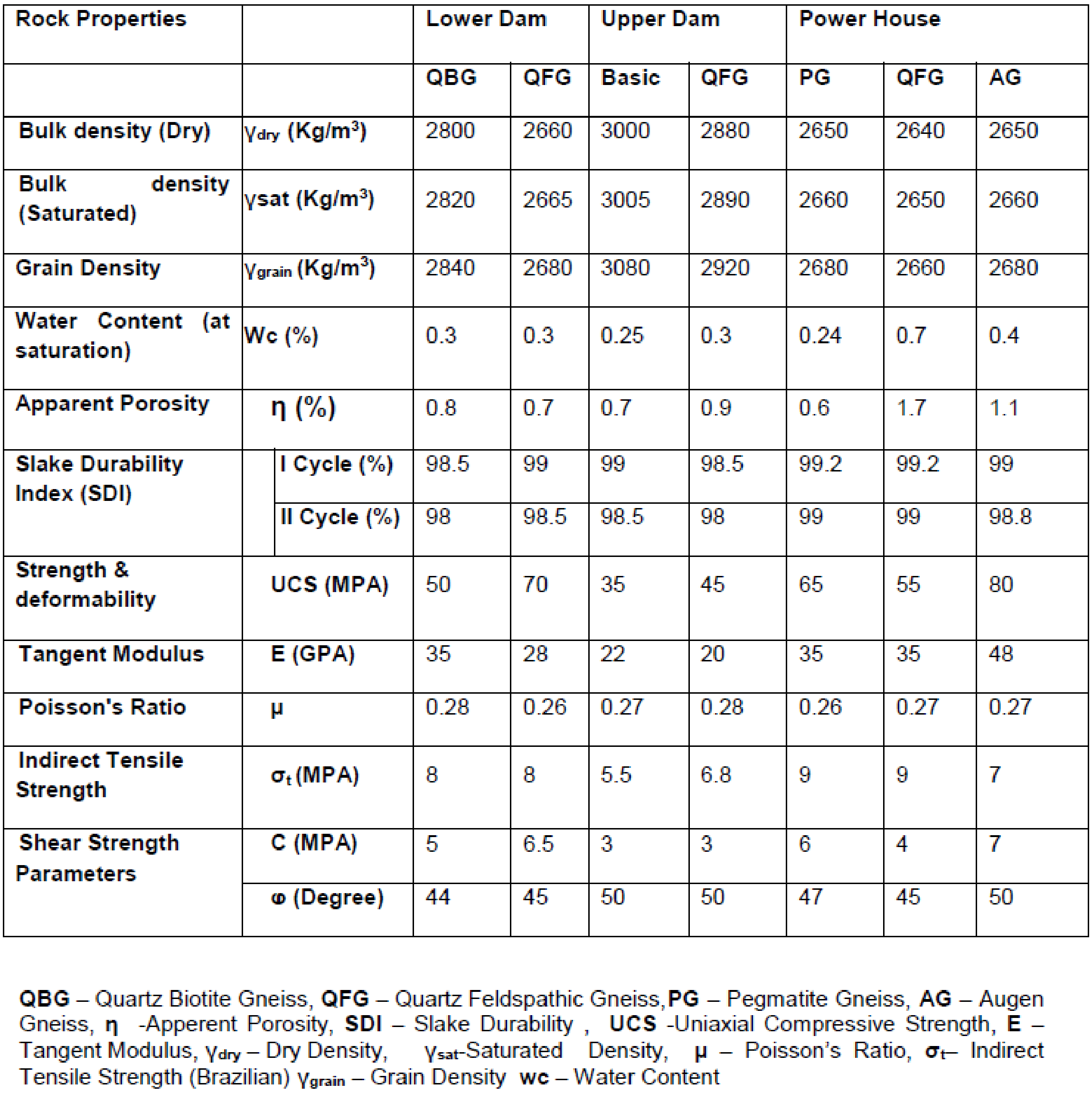
Component Site	holes	Length (m)	Remarks
Upper Dam	18	648.1	with Lugeon tests
Lower Dam	18	702	including Saddle Dam, with Lugeon tests
Power House	5	689	with Lugeon tests
Intake and Headrace Tunnel	2	145.5	with Lugeon tests
Tailrace Tunnel	1	45.5	with Lugeon tests
Drift Area	3	44	Drift is the exploratory adit for power house.
Quarry Site	2	60	
Total	49	2334.1	

Logs of core boring are in Annexure 1A of DPR Vol.5, and results of Lugeon tests are shown in Annexure 1B of DPR Vol.5.

(3) Laboratory test

Laboratory tests have been conducted with the boring core obtained at the upper dam site, the lower dam site and the power house site. The outline of these results are shown in Table 6.1.3-2.

Table 6.1.3-2 Results of Laboratory Test of Boring Core



Rock Properties		**Lower Dam**		**Upper Dam**		**Power House**		
		QBG	**QFG**	**Basic**	**QFG**	**PG**	**QFG**	**AG**
Bulk density (Dry)	γ_{dry} **(Kg/m³)**	2800	2660	3000	2880	2650	2640	2650
Bulk density (Saturated)	**γsat (Kg/m³)**	2820	2665	3005	2890	2660	2650	2660
Grain Density	γ_{grain} **(Kg/m³)**	2840	2680	3080	2920	2680	2660	2680
Water Content (at saturation)	**Wc (%)**	0.3	0.3	0.25	0.3	0.24	0.7	0.4
Apparent Porosity	**η (%)**	0.8	0.7	0.7	0.9	0.6	1.7	1.1
Slake Durability Index (SDI)	**I Cycle (%)**	98.5	99	99	98.5	99.2	99.2	99
	II Cycle (%)	98	98.5	98.5	98	99	99	98.8
Strength & deformability	**UCS (MPA)**	50	70	35	45	65	55	80
Tangent Modulus	**E (GPA)**	35	28	22	20	35	35	48
Poisson's Ratio	**μ**	0.28	0.26	0.27	0.28	0.26	0.27	0.27
Indirect Tensile Strength	σ_t **(MPA)**	8	8	5.5	6.8	9	9	7
Shear Strength Parameters	**C (MPA)**	5	6.5	3	3	6	4	7
	φ (Degree)	44	45	50	50	47	45	50

QBG – Quartz Biotite Gneiss, **QFG** – Quartz Feldspathic Gneiss, **PG** – Pegmatite Gneiss, **AG** – Augen Gneiss, **η** -Apperent Porosity, **SDI** – Slake Durability , **UCS** -Uniaxial Compressive Strength, **E** – Tangent Modulus, γ_{dry} – Dry Density, γ_{sat}-Saturated Density, **μ** – Poisson's Ratio, σ_t– Indirect Tensile Strength (Brazilian) γ_{grain} – Grain Density **wc** – Water Content

(source: DPR Vol.5 p32 Table 5.6.2)

(4) In-situ tests

Goodman jack tests have been conducted in boreholes at the lower dam site (DPR Vol.6 Appendix 1).

After the completion of DPR, hydro fracture tests have been conducted in the drift (exploration adit) for power house.

In-situ rock mechanical tests such as rock shear test have been planned in Detailed Design Stage.

(5) Drift

A drift (exploration adit) is under excavation toward the power house site. The face of the drift was at 120 m before the power house cavern (262 m from the entrance) in October 2017. Logs of the drift from the entrance to 103 m are in Appendix I h of DPR Vol.5.

6.1.4 Geology of the Project Area

Based on DPR Vol.1 Chap5 p20-22 and Figure 6.1.3-1, geology of the project area is as follows.

The project area consists dominantly of hard compact quartzo-feldspathic gneisses and subordinate zones of meta-basic rocks. Three major litho-types of gneisses are augen gneiss accompanied by pegmatite, quartzo-feldspathic gneiss accompanied by mica schist, and quartz-biotite gneisses.

There is a syncline in foliation of gneisses between the upper dam site and the lower dam site. The axis of that syncline trends WSW - ESE and plunges to ESE. The lower dam site and power house site are on the south wing of the syncline, and prominent foliation dips north to northeast at 30º-55º. The upper dam site is on the north wing, and prominent foliation-dips SSE at 30°-35°.

Fractured quartzo-feldspathic gneisses exposed along the river bed of Turga nala near the upper dam site where the NW-SE remarkable lineament has been recognized by aerial photograph interpretation.

The valley slopes in the project area are generally characterized by sporadic rock outcrops and colluvium/scree cover with thickness less than 10 m.

6.2 GEOLOGY OF STRUCTURE SITES

6.2.1 Upper Dam Site

(1) Topography

The upper dam site is located in the valley of Turga nala where its bottom is about 410 m in elevation. Full Reservoir Level (FRL) of the upper reservoir is 464.00 m. The valley bottom is about 200 m wide. The dam axis on both banks is along gentle ridge slopes. The slope on the left bank climbs at about 15° in average, and that on the right bank climbs at about 10° in average (Figure 6.2.1-1).

(2) Geology

The geological maps of the upper dam site are shown in Figure 6.1.3-1 and Figure 6.2.1-1 respectively.

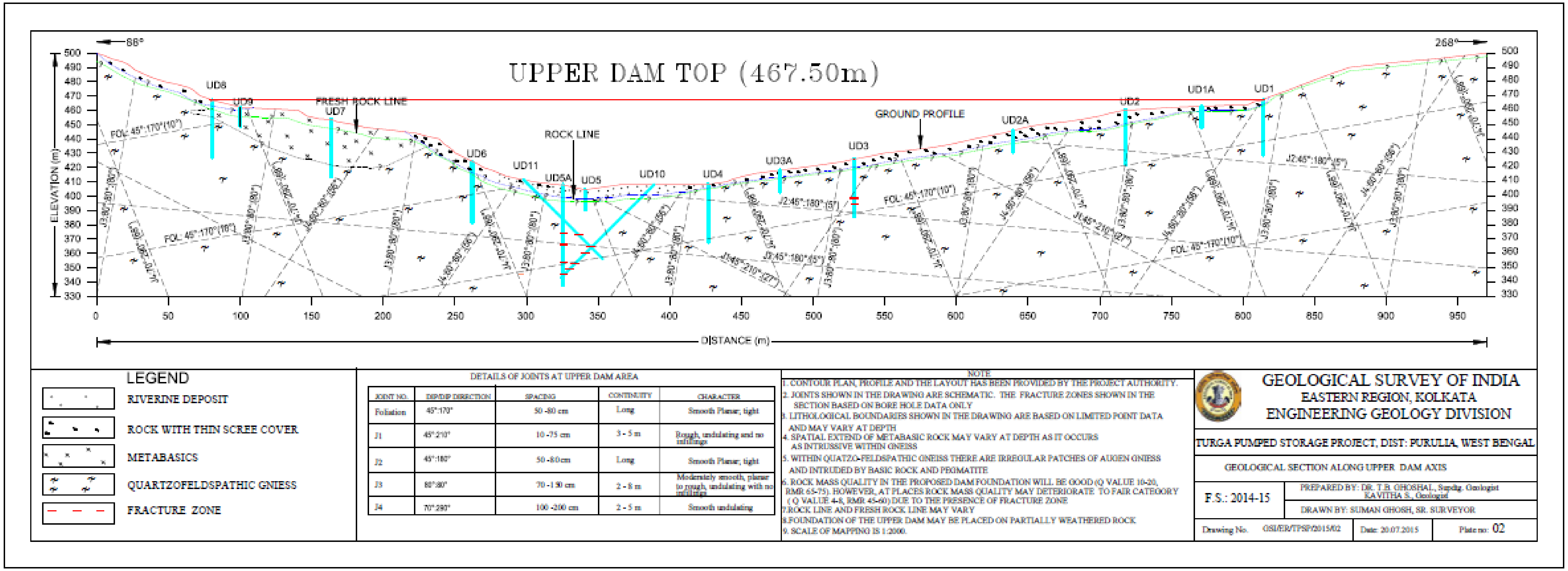
The bedrock at the upper dam site is composed by quartzo- feldspathic gneiss accompanied by meta-basics. The bedrock is generally covered with river deposits and slope deposits less than 10 m in thickness. Exposed bedrocks show foliation generally dipping downstream at about 45° and joints of four directions (Table 6.2.1-1).

Because a remarkable lineament is recognized by aerialphoto interpretation (DPR Vol.5 Annexure-3) and fractured bedrocks exposed along the Turga nala, five core borings are conducted on the valley bottom. Among them, two core borings are drilled at 45° so as to cross each other below the valley bottom. Any large fracture zones have not been found by these borings (DPR Vol.5 p37).

(3) Geotechnical Evaluation

At the upper dam site, the thickness of the surface deposits confirmed by core borings are less than 10 m. The depth of the surface of fresh rocks are maximum 12.4 m and generally less than 10 m deep. Fresh rocks have rock mechanical parameters of RQD more than 75 %, joint interval 30 - 70cm, unconfined compression strength 45 MPa. These parameters introduce RMR value around 60, which indicate near the border between Class II and Class III. So, the fresh rock at the upper dam site is strong enough for the foundation of the proposed rock fill dam.

The permeability of the bed rocks at the upper dam site have been investigated by Lugeon tests conducted in boreholes. Most of Lugeon tests have been conducted in fresh rocks. At slopes on both banks, permeability of fresh rocks at the depth shallower than 25 m are relatively high (generally 7 - 10 Lu). Those at deeper depth are mostly less than 4 Lu. Groundwater levels are 10 to 25 m which are concordant with the depth of the relatively high permeable zone. At valley bottom, some test sections in fresh rock show about 5 Lu at the depths deeper than 25 m including 10 Lu at the depths about 50 m (UD-10). The fresh rocks at the upper dam site generally become watertight by ordinal grouting except valley bottom where careful grouting would be needed.



DETAILS OF JOINTS AT UPPER DAM AREA

JOINT NO.	DIP/DIP DIRECTION	SPACING	CONTINUITY	CHARACTER
Foliation	45°:170°	50 -80 cm	Long	Smooth Planar; tight
J1	45°:210°	10 -75 cm	3 - 5 m	Rough, undulating and no infillings
J2	45°:180°	50 -80cm	Long	Smooth Planar; tight
J3	80°:80°	70 -150 cm	2 - 8 m	Moderately smooth, planar to rough, undulating with no infillings
J4	70°:290°	100 -200 cm	2 - 5 m	Smooth undulating

NOTE

1. CONTOUR PLAN, PROFILE AND THE LAYOUT HAS BEEN PROVIDED BY THE PROJECT AUTHORITY.
2. JOINTS SHOWN IN THE DRAWING ARE SCHEMATIC. THE FRACTURE ZONES SHOWN IN THE SECTION BASED ON BORE HOLE DATA ONLY
3. LITHOLOGICAL BOUNDARIES SHOWN IN THE DRAWING ARE BASED ON LIMITED POINT DATA AND MAY VARY AT DEPTH
4. SPATIAL EXTEND OF METABASIC ROCK MAY VARY AT DEPTH AS IT OCCURS AS INTRUSSIVE WITHIN GNEISS
5. WITHIN QUATZO-FELDSPATHIC GNEISS THERE ARE IRREGULAR PATCHES OF AUGEN GNIESS AND INTRUDED BY BASIC ROCK AND PEGMATITE
6. ROCK MASS QUALITY IN THE PROPOSED DAM FOUNDATION WILL BE GOOD (Q VALUE 10-20, RMR 65-75). HOWEVER, AT PLACES ROCK MASS QUALITY MAY DETERIORATE TO FAIR CATEGORY (Q VALUE 4-8, RMR 45-60) DUE TO THE PRESENCE OF FRACTURE ZONE
7. ROCK LINE AND FRESH ROCK LINE MAY VARY
8. FOUNDATION OF THE UPPER DAM MAY BE PLACED ON PARTIALLY WEATHERED ROCK
9. SCALE OF MAPPING IS 1:2000.

GEOLOGICAL SURVEY OF INDIA
EASTERN REGION, KOLKATA
ENGINEERING GEOLOGY DIVISION

TURGA PUMPED STORAGE PROJECT, DIST: PURULIA, WEST BENGAL

GEOLOGICAL SECTION ALONG UPPER DAM AXIS

F.S.: 2014-15

PREPARED BY: DR. T.B. GHOSHAL, Supdg. Geologist
KAVITHA S., Geologist

DRAWN BY: SUMAN GHOSH, SR. SURVEYOR

Drawing No. GSI/ER/TPSP/2015/02
Date: 20.07.2015
Plate no: 02

(source: DPR Vol.5 Plate 2)

Figure 6.2.1-1 Geological Profile of the Upper Dam Site

Table 6.2.1-1 Discontinuities at the Upper Dam Site

Joint No	Average attitude (Dip/dip direction)	Spacing	Continuity	Characteristics
Foliation	Dips:45° Dip Direction:170°	50-80 cm	Long	Smooth planar ;tight
J1	Dip: 45°, Dip Direction:210°	10-75 cm	3-5m	Rough undulating and no infillings
J2	Dip: 45°,Dip Direction:180°	50-80 cm	Long	Smooth planar, tight
J3	Dip: 80°,Dip Direction:80°	70-150 Cm	2-8m	Moderately smooth, planar to rough Undulating with no infillings
J4	Dip: 70°,Dip Direction:290°	100-200 Cm	2-5m	Smooth undulating

(source: DPR Vol.5 p35 Table 5.7.1)

6.2.2 Lower Dam Site

(1) Topography

The lower dam site is located near the downstream end of the valley, where Turga nala laeves Ajodhya Hills and flows down to lowland. The lower reservoir is generated by the lower dam and a saddle dam. The valley bottom at the lower dam site is about 260 m in elevation and FRL of the lower reservoir is 316.5 m. The valley bottom is almost flat and about 330 m wide. There is an existing irrigation dam at this dam site. The dam axis on the left bank is along a ridge extending east with two saddles. The slope on the right bank of the dam site rises at around 30° up to an isolated hill which top is about 330 m in elevation (Figure 6.2.2-1).

(2) Geology

The geological maps of the upper dam site are shown in Figure 6.1.3-1 and Figure 6.2.2-1 respectively.

The bedrock at the lower dam site consist mainly of quartzo- feldspathic gneiss and augen gneiss, and subordinately of meta-basics exposed 100 - 200 m wide zone on the left bank. Exposed bedrocks show foliation generally dipping north (upstream) at 35° in average and joints of three directions (Table 6.2.2-1).

The deposits on valley floor are thick up to 16.5 m and the bottom of the deposits is 247.7 m in elevation (LD-10). The bottom of the existing irrigation dam body have been confirmed at the depth of 34 m (242.7 m in elevation) in LD-4. On the left bank, rather thick (4.5 - 10.5 m) deposits have been found. The rocks are exposed in most area on the right bank.

(3) Geotechnical evaluation

At the lower dam site, the depth of the surface of fresh rocks are up to 20 m at valley floor, 5 - 9.8

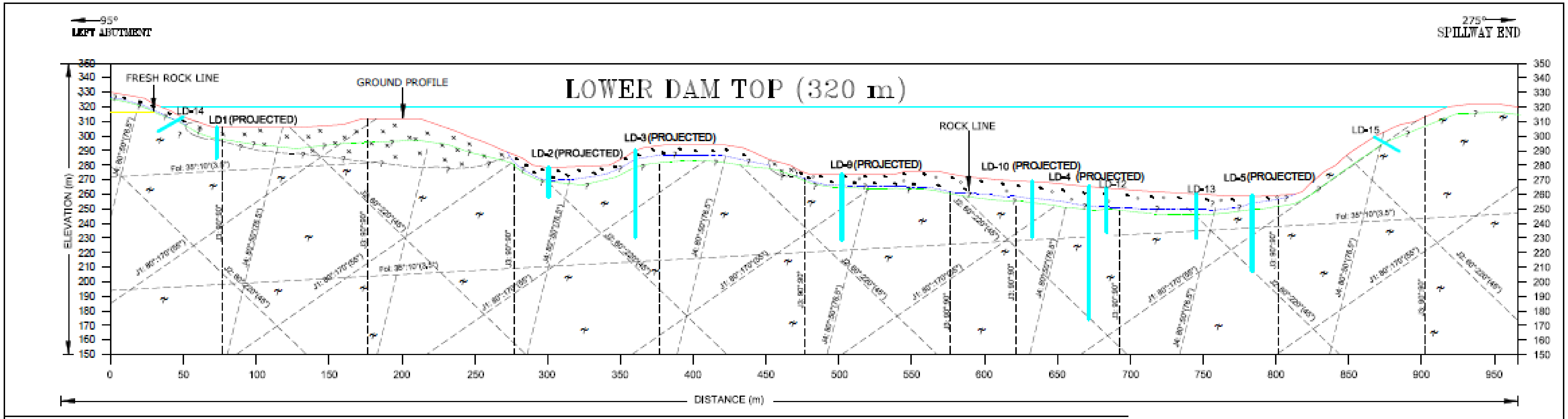
m on the left bank and around 8 m on the right bank. Fresh rocks are Class II according to logs of borings. Goodman jack tests conducted in fresh rocks of gneisses have provided deformation coefficient of 1100 to 4500 MPa (DPR Vol.6 Appendix 1). Fresh rocks at the lower dam site are evaluated strong enough for the foundation of the proposed concrete gravity dam.

The permeability of the fresh rocks at the lower dam site have been investigated by Lugeon tests conducted in boreholes. Permeability of fresh rocks at valley bottom are generally less than 3 Lu except LD-10 borehole with three test sections of 15 - 20 Lu at the depth around 30 m.

Those on the left bank are less than 2 Lu at depths deeper than 15 m. Groundwater levels on the left bank are shallower than 10 m.

The right bank have been investigated by one borehole (LD-15) which have provided permeability of 5 Lu at depths of 10 m to 25m (bottom of the borehole) and shallow groundwater level of 5 m.

The fresh rocks at the lower dam site become watertight by ordinal grouting, because permeable zone is generally shallow.



LEGEND

- RIVERINE DEPOSIT MIXED WITH SLOPE WASH MATERIAL
- ROCK WITH THIN SCREE COVER
- METABASICS
- QUARTZOFELDSPATHIC GNIESS

DETAILS OF JOINTS AT LOWER DAM AREA

JOINT NO.	DIP/DIP DIRECTION	SPACING	CONTINUITY	CHARACTER
FOLIATION (J1)	35°:10°	5 -20 cm	Long	Moderately smooth, planar
J1	80°:170°	10 -75 cm	>5 m	Moderately smooth, planar to rough, undulating
J2	60°:220°	10 -75 cm	2 m	Rough, undulating
J3	90°:90°	70 -100 cm	>5 m	Moderately smooth, planar to rough, undulating
J4	80°:50°	5 -150 cm	0.75- 1.5 m	Rough, undulating

NOTE

1. CONTOUR PLAN, PROFILE AND THE LAYOUT HAS BEEN PROVIDED BY THE PROJECT AUTHORITY.
2. JOINTS SHOWN IN THE DRAWING ARE SCHEMATIC.
3. LITHOLOGICAL BOUNDARIES SHOWN IN THE DRAWING ARE BASED ON LIMITED POINT DATA AND MAY VARY SPATIALLY
4. SPATIAL EXTEND OF METABASIC ROCK MAY VARY
5. WITHIN QUARTZO-FELDSPATHIC GNEISS THERE ARE IRREGULAR AUGEN GNIESS AND INTRUDED BY BASIC ROCK
6. ROCK MASS QUALITY IN THE PROPOSED DAM FOUNDATION WILL BE GOOD (Q VALUE 12-15,RMR 70-75) HOWEVER, AT PLACES ROCK MASS QUALITY MAY DETERIORATE TO FAIR CATEGORY (Q VALUE 8-10, RMR 55-65) DUE TO THE PRESENCE OF FRACTURE ZONE
7. ROCK LINE AND FRESH ROCK LINE MAY VARY
8. SCALE OF MAPPING IS 1:2000.
9. BOREHOLE 4 HAS BEEN DRILLED ON THE EXISTING IRRIGATION DAM TOP & BOREHOLE 10 HAS BEEN DRILLED ON THE DUMPED MATERIAL.

GEOLOGICAL SURVEY OF INDIA
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TURGA PUMPED STORAGE PROJECT, DIST: PURULIA, WEST BENGAL

GEOLOGICAL SECTION ALONG LOWER DAM AXIS

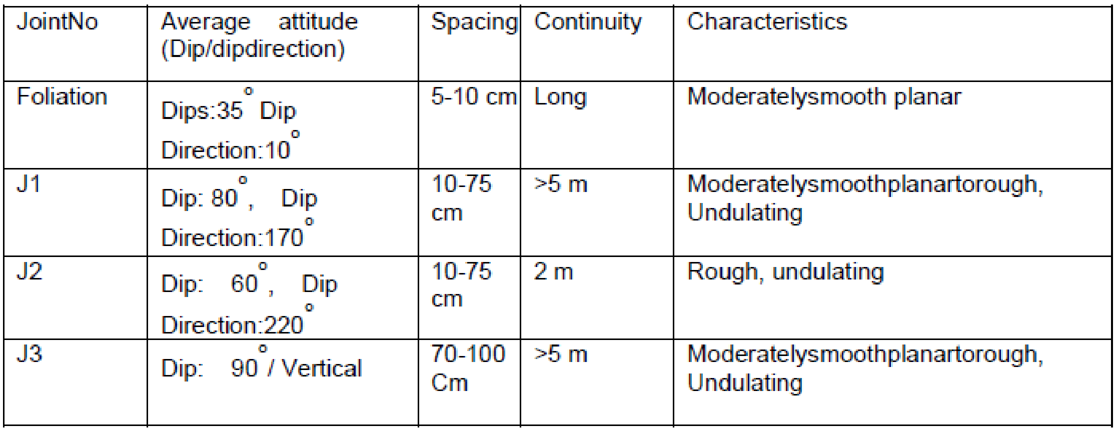
F.S.: 2014-15
PREPARED BY: DR. T.B. GHOSHAL, Supdtg. Geologist
KAVITHA S., Geologist
DRAWN BY: SUBRATA DAS, SR. SURVEYOR

Drawing No. GSI/ER/TPSP/2015/03
Date: 20.07.2015
Plate no: 03

(source: DPR Vol.5 Plate 3)

Figure 6.2.2-1 Geological Map of the Lower Dam Site

Table 6.2.2-1 Discontinuities at the Lower Dam Site



JointNo	Average attitude (Dip/dipdirection)	Spacing	Continuity	Characteristics
Foliation	Dips:35° Dip Direction:10°	5-10 cm	Long	Moderatelysmooth planar
J1	Dip: 80°, Dip Direction:170°	10-75 cm	>5 m	Moderatelysmoothplanartorough, Undulating
J2	Dip: 60°, Dip Direction:220°	10-75 cm	2 m	Rough, undulating
J3	Dip: 90° / Vertical	70-100 Cm	>5 m	Moderatelysmoothplanartorough, Undulating

(source: DPR Vol.5 p41 Table 5.7.2)

6.2.3 Saddle Dam Site

(1) Topography

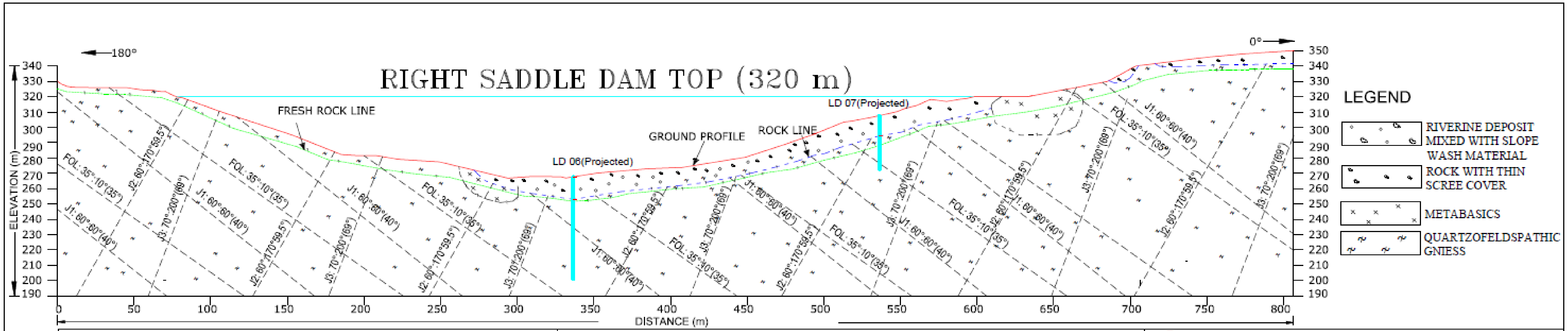
The saddle dam site is located to the north of the isolated hill on the right bank of the lower dam site. The lowest elevation at the saddle dam site is about 270 m. The height of the proposed dam is 50 m. FRL of the lower reservoir is 316.5 m. The gradient of slopes on the left bank and on the right bank are about 20° and 15° respectively. These slopes become gentler toward downslope to form gentle saddle (Figure 6.2.3-1).

(2) Geology

The geological maps of the saddle dam site are shown in Figure 6.1.3-1 and Figure 6.2.3-1 respectively.

The bedrock at the saddle dam site is composed mainly by quartzo-feldspathic gneiss. Exposed bedrocks show foliation generally dipping north (toward right bank) at around 35º and joints of three directions (Table 6.2.3-1).

The saddle dam site was investigated by two core borings. The thickness of deposits was 14.6 m near the saddle (LD-6) and 13.25 m on the right bank (LD-7). Bedrocks are exposed in most areas on the left bank.



DETAILS OF JOINTS AT RIGHT SADDLE DAM AREA

JOINT NO.	DIP/DIP DIRECTION	SPACING	CONTINUITY	CHARACTER
FOLIATION	35°:10°	5 -20 cm	> 5 m	Moderately smooth, Undulating
J1	60°:60°	5 - 150 cm	0.75 - 1.5 m	Rough, undulating
J2	60°:170°	10 -75 cm	5 m	Moderately smooth, planar to rough, undulating
J3	70°:200°	10 -75 cm	3 m	Rough, undulating

NOTE

1. CONTOUR PLAN, PROFILE AND THE LAYOUT HAS BEEN PROVIDED BY THE PROJECT AUTHORITY.
2. JOINTS SHOWN IN THE DRAWING ARE SCHEMATIC.
3. LITHOLOGICAL BOUNDARIES SHOWN IN THE DRAWING ARE BASED ON LIMITED POINT DATA AND MAY VARY SPATIALLY
4. SPATIAL EXTEND OF METABASIC ROCK MAY VARY AT DEPTH
5. WITHIN QUARTZO-FELDSPATHIC GNEISS THERE ARE IRREGULAR PATCHES OF AUGEN GNIESS AND INTRUDED BY BASIC ROCKS AND PEGMATITE
6. ROCK MASS QUALITY IN THE PROPOSED DAM FOUNDATION WILL BE GOOD (Q VALUE 10-15 RMR 60-70) HOWEVER, AT PLACES ROCK MASS QUALITY MAY DETERIORATE TO FAIR CATEGORY (Q VALUE 5-8, RMR 55-60) DUE TO THE PRESENCE OF FRACTURE ZONE
7. ROCK LINE AND FRESH ROCK LINE MAY VARY
8. SCALE OF MAPPING IS 1:2000.

GEOLOGICAL SURVEY OF INDIA
EASTERN REGION, KOLKATA
ENGINEERING GEOLOGY DIVISION

TURGA PUMPED STORAGE PROJECT, DIST: PURULIA, WEST BENGAL

GEOLOGICAL SECTION ALONG RIGHT SADDLE DAM AXIS

F.S.: 2014-15

PREPARED BY : Dr. T.B. GHOSHAL, Suptdg. Geologist
KAVITHA S., Geologist

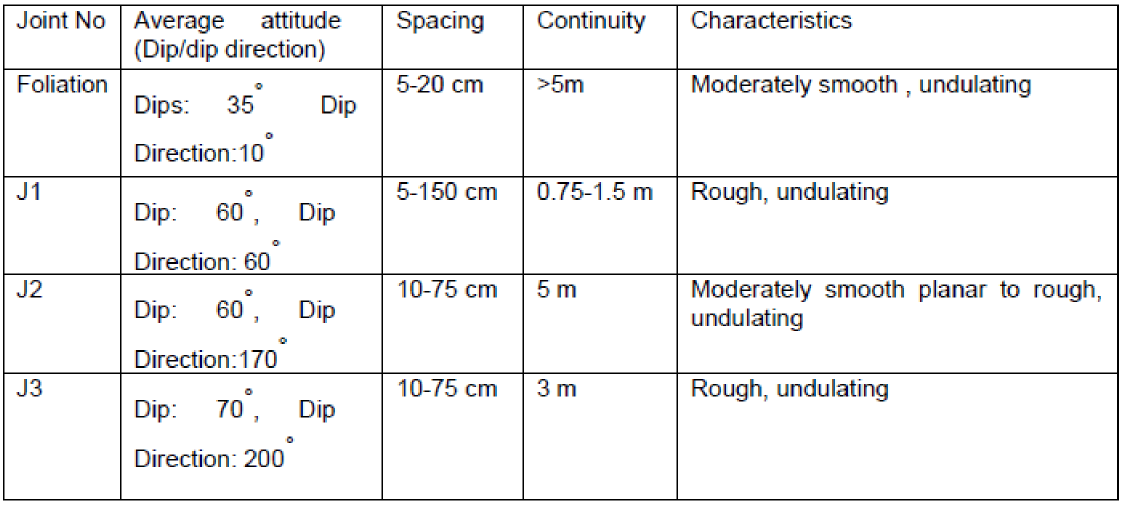
DRAWN BY : SUMAN GHOSH, Sr. SURVEYOR

Drawing No. GSI/ER/TPSP/2015/04 | Date: 20.07.15 | Plate No. 04

(source: DPR Vol.5 Plate 4)

Figure 6.2.3-1 Geological Map of the Saddle Dam Site

Table 6.2.3-1 Discontinuities at the Saddle Dam Site



Joint No	Average attitude (Dip/dip direction)	Spacing	Continuity	Characteristics
Foliation	Dips: 35° Dip Direction:10°	5-20 cm	>5m	Moderately smooth , undulating
J1	Dip: 60°, Dip Direction: 60°	5-150 cm	0.75-1.5 m	Rough, undulating
J2	Dip: 60°, Dip Direction:170°	10-75 cm	5 m	Moderately smooth planar to rough, undulating
J3	Dip: 70°, Dip Direction: 200°	10-75 cm	3 m	Rough, undulating

(source: DPR Vol.5 p41 Table 5.7.3)

(3) Geotechnical evaluation

At the saddle dam site, the depth of the surface of fresh rocks are 14.65 m near the saddle, and 19.5 m on the right bank. Those on the left bank are inferred around 8 m which is obtained by LD-15 on the right bank of the lower dam site. Fresh rocks at the saddle dam site are evaluated as Class II according to logs of boring and strong enough for the foundation of the proposed rock fill dam.

Lugeon tests have been conducted at depths deeper than approximate surface of fresh rocks. Permeabilities of fresh rocks near the saddle in LD-6 are generally less than 3 Lu except one test section of 8.5 Lu around the depth of 45 m. Groundwater level is shallower than 1 m. On the right bank in LD-7, they are less than 2 Lu, and groundwater level is around 10 m. On left bank, by LD-5, they are inferred around 5 Lu at the depths deeper than 10 m, and groundwater level is inferred around 5 m.

The fresh rocks at the saddle dam site become watertight by ordinal grouting, because permeable zone is generally limited in shallow depth. But, existing core borings are only two. Additional core borings and Lugeon tests are needed in Detailed Design Stage.

6.2.4 Upper Reservoir Area

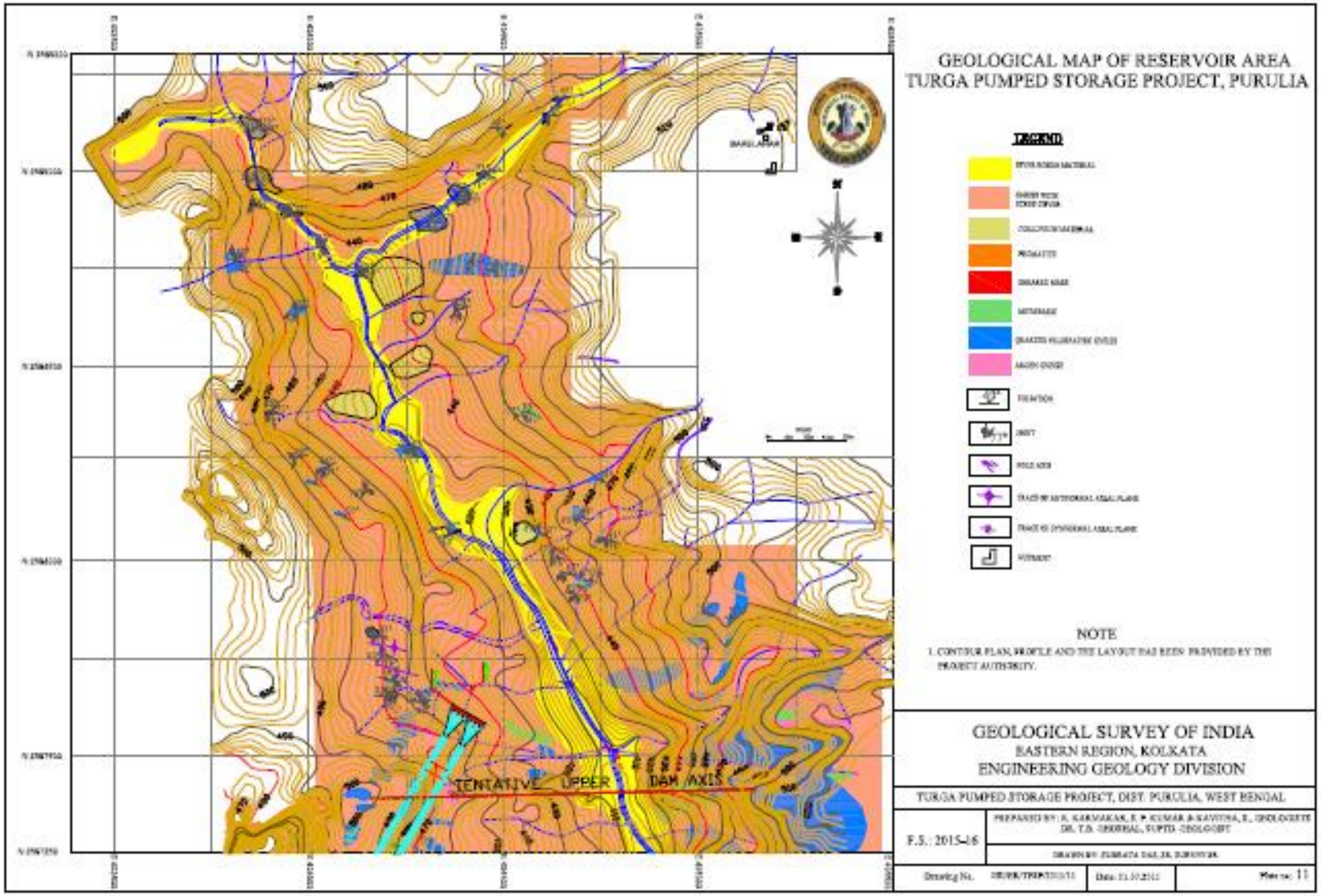
The FRL of the upper reservoir is 464.00 m. Slopes climb up to the plateau of Ajodhya Hills which elevation are around 500 m on the left bank, and climb up to the ridge of elevation higher than 490 m on the right bank. Slopes on both banks are gentler than 20° below around Minimum Drawdown Level (MDDL; 441.40 m), and steeper above that elevation.

Based on the geological map (Figure 6.2.4-1), bedrock in the upper reservoir area composed mainly by quartzo- feldspathic gneiss. Foliations generally dip toward N to NE (toward upstream and left bank) at 30 - 60° which is favorite in stability of many slopes in the reservoir area. Outcrops of bedrock are however limited and most areas in reservoir area are covered with deposits less than 10 m in thickness which is inferred from the results of core borings at dam site.

Most of the slopes in reservoir areas are moderately vegetated containing large long trees and do not show any signs of creep of slope instability (DPR Vol.5 p54).

Abovementioned gentle slope gradient, favorite attitude of foliations and no sign of slope instability indicate that slopes in the reservoir area are stable.

At the upper dam site, bed rocks are generally impermeable at depths deeper than 25m and groundwater levels are shallower than this depth. Similar hydrogeological situation supposed applicable to the reservoir area. The plateau and ridge surrounding the reservoir are more than 25m above FRL. Any faults and lineaments continuing to outside the reservoir area are not found. Therefor the reservoir area is judged watertight.



(source: DPR Vol.5 Plate 11)

Figure 6.2.4-1 Geological Map of the Upper Reservoir Area

6.2.5 Lower Reservoir Area

The FRL of the lower reservoir is 316.5 m. Lower reservoir are surrounded by the slopes on the right bank, those on the left bank and those of the isolated hill between the lower dam site and the saddle dam site.

Based on the geological map (Figure 6.2.6-1), bedrock in the lower reservoir area composed by quartzo-feldspathic gneiss, augen gneiss and meta-basics. The covers of deposits are thin in general.

On the right bank, slopes incline toward S and foliations generally dip toward N at 20 - 50° which is favorite in slope stability. On the left bank, slopes incline toward N and foliations generally dip toward the same direction at angles steeper than slope. This combination is also favorite in slope stability. Most of the slopes of isolated hills facing the reservoir are not covered with deposits and stable. Therefor slopes in the reservoir area are judged stable.

The ridge on the right bank is watertight as indicated by low permeability at the power house site shown in 6.2.6. The ridge on the left bank is expected to be watertight because it is extension of the ridge on the dam abutment where permeability is less than 2 Lu at depths deeper than 15 m and groundwater levels are shallower than 10 m. The permeability of isolated hill, which top is only 13.5 m above FRL, is supposed around 5 Lu at the depth deeper than 10m and groundwater level is about 5 m. Investigation of this isolated hill has been planned in Detailed Design stage.

6.2.6 Power House Site

For power house, excavation of an underground cavern which is 25 m wide, 55m high and 160m long have been proposed. The site of power house was selected in the mountain body on the right bank of Turga nara. The elevation of the crown of the cavern is about 280 m and at the depth of about 150 m from the ground surface. In order to construct such a big cavern in deep underground, good rockmass and in-situ pressure should be confirmed.

Three core borings have been drilled to the elevation of the bottom of the cavern. Based on these borings and surface geological mapping, geological profiles have been presented (Figure 6.2.6-2).

Rocks at the power house site insist mainly of quartzo-feldspathic gneiss accompanied by pegmatite and meta-basics. Exposed bedrocks near the power house site show foliations generally dipping north (toward intake) at around 45° and joints of four directions (Table 6.2.6-1) (DPR Vol.5 p44).

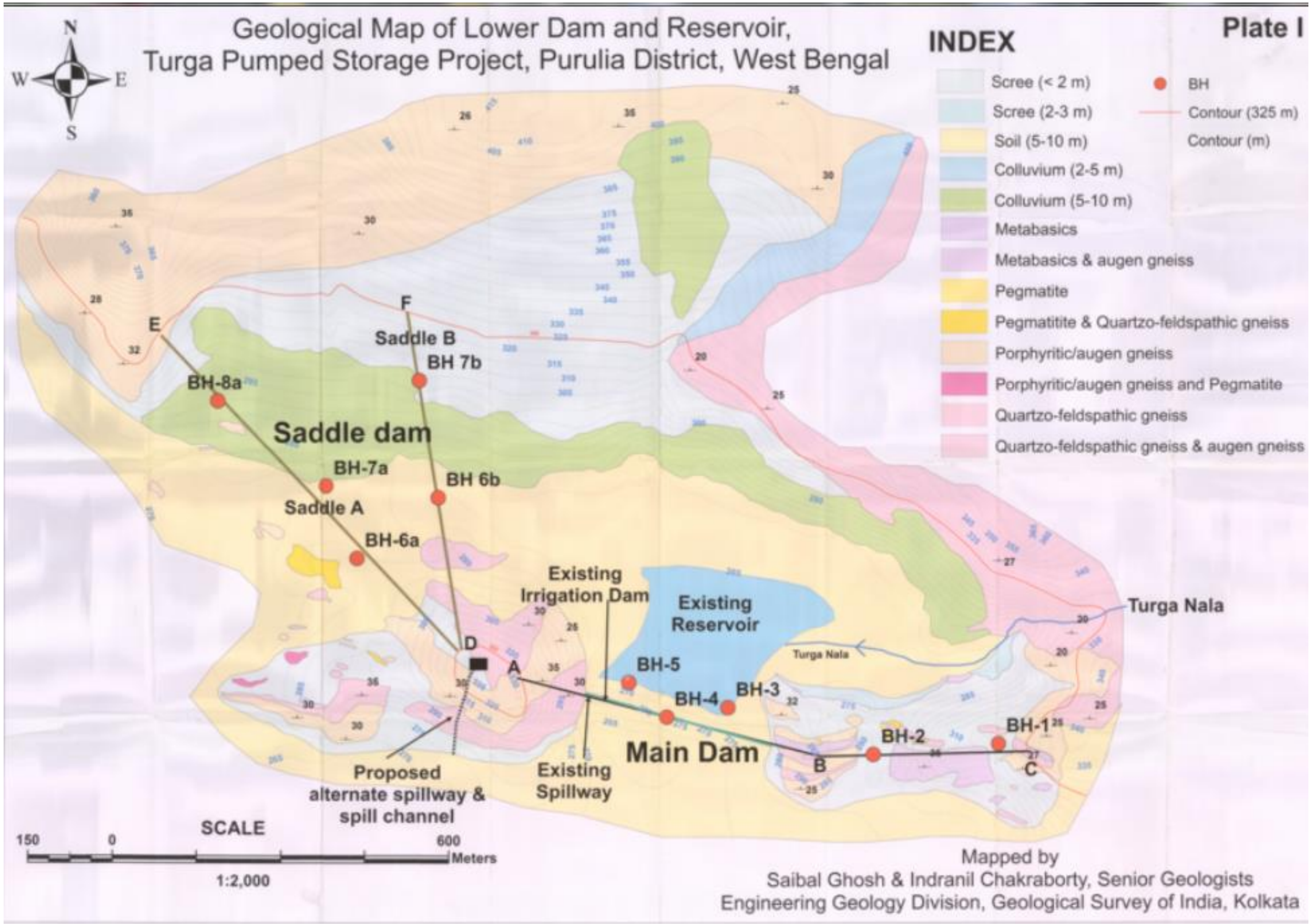
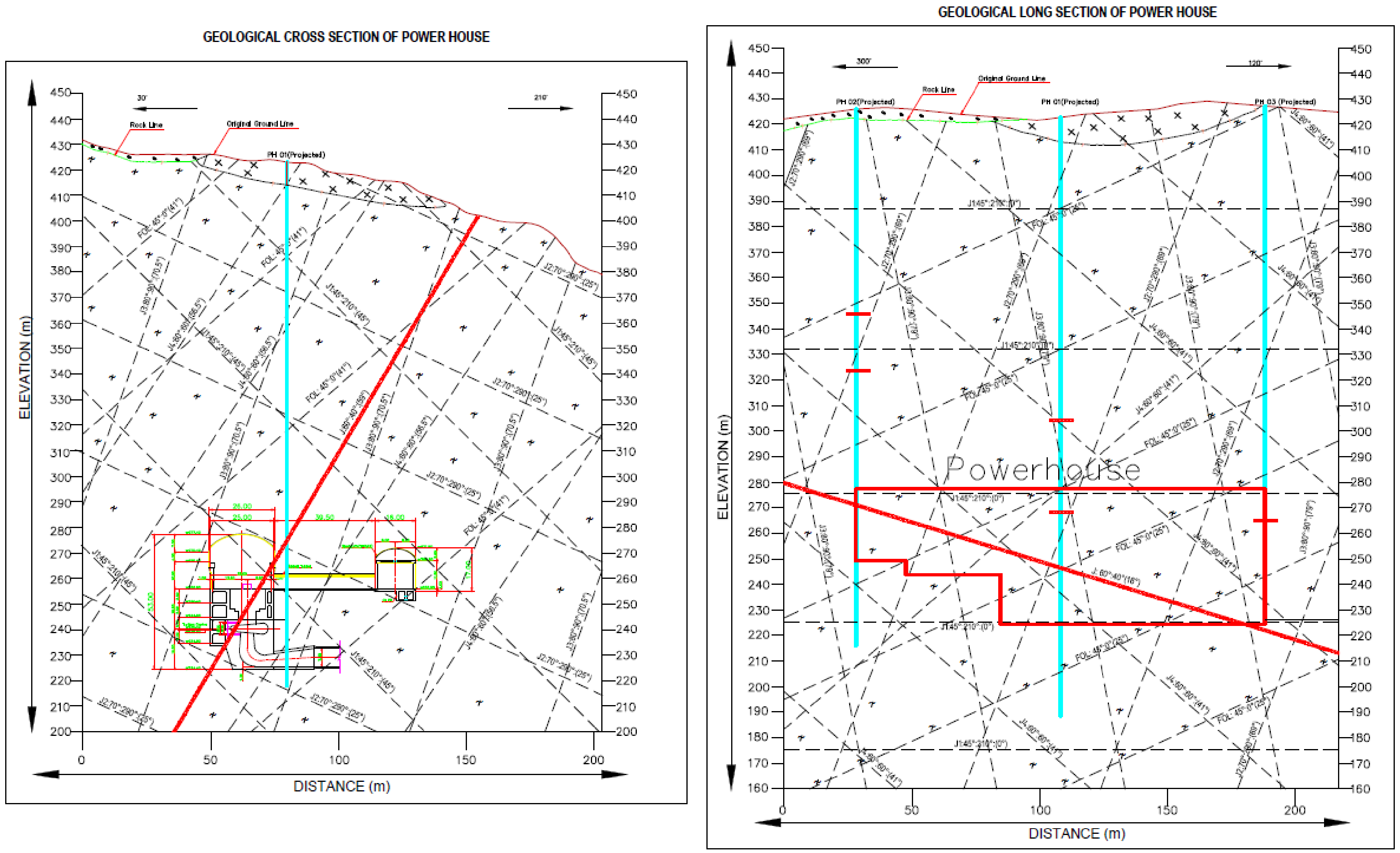


Figure 6.2.6-1 Geological Map of the Lower Reservoir Area

(note : This geological map was made at the middle stage of geological investigation and dam axis boreholes were then planned. It was adopted as it includes useful detailed geological information)



LEGEND	
• •	ROCK WITH THIN SCREE COVER
×	METABASICS
~	QUARTZO-FELDSPATHIC GNEISS
▬	FRACTURE ZONE

DETAILS OF JOINT SETS AT POWERHOUSE COMPLEX

Foliation	45°: 0°	50 -80 cm	Long	Smooth Planar; tight
Joint	45°:210°	10 -75 cm	3 - 5 m	Rough, undulating and no infillings
Joint	70°:290°	70 -100 cm	2-5 m	Moderately smooth, planar to rough, undulating
Joint	80°:90°	70 -150 cm	2 - 8 m	Moderately smooth, planar to rough, undulating with no infillings
Joint	60°:60°	100 -200 cm	2-3 m	Rough, undulating, Random

NOTE

1. CONTOUR PLAN, PROFILE AND THE LAYOUT HAS BEEN PROVIDED BY THE PROJECT AUTHORITY.
2. JOINTS SHOWN IN THE DRAWING AREA SCHEMATIC.
3. LITHOLOGICAL BOUNDARIES SHOWN IN THE DRAWING ARE BASED ON LIMITED POINT DATA AND MAY VARY AT DEPTH
4. SPATIAL EXTEND OF METABASIC ROCK MAY VARY AT DEPTH AS IT OCCURS AS INTRUSSIVE WITHIN GNEISS
5. ROCK MASS QUALITY IN THE PROPOSED POWER HOUSE CAVERN WILL BE GOOD (Q VALUE 10-20, RMR 65-75). HOWEVER, AT PLACES ROCK MASS QUALITY MAY DETORIATE TO FAIR CATEGORY (Q VALUE 5-8, RMR 50-60) DUE TO THE PRESENCE OF FRACTURE ZONE
6. WITHIN QUATZO-FELDSPATHIC GNEISS THERE ARE IRREGULAR PATCHES OF AUGEN GNEISS AND INTRUDED BY BASIC ROCK AND PEGMATITE
7. SCALE OF MAPPING IS 1:2000

GEOLOGICAL SURVEY OF INDIA
EASTERN REGION KOLKATA
ENGINEERING GEOLOGY DIVISION

TURGA PUMPED STORAGE PROJECT, DIST. –PURULIA, WEST BENGAL

GEOLOGICAL SECTIONS OF POWER HOUSE

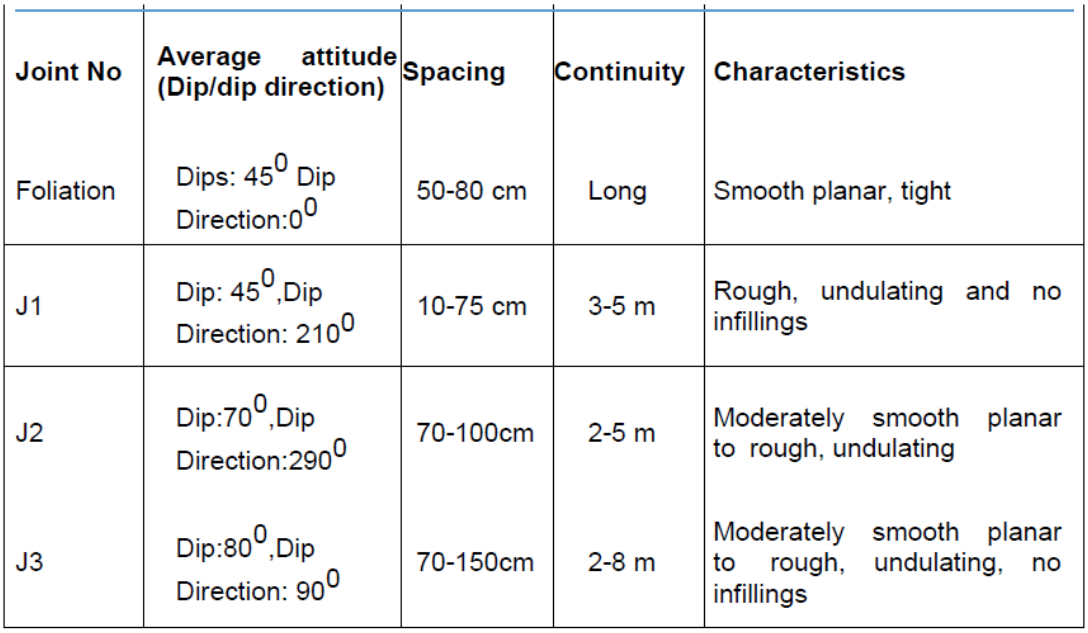
F.S.: 2014-15
PREPARED BY: DR. T.B. GHOSHAL, Supdtg. Geologist
KAVITHA S., Geologist
DRAWN BY: SUBRATA DAS, SR. SURVEYOR

Drawing No. GSI/ER/TPSP/2015/07
Date: 20.07.2015
Plate no: 7

(source: DPR Vol.5 Plate 7)

Figure 6.2.6-2 Profile of the Power House Site

Table 6.2.6-1 Discontinuities at the Power House Site



Joint No	Average attitude (Dip/dip direction)	Spacing	Continuity	Characteristics
Foliation	Dips: 45^0 Dip Direction:0^0	50-80 cm	Long	Smooth planar, tight
J1	Dip: 45^0,Dip Direction: 210^0	10-75 cm	3-5 m	Rough, undulating and no infillings
J2	Dip:70^0,Dip Direction:290^0	70-100cm	2-5 m	Moderately smooth planar to rough, undulating
J3	Dip:80^0,Dip Direction: 90^0	70-150cm	2-8 m	Moderately smooth planar to rough, undulating, no infillings

(source: DPR Vol.1 Capter5 p41 Table 5.8.6)

By core borings, the rocks near the power house site have been confirmed to be Good Rock of class II having RMR value of 70 - 80. One fracture zone of 3 m wide has been encountered by three core borings. The attitude of this fracture zone has been calculated as 60° towards N 40°E. This fracture zone in PH-1 is 153.6 - 156.2m composed by fractured meta-basic with core recovery 92.3 % and RQD 51 %. During the field visit in October 2017, clayey materials was not observed in corresponding core box.

A drift, which entrance is located to the west of the power house site and at the elevation of 290 m, reached 262 m from the entrance when visited on October 10th, 2017. Hard rockmass with wide joint interval was observed continuously on the side walls of the drift. Inflow of groundwater was very small in volume that is concordant with low permeability obtained by Lugeon tests in boreholes.

In-situ stress was measured by hydro fracturing tests in a vertical borehole drilled in the drift at 216 m from the entrance (120m to the power house site) and at the depth about 105m from the ground surface. Results of tests are

Maximum horizontal stress (σ H) = 7.30MPa

Minimum horizontal stress (σ h) = 4.85MPa

Estimated vertical stress (σ V) = 3.16MPa

σ H/ σ V = 2.31

σ h/ σ V = 1.53

Average orientation of Maximum horizontal stress (σ H): N 36° W

Because horizontal stress is larger than vertical stress, more reliable in-situ stress, rock mechanical ~~is~~ characteristics and orientation of discontinuities of rockmass are needed. They will be obtained by tests and geological observation in the drift which excavation is being continued to reach the power house site.

6.2.7 Water Way Route

Geology of the water way route based on the geological map (Figure 6.1.3-1) and geological profile (Figure 6.2.7-1) are as follows.

(1) Intake site

The intake site is located on the slope on the right bank upstream of the upper dam site. The slope will be excavated to form about 50 m high cut slope.

At the intake site, slope is gentle (around 10°) and underlain by quartzo-feldspathic gneiss which exposes near the intake site and show the foliations dipping north at 45°. One core boring (INT-1: 40m long) was drilled and confirmed 3m thick deposits and the surface of fresh rock at the depth of 5.5 m.

Cut slopes facing north would be steeper than dip of foliations and needs careful excavation.

(2) Headrace Tunnel Route

The headrace tunnels are 9 m in diameter and pass under the ridge on the right bank of the upper dam site. The depths of the headrace tunnels from the ground surface are 30 - 100 m. One core boring (HRT-1: 105 m long) was drilled and confirmed fresh rock of quartzo-feldspathic gneiss and biotite gneiss below the depth of 5.3 m. Most of fresh rocks in this borehole shows RQD of more than 90 % and evaluated as Class II by RMR.

Exposed bedrocks near the headrace tunnels route show foliations generally dipping north (toward intake) at around 45^{o} which is not unfavorable to the stability of tunnel walls.

These tunnels will be excavated without any big problems.

(3) Penstock Route

Penstock is composed by inclined and horizontal tunnels with diameter of 9 - 4.4 m. The depths from the ground surface are 100 - 200 m. Though no core boring was drilled, rocks are expected to be composed mainly by quartzo-feldspathic gneiss and as good as those at the power house site and the headrace tunnel route.

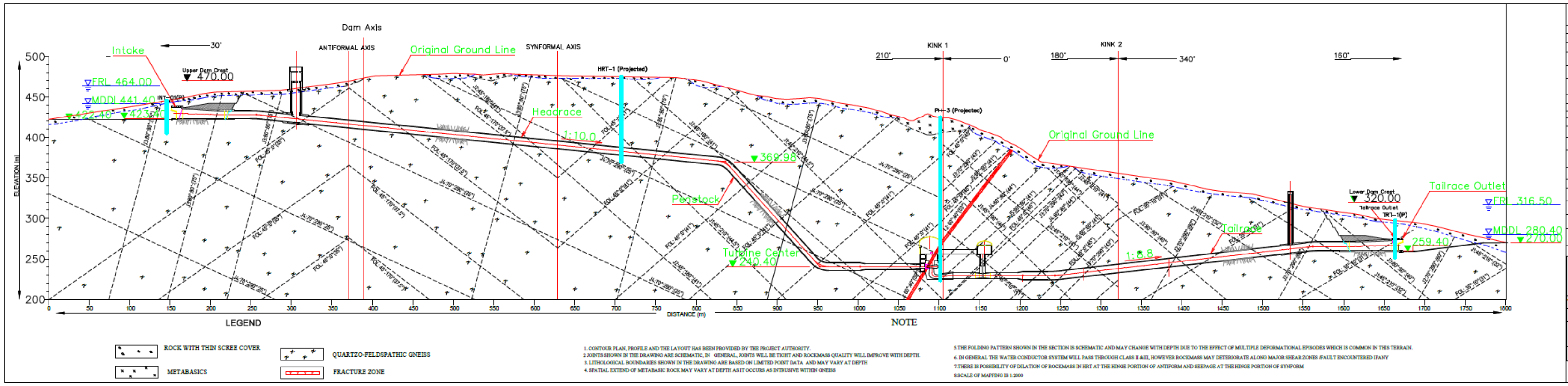
Exposed bedrocks near the headrace tunnels route show foliations generally dipping north (toward intake) at around 45° which is not unfavorable to the stability of tunnel walls.

(4) Tailrace Tunnel Route

The tailrace tunnels are 7 m and 10 m in diameter and lie at the depths more than 30 m from the ground surface. Good rocks as those at the power house site and the tailrace outlet site shown in (5) are expected. Exposed bedrocks near the headrace tunnels route show foliations generally dipping north (toward power house) at around 40° which is not unfavorable to the stability of tunnel walls.

(5) Tailrace Outlet Site

Tailrace outlet will be constructed on the lower slope adjacent to the saddle dam site. At this site, slopes are inclined to south at around 10°. Outcrops of augen gneiss have been observed near the site. One core boring (IRT-1: 45.5 m long) has been drilled and confirmed 9.45 m thick deposits and surface of fresh rock at the depth of 10 m. This site will be excavated to fresh rocks. Outcropping bedrocks show foliations generally dipping north at around 45° which is favorite to the stability of cut slopes at this site. But, about 10 m thick deposits needs careful excavation.



NOTE

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2. JOINTS SHOWN IN THE DRAWING ARE SCHEMATIC, IN GENERAL, JOINTS WILL BE TIGHT AND ROCKMASS QUALITY WILL IMPROVE WITH DEPTH.
3. LITHOLOGICAL BOUNDARIES SHOWN IN THE DRAWING ARE BASED ON LIMITED POINT DATA AND MAY VARY AT DEPTH
4. SPATIAL EXTEND OF METABASIC ROCK MAY VARY AT DEPTH AS IT OCCURS AS INTRUSIVE WITHIN GNEISS
5. THE FOLDING PATTERN SHOWN IN THE SECTION IS SCHEMATIC AND MAY CHANGE WITH DEPTH DUE TO THE EFFECT OF MULTIPLE DEFORMATIONAL EPISODES WHICH IS COMMON IN THIS TERRAIN.
6. IN GENERAL THE WATER CONDUCTOR SYSTEM WILL PASS THROUGH CLASS II &III, HOWEVER ROCKMASS MAY DETERIORATE ALONG MAJOR SHEAR ZONES /FAULT ENCOUNTERED IFANY
7. THERE IS POSSIBILITY OF DILATION OF ROCKMASS IN HRT AT THE HINGE PORTION OF ANTIFORM AND SEEPAGE AT THE HINGE PORTION OF SYNFORM
8. SCALE OF MAPPING IS 1:2000

DETAILS OF JOINTS AT WATER CONDUCTOR II

JOINT NO.	DIP/DIP DIRECTION	SPACING	CONTINUITY	CHARACTER
DAM COMPLEX				
Foliation	45°:170°	50 -80 cm	Long	Smooth Planar, tight
J1	45°:210°	10 -75 cm	3 - 5 m	Rough, undulating and no infillings
J2	45°:180°	50 -80 cm	Long	Smooth Planar, tight
J3	80°:60°	70 -150 cm	2 - 8 m	Moderately smooth, planar to rough, undulating with no infillings
J4	70°:290°	100 -200 cm	2 - 5 m	Smooth undulating
POWERHOUSE COMPLEX				
Foliation	45°:0°	50 -80 cm	Long	Smooth Planar, tight
J1	45°:190°	50 -80 cm	Long	Smooth Planar, tight
J2	45°:210°	10 -75 cm	3-5 m	Rough, undulating and no infilings
J3	70°:290°	70 -100 cm	2-5 m	Moderately smooth, planar to rough, undulating
J4	80°:80°	70 -150 cm	2 - 8 m	Moderately smooth, planar to rough, undulating with no infillings
J5	60°:60°	100 -200 cm	2 - 3 m	Rough, undulating
TRT AREA				
Foliation	35°:10°	50 -80 cm	Long	Smooth Planar, tight
J1	45°:210°	10 -75 cm	3 - 5 m	Rough, undulating and no infillings
J2	70°:290°	70 -100 cm	2-5 m	Moderately smooth, planar to rough, undulating
J3	80°:80°	70 -150 cm	2 - 8 m	Moderately smooth, planar to rough, undulating with no infillings

GEOLOGICAL SURVEY OF INDIA
EASTERN REGION, KOLKATA
ENGINEERING GEOLOGY DIVISION

TURGA PUMPED STORAGE PROJECT, DIST: PURULIA, WEST BENGAL

GEOLOGICAL SECTION OF WATER CONDUCTOR SYSTEM - II

F.S.: 2014-15
PREPARED BY: DR. T.B. GHOSHAL, Supdtg. Geologist
KAVITHA S., Geologist
DRAWN BY: SUBRATA DAS, SR. SURVEYOR

Drawing No. GSI/ER/TPSP/2015/06 Date: 20.07.2015 Plate no: 06

(source: DPR Vol.5 Plate 5)

Figure 6.2.7-1 Profile of the Water Way Route

6.3 CONSTRUCTION MATERIALS

The results of investigations and evaluation in 5.9 of DPR Vol.1 Chapter 5 are as follows.

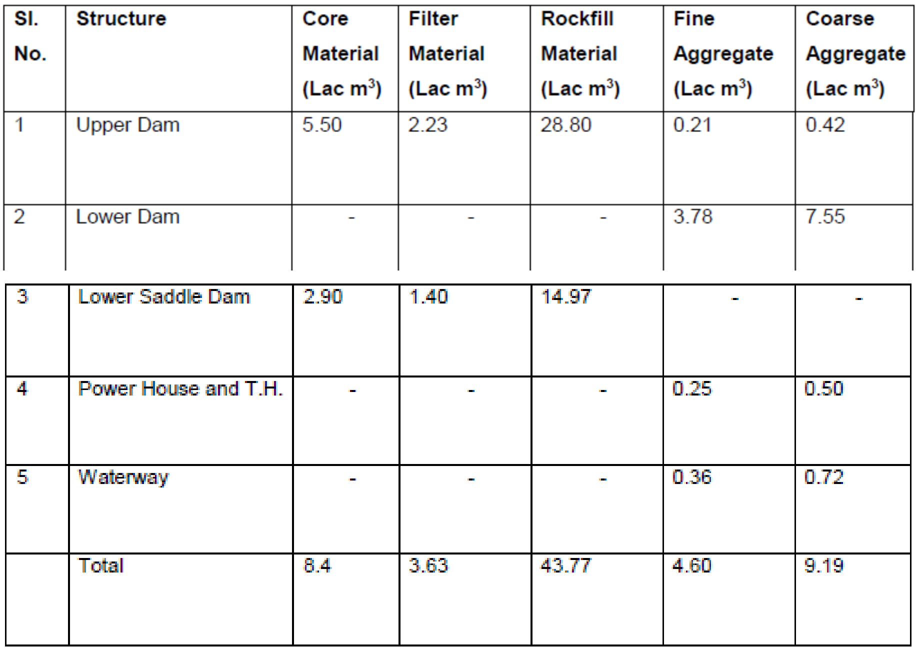
6.3.1 Quantity of Construction Materials

In Turga Pumped Storage Project, two Rock fill dams and one concrete gravity dam have been proposed. Other concrete structures such as power house and water way are also proposed.

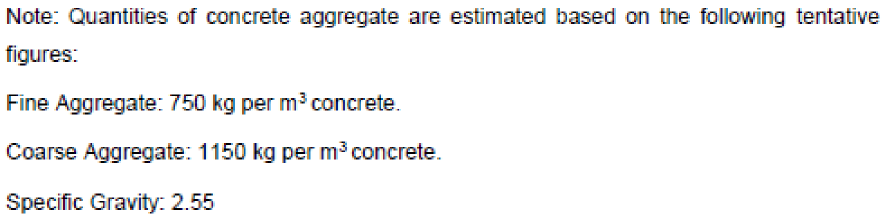
Rock fill dams are constructed mainly with core material, filter material and rock material. Concrete gravity dam, power house and water way are constructed with concrete which main component are coarse concrete aggregate and fine concrete aggregate.

Estimated quantity of construction materials required are shown in Table 6.3.1-1. Quantity of the construction materials available in borrow areas and quarry sites are shown in Table 6.3.1-2.

Table 6.3.1-1 Quantities of Construction Materials Required



Sl. No.	Structure	Core Material (Lac m^3)	Filter Material (Lac m^3)	Rockfill Material (Lac m^3)	Fine Aggregate (Lac m^3)	Coarse Aggregate (Lac m^3)
1	Upper Dam	5.50	2.23	28.80	0.21	0.42
2	Lower Dam	-	-	-	3.78	7.55
3	Lower Saddle Dam	2.90	1.40	14.97	-	-
4	Power House and T.H.	-	-	-	0.25	0.50
5	Waterway	-	-	-	0.36	0.72
	Total	8.4	3.63	43.77	4.60	9.19



Note: Quantities of concrete aggregate are estimated based on the following tentative figures:

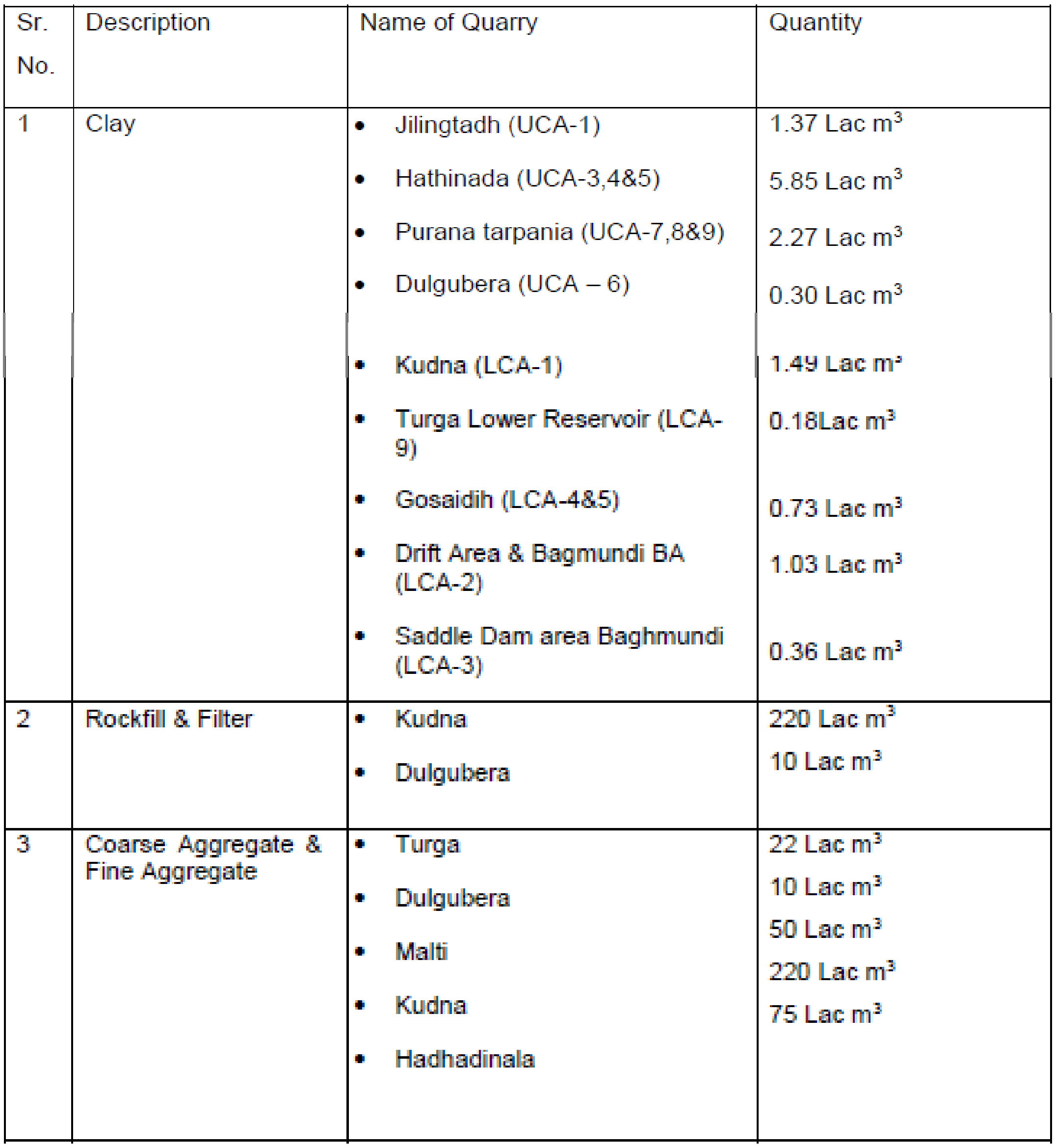
Fine Aggregate: 750 kg per m^3 concrete.

Coarse Aggregate: 1150 kg per m^3 concrete.

Specific Gravity: 2.55

Lac $m^3 = 10^5$ m^3 (source: DPR Vol.1 Capter5 p54 Table 5.9.1)

Table 6.3.1-2 Quantities of Construction Materials Available



Sr. No.	Description	Name of Quarry	Quantity
1	Clay	• Jilingtadh (UCA-1) • Hathinada (UCA-3,4&5) • Purana tarpania (UCA-7,8&9) • Dulgubera (UCA – 6) • Kudna (LCA-1) • Turga Lower Reservoir (LCA-9) • Gosaidih (LCA-4&5) • Drift Area & Bagmundi BA (LCA-2) • Saddle Dam area Baghmundi (LCA-3)	1.37 Lac m³ 5.85 Lac m³ 2.27 Lac m³ 0.30 Lac m³ 1.49 Lac m³ 0.18Lac m³ 0.73 Lac m³ 1.03 Lac m³ 0.36 Lac m³
2	Rockfill & Filter	• Kudna • Dulgubera	220 Lac m³ 10 Lac m³
3	Coarse Aggregate & Fine Aggregate	• Turga • Dulgubera • Malti • Kudna • Hadhadinala	22 Lac m³ 10 Lac m³ 50 Lac m³ 220 Lac m³ 75 Lac m³

Lac $m^3 = 10^5$ m^3

(source: DPR Vol.1 Capter5 p55・56 Table 5.9.2)

6.3.2 Core Materials

(1) Laboratory tests

In order to confirm the suitability for core materials, following laboratory tests have been conducted.

- Mechanical Analysis
- Atterberg Limits
- Standard Procter Compaction
- Specific Gravity
- Triaxial Shear Test
- One Dimension Consolidation

- Laboratory Permeability
- Soil Diversity Identification Test
- Chemical Analysis of Soil

(source: DPR Vol.1 Capter5 p58・59)

(2) Selected Borrow Area

Borrow areas selected for the upper dam based on the results of the laboratory tests are shown in Table 6.3.2-1. Available quantity of core material shown in the same table is enough larger than the quantity required for the upper dam (5.5 × 10^5 m^3).

Table 6.3.2-1 Selected Borrow Areas for the Upper Dam

Borrow Area	Distance from Upper Dam Site（km）	Available Volume（10^5 m^3）
Jilingtadh	3.7	1.37
Hathinada	2	5.85
Parana Tarpania	1	2.27
Total		9.49

Borrow areas selected for the saddle dam after the laboratory tests are shown in Table 6.3.2-2. Available quantity of core material shown in the same table is larger than the quantity required for the saddle dam (2.9 × 10^5 m^3).

Table 6.3.2-2 Selected Borrow Areas for the Saddle Dam

Borrow Area	Distance from Saddle Dam Site (km)	Available Volume (10^5 m^3)
Kudna	5	1.49
Turga Lower Reservoir	0.5	0.18
Gosaidih	1	0.7
Drift and Baghmundi	1	1.03
Total		3.4

6.3.3 Rock and Filter Marerials

Quantity of rock materials and that of filter material for both upper dam and saddle dam are 43.77 × 10^5 m^3 and 3.63 × 10^5 m^3 respectively. Total quantity of these materials is 47.4 × 10^5 m^3.

Two quarry sites have been investigated. They are Kudna quarry and Dulgubera (Table 6.3.3-1) and had been developed during the construction of Purulia Pumped Storage Project.

Large size oedometer test and large size tri-axial test have been conducted by using blasted materials of these quarries. And by these large size tests, materials of Kudna quarry and Dulgubera quarry have been confirmed to be suitable for rock material and filter material.

The quantity of materials available for rock material and filter material is 230 × 10^5 m^3. About 180 × 10^5 m^3 material remains at these quarry sites after they provided rock and filter materials required (Table 6.3.3-1).

Table 6.3.3-1 Selected Quarry Sites for Rock and Filter Materials

Quarry Site	Distance from Upper Dam Site and Saddle Dam Site (km)	Available Volume (10^5 m^3)
Kudna	12 (Upper Dam Site) and 5 (Saddle Dam Site)	220
Dulgubera	2 (Upper Dam Site)	10
Total		230

6.3.4 Concrete Aggregates

(1) Coarse Aggregate

Quantity of coarse aggregate required in the construction estimated 9.19 × 10^5 m^3.

Five quarry sites have been investigated.

After the laboratory test shown below, materials of Kudna quarry site, Dulgabera quarry site and Hadhadi quarry site were confirmed to be suitable for coarse aggregate. These three quarrys can provide enough quantity of coarse aggregate (Table 6.3.4-1).

- Specific Gravity
- Water absorption
- Aggregate Impact value
- Aggregate Crushing Value
- Aggregate Abrasion Value (Los- Angeles)
- Soundness Loss (5cycles)
- Alkali Aggregate reactivity test
- Petrographic examination

(source: DPR Vol.1 Chapter 5 p81)

Table 6.3.4-1 Selected Quarry Sites for Coarse Concrete Aggregates

Quarry Site	Distance from Upper Dam Site and Saddle Dam Site* (km)	Available Volume (10^5 m^3)
Kudna	12 (Upper Dam Site) and 5 (Saddle Dam Site)	220
Dulgubera	2 (Upper Dam Site)	10
Hadhadi Nala	2	75
Total		305

(*:Planned construction facilities are close to the upper dam site and the saddle dam site.)

(2) Fine Aggregate

Estimated quantity of coarse aggregate required in the construction is 4.6 × 10^5 m^3.

Material in Kudna quarry site had been used for fine aggregate during the construction of Purulia Pumped Storage Project. Enough material remaining in Kudna quarry site is also suitable for fine aggregate in the construction of Turga Pumped Storage Project.

CHAPTER 7

HYDROLOGY

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The Turga pumped storage power project is planned to utilize hydro potential of Ajodhya Plateau by constructing upper dam and lower dam having catchment area of 8.29 km^2 and 12.66 km^2 respectively at Turga Nala, a tributary of Subarnarekha river. Both dams are connected with a water way system and an underground powerhouse. There exists reservoir of Turga irrigation dam with a storage capacity of 1.70 MCM between maximum water level (EL. 272.48 m) and dead storage level (EL. 262.72 m).

At present, the existing reservoir provides irrigation water for irrigable area of 708 ha located downstream, and the total water requirement of crop, so-called Kharif (during monsoon season) and Rabi (during non-monsoon season), is around 4.6 MCM (458.238 ha.m) annually. The existing reservoir will be replaced by the lower reservoir for the Turga PSP. New lower reservoir is planned to increase the gross storage capacity to 18.0 MCM (at Full Supply Level; FSL) and effective storage capacity to 14.2 MCM by raising the height of the lower dam more than the existing dam. The upper reservoir will have the gross storage capacity of 21.6 MCM (at FSL) and effective storage capacity of 15.7 MCM, 14.2 MCM for Turga PSP and 1.5 MCM for irrigation purpose. Thus, the storage capacity for irrigation, which is kept in the existing dam at present, will be kept in the upper dam after Turga PSP.

Power from the project will be generated during peak time by releasing the water from upper dam and the head available and will be pumped back during off-peak time.

The catchment area map of the lower and upper dams is shown in Figure 7.1-1 and index map is in Figure 7.1-2.

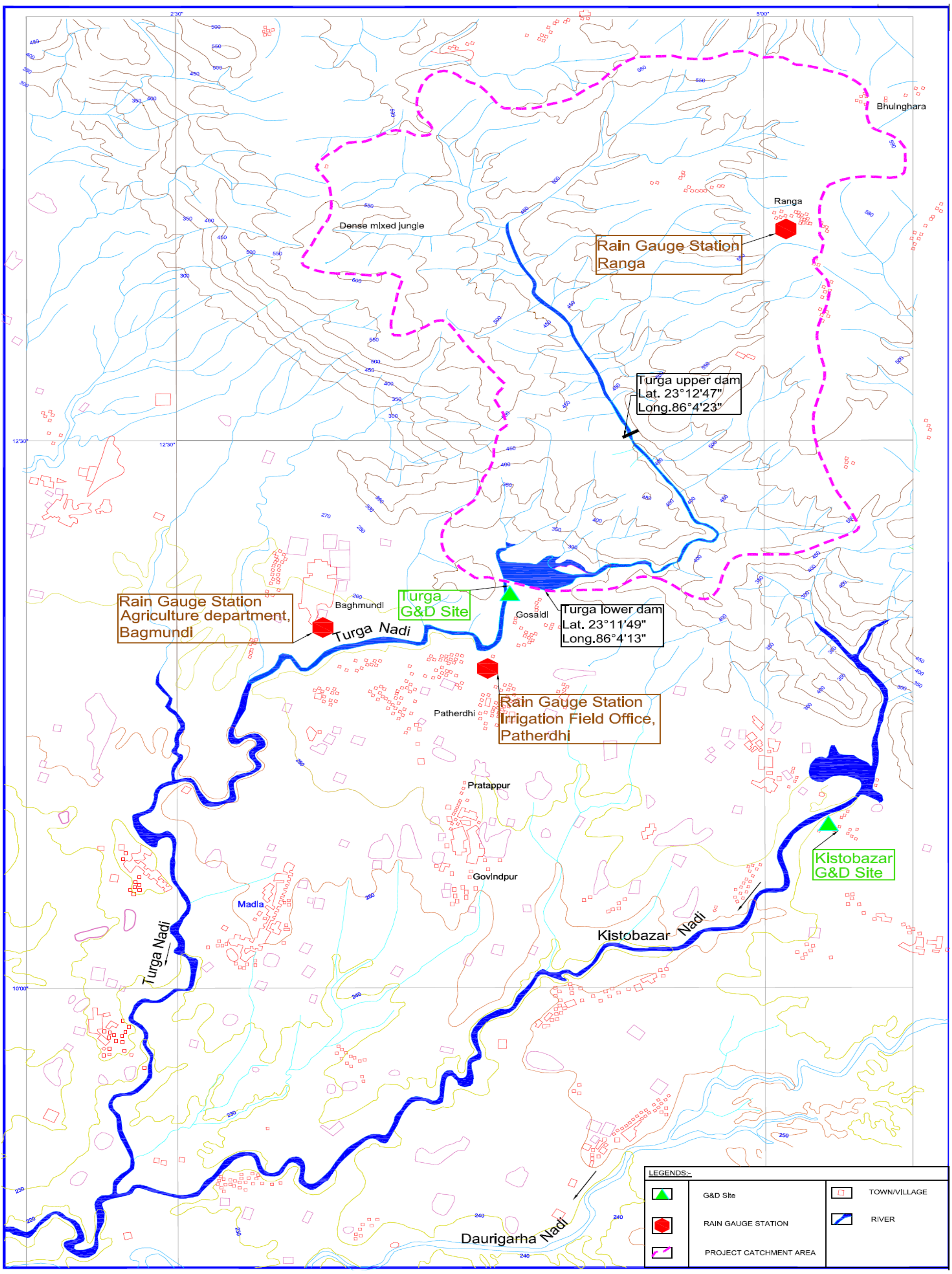
Following hydrological studies were made in the Detailed Project Report (DPR).

1) Simulation studies including water availability to develop inflow series for the upper and lower dams.
2) Estimation of monthly evaporation losses for the upper and lower reservoirs.
3) Estimation of design flood for the spillway of upper and lower dams according to guideline of I. S. 1123-1985.
4) Estimation of flood for the diversion structure of upper and lower dams
5) Sedimentation studies to determine new zero elevation for fixing the dead storage level and sediment distribution in different zones of reservoir

7.1 CLIMATE

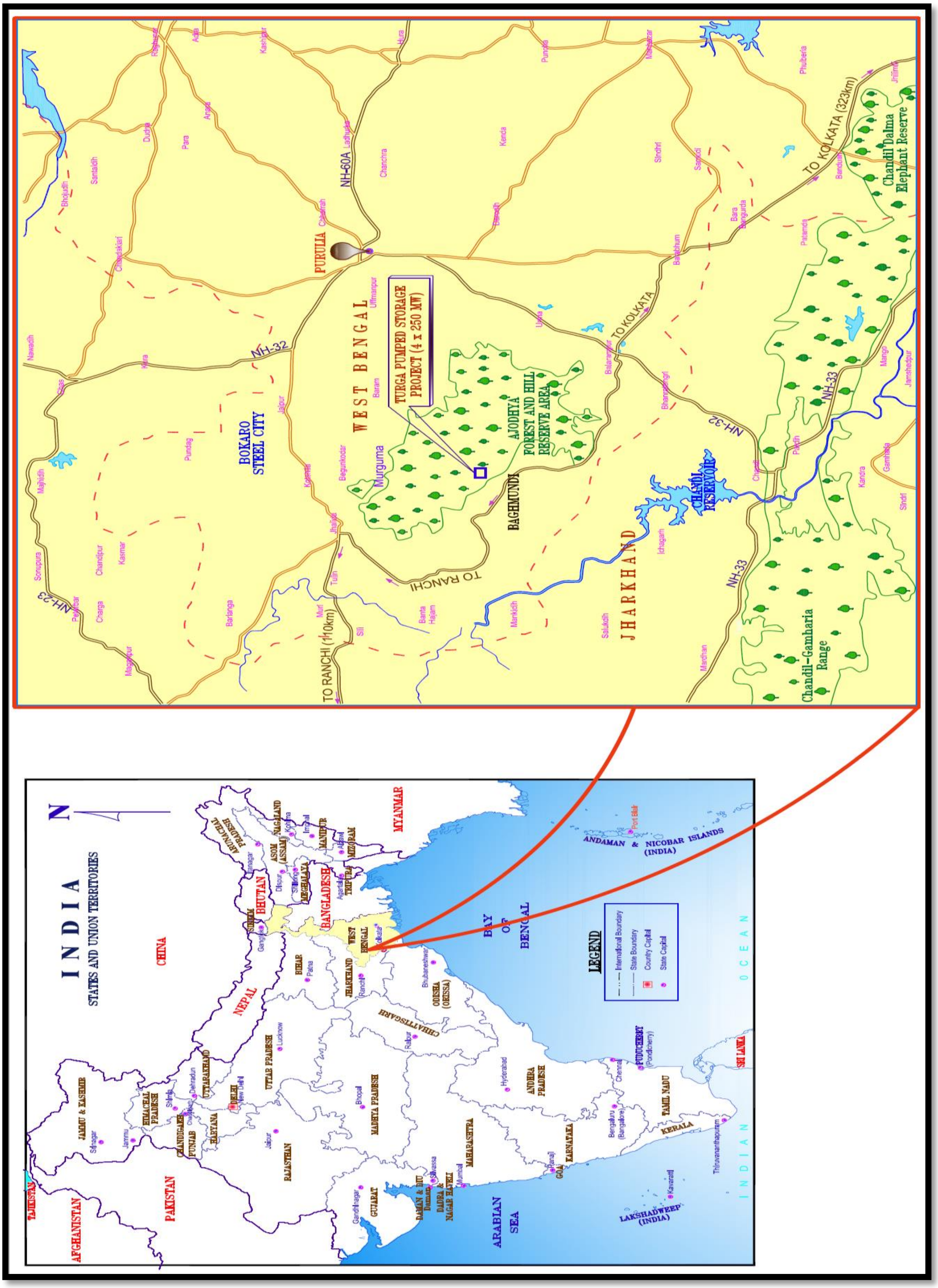
The climate of the region consists of the south-west monsoon period from middle of June to October and non-monsoon period. The monsoon retreat from October to November and the cold weather starts from middle of November and lasts till end of February followed by hot summer. The mean daily maximum and minimum temperatures of the region are 25.3°C and 12.4°C, respectively. The

Baghmundi rainfall gauging station is the nearest of the region where the average annual rainfall is 1,334 mm. Non-monsoon rainfall is scare and varies from 3 to 25% of the annual rainfall.



(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Figure 7.1-1 Location of Rain Gauge and Gauge and Discharge (G&D) Station



(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Figure 7.1-2   Index Map

7.2 RAINFALL AND DISCHARGE

7.2.1 Required Time Period for Checking Water Availability of Project

The effective reservoir storage capacity of the project is planned as 15.7 MCM for the upper reservoir and 14.2 MCM for the lower reservoir, while the annual inflows to the lower reservoir and upper reservoir is estimated to be 4.51 MCM and 6.88 MCM, respectively. Thus, both the reservoirs are defined as the type of carry over storage project since both the reservoirs' effective storage capacity are larger than the annual inflows.

According to the guideline of Ministry of Water Resources for preparation of Detailed Project Report (DPR) of irrigation/hydropower/multipurpose projects, the minimum length of hydrological data is 40 years in monthly base time unit.

7.2.2 Rainfall Data

All available rainfall data of Turga Nala and the adjoining basin 'Kistobazar' Nala are given in the Table 7.2.2-1 and the location of rain gauge and the G&D station are shown in Figure 7.1-1.

Table 7.2.2-1 Collected Rainfall Data

No.	Name of Station	Type of Data	River Basin	Period		Remarks
				From	To	
1	Purulia Upper dam	Monthly	Kistobazar Nala (Purulia Pumped storage Project)	1983	Oct. 1990	Monthly monsoon months available in DPR of Purulia Pumped Storage Project
2	Purulia Lower Dam	Monthly	Ditto	1983	Oct. 1990	Ditto
3	Ranga Center	Monthly	Ditto	Aug. 1982	Jan. 1987	Ditto
4	Kistobazar	Daily	Ditto	June 1983	Oct. 1989	Ditto
5	Purulia	Daily	Ditto	June 2000	Dec. 2012	ditto
6	Baghmundi	Monthly	Turga Nala (Turga Pumped Storage Project)	1958	2012	A monthly monsoon rainfall data made available from 1958 to 2012 Missing year 1998, 1999 & 2000.
7.	Ajodhya Hills	Monthly	Kistobazar (Purulia Pumped storage Project)	Aug. 1983	2002	
8.	Turga	Daily	Turga Nala (Turga Pumped Storage Project)	June 2003	2011	

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Among the above 8 rain gauge stations, only 3 stations' data has been used for the DPR of Turga PSP.

As mentioned the above, at least 40 years sequential monthly hydrological data i.e., discharge data is required for the DPR. Only the rainfall data at Baghmundi station matches to the minimum requirement.

The monthly monsoon rainfall data at Baghmundi rain gauge station is available from 1958 to 2012 but missing in the year 1998, 1999 and 2000. To fill up this missing data, the annual rainfall of Baghmundi for the years from 1998 to 2000 has been calculated by multiplying the respective annual rainfall of Ayodhya Hills by the ratio between the average annual rainfall of Ayodhya Hills, which is located at the upstream of same river basin, and the average annual rainfall of Baghmundi. The annual rainfall at Ajodhya Hills rain gauge station has been allocated proportionally to the average monthly monsoon rainfall and non-monsoon monthly rainfall at Baghmundi for the observed period. The rainfall series at Baghmundi and those at Ajodhya Hills are presented in Table 7.2.3-1 and Table 7.2.3-2.

Furthermore, the rainfall series at Kistobazar have been utilized for generating synthetic runoff at the existing Turga dam from 1983 to 1989 based on the runoff series at Kistobazar for the same period. The rainfall series at Kistobazar are presented in Table 7.2.3-3.

7.2.3 Runoff Data

Two discharge data are available at the Turga Nala and the adjoining basin, the Kistobazar Nala. The catchment area at Kistobazar dam on the Kistobazar Nala is 18.75 km^2. This catchment is adjacent to the Turga Nala catchment. The Turga Nala and the Kistobazar Nala both joins the Subarnarekha River. Both the catchments fall in the same hydro-meteorological region and also the type of soil is red sandy soil.

The monthly monsoon discharge data at the existing Turga dam (at Baghmundi, C.A = 12.66 km^2) is available for 8 years from 1990 to 1997 for the months from June to October in the preliminary feasibility report (PFR) prepared by EDF in the year 1999.

The discharge data at Kistobazar Nala (C.A. = 18.75 km^2) for the months June to October and non-monsoon as one unit is available for 7 years from 1983 to 1989 in the DPR of Purulia Pumped Storage Scheme. Beyond 1989, no discharge data is available.

The location of rain gauge stations and gauge & discharge (G&D) stations are shown in Figure 7.1-1. The observed runoff at the Kistobazar dam (1983-1989) and the existing Turga dam (1990-1997) are presented at Table 7.2.3-4 and Table 7.2.3-5.

Table 7.2.3-1 Monthly Rainfall Data at Baghmundi Rain Gauge Station (1958-2012) in mm

Year	June	July	Aug	Sep	Oct	Monsoon Total	Non Monsoon Total	Annual
1958	152.60	417.40	234.00	403.80	70.60	1,278.40	412.10	1,690.50
1959	150.50	412.00	231.30	256.50	252.30	1,302.60	145.60	1,448.20
1960	107.70	279.00	385.10	257.20	91.60	1,120.60	59.70	1,180.30
1961	365.90	94.00	260.20	419.40	223.00	1,362.50	106.70	1,469.20
1962	159.70	315.50	285.40	327.00	105.40	1,193.00	30.70	1,223.70
1963	166.60	349.90	351.60	243.60	162.20	1,273.90	42.60	1,316.50
1964	223.50	465.90	370.00	273.50	100.20	1,433.10	98.50	1,531.60
1965	164.70	478.70	329.00	103.20	39.00	1,114.60	91.50	1,206.10
1966	302.70	90.10	248.60	96.70	70.10	808.20	63.10	871.30
1967	14.30	32.90	405.50	815.00	0.00	1,267.70	121.70	1,389.40
1968	255.50	503.50	440.00	39.50	29.00	1,267.50	44.00	1,311.50
1969	105.00	238.00	198.20	240.40	4.00	785.60	86.00	871.60
1970	177.30	391.30	263.70	474.90	68.80	1,376.00	47.20	1,423.20
1971	334.10	426.60	505.00	131.70	59.10	1,456.50	416.00	1,872.50
1972	97.40	196.60	391.60	152.70	77.30	915.60	63.00	978.60
1973	140.70	367.80	281.00	302.50	151.80	1,243.80	90.20	1,334.00
1974	68.20	634.60	282.00	256.60	14.00	1,255.40	43.00	1,298.40
1975	153.50	197.00	95.00	361.00	50.00	856.50	76.60	933.10
1976	60.00	181.00	93.00	283.20	11.00	628.20	59.20	687.40
1977	270.00	309.00	188.00	157.00	29.00	953.00	144.20	1,097.20
1978	281.00	202.00	306.00	379.00	122.00	1,290.00	213.50	1,503.50
1979	187.80	266.00	215.40	90.00	49.40	808.60	149.80	958.40
1980	157.40	476.60	225.60	196.00	108.80	1,164.40	146.80	1,311.20
1981	169.80	432.40	315.00	226.60	0.00	1,143.80	382.00	1,525.80
1982	177.10	205.20	272.40	95.60	105.40	855.70	228.60	1,084.30
1983	132.00	288.20	239.20	383.00	113.90	1,156.30	156.70	1,313.00
1984	719.00	197.40	429.80	161.40	74.80	1,582.40	126.80	1,709.20
1985	185.40	469.40	359.20	376.00	217.80	1,607.80	138.60	1,746.40
1986	228.50	261.80	379.60	330.60	101.80	1,302.30	284.40	1,586.70
1987	133.40	448.80	352.00	270.00	21.80	1,226.00	139.40	1,365.40
1988	522.00	176.80	199.40	219.00	10.40	1,127.60	96.40	1,224.00
1989	337.00	310.60	353.30	219.20	31.60	1,251.70	79.20	1,330.90
1990	348.50	684.70	216.00	330.80	81.00	1,661.00	248.50	1,909.50
1991	80.00	341.60	404.40	168.10	16.80	1,010.90	268.80	1,279.70
1992	160.00	281.00	279.80	470.00	27.20	1,218.00	210.00	1,428.00
1993	297.60	193.40	193.50	413.00	106.00	1,203.50	111.80	1,315.30
1994	523.40	482.80	298.60	161.70	104.80	1,571.30	157.00	1,728.30
1995	222.40	337.80	468.10	402.90	94.00	1,525.20	261.50	1,786.70
1996	586.60	346.20	345.60	107.80	11.20	1,397.40	39.40	1,436.80
1997	248.00	436.30	537.00	212.70	43.80	1,477.80	107.40	1,585.20
1998*	209.76	298.50	277.46	232.47	63.16	1,081.36	123.92	1,205.29
1999*	289.12	411.43	382.43	320.42	87.06	1,490.46	170.81	1,661.26
2000*	166.50	236.94	220.24	184.52	50.14	858.34	98.37	956.70
2001	404.90	367.50	247.20	98.00	17.60	1,135.20	155.60	1,290.80
2002	429.20	138.00	332.80	150.20	102.80	1,153.00	84.20	1,237.20
2003	71.40	228.60	321.80	126.20	178.60	926.60	87.40	1,014.00
2004	74.00	212.40	390.80	125.40	86.80	889.40	114.60	1,004.00
2005	118.20	311.60	216.40	146.80	67.80	860.80	119.00	979.80
2006	192.20	314.60	248.00	219.60	19.00	993.40	129.80	1,123.20
2007	144.00	593.80	350.60	328.60	10.00	1,427.00	144.00	1,571.00
2008	515.40	581.00	288.00	150.80	4.00	1,539.20	67.20	1,606.40
2009	35.20	356.80	295.00	363.00	39.20	1,089.20	136.80	1,226.00
2010	126.70	163.30	162.80	190.40	25.20	668.40	175.40	843.80
2011	591.80	237.00	559.00	275.40	40.60	1,703.80	83.20	1,787.00
2012	232.40	497.80	367.60	429.20	1.80	1,528.80	64.40	1,593.20
Average	**232.14**	**330.35**	**307.06**	**257.27**	**69.90**	**1,196.72**	**137.14**	**1,333.86**

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

* These values have been filled up by the average monthly monsoon rainfall data and non-monsoon rainfall data of Baghmundi based on the annual rainfall data at Ajodhya Hills rainfall gauging station.

Table 7.2.3-2 Monthly Rainfall Data at Ajodhya Hills Rain Gauge Station (1983-2002) in mm

Year	June	July	Aug	Sep	Oct	Monsoon Total	Non Monsoon Total	Annual
1983	190.20	255.30	347.40	391.60	185.00	1,369.50	155.90	1,525.40
1984	838.50	219.50	377.00	168.20	117.50	1,720.70	81.00	1,801.70
1985	166.00	394.50	380.50	325.50	154.00	1,420.50	91.00	1,511.50
1986	388.90	324.50	252.50	319.50	116.50	1,401.90	232.80	1,634.70
1987	98.90	525.30	511.40	264.00	0.00	1,399.60	151.00	1,550.60
1988	614.30	277.30	166.50	300.20	22.50	1,380.80	144.80	1,525.60
1989	452.00	475.60	569.00	238.50	56.00	1,791.10	132.20	1,923.30
1990	259.50	667.00	272.00	441.00	167.50	1,807.00	306.50	2,113.50
1991	71.20	410.80	459.21	370.00	3.00	1,314.21	153.50	1,467.71
1992	188.00	374.10	74.10	755.00	52.00	1,443.20	275.70	1,718.90
1993	338.90	211.70	200.50	393.00	135.00	1,279.10	143.80	1,422.90
1994	382.40	503.80	359.10	250.10	116.60	1,612.00	140.40	1,752.40
1995	106.20	325.60	451.39	464.80	144.10	1,492.09	345.40	1,837.49
1996	681.40	276.20	303.20	86.50	47.30	1,394.60	127.60	1,522.20
1997	390.90	469.70	602.80	233.60	30.30	1,727.30	157.60	1,884.90
1998	74.00	231.20	366.20	252.40	269.00	1,192.80	296.70	1,489.50
1999	407.00	383.00	414.00	531.00	207.00	1,942.00	111.00	2,053.00
2000	198.70	365.40	185.20	128.00	93.00	970.30	212.00	1,182.30
2001	499.00	474.00	293.00	188.00	100.00	1,554.00	253.00	1,807.00
2002	312.00	97.00	440.00	312.00	124.00	1,285.00	43.00	1,328.00
Average	**332.90**	**363.08**	**351.25**	**320.65**	**107.02**	**1,474.89**	**177.75**	**1,652.63**

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Table 7.2.3-3 Monthly Rainfall Data at Kistobazar Rain Gauge Station (1983-1989) in mm

Year	June	July	Aug	Sep	Oct	Monsoon
1983	101.80	173.50	275.50	310.40	113.90	975.10
1984	739.20	200.50	403.30	130.80	75.00	1,548.80
1985	169.10	482.90	329.60	296.10	212.60	1,490.30
1986	255.90	304.90	311.40	254.20	95.20	1,221.60
1987	108.80	483.50	397.70	291.60	5.70	1,287.30
1988	529.20	283.20	201.20	283.40	9.40	1,306.40
1989	426.10	346.20	386.50	205.90	71.30	1,436.00
Average	**332.87**	**324.96**	**329.31**	**253.20**	**83.30**	**1,323.64**

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Table 7.2.3-4 Monthly Runoff Data at Kistobazar Dam (1983-1989) in mm

Year	June	July	Aug	Sep	Oct	Monsoon Total	Non Monsoon Total	Annual
1983	8.20	76.00	120.20	215.50	111.90	531.80	9.80	541.60
1984	574.00	128.00	269.30	155.30	54.00	1,180.60	45.10	1,225.70
1985	12.70	167.20	162.10	181.60	102.10	625.70	100.10	725.80
1986	33.90	129.40	206.11	156.00	83.10	608.51	180.80	789.31
1987	4.60	163.70	227.80	123.40	28.30	547.80	113.00	660.80
1988	320.00	66.80	56.90	120.00	39.60	603.30	143.70	747.00
1989	107.30	120.00	182.00	156.00	92.60	657.90	67.50	725.40
Average	**151.53**	**121.59**	**174.92**	**158.26**	**73.09**	**679.37**	**94.29**	**773.66**

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Table 7.2.3-5 Monthly Runoff Data at Existing Turga Dam (1990-1997) in mm

Year	June	July	Aug	Sep	Oct	Monsoon Total
1990	43.28	155.62	229.08	117.54	120.23	665.75
1991	5.29	24.11	113.59	141.09	45.83	329.91
1992	29.77	63.69	124.83	255.70	73.65	547.64
1993	39.05	31.39	63.48	120.48	51.57	305.97
1994	90.27	193.19	121.92	91.38	41.48	538.24
1995	14.30	68.50	304.30	315.40	76.52	779.02
1996	146.36	113.58	161.01	81.38	40.86	543.19
1997	30.20	125.08	240.85	123.18	41.90	561.21
Average	**49.82**	**96.90**	**169.88**	**155.77**	**61.51**	**533.87**

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Since the recorded periods of both discharge are quite limited, 8 years at the existing Turga dam and 7 years at Kistobazar, respectively, the combined synthetic discharge data at the existing Turga dam was made to obtain the longer discharge series at the existing Turga dam by using the discharge at Kistobazar dam site.

The discharge data of the Kistobazar dam have been transferred at the existing Turga dam based on the average monsoon rainfall ratio and catchment area proportion for the concurrent period. The average monsoon rainfall (June to October) at the Kistobazar dam for the period from 1983 to 1989 is calculated as 1,323.64 mm and the rainfall for Baghmundi as 1,322.01 mm. The average monsoon rainfall ratio works out to 0.9988. The catchment area ratio works out to 0.6752, i.e. 12.66 km^2/18.75 km^2. Using cumulative ratio as 0.67, the monsoon runoff series for the period 1983 to 1989 at the Kistobazar dam has been transferred to the existing Turga dam. Thus, the discharge series at the existing Turga dam would be from 1983 to 1997 (15 years) and the computations are presented in Table 7.2.3-6.

Table 7.2.3-6 Monthly Runoff Data at Existing Turga Dam (1983-1997) in mm

Year	June	July	August	September	October	Monsoon
1983*	5.53	51.26	81.06	145.34	75.47	358.65
1984*	387.11	86.33	181.62	104.74	36.42	796.21
1985*	8.57	112.76	109.32	122.47	68.86	421.98
1986*	22.86	87.27	139.00	105.21	56.04	410.39
1987*	3.10	110.40	153.63	83.22	19.09	369.44
1988*	215.81	45.05	38.37	80.93	26.71	406.87
1989*	72.36	80.93	122.74	105.21	62.45	443.70
1990	43.28	155.62	229.08	117.54	120.23	665.75
1991	5.29	24.11	113.59	141.09	45.83	329.91
1992	29.77	63.69	124.83	255.70	73.65	547.64
1993	39.05	31.39	63.48	120.48	51.57	305.97
1994	90.27	193.19	121.92	91.38	41.48	538.24
1995	14.30	68.50	304.30	315.40	76.52	779.02
1996	146.36	113.58	161.01	81.38	40.86	543.19
1997	30.20	125.08	240.85	123.18	41.90	561.21
Average	**74.26**	**89.94**	**145.65**	**132.88**	**55.80**	**498.55**

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

* Values obtained from average monsoon rainfall and catchment area ratio at both stations

7.2.4 Consistency Test between Rainfall and Runoff

Before estimating the water availability of the project area, the following correlations between rainfall and discharge have been studied as a consistency check in the data series depending on the length of rainfall and discharge data available.

(1) Rainfall-Runoff Correlation between at Existing Truga Dam (at Baghmundi), (1990-1997)

The monsoon rainfall-runoff (from June to October) correlation study at the existing Turga dam based on concurrent rainfall data at Baghmundi station and runoff data at the existing Turga dam from 1990 to 1997 has been calculated. The coefficient of correlation obtained is 0.7838.

(2) Rainfall-Runoff correlation at Kistobazar Dam (1983-1989)

The correlation for annual flows and monsoon flows at Kistobazar dam site, adjacent to Turga Nala for the period 1983 to 1989 and concurrent rainfall data at Baghmundi station have been calculated and the correlation coefficients are 0.5872 (annual) and 0.643 (monsoon), respectively

(3) Rainfall-Runoff (synthetic) correlation at existing Turga dam (1983-1997)

The correlation coefficient for monsoon flows at the existing Turga dam and monsoon rainfall data of Baghmundi station from 1983 to 1997. The discharge data of Kistobazar site from 1983 to1989 have been transferred by applying catchment area and rainfall ratio in order to make long term runoff series from 1983 to 1997. The coefficient of correlation on monsoon flow basis is 0.6273.

As introduced the above, the consistencies between rainfall and runoff for three cases were checked by calculating the correlation coefficients which vary from 0.5872 to 0.7838. The results for all cases reveal that all the data are reasonable because it is generally said that correlation coefficient over 0.7 means strong correlation and that between 0.4 to 0.7 means moderate correlation.

7.2.5 Runoff Data Generation

The period of available runoff data at the existing Turga dam is quite limited while in this case, hydrological input over 40 years is required for DPR of this type of project according to the guidelines of Ministry of Water Resources.

The discharge data available at two stations, i.e. Kistobazar dam on Kistobazar Nala and the existing Turga dam on Turga Nala, have been used to formulate discharge series for the period from 1983 to 1997. The discharge data at the Kistobazar dam found to be inconsistent with the rainfall data at Baghmundi station in the monsoon of 1984. The runoff coefficients during monsoon from 1983 to 1989 except the monsoon of 1984 varies from 39% to 54%, while that of 1984 is 75% as shown in Table 7.2.5-1 and it is too much high. Thus, the runoff data of 1983 and 1984 have been excluded. The month wise runoff equation has been developed for the monsoon season using the concurrent rainfall and discharge data from 1985 to 1997 as shown in Table 7.2.5-2.

The average monsoon runoff coefficient computed as around 0.40.

Table 7.2.5-1   Monsoon Runoff Coefficient of Rainfall at Baghmundi and Runoff at Kistobazar

Year	Rainfall at Baghmundi (mm)	Runoff at Kistobazar (mm)	Runoff Coefficient
1983	1,156.30	531.80	45.99%
1984	1,582.40	1,180.60	74.61%
1985	1,607.80	625.70	38.92%
1986	1,302.30	608.51	46.73%
1987	1,226.00	547.80	44.68%
1988	1,127.60	603.30	53.50%
1989	1,251.70	657.90	52.56%
Average	1,322.01	679.37	51.39%

(source: JPOWER based on DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Table 7.2.5-2   Regression Equations

Month	Regression Equation	R^2	R
June	$Y = 0.264X – 27.43$	0.81	0.90
July	$Y = 0.432X – 39.29$	0.81	0.90
August	$Y = 0.668X – 60.47$	0.82	0.905
September	$Y = 0.411X + 38.75$	0.83	0.911
October	$Y = 0.178X + 0.10X_{–1} +29.99$	0.52	0.721

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

where,

X : Rainfall (mm) of current month

X_{-1} : Rainfall (mm) of previous month

Y : Runoff (mm) of current month

Based on the above rainfall-runoff equations and having long term rainfall data at Baghmundi rain gauge station, the monsoon month flow series has been calculated at the Turga lower dam location. The non-monsoon flow has been considered as 11% of the monsoon flows based on the rainfall data pattern at Baghmundi rain gauge station. The inflow series at Turga upper dam location has been calculated by transferring the lower dam series in catchment area proportion. The inflow series of two dam location are shown in Table 7.2.5-3 and Table 7.2.5-4.

The average, 50%, 75% and 90% dependable flows at the two dam sites are as shown in Table 7.2.5-5.

Table 7.2.5-3 Monthly Inflow at Turga Upper Dam in MCM (C.A. = 8.29 km^2)

Year	June	July	Aug	Sep	Oct	Monsoon Total	Non Monsoon Total	Annual
1958	0.11	1.17	0.79	1.70	0.63	4.40	0.48	4.88
1959	0.10	1.15	0.78	1.20	0.78	4.00	0.44	4.44
1960	0.01	0.67	1.63	1.20	0.54	4.05	0.45	4.50
1961	0.57	0.01	0.94	1.75	0.87	4.14	0.46	4.60
1962	0.12	0.80	1.08	1.44	0.62	4.06	0.45	4.50
1963	0.14	0.93	1.45	1.15	0.63	4.29	0.47	4.77
1964	0.26	1.34	1.55	1.25	0.57	4.97	0.55	5.52
1965	0.13	1.39	1.32	0.67	0.33	3.85	0.42	4.27
1966	0.44	0.00	0.88	0.65	0.37	2.34	0.26	2.59
1967	0.00	0.00	1.74	3.10	0.87	5.71	0.63	6.34
1968	0.33	1.48	1.94	0.46	0.27	4.47	0.49	4.96
1969	0.00	0.53	0.60	1.14	0.40	2.66	0.29	2.95
1970	0.16	1.08	0.96	1.94	0.69	4.82	0.53	5.35
1971	0.50	1.20	2.30	0.77	0.39	5.16	0.57	5.73
1972	0.00	0.38	1.67	0.84	0.43	3.32	0.37	3.68
1973	0.08	0.99	1.05	1.35	0.67	4.14	0.46	4.60
1974	0.00	1.95	1.06	1.20	0.42	4.63	0.51	5.14
1975	0.11	0.38	0.02	1.55	0.56	2.63	0.29	2.92
1976	0.00	0.32	0.01	1.29	0.44	2.06	0.23	2.29
1977	0.36	0.78	0.54	0.86	0.36	2.90	0.32	3.22
1978	0.39	0.40	1.19	1.61	0.68	4.28	0.47	4.75
1979	0.18	0.63	0.69	0.63	0.34	2.47	0.27	2.74
1980	0.12	1.38	0.75	0.99	0.51	3.75	0.41	4.16
1981	0.14	1.22	1.24	1.09	0.38	4.08	0.45	4.53
1982	0.16	0.41	1.01	0.65	0.43	2.65	0.29	2.94
1983	0.06	0.71	0.82	1.63	0.68	3.89	0.43	4.32
1984	1.35	0.38	1.88	0.87	0.43	4.91	0.54	5.45
1985	0.18	1.36	1.49	1.60	0.82	5.45	0.60	6.05
1986	0.27	0.61	1.60	1.45	0.61	4.55	0.50	5.05
1987	0.06	1.28	1.45	1.24	0.45	4.48	0.49	4.97
1988	0.92	0.31	0.60	1.07	0.39	3.28	0.36	3.64
1989	0.51	0.79	1.46	1.07	0.42	4.24	0.47	4.71
1990	0.54	2.13	0.69	1.45	0.58	5.39	0.59	5.98
1991	0.00	0.90	1.74	0.89	0.35	3.88	0.43	4.31
1992	0.12	0.68	1.05	1.92	0.62	4.39	0.48	4.88
1993	0.42	0.37	0.57	1.73	0.69	3.78	0.42	4.19
1994	0.92	1.40	1.15	0.87	0.48	4.83	0.53	5.36
1995	0.26	0.88	2.09	1.69	0.66	5.59	0.62	6.21
1996	1.06	0.91	1.41	0.69	0.30	4.37	0.48	4.85
1997	0.32	1.24	2.47	1.05	0.43	5.50	0.61	6.11
1998	0.23	0.74	1.04	1.11	0.48	3.60	0.40	4.00
1999	0.41	1.15	1.62	1.41	0.58	5.17	0.57	5.74
2000	0.14	0.52	0.72	0.95	0.42	2.75	0.30	3.05
2001	0.66	0.99	0.87	0.66	0.30	3.47	0.38	3.85
2002	0.71	0.17	1.34	0.83	0.47	3.52	0.39	3.91
2003	0.00	0.49	1.28	0.75	0.56	3.08	0.34	3.42
2004	0.00	0.43	1.66	0.75	0.42	3.27	0.36	3.63
2005	0.03	0.79	0.70	0.82	0.41	2.75	0.30	3.06
2006	0.19	0.80	0.87	1.07	0.40	3.34	0.37	3.70
2007	0.09	1.80	1.44	1.44	0.48	5.25	0.58	5.82
2008	0.90	1.76	1.09	0.84	0.32	4.91	0.54	5.45
2009	0.00	0.95	1.13	1.56	0.55	4.19	0.46	4.65
2010	0.05	0.26	0.40	0.97	0.39	2.06	0.23	2.29
2011	1.07	0.52	2.59	1.26	0.48	5.92	0.65	6.58
2012	0.28	1.46	1.53	1.78	0.55	5.61	0.62	6.22
Average	0.29	0.86	1.20	1.20	0.51	4.06	0.45	4.51

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Table 7.2.5-4 Monthly Inflow at Turga Lower Dam in MCM (C.A. = 12.66 km^2)

Year	June	July	Aug	Sep	Oct	Monsoon Total	Non Monsoon Total	Annual
1958	0.16	1.79	1.21	2.59	0.96	6.71	0.74	7.45
1959	0.16	1.76	1.19	1.83	1.18	6.11	0.67	6.78
1960	0.01	1.03	2.49	1.83	0.82	6.18	0.68	6.86
1961	0.88	0.02	1.43	2.67	1.32	6.32	0.70	7.02
1962	0.19	1.23	1.65	2.19	0.94	6.20	0.68	6.88
1963	0.21	1.42	2.21	1.76	0.96	6.56	0.72	7.28
1964	0.40	2.05	2.36	1.91	0.86	7.59	0.83	8.43
1965	0.20	2.12	2.02	1.03	0.51	5.88	0.65	6.52
1966	0.66	0.00	1.34	0.99	0.57	3.57	0.39	3.96
1967	0.00	0.00	2.66	4.73	1.32	8.72	0.96	9.68
1968	0.51	2.26	2.96	0.70	0.41	6.82	0.75	7.57
1969	0.00	0.80	0.91	1.74	0.60	4.06	0.45	4.51
1970	0.25	1.64	1.46	2.96	1.05	7.36	0.81	8.17
1971	0.77	1.84	3.51	1.18	0.59	7.88	0.87	8.74
1972	0.00	0.58	2.55	1.29	0.66	5.07	0.56	5.63
1973	0.12	1.51	1.61	2.06	1.02	6.33	0.70	7.02
1974	0.00	2.97	1.62	1.83	0.65	7.07	0.78	7.84
1975	0.17	0.58	0.04	2.37	0.86	4.01	0.44	4.45
1976	0.00	0.49	0.02	1.96	0.67	3.15	0.35	3.50
1977	0.56	1.19	0.82	1.31	0.56	4.43	0.49	4.92
1978	0.59	0.61	1.82	2.46	1.05	6.53	0.72	7.25
1979	0.28	0.96	1.06	0.96	0.52	3.77	0.41	4.18
1980	0.18	2.11	1.14	1.51	0.78	5.73	0.63	6.35
1981	0.22	1.87	1.90	1.67	0.58	6.23	0.69	6.92
1982	0.24	0.62	1.54	0.99	0.65	4.05	0.44	4.49
1983	0.09	1.08	1.26	2.48	1.03	5.95	0.65	6.60
1984	2.06	0.58	2.87	1.33	0.66	7.50	0.83	8.33
1985	0.27	2.07	2.27	2.45	1.26	8.32	0.92	9.23
1986	0.42	0.93	2.44	2.21	0.94	6.95	0.76	7.71
1987	0.10	1.96	2.21	1.90	0.68	6.84	0.75	7.60
1988	1.40	0.47	0.92	1.63	0.59	5.01	0.55	5.56
1989	0.78	1.20	2.22	1.63	0.64	6.47	0.71	7.19
1990	0.82	3.25	1.06	2.21	0.89	8.23	0.91	9.14
1991	0.00	1.37	2.65	1.37	0.54	5.93	0.65	6.58
1992	0.19	1.04	1.60	2.94	0.95	6.71	0.74	7.45
1993	0.65	0.56	0.87	2.64	1.05	5.77	0.63	6.41
1994	1.40	2.14	1.76	1.33	0.73	7.37	0.81	8.18
1995	0.40	1.35	3.19	2.59	1.01	8.54	0.94	9.48
1996	1.61	1.40	2.16	1.05	0.45	6.67	0.73	7.40
1997	0.48	1.89	3.78	1.60	0.66	8.40	0.92	9.33
1998	0.35	1.14	1.58	1.70	0.73	5.50	0.60	6.10
1999	0.62	1.75	2.47	2.16	0.89	7.89	0.87	8.76
2000	0.21	0.80	1.10	1.45	0.64	4.19	0.46	4.65
2001	1.01	1.51	1.32	1.00	0.45	5.30	0.58	5.88
2002	1.09	0.26	2.05	1.27	0.71	5.38	0.59	5.97
2003	0.00	0.75	1.96	1.15	0.85	4.71	0.52	5.23
2004	0.00	0.66	2.54	1.14	0.65	4.99	0.55	5.54
2005	0.05	1.21	1.06	1.25	0.63	4.20	0.46	4.67
2006	0.30	1.22	1.33	1.63	0.61	5.10	0.56	5.66
2007	0.13	2.75	2.20	2.20	0.73	8.01	0.88	8.90
2008	1.38	2.68	1.67	1.28	0.49	7.49	0.82	8.32
2009	0.00	1.45	1.73	2.38	0.84	6.40	0.70	7.11
2010	0.08	0.40	0.61	1.48	0.59	3.15	0.35	3.50
2011	1.63	0.80	3.96	1.92	0.73	9.05	1.00	10.04
2012	0.43	2.23	2.34	2.72	0.84	8.56	0.94	9.50
Average	0.45	1.32	1.83	1.83	0.77	6.20	0.68	6.88

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Table 7.2.5-5 Dependable Flows at Both Dams

Location	Catchment Area (km^2)	90% Dependable Flow (MCM)	75% Dependable Flow (MCM)	50% Dependable Flow (MCM)	Average Annual Runoff (MCM)
Lower Dam	12.66	4.47	5.63	7.02	6.88
Upper Dam	8.29	2.93	3.68	4.6	4.51

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

The power potential studies for the Turga PSP have been carried out taking into account the irrigation and water supply requirements.

7.3 EVAPORATION

(1) Evaporation (E)

The lake evaporation losses have been read from the isopleths charts prepared on the basis of the observed evaporation data for the period 10 to 15 years and published by India Meteorological Department (IMD). The lake evaporation losses proposed to be considered are shown in Table 7.3-1.

Table 7.3-1 Lake Evaporation in mm

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
70	80	140	180	210	170	110	120	100	90	70	50	1,390

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

(2) Evapotranspiration (E_{TA})

Evapotranspiration of the project area can be calculated by simple water balance equation as following.

Evapotranspiration (before impounding) = Rainfall – Inflow

The same values of evapotranspiration are used for the upper and lower reservoir areas.

Table 7.3-2 Evapotranspiration in mm

	June	July	Aug.	Sep.	Oct.	Monsoon	Non-Monsoon	Annual
Rainfall	232	330	307	257	70	1,197	137	1,334
Inflow	35	104	145	145	62	490	54	544
E_{TA}	197	226	162	112	8	707	83	790

(source: JPOWER revised DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)
(note: The above figures are average from 1958 to 2012)

(3) Incremental Evaporation Losses from Reservoirs

The incremental evaporation losses from the upper and the lower reservoirs are differences between the evaporation from the reservoir after impounding and the evapotranspiration from reservoir area before impounding. The monthly incremental evaporation is shown in Table 7.3-3.

The same values of incremental evaporation are used for the upper and lower reservoir areas. These values are used for estimating impounding schedule of the project.

As a matter of course, incremental evaporation from reservoir volume, which is expressed in MCM, varies depending on reservoir surface area.

Table 7.3-3 Incremental Evaporation in mm

	June	July	Aug.	Sep.	Oct.	Monsoon	Non-Monsoon	Annual
Evaporation	170	110	120	100	90	590	800	1,390
Evapotranspiration	197	226	162	112	8	707	83	790
Δ Evaporation	-27	-116	-42	-12	82	-117	717	600

(source: JPOWER revised DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

(4) Annual Loss Volumes from Reservoirs due to Incremental Evaporations

The incremental evaporation volume from reservoir is assumed to be exactly proportional to submerged area, which of the upper reservoir varies from 0.53 km^2 (at MDDL) to 0.93 km^2 (at FRL) and that of the lower reservoir varies from 0.28 km^2 (at MDDL) to 0.53 km^2 (at FRL) approximately.

The submerged areas of the upper and lower reservoir at each medium storage capacity between FRL and MDDL are used for estimating annual losses due to incremental evaporation, since the relation between the water levels and the reservoir areas above MDDLs of the upper and lower reservoir are almost linear.

At the medium storage capacity between FRL & MDDL, the submerged area of the upper reservoir is 0.73 km^2 and that of the lower reservoir is 0.42 km^2 respectively, and the annual losses due to the incremental evaporation from the upper and the lower reservoirs are 0.44 MCM (0.73 × 0.600) and 0.25 MCM (0.42 × 0.600) respectively.

7.4 SEDIMENTATION

(1) Sedimentation Rate

Since no sediment data is available either for Turga catchment or any other adjacent catchment, the sedimentation rate of 1,045 m^3/km^2/year has been considered.

The sediment rate of 1,045 m^3/km^2/year or 1.045 mm/year is based on the average sediment rate in the region of Indo-Gangetic Plains derived from the capacity survey carried out for reservoirs in this region, which is mentioned in the compendium on silting of Reservoir in India, 2001 prepared by Central Water Commission (CWC).

(2) Reservoir Trap Efficiency

Brune derived a relationship between reservoir trap efficiency and the ratio of reservoir storage capacity to mean annual inflow as shown in Figure 7.4-1.

The gross reservoir storage capacity of the upper Turga reservoir at Full Reservoir Level (FRL) is 21.6 MCM and that of lower Turga reservoir is 18.0 MCM. The mean annual inflow of upper Turga reservoir 4.51 MCM and that of lower Turga reservoir is 6.88 MCM.

The ratios of reservoir storage capacity to mean annual inflow for the upper reservoir and the lower reservoir are 4.8 and 2.6, respectively. By Brune curve, the reservoir trap efficiencies of the upper dam and lower dam are both around 98% to 99%. However, 100% reservoir trap efficiency was used for both reservoir in DPR.

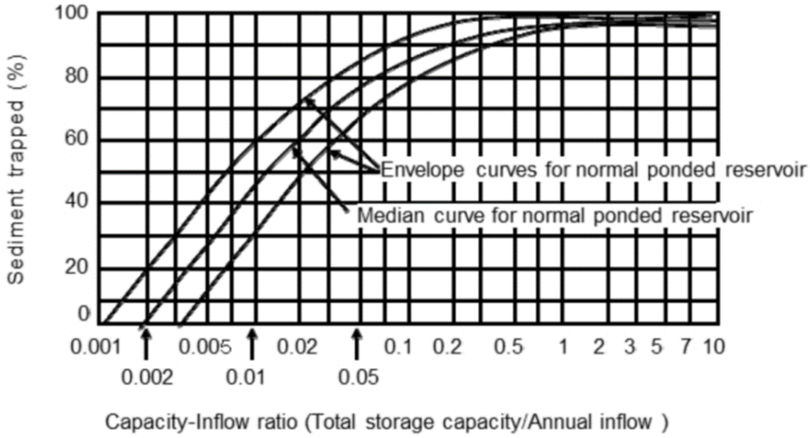


Figure 7.4-1 Reservoir Trap Efficiency (by Brune)

(3) Sediment Volume

According to I.S. guidelines 12182-1987 “Determination of effects of sedimentation in planning and performance of reservoir”, feasible service time of the reservoir for hydropower shall not less than 70 years[1].

The catchment areas (C.A.) of upper and lower dams are 8.29 km^2 and 12.66 km^2, respectively. The intermediate catchment area between upper dam and lower dam is 4.37 km^2. The total sediment volumes for 70 years at lower and upper dams are calculated as following.

Sediment volume of upper dam = 1,045 × 8.29 × 70 = 0.606 MCM
Sediment volume of lower dam (intermediate) = 1,045 × 4.37 × 70 = 0.320 MCM

The estimated annual sediment volumes for upper dam (C.A. = 8.29 km^2) and lower dam (C.A. = 4.37 km^2, considering interception by upper dam) are 0.0087 MCM and 0.0046 MCM. The ratios of the annual sediment volumes to gross storage capacity of upper dam (21.6 MCM) and lower dam (18.0 MCM) are 0.040% and 0.026%. Thus, the reservoir sediment problem is insignificant because

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[1] The economic life of the project in DPR is 35 years.

these ratios are less than 0.1%.

Moreover, the Minimum Drawdown Levels (MDDL) of the upper and lower reservoirs are EL. 441.40 m and EL. 280.40 m respectively with corresponding dead storage capacity of 5.9 MCM and 3.8 MCM against the estimated sediment volumes of 0.606 MCM and 0.320 MCM. The estimated sediment volumes are equivalent to EL. 422.40 m and EL. 259.40 m respectively. It means that there is no effect even if sediment is distributed on the level (flatly) in the reservoirs, since the intake sill levels (EL. EL. 422.40 m for upper dam and EL. 260.40 m for lower dam) is still above the sediment levels.

(4) Sediment Distribution in Reservoirs

The distribution of sediment in the upper reservoir is estimated by empirical area reduction method developed from field survey data by Borland and Miller (1958) and modified by Lara (1962). The new zero elevation[2] for the upper dam after feasible service time, i.e. 70 years, was computed as EL. 408.2 m which is far below the Minimum Drawdown Level (MDDL = EL. 441.40 m).

Area-incremental method developed by U. S Reclamation Bureau was used for calculating the new zero elevation for the lower dam due to the incomplete reservoir elevation vs. area/storage capacity curve of the lower reservoir caused by the existing Turga reservoir. The new zero elevation for the lower dam was estimated as around EL. 255.5 m which is also much below the MDDL (MDDL = EL. 280.40 m).

7.5 IRRIGATION REQUIREMENT

The existing irrigation dam on Turga Nala (C.A. = 12.66 km^2) having live storage capacity of 1.4875 MCM provides irrigation water to irrigable area of 9.065 km^2. At present the water from the reservoir is being drawn to irrigate Kharif (during monsoon) and Rabi (during non-monsoon) crops. The monthly water requirements are as following.

Table 7.5-1 Irrigation Water Requirement

Kharif Crop	Water Requirement (MCM)
July	0.50449
August	1.39260
September	1.03366
October	1.15206
Sub-total	4.08281
Rabi Crop	
November to February	0.49957
Total	4.58238

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

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[2] The deepest river bed elevation after 70 years.

The necessary reservoir storage capacity for satisfying the above irrigation requirements is planned to keep at the upper dam after the completion of Turga PSP.

7.6 WATER SUPPLY DEMAND

Baghmundi & Adjoining Mouzas water supply scheme was designed to cover a service area of around 1,507 ha with design population of 12,476 for the year 2025. The scheme was technically cleared by the state level Scientific Source Funding Committee in the year 2002. As no ground water is available in the near area due to geological reasons, the scheme proposes utilization of water of the existing Turga dam by installing suitable intake structure. The total water demand in 2025 with 5% treatment loss has been projected 585 kℓ/day, which is equivalent to 0.214 MCM/year. This demand has also to be taken into account in the reservoir storage capacity of the upper dam for Turga PSP.

7.7 WATER BALANCE OF TURGA RIVER BASIN

As shown in Table 7.7-1, the flow in the Turga Nala is annually enough to meet the environmental flow, irrigation requirement, evaporation losses etc. However, the shortage of the month of October & non- monsoon period will be meet up from the irrigation reserve of 1.5 MCM.

Table 7.7-1 Water Balance in MCM

	June	July	Aug.	Sep.	Oct.	Monsoon Total	Non-monsoon Total	Annual
a. Turga Inflow (Lower Dam)	0.450	1.320	1.830	1.830	0.770	6.200	0.680	6.880
b. Environmental flow	0.050	0.170	0.010	0.710	0.260	1.200	0.110	1.310
c. Balance flow (a-b)	0.400	1.150	1.820	1.120	0.510	5.000	0.570	5.570
d. Loss due to evaporation	0.196	0.127	0.138	0.115	0.104	0.679	0.920	1.599
e. Gain due to evapotranspiration	0.288	0.330	0.238	0.166	0.016	1.038	0.121	1.159
f. Balance flow after incremental evaporation	0.492	1.353	1.920	1.171	0.423	5.360	-0.229	5.131
g. Irrigation requirement	0.000	0.504	1.393	1.034	1.152	4.083	0.500	4.582
h. Balance flow after irrigation demand (f-g)	0.492	0.849	0.527	0.138	**-0.729**	1.277	**-0.729**	0.549

The required reservoir storage capacity of 1.5 MCM for the environmental flow, irrigation requirement, evaporation losses etc. which is kept at the existing Turga dam at present will be shifted to the upper dam after completion of the project. This issue has already been consulted with Public Health Engineering Department and Irrigation & Waterways Department, Government of West Bengal, by WBSEDCL through Department of Power & Non Conventional Energy Sources, Government of West Bengal, and adjusted among the related Departments.

7.8 DESIGN FLOOD

The design flood of the Turga PSP was estimated base on the Indian Standard, I.S. code 11223-1985 for design of spillway.

7.8.1 Indian Guideline

I.S. specifies that the dams may be classified to size by using static head at Full Reservoir Level (from FRL to the minimum tail water level) and the gross storage capacity of the dam. The overall size classification for the dam would be greater of that indicated by either of the following two parameters shown in Table 7.8.1-1.

Table 7.8.1-1 Specification for Classification of Dam (I.S. code 11223-1985)

Classification	Gross Storage (MCM)	Static Head (m)
Small	Between 0.5 and 10	Between 7.5 and 12
Intermediate	Between 10 and 60	Between 12 and 30
Large	Greater than 60	Greater than 30

The inflow design flood (IDF) for the dam safety will be 100 years return period flood for “Small”, Standard Project Flood (SPF) based on Standard Project Storm (SPS) for “Intermediate” and Probable Maximum Flood (PMF) based on Probable Maximum Precipitation (PMP) for “Large”.

7.8.2 Selection of Inflow Design Flood

The Turga PSP consists of the upper dam and the lower dam on Turga Nala. The gross storage capacity of the upper dam and the lower dam is 21.6 MCM and 18.0 MCM respectively, which are between 10 MCM and 60 MCM, the static head at FSL is over 30 m. According to the criteria, the inflow design flood for the upper dam and the lower dam will be the Probable Maximum Flood (PMF).

7.8.3 Time of Concentration

The time of concentration of the flood to the lower reservoir was examined as following.

(1) Topographical Features of Basin

The topographical features of the lower dam river basin are as following;

Catchment Area : $A = 12.66$ km^2,
Length of Liver : $L = 7.90$ km,
Centroid length of liver : $Lc = 3.50$ km,
Average Slope of Liver : $S = 43.42$ m/km,
Difference in Elevation : $H = 319$ m.

(2) Time of Concentration

Base on the above mentioned topographic features of the lower dam, the time of flood concentration was estimated as follows by 3 formulas.

By Kirpich Formula

$$t_c = 0.94545\left(L^{o.77}/_{S^{0.385}}\right) = 1.09 \text{ (hours)}$$

By California Formula

$$\mathrm{t_c} = \left(0.87\mathrm{L}^3/_{\mathrm{H}}\right)^{0.385} = 1.12 \text{ (hours)}$$

By Bhatnagar

$$\mathrm{t_c} = \left(\mathrm{L}^3/_{\mathrm{H}}\right)^{0.345} = 1.16 \text{ (hours)}$$

From the above 3 formulas, the time of concentration is about 1.1 hours.

Since the catchment areas of the two dams (upper dam 8.29 km^2 & lower dam 12.66 km^2) are small and the time of concentration is short as expected, Rational Formula and one-day storm will be applicable for design flood study.

7.8.4 Design Flood

(1) Probable Maximum Precipitation (PMP)

From the latest PMP Atlas for Mahanadi and adjoining river basin, one-day SPS depth has been taken as 565 mm and one-day PMP is 735 mm. The moisture adjustment factor is considered 30% (MAF as 1.3). After applying clock hour correction subject to maximum 50 mm, the 24-hour PMP value has been computed as 785 mm and the same has been adopted to estimate the PMF for the lower dam and upper dam.

(2) Probable Maximum Flood (PMF)

The design flood has been estimated based on Rational Formula. 1-hour PMP was calculated as 122.75 mm/hour (785×0.695×0.225) based on the conversion coefficients of 0.695, which is applied to convert from 24-hour PMP to 12-hour PMP, and 0.225, which is applied to convert from 12-hour PMP to 1-hour PMP. These coefficients come from the latest Atlas for Mahanadi and adjoining river basin. In addition, the loss rate of 1.5 mm/hour and base flow of 0.05 m^3/km^2 have been considered as given in the Flood Estimation Report of CWC. The PMF of lower dam and upper dam were calculated as following.

$Q = 0.278CIA$

Where,

C : runoff coefficient taken as 1
I : rainfall intensity (mm/hour)
A : catchment area (km^2)

1) Flood Estimation for Upper Dam

Net I = 122.75 – 1.5 = 121.25 mm/hour
A = 8.29 km^2
Q = 279.44 m^3/s
Q_{base} = 0.42 m^3/s
ΣQ = 279.86 ≈ 280 m^3/s

2) Flood Estimation for Lower Dam

Net I = 122.75 – 1.5 = 121.25 mm/hour
A = 12.66 km^2
Q = 426.74 m^3/s
Q_{base} = 0.42 m^3/s
ΣQ = 427.37 ≈ 428 m^3/s

The PMF of the upper dam and the lower dam work out to 280 m^3/s and 428 m^3/s respectively which have been considered for the design.

(3) Diversion Flood

According to I.S. 14815-2000 (Design flood for river diversion works - guidelines), the diversion flood for concrete dams is to be higher of maximum observed non-monsoon flow at the dam site and 25 years return period flow computed based on non-monsoon peaks.

In the absence of observed non-monsoon flood peaks nearby station, the 25 years return period flood has been estimated by Rational formula considering 25 years return period rainfall at the project site location (as 24 cm as per Isohyet maps of Eastern India (Part-II) published by India Meteorological Department (IMD)). The 25 years return period flood of 109 m^3/s and 167 m^3/s have been computed for the upper dam and the lower dam, respectively.

CHAPTER 8

REVIEW FOR CIVIL DESIGN

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CHAPTER 8 REVIEW FOR CIVIL DESIGN

JICA study team reviews the civil design on Detailed Project Report (DPR) which is issued by West Bengal State Electricity Distribution Company Limited (WBSEDCL). The reviewed result is described below in Chapter 8.

8.1 GENERAL LAYOUT

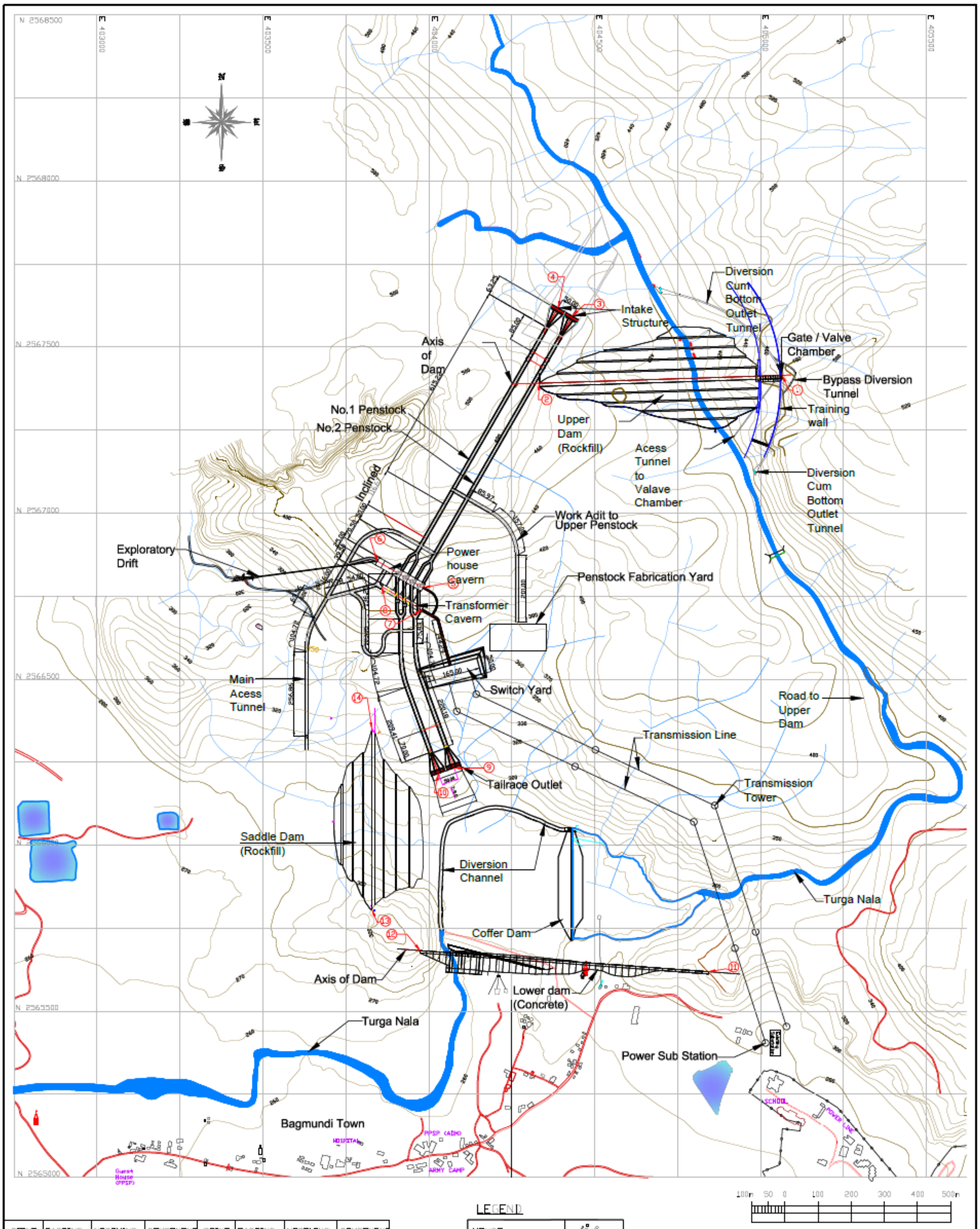
8.1.1 Layout

Figure 8.1.1-1 and Figure 8.1.1-2 show the overall layout and longitudinal section of waterway for Turga Pumped Storage Project. The optimization of upper & lower reservoirs including in the dam axis of the project is decided of following conditions:

- Topographical features
- Geological features
- Embankment material and Cost
- Avoid the influence to the nearby residents

Rock-fill type dams are selected for Upper dam & Lower saddle dam and Concrete gravity type dam is selected for Lower main dam based on above point of views.

The overall layout and dam type selection of DPR are reasonable.



POINT	EASTING	NORTHING	COMPONENT	POINT	EASTING	NORTHING	COMPONENT
1	405064.831	2567415.095	UPPER DAM	9	404075.983	2566232.530	TAILRACE OUTLET
2	404332.556	2567391.165		10	404028.999	2566215.429	
3	404432.830	2567593.854	INTAKE	11	404843.406	2565619.006	LOWER DAM
4	404389.528	2567618.854		12	403973.742	2565682.666	
5	403983.108	2566775.713	POWER HOUSE	13	403828.534	2565805.865	SADDLE DAM
6	403844.544	2566855.713		14	403828.408	2566349.700	
7	403979.234	2566708.668	TRANS-FORMER ROOM				
8	403858.711	2566778.251					

LEGEND

HOUSE	▢
TEMPLE	▲
RIVER/NALA	▬
POND (Existing)	●
TEMPORARY ROAD	〰
MAJOR CONTOUR	〜
EXISTING ROAD	╱

TURGA PUMPED STORAGE PROJECT

GENERAL LAYOUT PLAN
OF THE PROJECT

Drawing No. C - G - 01

Figure 8.1.1-1 General Layout

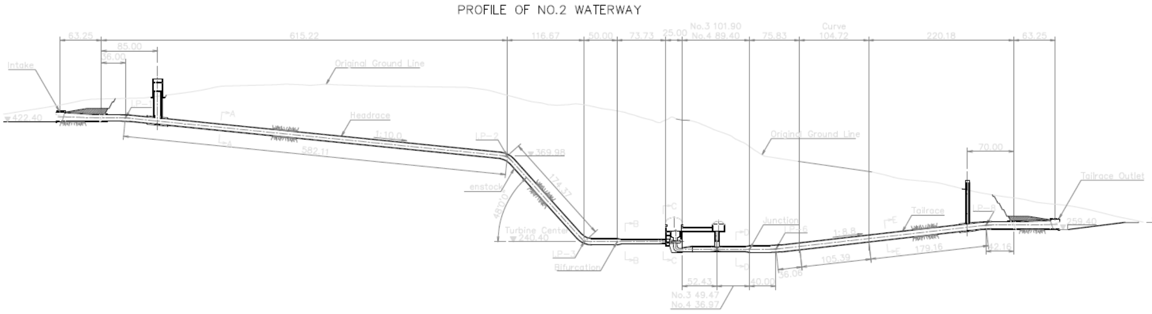


Figure 8.1.1-2 Longitudinal Section

8.1.2 Upper Reservoir and Upper Dam

Three candidate dam axes for upper reservoir are compared for justification in DPR. The lowest dam axis is selected taking into account the reservoir capacity, topographical & geological, and Cost - H/L Ratio. The rock-fill type dam with center impervious zone is selected compare with the gravity type dam taking into account the technical and economical point of views.

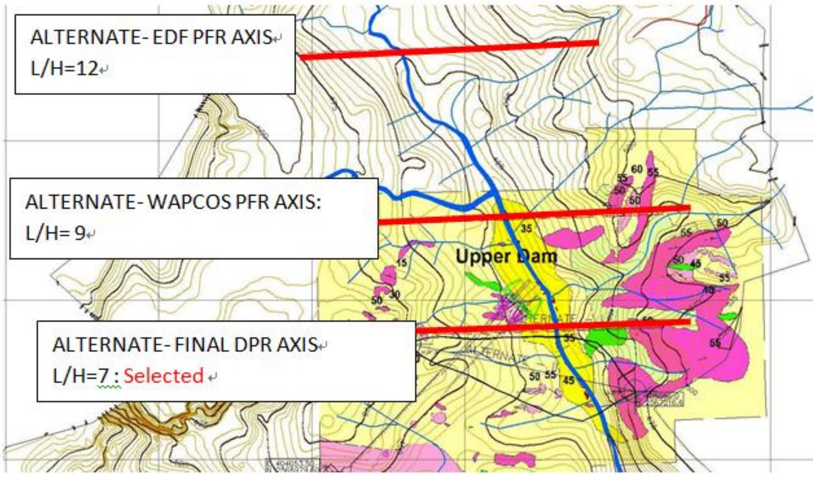


Figure 8.1.2-1 Alternatives for Upper Dam Axis study

The processes and the selected dam axis & dam type are reasonable, and considered for environmental impact to reduce the dam embankment area rather than the earth fill type dam.

8.1.3 Waterway

(1) Waterway Plan

The arrangement of Powerhouse is positioned in the middle of the waterway to cut the planning surge chambers both on the headrace tunnel and on the tailrace tunnel. The shape and dimension of Powerhouse are designed referring to Purulia Pumped Storage Project as best practice. The planned layout number 2 on DPR showing in Figure 8.1.3-1 is finally selected from three alternative plans based on the following reason: Minimizing the hydraulic losses, Geological feature to make a large scale Powerhouse and waterway underground. The processes and the selected waterway arrangement are reasonable.

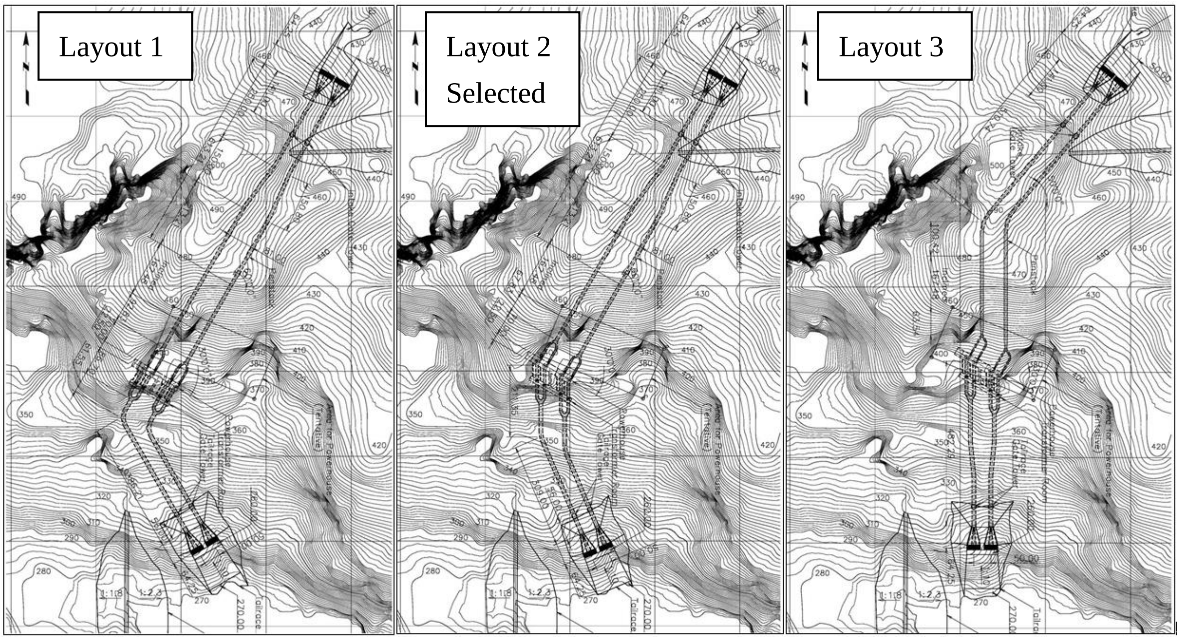


Figure 8.1.3-1 Alternatives for Waterway

(2) Waterway longitudinal section

Figure 8.2.1-1 shows the longitudinal section for waterway. The penstock tunnel is consisting of the upper horizontal tunnel, inclined tunnel, lower horizontal tunnel. Applying inclined Penstock tunnel can be reduced the excavation quantity for cost and schedule efficiency. On the other hand the capability of Civil contractor for inclined tunnel excavation work and also huge diameter tunnel excavation work will be required to carry out the work, so on PQ and Evaluation stage for selecting Civil contractor, the experienced and capable Civil contractor above shall be selected.

8.1.4 Lower Reservoir and Lower Dam

The concrete dam type is selected taking into account the reservoir capacity, topographical & geological feature, and the environmental influences. By means of selecting the thinner concrete gravity dam on the same dam axis of the existing irrigation dam after the removal, the land acquisition of private lands is not needed. The processes and the selected dam axis & dam type are reasonable, and considered for environmental impact to reduce the dam area rather than the rock fill type dam.

8.2 INTAKE AND HEADRACE TUNNEL

8.2.1 Alignment of Headrace Penstock Tunnel

Two rows type of penstock headrace tunnel is applied. The length of the tunnel is around one thousand meter from Intake to Inlet valve of Powerhouse. The section shape of Headrace tunnel is circle. Intake gate is designed in a shaft tunnel. A surge chamber is not planned.

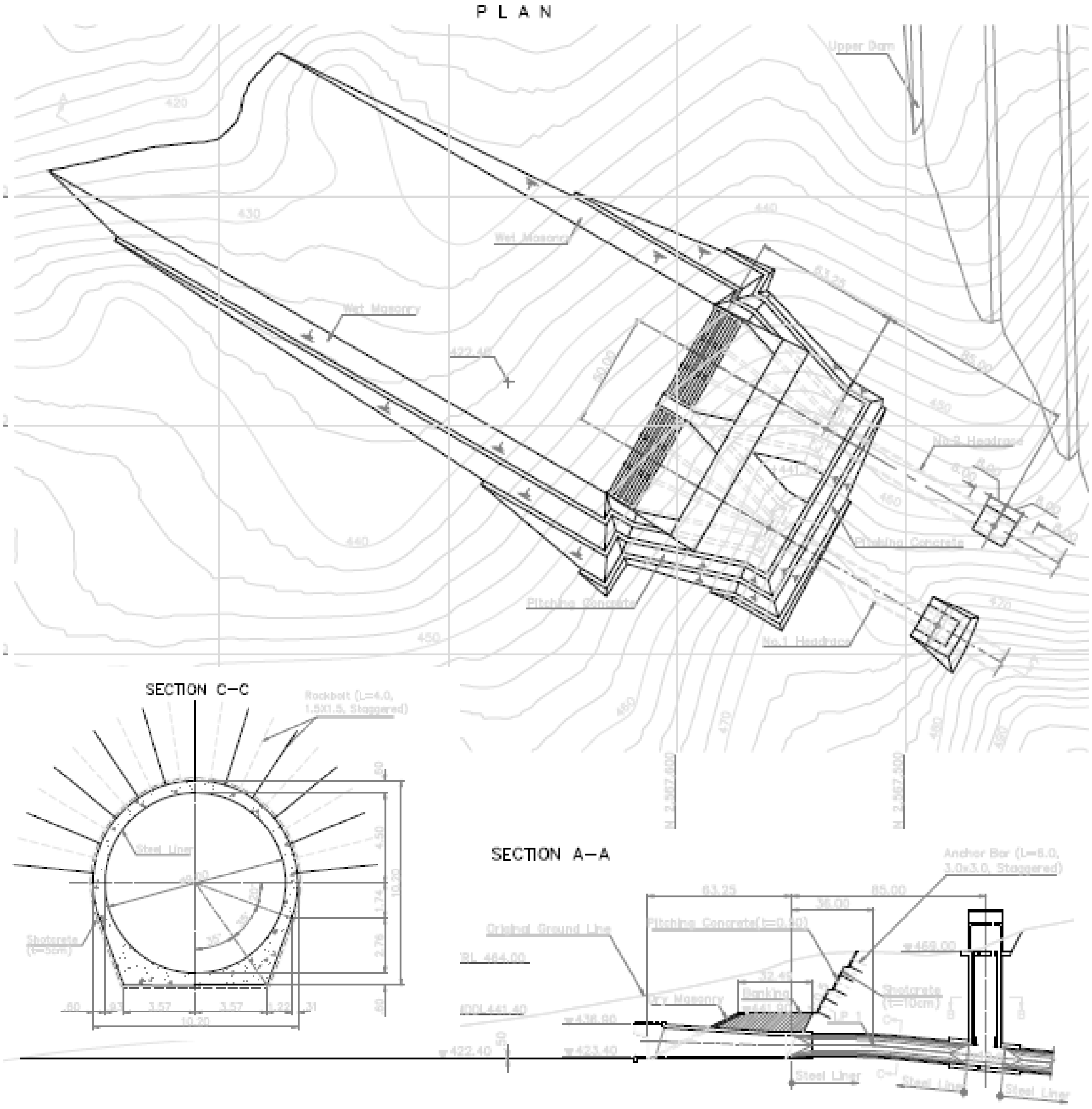


Figure 8.2.1-1 Intake

8.2.2 Diameter of Headrace Penstock Tunnel

The inner diameter of Headrace tunnel is designed with the optimal diameter method taking into account the initial capital cost and the loss of profit due to mainly the friction loss of water flow in Penstock tunnel on DPR. The calculation result for optimal diameter method is 9.0m with the given condition of selling rate - 6.59 INR/kWh on generating phase & buying rate - 3.70 INR/kWh on pumping up phase. However, the result will be varied in case of changing the given values. But it is difficult to forecast these values accurately. So the calculated result above of the optimal diameter is applicable.

8.3 PENSTOCK AND GATES

8.3.1 Alignment of Penstock Tunnel

The two row penstocks of embedded type extend to the turbines on the best route, bifurcating into four just an upstream of the turbines. The headrace tunnel is consist of upper horizontal tunnel, inclined tunnel and lower horizontal tunnel taking into account the cost efficiency. It is common to design the inclined type penstock tunnel for hydropower projects in Japan. However the capability of Civil contractor will be required to carry out the large diameter and inclined tunnel excavation work, so it is recommended that the qualification of the civil contractor shall be examined with experiences of the similar scale and grade of construction.

8.3.2 Penstock

The weight of the steel penstock is calculated based on the following conditions:

- Design dynamic pressure at the turbine:	30% of the hydrostatic pressure
- Support rate by surrounding rock:	30%
- Standard of steel:	ASTM A537 CL2 and A517F
- Penstock stiffener:	Applied

Penstock is designed with the large diameter & high-tension steel. So, it is recommended that the qualification of the Contractor shall be examined with experiences of the similar scale and grade of construction below.

- Fabrication experiences for penstocks and Y-shape bifurcation tube with high-strength steels
- Installation work experiences for large diameter penstocks and Y-shape bifurcation tube

8.3.3 Quantity Table for Penstock and Gate

Table 8.3.3-1 lists the number of penstocks and gates.

Table 8.3.3-1 Metal Work List

		Quantity
1)	Intake Equipment	
	• Intake trashrack	: 6 sets
	• Intake Auxiliary gate	: 2 sets
	• Intake gate	: 2 sets
2)	Steel Penstock and Steel liner of tailrace tunnel	
	• Steel penstock	: 2 lanes to 4 lanes
	• Steel liner of tailrace tunnel	: 4 lanes
3)	Draft Equipment	
	• Draft tube gate	: 4 sets
4)	Tailrace Equipment	

	• Tailrace trashrack	: 6 sets
	• Tailrace gate	: 2 sets
5)	Bottom outlet Equipment of Lower Dam	
	• Bulkhead gate	: 1 set
	• Auxiliary gate	: 1 set
	• Main gate	: 1 set
6)	Environmental Flow Equipment of Lower Dam	
	(Irrigation & drinking water supply and environmental flow)	
	• Auxiliary gate	: Each 1 set
	• Main gate	: Each 1 set
	• Steel conduit	: 1 set
7)	Bottom outlet Equipment of Upper Dam	
	• Trashrack	: 1 set
	• Stoplog	: 1 set
	• Auxiliary gate	: 1 set
	• Main gate	: 1 set
	• Steel conduit with environmental flow equipment of upper dam	: 1 set

8.4 UNDERGROUND POWERHOUSE

8.4.1 Structural Design

(1) Powerhouse cavern

The rock condition is calcified CH class in Central electric power research institute’s rock classification according to the geological survey. Therefore it has enough strength to keep the stable big cavern for Powerhouse. And also the rock support patterns are practical.

(2) Main transformer room

Two types of main transformer room have been usually taken, i.e. arranged at the same cavern of generator or at another cavern. For the project, the latter is selected taking into account the good rock condition. So, it is applicable without design modification.

8.4.2 Cavern Dimension

The cavern dimension is W: 25m, H: 55m, L: 160m. The Cavern dimension is similar to the other pumped storage project. So, it is reasonable design.

It is recommended to update the dimension in accordance with the specification for Electrical-mechanical works in DD phase. And also, it is recommended that the qualification of the Contractor shall be examined with experiences of the similar scale and grade of construction.

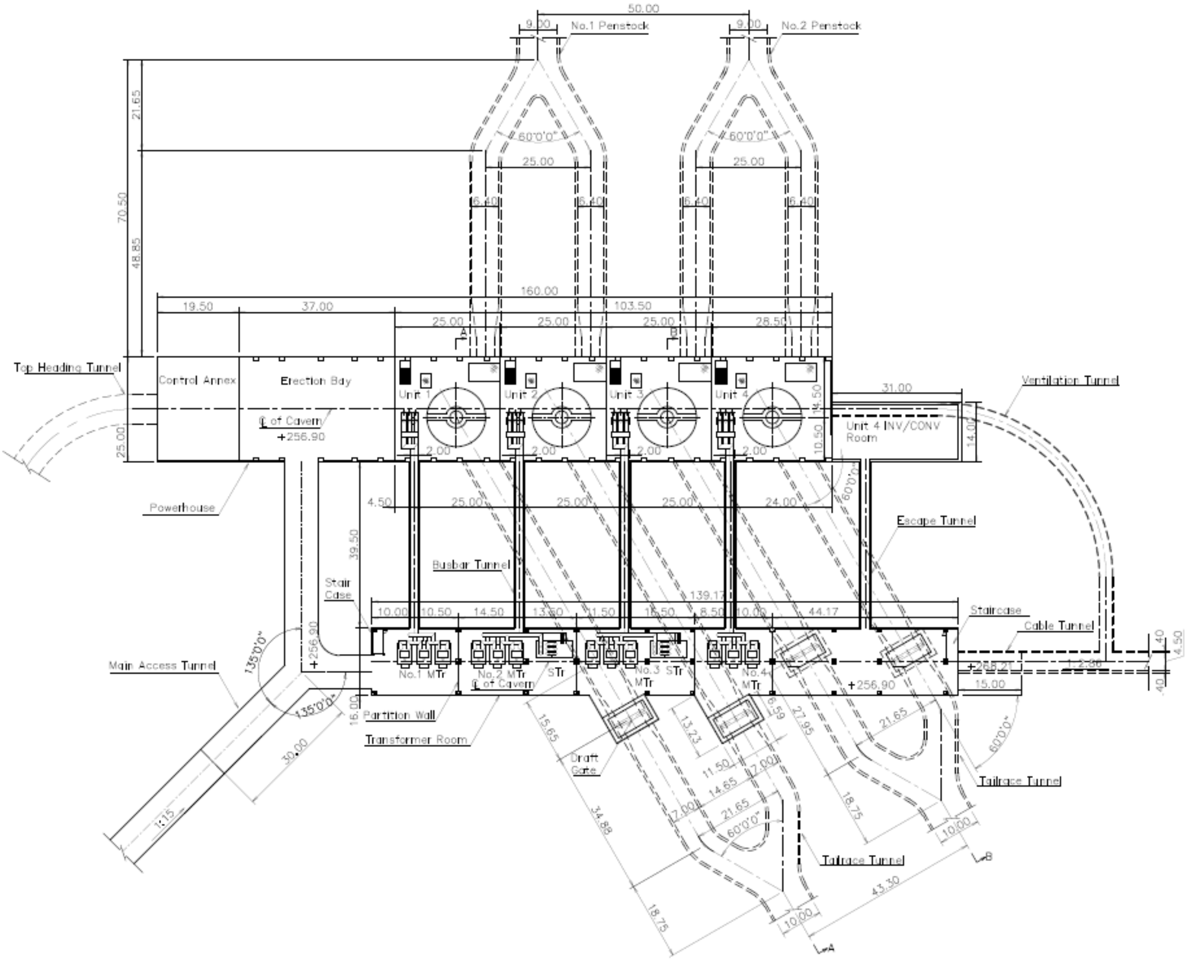


Figure 8.4.2-1 Powerhouse Plan

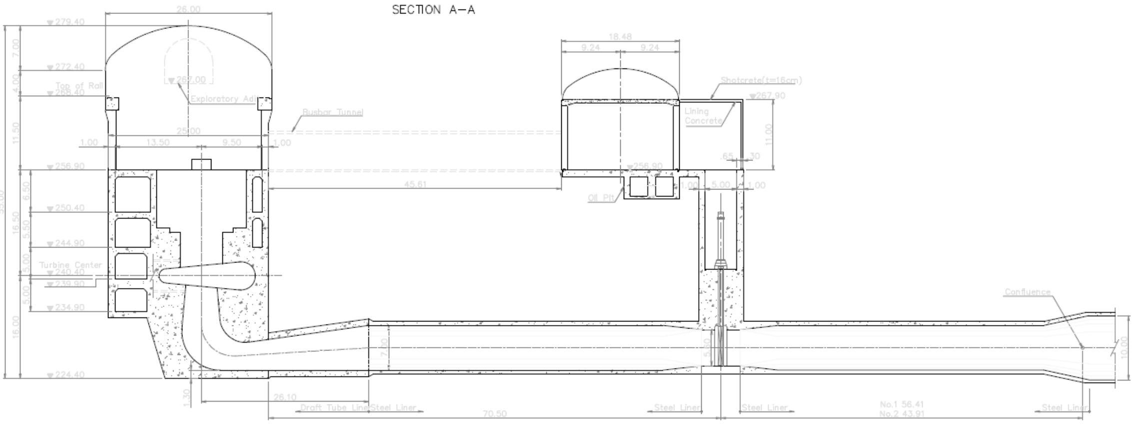


Figure 8.4.2-2 Powerhouse Profile

8.5 TAILRACE

8.5.1 Structural Design

The two row tailrace tunnels extend to the outlets merging the four line draft tunnels. The horizontal distance is circa 550 m from the powerhouse exit to the outlet. The outlet gate on tailrace tunnel is in circular shape gate shaft.

8.5.2 Section Dimension

The inner diameter of the tailrace tunnel before merging is 7.0 m while after merging it becomes 10.0 m respectively. In case that the flow velocity in Tailrace is above 5.5m/s with the 550m tailrace length, the surge chamber shall be designed. To design the tailrace system without surge chamber for reducing cost and working schedule, the inner diameter is determined to be under the critical flow velocity in tailrace tunnel. Above large dimension tunnel design is practical in Japan. However the capability of the contractor will be required to carry out the large diameter tunnel excavation work, so it is recommended that the qualification of the contractor shall be examined with experiences of the similar scale and grade of construction.

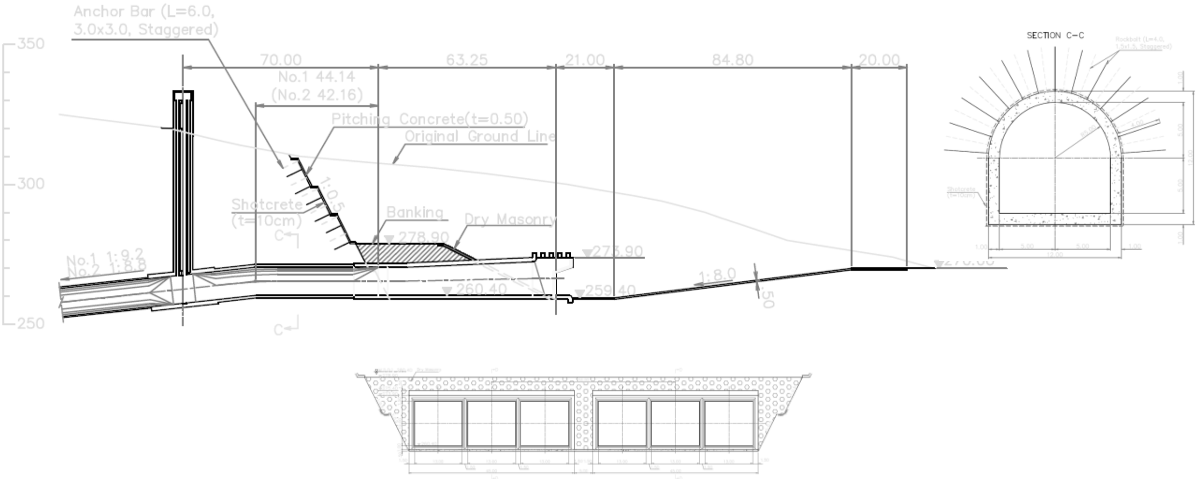


Figure 8.5.2-1 Tailrace Profile & Section and Outlet Section

8.6 OUTLET

8.6.1 Structural Design

The structural design is consisted of three square shaped outlets with dimension W13.0m and H12.0m. the tailrace gate is located in a shaft tunnel. The velocity at the face of the outlet is designed 0.86m/s which is enough small not to affect to the occurrence of dam erosions. Two line tailrace tunnels extend to the outlets merging the four line draft tunnels. The horizontal distance is circa 550 m from the powerhouse exit to the outlet. The type of the outlet gate, tailrace tunnel is of gate shaft, circular shape tunnel.

8.7 REVIEW RESULT

It is applicable design of civil work as a result of reviewing DPR. The detail design shall be updated on DD stage. It is recommended that the qualification of the civil contractor for tunnel excavation work and metal work shall be examined with experiences of the similar scale and grade of construction.

CHAPTER 9

ELECTROMECHANICAL EQUIPMENT DESIGN

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CHAPTER 9 ELECTROMECHANICAL EQUIPMENT DESIGN

9.1 REVIEW OF ELECTROMECHANICAL DESIGN

The details of the design of electromechanical equipment are described in detail in the Detailed Project Report (DPR), but the validity of it has been confirmed as follows.

9.1.1 Type of pump turbine

Regarding the form of the pump turbine, an optimum water turbine type is generally selected from the head and the output.

Also in this project Francis type reversible pump turbine is selected as the most appropriate turbine type at the effective head of 146.4 m and output 250 MW from the water turbine selection chart.

9.1.2 Input and output of pump turbine

In determining the turbine output and pump input, it was confirmed as below that it was calculated so as to satisfy the operation performance under the most severe conditions such as maximum discharge and maximum pumping water.

(1) Turbine output (Pt)

$$Pt = 9.8 \times Qt \times Ht \times \eta t = 9.8 \times 197.0 \times 146.4 \times 0.904 = 255{,}500\text{kW}$$

Where,

Pt : turbine rated output

Qt : maximum discharge at one (1) unit = 197.0 m^3 / s

Ht : normal head= 146.4m

η t : turbine efficiency= 90.4%

(2) Pump input (Pp)

Maximum pump input is calculated as follows:

$$Pp = 9.8 \times Qp \times Hp / \eta p = 9.8 \times 196.7 \times 136.2 / 0.921 = 285{,}000\text{kW}$$

Where,

Pp : maximum pump input

Qp : maximum pumping water = 196.7m^3 / s

Hp : minimum effective head = 136.2 m

η p : pump efficiency= 92.1%

pumping efficiency is estimated 0.921from the experience of PPSP

(3) Turbine center

In designing the pump turbine, it is necessary to determine the water turbine center (installation position) so as not to have cavitation in the runner blade after considering the normal head and the discharge water used based on the design specifications of the civil engineering.

Therefore, it is necessary to obtain the difference between the Lower Reservoir Water Level and the lower end of the runner, Static Suction Head (Hs).

Calculation formula of Hsis as follows:

$Hs = Hb - Hv - \sigma p \times Hp$

Where,

Hb : Atmospheric pressure 10 m (required from power station Elevation)

Hv : vapor pressure = 0.4m at 30°C

σ p : cavitation coefficient= 0.25 (IS12800 : Indian standard)

Hp : maximum pumping head=186.9m (most severe condition for operation)

Hs is calculated as follows:

$Hs = 10 - 0.4 - 0.25 \times 186.9 = -37.1m$

The difference between the lower end of the runner and the center of the runner is estimated to be 1.9 m and the water turbine center level is at a position of -35.2 m from the low water level of the Lower Reservoir, but Hs requires a certain margin, It is reasonable to take 5m margin and finally set it to a position of -40 m above the lowest water level.

9.1.3 Motor-generator

(1) Motor generator type

The most appropriate three-phase AC synchronous generator motor, longitudinal axis rotation field type, closed type rim duct air-cooled semi umbrella type is adopted in consideration of the motor generator type of 250 MW class and rotation speed 187.5 min $^{-1}$.

(2) Main design value

The capacity of the generator-motor is determined by the turbine output, the pump input, and the regulating ability of reactive power and system stability.

Generally, the power factor of the generator motor is selected to be delayed from 0.90 to 0.95 on the power generation side and from 0.95 to 1.0 for the motor side, considering the reactive power capability.

It is a reasonable selection that the following values are adopted in this project.

Generator side : 0.90 (delay)
Motor side : 0.95 (lead)

1) Generator capacity

Generator capacity is calculated as follows:

$$Pg = Ptover \times \eta g / Pfg = 280{,}600 \times 0.98 / 0.90 = 306MVA$$

Where,

η g : generator efficiency = 98%
Pfg : power factor of generator = 0.90 delay

2) Motor caacity

$$Pmout = Pp + 5\% \text{ margin} = 285{,}000 \times 1.05 = 300MW$$

$$Pmc = Pmout / (\eta m \times Pfm) = 300 / (0.98 \times 0.95) = 321MVA$$

Where,

Pmout : motor output
Pmc : motor capacity
Pp : maximum pump input = 285,000kW
Hm : motor efficiency = 98%
Pfm : motor power factor = 0.95

Regarding the efficiency of each generator and motor, if data of the latest equipment is reflected, there is a possibility of adopting even higher values and it will be studied in detailed design.

9.1.4 Main transformer

(1) Type of main transformer

Adopted an indoor type oil immersed three phase (single phase × 3) AC transformer.

- 3-phase AC transformer with 3 single phases in consideration of price and transportation is the most appropriate type
- Transformer capacity of this project was determined to 330 MVA from the following conditions.
- Generator motor capacity: 321 MVA (motor side)
- Excitation Tr capacity: 1.3 MVA
- House Tr capacity: 7 MVA
- Also, the capacity of the SFC at pumping is considered as the short time withstand capacity.
- Figures 9.1.7-1 to 9.1.7-3 shows the layout of the main transformer.

9.1.5 400 kV XLPE cable

For connection between the main transformer and the outdoor GIS, a 400 kV XLPE cable is laid from the underground transformer room to the external Switchyard via a cable tunnel. The length of the cable route is estimated to be about 350 m.

(1) Cable laying conditions

The cable is secured to the cable rack inside the cable tunnel with a cleat laid sneak and stacking. The cable sheath on the Switchyard side is firmly grounded and the cable sheath on the side of the main transformer is planned to be grounded via a grounding device, for example, a gapless arrester, and safety is secured. Also, the rated data is calculated by the calculation method of regulations and there is no problem.

The rated current of the secondary transformer is calculated as 476 A based on rated capacity and voltage and the maximum three phase short circuit current at 400 kV Switchyard is rated as 50 kA based on CEA guidelines. The conductor size of the 400 kV XLPE cable was determined to be 630 mm 2 based on these parameters.

The main ratings of the 400 kV XLPE cable are as follows.

Rated voltage: 400 kV

- Conductor size: 630 mm^2
- Cable outer diameter: 120 mm
- Maximum operating temperature: 90°C
- Rated current: 1,010 A
- Short-time current capacity: 63.7 kA (2 seconds)
- System basic impulse insulation level: 1,425 kV
- Number of circuit: 4 ccts + 1 Spare cable

Figure 9.1.7-5 shows a plan view of cable tunnel and Switchyard.

9.1.6 Switchyard Equipment (GIS)

(1) Configuration

Switchyard is a 400 kV gas insulated switchgear (GIS) type and is a dual bus configuration of 9 feeders including 2 feeders for future expansion of transmission lines.

The GIS double bus consists of four main circuits connected from a 400 kV power cable, four transmission lines and one Bus Tie connection.

It consists of CB (circuit breaker), LS (line switch), ES (earthing switch), potential transformer and so on.

(2) Method of monitoring and inspection SF6 insulating gas

It is completely isolated from other sealed sections for gas monitoring, inspection and disassembly of GIS equipment, the housing of GIS is made of aluminum alloy, nonmagnetic stainless steel or steel plate and avoid eddy current path by magnetic field.

Also, as a countermeasure against the following problems, a bellows is attached to the connecting portion.

1) Expansion and contraction of the enclosure due to temperature change
2) Vibration caused by operation of the switching device
3) Dimensional error due to unbalanced setting of foundation

The construction of the bus is designed considering future expansion, and GIS has a track record adopted at Purulia pspp, so there is no problem in introduction.

Figure 9.1.7-6 shows the layout of GIS.

9.1.7 Basic design of variable speed power plant

In the Detailed Project Report (DPR), the following items are considered as the basic design when introducing the variable speed power plant as CONSIDERATION OF VARIABLE SPEED OPTIONS.

(1) Variable range of rotation speed and pump input
(2) Selection of secondary excitation method
(3) Pump starting method
(4) Design of pump turbine runner
(5) Tolerance capacity of secondary excitation system
(6) Black start capacity

Above items are necessary for considering a variable speed power plant.

The variable range of rotation speed and pump input is designed so that the frequency can be adjusted within the range of ± 5% as the design value, and it is equivalent to the variable speed range of the same class operating in Japan.

For other items as well, it is adopted design values based on Japan's operational performance, and no problems are recognized.

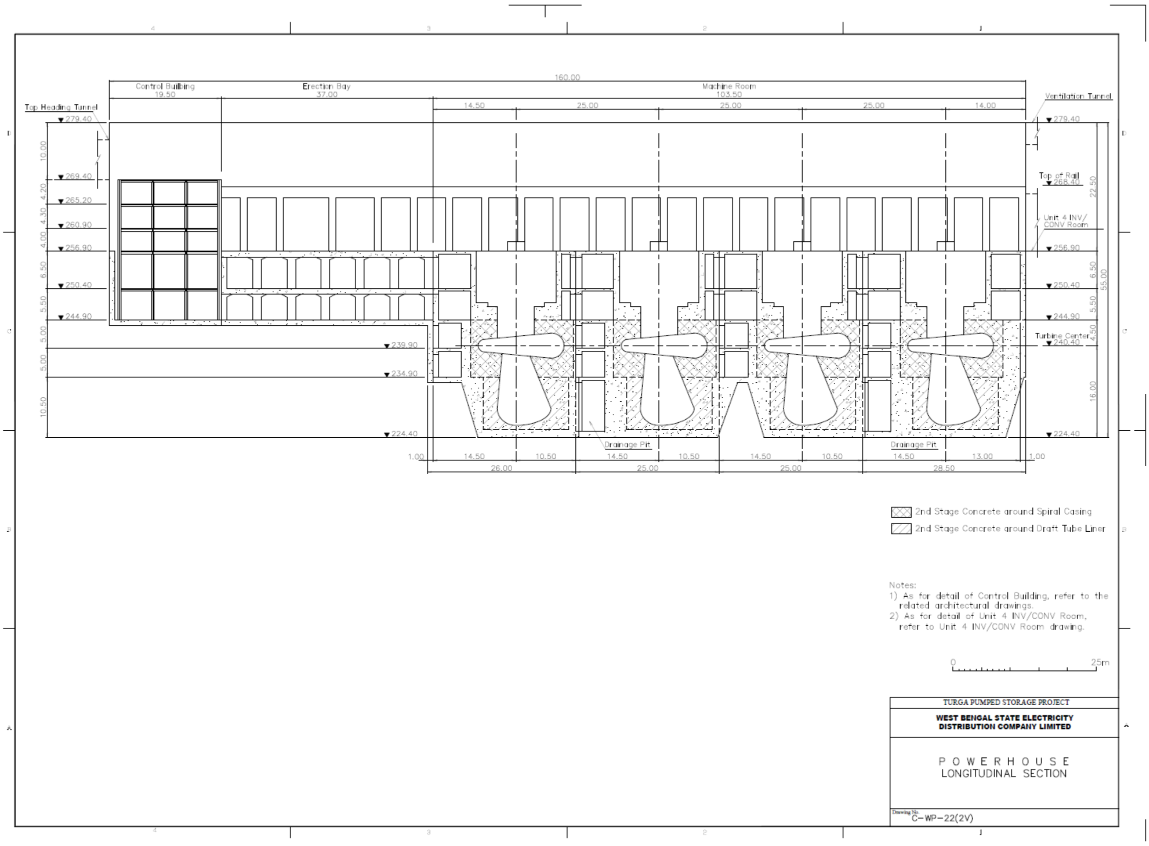

Figure 9.1.7-1 Power House Longitudinal Section

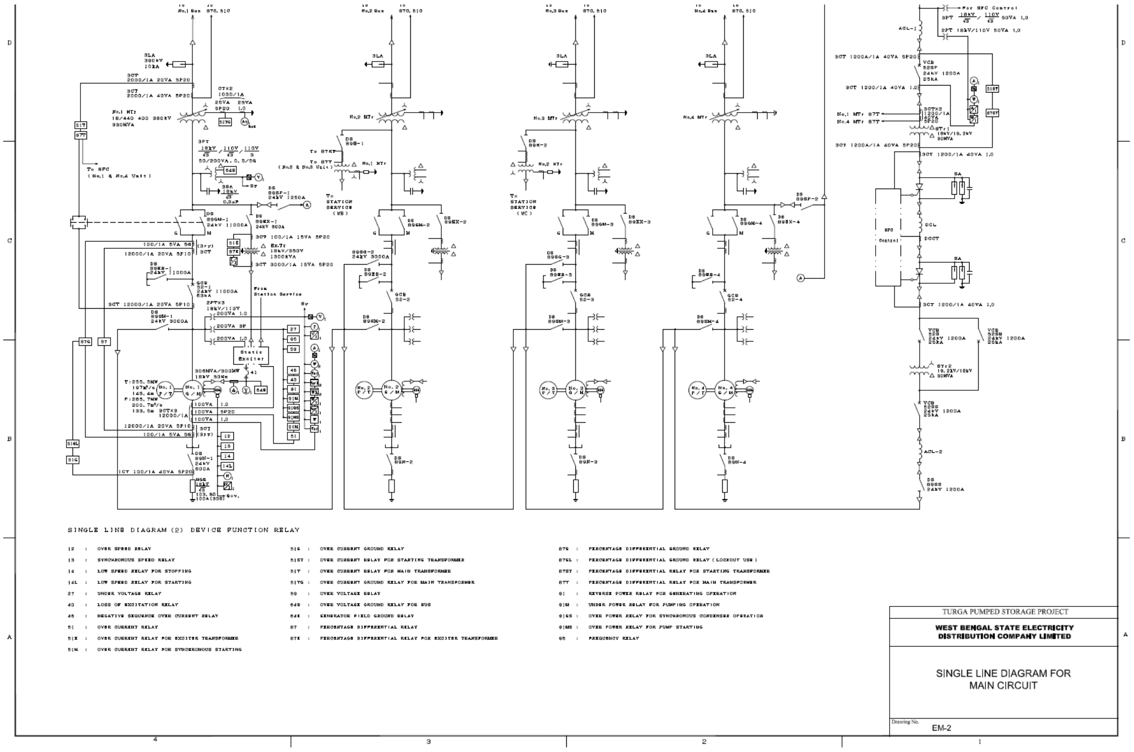

Figure 9.1.7-2 Single Line Diagram For Main Circuit

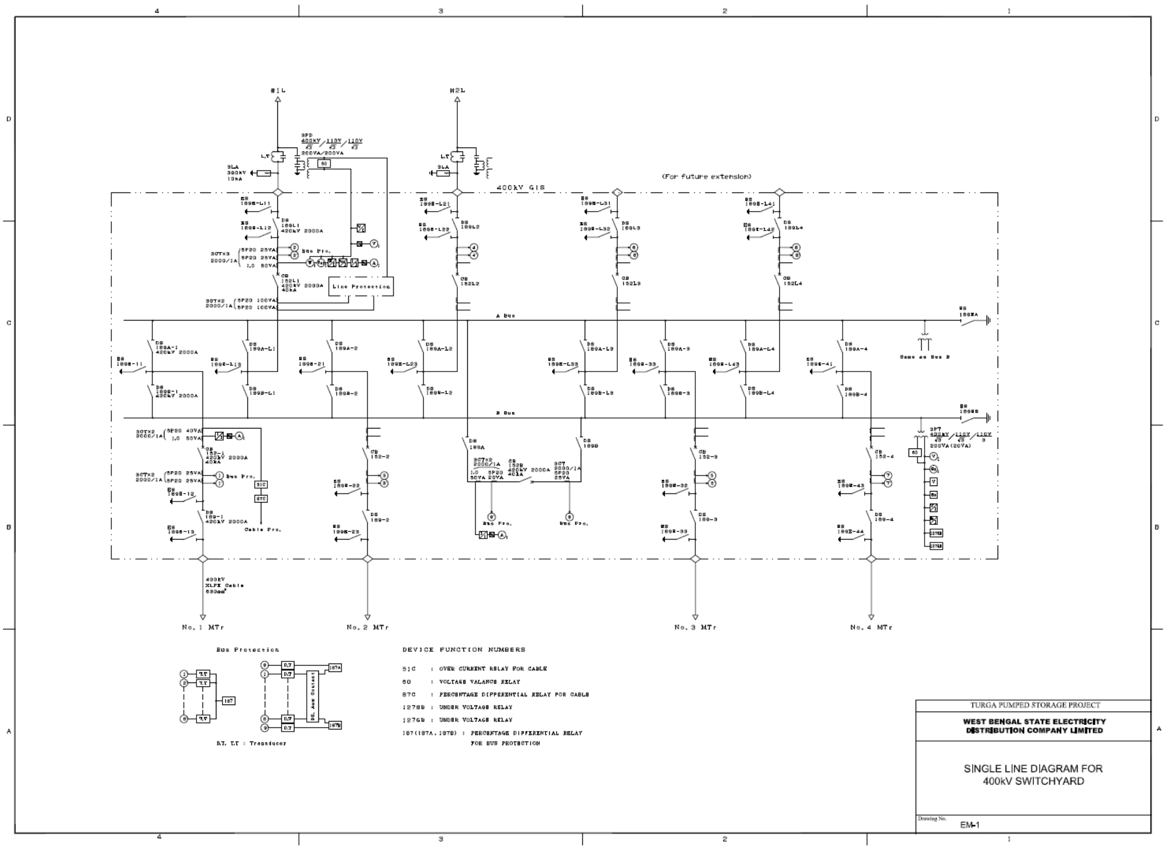

Figure 9.1.7-3 Single Line Diagram for Switchyard

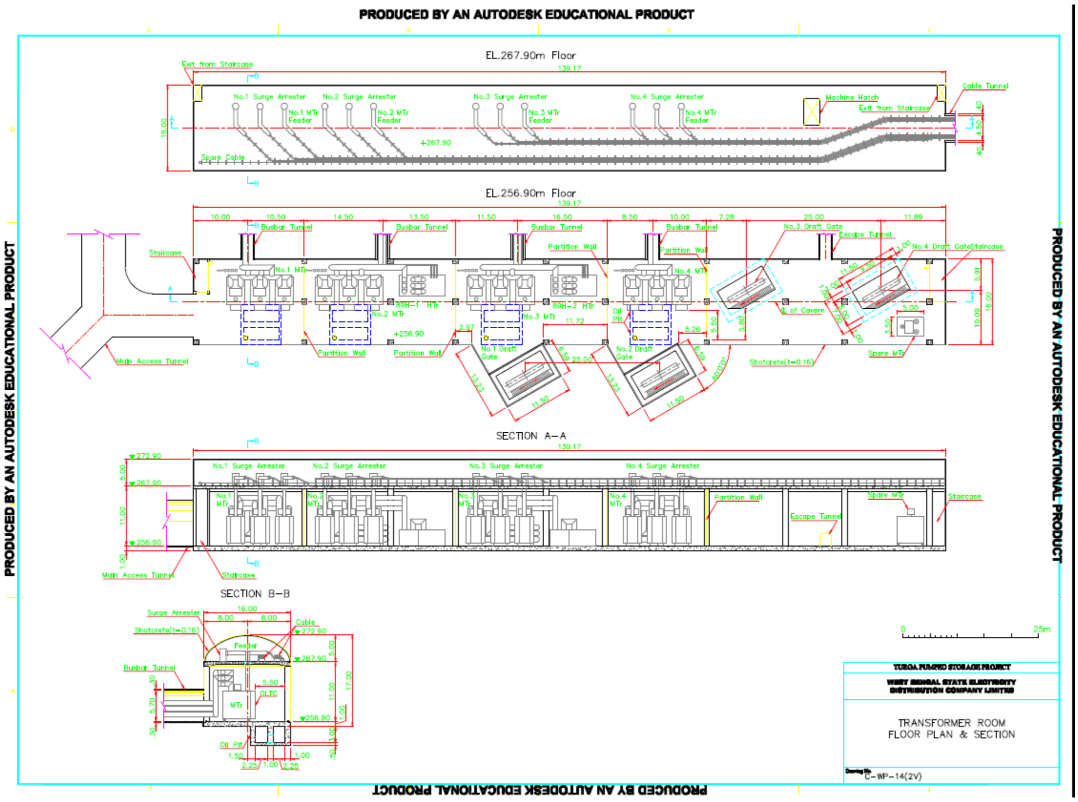

Figure 9.1.7-4 Main Transformer Floor Plan

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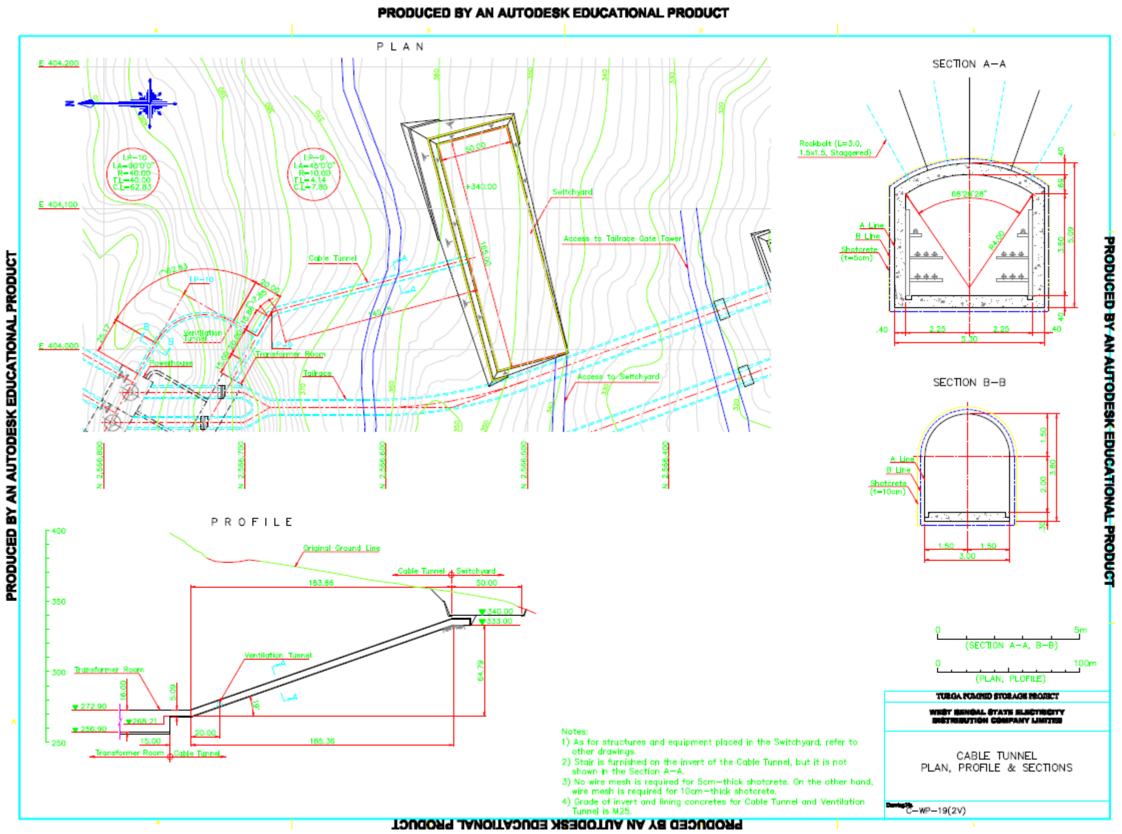

Notes:
1) As for structures and equipment placed in the Switchyard, refer to other drawings.
2) Stair is furnished on the invert of the Cable Tunnel, but it is not shown in the Section A–A.
3) No wire mesh is required for 5cm–thick shotcrete. On the other hand, wire mesh is required for 10cm–thick shotcrete.
4) Grade of invert and lining concretes for Cable Tunnel and Ventilation Tunnel is M25.

Figure 9.1.7-5 Cable Tunnel Plan and Section, Switchyard Plan

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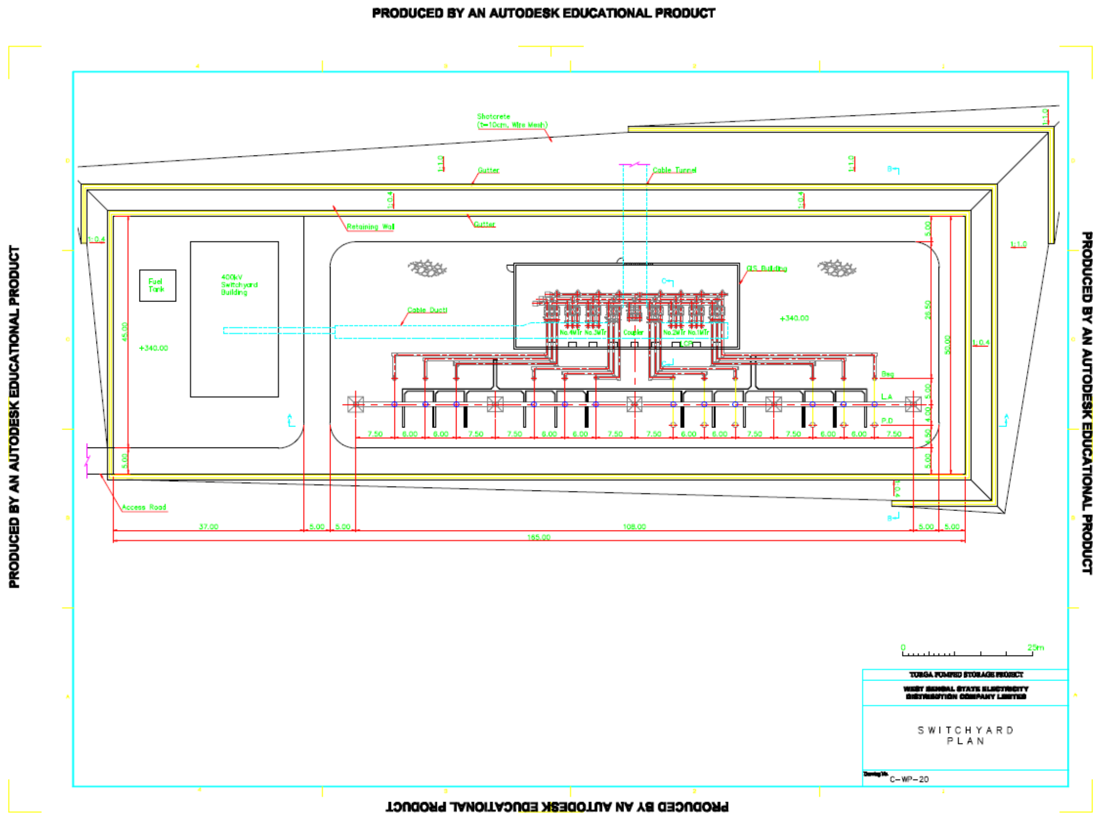


Figure 9.1.7-6 GIS Floor Plan

9.2 INDIAN GOVENRNMENT AND WEST BENGAL STATE POLICY ON VARIABLE PUMPED STORAGE POWER PLANT UTILIZATION

Regarding the Indian government's electricity policy, CEA (Central Electricity Authority) issued Draft National Electricity Plan 2016 (NEP 2016) in December 2016.

This is the review of the electricity policy implemented once every five years based on the Electricity Act enacted in 2003. As a result of hearing of WBSEDCL in the second field survey this year, we ascertained the policy of CEA as it was no change.

In the plan, the renewable energy of India as a whole is 42, 849.38 MW in total as of March 2016, solar (PV), wind power and others. For PV, it is 6,762.85 MW, which is only 16% of the total renewable energy.

However, the plan is to increase renewable energy to 175 GW by 2022, PV will be 100 GW, accounting for 57% of total renewable energy.

The following problems are pointed out when massive introduction of PV among renewable energy progresses.

- Power generation equipment for stabilizing the power system is required due to increase of power supply from unstable power generation system for power grid.
- In case of PV is oversupplied against demand in the daytime, resulting in a reduction in PV capacity factor due to suppression of thermal power generation, pumping power input as demand power, and disconnection of renewable energy.
- Power balance of the power grid will become unbalance due to voltage fluctuation of power distribution system by sudden surplus power increase, and also the risk of power failure will increase due to sudden rise in frequency as well.

Based on the idea that variable-speed pumped-storage power plant of an appropriate scale is effective against the above tasks, CEA will continue to contribute to the suppression of ramping of the power system accompanying the increase in renewable energy WBSEDCL has not changed its policy as well.

The plan for introducing PV at WBSEDCL is as shown in the Table 9.2-1.

It is planned that the amount of PV power plant from 2017 to 2018 will increase to 94 MW, and in 2020 to 387 MW, it is only 0.39% against 100 GW of India as a whole.

On the other hand, the introduction situation and the future plan of WBSEDCL's renewable energy based on RPO (Renewable Purchase Obligation) are as shown in the Table 9.2-2.

While the purchase target of renewable energy from 2015 to 2016 is 5% of the power consumption and 1149.55 MU, the actual amount of electricity purchased is 1381.77 MU, It is understood that electricity purchased is a part of power supply.

Although the purchase status of PV power was only 0.2% in the plan against the purchase obligation

5%, the actual amount of electricity purchased was 78.49 MU of PV, 6.8% of the purchase obligation amount, and 5.7% of the total renewable energy purchased in the year.

In terms of the whole of India, renewable energy is unevenly distributed in the western part, but it can be evaluated as a plan considering procurement of coordination power utilizing interconnection lines.

In West Bengal, although the ratio of renewable energy is lower than that in the western part of India, there is a tendency to increase the supply of PV with respect to electricity demand.

WBSEDCL plans to continue to increase the purchase amount of PV, and in 2021, it is expected to purchase more than twice as much as 298,000 MWh for the purchase obligation amount of 140,000 MWh of RPO.

Table 9.2-1 Cogeneration and Renewable Purchase Obligation and achievement by different licensees under the purview of WBERC for FY2015-2016

SL No.	Distribution Licensees	Total consumption of electricity (in MU)	Target RPO %				Power purchased during the year		RECs purchased during the year		RPO % Met during the year	
			Solar RPO %	Total RPO %	Solar Purchase Obligation (in MU)	Total Purchase Obligation (in MU)	Solar	Non - Solar	Solar	Non Solar	Total	Solar
							(in MU)	(in MU)	(in MU)	(in MU)	(in %)	(in %)
1	WBSEDCL	22991	0.20%	5.00%	45.98	1149.55	78.49	1303.28	0	0	6.01%	0.34%
2	CESC Ltd	9225	0.20%	5.00%	18.45	461.25	1.27	46	0	0	0.51%	0.01%
3	DPL	1903.74	0.20%	5.00%	3.81	95.19	6.02	0	0	0	0.32%	0.32%
4	IPCL	799.13	0.20%	5.00%	1.6	39.96	0.59	0	0	0	0.07%	0.07%
5	DVC	6409	0.20%	5.00%	12.82	320.45	13.39	0	0	1.5	0.23%	0.21%

(source : WBERC (West Bengal Electricity Regulatory Commission) Home Page)

Table 9.2-2 Renewable Purchase Obligation of WBSEDCL

(Not be disclosed per internal corporate information)

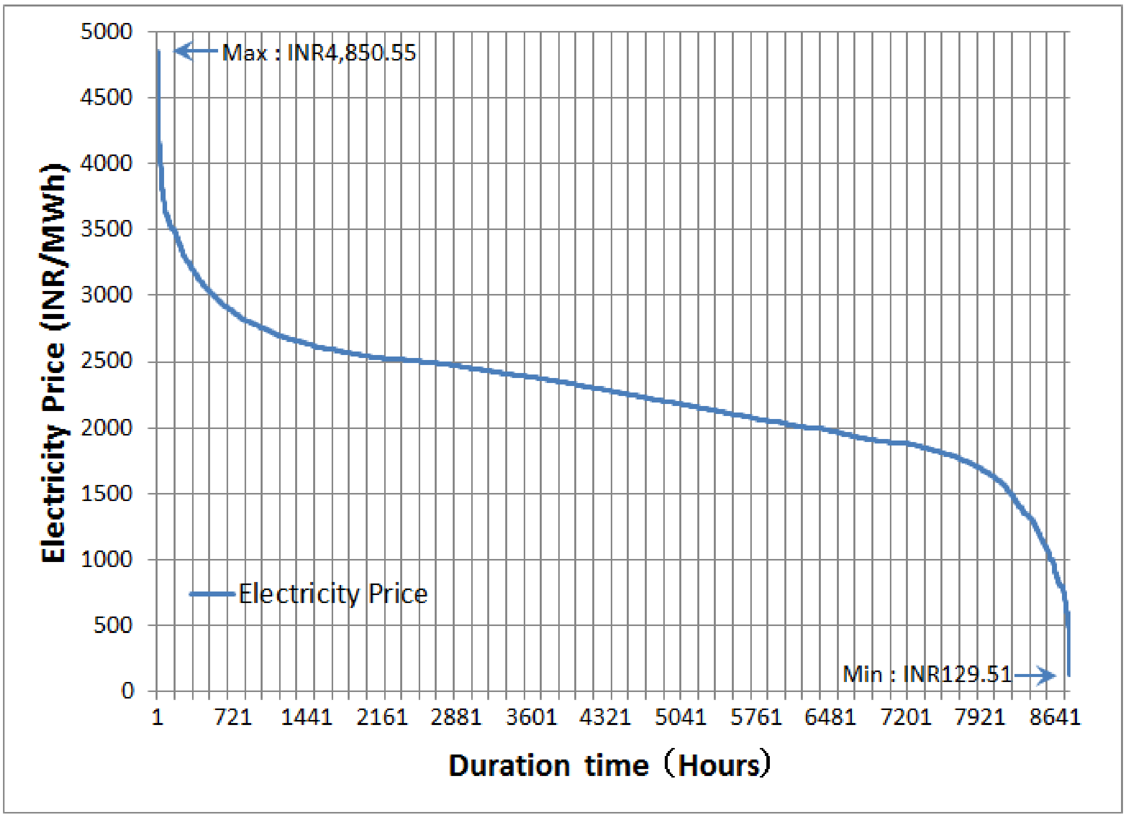
(source : Information Handed Over By WBSEDCL on Nov.27, 2017)

9.3 THE NECESSITY OF PEAK POWER (1,000MW)

9.3.1 Grounds for selection in the DPR

Pursuant to the experience that cost effectiveness is increases as the scale of development increases, installed capacity has been determined as 1,000MW based on peak load duration and water volume that the power station can make the utmost use of its lower reservoir capacity. And the peak load duration supplied by pumped storage power plant (PSP) was estimated as 5 hours per day after commencement of Turga PSP operation in consideration of demand forecast.

As a reason for this assessment, it can be cited that, in addition to needs as peak power plants, the supply-demand structure and the electricity market environment are disposed to making an economical pumping operation possible as surmised from the electricity market price in West Bengal in 2016-17, shown in Figure 9.3.1-1. Generally, the economical operating time per annum of the peak power plants, to which the PSP belongs to, is said to be about 900 to 1,800 hours (about 10-20% of a year) and when one focuses on the top and bottom 10% of actual electricity market prices, which range respectively from INR2,800 to INR4,850 in the top 10% to INR130 to INR1,700 in the bottom 10%, there is a potential to improve the difference in price by about INR2,700 to 3,000 with economical pumping operations.



(source : Compiled by study team based on operational records provided by WBSEDCL, 2018)

Figure 9.3.1-1 Electricity market price records on 2016-17

Checking operation hours of the WBSEDCL-owned Purulia PSP in 2016-17 for reference, it was operating for quite a long time as peak power plants. It was also confirmed, by drawing operation record of the Purulia PSP, system demand and electricity market price in chronological order as in Annexure-1 and 2, that the Purulia PSP was used not only as peak power plants during peak periods almost every day but also as economic pumping operation in accordance with changes in electricity market price.

(Not be disclosed per internal corporate information)

(source : Compiled by study team based on operational records provided by WBSEDCL, 2018)

Figure 9.3.1-2 Operational records of Purulia PSP on 2016-17

As described in 3.2, considering that demand growth rate is expected to be 4-5% annually in the near future, there is a little necessity of 1,000MW as peak power at the commencement of commercial operation of Turga PSP. However, the necessity of peak power will continue for a while, so it can be said that the idea of maximizing development as far as cost effectiveness is not impaired is a certain understanding, as long as a large scale system countermeasures is not required due to constraints of power system, change of interconnection system voltage, etc.

9.3.2 Demand projection and power development plan

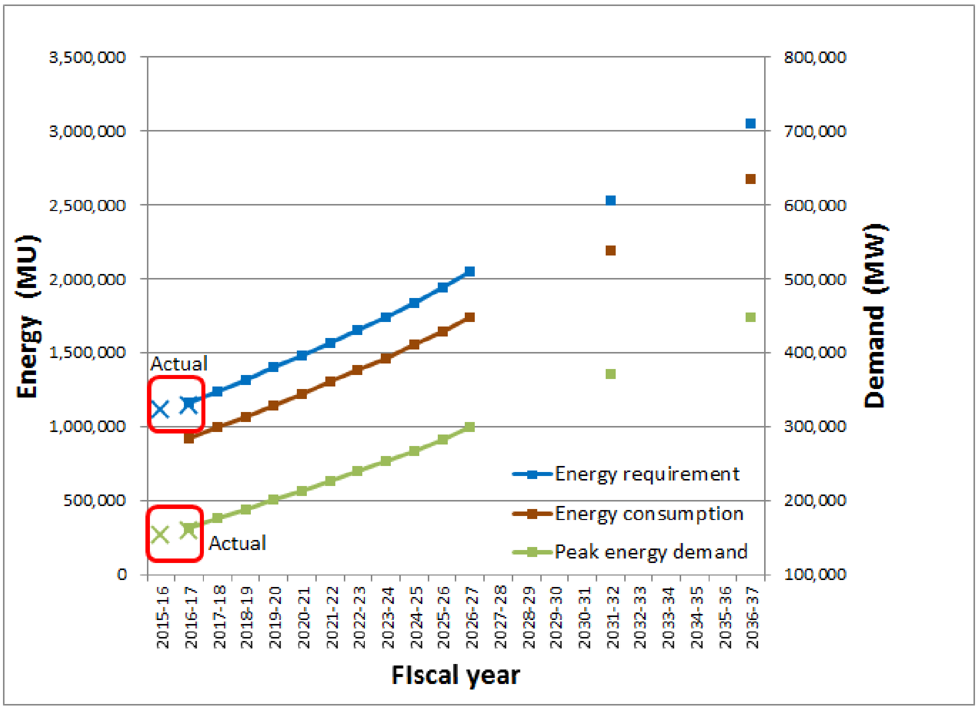
(1) The whole of India

The 19th. Electric Power Survey of India (EPS) was published in January 2017, and it forecasts an electricity demand throughout all of India as shown in Table 9.3.2-1 and Figure 9.3.2-1. A strong growth in energy and peak demands is also expected in the next twenty years as shown in Table 9.3.2-2.

Table 9.3.2-1 Demand projection between FY2016 and FY2036

Particulars	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2031-32	2036-37
Energy requirement		1,160,429	1,240,760	1,317,962	1,399,913	1,483,257	1,566,023	1,650,594	1,739,618	1,836,001	1,939,111	2,047,434	2,530,531	3,049,478
Actual	1,114,408	1,142,929												
Energy consumption		920,837	994,382	1,066,989	1,144,579	1,222,286	1,300,486	1,380,197	1,463,505	1,551,066	1,644,635	1,743,036	2,192,305	2,672,302
Peak energy demand		161,834	176,897	188,360	200,696	213,244	225,751	238,899	252,288	266,844	282,418	298,774	370,462	447,702
Actual	153,366	159,542												

(source : Compiled by study team based on 19th EPS & Load Generation Balance Report (LGBR) 2017-18, CEA, 2017)



(source : Compiled by study team based on 19th EPS & LGBR2017-18, CEA, 2017)

Figure 9.3.2-1 Demand forecast (All India)

Table 9.3.2-2 Compounded annual growth rate (CAGR) of future energy and demand

Particulars	For 5years	For 10years	For 15years	For 20years
Energy requirement	6.99%	7.64%	7.87%	8.14%
Peak energy demand	7.90%	8.46%	8.59%	8.83%

(source : Compiled by study team based on 19th EPS & LGBR2017-18, CEA, 2017)

On the other hand, the draft of the 13th National Electricity Plan (NEP), which is now being finalized, projects power development plan, as shown in Table 9.3.2-3, in line with such a growth in demands and supply capacity is expected to be secured as indicated in Table 9.3.2-4.

Table 9.3.2-3 Power development plan on 19th NEP (Draft)

(Unit : MW)

Fuel type	Actual		Projected capacity by 19th NEP(Draft)				
	on 2016.3	on 2017.3	on 2017.3	on 2021-22	Addition	on 2026-27	Addition
Hydro	42,783	44,478	44,498	59,828	15,330	71,828	12,000
Coal + Lignite	185,173	192,163	198,488	248,513	50,025	248,513	0
Gas	24,509	25,329	25,628	29,968	4,340	29,968	0
Diesel	994	838					
Nuclear	5,780	6,780	7,280	10,080	2,800	14,880	4,800
Sub total (Conventional)	259,238	269,588	275,894	348,389	72,495	365,189	348,389
Wind	26,777	32,280	30,967	60,000	29,034	100,000	40,000
Solar	6,763	12,289	18,763	100,000	81,237	150,000	50,000
Bio Mass	8,110	8,296	5,446	10,000	4,554	17,000	7,000
Small Hydro	4,273	4,380	4,498	5,000	502	8,000	3,000
Sub total (RES)	45,924	57,244	59,674	175,000	115,327	275,000	100,000
Total	305,163	326,833	335,568	523,389	187,822	640,189	448,389

(source : Compiled by study team based on 13th NEP (Draft) & LGBR2017-18, CEA, 2016 & 2017)

Table 9.3.2-4 Load generation balance projection

(Unit : MW)

Particulars	on 2017.3	on 2021-22	on 2026-27
Demand	161,834	225,751	298,774
Installed capacity	335,568	523,389	640,189
Conventional	275,894	348,389	365,189
RES	59,674	175,000	275,000
Difference	173,734	297,638	341,415
Reserve margin	107%	132%	114%

(source : Compiled by study team based on various reports)

In terms of future power developments in India, given the emphasis put on renewable energy resources, no new coal-fired power plant development is planned except for the 50,025MW worth that is currently under construction. The power development plan of conventional power plants for 2017-2027 remains at 39,270MW in total, consisting mainly of 27,330MW worth of hydro power, 4,340MW worth of gas-fired power plants and 7,600MW worth of nuclear power plants, which correspond to a little less than 30% of the 136,940MW increase in demand during that period (65% or 89,295MW including the coal-fired power plants under construction).

Considering the above situation, while the development of renewable energy resources will continue to progress with strong governmental leadership, it is necessary in terms of securing the reliability in electric power supply to make steady progress in the development of conventional power plants. Therefore, a more stable production of electricity can be expected and the Turga PSP, which is already included in the hydroelectric plant development plans, should be developed at the planned capacity (1,000MW).

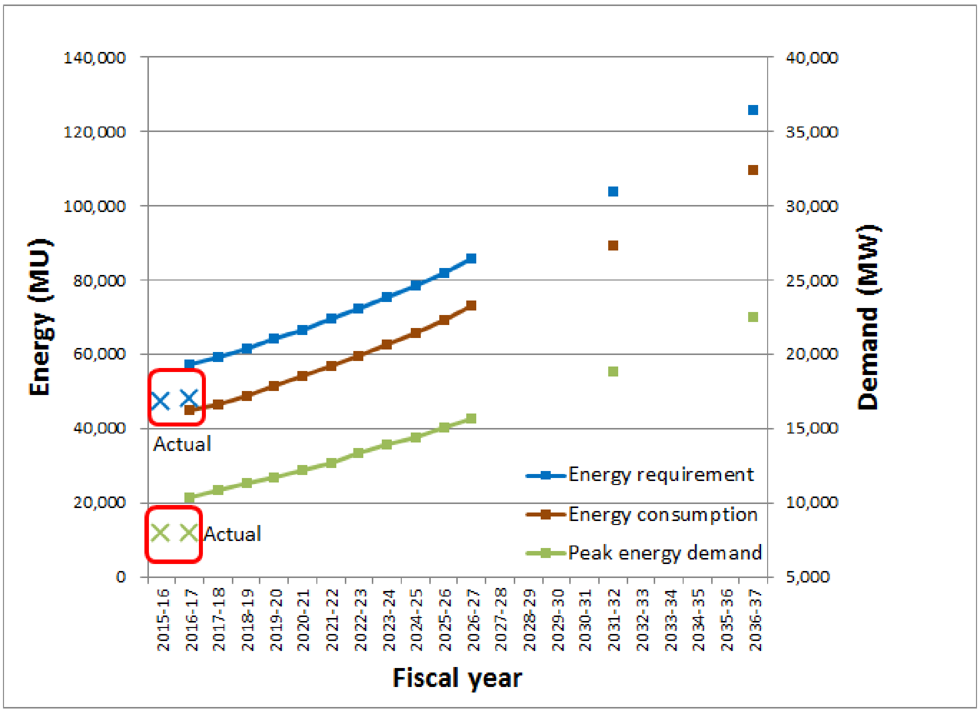
(2) West Bengal state

The 19$^{th.}$ EPS forecasts demand in the state of West Bengal to trend as shown in Table 9.3.2-5 and Figure 9.3.2-2. While the demand seems to be increasing little recently, energy and peak demand in West Bengal is expected to grow steadily over the next twenty years as indicated in Table 9.3.2-6, even though the demand growth rate in West Bengal is lower than what is expected for all of India.

Table 9.3.2-5 Energy and demand projection during FY2016 and FY2036

Particulars	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2031-32	2036-37
Energy requirement		57,342	59,148	61,485	63,979	66,634	69,361	72,222	75,264	78,463	81,915	85,590	103,722	125,708
Actual	47,359	47,949												
Energy consumption		44,710	46,572	48,866	51,334	53,952	56,644	59,493	62,516	65,733	69,176	72,848	89,315	109,504
Peak energy demand		10,383	10,817	11,267	11,724	12,191	12,688	13,318	13,873	14,435	15,065	15,680	18,827	22,461
Actual	7,905	7,931												

(source : Compiled by study team based on 19th EPS & LGBR2017-18, CEA, 2017)



(source : Compiled by study team based on 19th EPS & LGBR2017-18, CEA, 2017)

Figure 9.3.2-2 Demand forecast (West Bengal state)

Table 9.3.2-6 CAGR on future energy and demand

Particulars	For 5years	For 10years	For 15years	For 20years
Energy requirement	4.19%	4.93%	5.39%	5.96%
Peak energy demand	4.44%	5.10%	5.42%	5.82%

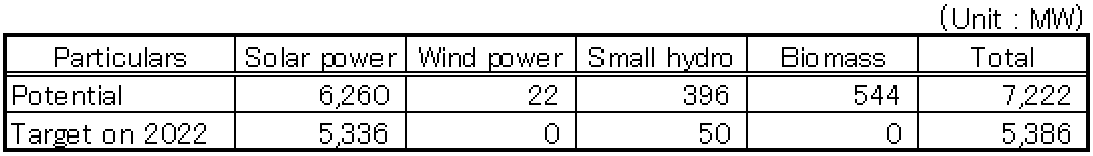
(source : Compiled by study team based on 19th EPS & LGBR2017-18, CEA, 2017)

Even though some revisions may be made to the final version of the 13th. NEP taking into consideration the difference that was found of about 2,500MW (25%) between actual demand and forecasted demand in 2016-17, assuming that the increase in demand for each period is as forecasted, required power development or additional power supply capacity will reach 2,300MW by 2021-22 and 5,300MW by 2026-27.

On the other hand, power development plans in West Bengal state until 2026-27 are only hydroelectric plants and renewable energy resources. Regarding hydroelectric power development, only the Ramman-III project (4×30MW) led by the Central sector is planned, and the other developments are by renewable energy resources consisting mostly of solar power generation as shown in Table 9.3.2-7.

(However, 300MW of thermal power development is listed in the 13th. NEP Vol.2 Transmission)

Table 9.3.2-7 Renewal energy potential and development target in West Bengal state



(Unit : MW)

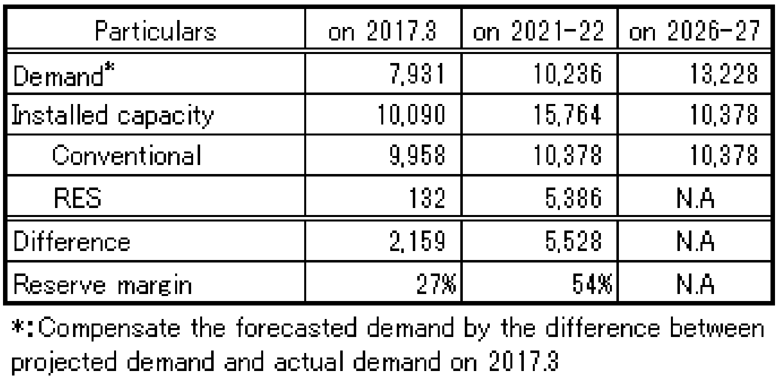
Particulars	Solar power	Wind power	Small hydro	Biomass	Total
Potential	6,260	22	396	544	7,222
Target on 2022	5,336	0	50	0	5,386

(source : Compiled by study team based on 13th NEP (Draft) , CEA, 2016)

As indicated in Table 9.3.2-8, the installed capacity in West Bengal state as of March 31, 2017 was about 10,000MW and it will be able to secure the power supply if power development, including renewable energy resources, are consistently implemented in line with demand forecast. However, as the ratio of renewable energy resources to supply capacity projected by 2021-22 will reach about 35%, when bad weather comes, reserve margin will become almost fully depleted. Moreover since the thermal power plants stop for about 4 months for overhaul and for around 2 weeks to a month for periodic inspection and maintenance as shown in Table 9.3.2-9, available power supply will decrease sharply. Actually, "Load Generation Balance Report 2017-18" (LGBR2017-18) published by CEA records and states that t power supply trouble occurred in year 2016-17, as a result of nearly 20% drop in power supply capacity from 10,090MW down to 7,886MW.

In addition, as about 75% of available renewable energy resources will be developed by 2021-22, there remains no potential for further development by 2026-27 and even if all remaining resources can be fully developed, reserve margin will fall to 30%. Therefore, taking into account the above-stated weather condition risk and also scheduled outage of thermal power plants for inspection and maintenance, it is expected to increase the amount of power purchase from elsewhere unless power development is additionally carried out in the period from 2022 to 2027.

Table 9.3.2-8 Load generation balance projection



Particulars	on 2017.3	on 2021-22	on 2026-27
Demand*	7,931	10,236	13,228
Installed capacity	10,090	15,764	10,378
Conventional	9,958	10,378	10,378
RES	132	5,386	N.A
Difference	2,159	5,528	N.A
Reserve margin	27%	54%	N.A

*: Compensate the forecasted demand by the difference between projected demand and actual demand on 2017.3

(source : Compiled by study team based on various reports)

Table 9.3.2-9 Maintenance schedule of conventional plants in 2016-17 (Eastern Region)

Station / System/ State	Unit Number	Capacity (MW)	Start Date	End Date	No. of Maintenance Days	Reason
EASTERN REGION						
BSPTCL MTPS (KUNL)	1	110	15.06.16	15.07.16	31	Overhaul
BSPTCL BTPS	6	105	01.04.16	31.12.16	275	Under S/D since 18.03.12 for R&M work (CEA shown gen. from Jan'17)
BSPTCL BTPS	7	105	01.04.16	30.09.16	183	Under S/D since 22.08.06 for R&M work (CEA shown gen. from Oct'16)
JUSNL PTPS	4	40	01.04.16	31.03.17	365	Maintenance
JUSNL PTPS	6	90	01.04.16	31.03.17	365	Maintenance
JUSNL PTPS	7	105	01.04.16	31.03.17	365	Maintenance
JUSNL PTPS	9	110	01.04.16	30.09.16	183	Maintenance (CEA shown gen. from Oct'16)
JUSNL TVNL, Tenughat	1	210	01.06.16	15.07.16	45	Unit Overhauling
JUSNL TVNL, Tenughat	2	210	01.08.16	15.09.16	46	Unit Overhauling
DVC MTPS	1	210	05.06.16	05.07.16	31	AOH & Boiler Acid cleaning
DVC MTPS	2	210	01.08.16	16.08.16	16	Burner Replacement
DVC MTPS	4	210	01.11.16	21.11.16	21	AOH
DVC MTPS	5	210	14.09.16	29.09.16	16	Burner Replacement
DVC MTPS	6	210	02.12.16	11.01.17	41	COH
DVC MTPS	7	500	22.01.17	06.02.17	16	Burner Replacement
DVC MTPS	8	500	02.05.16	27.05.16	26	AOH (Blr, TGbpp, LPT, Gen)
DVC BTPS'B	1	210	20.08.16	29.09.16	41	COH
DVC BTPS'B	2	210	01.07.16	21.07.16	21	AOH
DVC BTPS'B	3	210	22.10.16	06.11.16	16	Burner Replacement
DVC CTPS	1	130	20.05.16	29.06.16	41	COH
DVC CTPS	2	130	02.04.16	17.04.16	16	Burner Replacement
DVC CTPS	3	130	23.08.16	12.09.16	21	AOH
DVC CTPS	7	250	22.02.17	14.03.17	21	AOH
DVC CTPS	8	250	15.07.16	30.07.16	16	Burner Replacement
DVC DTPS	4	210	14.02.17	26.03.17	41	COH
DVC DSTPS	1	500	02.04.16	27.04.16	26	AOH (Blr, TGbpp, LPT, Gen)
ODISHA TTPS	1	60	09.11.16	23.11.16	15	Boiler Overhaul
ODISHA TTPS	2	60	13.07.16	27.07.16	15	Boiler Overhaul
ODISHA TTPS	3	60	14.10.16	28.10.16	15	Boiler Overhaul
ODISHA TTPS	4	60	05.08.16	19.08.16	15	Boiler Overhaul
ODISHA TTPS	5	110	15.06.16	04.07.16	20	Boiler Overhaul
ODISHA TTPS	6	110	25.08.16	29.09.16	36	BOH+COH of Tur.+IP Rot. Rep.+OH of HP mod.+ESP-III addition & ESP-I isolation
ODISHA TTPS			17.03.17	23.03.17	7	ESP-I normalisation
ODISHA IB TPS	2	210	05.07.16	25.07.16	21	Annual maintenance
WBPDCL KTPS	1	210	01.08.16	05.09.16	36	B-T-G
WBPDCL KTPS	2	210	15.01.17	21.01.17	7	Boiler License
WBPDCL KTPS	3	210	15.07.16	21.07.16	7	Boiler License
WBPDCL KTPS	4	210	01.06.16	10.07.16	40	GT Recommissioning
WBPDCL KTPS	5	210	20.12.16	09.01.17	21	Boiler Overhauling
WBPDCL Bakreswar TPS	2	210	21.08.16	20.09.16	31	Boiler Overhauling + APH Tube Replacement
WBPDCL Bakreswar TPS	3	210	06.11.16	11.12.16	36	B-T-G + RLA + TPR (EHG) Upgrade
WBPDCL Bandel TPS	1	60	01.02.16	31.05.16	121	RLA + BTG Overhauling
WBPDCL Bandel TPS	3	60	01.07.16	30.10.16	123	RLA + BTG Overhauling
WBPDCL Bandel TPS	4	60	01.12.16	31.03.17	122	RLA + BTG Overhauling
WBPDCL Santaldih TPS	5	250	01.12.16	07.12.16	7	Boiler License
WBPDCL Santaldih TPS	6	250	01.06.16	05.07.16	35	B-T-G
WBPDCL Sagarighi TPS	1	300	01.11.16	30.11.16	30	Boiler Overhauling
WBPDCL Sagarighi TPS	2	300	10.12.16	17.12.16	8	Boiler License
CESC BUDGE-BUDGE	1	250	22.12.16	28.12.16	7	Annual Overhauling
CESC BUDGE-BUDGE	2	250	29.12.16	12.01.17	15	Annual Overhauling
CESC BUDGE-BUDGE	3	250	15.01.17	29.01.17	15	Annual Overhauling
CESC TITAGARH	1	60	18.11.16	02.12.16	15	Annual Overhauling
CESC TITAGARH	2	60	11.01.17	14.01.17	4	Hydraulic Test
CESC TITAGARH	3	60	30.10.16	02.11.16	4	Hydraulic Test
CESC TITAGARH	4	60	03.11.16	17.11.16	15	Annual Overhauling
CESC SOUTHERN	1	67.5	03.12.16	06.12.16	4	Hydraulic Test
CESC SOUTHERN	2	67.5	07.12.16	21.12.16	15	Annual Overhauling
HEL HALDIA	1	300	01.12.16	15.12.16	15	Annual Overhauling / Boiler Overhauling
HEL HALDIA	2	300	01.02.17	15.02.17	15	Annual Overhauling / Boiler Overhauling
DPL DPPS	6	110	01.04.16	31.03.17	365	Continuing since previous year (No gen. shown by CEA)
DPL DPPS	7	300	01.12.16	31.12.16	31	Boiler Overhauling
DPL DPPS	8	250	10.01.17	09.02.17	31	Boiler Overhauling
NTPC FSTPS	1	200	27.05.16	10.07.16	45	Boiler+ESP R&M+HP-IP-LPT+Gen
NTPC FSTPS	3	200	06.04.16	20.05.16	45	Boiler OH+ESP R&M
NTPC FSTPS	5	500	15.11.16	19.12.16	35	Boiler OH+LPT OH+Gen OH+DDCMIS R&M
NTPC KhSTPS	3	210	01.06.16	05.07.16	35	Capital+DDCIMS+Boiler RLA+Boiler Acid Cleaning
NTPC KhSTPS	4	210	08.11.16	12.12.16	35	Capital+Gen+DDCIMS
NTPC KhSTPS	5	500	01.05.16	30.05.16	30	Boiler+PAPH-5B Turnion Shat Replacement
NTPC KhSTPS	7	500	15.08.16	18.09.16	35	Capital+ Gen.
NTPC Barh	4	660	25.08.16	23.09.16	30	Boiler+Cond. Acid Clean+IP-LP crossover pipe metalic gasket rep.
NTPC TSTPS	2	500	20.10.16	18.11.16	30	Boiler
NTPC TSTPS	5	500	25.07.16	18.08.16	25	Boiler+ESP R&M
NTPC TSTPS	6	500	06.06.16	10.07.16	35	Boiler+RH Modification+ESP R&M
IPP GMR	1	350	06.07.16	30.07.16	25	Boiler Overhauling
IPP GMR	3	350	06.09.16	30.09.16	25	Boiler Overhauling
IPP JITPL	1	600	16.09.16	28.09.16	13	Minor Overhauling
IPP JITPL	2	600	16.05.16	28.05.16	13	Minor Overhauling
IPP VEDANTA (SSL)	1	600	15.08.16	15.09.16	32	Annual Overhauling
IPP VEDANTA (SSL)	2	600	01.07.16	30.07.16	30	Annual Overhauling
IPP MPL	2	525	Mid Aug'16	Mid Sep'16	30 (Approx.)	No info. received from MPL. S/D shown based on CEA gen. target trend
IPP APNRL	1	270	01.07.16	31.07.16	31	Gen. Overhauling
IPP APNRL	2	270	15.10.16	14.11.16	31	Gen. Overhauling

(source : LGBR2016-17, CEA, 2016)

Accordingly, although the demand-supply balance in West Bengal seems to be secured, if the construction of new thermal power stations, especially coal-fired power plants, is stopped in accordance with India’s national electricity plan, power supply trouble is expected to occur after 2022, even though development of renewable energy resources is planned. Under such circumstances and taking into account the situation in West Bengal where there is little possibility for future hydroelectric power development, and difficulty in gas-fired power development due to the underdevelopment in gas infrastructure, it can be said that it is indispensable to develop the Turga PSP for securing power supply capacity and stable power supply.

9.3.3 The necessity of pumped-storage power equipment

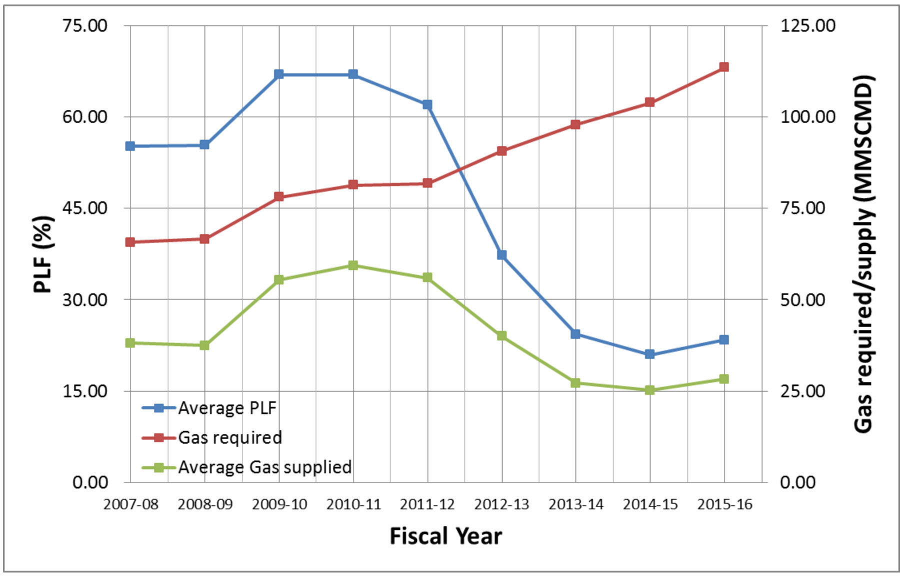
The 13th. NEP (Draft) includes an ambitious plan to increase the capacity ratio of future renewable energy resources, excluding large-scale hydroelectric, to 33% in 2021-22 and as much as 43% by 2026-27. To realize such a plan, besides the network reinforcement, improvements of output prediction accuracy from renewable energy resources, market design, utilization of demand response, etc., flexibility in conventional power resources is recognized as being imperative and, in particular, expectations are placed on hydroelectric power, PSP and gas-fired power generation.

However, future development in gas-fired power generation will amount only to 4,340MW, and as a result, its share in power supply capacity is small (Table 9.3.3-1). In addition, gas-fired power generation has a low priority in India in terms of gas allocation because of the gas distribution policy of the Ministry of Petroleum and Natural Gas which prioritizes gas conversion for automotive energy and city gas supply in order to reduce government subsidies for household LPG. Besides that, there is issues regarding gas-related infrastructure, such as the delay in the construction of pipeline for LNG terminals, and consequently the actual utilization rate of gas-fired power plants is very low as shown in Figure 9.3.3-1.

Table 9.3.3-1 Likely installed capacity by end of 2026-27

Installed capacity	Unit	Actual on 2017.3	Projected on 2021-22	Projected on 2026-27
Total	MW	335,568	523,389	640,189
Gas	MW	25,628	29,968	29,968
	%	7.6	5.7	4.7
RES	MW	59,674	175,000	275,000
	%	17.8	33.4	43.0

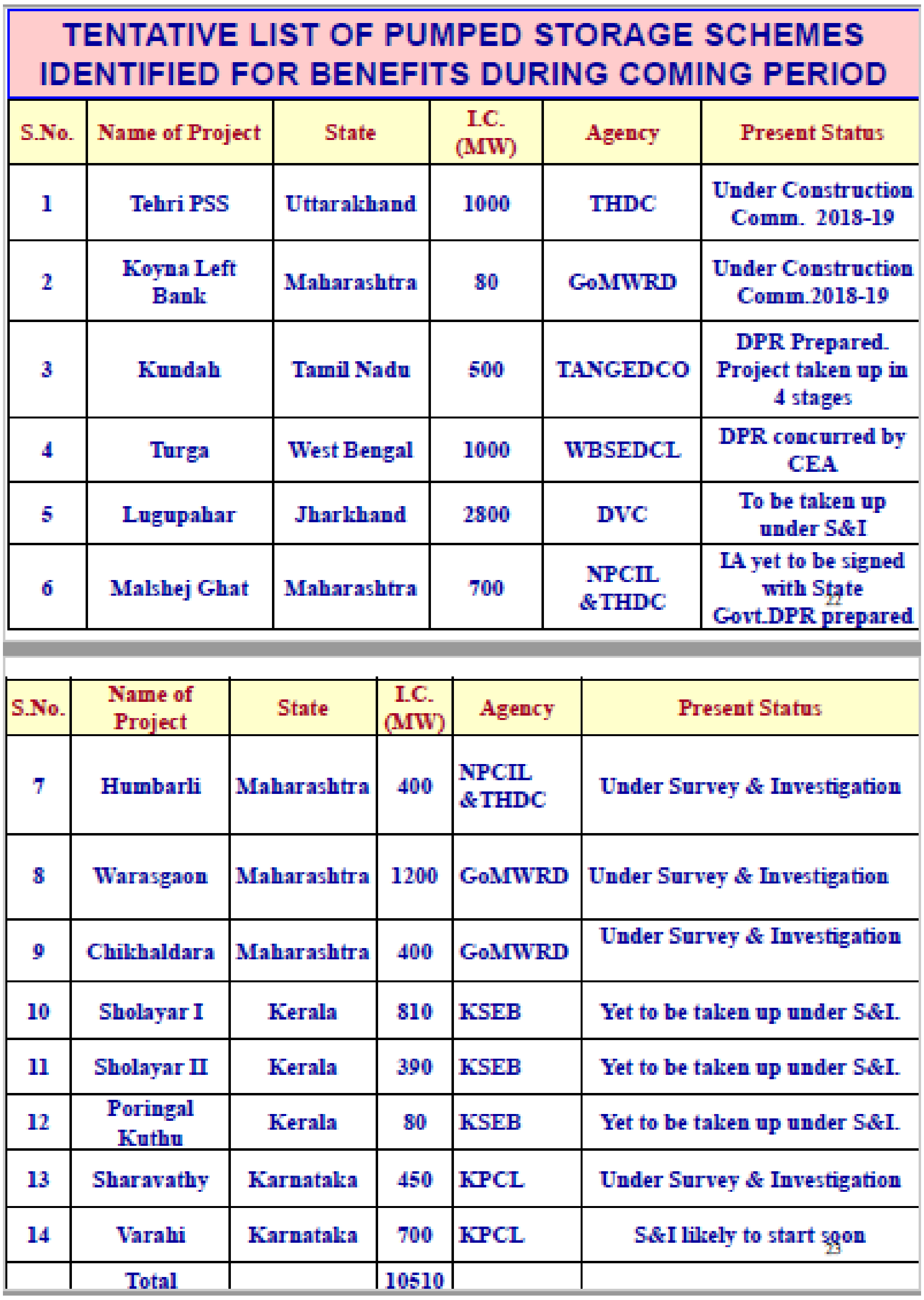
(source : Compiled by study team based on 13th NEP ((Draft , CEA, 2016)



(source : Compiled by study team based on 13th NEP (Draft) , CEA, 2016)

Figure 9.3.3-1 Trend of Plant Load Factor (PLF) of Gas based power plants

On the other hand, in terms of PSP, 9 projects in total capacity of 4,786MW have already been developed, of which 2,600MW (5 projects) are being operated. However, for another 4 projects, 2,186MW, the operation has not been started due to delay in lower reservoir construction work and vibration issues. According to the material for “Operationalization of existing pump storage plants” event organized by the CEA on June 28, 2017, it was stated that there is development potential for 63 sites of pumped-storage power station in total capacity of 96,524MW. However, there are only a few development plans that are expected to become projects and expected power development capacity by 2027 is quite small. Therefore, it can be said that 2 projects in total capacity of 1,080MW, currently in progress and this Turga PSP project approved in the DPR are positioned as valuable energy storage projects.



TENTATIVE LIST OF PUMPED STORAGE SCHEMES IDENTIFIED FOR BENEFITS DURING COMING PERIOD

S.No.	Name of Project	State	I.C. (MW)	Agency	Present Status
1	Tehri PSS	Uttarakhand	1000	THDC	Under Construction Comm. 2018-19
2	Koyna Left Bank	Maharashtra	80	GoMWRD	Under Construction Comm.2018-19
3	Kundah	Tamil Nadu	500	TANGEDCO	DPR Prepared. Project taken up in 4 stages
4	Turga	West Bengal	1000	WBSEDCL	DPR concurred by CEA
5	Lugupahar	Jharkhand	2800	DVC	To be taken up under S&I
6	Malshej Ghat	Maharashtra	700	NPCIL &THDC	IA yet to be signed with State Govt.DPR prepared
7	Humbarli	Maharashtra	400	NPCIL &THDC	Under Survey & Investigation
8	Warasgaon	Maharashtra	1200	GoMWRD	Under Survey & Investigation
9	Chikhaldara	Maharashtra	400	GoMWRD	Under Survey & Investigation
10	Sholayar I	Kerala	810	KSEB	Yet to be taken up under S&I.
11	Sholayar II	Kerala	390	KSEB	Yet to be taken up under S&I.
12	Poringal Kuthu	Kerala	80	KSEB	Yet to be taken up under S&I.
13	Sharavathy	Karnataka	450	KPCL	Under Survey & Investigation
14	Varahi	Karnataka	700	KPCL	S&I likely to start soon
	Total		10510		

(source : Presentation materials of aforementioned meeting held by CEA on 28th June, 2017)

Figure 9.3.3-2 Tentative list of Pumped Storage Schemes

According to Annexure-1 showing the power demand trend in West Bengal over the year of 2016, it shows the characteristic that the peak demand appears in the lighting time zone. Especially in the 4-months from October to January, the demand at the off-peak time decreases up to 50% of the peak demand, as shown in Figure 9.3.3-3. The 19th. EPS assumes that even when Demand supply management (DSM), energy conservation and improvement of efficiency are taken into account, this trend would persist even into the future. As a result, it estimates that the load factor in West Bengal is about 60%, while that across all of India is maintained around 80%.

(Not be disclosed per internal corporate information)

(source : Compiled by study team based on operational records provided by WBSEDCL)

Figure 9.3.3-3 Operational record during Dec. 23rd - 29th, 2016

As shown in Figure 9.3.3-4, sorting the actual power demand of West Bengal in 2016 in descending order as a load duration curve, it can be confirmed that load factor of West Bengal is low. The load duration curve shows a gradual downward-sloping trend which corroborates the statement “the ratio of base load power plants to peaking power plants should be 40:60 and as a way to attain it, PSP is effective” made by WBSEDCL at the ”Operationalization of existing pump storage plants” event held by CEA on June 28, 2017.

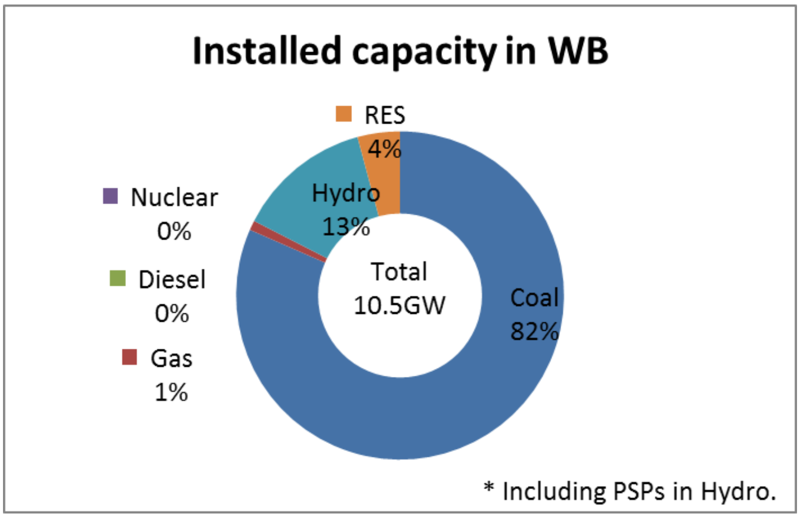
In general, the load duration curve rises as demand increases, but as the curve does not uniformly increase and the high load zone tends to increase more than the low load zone, it will change to a steeper descent curve. An effective way to respond to such a change is a well-balanced development of base load, middle and peaking power sources, as is done in Japan, for example. However, in the Eastern Region and West Bengal, there is very few room for middle power source developments because of their low potential in gas-fired power generation. Then, they have no alternative but to either combine coal-fired thermal power plants and PSPs that are under their jurisdiction or to procure electricity from elsewhere in order to satisfy the peak demand. Under these circumstances, WBSEDCL seems to count on the development of PSP as stated above.

(Not be disclosed per internal corporate information)

(source : Compiled by study team based on operational records provided by WBSEDCL, 2017)

Figure 9.3.3-4 Actual load duration curve of West Bengal in 2016

Furthermore, given that the current energy mix in West Bengal consists mostly of coal-fired thermal plants, as shown in Figure 9.3.3-5, and most of the power sources that is planned to be developed in the future is limited to solar power generation. Therefore, in order to cope with the rapid increase in demand towards the lighting time zone, there are not so many power sources that can start-up in a short time or with high ramp rate.



(source : Compiled by study team based on all India installed capacity (in MW) of power stations (As on 31.01.2018) , CEA, 2018)

Figure 9.3.3-5 Installed capacity in West Bengal state (31st Jan., 2018)

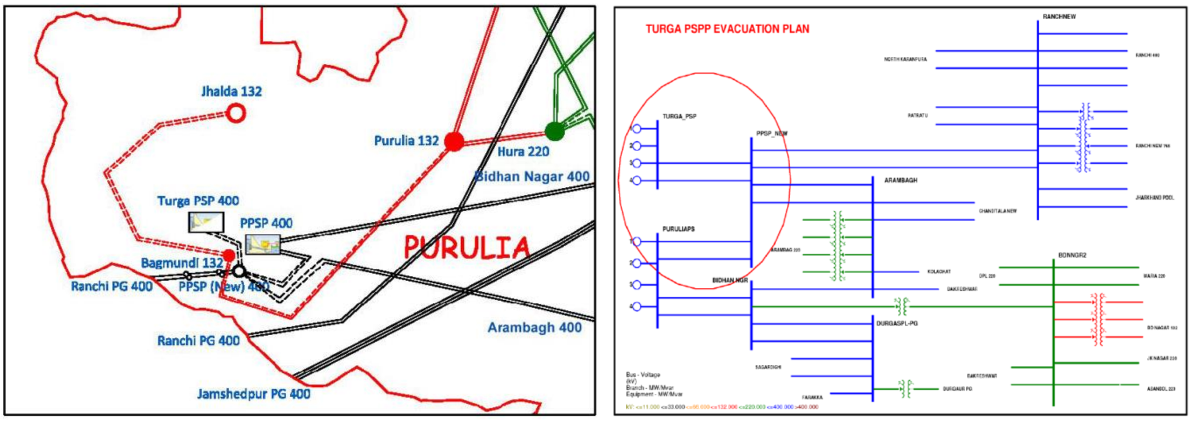
Demand will increase in the future, while the load factor will stay pretty much the same. This means that load-following from low load time zones to lighting peak time zones will become much harder. Considering that in West Bengal there is hardly any potential for development in gas-fired power generation nor hydroelectric power generation, it can be said, based on the future demand forecast, that the development of Turga PSP is indispensable for stable demand/supply operation in West Bengal, because it can improve load factor and provide regulation capacity through its high ramp up/down capability and quick start-up function.

9.3.4 Transmission development plan

Details of the transmission development plan in West Bengal are as stated in 3.2.4 "Transmission plan". According to this plan, the reinforcement of the power system in response to the steady growth in demand and measure for apparent transmission congestion are planned and implemented.

On the other hand, power evacuation system of Turga PSP to the extra-high voltage system of West

Bengal stays the same as that of the DPR and it is planned as shown in Figure 9.3.4-1.



(source : Detailed Project Report (DPR) of Turga Pumped Storage Power Plant, WBSEDCL, 2016)

Figure 9.3.4-1 Power evacuation system from Turga PSP

In regard to the interconnection of Turga PSP, it was recommended the construction of the following transmission development in the DPR. Currently, (a), a new switching substation, (b) and (d), a 400kV transmission line, have already been constructed, and the remaining (c) has not been developed yet. But they are already listed in the $13^{th.}$ NEP (Draft), so that it is expected that they will be constructed and operational by FY2021.

(a) Establishment of new 400kV switching substation PPSP (New) near Purulia PSP

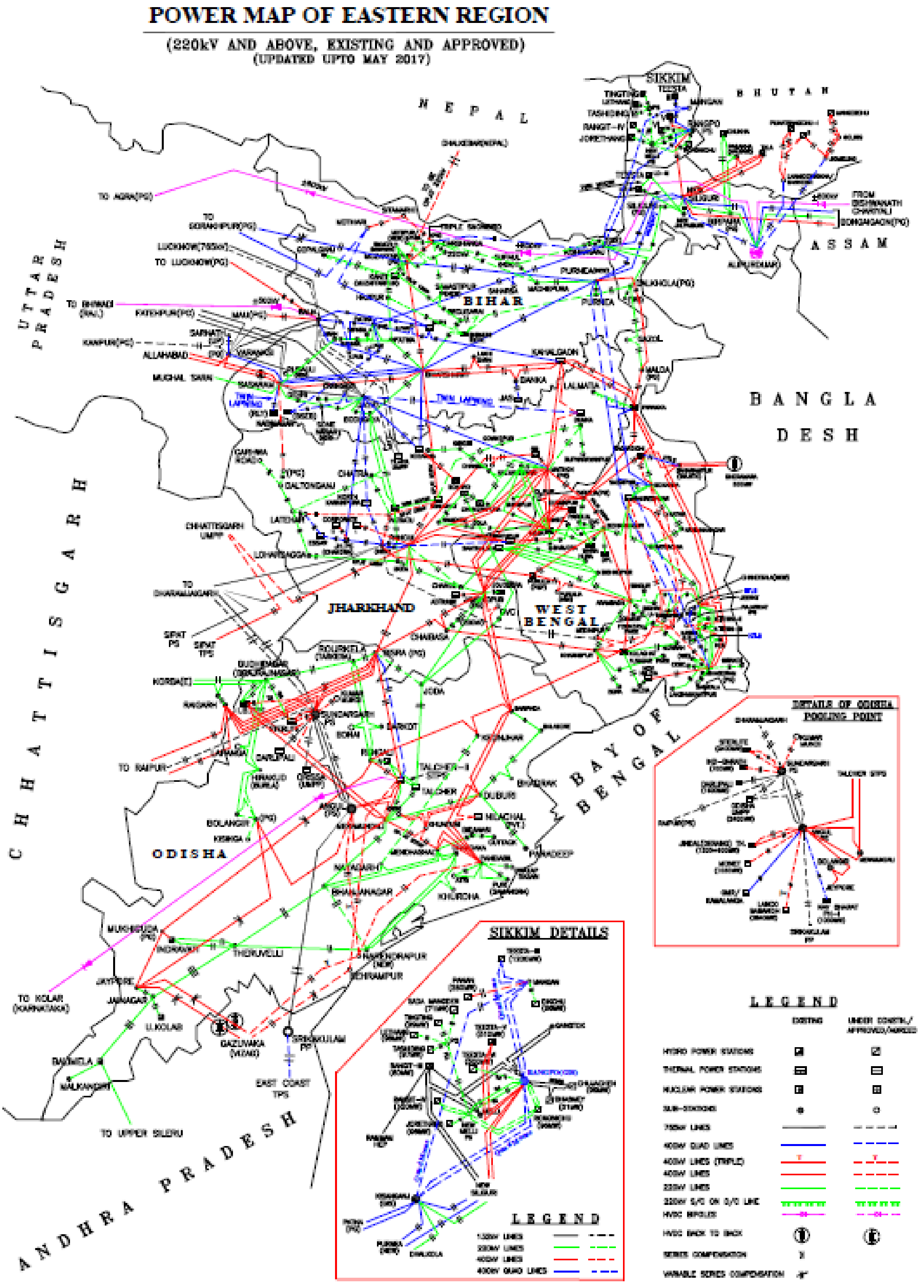
(b) Loop-in Loop-out (LILO) of Purulia PSP-Arambagh 400kV D/c line at PPSP (New) S/s

(c) Turga PSP-PPSP (New) 400kV D/c line

(d) Termination of Ranchi (New) -Purulia PSP 400kV D/c line at PPSP (New) 400kV switching substation

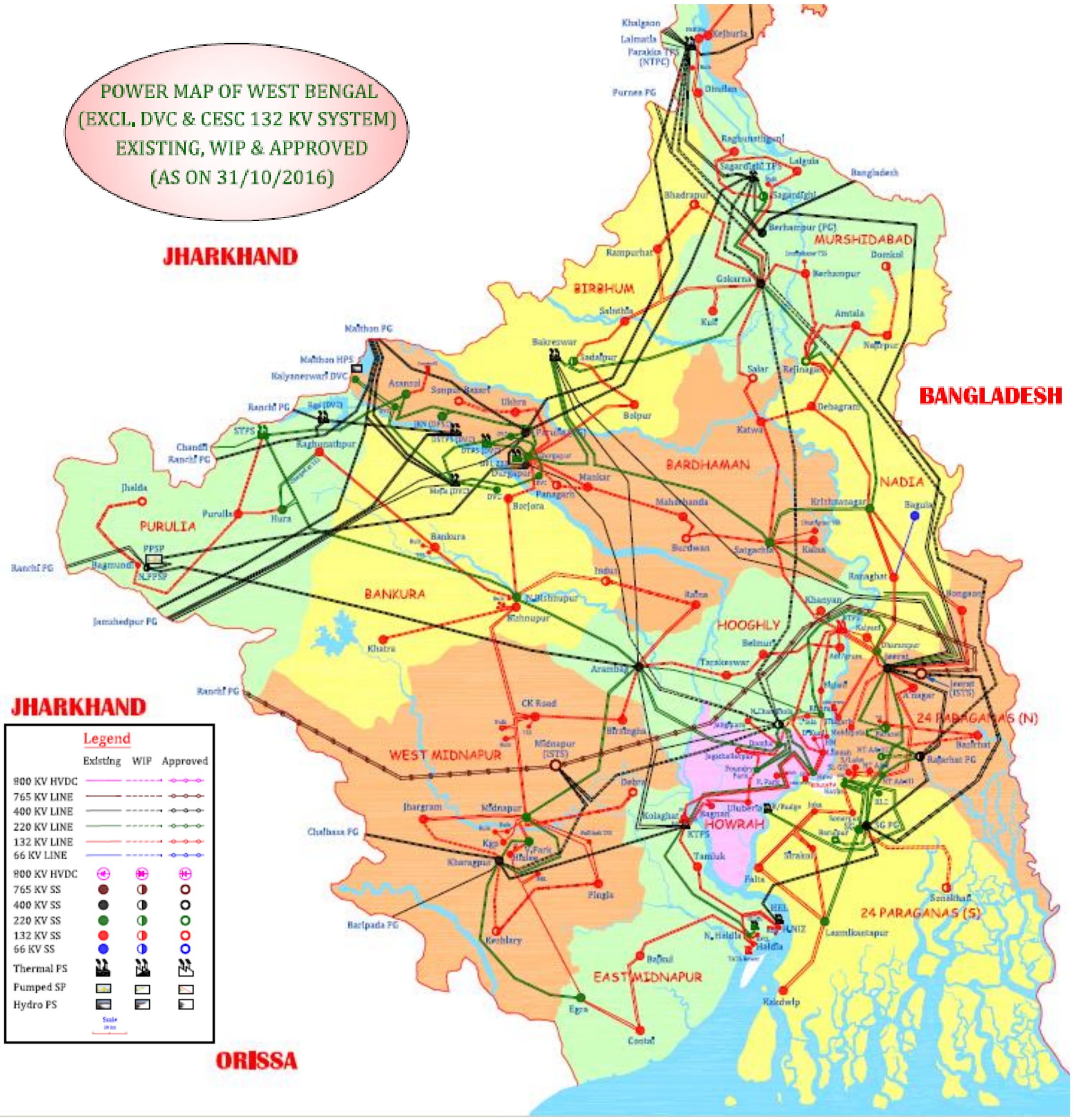
And, in the case of transmission line outage (N-1 condition), since the grid around the Turga PSP will be overloaded especially when pumping operations are conducted in off-peak periods, the construction of the following new 400kV transmission lines was suggested in the DPR. However, this equipment is not listed in the $13^{th.}$ NEP (Draft). This is because, India's "Manual on Transmission Planning Criteria" (CEA, 2013 Jan.) provides that the power system analysis necessary to prepare the transmission development plan may be carried out on a 3 to 5 year span considering that the period generally required for transmission lines to start operating is 4 to 5 years. Therefore, it is necessary to confirm the progress of future development while considering the start period of the Turga PSP operation.

The latest power map of West Bengal and Eastern Region obtained through this study are shown below.



(source : CEA homepage, 2018)

Figure 9.3.4-2 Power Map of Eastern Region



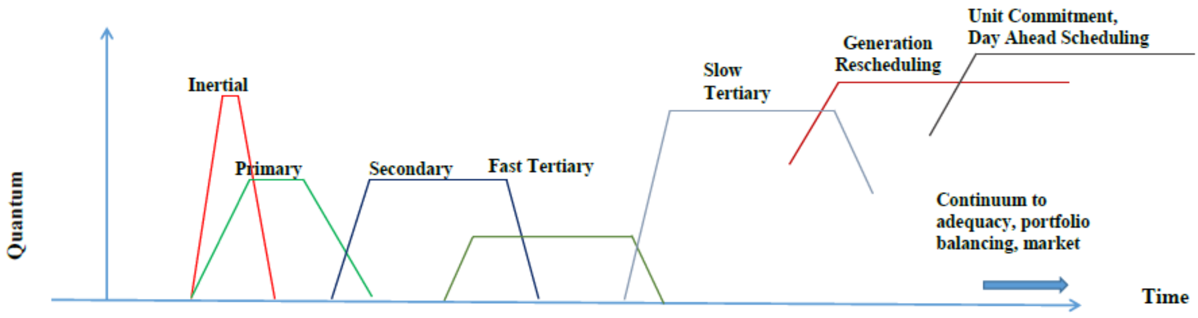
(source : Compiled by study team based on WBSETCL homepage, 2018)

Figure 9.3.4-3 Power Map of West Bengal around Turga PSP site

9.4 ADVANTAGES OF FREQUENCY CONTROL FUNCTION DURING PUMPING OPERATION

9.4.1 The frequency control system and its profile in India

There are two kind of frequency control system in India, one is governor-free function (primary control) that restores the demand/supply mismatch due to sudden generator tripping or load shedding after several seconds. The other is Reserve Regulation Ancillary Service (RRAS, tertiary control) which is activated to control specific generator output manually when it comes to predetermined conditions such as abnormally weather conditions or frequency deviation beyond the operational criteria, etc. But the Automatic Generation Control (AGC, secondary control) function which performs on-line frequency control for the control area and reverts the governor control back to its initial state after disturbance, has not yet been introduced, and it is in the stage of conducting the demonstration test using pilot plant since 2017.

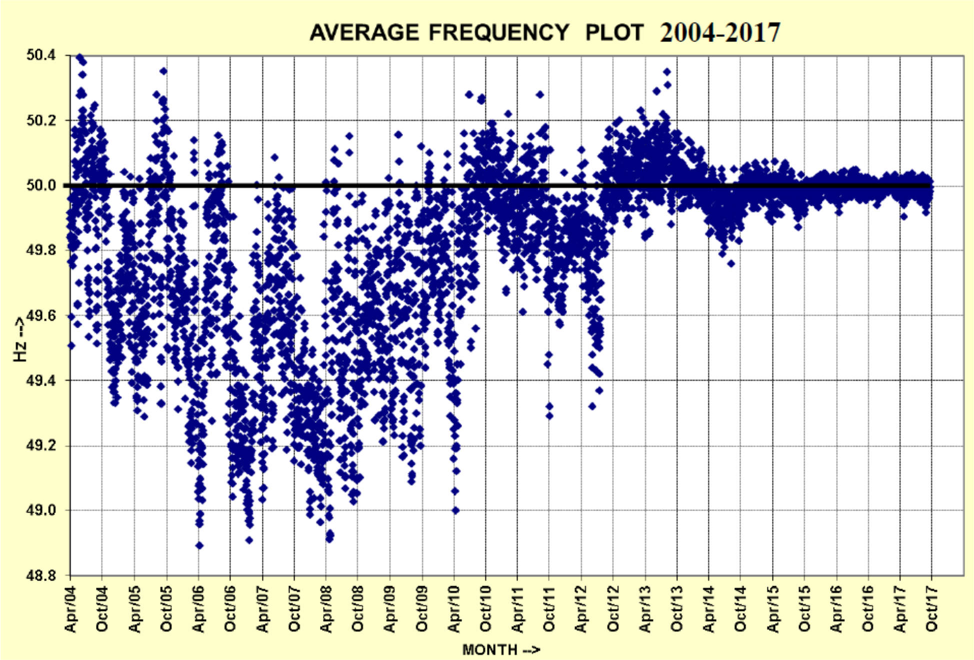


Response → Attribute↓	Inertial	Primary	Secondary	Fast Tertiary	Slow Tertiary	Generation Rescheduling/Market	Unit Commitment
Time	First few secs	Few sec - 5 min	30 s – 15 min	5 - 30 min	> 15 – 60 min	> 60 min	Hours/ day-ahead
Quantum	~ 10000 MW/Hz	~ 4000 MW	~ 4000 MW	~ 1000 MW	~ 8000-9000 MW	Load Generation Balance	Load Generation Balance
Local / LDC	Local	Local	NLDC / RLDC	NLDC	NLDC / SLDC	RLDC / SLDC	RLDC / SLDC
Manual / Automatic	Automatic	Automatic	Automatic	Manual	Manual	Manual	Manual
Centralized / Decentralized	Decentralized	Decentralized	Centralized	Centralized	Centralized/ Decentralized	Decentralized	Decentralized
Code / Order	IEGC / CEA Standard (?)	IEGC / CEA Standard	Roadmap on Reserves	Ancillary Regulations	Ancillary Regulations	IEGC	IEGC
Paid / Mandated	Mandated	Mandated	Paid	Paid	Paid	Paid	Paid
Regulated / Market	Regulated	Regulated	Regulated	Regulated	Regulated / Market	Regulated / Market	Regulated / Market
Implementation	Existing	Partly Existing	Yet to start	Yet to start	Existing	Existing	Existing

(source : Report of Expert Group to review and suggest measures for bringing power system operation closer to National Reference Frequency, CERC, 2017 Nov.)

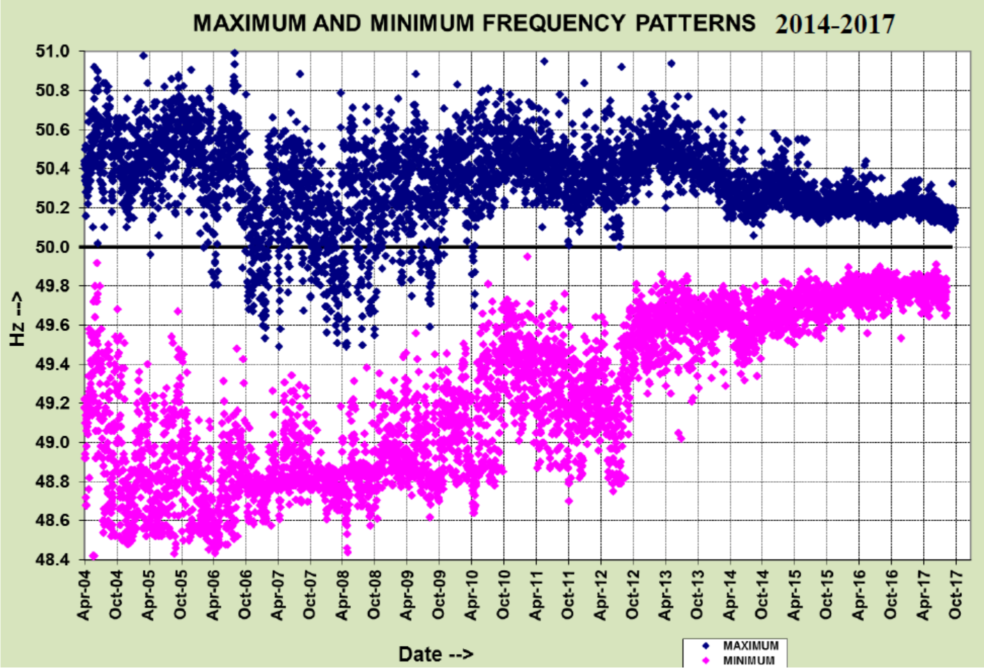
Figure 9.4.1-1 Schematic of Reserves, Balancing and Frequency Control Continuum in India

Accordingly, in West Bengal state as well, the frequency control is performed only by the governor free operation and the manual output adjustment of some generators as stated above, and its main purpose is imbalance control in the demand/supply plan prepared for each 15 minutes transaction. In the aforementioned Expert Group report, it was reported that the power frequency constants increased from 6,000MW/Hz to 9,000 - 10,000MW/Hz as a result of interconnecting the central region and southern region of India to a huge single network at the end of 2013. Therefore, since the frequency fluctuation is suppressed by the huge inertia of the Indian network system, even if only the imbalance control is made, there is no big problem in the demand/supply operation at the present time. From the transition of average, maximum and minimum frequency shown in Figure 9.4.1-2 and 9.4.1-3, it can be confirmed that frequency fluctuations decreased as the system capacity increased.



(source : Report of Expert Group to review and suggest measures for bringing power system operation closer to National Reference Frequency, CERC, 2017 Nov.)

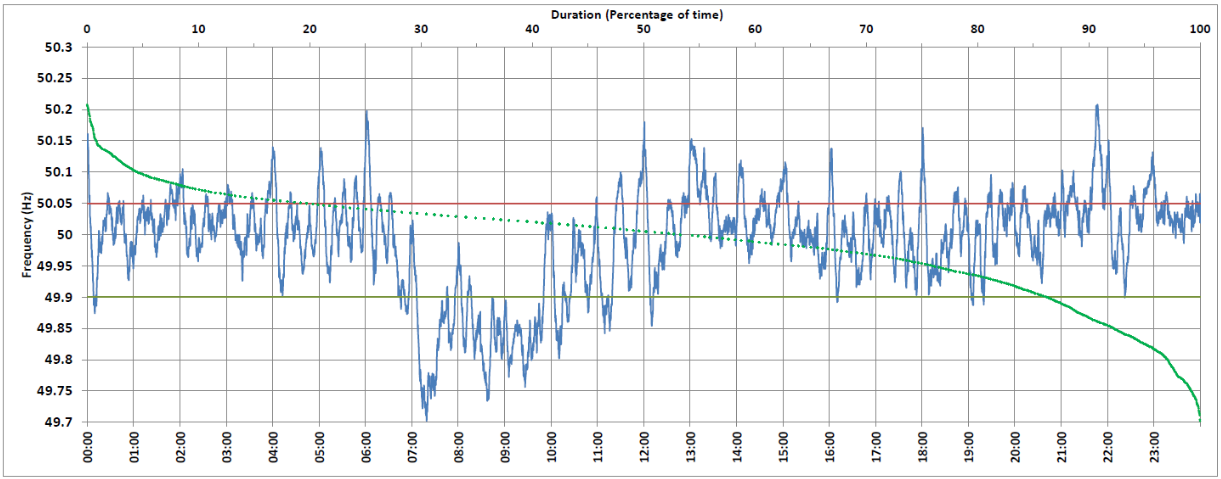
Figure 9.4.1-2 Average frequency of the Indian grid since 2004



(source : Report of Expert Group to review and suggest measures for bringing power system operation closer to National Reference Frequency, CERC, 2017 Nov.)

Figure 9.4.1-3 Variation in maximum and minimum frequency of the Indian grid since 2004

However, frequency fluctuation is still large during light load period, for example, fluctuation close to 0.3Hz has been observed on January 1st. 2018.



<49.7	<49.90	<49.97	49.7-49.8	49.8-49.9	49.9-50.0	50.0-50.1	50.1-50.2	49.90-50.05	49.7-50.2	49.97-50.03	50.05-50.1	>50	>50.03	>50.05	>50.2
0.00	13.66	29.99	2.89	10.76	31.98	49.72	4.50	66.63	99.86	37.59	15.75	53.29	32.42	19.71	0.14

(source : Power System Operation Corporation Limited (POSOCO) HP, 2018)

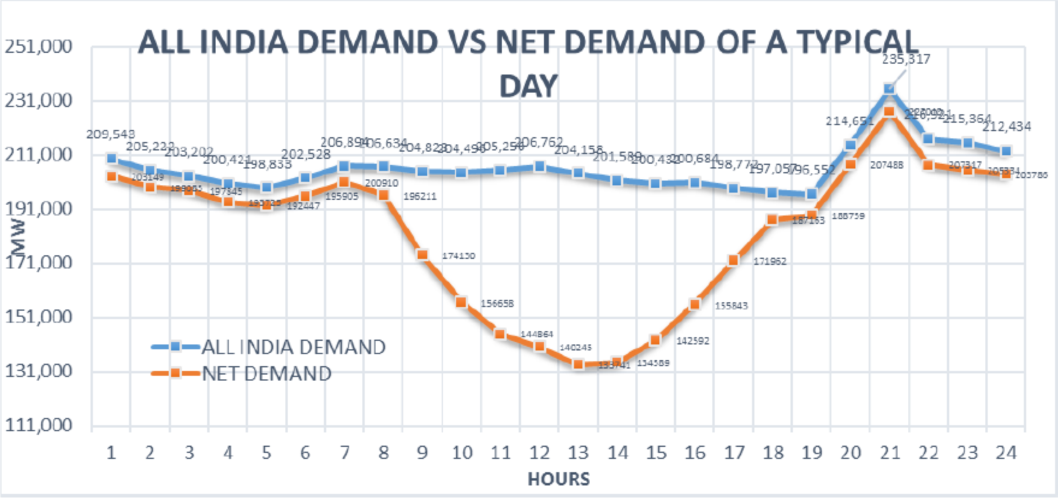
Figure 9.4.1-4 Frequency profile on Jan. 1st, 2018

India plans to cover most of the increasing demand by massive introduction of renewable energy, and aims to further improve frequency fluctuations as much as Western countries. In order to realize this, the necessity of the following initiatives is indicated to the 13th. NEP (Draft), and the balancing/frequency control capability is increasingly required in the future.

- Introducing secondary control using the AGC function
- Adding of fast tertiary control by applying RRAS to hydroelectric plants
- Improving controllability of governor free operation through governor control mode change and dead band elimination
- Measuring and managing Area Control Error (ACE)

9.4.2 Necessity of frequency control capability during pumping operation

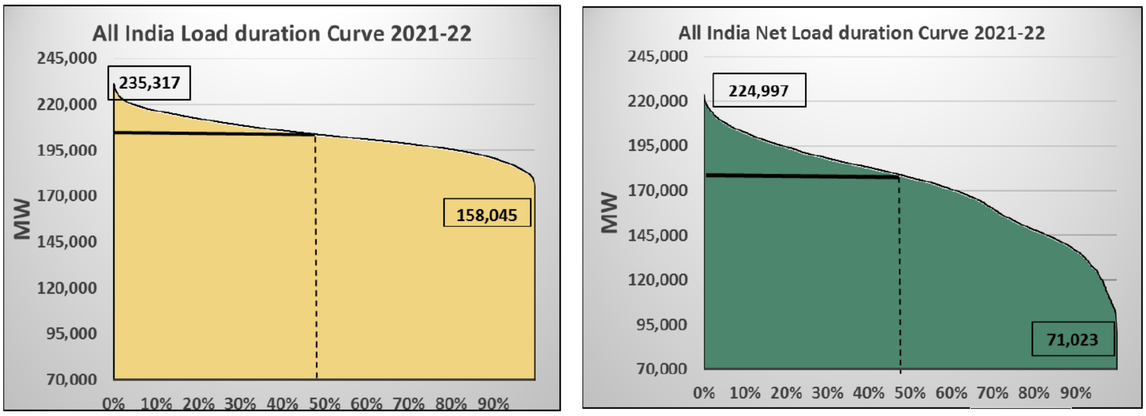
In accordance with the objective of introducing 175GW of renewable energy power in 2021-22 and even 275GW in 2026-27, a large amount of solar power generation that produce electricity only in day time will be introduced, consequently it is expected that the daily load curve will change into the form as shown in Figure 9.4.2-1.



(source : 13th NEP (Draft) , CEA, 2016)

Figure 9.4.2-1 Forecasted load profile after introducing massive capacity of renewable energy sources

Load duration curves obtained by sorting forecasted daily load curves in 2021-22 in descending order is shown in Figure 9.4.2-2. Even if a large amount of renewable energy is introduced, the peak demand hardly changes, only the load factor drops, and as a result, it is expected that the demand shape supplied by the conventional power plants will be more sharpened.



(a) All India load duration curve (b) All India Net load duration curve

(source : 13th NEP (Draft) , CEA, 2016)

Figure 9.4.2-2 All India Expected load duration curve in 2021-22

If 100 GW solar power generation is introduced by 2021 - 22 and 150GW by 2026-27, the net demand during the daytime greatly decreases and the power supply from the conventional power plants drastically decreases, so that the lack of the frequency regulation capability cannot be avoided. Besides, the problem of surplus power is expected in the daytime of light load period. To overcome this situation, the following countermeasures are assumed in the 13^{th.} NEP (Draft). Especially the development of adjustable speed PSP (AS-PSP), which is technically established and enables frequency regulation during pumping operation, is one of a promising measure to resolve both surplus power and deficit of frequency regulation capacity while also being a proven technology.

- effective utilization of conventional power plants, especially hydroelectric power plants, PSPs and gas-fired power plants and their flexibility enhancement
- reinforcement of transmission system
- improvement in power generation prediction accuracy for renewable energy, etc.

9.4.3 Advantages of frequency control function during pumping operation

While the advantages of frequency control function that the AS-PSPs provide during pumping operation have received worldwide recognition, the method to quantify their benefits is in the stage of trial and error since markets that appropriately monetize their functions have not yet been developed and furthermore, discussions leading to a rise in the electricity tariff are not active given the limited number of equipment and owners.

And the approach and result for evaluation regarding the frequency control function during pumping operation in the Turga PSP project differ depending on whether they are estimated based on the demand/supply operation cost within only West Bengal state, which will introduce the AS-PSPs, or assessed as a benefit for the whole of India, which projects in the national electricity plan for the next decade to introduce a huge amount of renewable energy resources by curbing new development of conventional power plants, especially those derived from fossil fuels.

On the other hand, if the focus is only on the variable cost and start-up cost of thermal power plants, which are predominant in demand/supply operation cost, those cost of renewable energy resources is theoretically naught. However, the introduction of renewable energy resources brings on additional cost required for transmission system reinforcement, ancillary services, etc. and has augmentative impact on electricity price. Moreover, the introduction of them decreases not only market clearing price but also capacity factor of conventional power plants, and as a result, generation costs will be changed substantially. (When the capacity factor drops below the assumed level, the alternative will be whether to raise the power selling price to recover costs or to abolish plants) Since those costs mutually influence the demand/supply operation cost, the analysis placing focus only on current operation cost without taking into account such influence can hardly be called a correct evaluation of the advantages of adjustable-speed pumping function.

Nevertheless, since the Turga PSP project is planned to introduce the adjustable speed pumping function to 2 units out of 4, the following is the result of a study on why the frequency control capability during pumping operation is beneficial and what benefit can be expected from this capability in West Bengal state and in the whole of India, with focus placed on variable cost and start-up cost in the above-mentioned demand/supply operation.

(1) Principle of benefit generation

Electricity has an inherent characteristic that frequency changes unless the balance between ever-changing demand and supply is maintained. In case of that the balance between demand and supply is broken considerably and frequency changes by more than a certain amount, the operation of the protection devices installed in the power system cause a large scale blackout in the worst case. On the other hand, it is impossible to predict demand without error, and the power supply could be lost by accidents such as lightning strikes given that most power facility is exposed to nature. Therefore, in actual operation, the power supply is dispatched considering AGC capacity (Secondary control) as frequency control function and spinning reserve as reserve margin in advance in order to keep demand and supply balance.

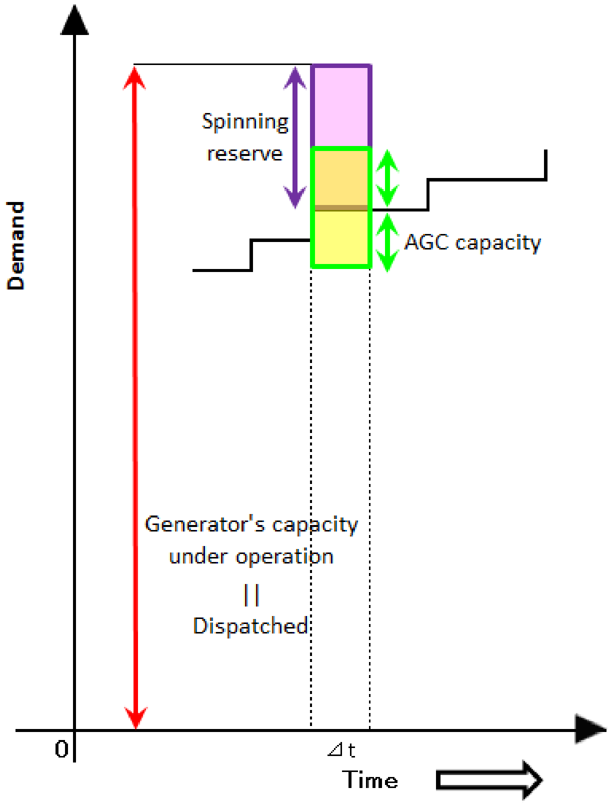


Figure 9.4.3-1 Actual generator dispatch in consideration of regulation and reliability

Although there may be a difference in response speed, it can be secured for spinning reserve by partial load operation of interconnected plants. On the other hand, since the AGC capacity can only be obtained from specific power plants which receive control signal from Load Dispatch Center, and can ramp up/down output at high speed, it is therefore difficult to secure necessary capacity.

Subsequently, demand fluctuates significantly not only by season but within the day, as can be observed in the demand record of West Bengal state in 2016 shown in Figure 9.4.3-2. As few power plants are interconnected on the grid during light load condition due to the minimum output constraint of each power plant, there are only the following two ways of securing AGC capacity which should correspond to about 1 to 2% of the demand.

(Not be disclosed per internal corporate information)

(source : Compiled by study team based on operational records provided by WBSEDCL)

Figure 9.4.3-2 Example of difference in demand profile

Means 1 : Stopping low-price base load power plants and switching to the high-price power plants with AGC function => Increase cost of power generation unit price difference and start/stop cost

Means 2 : Increasing net demand by pumping operation of PSPs and interconnecting additional plants with AGC function => Cost increase corresponding to cycle efficiency loss in PSP operation

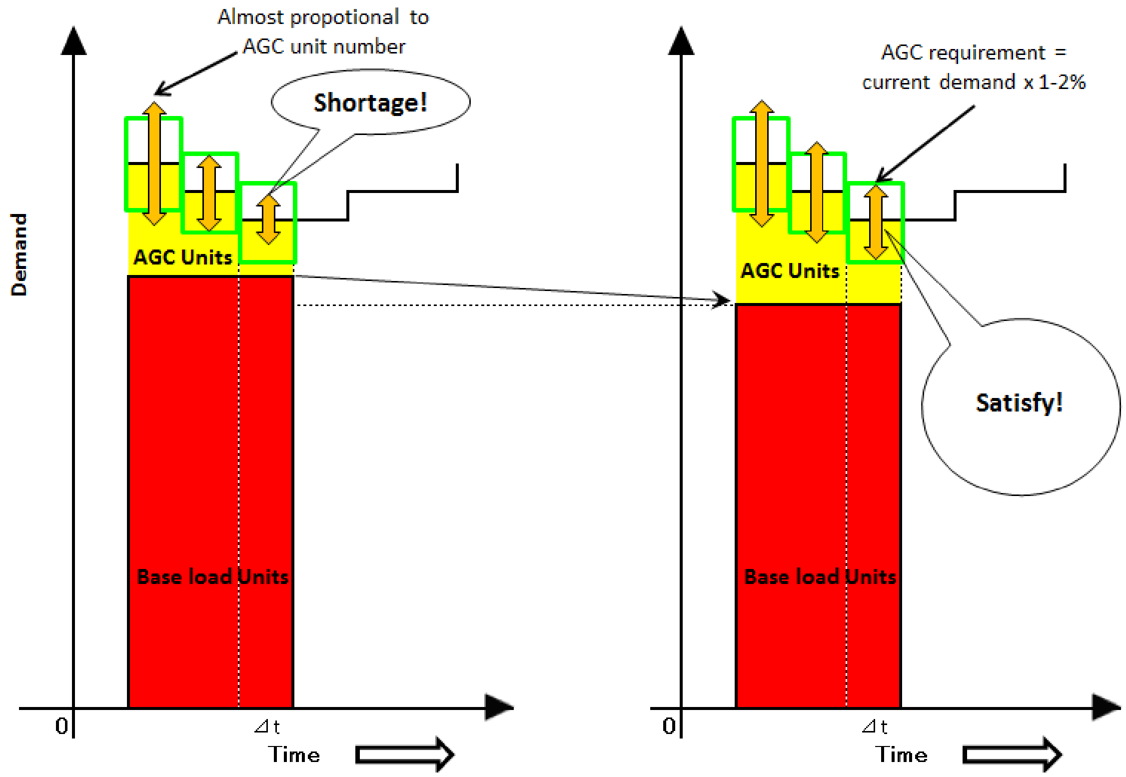


Figure 9.4.3-3 Means No.1

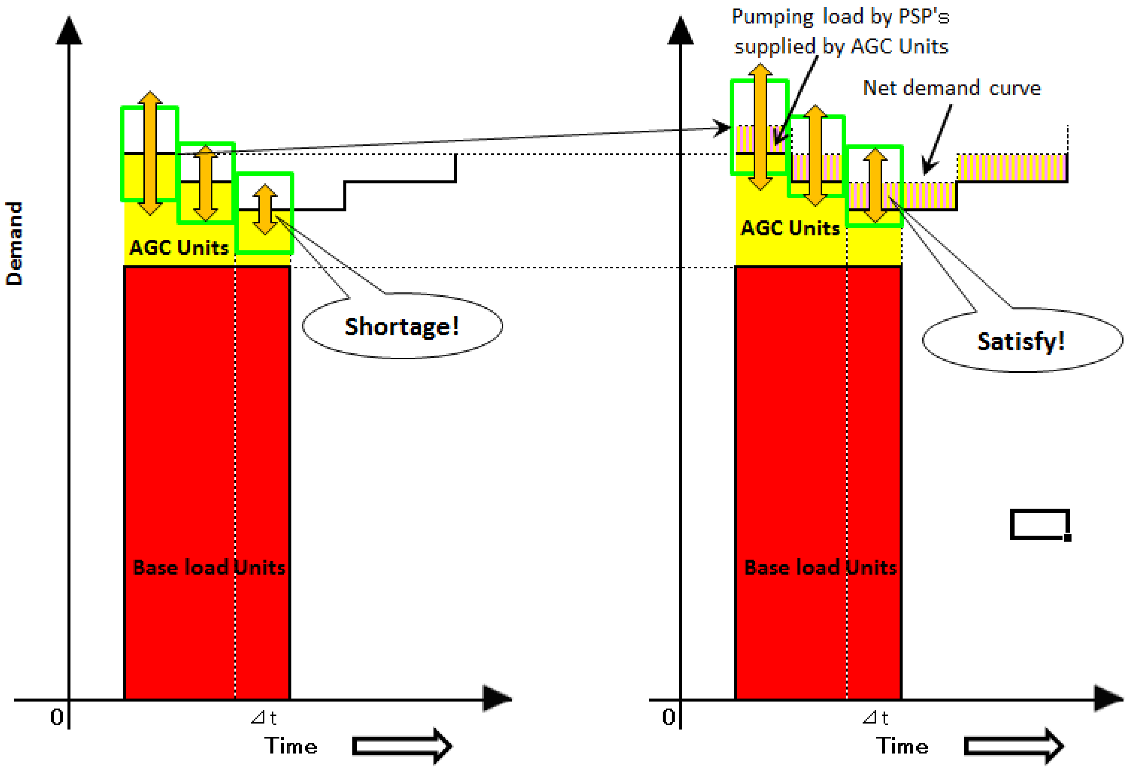


Figure 9.4.3-4 Means No.2

However since both means increase the cost, the needs to resolve the insufficient AGC capacity at light load while carrying out load leveling has increased. As a result, it began to use 2 "means 3" which adopted adjustable speed pumping technology in some countries, because it can not only reduce the number of additional start-up of thermal power plants with AGC function but also replace a part of them with cost competitive base load power plants, if the PSPs themselves provide AGC capacity.

An image of the dispatch plan according to such a scheme is shown in Figure 9.4.3-5.

In other words, if the frequency control function can be utilized during pumping operation, it would enable shifting the dispatch plan from that in means 1 to 3, or 2 to 3 and reduce operation cost because of the advantages it presents, such as reduction of the number of start/stop operation of base load power plants, replacement of the power supply (from expensive AGC power plants to cost competitive base load power plants), etc.

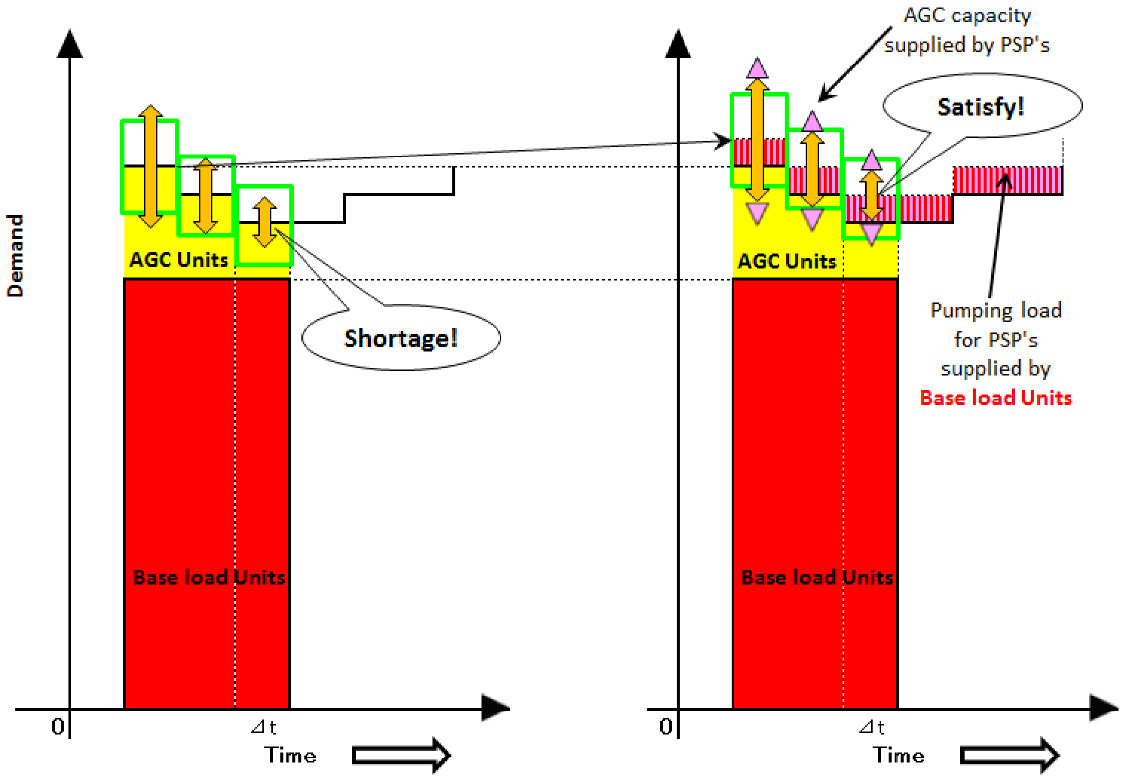


Figure 9.4.3-5 Dispatch plan using Adjustable Speed PSP's (Means No.3)

(2) Benefit expected in West Bengal state and India

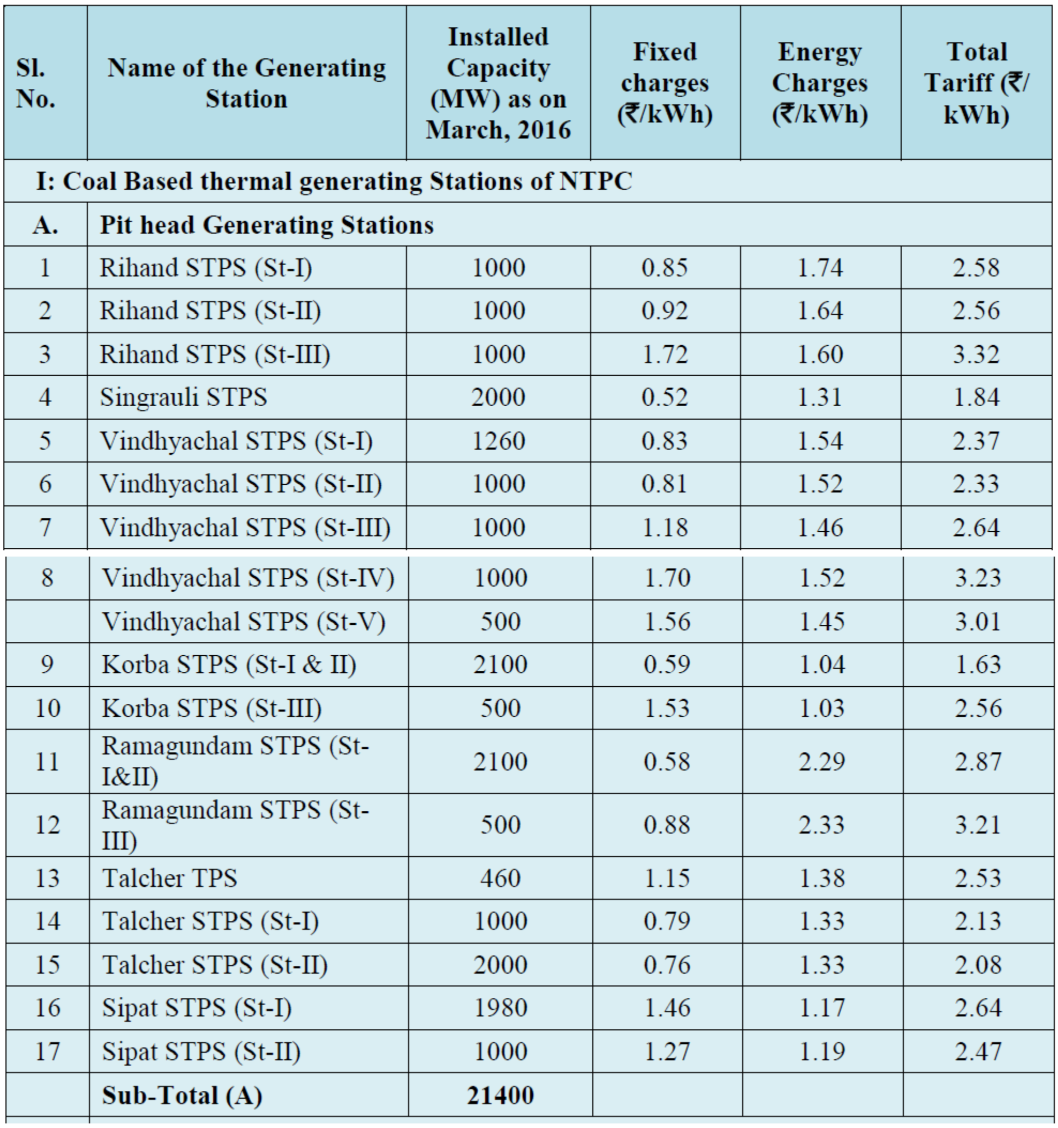
The above-mentioned benefit that adjustable speed PSP can offer during pumping operation varies greatly depending on the demand-supply structure characterized by the energy mix and demand characteristics, the electricity market price and electric power industry system of the application country.

As stated in 9.4.1, as of today India has not yet introduced secondary control, and thus the frequency control system described in 9.4.3 (1) is not operational. This means that there is no specific expenditure made for frequency control at present, and so the introduction of AS-PSP would only bring about power quality improvement related to frequency, but financial benefit can't be evaluated since there is no target for streamlining demand/supply operation.

Although the data is somewhat old, the "Report on Short-term Power Market in India, 2015-16" compiled annually by CERC reports on electricity market prices as shown in Table 9.4.3-1, 2, 3 and 4. Large price differences are apparent here; coal-fired power prices at INR2.71 - 4.69, compared to the gas-fired power price at INR6.13 (Natural Gas) and INR8.05 (Liquefied Natural Gas). However, since the actual plant load factor in gas-fired power plant is extremely low and its new development plan is also limited, India, where a huge amount of renewable energy sources will be introduced, needs to utilize gas-fired power plants as much as possible.

As for West Bengal state, given that there is little potential nor plans for the development of gas-fired power plant, gas-fired power plants can be expected to remain almost non-existent even in the future. Consequently, India as a whole, as well as West Bengal state, has no options with regard to gas-fired power plants operation, and it is expected that especially India will have to make the most of all its gas-fired power plants and AS-PSPs for their stable power supply.

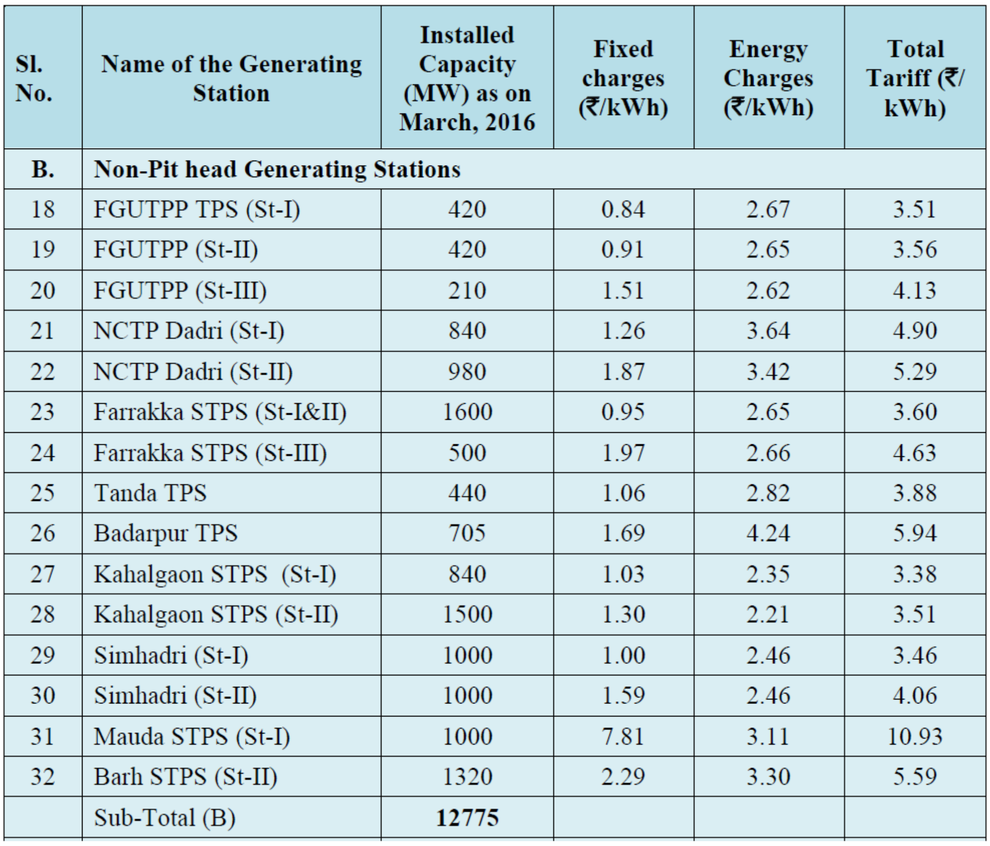
Table 9.4.3-1 Tariff of Central Thermal Power Stations, 2015-16 (Coal (Pit head))



Sl. No.	Name of the Generating Station	Installed Capacity (MW) as on March, 2016	Fixed charges (₹/kWh)	Energy Charges (₹/kWh)	Total Tariff (₹/ kWh)
I: Coal Based thermal generating Stations of NTPC					
A.	**Pit head Generating Stations**				
1	Rihand STPS (St-I)	1000	0.85	1.74	2.58
2	Rihand STPS (St-II)	1000	0.92	1.64	2.56
3	Rihand STPS (St-III)	1000	1.72	1.60	3.32
4	Singrauli STPS	2000	0.52	1.31	1.84
5	Vindhyachal STPS (St-I)	1260	0.83	1.54	2.37
6	Vindhyachal STPS (St-II)	1000	0.81	1.52	2.33
7	Vindhyachal STPS (St-III)	1000	1.18	1.46	2.64
8	Vindhyachal STPS (St-IV)	1000	1.70	1.52	3.23
	Vindhyachal STPS (St-V)	500	1.56	1.45	3.01
9	Korba STPS (St-I & II)	2100	0.59	1.04	1.63
10	Korba STPS (St-III)	500	1.53	1.03	2.56
11	Ramagundam STPS (St-I&II)	2100	0.58	2.29	2.87
12	Ramagundam STPS (St-III)	500	0.88	2.33	3.21
13	Talcher TPS	460	1.15	1.38	2.53
14	Talcher STPS (St-I)	1000	0.79	1.33	2.13
15	Talcher STPS (St-II)	2000	0.76	1.33	2.08
16	Sipat STPS (St-I)	1980	1.46	1.17	2.64
17	Sipat STPS (St-II)	1000	1.27	1.19	2.47
	Sub-Total (A)	**21400**			

(source : Report on Short-term Power Market in India : 2015-16, CERC, 2016)

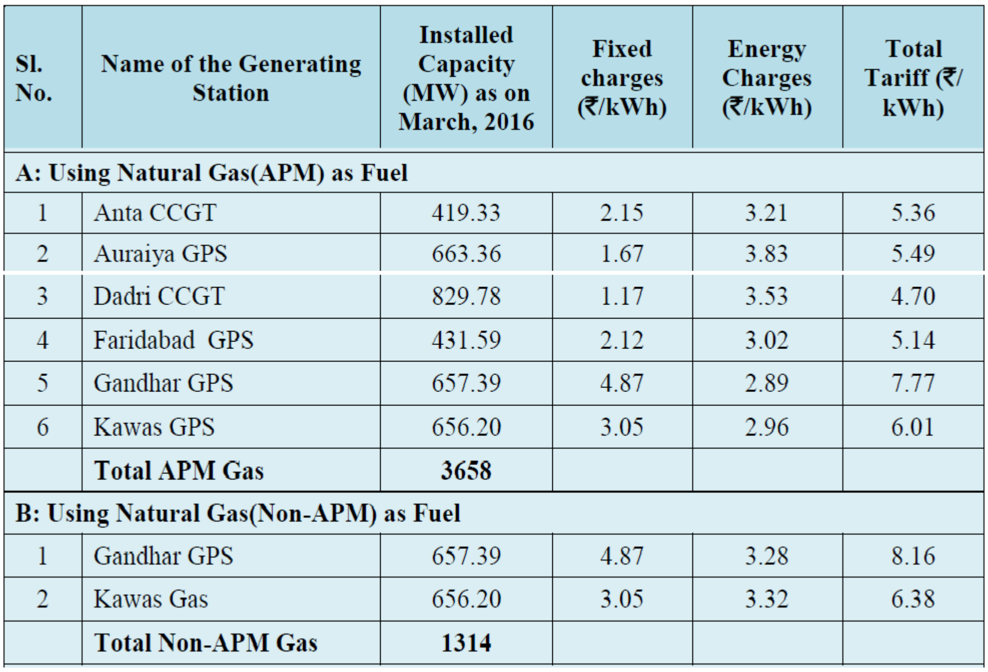
Table 9.4.3-2 Tariff of Central Thermal Power Stations, 2015-16 (Coal (Non-pit head))



Sl. No.	Name of the Generating Station	Installed Capacity (MW) as on March, 2016	Fixed charges (₹/kWh)	Energy Charges (₹/kWh)	Total Tariff (₹/ kWh)
B.	**Non-Pit head Generating Stations**				
18	FGUTPP TPS (St-I)	420	0.84	2.67	3.51
19	FGUTPP (St-II)	420	0.91	2.65	3.56
20	FGUTPP (St-III)	210	1.51	2.62	4.13
21	NCTP Dadri (St-I)	840	1.26	3.64	4.90
22	NCTP Dadri (St-II)	980	1.87	3.42	5.29
23	Farrakka STPS (St-I&II)	1600	0.95	2.65	3.60
24	Farrakka STPS (St-III)	500	1.97	2.66	4.63
25	Tanda TPS	440	1.06	2.82	3.88
26	Badarpur TPS	705	1.69	4.24	5.94
27	Kahalgaon STPS (St-I)	840	1.03	2.35	3.38
28	Kahalgaon STPS (St-II)	1500	1.30	2.21	3.51
29	Simhadri (St-I)	1000	1.00	2.46	3.46
30	Simhadri (St-II)	1000	1.59	2.46	4.06
31	Mauda STPS (St-I)	1000	7.81	3.11	10.93
32	Barh STPS (St-II)	1320	2.29	3.30	5.59
	Sub-Total (B)	**12775**			

(source : Report on Short-term Power Market in India : 2015-16, CERC, 2016)

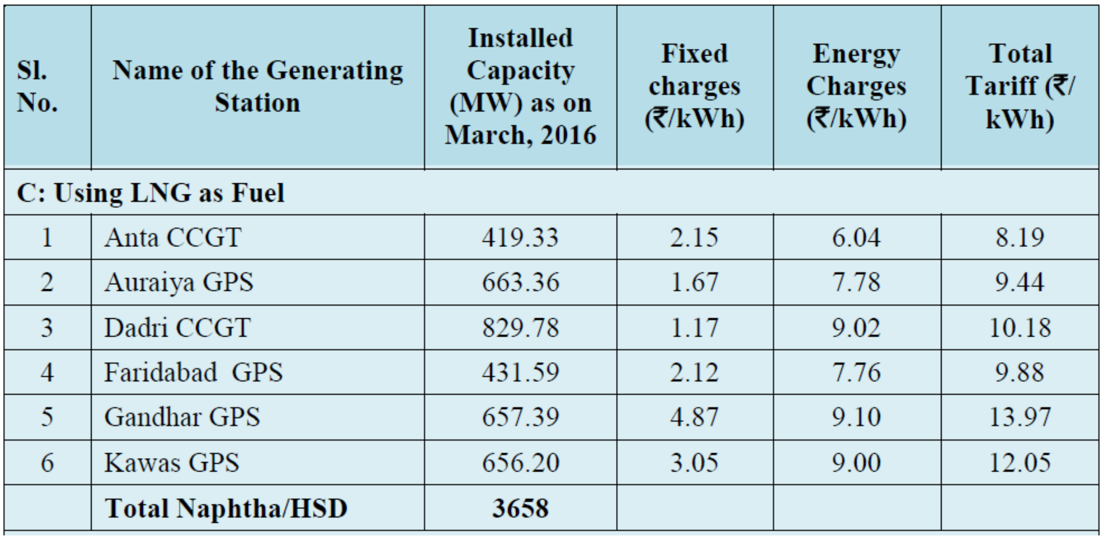
Table 9.4.3-3 Tariff of Central Thermal Power Stations, 2015-16 (Natural gas)



Sl. No.	Name of the Generating Station	Installed Capacity (MW) as on March, 2016	Fixed charges (₹/kWh)	Energy Charges (₹/kWh)	Total Tariff (₹/ kWh)
A: Using Natural Gas(APM) as Fuel					
1	Anta CCGT	419.33	2.15	3.21	5.36
2	Auraiya GPS	663.36	1.67	3.83	5.49
3	Dadri CCGT	829.78	1.17	3.53	4.70
4	Faridabad GPS	431.59	2.12	3.02	5.14
5	Gandhar GPS	657.39	4.87	2.89	7.77
6	Kawas GPS	656.20	3.05	2.96	6.01
	Total APM Gas	**3658**			
B: Using Natural Gas(Non-APM) as Fuel					
1	Gandhar GPS	657.39	4.87	3.28	8.16
2	Kawas Gas	656.20	3.05	3.32	6.38
	Total Non-APM Gas	**1314**			

(source : Report on Short-term Power Market in India : 2015-16, CERC, 2016)

Table 9.4.3-4 Tariff of Central Thermal Power Stations, 2015-16 (LNG)



Sl. No.	Name of the Generating Station	Installed Capacity (MW) as on March, 2016	Fixed charges (₹/kWh)	Energy Charges (₹/kWh)	Total Tariff (₹/ kWh)
C: Using LNG as Fuel					
1	Anta CCGT	419.33	2.15	6.04	8.19
2	Auraiya GPS	663.36	1.67	7.78	9.44
3	Dadri CCGT	829.78	1.17	9.02	10.18
4	Faridabad GPS	431.59	2.12	7.76	9.88
5	Gandhar GPS	657.39	4.87	9.10	13.97
6	Kawas GPS	656.20	3.05	9.00	12.05
	Total Naphtha/HSD	**3658**			

(source : Report on Short-term Power Market in India : 2015-16, CERC, 2016)

9.5 REQUIRED NUMBER OF ADJUSTABLE SPEED GENERATOR/MOTOR UNITS

9.5.1 Method used to determine the unit number in the DP

As one unit of AS-PSP is expected to provide +/-75MW of regulation capacity during pumping operation, in the DPR it is determined, without conducting any simulations, that the required number of adjustable speed generator/motors is 2 units. This is because that based on the assumption that 300MW will be introduced by future solar power generation with output fluctuation within 50% of the rated output, and as a result the necessary capacity for secondary control capacity would be 150MW.

9.5.2 Required capacity estimation for secondary control

(1) West Bengal state

1) In case of pumping during night (solar power generation is not available)

When there is no surplus electricity from renewable energy resources, the PSPs runs pumping operation during light load period and generates electricity in peak time.

Therefore, daily load curve on a minimum load day in FY2021 is supposed as shown in Figure 9.5.2-1 by processing the demand data of West Bengal state in 2016 using “Compound Annual Growth Rate” (CAGR) of future demand of the state shown in Table 9.3.2-6, and the secondary control capacity required during pumping operation is estimated.

(Not be disclosed per internal corporate information)

(source : Compiled & modified by study team based on operational records provided by WBSEDCL, 2017)

Figure 9.5.2-1 Assumed West Bengal daily load curve on Nadir day in FY2021

Although little has been reported on how to calculate the required capacity of secondary control, it is generally said that it should correspond to about 1 to 5% of the system demand. In fact, Japanese electric power companies set it at 1 to 2% and acccording to a research paper the American company PJM sets it at 1% of the system demand.

Fortunately, the formula for calculating required AGC capacity was found in a material provided by one of Japanese electric power company to educational institutions. By substituting the system demand of 3,500 MW into this formula and computing the minimum required AGC capacity, it was 80 MW, which was equivalent to about 2.3% of the system demand.

< Calculation formula for required AGC capacity >

$$\text{Minimum AGC requirement} = \sqrt{\left((1.44 \times P) + (0.01 \times \mathrm{P})^2\right)} \ \text{[MW]}$$

Where P is system demand [MW]

2) In case of pumping during daytime (solar power generation is available)

West Bengal state plans to introduce about 5,400MW of solar power generation by FY2021. Alghough the peak demand is estimated as 12,688MW, this occurs during the lighting time zone and the demand during the daytime, when solar power generates electricity, drops to about 70% of the peak demand as shown in Annexure-1. Therefore, residual net load in the daytime is estimated to be 3,500MW at most, and surplus power would be generated during light load period as clearly shown in Figure 9.4.2-1.

Such a demand-supply structure can not be fully regulated by only controling conventional power plants, and control of renewable energy resources and of demand side through Demand Response (DR) system would also be necessary, so the required AGC capacity can not be calculated by methods used in current demand/supply operation, and should be determined based on the newly established operation guideline in future.

Conversely under such circumstances, it would be difficult for a state alone to keep demand supply balace and frequency regulation. Therefore, as will be described later, it is expected that the power system in which huge amount of renewable energy resources is introduced will be widely operated throughout India.

(2) The whole of India

1) In case of pumping during night (solar power generation is not available)

Presently, as shown in Figure 9.4.1-2, -3 and -4, since frequency is stabilized without AGC control owing to the inertia present in large scale systems, and thus capacity estimation during night period, where the influence of renewable energy resources are not so salient and regulation capacity is not likely required so much, is skipped.

2) In case of pumping daytime (solar power generation is available)

The daily load curve throughout the whole of India is not published and the only available information is the curve shown in Figure 9.4.2-1 taken from the 13th NEP (Draft). Therefore the AGC capacity necessary for the residual net load will be calculated based on this information.

Since the minimum demand during daytime is 133,741MW from this information, substituting this demand into the formula described above, the minimum required AGC capacity becomes 1,400MW, which corresponds to about 1.1% of the system demand.

9.5.3 Required number of adjustable speed generator/motor units for Turga PSP project

As inferred in 9.5.2, if West Bengal state have to keep demand supply balance on its own, required number of AS-PSP units is one in the case of night period where solar power generation don't operate, since required AGC capacity during the time period is about 80MW.

However, if pumping operation is carried out during daytime when solar power generation operates, it is advisable to equip all units with adjustable speed function in order to be able to absorb surplus power and frequency control in any given ratio. Or rather, since India as a whole is expected to have to operate their power system cross-regionally in order to introduce huge amount of renewable energy resources, plants with frequency control functions are expected to be used to the fullest extent.

Based on the above, if it is expected that the pumping operation will be carried out during the daytime, and considering that plants with the AGC function are currently pilot plant units only, it can be said that, from the viewpoint of demand supply operation, it is desirable to provide all units with adjustable speed function.

9.5.4 Financial aspect for number of adjustable speed generators

The financial evaluation was conducted for estimating number of adjustable speed generators in the course of DPR preparation. The result was shown in Table 9.5.4-1.

Table 9.5.4-1 Levelised Tariff Comparison of Unit Number of Adjustable Speed PSP

(Not be disclosed per cost related information)

Annexure 9-1

Operational records of West Bengal state system in FY2016 (Per month)

(Not be disclosed per internal corporate information)

Annexure 9-2

Relationship between electricity price and PPSP operation in FY2016 (Per week)

(Not be disclosed per internal corporate information)

CHAPTER 10

POWER SYSTEM ANALYSIS, TRANSMISSION LINE DESIGN, SWITCHYARD DESIGN

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CHAPTER 10 TRANSMISSION AND DISTRIBUTION EQUIPMENT DESIGN

10.1 POWER SYSTEM ANALYSIS

10.1.1 Objective

Since this project involves the development of a large scale pumped-storage power plant with a capacity of 1,000MW, it is necessary to conduct a study to confirm that it will not adversely affect the existing system and, on the other hand, that the operation of the pumped-storage power plant will not be subject to constraints caused by the power system network. Such a study was conducted in 2015 and the Detailed Project Report (DPR) was based on it. However, three years have passed since then and there may have been changes in demand forecast, in the power system conditions, and in future development plans in terms of power plants and transmission system. The objective of this chapter is therefore to check again to be sure, based on the latest data, load flow, short-circuit capacity and dynamic stability of the power system to confirm that the Turga pumped-storage power plant (Turga PSP) can be safely operated.

10.1.2 Content of the study

The study includes load flow calculation, short-circuit capacity calculation and dynamic stability analysis of Extra-High voltage systems (220kV or more) in India as a whole, incorporated with West Bengal grid systems (132kV or more) including power evacuation system for the Turga PSP under the 3 operational scenarios of peak load condition, off-peak load condition and dry season with low-hydro power as in the DPR.

Timeframe of the study is 2023-24 which all the required input data is available including generation and transmission plans. The peak load in West Bengal is set as 13,873 MW based on the 19th Electric Power Survey (EPS), and distribution of the load is set as in Table 10.1.2-1 based on the load projection of each distribution companies.

Timeframe of the DPR was for 2020-21. The estimate this time is for 2023-24 but it is 20% less to those of the DPR as the recent demand growth was under the past projection.

Table 10.1.2-1 Load Flow Calculation Conditions

Discoms	WBSEDCL	DVC	CESC	DPL	IPCL	Total
Peak Demand(MW)	8,023	2,584	2,573	480	214	13,973

(1) Load flow calculation

Confirming compliance of voltage range and thermal capacity in the power system with criteria prescribed in standards such as the “Manual on Transmission Planning Criteria (Manual)” and the “Indian Electricity Grid Code (IEGC)” by calculating voltage and its angle at each bus, and active and reactive power in each transmission line.

(2) Short-circuit capacity calculation

Confirming non-exceedance of rating in existing circuit breakers and compliance with the upper limit prescribed for each voltage class by the Manual and the IEGC by calculating fault current in the case of three-phase ground fault and single-phase ground fault at each bus near the Turga PSP.

(3) Dynamic stability analysis

Confirming that dynamic stability is ensured by checking the response of the Turga PSP and the power system network against various faults.

10.1.3 Criteria

(1) Overload

Normal loading in transmission lines and transformers shall not exceed 70% of their rated capacities (MVA).

In the case of an N-1 fault in a double circuit transmission line, loading in sound circuits and nearby transmission lines should not exceed 90%, and in the case of route down fault by an N-1-1 fault, loading in the adjacent transmission lines should not exceed 90% of ratings.

(note: 400 kV class transmission line thermal capacity differs by conductor types but is around 1,300 MW/cct.)

(2) Voltage range

Normal voltage range shall be within the rated voltage±5% for both of 400kV and 220kV systems, whereas in the case of fault, it shall be within ±5% for 400kV systems and ±10% for 220kV systems.

10.1.4 Study result

The power system analysis was entrusted to and conducted by the Power Grid Corporation in India Limited (PGCIL) who is in charge of system planning for Extra-High voltage system throughout all of India and owns and manages system data. Details of the method used and the result of the analysis are as stated in the study report attached to Appendix-1, and the following is a summary of the findings of this study.

In India, development of transmission lines is completed within at most 4 years, so that the Manual stipulates that formulation and review of transmission development plan shall be carried out within 3 to 4 years timeframe. Therefore, the purpose of this study is to identify equipment that needs measures and reinforcement, and to grasp issues before the Turga PSP start operating, rather than an evaluation of the feasibility of the project.

(1) Load flow calculation

For each demand scenario shown in Table 10.1.4-1, the results of load flow calculation at sound condition before Turga PSP development and, at both sound and N-1 condition after Turga PSP development are indicated in Table 10.1.4-2 and, the same as the results obtained in the DPR, overloaded equipment is confirmed only when one circuit of PSP (New) – Ranch (New) 400kV D/c is faulted. But the extent of overloaded equipment is largely decreased reflecting the estimated load demand is decreased compared to the DPR.

Table 10.1.4-1 Load Flow Calculation Conditions

Case	Scenario	Generation(MW)	Load(MW)	Export(MW)	PSP’s condition (MW)
0	Peak	13,744	12,625	1,119	Turga Gen/ Non Purulia Gen/+900
1	Peak	14,744	12,625	2,119	Turga Gen/+1,000 Purulia Gen/+900
2	Light	8,076	9,790	-1,514	Turga Pump/-1,144 Purulia Pump/-1,030
3	Low Hydro	7,793	12,410	-4,345	Turga Pump/-1,144 Purulia Pump/-1,030

Table 10.1.4-2 Load Flow Analysis Case and Results for Transmission Lines

Case	Line outage	Violations
0	Non (Without Turga PSP)	No
1	Non	No
1a	One circuit of PPSP(New)-Ranchi(New) 400kV D/c	No
1b	One circuit of Purulia PSP-Bidhan Nagar 400kV D/c	No
1c	One circuit of PPSP(New)-Arambagh 400kV D/c	No
1d	Bidhan Nagar-Arambagh 400kV D/c	No
2	Non	No
2a	One circuit of PPSP(New)-Ranchi(New) 400kV D/c	No
2b	One circuit of Purulia PSP-Bidhan Nagar 400kV D/c	No
2c	One circuit of PPSP(New)-Arambagh 400kV D/c	No
3	Non	No
3a	One circuit of PPSP(New)-Ranchi(New) 400kV D/c	Yes
3b	One circuit of Purulia PSP-Bidhan Nagar 400kV D/c	No
3c	One circuit of PPSP(New)-Arambagh 400kV D/c	No

Table 10.1.4-3 Line loading without any strengthening

Case	400kV D/c Line loading (MW)		
	PPSP(New)-Ranchi(New)	Purulia PSP-Bidhan Nagar	PPSP(New)-Arambagh
0	-2×84	2×188	2×286
1	2×165 (229) *	2×317 (415) *	2×393 (494) *
2	-2×722 (-997) *	-2×247 (-324) *	-2×130 (-165) *
3	-2×950 (-1,303) *	-2×138 (-184) *	-2×34 (-45) *

(note : * under N-1 contingency of respective line)

The result of Case 3 above is shown in Figure 10.1.4-1 as an example of the result of load flow calculations.

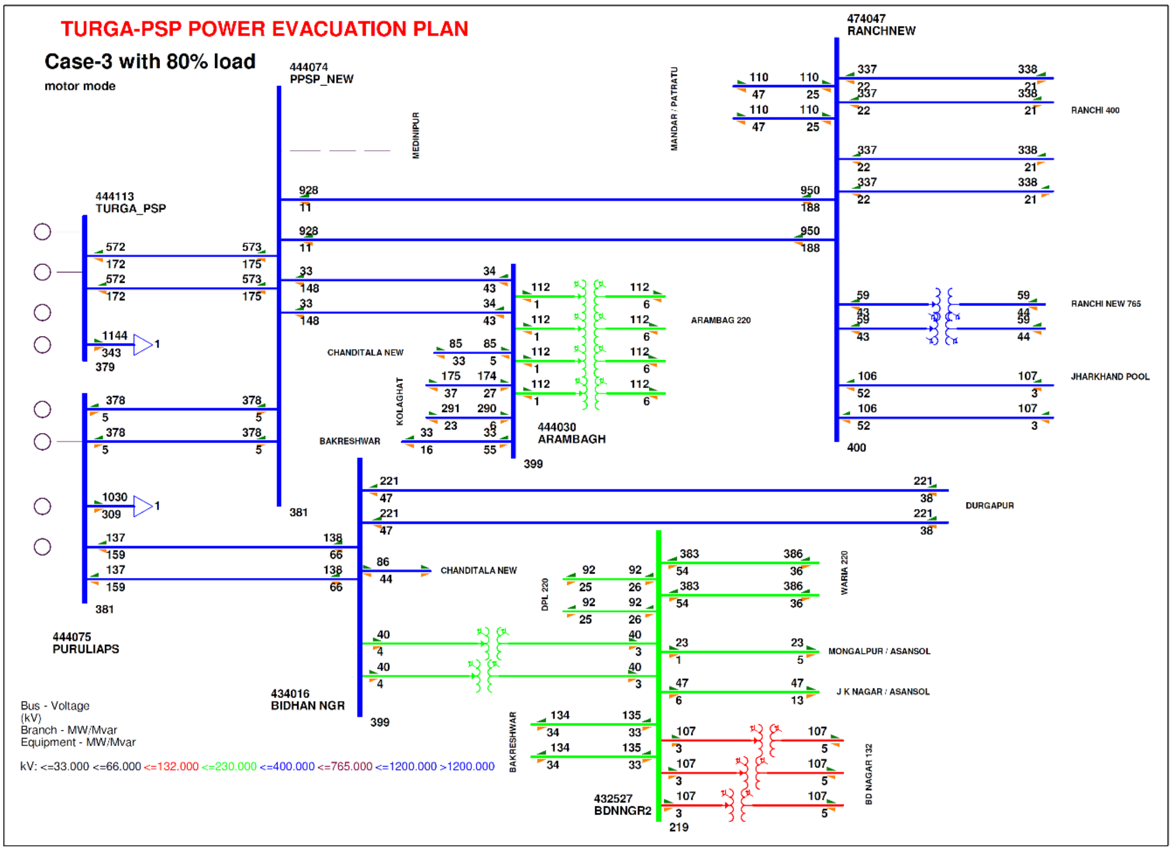


Figure 10.1.4-1 Result of Load Flow Analysis for Case No.1

Since some of overloading equipment are found similar to what was seen during the preparation of the DPR, PGCIL has made a number of reinforcement suggestions enabling the improvement / mitigation of those problems. After additional load flow analysis, the following new 400kV transmission line was proposed in accordance with construction of the Turga PSP, among those reinforcement suggestions (Table 10.1.4-4, Figure 10.1.4-2).

New transmission line: PPSP (New)-Raghunathpur 400kV Quad circuit line (approx. 60km)

Table 10.1.4-4 Line Loading with Proposed Strengthening

Case	Line loading (in MVA)			
	Purulia PSP-Bidhan Nagar 400kV D/c	PPSP (New) - Arambagh 400kV D/c	Ranch (New) - PPSP (New) 400kV D/c	PPSP (New) - Raghunathpur 400kV Quad/c
3 Low Hydro case	-2×138 (-184) *	-2×34 (-45) *	-2×950 (-1,303) *	-
3B Strengthening	2×116 (144) *	2×175 (211) *	-2×484 (-592) *	-2×946 (-1,463) *

(note : * under N-1 contingency of respective line)

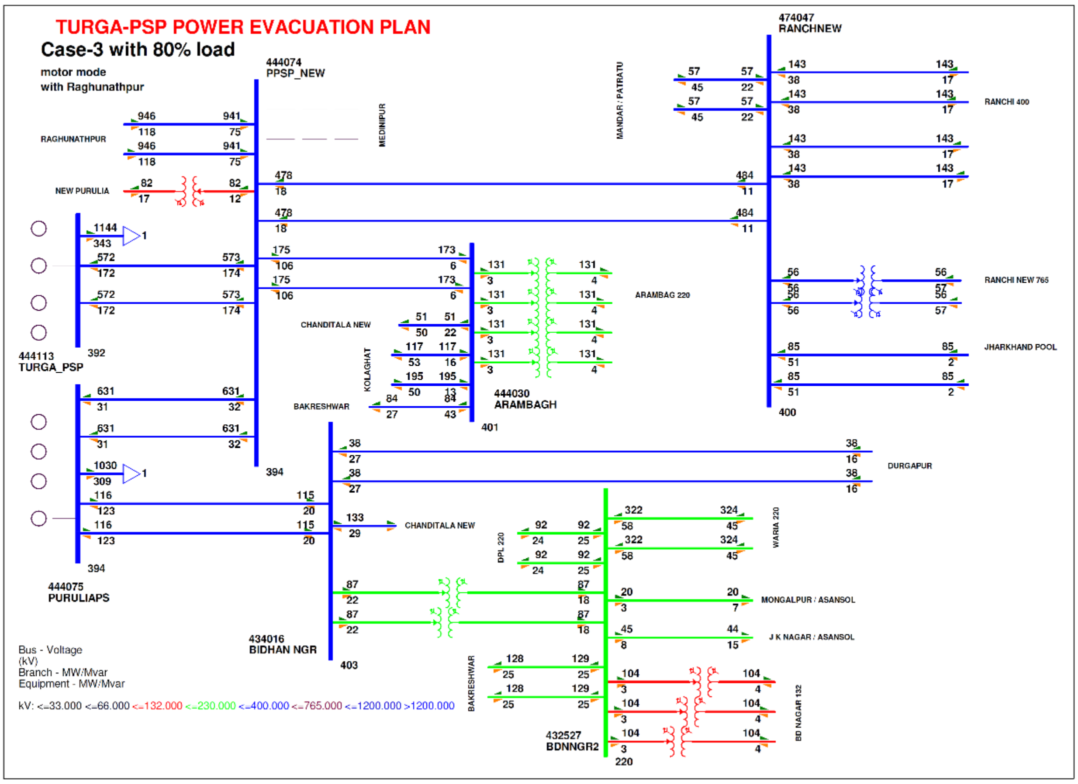


Figure 10.1.4-2 Result of Load Flow Analysis for Case No.3B

This time the power system analysis was conducted for 2023-24 timeframe as there is a restriction of obtaining or unavailability of estimated data beyond that. It is confirmed that Turga PSP has been set backwards for its commencement of operation till 2026-27. Therefore it is possible that power flow may increase in possible demand growth. But as the impact on load flow is Turga PSP operation as shown in Table 10.1.4-3, so there is a low possibility to cause the restriction on Turga PSP operation due to system constraints for the time being.

However the power development in India keeps on in line with demand growth and economic growth, steady implementation of the above measures as well as transmission development in West Bengal state should take place at appropriate timing and these should be observed as the Turga PSP project progresses.

(2) Short-circuit capacity calculation

Table 10.1.4-5 shows calculation results of fault current when three-phase ground fault or single-line to ground fault occur at each bus-bar at near Turga PSP at each load condition.

Table 10.1.4-5 Three Phase and Single Line to Ground Short Circuit Current near Turga PSP Site

Sl. No.	Name of S/s (design short circuit level)	kV	Peak Load		Off Peak Load		Low Hydro Gen	
			3-phase(A)	L-G(A)	3-phase(A)	L-G(A)	3-phase(A)	L-G(A)
Without Strengthening								
1	BIDHAN NGR (40kA)	400	26,521	19,935	22,878	17,235	24,298	18,167
2	ARAMBAG (40kA)	400	25,568	18,382	23,351	16,705	23,127	16,527
3	PPSP_NEW (50kA)	400	33,253	31,396	17,449	10,840	19,390	12,207
4	PURULIA_PSP (50kA)	400	32,588	30,732	17,172	10,654	19,149	12,046
5	TURGA_PSP (63kA)	400	28,347	27,387	15,498	9,542	17,010	10,586
6	RANCH_NEW (63kA)	400	60,749	44,544	57,595	42,136	57,919	42,402

With Strengthening

Sl. No.	Name of S/s	kV	Peak Load with PPSP(New) – Raghunathpur T/L	
			3-phase(A)	L-G(A)
1	BIDHAN NGR (40kA)	400	26,919	20,103
2	ARAMBAG (40kA)	400	27,869	19,335
3	PPSP_NEW (50kA)	400	26,019	18,544
4	PURULIA_PSP (50kA)	400	40,948	37,355
5	TURGA_PSP (63kA)	400	39,700	36,112
6	RANCH_NEW (63kA)	400	33,376	31,065
7	MEDINIPIUR (63kA)	400	60,644	44,487
8	RAGHUNATHPUR (50kA)	400	43,449	37,792

At DPR analysis, there were a lot of cases that exceeded the rated breaking capacity of the existing circuit breaker on bus bars in some sub-stations or deviated from transmission planning criteria. But this time, as the assumed peak load is to decrease compared to what was seen in the DPR, and also as planned transmission system will be enhanced since then, no case was observed that fault currents affects these facilities. Also, no issues were observed even though proposed new transmission lines will be installed in order to eliminate the overload.

However, as the new transmission line development plan of the PPSP (New) – Jamshedpur 400kV D/c proposed by PGCIL at that time was excluded from this overload countermeasure proposal due to the increase of fault current level in Jamshedpur with the expansion of the Indian power system since the DPR preparation, the possibility is high for fault current level would increase beyond the above result by 2026-27 when Turga PSP is planned to commence operation.. Thus, it is necessary to monitor the fault current level near Turga PSP periodically. But yet, considering the fact that such current level can be controlled by newly installed generator step-up transformers with adequate impedance or operation procedures/methods such as changing system configuration and bus separations, or that new transmission lines can be constructed within 3-4 years in current India, the possibility of increasing the fault current in the future will not be a significant risk with regards to the Turga PSP project.

(3) Dynamic stability analysis

Dynamic stability analysis was carried out in accordance with the Manual, focusing not only on the Turga PSP but also on the existing Purulia pumped-storage power plant (Purulia PSP).
More specifically, the response of both pumped-storage power plants and system stability are confirmed in case of the following two types of transmission line faults, which deemed to be severe for both pumped-storage power plants, for each of three demand scenarios as shown in the load flow calculation.

<Fault type>

1) N-1 contingency

   Three phase to ground fault has been simulated on 400kV line close to bus followed by 3-pole opening of the transmission line after 100ms.

2) N-1-1 contingency

   Contingencies have been simulated with two sequential three phase faults on two transmission lines close to bus with interval of 2 sec between them, followed by 3-pole opening time of 100ms for each.

The transmission line fault was applied at 5 places as shown Figure 10.1.4-3. Table 10.1.4-6 shows the simulation cases with each result. The response of Turga PSP of case A1 (Machine angle) is shown in figure 10.1.4-4 as a typical example of this study.

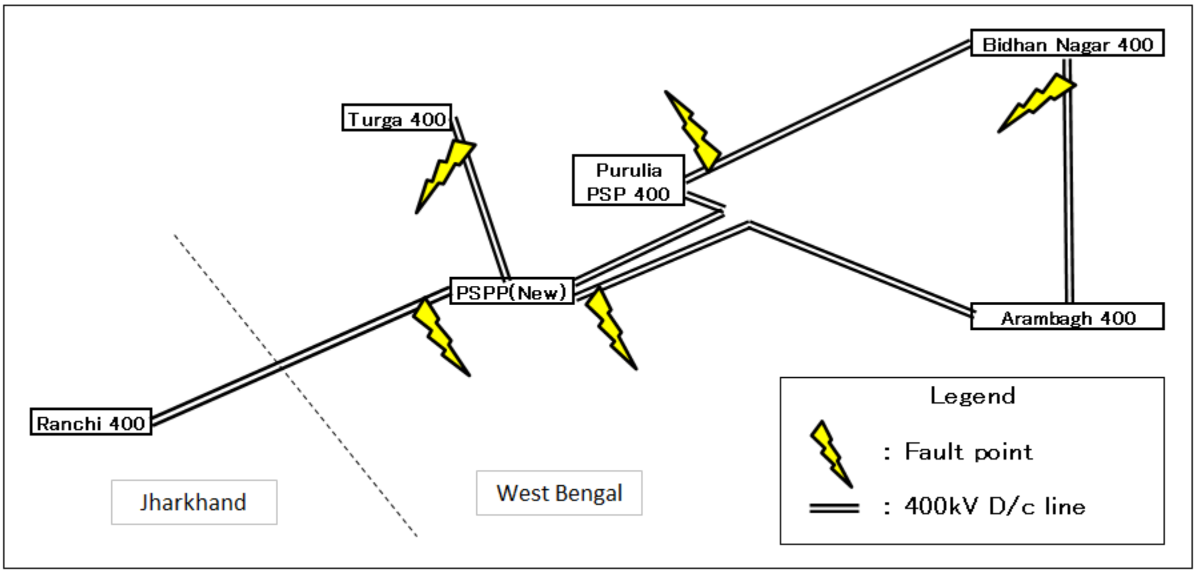


Figure 10.1.4-3 Fault Point in Dynamic Stability Study

Table 10.1.4-6 Dynamic Stability Study Cases and Each Result

Case	Scenario	Fault type	Fault situation	Stability
A1	Peak	N-1	3 phase fault close to PPSP(New) bus in one circuit of PPSP(New)-Ranchi(New) 400kV D/c line	Stable
A2		N-1	3 phase fault close to Purulia PSP bus in one circuit of Purulia PSP-Bidhan Nagar 400kV D/c line	Stable
B1	Light	N-1	3 phase fault close to PPSP(New) bus in one circuit of PPSP(New)-Ranchi(New) 400kV D/c line	Stable
B2		N-1	3 phase fault close to Purulia PSP bus in one circuit of Purulia PSP-Bidhan Nagar 400kV D/c line	Stable
B3		N-1-1	3 phase fault close to PPSP(New) bus in both circuits of PPSP(New)-Ranchi(New) 400kV D/c line	Stable
C1	Low Hydro	N-1	3 phase fault close to PPSP(New) bus in one circuit of PPSP(New)-Ranchi(New) 400kV D/c line	Stable
C2		N-1	3 phase fault close to Purulia PSP bus in one circuit of Purulia PSP-Bidhan Nagar 400kV D/c line	Stable
C3		N-1-1	3 phase fault close to Purulia PSP bus in both circuits of Purulia PSP-Bidhan Nagar 400kV D/c line	Stable
C4		N-1-1	3 phase fault close to Turga PSP bus in both circuits of Turga PSP-PPSP(New) 400kV D/c line	Stable
C5		N-1	3 phase fault close to Bidhan Nagar bus in Bidhan Nagar-Arambagh 400kV S/c line	Stable
C6		N-1-1	3 phase fault close to PPSP(New) bus in one circuit of PPSP(New)-Arambagh 400kV D/c line	Stable
C7		N-1	3 phase fault close to PPSP(New) bus in both circuits of PPSP(New)-Arambagh 400kV D/c line	Stable

Dynamic stability analysis consisted of verifying system frequency, bus voltage and relative angles of 400kV bus at Ranchi (New), PPSP (New), Purulia PSP, Bidhan Nagar and Turga PSP as well as relative angle of Turga PSP (Peak load condition and Low Hydro scenario) and Kolaghat generator (Light load condition), and it was confirmed they all turned out to be stable in every case as they were in DPR.

Furthermore, at the year 2026-27 when Turga PSP will commence its operation, Indian electric power system will be further developed and enhanced. Generally, as the number of interconnected generators increase in line with the enlargement/enhancement of power system, dynamic stability (synchronous stability) shows a tendency to increase and system impact of a generator trip would relatively become less, so there is no risk that the dynamic stability would become lowered in the future from the simulation result of this time, and rather would be more stabilized. Therefore, it is concluded there is no dynamic stability issues with Turga PSP.

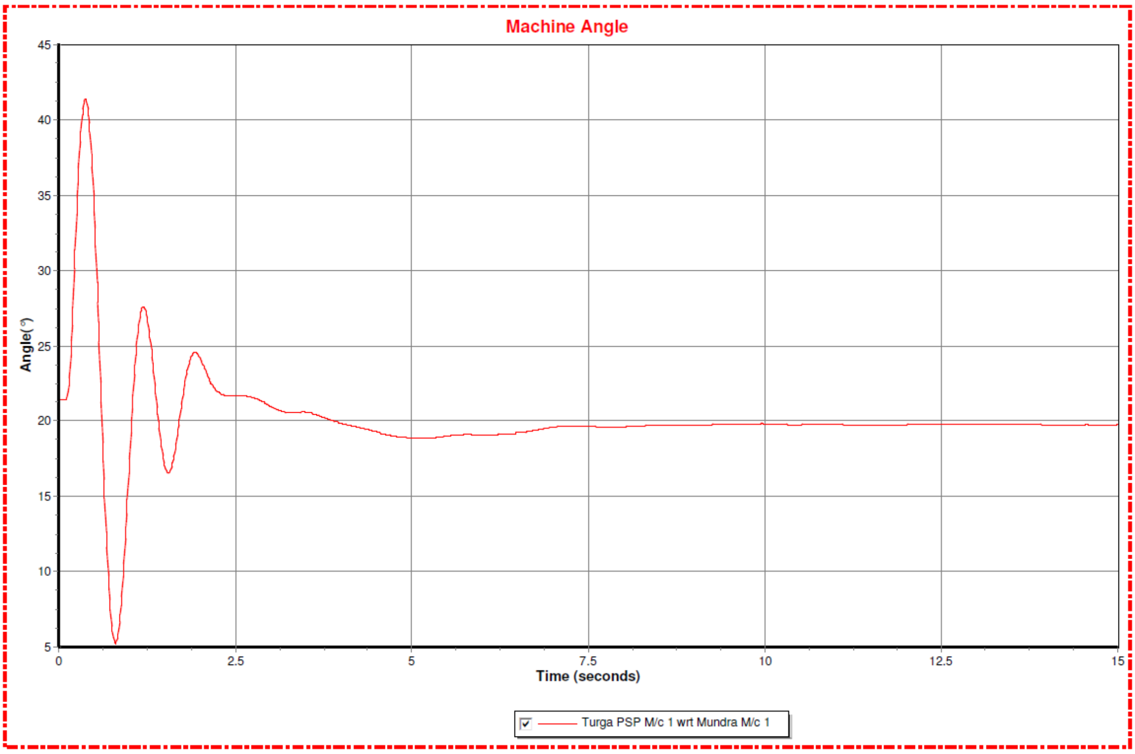


Figure 10.1.4-4 Result of Dynamic Stability Analysis for Case A1 (Turga PSP Machine Angle)

10.2 TRANSMISSION LINE DESIGN

10.2.1 Transmission Capacity

(1) Required Transmission Capacity

Turga PSP (4 × 250MW) each of the generator-motors draw maximum power of 291 MW (= maximum pump input 285 MW/motor efficiency 0.98) against 250MW in generation mode. Thus, the immediate evacuating line should be capable of carrying 1164 MW (= 291 MW × 4 units) by single circuit at emergency condition.

(2) Transmission Planning Criteria and Temperature Condition

According to information are obtained from CEA's (*) Transmission Planning Criteria (published in January 2013) and description in IS 802, following conditions are decided to use for calculations of the transmission capacities of the transmission line.

(*): Central Electricity Authority

- Ambient temperature; 45 deg. Celsius,
- Max. conductor temperature (for ACSR at normal condition); 75 deg. Celsius,
- Max. conductor temperature (for ACSR at emergency condition); 85 deg. Celsius

(3) Conductor Type

As for some types of ACSR conductors described in CEA's Transmission Planning Criteria, transmission capacities of those ACSR conductors are calculated and shown in Table 10.2.1-1.

Among those conductor types in Table 10.2.1-1 have enough capacities to transmitted required transmission capacity as 1164 MW, quadruple Moose conductor is selected as the most preferable type for the transmission line. The reason is as follows.

- Moose conductor (quadruple-bundled or twin-bundled) is generally used for 400kV transmission lines in WBSEDCL service area. Adjacent transmission lines from Purulia PSP are also composed by Moose conductor.
- Standardizations and unifications of conductor types can be helpful for simplifications of maintenance works and asset managements. And, storage materials can be decreased as a result of communalizations of materials for restorations.

Table 10.2.1-1 Transmission Capacity for Each Conductor Type

Conductor Type	Metallic Area [sq.mm]	Diameter [mm]	at Continuous Condition (Ambient Temp.=45degC, Max.Conductor Temp.=75degC)					at Emergency Condition (Ambient Temp.=45degC, Max.Conductor Temp.=85degC)				
			Ampacity	Transmision Capacity (Power Factor is condsidered as 0.8)				Ampacity	Transmision Capacity (Power Factor is condsidered as 0.8)			
			[A]	x 1 conductor (Single) [MW]	x 2 conductors (Twin) [MW]	x 3 conductors (Triple) [MW]	x 4 conductors (Quad.) [MW]	[A]	x 1 conductor (Single) [MW]	x 2 conductors (Twin) [MW]	x 3 conductors (Triple) [MW]	x 4 conductors (Quad.) [MW]
ACSR Zebra	484.00	28.62	560	310	620	930	1240	703	390	780	1170	1560
ACSR Moose	597.00	31.77	631	350	700	1050	**1400**	798	442	884	1326	**1768**
ACSR Snowbird	552.23	30.57	630	349	698	1047	1396	795	441	882	1323	1764
ACSR Bersimils	724.69	35.04	732	406	812	1218	1624	933	517	1034	1551	2068
ACSR Lapwing	863.47	38.22	773	428	856	1284	1712	992	550	1100	1650	2200

🟨 : > Required Tranmission Capacity (1164[MW])

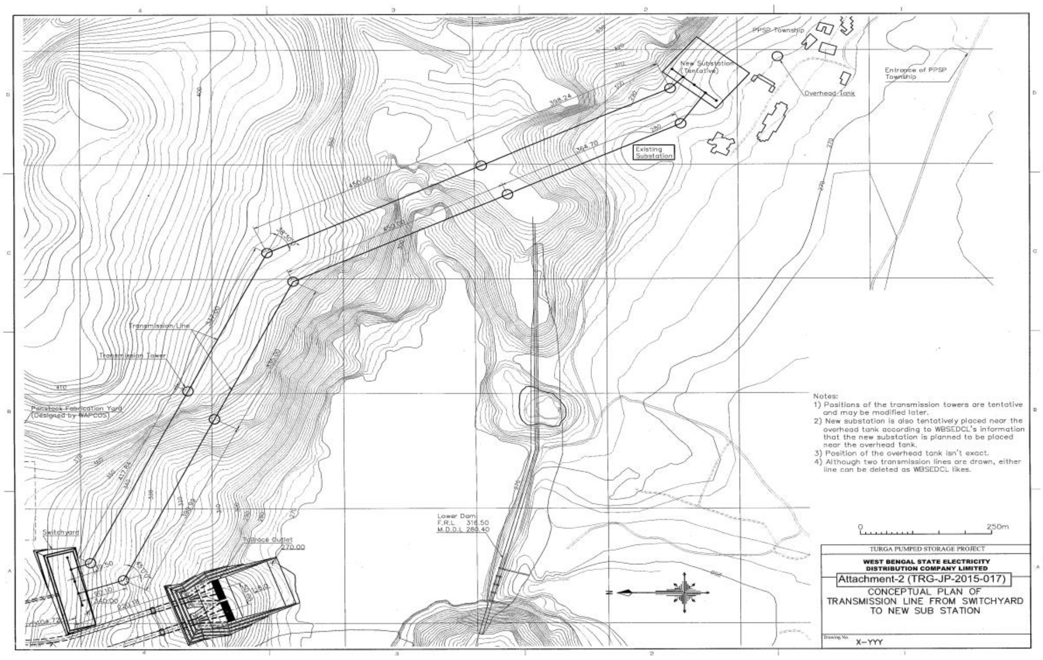
10.2.2 Transmission Line Route and New Substation

(1) Transmission Line Route

Proposed route for the transmission line from ‘Turga PSP switchyard’ to ‘PPSP New substation’ is shown in Figure 10.2.2-1. The transmission line route is selected in consideration with following points.

- Bending points on transmission line route are minimized.
- Generally, transmission line route with each span length as approximately 350 m to 450 m is the most economical. Thus, the route and tower locations are considered to keep each span length as 350m to 450m.
- Tower locations are considered not to rise tower height such as not to cross the existing transmission line.
- In order to reduce the environmental burden and reduce the construction cost, the tower position is selected in the vicinity of the construction road for construction of the power station so as not to install the transportation facilities for construction as much as possible.

From the above viewpoint, it can be considered as the optimal power transmission route at the present time. However final transmission route and tower locations are necessary to be determined after conducting tower site geometry and geological investigations with those results.



Notes:
1) Positions of the transmission towers are tentotive and may be modified later.
2) New substation is also tentatively placed near the overhead tank according to WBSEDCL's information that the new substation is planned to be placed near the overhead tank.
3) Position of the overhead tank isn't exact.
4) Although two transmission lines are drawn, either line can be deleted as WBSEDCL likes.

Figure 10.2.2-1 Conceptual Plan of Transmission Line from Switchyard to New Sub Station

(2) Location of PPSP-New Substation

The location of site for PPSP New Substation is fixed, and it is as shown in Figure 10.2.2-1. However, the layout between New Substation and transmission line needs to be reconsidered after determinations of detailed condition.

10.2.3 Estimates of Costs

Estimated cost for the transmission line from 'Turga PSP switchyard' to 'PPSP New substation' is shown in Table 10.2.3-1.

Table 10.2.3-1 Estimated Cost of the Transmission Line and Bay work

(Not be disclosed per cost related information)

10.3 SWITCHYARD DESIGN

10.3.1 Constitution of Switchyard Equipment

(1) Constitution of Switchyard Equipment

A gas insulated switchgear (GIS) is adopted to compose 400kV switchyard equipment. GIS contains busbars, circuit breakers, disconnectors, earthing switches, instrument transformers, etc. This GIS is installed in a building equipped with an electric overhead travel crane (EOT crane) to lift GIS in case of maintenance and repair. The other building is prepared to contain control boards and protective relay boards for the switchyard.

Two (2) transmission lines from *New PPSP Gas Substation* are connected to the switchyard. A gantry is installed for these two (2) transmission lines, moreover, a gantry for additional two (2) transmission lines which are supposed to be developed in future is installed. Lightning arresters, potential transformers, line traps and coupling capacitors are installed outdoor for two transmission lines.

The dimension of the switchyard area is planned to be 165m and 50m. Comparing the drawing of *General Layout Plan* with the site condition, sufficient area for the switchyard is considered to be ensured.

(2) GIS

A double busbar system is applied to the 400kV switchyard. According to the single line diagram of 400kV Switchyard, GIS includes bus bars, nine (9) circuit breakers, twenty-six (26) disconnectors, twenty-six (26) earthing switches, instrument transformers, etc. In such case, GIS is usually supposed to be composed with nine (9) units which consists of four (4) transmission line units, four (4) generator units and one (1) bus tie unit. Considering layouts of switchyard equipment of similar plants, GIS can be installed in the building shown in the drawing of *Switchyard Plan*.

GIS is equipped with SF6 gas pressure sensors to detect deviation of SF6 gas pressure from normal range.

(3) Circuit Breaker

The circuit breakers are of SF_6 gas puffer type with pneumatic or hydraulic operating mechanism, and arranged for automatic one-pole and three-pole high speed reclosing service. They are of electrically and mechanically trip-free type. Dual-trip coils are furnished for each circuit breaker and it can be tripped effectively by operation of either coil.

The primary specifications of circuit breakers of the GIS are listed below.

- Rated voltage: 420kV
- Rated normal Current: 2,000A
- Rated short circuit breaking current: 50 kA
- Rated frequency: 50 Hz
- Rated operating duty:

  For transmission line and bus tie
  O-t-CO-t’-CO
  where, t= 0.3 sec, t’= 60 sec

  For generator-motor
  CO-t”-CO
  where, t”= 15 sec

- Rated lightning impulse withstand voltage: 1,425 kV

(4) Disconnector

The disconnectors and earthing switches are of pneumatically-operated or motor-operated type. The disconnectors are able to interrupt the charging current of 400 kV bus and other equipment.

The primary specifications of disconnectors of the GIS are listed below.

- Rated voltage: 420kV
- Rated normal Current: 2,000A
- Rated frequency: 50 Hz
- Rated short time (2 sec) withstand current:50 kA
- Rated peak withstand current: 100 kA
- Rated lightning impulse withstand voltage: 1,425 kV

(5) Current Transformer

The primary specifications of current transformers in the switchyard are listed below.

- Rated primary current: 2,000 A
- Rated secondary current: 1 A
- Rated frequency: 50 Hz
- Rated lightning impulse withstand voltage: 1,425 kV
- Accuracy class
    - For protection: Class 5P
    - For measuring: Class 1.0

Accuracy class will be reviewed and finalized in cooperation with measuring devices and protection relays in a detailed design.

(6) Voltage Transformer

The primary specifications of voltage transformers in the switchyard are listed below.

- Rated primary voltage: 400 kV/$\sqrt{3}$
- Rated secondary voltage: 110 V/$\sqrt{3}$
- Rated frequency: 50 Hz
- Rated lightning impulse withstand voltage: 1,425 kV
- Accuracy class
    - For protection: Class 3P
    - For measuring: Class 1.0

(7) XLPE Cable

Single core 400kV XLPE cables will be installed from the underground powerhouse to the switchyard through the cable tunnel to connect the main transformers and the GIS in the switchyard. Length of the cable route is estimated to be approximately 350 m. The rated current of the main transformer at the secondary side is calculated as 476 A based on the rated capacity and voltage, and the maximum 3-phase short circuit current at the switchyard is assumed to be 50 kA according to CEA's guideline. The conductor size of the 400 kV XLPE cable is determined to be 630 mm^2 based on these parameters.

The primary specifications of the XLPE cables are listed below.

- Rated voltage: 400 kV
- Conductor Size: 630mm^2
- Outer diameter of cable: approx. 120 mm
- Maximum operating temperature: 90°C (2 sec)
- System basic impulse insulation level: 1,425 kV
- Number of circuits: 4 ccts + 1 spare cable

Oil insulation is applied to the terminal box of the cable to enhance insulation of the cable head. Therefore, an oil tank and oil supply equipment are equipped with the terminal box.

10.3.2 Switchyard Design

(1) Insulation design

One set of surge arrester is installed at the each connecting point of the 400kV outgoing transmission line in order to protect the switchyard equipment from lightning surge. A gap-less ZnO surge arrester with nonlinear resistance will be adopted due to its good nonlinear characteristic.

The primary specifications of arresters in the switchyard are listed below.

- Type: Gap-less with ZnO elements
- Rated voltage: 390 kV
- Rated frequency: 50 Hz
- Normal discharge current: 10 kA

Table 10.3.2-1 The Surge arrester has non-linear resistance

Voltage (kV)	Current (A)
0	0
540	0.001
845	10,000
910	15,000
980	20,000
1080	40,000

Considering the dimension of the switchyard equipment such as GIS, it is considered that surge arresters installed at the connecting points of the outgoing transmission lines are able to protect entire switchyard equipment, but the main transformers cannot be protected by these surge arresters because the main transformers are substantially away from these surge arresters. Therefore, surge arresters are needed at the incoming lines to the main transformers.

In a detailed design, it shall be confirmed where surge arresters are installed by executing a lightning surge analysis.

(2) Grounding and lightning protection

As for lightning protection for the outside switchyard equipment such as gantry to connect the outgoing transmission lines, grounding wire is applied. The metal enclosure of the isolated-phase bus between the gantry and the building is grounded firmly.

Grounding conductors are laid under the ground in the switchyard area to form a grounding mesh. Earth resistance shall satisfy requirements on touch voltage and step voltage stipulated in IEEE Std 80-2000. In a detailed design, touch voltage and step voltage will be calculated based on earth resistivity measured in the switchyard area and grounding mesh shall be designed to ensure that calculated values satisfy requirements stipulated in IEEE standard.

(3) Salt damage

Since the area of TPSP is located approximately 230 km away from the coast, salt damage doesn’t need to be considered in design of the switchyard equipment.

(4) Noise

Level of noise emitted from the switchyard shall comply with the regulation, *The National Environment (Noise Standard and Control) Regulations, 2003*.

Noise from the main transformers doesn’t need to be considered because the main transformers are planned to be installed in the underground powerhouse. Therefore, noise from the circuit breakers and the emergency generator needs to be considered. Noise from the circuit breaker is impulsive noise. If the noise exceeds the requirement stipulated in the regulation, a soundproof wall is added or a soundproof building is adopted. As for noise from the emergency generator, the generator needs to be installed in a soundproof building.

Table 10.3.2-2 Maximum permissible noise level

Facility	Noise limits B (A) (Leq)	
	Day 6:00am - 10:00pm	Night 10:00pm - 6:00am
A. Any building used as hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms,	45	35

public library, environmental or recreational sites.		
B. Residential buildings	50	35
C. Mixed residential (with some commercial and entertainment)	55	45
D. Residential + industry or small-scale production + commerce	60	50
E. Industrial	70	60

(source: The National Environment (Noise Standard and Control) Regulations, 2003)

Table 10.3.2-3 Maximum permissible noise level for impact or impulsive noise

Sound level dB (A) (Lmax)	Permitted number of impulses or impacts per day
140	100
130	1,000
120	10,000

(source: The National Environment (Noise Standard and Control) Regulations, 2003)

(5) Fire Protection

Ionization smoke detectors and rate of rise heat detectors will be installed in the buildings in the switchyard, and the room for security personnel will be equipped with a fire alarm control panel which collects signal from the detectors and displays information.

Dry chemical fire extinguishers, CO_2 fire extinguishers and water mist fire extinguishers will be equipped with the switchyard.

(6) Ventilation

The buildings for the GIS and the control panels should be equipped with a ventilation system. In particular, computer and control/relay panel rooms should be equipped with an air conditioning system.

It is planned that the cable tunnel is used as a ventilation duct to exhaust air from the underground powerhouse to outdoor and moreover ventilation fans are equipped at an outlet of the ventilation duct. Since, in the current design, layout of a ventilation duct and ventilation fans in the switchyard isn’t shown clearly in the relative drawings, this layout needs to be studied.

(7) Communication System

Power line carrier communication system (PLCC) is adopted as a main communication system between TPSP and other electrical facilities such as substations. A line trap and a coupling capacitor are attached to the each transmission line from TPSP. In addition to PLCC, optical ground wire (OPGW) is applied for a back-up communication method.

10.3.3 Protection Relay

(1) Transmission line

In general, a differential relay is adopted as a main protection relay and a distance relay is adopted as a back-up relay. In TPSP, a distance relay is adopted as a main relay because the transmission line from TPSP to the substation, *New PPSP GIS Substation*, where the transmission line outgoing from TPSP will be connected, is 3km long and categorized as a short-length transmission line.

(2) Busbar

A percentage differential relay is adopted for protection of the busbar. This protection relay is able to interrupt two (2) busbars selectively.

(3) XLPE cable

A percentage differential relay is adopted as a main protection relay, and an overcurrent relay is adopted as a back-up relay.

In conclusion, no specific issues have been considered as far as the DPR is concerned.

CHAPTER 11

ENVIRONMENTAL
AND
SOCIAL CONSIDERATION

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CHAPTER 11 ENVIRONMENTAL AND SOCIAL CONSIDERATION

The Project was planned and prioritized to contribute to the achievement of stable power supply and better quality of power in West Bengal State and eastern part of India. An environmental impact assessment (EIA) was conducted in accordance with the Indian legislation and its report was compiled in April 2016, to which the Environmental Advisory Committee (EAC) of the Ministry of Environment, Forest and Climate Change (MoEFCC) gave a recommendation for an environmental clearance (EC) in June 2016. There also held a Forestry Advisory Committee (FAC) Meeting in Delhi on 25 January 2018, in which the FAC recommended for the stage-I forest clearance (FC).

In the JICA Preparatory Survey, in parallel with the above official procedures in India, the EIA has been perused to confirm environmental and social impacts, and environmental and social supplemental survey were conducted that met the requirements of the JICA Guidelines for Environmental and Social Considerations (issued in April 2010) to seek the possibility of applying a Japanese ODA finance to the Project.

11.1 OUTLINE OF PROJECT COMPONENTS THAT MAY CAUSE ENVIRONMENTAL AND SOCIAL IMPACTS

This project is comprised of the following four components from (1) to (4).

1. **Construction of a pumped storage power generation facilities (upper reservoir, lower reservoir, power intake, intake tunnel, penstock, tailrace tunnel, tailrace outlet, underground powerhouse (output: 250 MW *4), etc.)**
2. **Procurement of materials and installation works**
3. **Extension of transmission lines and towers (approximately 1.7 km from the switchyard to the existing power substation)**
4. **Provision of consultancy services (detailed design, assistance for tenders, supervision of construction works, etc.)**

According to the WBSEDCL, the Project will require approximately 300 ha of land, of which 292 ha is to be diverted for the pumped storage power plant and associated facilities[1], and 7.82 ha for transmission line ROW and tower locations. 292 ha for Turga PSP is comprised of 234 ha of forest land, 58 ha of non-forest land (34 ha of irrigation reservoir that presently belongs to the Irrigation & Waterways Department (I&W Dept.), and 24 ha of WBSEDCL's land and private land). The tenure of the irrigation reservoir will be transferred to WBSEDCL, and 24 ha may be temporarily used or leased. The submergence area for upper and lower reservoirs is 146.589 ha. The lower reservoir is planned to

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[1] The usages of the required land (292 ha) are: 146.589 ha for upper and lower reservoirs, 16.332 ha for civil structures, 16.332 ha for construction facilities, 18.60 ha of stockpile, processing and disposal areas, 21.97 ha for project roads (permanent and temporary), 18.60 ha for rock quarry areas 42.401 ha for borrow areas (clay areas), and 8.537 ha for other project components. Besides, sufficient space for soil disposal (13.37 ha) is already obtained if the soil piles up to a height of 20 meters without compaction.

be developed by expanding the existing irrigation reservoir.

11.2 OVERVIEW OF THE PRESENT STATE OF THE PROPOSED PROJECT AREA

11.2.1 Natural Environment

(1) General descriptions of natural environment of Turga PSP construction area

The Turga Pumped Storage Project (Turga PSP) will be located on Ajodhya hills as same as Purulia Pumped Storage Plant (PPSP), the existing power plant. Turga PSP will renovate existing irrigation reservoir as the lower reservoir. On the other hand, the upper reservoir will be newly established.

Table 11.2.1-1 Land use condition of the Survey area

Land use	Area (ha)	Rate (%)
Settlements / Waterbody	223	0.73
Grassland	13,189	31.13
Agricultural land	12,325	29.09
Barren land / Rocky outcrops	10,839	25.58
Shrub	5,708	13.47
Total	**42,367**	**100.00**

source: DPR and EIA Report

The land use pattern of the survey area is given in Table 11.2.1-1. The major land use category in the area is grassland as it accounts for 31.13 %. Following that, agricultural land accounts for 29.09 % and Barren land/Rocky outcrops occupy 25.58 %. On the other hand, settlements and water bodies account only for about 0.2 % and 0.53 %, respectively. In the area, shrubby woodland accounts for 13.47 %. This woodland is sparsely and their stand densities are estimated approximately 1,000 - 1,200 ha^{-1}. According to Indian classification, the woodland is fallen into Northern Tropical Dry Deciduous Forest type and Dry peninsular sal (*Shorea robusta*) forest. Since time immemorial the local people have been using large number of wild plant resources from the woodland as medicinal value, edible plants, fodder, timber, etc.

Generally the survey area has a dry climate with large variations in temperature and scanty rainfall. The climate of Purulia district can be divided into four distinct seasons. The winter season lasts from November to March which is followed by summer season from April to June. The monsoon season begins in July and ends by mid-September. The period from mid-September to October is the post-monsoon season or the retreating monsoon season.

There is no Wildlife sanctuary, National park or Biosphere Reserve present within the survey area. For that matter, the area is largely a degraded ecosystem due to high human pressure, large scale lopping and removal of fodder and timber species for preparation of agricultural fields, grazing, construction of road, etc. As per Red Data Book of India, no rare and endangered species are reported from the survey area.

Mammalian fauna of the surroundings of the project area comprises of more than 25 species that come from 16 families. According to the EIA Report submitted to the MoEFCC in 2016 a total number of 66 species of birds were encountered during the survey period.

Based on the EIA and DPR, assumed impacts on the natural environment by construction of Turga PSP will be summarized in the next section.

(2) Impact on the vegetation by constructions of Turga PSP and related facilities

1) Upper Reservoir Area

Figure 11.2.1-1 shows general view of proposed upper dam area. The area crosses Turga Nala which is a tributary of Subarnarekha River, and the catchment area is calculated as 8.29 km^2. It is planned to construction by excavating construction method using existing water system, and the catchment area will be approximately 1.17 km^2. There is no rare and endangered species are reported from the survey area as mentioned above.

source: DPR Survey Team, April 2014

Figure 11.2.1-1 General View of Proposed Upper Dam Area

2) Powerhouse and Waterways

Since power plants and waterways are constructed as underground structures, no impact on the vegetation is assumed. The surface geology is dominated by hard granite gneiss. Alfisols (red weathered soil) characterized by low nutrients and water retention is narrowly distributed.

Figure 11.2.1-2 General View of Proposed Outlet Area

3) Construction Road (Approach Road)

Proposed construction area of approach road is also sparse shrub land on the hard granite and immature soils.

4) Tailrace Outlet

Proposed outlet site is located on the right bank of lower dam and presents a bald mountain where shrubs partially grow on the exposed basement rock (Figure 11.2.1-2). Vegetation density is slightly higher than the surrounding area of the upper dam site because the ground surface is relatively wet due to the accumulation of surface water.

5) Lower Reservoir

An overview of the natural environment in the surrounding area of lower dam site is similar to the outlet site. A bald land where shrubs partially grow on the exposed basement rock is observed (Figure 11.2.1-3). According to the EIA report, the water quality of irrigation reservoir has no particular problems in general items and nutrient content.

source: DPR Survey Team, April, 2014

Figure 11.2.1-3 General View of the Existing Irrigation Reservoir and Surroundings

According to the EIA report, water pH value of this irrigation reservoir only showed weak alkalinity (approx. pH 8) in each season among 4 observation points including upper and down stream of the planned upper reservoir area. The results are considered to be the influence of photosynthesis by phytoplankton growing in stagnant water and no concern of water quality abnormality. On the other hand, the lower reservoir will be established by extending ready-made irrigation reservoir in the project as mentioned above. For the expansion work, predicting flow rate between the upper and lower reservoir was calculated based on precipitation and flow volume for more than six decades (from 1958 to 2012), and the EIA report concluded there was no specific negative impact anticipated to reduce amount of water usable for irrigation after construction work.

6) Switchyard

Surroundings of proposed switching yard site is also dwarf broad-leaved tree area and shrubland growing on rocky stretch consisted of granitic gneisses.

7) Transmission Lines

As same as condition of the switching yard site, surrounding area of proposed transmission line facilities is also dwarf broad-leaved tree area and shrubland growing on rocky stretch consisted of granitic gneisses.

8) Soil Disposal Site

The Project will generate construction-derived soils on the order of 3.2 million m^3. Assuming that expansion ratio is 25 %, actual total amount of the soil is estimate 4 million m^3. Since half of them are used as construction materials, the remaining 2 million m^3 of the generated soil will be discarded. Terraces created in a hilly area is planned to be used at the soil disposal areas.

The soil disposal plan will be drawn up in the detailed design stage or later including construction of multistep terraces with a height of about 10 meters each for mild-sloping and stabilization with installation of revetments, drainage facilities, rolling compaction of disposal soil, and so on through the appropriate construction management. Forest Clearance obliges implementation of soil disposal plan to prevent collapse with stabilization of revetment and terrace under the supervision of the Forest Department of West Bengal State. Therefore, safety on the construction is secured by regulatorily and technically.

The sites for disposal area are plotted in Annexure 11-1. The total 6 sites are selected for stockpile, processing, and disposal areas (186,000m2). The allocations for each haven't been determined in DPR but most probable 2 sites for disposal occupy 70% of the area (133,700m2) would suffice the required 2 Million m3 assuming 20m height. More volume can be deposited when rolling compaction is counted.

(3) Impact on Animals by Construction of Turga PSP and Related Facilities

1) Terrestrial Fauna

According to the EIA report and DPR, mammalian fauna of the surrounding areas of the Project comprises of more than 25 species that come from 16 families. Rhesus Macaque and Common Langur inhabit forested as well as settlement areas and are common in their presence. All the members of cat family mentioned below prefer to inhabit the lower and open areas in the region. Jungle Cat is sighted frequently by villagers near settlement area at day time. Jackal covers a wide range of habitat and spotted by villagers frequently in and around the settlement. Wild Boar is a nocturnal animal and raids agricultural fields at night. It is found in inner and open forest areas. Grey Mongoose, Brush-tailed Porcupine, Indian Hare prefer to inhabit scrub forests while Pangolin is predominant in the Sal and mixed forest to meet its food requirement, feeds on ants. Tree Shrew is widely distributed in the area, found in forest as well as settlement areas.

In DPR, Dhole (*Cuon alpinus*: EN), Asian Elephant (*Elephas maximus*) and Sloth Bear (*Melursus ursinus*) were observed in the Project area in the past. However, the main habitat of Dhole is usually in the highland with altitude of 3,000 m or more. Besides, geographic ranges[2] of those three endangered species which are officially announced by International Union for Conservation of Nature and Natural Resources (IUCN) suggests that they do not inhabit in the Project area. Figure 11.2.1-4, Figure 11.2.1-5 and Figure 11.2.1-6 illustrate geographical distributions of Dhole, Asian Elephants and Sloth Bear by IUCN, respectively. However, the scales in each figures are added by JICA Study Team only as a guide.

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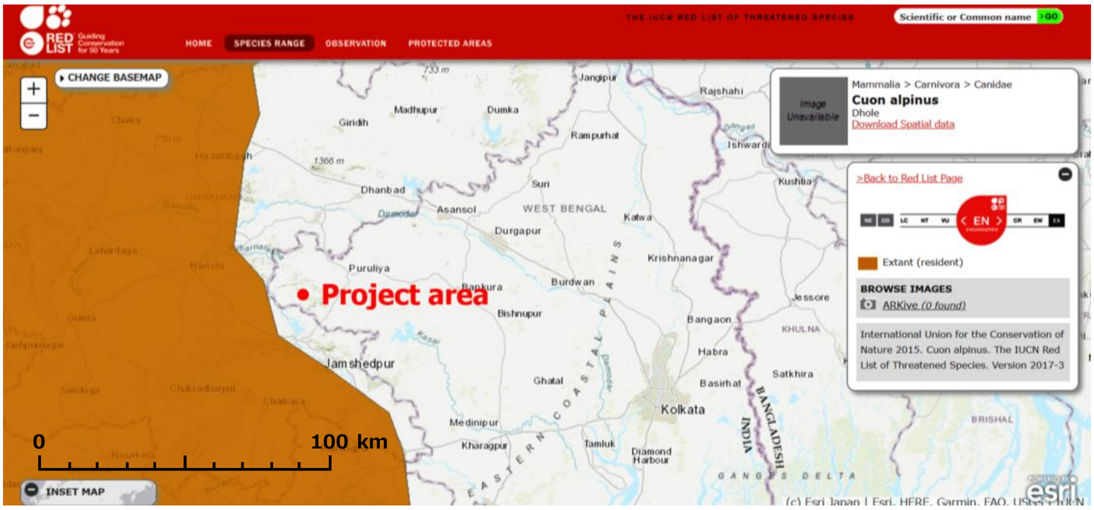
[2] http://www.iucnredlist.org/ (accessed in late September 2017)

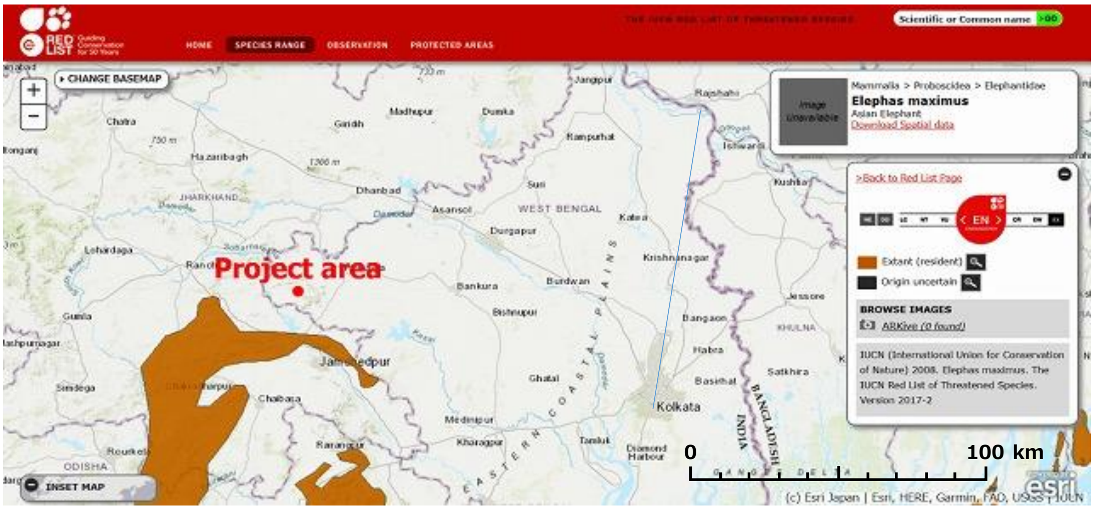


International Union for the Conservation of Nature 2015. Cuon alpinus. The IUCN Red List of Threatened Species. Version 2017-3

(c) Esri Japan | Esri, HERE, Garmin, FAO, USGS | IUCN

source: http://maps.iucnredlist.org/map.html?id=5953 , visited on September 2017

Figure 11.2.1-4 Geographical Distribution of Dhole

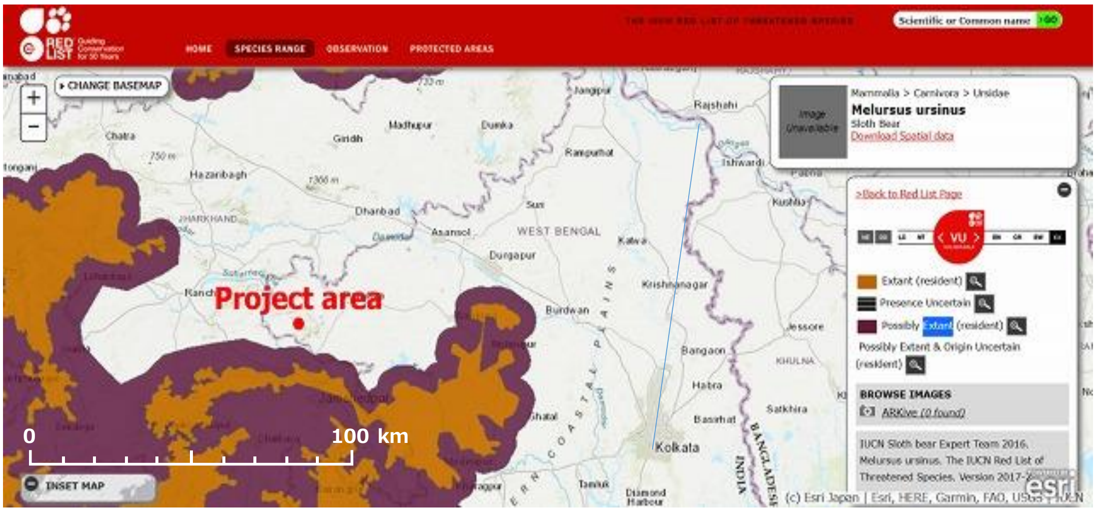


IUCN (International Union for Conservation of Nature) 2008. Elephas maximus. The IUCN Red List of Threatened Species. Version 2017-2

(c) Esri Japan | Esri, HERE, Garmin, FAO, USGS | IUCN

source: http://maps.iucnredlist.org/map.html?id=7140 , visited on September 2017

Figure 11.2.1-5 Geographical Distribution of Asian Elephant



IUCN Sloth bear Expert Team 2016. Melursus ursinus. The IUCN Red List of Threatened Species. Version 2017-2

(c) Esri Japan | Esri, HERE, Garmin, FAO, USGS | IUCN

source: http://maps.iucnredlist.org/map.html?id=13143, visited on September 2017

Figure 11.2.1-6 Geographical Distribution of Sloth Bear

Summer visitors include species of Common Sandpiper (*Actitis hypoleucos*), Green Sandpiper (*Tringa ochropus*), Little Cormorant (*Phalacrocorax niger*), Indian Golden Oriole (*Oriolus kundoo*), Red-breasted Flycatcher (*Ficedula parva*) and Grey-backed Shrike (*Lanius tephronotus*). The most common species recorded from the different sites of study area during post monsoon and monsoon seasons were *Francolinus pondicerianus*, *Megalaima haemacephala*, *Psittacula eupatria* (Alexandrine Parakeet, see Figure 11.2.1-7), *Centropus sinensis*, *Dicrurus macrocercus*, *Dendrocitta vagabunda*, *Chloropsis cochinchinensis*, *Sturnus pagodarum*, *Phylloscopus fuligiventer* and *Turdoides striatus*. All these birds do not fall under endangered categories as a conservation situation by IUCN.

source: EIA Report

Figure 11.2.1-7 Alexandrine Parakeet

2) Fisheries

Turga is a small river with shallow bottom, therefore, hardly harbours small species like *Bariliusbendelisis*, *Chela cachius*, *Puntius spp.* (Figure 11.2.1-8) and *Nemacheilus spp*. Some of the species like *Labeorohita*, *L. calbasu*, *Catlacatla*, *Cirrhinusmrigala*, *Anabas testudineus*, *Badisbadis*, etc have been introduced in the existing Turga Reservoir of I & W Directorate, Govt. of West Bengal. In addition, species like Puntius spp. and Macrognathusaral also inhabit the reservoir.

source: EIA Report

Figure 11.2.1-8 Puntius

3) Reptiles and Amphibians

The presence of a total of 18 species of Herpetofauna grouped under 10 families could be confirmed in the surrounding areas of proposed project from different sources including direct sightings and by interviewing local people. The present study area falls under the tropical limits and stands for the warm temperature for most of the months. The climatic condition seems highly conducive for herpetofaunal diversity. However, the area is considerably unexplored and very limited information is available on the herpetofaua. Out of 20, three species *Duttaphrynusmelanostictus*, *Laloulapulchera* and Rana/*Hoplobatrachustigerinus* belong to Amphibia, one species of pond turtle from Geomydidae family and remaining comes from Reptiles.

source: EIA Report

Figure 11.2.1-9 *Calotesversicolor* (Reptilia)

The agriculture fields in the study area provides ideal habitat for many snakes and reptiles. Reptiles such as cobra, and python were found occasionally in the dense vegetation areas as narrated by local people. Monitor Lizard was observed along the roadside during the survey. Out of seven species of reptiles recorded, three species of lizard i.e *Hemidactylissp* (House lizard) and *Calotessp* (Garden lizard, see Figure 11.2.1-9) are common in occurrence. Majority of the species are categorized as 'Least Concerned' as per IUCN criterion. Cobra is protected under schedule II of Indian Wildlife Protection Act (1972). None of the reptile species is present in the IUCN Red List of threatened animals (2014).

4) Insects

source: EIA Report

Figure 11.2.1-10 *Common Grass Yellow (Euremahecabe)*

Insects are the most numerous, and dominant life forms on the earth. Among insects, butterflies are considered as environment indicator which plays important role in pollination. The insect fauna listed consists of mostly 'common' and generalist species as none of them is threatened globally as per the IUCN Red list 2014. A total of 51 species from 6 families could be located from study area of proposed project, of which 32 species were observed in post-monsoon season, 24 species during summers and 38 species in monsoon season, respectively. A total of 18 species like Common Rose (*Pachlioptaaristolochiae*), Common Mormon (*Papiliopolytes*), Common Grass Yellow (*Euremahecabe*, see Figure 11.2.1-10), Small Grass Yellow (*Euremabrigitta*), Dark Cerulean (*Jamidesbochus*), Common Cerulean (*Jamidesceleno*), Glassy Tiger (*Paranticaaglea*), Common Crow (*Euploea core*), Blue admiral (*Nymphaliscanace*), etc. were common in nature. Common Mormon (*Papiliopolytes*), Elbowed Pierrot (*Caletaelnanoliteia*), Common Cerulean (*Jamidesceleno*), Common Grass Yellow (*Euremahecabe*), Small Grass Yellow (*Euremabrigitta*), Himalayan Fivering (*Ypthima sacra*) and Common Sailer (*Neptishylas*) were most common and abundant species.

5) Other invertebrates

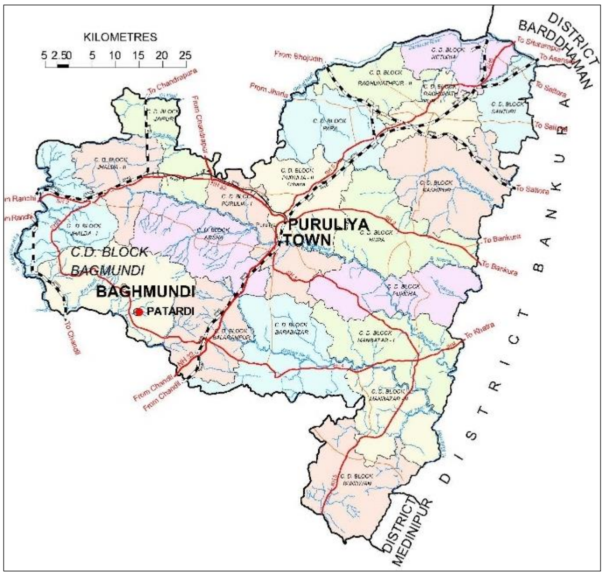
Other invertebrate taxa include a wide variety of species like annelids, mollusks, insects etc., however, a few species having ethnobiological importance in the area are included here. Bellamyabengalensis (Snail), Gerrisgibbifer (Water Spider), Nephilapilipes (Wood spider), Pheritimaposthuma (Earthworm), etc. are most common invertebrates in the surrounding areas. These species play an important role in ethnobiology of the area. Other invertebrate species from gastropods are also found in ponds and reservoir. The terrestrial insects which lay their eggs in water comprise of Mayflies (Ephemeroptera), Cadisflies (Trchiptera), Stoneflies (Placoptera), Bugs (Hemiptera), etc. There is nothing that corresponded to Threatened Species by IUCN.

11.2.2 Social Conditions

(1) Administrative Boundaries

The project site is in Baghmundi Community Development Block (hereinafter referred as "Baghmundi Block") of Purulia District in West Bengal State (Figure 11.2.2-1).

Population of Baghmundi Block and Purulia District are 136,000 and 2.93 million, and their population densities are 317 / km^2 and 468 / km^2, respectively (Table 11.2.2-1).



source: Population Census 2011

Figure 11.2.2-1 Puruliya District

Table 11.2.2-1 Basic Information of Purulia District and Baghmundi C.D. Block

	Unit	Purulia District	Baghmundi C.D. Block
Total area	km2	6,259.00	427.95
Total population	No of psn	2,930,115	135,579
Total number of villages	No	2,667	142
Distance from state capital to district center (approx.)	km	320	-
Distance from district center to CD Block center (approx.)	km	-	50

source: Population Census 2011

A map of Baghmundi Block with village administrative borders are shown in Figure 11.2.2-2. The planned project facilities are in eight villages: Teliabhasa, Ranga, Hathinada, Baghmundi, Gosaidi, Patardi, Barria, and Kudna of the Block[3].

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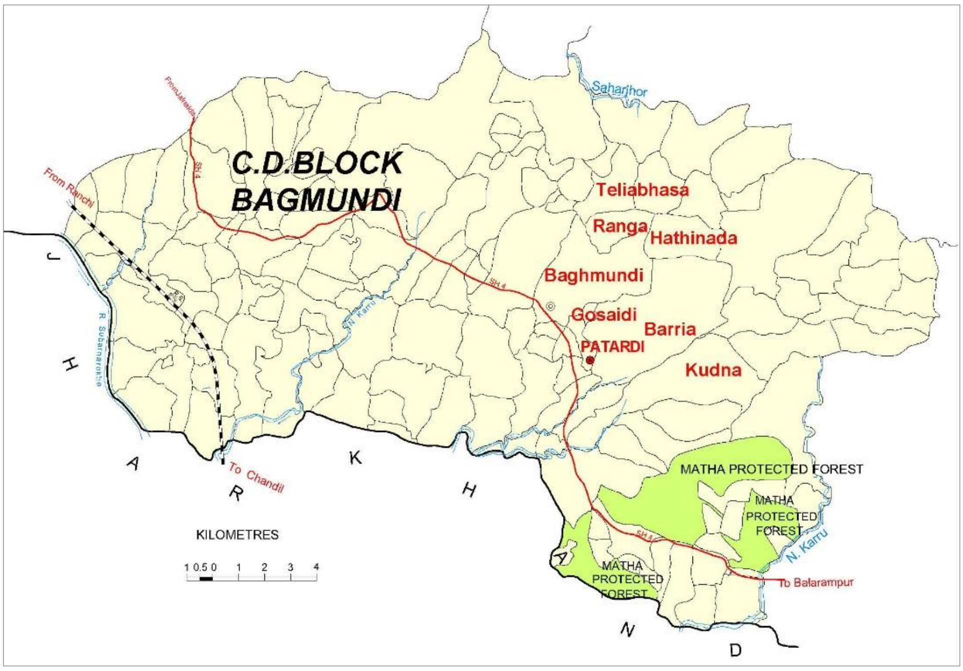
[3] A land unit called "mouza" is traditionally used in rural part of West Bengal State for revenue collection and administration. Each mouza is divided into plots, based on which land tenue is registered at the Revenue Inspectors' Office at Gram Panchayat level, and the Land & Land Reforms Department at State level. Land owners pay tax based on the number of plots that belong to them. A plot can be owned by several people. "Mouza" is also described as "revenue village" as the term "village" is more common as the unit for revenue collection throughout the country. The smallest electoral unit in West Bengal is "Gram Sabha Ward" comprised of one or several mouzas represented by Panchayat. Gram Panchayat is selected among Panchayats, and Panchayat Samiti represents Gram Panchayats.
Puruliya District has 20 Panchayat Samitis. Baghmundi Panchayat Samiti is one of them who is selected from the area covered by Baghmundi C.D. Block. There are eight Gram Panchayats in Baghmundi PS, among which the project facilities are planned in Baghmundi Gram Panchayat and Ajodhya Gram Panchayat areas. Procedures for land acquisition (including forest land) for the Project are done according to plots and mouza wise. While the population census conducted every ten years in India is based on village wise. The geographical area which one mouza shows is not always coherent with one census village. Take Baghmundi Gram Panchayat, for instance, it has 29 mouzas (revenue village) represented by 15 Gram Sabha Ward, whereas there are 17 census villages in the same area. As the population census is the only result that officially shows demographic features of the project area, this report makes use of the village-wise data and information collected in the Population Census 2011 to describe salient features of the project area in 11.2.2 and 11.6.3.



source: Population Census 2011

note: Names of the eight villages where the project facilities are planned are highlight in red color.

Figure 11.2.2-2 Baghmundi C.D. Block and the Project Planned Villages

(2) Population

Demographic data of the villages where the project facilities are planned are shown in Table 11.2.2-2. Most of the population in Teliabhasa, Ranga and Hathinada, where upper reservoir and its quarry sites are planned, are the Scheduled Tribes (ST). Over 70% of Gosaidi population, where part of lower reservoir will be developed, is also comprised of the ST. In the rest villages, Baghmundi, Patardi, Barria and Kudna, the population of the Scheduled Castes (SC) and ST is not much.

Table 11.2.2-2 Demographic Data of the Project Planned Villages

	Village Name	Total Area (ha)	Total HH	Total Population			Scheduled Caste out of Total Population			Scheduled Tribes out of Total Population		
				Total	Male	Female	Total	Male	Female	Total	Male	Female
1	Telia Bhasa	406.71	78	367	191	176	0	0	0	367	191	176
2	Ranga	270.74	145	726	367	359	8	4	4	714	361	353
3	Hathinada	394.57	145	724	351	373	0	0	0	719	346	373
4	Baghmundi	1,109.25	817	4,035	2,095	1,940	576	294	282	513	260	253
5	Gosaidi	34.40	39	183	94	89	5	2	3	134	66	68
6	Patardi	105.22	326	1,609	863	746	199	89	110	17	10	7
7	Barria	1,708.59	837	3,982	2,046	1,936	599	301	298	738	376	362
8	Kudna	961.13	219	1,137	570	567	18	10	8	330	164	166

source: Population Census 2011

note: Ranga village is comprised of two constituent villages: Ranga and Bare Lohar, and Baghmundi village is comprised of two constituent villages: Baghmundi and Tarpania.

(3) Education

The lowest literacy rate is found in Ranga (37.6%: 221 people), and the highest in Patardi (67.5%: 924 people) among eight villages. Literacy rates are relatively higher among male from 54.5% (162 males in Ranga) to 85.4% (639 males in Patardi), which has a big gap with that of female from 20.3% (59 females in Ranga) to 58.7% (981 females in Baghmundi).

Table 11.2.2-3 Literacy Rates of the Project Planned Villages

	Village Name	Population over 7 years (Number of person)			The literate out of population over 7 years					
					Number of person			Percentage		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
1	Telia Bhasa	298	153	145	152	102	50	51.0%	66.7%	34.5%
2	Ranga	588	297	291	221	162	59	37.6%	54.5%	20.3%
3	Hathinada	597	288	309	264	165	99	44.2%	57.3%	32.0%
4	Baghmundi	3,474	1,804	1,670	2,340	1,359	981	67.4%	75.3%	58.7%
5	Gosaidi	148	73	75	87	53	34	58.8%	72.6%	45.3%
6	Patardi	1,369	748	621	924	639	285	67.5%	85.4%	45.9%
7	Barria	3,300	1,690	1,610	1,933	1,234	699	58.6%	73.0%	43.4%
8	Kudna	936	467	469	558	345	213	59.6%	73.9%	45.4%

source: Population Census 2011

In terms of education facilities, pre-primary school facilities up to senior secondary level are available in Baghmundi (mainly government schools). Except Gosaidi and Patardi, the rest villages have education facilities up to primary level. There are no vocational training schools or training centers.

Table 11.2.2-4 Education Facilities in the Project Planned Villages

	Village Name	Pre-primary School		Primary School		Middle School		Secondary School		Senior Secondary School		School for Disabled	
		Govt.	Pvt.	Govt.	Pvt.	Govt.	Pvt.	Govt.	Pvt.	Govt.	Pvt.	Govt.	Pvt.
1	Telia Bhasa	1	1	1	1	1	NA	NA	NA	NA	NA	NA	NA
2	Ranga	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA
3	Hathinada	2	NA	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	Baghmundi	3	1	3	NA	3	NA	3	NA	3	NA	1	NA
5	Gosaidi	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	Patardi	1	NA	1	NA	NA	NA	1	NA	NA	NA	NA	NA
7	Barria	2	1	2	NA	1	NA	NA	NA	NA	NA	NA	NA
8	Kudna	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA

source: Population Census 2011

(4) Occupation

More than half of the population in Hathinada, Barria and Kudna are involved in agriculture sector as cultivator and agricultural laborer (50.9%, 73.9% and 97.0% respectively). The rest villages show different features, among which over 90% of Teliabhasa and Gosaidi population are in non-agriculture and non-household works.

Table 11.2.2-5 Working Status of the Project Planned Villages

	Village Name	Total Number of Worker	Ratio out of total population (%)	Breakdown (Number)				Breakdown (percentage)			
				Cultivator	Agricultural laborer	Household Industries	Others	Cultivator	Agricultural laborer	Household Industries	Others
1	Telia Bhasa	211	57.5%	5	9	0	197	2.4%	4.3%	0.0%	93.4%
2	Ranga	210	28.9%	83	0	2	125	39.5%	0.0%	1.0%	59.5%
3	Hathinada	171	23.6%	6	81	1	83	3.5%	47.4%	0.6%	48.5%
4	Baghmundi	1,400	34.7%	111	571	24	694	7.9%	40.8%	1.7%	49.6%
5	Gosaidi	77	42.1%	1	2	0	74	1.3%	2.6%	0.0%	96.1%

	Village Name	Total Number of Worker	Ratio out of total population (%)	Breakdown (Number)				Breakdown (percentage)			
				Cultivator	Agricultural laborer	Household Industries	Others	Cultivator	Agricultural laborer	Household Industries	Others
6	Patardi	620	38.5%	65	205	1	351	10.2%	33.1%	0.2%	56.6%
7	Barria	1,349	33.9%	139	858	8	344	10.3%	63.6%	0.6%	25.5%
8	Kudna	498	43.8%	5	478	1	14	1.0%	96.0%	0.2%	2.8%

source: Population Census 2011

note: "Others" include all government servants, municipal employees, teachers, factory workers, plantation workers, those engaged in trade, commerce, business, transport, banking, mining, construction, political or social work, priests, etc.

(5) Electricity

Electricity was supplied approximately from 12 to 19 hours per day as of 2011, which was used for domestic purpose. There was no power supply for agriculture. It was only Baghmundi and Patardi where power was supplied for commercial purpose.

Table 11.2.2-6 Status of Power Supply in the Project Planned Villages

	Village Name	For Domestic Use			For Agriculture Use			For Commercial Use		
		Status	Summer	Winter	Status	Summer	Winter	Status	Summer	Winter
		Yes/NA	hrs/day	hrs/day	Yes/NA	hrs/day	hrs/day	Yes/NA	hrs/day	hrs/day
1	Telia Bhasa	Yes	18	19	NA	0	0	NA	0	0
2	Ranga	Yes	15	16	NA	0	0	NA	0	0
3	Hathinada	Yes	16	17	NA	0	0	NA	0	0
4	Baghmundi	Yes	12	12	NA	0	0	Yes	10	11
5	Gosaidi	Yes	15	13	NA	0	0	NA	0	0
6	Patardi	Yes	16	13	NA	0	0	Yes	10	11
7	Barria	Yes	13	14	NA	0	0	NA	0	0
8	Kudna	Yes	15	15	NA	0	0	NA	0	0

source: Population Census 2011

note: Summer is defined from April to September, and winter from October to March.

(6) Information and Communication Means

Baghmundi has all kind of information and communication means, whereas the rest villages are different in terms of availability of community center, public library, common reading room and daily newspaper supply. Five out of eight villages have post offices or sub-post offices. Either of land phone, public phone, mobile phone or internet is available in Gosaidi, Patardi, Barria and Kudna. No telephone service or internet was available in the rest three villages (Teliabhasa, Ranga, and Hathinada). No information was found how many people owned mobile phones.

Table 11.2.2-7 Availability of Information and Communication Means in the Project Planned Villages

	Village Name	Community Centre with / without TV	Public Library	Public Reading Room	Daily Newspaper Supply	Post Office	Sub Post Office	Private Courier Facility	Telephone (landlines)	Public Call Office /Mobile	Mobile Phone Coverage	Internet Cafes / Common Service Centre
1	Telia Bhasa	Yes	NA	Yes	NA	NA	NA	NA	NA	NA	NA	NA
2	Ranga	Yes	NA	NA	NA	NA	Yes	NA	NA	NA	NA	NA
3	Hathinada	Yes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	Baghmundi	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes
5	Gosaidi	Yes	NA	Yes	NA	NA	Yes	NA	Yes	NA	Yes	NA
6	Patardi	Yes	NA	Yes	Yes	NA	Yes	NA	Yes	NA	Yes	NA
7	Barria	Yes	NA	NA	Yes	Yes	Yes	NA	Yes	Yes	Yes	NA
8	Kudna	NA	NA	Yes	Yes	NA	NA	NA	NA	NA	Yes	NA

source: Population Census 2011

(7) Transportation Means

Transportation means are quite limited. Private bus service, van, tractor and cycle-pulled rickshaws are available in Baghmundi. There was no transportation means available in Teliabhasa.

Table 11.2.2-8 Availability of Transportation Means in the Project Planned Villages

		Public Bus Service	Private Bus Service	Railway Station	Auto/Modified Autos	Taxi	Vans	Tractors	Cycle-pulled Rickshaws (manual driven)	Cycle-pulled Rickshaws (machine driven)	Carts Driven by Animals
1	Telia Bhasa	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	Ranga	NA	NA	NA	NA	NA	NA	NA	NA	NA	Yes
3	Hathinada	NA	NA	NA	NA	NA	NA	NA	Yes	NA	Yes
4	Baghmundi	NA	Yes	NA	Yes	NA	Yes	Yes	Yes	NA	Yes
5	Gosaidi	NA	NA	NA	NA	NA	NA	NA	NA	NA	Yes
6	Patardi	NA	NA	NA	NA	NA	NA	Yes	NA	NA	Yes
7	Barria	NA	NA	NA	NA	NA	NA	NA	NA	NA	Yes
8	Kudna	NA	NA	NA	NA	NA	NA	NA	NA	NA	Yes

source: Population Census 2011

(8) Water and Sanitation

According to the Population Census 2011, the treated tap water was used in Baghmundi and Barria for drinking purpose. In the rest villages except Hathinada, either of well (covered or uncovered), handpump and other resources (river, canal, tank, pond etc.) is used for drinking purpose.

Table 11.2.2-9 Status of Drinking Water in the Project Planned Villages

		Tap Water (Treated)	Tap Water (Un-treated)	Covered Well	Un-covered Well	Hand Pump	Tube Wells / Borehole	Spring	River / Canal	Tank / Pond / Lake
1	Telia Bhasa	NA	NA	NA	Yes	Yes	NA	NA	NA	Yes
2	Ranga	NA	NA	NA	Yes	Yes	NA	NA	NA	NA
3	Hathinada	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	Baghmundi	Yes	NA	Yes	Yes	Yes	NA	NA	Yes	Yes
5	Gosaidi	NA	NA	Yes	NA	Yes	NA	NA	Yes	Yes
6	Patardi	NA	NA	Yes	Yes	Yes	NA	NA	Yes	Yes
7	Barria	Yes	NA	Yes	Yes	Yes	NA	NA	Yes	Yes
8	Kudna	NA	NA	NA	Yes	Yes	NA	NA	NA	NA

source: Population Census 2011

Underground water is the main source for agriculture, whereas the irrigated area is not sufficient. The irrigated area out of the net sown area in all villages, except Gosaidi which is nearby the irrigated pond[4], were far less than the unirrigated area as of 2011, so that paddy production remains only one time per year.

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[4] The existing irrigation reservoir at the planned lower reservoir location belongs to the I&W Dept. Its water is used for not only agriculture purpose but drinking purpose according to the agreement with the Public Health Engineering Department.

Table 11.2.2-10 Net Sown Area and Agricultural Commodities in the Project Planned Villages

(Unit: ha)

	Village Name	Net area sown			Agricultural commodities		
		Total	Irrigated area	Un-irrigated area	First	Second	Third
1	Telia Bhasa	305.97	35.59	270.38	Paddy	Maize	Tomato
2	Ranga	86.56	15.59	70.97	Paddy	Maize	N/A
3	Hathinada	104.33	3.22	101.11	Maize	Paddy	Tomato
4	Baghmundi	843.15	84.55	758.6	Paddy	Vegetable	N/A
5	Gosaidi	19.6	19.6	0	Paddy	N/A	N/A
6	Patardi	92.56	42.36	50.2	Paddy	Wheat	Tomato
7	Barria	608.41	146.54	461.87	Paddy	Maize	Wheat
8	Kudna	111.69	20.64	91.05	Paddy	Tomato	Brinjal

source: Population Census 2011

It was only Ranga and Baghmundi where drainage system was available as of 2011. Community toilet complex and waste disposal system were not available in all villages.

Table 11.2.2-11 Sanitation Status in the Project Planned Villages

	Village Name	Drainage			Community Toilet Complex	Community waste disposal system after house to house collection
			Open Pucca Drainage			
		Closed	Uncovered	Open Kuccha Drainage		
1	Telia Bhasa	NA	NA	NA	NA	NA
2	Ranga	NA	NA	Yes	NA	NA
3	Hathinada	NA	NA	NA	NA	NA
4	Baghmundi	NA	Yes	NA	NA	NA
5	Gosaidi	NA	NA	NA	NA	NA
6	Patardi	NA	NA	NA	NA	NA
7	Barria	NA	NA	NA	NA	NA
8	Kudna	NA	NA	NA	NA	NA

source: Population Census 2011

(9) Health Facilities

Primary health sub-center was available in Baghmundi, Patardi and Barria. Three dispensaries were found in Baghmundi too. The rest health facilities were not available in all eight villages as of 2011.

Table 11.2.2-12 Health Facilities in the Project Planned Villages

		Community Health Centre	Primary Health Center	Primary Health Sub-Center	Maternity & Child Welfare Center	TB Clinic	Allopathic Hospital	Hospital Alternative Medicine	Dispensary	Mobile Health Clinic	Family Welfare Center
1	Telia Bhasa	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	Ranga	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	Hathinada	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	Baghmundi	NA	NA	1	NA	NA	NA	NA	3	NA	NA
5	Gosaidi	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	Patardi	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
7	Barria	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
8	Kudna	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

source: Population Census 2011

notes: TB means tuberculosis. Allopathic hospital is where the medical practice treating diseases by folk remedies different from those by treatment.

11.3 SYSTEM AND ORGANIZATIONS RELATED TO ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

The legal system in India comprise 1) Act: approved by the Parliament; 2) Rules: enacted by line ministries for law enforcement; and 3) Notification: enacted by line ministries for their own mandates. Guidelines are also issued in addition to them, which however are not legal documents and thus have no legal binding force except those conformed to in the Rules.

India is a federal republic comprised of 29 States and seven Union territories. The Union and States have separate legislations. The Article 246 of the Constitution of India describes classifications of the Union (central government), State and Concurrent Lists in the Seventh Schedule. The Parliament has exclusive power to make laws with respect to any of the matters enumerated in the Union List. So is the Legislature of any State in the State List, and both the Union and State in the Concurrent List. According to the website of the West Bengal Judicial Academy[5], there are 173 State Acts in West Bengal starting from the Bengal Survey Act, 1875 (enacted on 23 September 1875 in which topographic features and state borders are stipulated) until the West Bengal Right to Public Services Rule, 2013 (enacted on 7 October 2013 which specifiesthe rights for public services.

This section describes institutional framework and legal framework policy framework for environmental issues of India as well as West Bengal State, and differences between what must be abided in such development activities as this project according to the relevant statutes in India and the JICA Guidelines for Environmental and Social Considerations issued in 2010.

11.3.1 Related Organization

(1) Central level

The Ministry of Environment, Forest and Climate Change (MoEFCC) is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs. According to the official website[6], the primary concerns of the Ministry are implementation of policies and programs relating to conservation of the country's natural resources including its lakes and rivers, its biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution. While implementing these policies and programmes, the Ministry is guided by the principle of sustainable development and enhancement of human well-being. As of January 2018, MoEFCC is divided into 2 sectors, namely, Environmental Wing[7] and Forest & Wildlife Wing[8]. The former consists of 28 divisions, the latter has 15 divisions, respectively.

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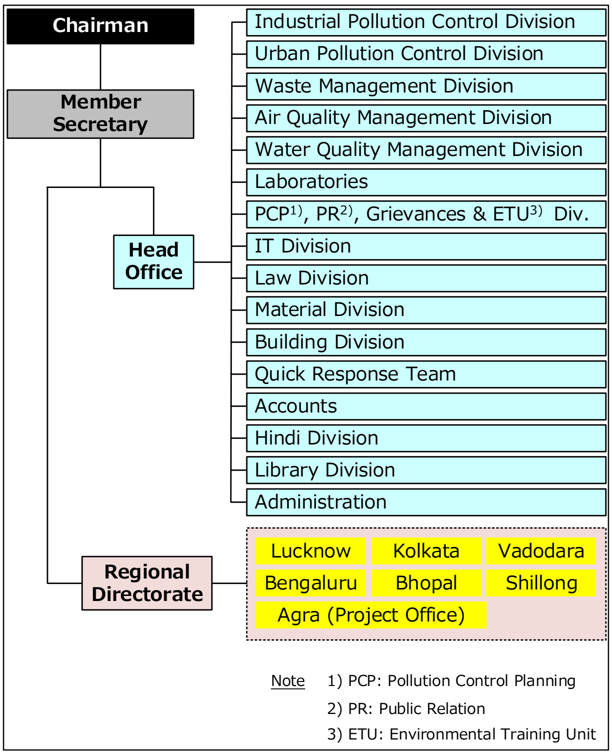
[5] http://www.wbja.nic.in/pages/display/148-west-bengal-state-laws (as of October 2017)

[6] http://www.moef.nic.in/about-ministry/about-ministry (as of December 2017)

[7] http://www.moef.nic.in/about-ministry/chart1-environment-wing

[8] http://www.moef.nic.in/about-ministry/chart2-forests-and-wildlife-wing



source: JICA Study Team

Figure 11.3.1-1 Organization Chart of CPCB

The Central Pollution Control Board (CPCB), statutory organization, was constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974. Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981. According to the official website[9], it serves as a field formation and also provides technical services to the Ministry of Environment and Forests of the provisions of the Environment (Protection) Act, 1986. Principal Functions of the CPCB, as spelt out in the Water (Prevention and Control of Pollution) Act, 1974, and the Air (Prevention and Control of Pollution) Act, 1981, (i) to promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution, and (ii) to improve the quality of air and to prevent, control or abate air pollution in the country. Figure 11.3.1-1 shows organization Chart of CPCB as of January 2018.

(2) State and District level

According to existing JICA survey report[10] and information provided by WBSEDCL and WAPCOS Limited, related organizations of state and district level are summarized below.

1) West Bengal Forest Department

According to the organization chart updated on April 19, 2017[11], West Bengal Forest Department consist of 78 senior officials from Principal Chief Conservator of Forests, Head of Forest Force down. Chief Conservator of Forests, South-West covers Purulia District as same as North and South Kangsabati District. The Department governs conservation and development of forests, wildlife and biodiversity within the state, especially wetland conservation, development of social forests and agricultural forests.

2) West Bengal Pollution Control Board

West Bengal Pollution Control Board (WBPCB) is a statutory authority entrusted to implement environmental laws and rules within the jurisdiction of the state of West Bengal, India. WBPCB

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[9] http://cpcb.nic.in/Functions.php

[10] http://libopac.jica.go.jp/images/report/12040226.pdf

[11] http://www.westbengalforest.gov.in/left_forest_organisation.php

was constituted immediately after the enactment of the first major environmental legislation of the country, the Water (Prevention and Control of Water Pollution) Act, 1974. It serves principally i) Industrial Pollution Control, ii) Environmental Monitoring, iii) Waste Management, iv) Legal and Public Grievance, v) Training and Awareness Program, vi) National Green Corps[12] and vii) Automobile Pollution Regulation. In addition, environmental clearance of various types of waste and imports of hazardous chemical substances in West Bengal State are also managed by WBPCB.

3) Department of Information & Cultural Affairs, Government of West Bengal

The Department of Information and Cultural Affairs is the nodal agency for all information and public relations activities of the West Bengal Government. Apart from dissemination of general information to the masses through different media, the department with its expertise in mass communication exercises initiates planning, conceptualized ideas and prepares designs and kits for effective execution of publicity campaign to popularize the policies, programs and activities of the State Government as well as its stands on major social, political and economic issues through press releases, films, journals, exhibitions, advertisements, cultural programs etc.

4) Panchayats & Rural Development Department, Government of West Bengal

It is entrusted with the responsibility of constitution and framing policy related to functioning of the rural local self-government. It aims at facilitating economic and social development in the rural areas of the State and organizes community action in all development initiatives in the rural sector by utilizing Central/State Sector programs. The thrust areas of the Department include the following : 1. Augmenting livelihood opportunities for the rural population, 2. Sustainable development of natural resources, 3. Providing social security and safety nets to the disadvantaged and socially excluded, 4. Improving the social and physical infrastructure in the rural areas, 5. Improving service delivery in the field of elementary education and preventive health care in collaboration with the respective departments of the state government, and 6. Organizing the rural poor in self-help group for socioeconomic development.

5) Public Health Engineering Department (PHED)

This was created as an independent full-fledged Department in 1987. It controls the Water Supply & Sanitation Budget of the State Government and undertakes programs of implementation of water supply and sanitation services mainly through Public Health Engineering Directorate under its administrative control.

6) Nongovernmental organizations (NGOs)

According to the official website of the Foreign Contribution Regulation Act (2010; FCRA)[13] under the jurisdiction of the Ministry of Home Affairs in India, 2,842 NGOs are registered in West

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[12] Environmental education program in which school children learn to recognize importance of environmental conservation through participating in various activities relevant to environmental conservation.

[13] https://fcraonline.in/

Bengal (as of March 2018). Registration based on FCRA is obligatory only for organizations receiving materials and funds from overseas, it is estimated to exceed 3,000 organizations including NGOs financed by the Indian government or private sector in West Bengal. Utilizing to web services such as NGO portal (http://www2.ngoportal.org/) and NGOs India (https://west-bengal.ngosindia.com/), Table 11.3.1-1 shows a list of NGOs which act in Purulia District.

Table 11.3.1-1 List of NGOs operating in Purulia District

Organization name	Centre for Environmental & Socio Economic Regeneration, Purulia
Address	Dulmi Down, Chaibasa Road, P.O.: Dulmi-Nadiha, Dist. - Purulia, West Bengal, PIN - 723102
Contact	Phone: +91-3252-224383/ Fax: +91-3252-224558/ Email: cesrpurulia@yahoo.co.in
Registered year	1993
Key issues	Socio-economic development of tribal and economically backward communities
Bygone/ongoing activities	・ Supplementary education program for children in Purulia ・ Adolescent and juvenescent intervention program ・ Girl child education ・ Mobile Health Unit program in Purulia by Save the Children ・ Diffusion of the internet access (Internet SAATHI Program)
Website	http://cesrindia.org/

Organization name	Hensla Haraparbati Club, Purulia
Address	Hensla, Arsha, Purulia, West Bengal, PIN: 723154
Contact	Phone: +91-3252-202578/ Mob: +91-95479-68383/ Email: puruliashgsrijanalaya@yahoo.com
Registered year	2008
Key issues	Health, Education, Livelihood, Community development, Civil society supports
Bygone/ongoing activities	N/A
Website	N/A

Organization name	Hensla Saroj Mukherjee Smriti Sangha, Purulia
Address	Hensla, Dhabani Radha Mohan Pur, Purulia, West Bengal, PIN: 723129
Contact	Phone: N/A/ Email: friendilip@gmail.com
Registered year	N/A
Key issues	Helping and motivating villagers to get better side of life.
Bygone/ongoing activities	N/A
Website	http://west-bengal.ngosindia.com/hensla-haraparbati-club-purulia

Organization name	Manbazar Rishi Arabinda Gram Bikash Kendra, Purulia
Address	Manbazar Dist, Purulia, Pin: 723131
Contact	Phone: +91-6542-220106/ Mob: +91-97351 12371/ Email: secretarymragbk@indiatimes.com
Registered year	N/A
Key issues	Education, Health, Rural development, Child development, Women empowerment, Disability
Bygone/ongoing activities	N/A
Website	N/A

Organization name	Mandra Lions Club, Purulia
Address	Sarada Pally, Baghmundi, Purulia, West Bengal, India, Pin: 723152
Contact	Phone: +91-9434033145/ Mob: +91 3252-250381/ Email: mlconline@rediffmail.com
Registered year	2003
Key issues	Education, Health, Rural development, Child development, Women empowerment, Disability
Bygone/ongoing activities	・ Child rights & education program at Balarampore Block of Purulia District ・ Livelihood and food security program ・ Hygiene and health in the Balarampur Block of Purulia district ・ Nutrition and public health program in Purulia, Maldah, Birbhum, Murshidabad, North Dinajpur and South Dinajpur
Website	http://www.mandralionsclub.net/index.php

Organization name	Mandir Bazar Young Fighters Club, South 24 Parganas
Address	Swagate Lodge, P.K.Raj, Kashipu, Purulia, Pin: 723132
Contact	Phone: + 91-94334 32847/ Mob: + 91-94334 32847/ Email: nabodayafoundation@gmail.com

Registered year	N/A
Key issues	Women and child development, SHG, awareness generation, rural development.
Bygone/ongoing activities	・ Education development in West Bengal Sate ・ Health development in rural and urban areas ・ Rural development
Website	http://myfcindia.in

Organization name	**Nabodaya Foundation, Purulia**
Address	Swagate Lodge, P.K.Raj, Kashipu, Purulia, Pin: 723132
Contact	Phone: + 91-94334 32847/ Mob: + 91-94334 32847/ Email: nabodayafoundation@gmail.com
Registered year	N/A
Key issues	Women and child development, SHG, awareness generation, rural development.
Bygone/ongoing activities	・ Education development in West Bengal Sate ・ Health development in rural and urban areas ・ Rural development
Website	http://www.navodayafoundation.in/

Organization name	**Nutanhat Development Society, Purulia**
Address	Hoochokpara, Purulia, Pin: 723101
Contact	Phone: + 91-3252-224364/ Email: ndspost@gmail.com
Registered year	1992
Key issues	Gender equality, Protect environment, Ensure food security, Child rights, Promote justice and peace
Bygone/ongoing activities	・ Lift irrigation program ・ HIV/AIDS program (Target intervention for 400 CSWs) ・ Water Campaign ・ Organic farming and vermi compost ・ Reproductive health activities ・ Youth development activates ・ Women empowerment program ・ Safe drinking water and sanitation programs, and so on
Website	N/A

Organization name	**Payel Training Institute, Purulia**
Address	Santuri, Purulia, Pin: 723101 Pin: 723101
Contact	Phone: + 91- 94342 56185/ Mob: +919433002282/ Email: goutam_patra_purulia@yahoo.co.in
Registered year	N/A
Key issues	To help people to help themselves
Bygone/ongoing activities	N/A
Website	N/A

Organization name	**Purulia Abul Kalam Azad Welfare Society, Purulia**
Address	J.K. College Road, Purulia, Pin: 723101
Contact	Phone: + 91- 99326 01811 / Email: ndspost@gmail.com
Registered year	1992
Key issues	To serve the needy for their education. To work for the welfare of the poor. To provide vocational training for self-employment. To run schools and health centers.
Bygone/ongoing activities	N/A
Website	N/A

Organization name	**Purulia Disha Foundation**
Address	J.K. College Road, Purulia, Pin: 723101
Contact	Phone: + 91- 99326 01811 / Email: disha_foundation@yahoo.co.in
Registered year	1992
Key issues	Education, Cultural activities, Old age home, Training to self-help group (SHG)
Bygone/ongoing activities	・ Women's economic empowerment ・ Awareness programs of child's health includes physical, mental and social well-being
Website	https://www.dishafoundationkolkata.com/

Organization name	**Purulia Manabi Sangathan**
Address	Leena Basu Basundhara Deshbandhu Road bi-Lane Purulia, Pin: 723101
Contact	Phone: + 91- 3252-203517/ Mob: +91-99323 94145/ Email: leenabasundhara@rediffmail.com
Registered year	2009
Key issues	Training to self-help groups (SHGs), Education, Cultural activities

Bygone/ongoing activities	N/A
Website	N/A

Organization name	**Resource Implementation Development & Allotropic Youjana Society, Purulia**
Address	AISECT Computer, Purulia, Pin: 723101
Contact	Phone: + 91- 3252-223894/ Email: shineacademy.prl@gmail.com
Registered year	2007
Key issues	Rural development under poverty line
Bygone/ongoing activities	N/A
Website	N/A

Organization name	**SOPAN, Purulia**
Address	Doctor Danga, Purulia, Pin: 723101
Contact	Phone: + 91-94341 76406/ Email: pkprl@yahoo.co.in
Registered year	2007
Key issues	Rural, urban slam development
Bygone/ongoing activities	N/A
Website	N/A

Organization name	**UTTARAN, Purulia**
Address	Namo Para, Jhalda, Purulia, Pin: 723101
Contact	Phone: + 91- 9564179900/ Email: puruliauttaran@gmail.com
Registered year	2015
Key issues	Improve income generating activity including rural poor & women through technical assistance
Bygone/ongoing activities	N/A
Website	http://www.puruliauttaran.org.in/

source: JICA Study Team

As shown in the table above, most NGOs in West Bengal have developed a social development program, with the aim of improving the social and economic situation in urban and rural areas, education for children, child welfare, gender equality , promoting women's empowerment, reducing poverty, improving hygiene environment, disaster management, etc. Regarding the management of natural resources and natural environment conservation, organic agriculture is promoted as part of agricultural conservation. NGOs, nonprofit organizations (NPOs) and volunteer organizations (VO) which conduct wildlife conservation activities were not confirmed.

However, World Wildlife Fund (WWF), the world's largest scale of the natural environment protection organizations, has installed an office in Kolkata, their activities in West Bengal almost limited around the border between Nepal and Bhutan. Even there are many investigations and studies targeting the Sunderban National Park, no scientific reports regarding activities in Purulia District could not be found through website. Among the West Bengal NGOs registered into the FCRA mentioned above, Nature Environment and Wildlife Society (http://naturewildlife.org/) and Raiganj Environmental & Wildlife Association (HP is unconfirmed) conduct protection of wild animals, but neither of them could confirm the achievements in Purulia District.

11.3.2 Relevant Statute

(1) Federal Law of India

Main federal laws of India regarding natural environment protection and pollution control are given in Table 11.3.2-1.

Table 11.3.2-1 Indian Federal Statutes regarding Environmental Protection

Issue	Name of Legislation	Year
Basic Statutes	The Environment (protection) Act	1986
	The Environment Protection Rules	1986
	Environment Impact Assessment Notification	1994
Air Quality	The Air (Prevention and Control of Pollution) Act	1981
	The Air (Prevention and Control of Pollution) Rules	1982
	The Air (Prevention and Control of Pollution) (Union Territories) Rules	1983
	Revised National Ambient Air Quality Standards, Notification	2009
Water Quality	The Water (Prevention and Control of Pollution) Act	1974
	The Water (Prevention and Control of Pollution) Rules	1975
	The Water (Prevention and Control of Pollution) Cess Act	1977
	The Water (Prevention and Control of Pollution) Cess Rules	1978
Noise & Vibration	The Noise Pollution (Regulation and Control) Rules	2000
Environmental Tribunals	Public Liability Insurance Act	1991
	Public Liability Insurance Rules	1991
	The National Environment Tribunal Act	1995
	The National Environment Appelate Authority Act	1997
	The National Environment Appellate Authority(Appeal) Rules	1997
	The National Green Tribunal Act	2010
Forest Conservation	The Indian Forest Act	1927
	The Forest (Conservation) Act	1980
	The Forest (Conservation) Rules	2003
	The National Forest Policy	1988
Wildlife Conservation	The Wild Life (Protection) Act	1972
	The Wild Life (Transactions and Taxidermy) Rules	1973
	The Wild Life (Protection) Licensing (Additional Matters for Consideration) Rules	1983
	Recognition of Zoo Rules	1992
	The wild life (Protection) Rules	1995
	The wild life (Specified Plants – Conditions for possession by Licensee) Rules	1995
	National Zoo Policy	1998
	The Wild Life (Protection) Amendment Act	2002
	The Declaration of Wild Life Stock Rules	2003
	The National Board for Wild Life Rules	2003
Biological Diversity	Biological Diversity Act	2002
Wastes Managements	The Hazardous Wastes (management and handling) Rules	1989
	The Bio-medical Waste (Management and Handling) Rules	1989
	The Municipal and Solid Wastes (Management and Handling) Rules	2000
Chemical Manufactures/ Byproducts Managements	The Manufacture, Storage, and Import of Hazardous Chemical Rules	1989
	The Ozone Depleting Substances (Regulation and Control) Rules	2000
	The Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Micro-organisms/Genetically Engineered Organisms or Cells	1989
	The chemical Accidents (Emergency Planning, Preparedness and Response) Rules	1996
	The Recycled Plastics Manufacture and Usage Rules	1999
	The Plastics Manufacture, Sale and Usage Rules	1999
	The Batteries (Management and Handling) Rules	2001

source: JICA Study Team

The Constitution of India obligates the state as well as citizens to protect and improve the environment. The Constitution (Forty-Second Amendment) Act, 1976 and Article 51A (g) cites, “The requirement of the time is that we should be real citizens of the country striving towards excellence in all spheres of individual and collective activity including the protection of environment.”

Environmental laws consist of all legal guidelines that are intended to protect our environment. The objective of environmental law is to preserve and protect the nature’s gifts from pollution. Further, the objective of environmental law is to protect the man’s fundamental rights of freedom, equality and adequate conditions of life in an environment of quality that permits a life of dignity and wellbeing.

Environmental Protection Act is positioned as the basic environmental law in India. Environmental

Protection Law stipulates the central government's responsibility for the prevention, control and reduction of environmental pollution, and has the authority to prepare appropriate rules to achieve the objectives. Environment Protection Rules 1986 is a specific law established under the provisions of Environment Protection Act, and set standards for environmental pollutants discharged from establishments. Environment Impact Assessment Notification 1994 defines procedures and restrictions for preventing environmental impact from new/existing projects.

On the other hand, individual laws regulate air quality, water quality, noise, environmental courts, forest conservation, wildlife protection, biodiversity, wastes, managements of chemical products and treatments of by-/ industrial products.

(2) Related State Statutes in West Bengal

1) The West Bengal Private Forests Act, 1948

An Act in provide for the conservation of private forests and for the afforestation in certain cases of waste-lands in West Bengal.

2) The West Bengal Wild Life Preservation Act, 1959

This state statute consists of Preliminary (Chapter 1), Authorities under the Act (Chapter 2), Hunting of Wild Animals (Chapter 3), Wild Life Sanctuaries (Chapter 4), Business in Trophies and Pet Animals (Chapter 5), Offences and Penalties (Chapter 6) and Miscellaneous (chapter 7), and stipulates that only licensed professional can limitedly hunt wildlife within restricted areas.

3) West Bengal Trees (Protection and Conservation in Non-Forest Areas) Act, 2006

An Act to encourage and promote plantation of trees, and to protect and conserve trees, particularly those looked upon as sacred groves, or identified as belonging to an endangered species or given the statues of heritage, bearing in mind that trees have great environmental value and are a renewable resource.

(3) Laws and Regulations on Environmental Impact

1) Outline of EIA in India

In India, the Environmental Clearance is mandatory for implementation of projects which may have a significant impact on the environment under EIA Notification 2006, amended in 2009. The EIA Notification has notified 39 developmental sectors which require prior environmental clearance. The following projects or activities shall require prior environmental clearance from the concerned regulatory authority, which shall hereinafter referred to be as the Central Government in MoEFCC for matters falling under Category A in the Schedule and at State Level the State Environment Impact Assessment Authority (SEIAA) for matters falling under Category B in the said Schedule, before any construction work, or preparation of land by the project management except for securing the land, is started on the project or activity:

(a) All new projects or activities listed in the Schedule to this notification;

(b) Expansion and modernization of existing projects or activities listed in the Schedule to the notification with addition of capacity beyond the limits specified for the concerned sector, that is, projects or activities which cross the threshold limits given in the Schedule, after expansion or modernization;

(c) Any change in product - mix in an existing manufacturing unit included in Schedule beyond the specified range.

All projects or activities included as Category A shall require prior Environmental Clearance from MoEFCC on the recommendations of an Expert Appraisal Committee (EAC) to be constituted by the Central Government for the purposes of the notification. Besides, all projects or activities included as Category B in the Schedule will require prior Environmental Clearance from SEIAA. The SEIAA shall base its decision on the recommendations of a State or Union territory level Expert Appraisal Committee (SEAC) as to be constituted for in the notification. In the absence of a duly constituted SEIAA or SEAC, a Category B project shall be treated as a Category A project.

2) Summary of EIA procedure

Flow of obtaining Environmental Clearance is given in Figure 11.3.2-1, and summary of procedure divided into application stage and acquisition stage is outlined below, respectively.

i) Application stage

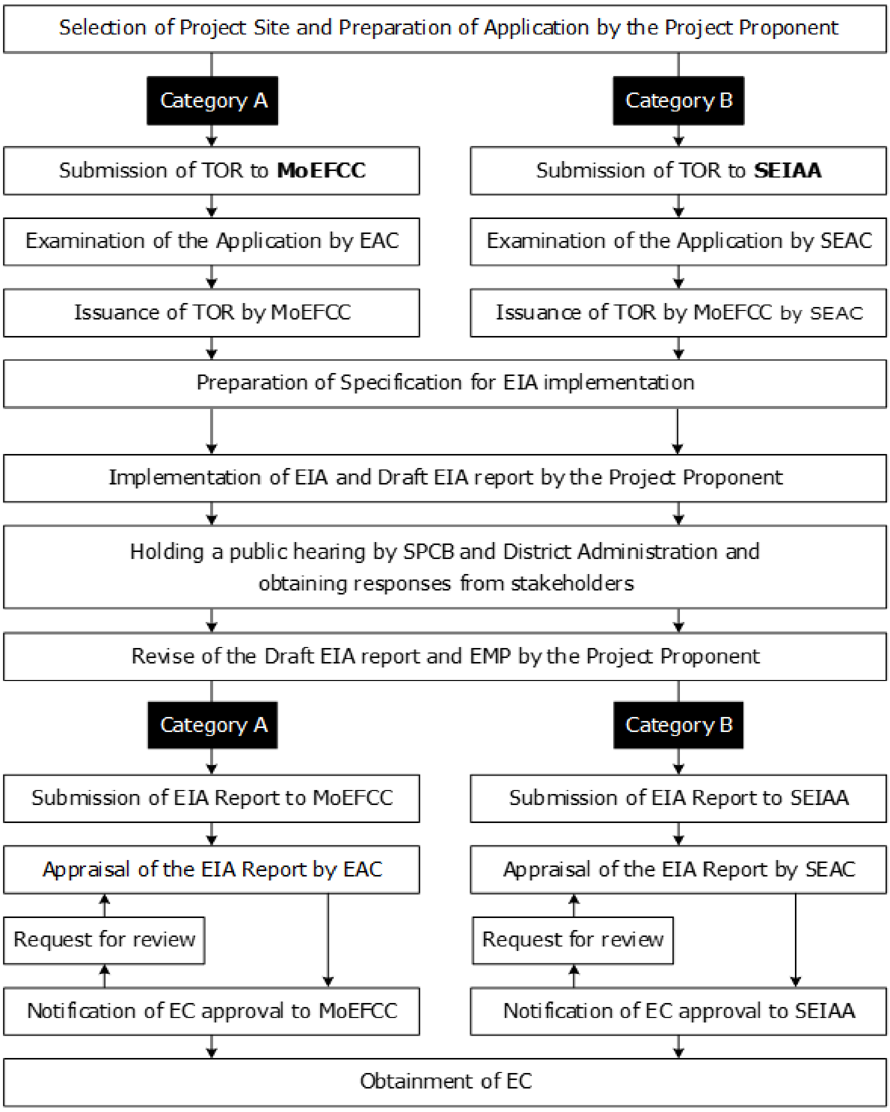
The acquisition process of Environmental Clearance differs according to project category. It is stipulated that projects fallen under category A will be applied to MoEFCC and projects fallen under category B to SEIAA. In the application, the following information is submitted to the relevant office first.

a) Information find mention in Appendix I to the EIA Notification

- Basic Information (Name of the Project, Location / site alternatives under consideration, Size of the Project, Expected cost of the project, Contact Information, Screening Category)
- Activity (1. Construction, operation or decommissioning of the Project involving actions, which will cause physical changes in the locality such as topography, land use, changes in water bodies, etc., 2. Use of Natural resources for construction or operation of the Project such as land, water, materials or energy, especially any resources which are non-renewable or in short supply, 3. Use, storage, transport, handling or production of substances or materials, which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health, 4. Production of solid wastes during construction or operation or decommissioning (MT/month), 5. Release of pollutants or any hazardous, toxic or noxious substances to air (Kg/hr), 6. Generation of Noise and Vibration, and Emissions of Light and Heat, 7. Risks of contamination of land or water from releases of pollutants into the ground or into sewers, surface waters, groundwater, coastal waters or the sea, 8. Risk of accidents during construction or operation of the Project, which could affect human health or the environment, 9. Factors which should be considered such as consequential development

which could lead to environmental effects or the potential for cumulative impacts with other existing or planned activities in the locality)

- Environmental Sensitivity
- Proposed Terms of Reference (TOR) for EIA studies



source: WBSEDCL based on Environment Impact Assessment Notification (1994)

Figure 11.3.2-1 Flow of Obtaining Environmental Clearance (EC)

b) Pre-feasibility project report (in case of construction projects or activities in item 8 of the Schedule, in addition to Form 1 and the Supplementary Form 1A, a copy of the conceptual plan shall be provided, instead of the pre-feasibility report)

c) In case of projects or activities in item 8 of the Schedule, information find mention in Appendix II to the EIA Notification (Land Environment, Water Environment, Vegetation, Fauna, Air Environment, Aesthetics, Socio-economic Aspects, Building Materials, Energy Conservation, Environment Management Plan)

ii) Acquisition stage of Environmental Clearance

The environmental clearance process for new projects will comprise of a maximum of four stages, all of which may not apply to particular cases as set forth below in this notification. These four stages in sequential order are:

Stage (1) Screening (Only for Category B projects and activities)

Stage (2) Scoping

Stage (3) Public Consultation

Stage (4) Appraisal

- Stage (1) Screening

In case of Category B projects or activities, this stage will entail the scrutiny of an application seeking prior environmental clearance made in Form 1 by the concerned State level Expert Appraisal Committee (SEAC) for determining whether or not the project or activity requires further environmental studies for preparation of EIA for its appraisal prior to the grant of environmental clearance depending up on the nature and location specificity of the project.

- Stage (2) Scoping

The Expert Appraisal Committee (EAC) or State level Expert Appraisal Committee (SEAC) concerned shall determine the Terms of Reference (TOR) on the basis of the information furnished in the prescribed application Form1/Form 1A including Terns of Reference proposed by the applicant, a site visit by a sub-group of EAC/SEAC concerned only if considered necessary by the EAC/SEAC concerned, TOR suggested by the applicant if furnished and other information that may be available with the EAC/SEAC concerned. All projects and activities listed as Category B in Item 8 of the Schedule (Construction/Township/Commercial Complexes /Housing) shall not require Scoping and will be appraised on the basis of Form 1/ Form 1A and the conceptual plan. Applications for prior environmental clearance may be rejected by the regulatory authority concerned on the recommendation of the EAC or SEAC concerned at this stage itself. In case of such rejection, the decision together with reasons for the same shall be communicated to the applicant in writing within sixty days of the receipt of the application.

- Stage (3) Public Consultation

The public hearing at, or in close proximity to, the site(s) in all cases shall be conducted by the State Pollution Control Board (SPCB) or the Union territory Pollution Control Committee (UTPCC) concerned in the specified manner and forward the proceedings to the regulatory authority concerned within 45 (forty-five) of a request to the effect from the applicant. For obtaining responses in writing from other concerned persons having a plausible stake in the environmental aspects of the project or activity, the concerned regulatory authority and the SPCB or UTPCC shall invite responses from such concerned persons by placing on their website the Summary EIA report prepared by the applicant within seven days of the receipt of a written request for arranging the public hearing. Applications for prior environmental clearance may be rejected by the regulatory authority concerned on the recommendation of the EAC or SEAC concerned at this stage itself. In case of such rejection, the decision together with reasons for the same shall be communicated to the applicant in writing within sixty days of the receipt of the application.

- Stage (4) Appraisal

Appraisal means the detailed scrutiny by the EAC/SEAC of the application and other documents like the Final EIA report, outcome of the public consultations including public hearing proceedings, submitted by the applicant to the regulatory authority concerned for grant of environmental clearance. This appraisal shall be made by EAC/SEAC concerned in a transparent manner in a proceeding to which the applicant shall be invited for furnishing necessary clarifications in person or through an authorized representative. On conclusion of this proceeding, the EAC/SEAC concerned shall make categorical recommendations to the regulatory authority concerned either for grant of prior environmental clearance on stipulated terms and conditions, or rejection of the application for prior environmental clearance, together with reasons for the same.

3) Generic Structure of Environmental Impact Assessment Document

Descriptions of the following items are indispensable in the EIA report.

- Introduction (Purpose of the report, Identification of project & project proponent, Brief description of nature, size, location of the project and its importance to the country, region, Scope of the study details of regulatory scoping carried out as per Terms of Reference)
- Project Description (Type of project, Need for the project, Location: maps showing general location, specific location, project boundary & project site layout, Size or magnitude of operation including Associated activities required by or for the project, Proposed schedule for approval and implementation, Technology and process description, Description of mitigation measures, Assessment of New & untested technology for the risk of technological failure)
- Description of the Environment (Study area, period, components & methodology, Establishment of baseline for valued environmental components, as identified in the scope, Base maps of all environmental components)
- Anticipated Environmental Impacts and Mitigation Measures (Details of Investigated Environmental impacts due to project location, possible accidents, project design, project construction, regular operations, final decommissioning or rehabilitation of a completed project, Measures for minimizing and / or offsetting adverse impacts identified, Irreversible and Irretrievable commitments of environmental components, Assessment of significance of impacts such as Criteria for determining significance, Assigning significance, Mitigation measures)
- Analysis of Alternatives: Technology and Site (Description of each alternative, Summary of adverse impacts of each alternative, Mitigation measures proposed for each alternative and

Selection of alternative)

- Environmental Monitoring Program (technical aspects of monitoring the effectiveness of mitigation measures including Measurement methodologies, frequency, location, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules)
- Additional Studies (Public Consultation, Risk assessment, Social Impact Assessment)
- Project Benefits (Improvements in the physical infrastructure, Improvements in the social infrastructure, Employment potential, other tangible benefits)
- Environmental Cost Benefit Analysis
- Environmental Management Plan: EMP (Description of the administrative aspects of ensuring that mitigation measures are implemented and their effectiveness monitored, after approval of the EIA)
- Summary & Conclusion (the summary of the EIA Report)
- Disclosure of Consultants engaged (The names of the Consultants engaged with their brief resume and nature of Consultancy rendered)

4) Public Consultation

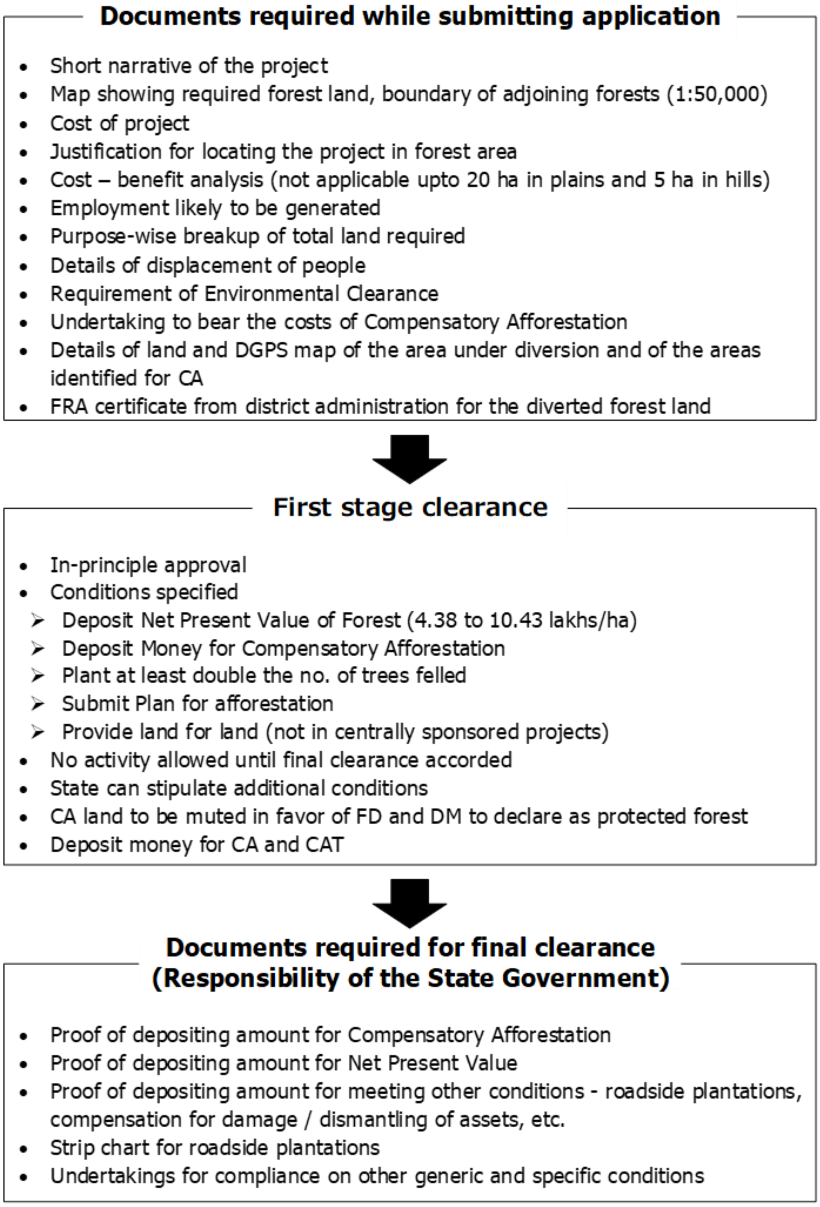
All Category A and Category B1 projects or activities shall undertake Public Consultation, except the following:

- Modernization of irrigation projects
- All projects or activities located within industrial estates or parks approved by the concerned authorities, and which are not disallowed in such approvals.
- Expansion of Roads and Highways which do not involve any further acquisition of land.
- All Building /Construction projects/Area Development projects and Townships
- All Category B2 projects and activities.
- All projects or activities concerning national defense and security or involving other strategic considerations as determined by the Central Government

For obtaining responses in writing from other concerned persons having a plausible stake in the environmental aspects of the project or activity, the concerned regulatory authority and SPCB or UTPCC shall invite responses from such concerned persons by placing on their website the Summary EIA report within seven days of the receipt of a written request for arranging the public hearing.

(4) Contents of environmental impact assessment required for project implementation

WBSEDCL has established the EIA report in June 2016 consisting of EIA, SIA, EMP and Minutes of Residents Consultation. MoEFCC conditioned to obtain Forest Clearance for implementation of the project. Here acquisition flow of Forest Clearance is illustrated in Figure 11.3.2-2.



Documents required while submitting application

- Short narrative of the project
- Map showing required forest land, boundary of adjoining forests (1:50,000)
- Cost of project
- Justification for locating the project in forest area
- Cost – benefit analysis (not applicable upto 20 ha in plains and 5 ha in hills)
- Employment likely to be generated
- Purpose-wise breakup of total land required
- Details of displacement of people
- Requirement of Environmental Clearance
- Undertaking to bear the costs of Compensatory Afforestation
- Details of land and DGPS map of the area under diversion and of the areas identified for CA
- FRA certificate from district administration for the diverted forest land

First stage clearance

- In-principle approval
- Conditions specified
  - ➢ Deposit Net Present Value of Forest (4.38 to 10.43 lakhs/ha)
  - ➢ Deposit Money for Compensatory Afforestation
  - ➢ Plant at least double the no. of trees felled
  - ➢ Submit Plan for afforestation
  - ➢ Provide land for land (not in centrally sponsored projects)
- No activity allowed until final clearance accorded
- State can stipulate additional conditions
- CA land to be muted in favor of FD and DM to declare as protected forest
- Deposit money for CA and CAT

Documents required for final clearance (Responsibility of the State Government)

- Proof of depositing amount for Compensatory Afforestation
- Proof of depositing amount for Net Present Value
- Proof of depositing amount for meeting other conditions - roadside plantations, compensation for damage / dismantling of assets, etc.
- Strip chart for roadside plantations
- Undertakings for compliance on other generic and specific conditions

source: JICA Study Team based on an interview to WBSEDCL on March 2018

Figure 11.3.2-2 Acquisition Flow of Forest Clearance (FC)

In India, areas that have been recognized as having special protection needed are designated as National Park or Sanctuary based on the Wildlife (Protection) Act mentioned above, however, forest in the project area are not subjected under the Act.

Formal approval will be issued by the Central Government after receiving a report which certifies the indicated compensation has been implemented from the State Government concerned. This phase is called 'Approval' or 'Final Approval' of the second stage. Forest Clearance will be issued by the regional office or MoEFCC in Delhi.

Forest Clearance will be issued by:

- Regional office in case of less than 5 hectares (ha) forest area,
- MoEFCC in Delhi in case of between 5 ha and 40 ha, after handling by the regional office,
- MoEFCC in Delhi directly in case of more than 40 ha.

As per chapter 4 of Forest (Conservation) Act 1980, as far as possible, the non-forest land for compensatory afforestation was to be identified contiguous to or in the proximity of Reserved Forest or Protected Forest. In case, non-forest land of compensatory afforestation was not available in the same district, non-forest land for compensatory afforestation was to be identified anywhere else in the State/Union Territory. If non-forest land was unavailable in the entire State/ UT, funds for raising compensatory afforestation in double the area in extent of the forest land diverted had to be provided by the user agency. The non-availability of suitable non-forest land for compensatory afforestation in the State / Union Territory would be accepted by the Central Government only on the Certificate of the Chief Secretary to the State/Union Territory Government to that effect.

11.3.3 Differences between Indian Environmental Legislation and JICA Guidelines

In addition to the compliance with the Indian environmental laws and regulations, differences from the JICA Guidelines are described in the table below to meet the requirements for obtaining a Japanese ODA loan to implement the project.

Table 11.3.3-1 Comparison between JICA Guidelines and Environment Impact Assessment Notification for Turga PSP regarding the Contents of EIA Report

Content	JICA Guidelines on Environmental and Social Considerations	Environment Impact Assessment Notification 2006 and its Amendment in 2012	Gap between JICA Guideline and Turkish Guideline/Action to be taken
Introduction	N/A	N/A	No gap.
Executive Summary	Concisely discusses significant findings and recommended actions.	APPENDIX III A: The Summary EIA shall be a summary of the full EIA Report condensed to ten A-4 size pages at the maximum. It should necessarily cover in brief the following Chapters of the full EIA Report.	No gap.
Legal framework on environmental and social considerations	Confirms that projects do not deviate significantly from the World Bank's Safeguard Policies and refers as a benchmark to the standards of international financial organizations.	SCHEDULE: List of Projects or Activities Requiring Prior Environmental Clearance	A few gaps: - Indian legal provisions regarding environmental conservation, e.g. Forest Conservation Act (1980), Supreme Court Order (1996), National Environment Policy (2006), etc., should be explained. - The EIA guidelines and standards in global treaties, international organizations and/or international development partners should be referred.
Environmental Impacts	Predicts and assesses the project's likely positive and negative impacts in quantitative terms, to the extent possible. It identifies mitigation measures	- Paragraph 7 - APPENDIX III: Generic Structure of Environmental Impact Assessment Document 4 Anticipated Environmental	A few gaps: - The process leading up to the scoping and background of EIA item selection needs to be explained.

Content	JICA Guidelines on Environmental and Social Considerations	Environment Impact Assessment Notification 2006 and its Amendment in 2012	Gap between JICA Guideline and Turkish Guideline/Action to be taken
	and any negative environmental impacts that cannot be mitigated and explores opportunities for environmental enhancement. It identifies and estimates the extent and quality of available data, essential data gaps and uncertainties associated with predictions, and it specifies topics that do not require further attention.	Impacts & Mitigation Measures	- The degree of uncertainty in EIA and additional future environmental impact caused by such uncertainty needs to be mentioned. - Some environmental/social information can be added based on the final scoping drafts and results of the supplemental survey.
Analysis of Alternatives	Systematically compares feasible alternatives to the proposed project site, technology, design, and operation including "Zero-Option" (without project) situation in terms of the following: the potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. For each of the alternatives, it quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. It also states the basis for selecting the proposed project design and offers justification for recommended emission levels and approaches to pollution prevention and abatement.	- Paragraph 7 III. Stage (3) - Public Consultation (vii) - APPENDIX III: Generic Structure of Environmental Impact Assessment Document 5 Analysis of Alternatives (Technology & Site)	A few gaps: - "Zero-Option" (without project) needs to be examined. - The degree of environmental impact of each alternative plan needs to be assessed in a quantitative manner.
Mitigation Measures	Identifies mitigation measures and any negative environmental impacts that cannot be mitigated and explores opportunities for environmental enhancement.	- APPENDIX III: Generic Structure of Environmental Impact Assessment Document 5 Analysis of Alternatives (Technology & Site)	No gap.
Environmental Management Plan	Describes mitigation, monitoring, and institutional measures to be taken during construction and operation to eliminate adverse impacts, offset them, or reduce them to acceptable levels.	- Paragraph 10. Environment Management Plan	No gap. However, In the case of monitoring items are added or changed based on supplementary findings, it is necessary to deal with the plan
Budget, financial sources and implementation arrangements	Appropriate follow-up plans and systems, such as monitoring plans and environmental management plans, must be prepared; the costs of implementing such plans and systems, and the financial methods to fund such costs, must be determined. Plans for projects with particularly large potential adverse impacts must be accompanied by detailed environmental management plans.	- APPENDIX III: Generic Structure of Environmental Impact Assessment Document 6 Environmental Monitoring Program	No gap. However, in the case of mitigation measures and/or monitoring items are added or changed based on supplementary findings, it is necessary to modify the cost.

Content	JICA Guidelines on Environmental and Social Considerations	Environment Impact Assessment Notification 2006 and its Amendment in 2012	Gap between JICA Guideline and Turkish Guideline/Action to be taken
Public Consultation with Stakeholder Meeting	In preparing EIA reports, consultations with stakeholders, such as residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared.	- Paragraph 7 III. Stage (3) - Public Consultation (vii) - APPENDIX IV Procedure for Conduct of Public Hearing	A few gaps: - Another stakeholder meeting needs to be conducted at the preparation stage of scoping drafts.
Information Disclosure	Discloses the results of such categorization on its website—including the name of each project and its country, location, project outline, category, and its reason—before making the decision to undertake preparatory surveys.	- APPENDIX IV Procedure for Conduct of Public Hearing 2.0 The Process	No gap.

source: JICA Study Team

11.4 CONSIDERATION OF ALTERNATIVE PLANS

Former West Bengal State Electricity Board (WBSEB)[14] conducted a potential survey for pumped storage power plants in 1979, in which they identified potential development sites within the State, evaluation, screening, and prioritization. Purulia, Turga, Kathlajal and Bandhu were the four most prioritized sites for PSP as a result of the survey, following which Purulia Pumped Storage Project (PPSP) was developed and started its operation in 2008. Turga PSP is the second most potential site in West Bengal and the present project site has been selected as the best option as the existing irrigation reservoir can be expanded to develop as lower reservoir, and there is valley area in upper stream area that is suitable for utilizing as upper reservoir.

11.4.1 Non-implementation of the Project

The potential environmental and social impacts in case the project is not implemented are described in Table 11.4.1-1.

Table 11.4.1-1 Anticipated Impacts when the Project is not Implemented

Item	Positive Impact	Negative Impact
Electric Demand, Stable Electric Supply	・ Acceleration of shifting to new paradigm aiming for energy saving society (such as users' awareness raising on energy saving, further development of energy-saving products) due to the shortage of peak load electricity sources, occurrence of fluctuation of power voltage and frequency.	・ It will become impossible to meet the peak power during power demand peak hours, which makes it difficult to supply electricity in a stable manner not only in West Bengal State but the eastern area of the country ・ If this project is not implemented, there are possibilities of construction of power plants/power generation facilities to cope with peak power hours in other regions. Alternative power sources, such as gas turbines using natural gas "fossil fuel power plants", are assumed. However, there is no natural gas supply in the eastern area of the country, so that it is more likely that coal with more carbons will be used as the fuel. In addition, since the ancillary service functions that can respond to rapid change in voltage and frequency are

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[14] WBSEB was unbundled into WBSETCL and WBSEDCL in April 2007.

Item	Positive Impact	Negative Impact
		insufficient, the probability of this reducing the quality of the stable supply of power is high. ・ The electricity sources that absorb and supplement the output fluctuation when renewable energy generation facilities such as solar power are built into the network near future. However, there is no alternative energy source at large-scale except pumped storage power generation. It will take considerable time for batteries to become alternative sources.
Environmental Pollution	・ No impacts on the water quality of surrounding area of the upper and lower reservoirs	・ If this project is not implemented, no negative impacts are predicted. However,if a "fossil fuel power plant" is constructed, environmental load on the air quality will be increased considerably.
Natural Environment	・ No inundation and no land alteration ・ No impacts on habitat of fauna and flora	・ If this project is not implemented, no negative impacts are predicted. However, if a "fossil fuel power plant" is constructed, land alteration for construction of new alternative thermal power plant sites and negative impacts for habitat of fauna/flora are to be concerned.
Social Environment	・ No land alteration will occur. ・ No temporary use of private land will occur during construction period ・ Small-scalle fishing activities at the existing irrigation reservoir will be kept as they are	・ There will be no contribution to increase local engagement. ・ There will be no improvement in local infrastructure (such as access road for construction works which will be developed by expanding the existing roads and constructing new permanent roads), or their development will delay, their scale and quality may be lower. ・ There will be no improvement in social infrastructure (such as clinic, education, communication and distribution networks) along with population increase during the construction period as many as 4,000 people, or their development will delay.
Others	・ No change to the level of discharged greenhouse gases (CO_2).	・ If this project is not implemented, negative impacts caused by greenhouse gases (CO_2) will not be anticipated. However, if a "fossil fuel power plant" is constructed, the level of discharged greenhouse gases will be increased.

source: JICA Study Team

11.4.2 Alternatives

According to the DPR of the Project, alternatives for the locations of project facilities, types and construction methods, location of the underground powerhouse, route of waterways, construction methods of tailrace outlet were examined with environmental and social impacts taken into consideration to prioritize them.

There are facilities with which alternatives cannot technically be examined due to the given geographic and topographic conditions such as switchyard, transmission lines and underground powerhouse. Their planes are also described below as they are closely related to the rest facilities.

(1) Lower Reservoir Dam Axis

It is necessary to reserve as much volume as 14.2MCM to run the generator of 1,000MW in total for five hours at the underground powerhouse. It was confirmed to select the option#1 (to expand the existing irrigation reservoir as the lower reservoir) as a result of examination (Table 11.4.2-1).

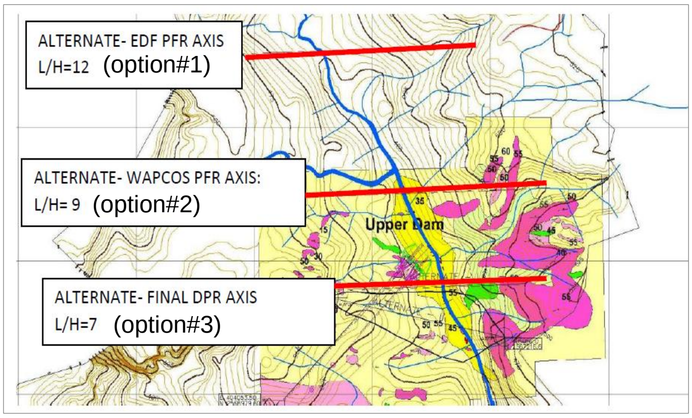
Table 11.4.2-1 Results of Alternative Examination for Lower Reservoir Dam Axis

Alternatives	Location	Results of Examination		Selection
			Results of Environmental and Social Examination	
Option#1	Same dam axis with the existing irrigation reservoir will be used	・ Granitic gneiss is found in the present dam axis. Bedrodck is surfaced on the right bank ridge, so that both ridges can be used. Dam crest lengh can be therefore minimized. ・ The volume of land alteration will be the least so that deforestation area will be minimized most. ・ Surface sediments are thin (5 to 10m in general). The left bank ridge is low which needs elevation.	<Advantages> ・ Dam crest lengh will be minimum, which will minimize the volume of land alteration (deforestation area will be minimized). The environmental impact will be most minimized among three options. <Disadvantages> ・ Elevation of present ridge height will require further exploration of earth and stones.	Selected
Option#2	Upstream of the existing irrigation reservoir	・ The narrow terrain will not allow reservoir volume sufficient (14.2MCM). ・ Surface sediments are thin (5 to 10m in general). The left bank ridge is low which needs elevation.	<Advantages> ・ Not particularly <Disadvantages> ・ Elevation of present ridge height will require further exploration of earth and stones.	Not selected
Option#3	Downstream of the existing irrigation reservoir	・ Lower end of the dam liner will affect private land. ・ Dam crest will be long. ・ Surface sediments are thin (5 to 10m in general). The left bank ridge is low which needs elevation.	<Advantages> ・ Not particularly <Disadvantages> ・ Elevation of present ridge height will require further exploration of earth and stones. ・ Dam crest lengh will be longer than the other two options, which will increase the volume of land alteration (deforestation area will increase). The environmental adverse impact will be the most serious among three options. ・ Permanent private land acquisition will be required for the dam construction. Adverse social impacts such as involuntary permanent resettlement and losses of livelihood means may occur.	Not selected

source: JICA Study Team

(2) Upper Reservoir Dam Axis

There was no other option available where the upper reservoir can be developed except the present location in the upper stream of the existing irrigation reservoir. In and around the selected site distributed stable granitic gneiss which is surfaced by talus deposits and colluvium deposits. Fault is not found. Bedrock is hard, and its permeability is low so that there found no problem in water cut-off. There is no Karst related formation (limestone deposits) or weak layer. Foundation excavation is not anticipated to be large amount as hard and stable granitic gneiss are distributed. Surface soil is estimated as deep as 10 to 15m, and the foundation can be reached without going deep. Water tightness and strength is sufficient and suitable as the dam foundation. Not many plants are found on surface. Among three options, the Option#3 in the following table is found most suitable (Figure 11.4.2-1 and Table 11.4.2-2).



source: Detailed Project Report

Figure 11.4.2-1 Alternatives for Upper Reservoir Location

Table 11.4.2-2 Results of Alternative Examination for Upper Reservoir Dam Axis

Alternatives	Location	Results of Examination	Results of Environmental and Social Examination	Selection
Option#1	Upstream	・ The length of waterway will be the longest, which will affect total cost.	<Advantages> ・ Not particularly <Disadvantages> ・ The length of waterway will be the longest, which will increase the volume of land alteration so that the adverse environmental impact will be big.	Not selected
Option#2	Midstream	・ It was estimated that dam height would become 85m and inundation area would be as large as 120ha when alternatives were examined. ・ The inundation area is bigger and the dam height is higher than the option#3.	<Advantages> ・ Not particularly <Disadvantages> ・ Large inundation area and high dam height will increaes the vlume of land alteration, so that the adverse environmental impact will be big.	Not selected
Option#3	Downstream	・ Talus deposits or colluvium deposits cover granitic gneiss and geological conditions are stable and hard. Foundation excavation will not be large amount. Fault is not found. Bedrock is hard and its permiability is low so that there found no problem in water cut-off. There is no Karst related formation (limestone deposits) or weak layer. ・ The length of dam crest will be reduced as the ridge is posted. ・ It was estimated that dam height would become 79m and inundation area would be as large as 87ha when alternatives were examined. ・ The length of waterway will be minimized. ・ (The impacts on the river alignment will be minimize by avoiding the swamp of tributary at the left bank of dam axis, and shifting the left bank part to downstream by 50 to 60 m.)	<Advantages> ・ The length of dam creast and waterways will be minimized. The volume of land alteration for dam construction will be therefore reduced. ・ Disposal amount of soil will be reduced, so that the volume of land alteration for developing the disposal sites will be reduced. ・ The impacts on the river alignment, so that adverse impacts on the environment as well as water use will be minimized. <Disadvantages> ・ Not particularly	Selected

source: JICA Study Team

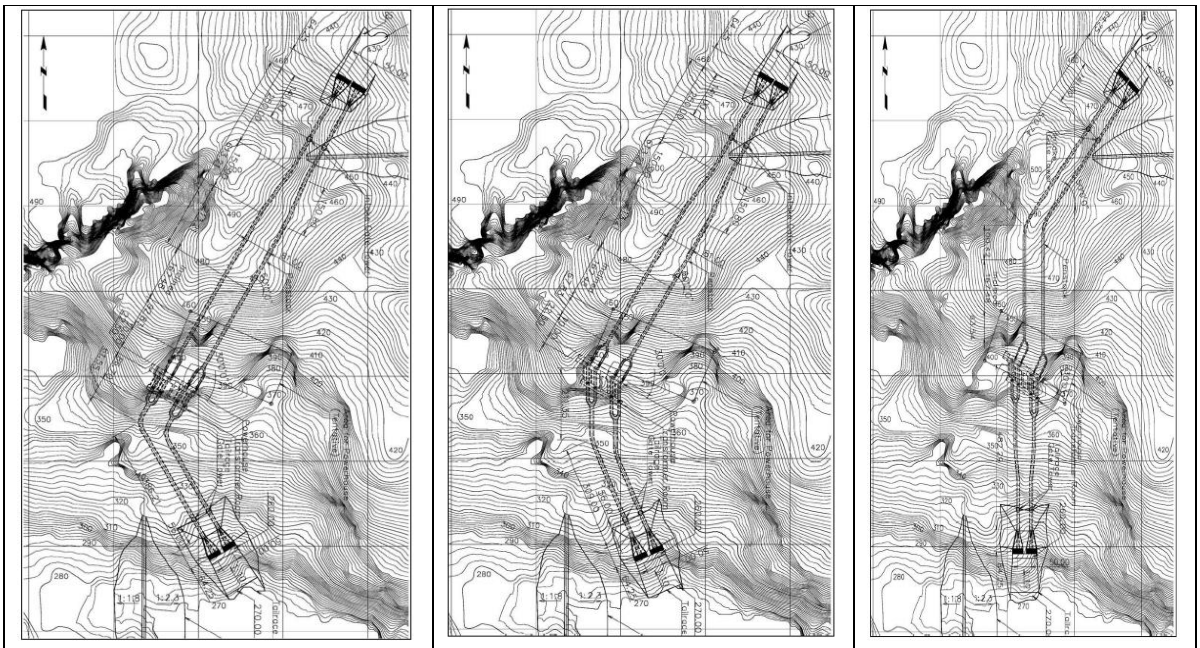
(3) Intake, Outlet, Waterways and Underground Powerhouse

If the intake structure and waterway are installed at the left bank, the length of waterways becomes longer. Furthermore, the waterway will go off the orthogonal direction of stratums and cross the river, which cause more complexity in topographic and geographic analysis.

The geographical conditions of the intake structure location at the right bank and waterways are stable with bulky and hard bedrock of granitic gneiss. The bedrock along the waterway does not have faults or weak layers anticipated, which is good for developing a tunnel / cavern for the underground powerhouse. The waterway can work well for the stability of underground tunnel since the bedding schistosity goes east to west, which crosses at right angles with the waterways designed north to south. At the tailrace outlet, granitic gneiss is distributed, and hard bedrocks are surfaced. The topsoil is thin and excavation amount will be limited.

Taking all the above examination into consideration, the layouts of waterways connecting the upper and lower reservoirs are economically designed by examining the length of waterways and soil conditions. The intake structure and tailrace outlet are designed at each edge of waterways in order not to do harms to the dam stability (Option#2 of Figure 11.4.2-2). The location of the underground powerhouse is selected at stable bulk area and avoids meta-basalt that is occasionally distributed. It is estimated that the excavation amount will be minimized, and the disposal amount will be reduced. It is anticipated that the negative impacts on the underground environment around the cavern will be lower.

The above examination to choose best option assumes the application of an adjustable speed type pumped storage system in the project. The system was developed to ensure the capacity of frequency adjustment while operation and realize the operation of power plant at highly efficient level. It has higher superiority compared with the case of “non-implementation of the project” and conventional type pumped storage system.



Option#1

Option#2 (selected)

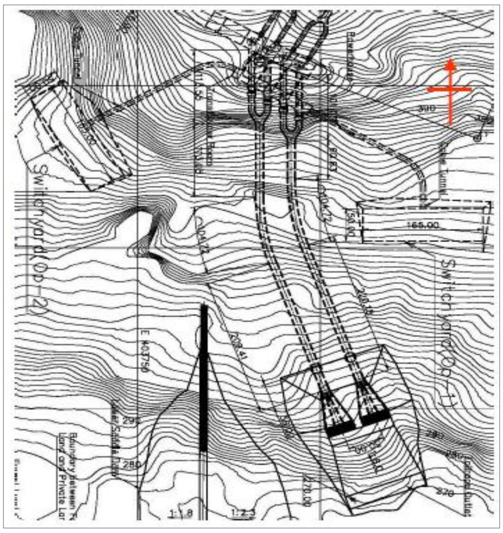
Option#3

source: Detailed Project Report

Figure 11.4.2-2 Alternatives for the Intake, Waterways, Outlet and Underground Powerhouse

(4) Switch Yard

The most economical design is applied for the layout of switchyard which locates near the powerhouse and the total cable length is the shortest consequently. The location is flat with granitic gneiss. Surface soil is as thin as less than 2m and excavation volume expected will be relatively small.



source: Detailed Project Report

Figure 11.4.2-3 Switchyard Plan

(5) Construction Materials, Quarry Area, and Disposal Site

By sampling and testing the soil of neighboring places, and collecting the existing data from Purulia PSP, the soil material for dam erection is selected. Granitic gneiss is distributed in and around the project site, which are suitable as rock quarry and rip-rap of rockfill dam. Fresh hard rock can be collected from the surface layer or under the thin topsoil.

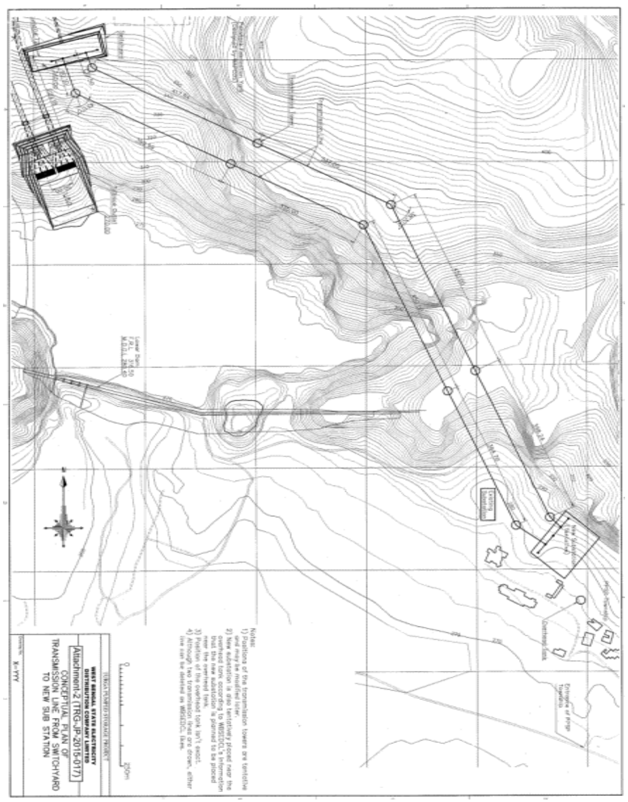
The rock quarry sites are planned within the forest land. The change or alteration of forest land will be minimized by reusing most use of crushed rocks collected in the underground excavation work. On the other hand, borrow areas are planned both in the forest land and non-forest land. The forest land which were diverted for Purulia PSP construction and non-forest land (WBSEDCL-owned land) which was used as borrow areas in Purulia PSP will be reused to the maximum extent possible, to minimize environmental adverse impact caused by forest land diversion. Detailed technical survey will be conducted in due course of time, which will identify the soil quality and quantity within the forest land, and it will decide if the soil needs to be collected at non-forest land.

Disposal sites have been selected at flat areas or depressions close to the contact road to upper reservoir and lower reservoir to shorten the length of access roads to the disposal areas and minimize the volume of land alteration. The driving distance of construction vehicles and exhaust gas emission will also be minimized. These measures are endorsed by the MoEFCC.

The grand lay out is shown in the Annex 11-1 in which borrow areas and disposal areas are also indicated.

(6) Transmission Line

The layout of transmission lines is shown in Figure 11.4.2-4. The extension of 400 kV transmission lines is approximately 1.7 km connected by double circuits. Five towers are planned from the switchyard to substation per one circuit[15]. However, it will be double circuits on one tower line, so that number of towers will remain 5.



source: Detailed Project Report

Figure 11.4.2-4 Layout of Transmission Line

The selected route is found most suitable from environmental aspect as a result of the following examination for layout of transmission lines and towers.

1) Install towers along with the permanent roads developed in the construction work

It is found efficient and makes it possible to reduce the work amount for installing and dismantling the temporary facilities required for transportation of tower construction.

2) Locate towers by reducing their volumes and the number of angle towers

Angle towers require bigger foundation area than straight towers, which makes more foundation excavation works and creates more amount of soil residue.

3) Install towers at gentle slopes

Land alteration works will be reduced.

4) Sustain the present route and number of tower

It is possible to reduce transmission route from two to one by increasing the number of conductors for bigger transmission capacity per one circuit. However, to reduce the number of towers, the wire shall fly over the reservoir and two towers crossing it require taller towers and wider arms, resulting bigger foundation per one tower.

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[15] The number of towers can be reduced; however, the wire shall fly over the reservoir and two towers crossing it require taller towers and wider arms, resulting bigger foundation per one tower. The present route and number of towers were designed in order not to cause such negative impacts to the environment.

(7) Others

Construction road will be developed by widening the existing roads and the number of newly developed roads is planned to be minimum to limit the land alteration. Many of former PPSP facilities are shared with Turga PSP such as lodges for construction workers and other structures for construction works, which is estimated to meet 75% of the required facilities.

11.5 SCOPING RESULTS AND TERMS OF REFERENCE FOR NATURAL AND SOCIAL ENVIRONMENTAL SURVEY

11.5.1 Scoping Results

The following two tables show the scoping drafts for Turga PSP including related facilities (Table 11.5.1-1) such as disposal sites and access roads, and for transmission lines (Table 11.5.1-2) based on the first country survey in October 2017. Each impact item follows that of the JICA Guidelines (2010) and anticipated impacts if no avoidance or mitigation measure is taken.

Table 11.5.1-1 Results of Scoping Draft (Turga PSP and Related Facilities)

Item	Impact		Rating		Results
			Pre-/Construction Phase	Operation Phase	
Pollution Controll	1	Air Quality	B-	D	**Construction phase**: Dust will be generated in the land preparation and other construction work, but the impact will remain temporary. Generation of air pollutants (SOx, NOx, etc.) could be expected from the operation of heavy machinery and trucks, but the impact will stay within the surrounding area. **Operation phase**: SOx, NOx, PM/dust will not be generated by the operation of the power plant.
	2	Water Quality	B-	C-	**Construction phase:** Water turbidity will be caused by the excavation work, but the impact will be temporary. There might be impacts caused by the concrete wastewater and oil-containing wastewater if not controlled. **Operation phase:** Possibility of water turbidity through the adverse impact on aquatic life caused by elevation difference of two dam sites will be predicted.
	3	Soil Quality	B-	D	**Construction phase:** Soil pollution will possibly be caused by leakage of lubricants and fuel oil from construction vehicles and machinery. **Operation phase:** There is no specific negative impact anticipated as no case of soil pollution has been confirmed in the operation of the existing power plant facilities in Purulia and with the limited number of personnel at work there.
	4	Sediment	B-	C-	**Construction phase:** Sediment pollution would possibly be caused if construction wastewater flows into the lower dam. **Operation phase:** Adverse impacts on aquatic life could not be caused by elevation difference of two dam sites.
	5	Noise and vibration	B-	D	**Construction phase**: Noise and vibration could be caused by the operation of heavy machinery and trucks, but will be limited to the surrounding area. **Operation phase**: Noise and vibration will not be experienced on the surface as the power plant will be constructed underground.
	6	Offensive odors	C-	D	**Construction phase:** Offensive odors from rotten waste may occur in the case that domestic waste from the workers' camp is not appropriately treated, but this would be very local. **Operation phase:** There is no occurrence of odor from domestic waste anticipated as the number of personnel at work in the power plant facilities is limited.
	7	Waste	B-	B-	**Construction phase:** General, industrial and hazardous wastes would be generated during the construction work. **Operation phase:** General (domestic) waste wastes would not be generated.
	8	Subsidence	D	D	No impact is anticipated because geological structure of the site is stabil and the projest will not pump up any groundwater.
n vi	9	Protected Area	D	D	Though useful plants such as medicinal, edible, oil expression and forage uses grow thickly, there are no rare species of fauna listed as threatened species in the IUCN

Item	Impact		Rating		Results
			Pre-/Construction Phase	Operation Phase	
					Red List identified and protected areas such as wildlife sanctuary, national park or biosphere reserve.
	10	Ecosystem	A-	C+	**Construction phase:** Negative impact on animal species and ecosystem will possibly be anticipated. **Operation phase:** Slight changes in ecosystem around the upper dam site might be seen due to the increasing population of waterfowl birds and amphibians.
	11	Hydrosphere	C-	C-	**Construction and Operation phase:** Construction of reservoir may make some impacts on the existing water level/ flow rate /flux.
	12	Topography and Geology	B-	C-	**Construction and Operation phase:** Soil erosion might be occurred at the embankment of the access road for construction, depending on the topographic condition. It might be occurred as well, depending on the geological conditions, at the soil disposal area.
Social Environment	13	Land acquisition	C-	D	**Pre-construction phase:** ・292ha of land is required for the PSP construction, stockyard, road development and others, out of which 234ha falls in the forest that requires official procedure for the FC. The rest 58ha is non-forest and private land, of which 34ha shall be transferred from the I&W Dept, 24ha shall be remporarily used or leased. Private land is not located within submergence area or acquired permanently. No involuntary resettlement is anticipated either. ・It is unknown if there are any livelihood activities conducted on the private land which is anticipated to be requisitioned temporarily. It is necessary to identify if there is any resettlement caused by the livelihood deterioration due to the temporary requisition of private land. ・It is necessary to examine the method and sequence of acquiring / using the required land in advance to reflect into the construction plan and schedule. Official procedures for land acquisition and requisition may have to be commenced prior to the construction work based on the construction plan. Suspension or relocation of livelihood activities can occur in particular locations, which shall be identified in the social survey. **Construction phase:** It is necessary to acquire / use the required land according to the construction plan and schedule. Suspension or relocation of livelihood activities can occur in particular locations, which shall be identified in the social survey. **Operation phase:** No major impact is anticipated.
	14	Disturbance to Poor People	C-/+	B+/-	**Construction phase:** ・Teliabhasa, Ranga and Baghmundi will accommodate the upper reservoir, whereas Baghmundi, Gosaidi and Barria will do the lower one. The demographic information of these villages including poverty rates are unknown, and shall be identified in the social survey. There may be certain people who are socially vulnerable, to whose livelihood and household economy the permanent acqisition of forest area and temporary land use during construction period may do harm directly / indirectly without appropriate countermeasures. ・It needs further investigation, analyses and confirmation if development / pagement of construction roads bring benefits to local people such as better access to social services and local market throughout a year. **Operation phase:** ・Deterioration of household economy may occur due to the losses of livelihood means if appropriate countermeasures are not taken. ・Development / pagement of construction roads may bring positive impacts to the local economy such as better access to social services and local market throughout a year.
	15	Disturbance to Ethnic Minority Groups and Indigenous People	C	C	**Construction and Operation phase:** There are scheduled tribes in the villages where the project facilities are planned. It needs further investigation and confirmation if there will be any negative impacts on their culture and customes.
	16	Deterioration of Local Economy	B-/+	B-/+	**Pre-construction / Construction phases:** ・According to the EIA report, there are plantation area where sal trees and butea trees are grown in the forest land near the planned upper reservoir area. There can be local people who are employed there, whose livelihood means may be affected directly / indirectly due to the permanent acquisition of forest land. ・Temporary requisition of private land may cause losses of livelihood means of local people. ・Development / pagement of construction roads may bring benefits to local people such as better access to social services and local market throughout a year. ・The project implementation may create local engagement and commercial opportunities with the outside people for the construction work. **Operation phase:**

Item	Impact		Rating		Results
			Pre-/Construction Phase	Operation Phase	
					・Deterioration of local economy may occur due to the relocation or losses of livelihood means if appropriate countermeasures are not taken. ・Development / pagement of construction roads may bring positive impacts to the local economy such as better access to social services and local market throughout a year.
	17	Land Use and Utilization of Local Resources	B-	B-/+	**Pre-construction / Construction phases:** ・According to the EIA report, there are plantation area where sal trees and butea trees are grown in the forest land near the planned upper reservoir area. Forest resources including the quoted plantation sites may be lost due to the permanent acquisition of forest land. ・The current land use of 58ha in total can be disturbed until the end of construction period due to the requisition of non-forest land and private land (further investigation and analyses will be made in the social survey). **Operation phase:** ・Permanent requisition of forest land (234ha) will permanently change the land use after the construction work.
	18	Disturbance to Water Usage, Water Rights, etc.	B-	C	**Construction phase:** ・There are people who do fishing in the Turga River and the existing irrigation reservoir. The construction work may affect the fishery at the irrigation reservoir negatively (scale may be smallened or totally suspended), the fishing activities at downstream, and cause water turbidity at downstream. ・Irrigation water and domestic water may be affected due to the development of lower reservoir by expanding the existing irrigation reservoir. ・Water sources and water use of each village nearby remain unknown, which needs to be identified in the site investigation. **Operation phase:** ・Although no major impact is anticipated, analyses shall be made based on the results of social survey.
	19	Disturbance to the Existing Social Infrastructure and Services	B-	B+	**Construction phase:** Traffic increase is anticipated. **Operation phase:** Positive impacts are expected through development / pagement of construction roads such as better access to social services and local market throughout a year.
	20	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	D	D	**Construction and Operation phase:** No specific impacts to the local communities are anticipated both in construction period and operation period.
	21	Misdistribution of Benefits and Losses	B-	B-	**Construction phase:** Unfairness between local people in the surrounding area benefited through the improvement of social infrastructure and services, and those whose livelihood means are affected may occur (further investigation and analyses will be made in the social survey). **Operation phase:** Without fair countermeasures taken in an appropriate manner, misdistribution of benefits and losses may last in long-term (further investigation and analyses will be made in the social survey).
	22	Local Conflicts of Interest	B-	B-	**Construction phase:** ・Unfairness between local people in the surrounding area benefited through the improvement of social infrastructure and services, and those whose livelihood means are affected may occur (further investigation and analyses will be made in the social survey). ・According to the EIA report, influx of outside people will reach 4,000 in total (1,000 project relevant people (200 technical people and 800 construction workers) and their family members, and subordinate people). Without appropriate countermeasures, local conflicts between local people and outside people may occur. **Operation phase:** Without fair countermeasures taken in an appropriate manner, local conflicts of interest may last in long-term (further investigation and analyses will be made in the social survey).
	23	Cultural Heritage	B-	C	**Construction phase:** ・There is a small Hindu temple on the left bank ridge of the planned lower reservoir, which needs to be relocated due to the construction work. ・There is no UNESCO World Heritage site in and near the project site. No historical, cultural or archeaological sites in and around the project site registered according to the Indian laws. **Operation period:** Further investigation and analyses will be made in the social survey if there is any negative impact.
	24	Landscape	C	C	**Construction phase:**

Item	Impact		Rating		Results
			Pre-/Construction Phase	Operation Phase	
					・No specific landscape is so far expected in and around the project site (further investigation and analyses will be made in the social survey). ・Rural landscape may be affected due to the tree felling in the construction workd. Further investigation and analyses will be made in the social survey. **Operation phase:** Impact on the rural landscape may last (further investigation and analyses will be made in the social survey).
	25	Gender	C	C	**Construction and Operation phase:** Although no major impact is anticipated, analyses shall be made based on the results of social survey.
	26	Children's Rights	C	C	**Construction and Operation phase:** Child labor may occur if contractors do not abide the law.
	27	Infectious Diseases	B-	D	**Construction phase:** Infectious diseases may locally spread triggered by massive influx of construction workers. **Operation phase:** No major impact is anticipated.
	28	Work Environment (Including Work Safety)	B-	B-	**Construction phase:** Risks of accidents are high through the construction work (further investigation and analyses will be made in the social survey). **Operation phase:** Industrial accidents can occur among workers.
Other	29	Accidents	B-	B-	Construction phase: ・Accidents may occur due to the constrution work. ・Traffic accidents may occur due to the increase of traffic volume. Operation phase: ・Accidents and death by drowing may occur in the reservoirs if there are no appropriate measures such as entry restriction are taken. ・Accidents can occur during maintenance work.
	30	Cross-boundary Impact and Climate Change	B-	C+	**Construction phase:** No impact on climate change is predicted although CO_2 will be produced in the construction work at relatively limited scale. **Operation phase:** CO_2 will not be produced by operation of hydropower plant. Hydropower plant has the role of reducing CO_2 emissions as an alternative energy source to fossil fuel.

source: JICA Study Team

Note:
A+/-: Significant positive/negative impact is expected,
B+/-: Positive/negative impact is expected to some extent,
C+/-: Extent of positive/negative impact is unknown (further examination is needed, and the impact may be clarified as the study progresses)
D: No impact is expected.

The transmission line route is drafted to commence at the switchyard to the existing power substations (approximately 1.7 km). The scoping results are drafted in the table below. An EIA is not required for the extension work of transmission lines according to the Indian laws and regulations.

Table 11.5.1-2 Result of Scoping Draft (T/L and Related Facilities)

Item	Impact		Rating		Results
			Pre-/ Construction Phase	Operation Phase	
Pollution Controll	1	Air Quality	B-	D	**Construction phase:** Dust will be generated in the land preparation and other construction work, but the impact will be temporary. Air pollutants (SOx, NOx, etc.) will be generated through the operation of heavy machinery and trucks, but the impact will be limited to the surrounding area. **Operation phase:** SOx, NOx PM/dust will not be generated by the operation of the T/L.
	2	Water Quality	B-	D	**Construction phase:** Soil runoff may occur from the exposed soil of the embankments and cut slopes, which may deteriorate water quality of the nearby creeks. **Operation phase:** Water Quality will not be affected by the operation of the T/L.
	3	Noise and Vibration	B-	D	**Construction phase:** The operation of heavy machinery and trucks will cause noise and vibration, but it will be limited to the surrounding area. **Operation phase:** No specific noise and vibration is expected.
ur al E	4	Protected Area	D	D	**Construction and Operation phase:** There is no specific negative impact expected.

Item	Impact		Rating		Results
			Pre-/ Construction Phase	Operation Phase	
	5	Ecosystem	C-	B-	**Construction phase:** Air pollution, noise and vibration may affect the terrestrial ecosystem. **Operation phase:** Collision between birds and transmission line may occur and cause transmission accidents.
	6	Topography and Geology	C-	C-	**Construction and Operation phase:** Depending on the geological conditions, soil erosion may occur from the exposed soil of the embankments and cut slopes at the tower locations.
Social Environment	7	Land acquisition	C	D	**Pre-construction / Construction phases:** ・It remains unknown and needs further investigation if there is any private land along the right of way (ROW), present land use of ROW, and necessity of land acquisition. ・There is no resettlement so far ancitipated. Further investigation in the social survey will be required to identify if there are local population in the ROW, or resettlement due to the deterioration of local livelihoods. **Operation phase:** No major impact is anticipated.
	8	Disturbance to Poor People	C	C	**Construction and Operation phase:** It remains unknown and needs further investigation if there are any people below poverty line living in the ROW.
	9	Disturbance to Ethnic Minority Groups and Indigenous People	C	C	**Construction and Operation phase:** There are scheduled tribes in the villages where the facilities of transmission lines are planned. It needs further investigation and confirmation if there will be any negative impacts on their culture and customes.
	10	Deterioration of Local Economy	C	C	**Construction and Operation phase:** It remains unknown and needs further investigation if there are any negative impacts to the local economy.
	11	Land Use and Utilization of Local Resources	B-	D	**Pre-construction / Construction phases:** ・Land at the tower bases will be occupied though it is small-scale. ・The land value of the ROW will decrease. **Operation phase:** No major impact is anticipated.
	12	Disturbance to Water Usage, Water Rights, etc.	C	C	**Construction and Operation phase:** It remains unknown and further investigation is required to identify if there are negative impacts and the impact degrees.
	13	Disturbance to the Existing Social Infrastructure and Services	B-	D	**Construction phase:** Traffic increase is anticipated. **Operation phase:** No major impact is anticipated.
	14	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	D	D	**Construction and Operation phase:** No specific impacts to the local communities are anticipated both in construction period and operation period.
	15	Misdistribution of Benefits and Losses	C	C	**Construction and Operation phase:** It remains unknown and further investigation is required to identify if there are negative impacts and the impact degrees.
	16	Local Conflicts of Interest	C	C	**Construction and Operation phase:** It remains unknown and further investigation is required to identify if there are negative impacts and the impact degrees.
	17	Cultural Heritage	C	C	**Construction phase:** There is no UNESCO World Heritage site in and near the project site. Further information shall be collected if there are any historical, cultural or archeaological sites in and around the project site registered according to the Indian laws (further investigation and analyses will be made in the social survey). **Operation period:** Further investigation and analyses will be made in the social survey if there is any negative impact.
	18	Landscape	C	C	**Construction phase:** ・No specific landscape is so far expected in and around the project site (further investigation and analyses will be made in the social survey). ・Rural landscape may be affected due to the extension of transmission lines. Further investigation and analyses will be made in the social survey. **Operation phase:** Impact on the rural landscape may last (further investigation and analyses will be made in the social survey).
	19	Gender	C	C	**Construction and Operation phase:** Although no major impact is anticipate, further analyses shall be made based on the results of social survey.
	20	Children's Rights	C	C	**Construction and Operation phase:** Child labor may occur (further investigation and analyses will be made in the social survey).
	21	Infectious Diseases	B-	D	**Construction phase:** Infectious diseases may locally spread triggered by massive influx of construction workers. **Operation phase:** No major impact is anticipated.
	22	Work Environment (Including Work Safety)	B-	B-	**Construction phase:** Risks of accidents are high through the construction work (further investigation and analyses will be made in the social survey). **Operation phase:** Industrial accidents can occur among workers.

Item	Impact		Rating		Results
			Pre-/ Construction Phase	Operation Phase	
Other	23	Accidents	B-	B-	**Construction phase:** ・ Accidents may occur due to the constrution work. ・ Traffic accidents may occur due to the increase of traffic volume. **Operation phase:** ・ Accidents and death by drowing may occur in the reservoirs if there are no appropriate measures such as entry restriction are taken. ・ Accidents can occur during maintenance work.
	24	Cross-boundary Impact and Climate Change	C-	D	**Construction phase:** No impact on climate change is predicted although CO_2 will be produced in the construction work at relatively limited scale. **Operation phase:** Transmission line will not cross a boundary. No CO_2 will be produced by the extension and operation of the transmission line.

source: JICA Study Team

note:
A+/-: Significant positive/negative impact is expected,
B+/-: Positive/negative impact is expected to some extent,
C+/-: Extent of positive/negative impact is unknown (further examination is needed, and the impact may be clarified as the study progresses)
D: No impact is expected.

11.5.2 TOR for Natural and Social Environmental Survey

The following two tables show the terms of reference for the natural and social environmental survey. The TOR excludes those issues which were already studied in the EIA report.

Table 11.5.2-1 Results of the EIA and Survey TOR under the Preparatory Survey (Turga PSP and Related Facilities)

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
Air Quality	Yes	・ There were no major sources of air pollution in the Project Site. ・ PM10, SOx and NOx were considerably lower than Indian Standard at 4 points of the Project Site in summer, winter and monsoon season, respectively.	・ Related Environmental Standerd ・ Meteorological information and data ・ Current condition of air quality	・ Collection of latest meteorological data and domestic air quality standards ・ Actual measurement of the current PM10, SOx and NOx concentration in the Project Site	Consideration of antipollution measures in the construction phase
Water Quality	Yes	・ There were no major sources of water pollution in the Project Site. ・ General items including metals were not exceeded the Indian Standard at 5 points of the Project Site in summer, winter and monsoon season, respectively.	・ Related Environmental Standerd ・ Meteorological information and data ・ Current condition of water system in the survey area	・ Collection of water body map in the Project Site, latest domestic water quality standards and effluent standards ・ Actual measurement of the current water quality	Consideration of antipollution measures in the construction phase
Soil Quality	Yes	・ Results of physicochemical analyses indicated oligotrophic soil distribution in the Project Site.	・ Related Environmental Standerd ・ Current condition of soil quality and distribution	・ Soil classification based on the profile survey and physicochemical analyses ・ Collection of soil distribution map	Consideration of measures against leakage of lubricants and fuel oil in the construction and operation phases
Sediment	No	・ Any information about reservoir sediments were not mentioned in the EIA.	Current condition of water quality and sediment of the lower dam	Site investigations of the lower reservoir sediment and interstitial water quality	Consideration of antipollution measures in the construction phase
Noise and Vibration	Yes	・ Traffic volume and population density are low, the Project Site is generally under quiet condition. ・ According to results of actual measurement, noise levels at 4 residential areas in the Project Site were quite lower than the standard values of "Silent Zone" which Environment Protection Rules (revised in 2000) defined as the most tranquility condition	・ Related Environmental Standerd ・ Confirmation of a positional relation between assumed noise and vibration causes such as diesel generator ・ and residential areas	Confirmation of a positional relation between assumed noise and vibration causes such as diesel generator・and residential areas	・ Consideration of mitigation measures for noise and vibration in the construction phase ・ Sufficient explanation to local stakeholders about possibilities of noise and vibration generation to gain their understandings

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
Offensive Oder	No	Any information about generation of offensive odor was unmentioned in the EIA	・ Related Environmental Standerd ・ Local customs of collection and classification for sorting	・ Confirmation of related laws and regulations regarding handlings of solid wastes such as collection and classification for sorting ・ Hearings with administrative body which has jurisdiction over waste treatments	Consideration of disposal plan for industrial wastes and domestic wastes which may emit odious smell in the construction and operation phases
Waste	No	Description on waste is already mentioned in the EIA report.	・ Related Environmental Standerd ・ Local customs of collection and classification for sorting	・ Confirmation of related laws and regulations regarding handlings of solid wastes such as collection and classification for sorting ・ Hearings with administrative body which has jurisdiction over waste treatments	Consideration of disposal plan for industrial wastes and domestic wastes which may emit odious smell in the construction and operation phases
Subsidence	No	Any information about possibility of occurrence of land subsiding	Current condition of hydrogeology in the survey area	Confirmation of hydro-geologic condition in the Project Site	Estimation of optimum pumping discharges in case of drawing groundwater for some purpose
Protected Area	Yes	Though useful plants such as medicinal, edible, oil expression and forage uses grow thickly, there are no rare species of fauna listed as threatened species in the IUCN Red List identified and protected areas such as wildlife sanctuary, national park or biosphere reserve.	・ Current condition of protected areas ・ Applicable laws and regulations	・ Confirmation of protected area location and applicable lows/regulations ・ Hearings with administrative body which has jurisdiction over wildlife protection	Consideration of mitigation measures if the project impacts on any protected areas
Ecosystem	Yes	Noise and vibration in the construction phase may temporarily impact on wildlife	・ Current habitat status of flora, mammal , birds, reptiles, amphibians, fish, precious species	・ Confirmation of current situation of fauna and flora in the survey area ・ Hearings with WBSEDCL about detail	・ Estimate the degree of impact on ecologically important habitats and take preventive

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
			(migrant birds) ・ Compensatory plantation plan	plan of compensatory plantation	measures if significant impact on the habitat is predicted. ・ Estimate the degree of impact on endangered species, and take preventive measures if significant impact on species is predicted. ・ Confirmation of the detail plan of compensatory plantation and revise, if any.
Hydrometeorology	No	Any information about hydrometeorological prediction was unmentioned in the EIA	・ Existing water system ・ Flow rate and water level	・ Confirmation of current water system based on satelite data ・ Field investigation	Consideration of mitigation measures if the project impacts on the local hydrometeorology
Topography and Geology	Yes	Lithological character, geological structure and topological situation were illustrate in great detail. Structural dynamic characteristics were also analyzed adequately.	Confirmation of geological stability, difficulty level in terms with economic and technical level for structural construction	・ Collection of distinct pictures and drawings to confirm the current condition ・ Hearings with experts regarding geological adequacy and stability for structural constructions ・ Field investigation	Geological revalidation of structural construction
Land acquisition and Resettlement	Yes	・ 292 ha of land is required for the PSP construction, stockyard, road development and others, out of which 234ha falls in the forest that requires official procedure for the FC. The rest 58ha is non-forest government and private land, of which 34ha shall be transferred from the I&W Dept, 24ha shall be temporarily used or leased. ・ (Locations of government land and private land within the project area. Their present use is not mentioned either => needs to be identified)	・ Locations and present use of the government land and private land which require temporary use and requisition ・ Confirm who the affected people are (including resettlers	・ Collect relevant laws and regulations ・ Identify the number of the affected villages and their locations ・ Conduct a household socioeconomic survey (population census,	Elaborate draft ARAP based on the survey results (if required)

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
	Yes	• Private land is not located within submergence area or acquired permanently. No involuntary resettlement is anticipated either and no rehabilitation measures will be required. Impacts to the local people will be temporary. (Degree of temporary impact and their contents are not described => needs to be identified)	and temporarily affected people) • Identify their livelihood means Examine methods and sequence of land acquisition	asset inventory and household survey)	
Poor People	No	(No investigation and analyses on the impacts on the poor people are described => needs to be identified)	Identify if there are people below poverty line among the affected people	• Collect relevant laws and regulations • Conduct socioeconomic survey	• Elaborate livelihood restoration measures based on the survey results (if required) • Develop permanent roads which local people can use even after the construction period
	Yes	• Development / pagement of construction roads may bring positive impacts to the local economy such as better access to social services and local market throughout a year. • The project implementation will create local engagement and commercial opportunities with the outside people for the construction work.			
Disturbance to Ethnic Minority Groups and Indigenous People	Yes	• Existence of scheduled castes and scheduled tribes in the study area are confirmed through the official results of the Population Census 2011. (It remains unknown if there are specific people who need protection and assistance, their living places and population => needs to be identified)	• Identify if there are people who require protection and assistance • Identify if there are negative impacts	• Interview with village heads Interview with local people	Elaborate livelihood assistance measures based on the survey results (if required)
Deterioration of Local Economy such as Losses of Employment and Livelihood Means	Yes	• There are people who do fishing in the existing irrigation reservoir. The construction work may affect the fishery there negatively (fishing volume may be reduced or their activities may totally be suspended) resulting in their livelihood losses. The fishing activities at downstreammay be affected. (It remains unknown the living locations and number of the affected population => needs to be identified)	• Identify the present household economy (livelihoods, occupations, etc) of the affected people whose livelihood means can be lost due to the temporary use of their private land during construction period, which Identify if there are involuntary resettlement due to the deterioration of their livelihoods	• Collect information on local engagement and hosuehold income • Conduct socioeconomic survey • Interview with local people	Elaborate livelihood restoration measures based on the survey results (if required)
	Yes	• There are plantation area where sal trees and butea trees are grown in the forest land near the planned upper reservoir area. (It remains unknown if there are local people who are employed there, and if the local livelihood means may be affected directly / indirectly due to the permanent acquisition of forest land. => needs to be identified)			
	No	(It is unknown if there are any livelihood activities conducted on the private land which is anticipated to be requisitioned temporarily. => needs to be identified)			

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
	Yes	- Development / pagement of construction roads may bring positive impacts to the local economy such as better access to social services and local market throughout a year. The project implementation will create local engagement and commercial opportunities with the outside people for the construction work.			
Land Use and Utilization of Local Resources	Yes	- Out of the required land (292 ha), 234ha is forest area that requires official procedures for the FC. There are plantation area where sal trees and butea trees are grown in the forest land near the planned upper reservoir area, which will be affected by the project. The remaining 58ha is non-forest government and private land, of which the tenure of 34ha will be transferred from the I&W Dept, and the other 24ha will be temporarily used or leased. - (The current land use of 58ha can be disturbed until the end of construction period due to the requisition of non-forest land and private land. Locations of private land and their present use, however, are unknown. => needs to be identified)	- Present land use Identify livelihoods and occupations of the household affected by the project	- Collect information on local engagement and hosuehold income Interview with the target households	Elaborate compensation and livelihood restoration measures (if required)
Disturbance to Water Usage, Water Rights, etc.	Yes	- There are people who do fishing in the Turga River, the existing irrigation reservoir and at downstream. Construction work may make it difficult for them to continue fishing in the irrigation reservoir, affect the fishing activities at the downstream, and cause water turbidity at downstream.	Present use of domestic water and agricultural water	- Conduct socioeconomic survey Interview with local people	- Conduct countermeasures to prevent water pollution during construction period - Satisfy the waste water standard by installing the waste water treatment facilities
	Yes	- Water of irrigation reservoir is used for agriculture and drinking purposes. By developing the coffer dam next to the existing reservoir, the water will be kept used even during the construction phase.			
	No	- (It is unknown if there are alternative water sources for agriculture and drinking purposes such as water intake from wells and other sources. => needs to be identified)			
Disturbance to the Existing Social Infrastructure and Services	Yes	- Traffic volume will increase during contruction period. - Development / pagement of construction roads may bring positive impacts to the local economy such as better access to social services and local market throughout a year.	Identify present traffic volume	Collect statistic data of traffic volumes	- Develop permanent roads which local people can use even after the constrution period

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
					・ Examine vehicle transportation schedule during the construction peiod
Misdistribution of Benefits and Losses	No	・ Unfairness between local people in the surrounding area benefited through the improvement of social infrastructure and services, and those whose livelihood means are affected may occur ・ (It remains unknown if there are local people who lose their livelihood means or not because no primary interview is conducted yet. => needs to be identified)	Identify livelihoods and occupations of the household affected by the project	・ Collect information on local engagement and hosuehold income Group interview with local people	Elaborate compensation and livelihood restoration measures based on the survey results (if required)
Local Conflicts of Interest	Yes	・ An influx of outside people will reach 4,000 in total (1,000 project relevant people (200 technical people and 800 construction workers) and their family members, and subordinate people). Without appropriate countermeasures, local conflicts between local people and outside people may occur.	Identify the locations and facilities of inbound people	Interview with WBSEDCL	Reflect countermeasures into the project plan
Cultural Heritage	Yes	・ There is a small Hindu temple on the left bank ridge of the planned lower reservoir, which needs to be relocated due to the construction work. ・ (It remains unknown if there are any historical, cultural or archeaological sites in and around the project site registered according to the Indian laws. => needs to be identified)	・ Identify the tenure of Hindu temple and local people who worship there Identify if there are any historical, cultural or archaeological sites in and around the project site registered according to the Indian laws.	・ Collect literature and information Interview with village heads, priest and local people	Reflect countermeasures into the project plan (if required)
Landscape	No	・ No specific landscape is so far expected in and around the project site ・ (It remains unknown if rural landscape may be affected due to the tree felling in the construction workd. => needs to be identified)	Identify if there are impacts to the landscape	Visual confirmation through digital image	-
Gender	No	・ (Countermeasures are examined. However, it remains unknown if there are local people who are affected or not because no primary interview is conducted yet. => needs to be identified)	・ Identify the gender among the affected people Access to health facilities	・ Collect relevant laws and regulations Conduct socioeconomic survey	Elaborate livelihood assistance measures based on the survey results (if required)
Children's Rights	No	・ (Possible child labor is anticipated. However, it remains unknown if there are children who are affected or not because no primary interview is conducted yet. =>	・ Identify the number of the project affected children and the local	・ Collect relevant laws and regulations ・ Conduct socioeconomic	Elaborate assistance measures based on the survey results (if required)

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
		needs to be identified)	sitauation they are faced with • Infant and childr mortality rates • Access to health facilities • Immunization rates • Education status	survey • Group interview with local people	
Infectious Diseases	Yes	• Occurrence of infectious diseases is anticipated triggered by pollutions and mosquitoes created by inappropriate treatment of discharged water and wastes, and massive influx of construction workers.	• Not particularly	• Not particularly	Develop the work and sanitation plan during construction period
Work Environment (Including Work Safety)	Yes	• Risks of accidents are high through the construction work. • Accidents can also occur during maintenance work.	• Not particularly	• Not particularly	Develop the work and safety plan during construction period and operation period.
Accidents	Yes	• Accidents may occur due to the constrution work. • Traffic accidents may occur due to the increase of traffic volume. • Accidents can occur during maintenance work.	• Not particularly	• Not particularly	Develop countermeasures to prevent accidents and responses to them
Cross-boundary Impact and Climate Change	No	• No survey was conducted.	• Present air quality • Degree of contribution to mitigate the climate change	• Observe the air pollutants (CO_2) • Evaluate by using the JICA Climate Finance Impact Tool for Mitigation and Adaptation (JICA Climate-FIT)	Estimate the amount of CO2 emission from construction vehicles and heavy vehicles.

source: JICA Study Team

Table 11.5.2-2 Results of the EIA and Survey TOR under the Preparatory Survey (T/L and Related Facilities)

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
Air Quality	Yes	・ There were no major sources of air pollution in the Project Site. ・ PM10, SOx and NOx were considerably lower than Indian Standard at 4 points of the Project Site in summer, winter and monsoon season, respectively.	Not particularly	Not particularly	Consideration of antipollution measures in the construction phase
Water Quality	Yes	・ There were no major sources of water pollution in the Project Site. ・ General items including metals were not exceeded the Indian Standard at 5 points of the Project Site in summer, winter and monsoon season, respectively.	Not particularly	Not particularly	Consideration of antipollution measures in the construction phase
Noise and Vibration	Yes	・ Traffic volume and population density are low, the Project Site is generally under quiet condition. ・ According to results of actual measurement, noise levels at 4 residential areas in the Project Site were quite lower than the standard values of "Silent Zone" which Environment Protection Rules (revised in 2000) defined as the most tranquility condition	・ Related Environmental Standerd ・ Confirmation of a positional relation between assumed noise and vibration causes such as diesel generator ・ and residential areas	Confirmation of a positional relation between assumed noise and vibration causes such as diesel generator・and residential areas	Consideration of mitigation measures for noise and vibration in the construction phase
Protected Area	Yes	Though useful plants such as medicinal, edible, oil expression and forage uses grow thickly, there are no rare species of fauna listed as threatened species in the IUCN Red List identified and protected areas such as wildlife sanctuary, national park or biosphere reserve.	Related lows, regulations and rules	Confirmation of the distribution of flora, fauna and migratory birds flyway	・ Estimation of the degree of impact on endangered species if their habitat is around the transmission line route and take preventive measures if significant impact on the species is predicted. ・ Taking protective measures if the habitat of large birds is distributed around the route.
Ecosystem	Yes	There are no rare species of fauna listed as threatened species in the IUCN Red List identified and protected areas such as wildlife sanctuary, national park or biosphere reserve.	・ Current status of ecologically valuable habitats. ・ Current habitat status of fauna and flora	Confirmation of distribution and habitat of wildlife	・ Estimation of the degree of impact on endangered species if their habitat is around the transmission line route and take

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
					preventive measures if significant impact on the species is predicted. • Taking protective measures if the habitat of large birds is distributed around the route. • Monitoring of bird strikes and take preventive measures if bird strikes occur
Topography and Geology	Yes	Lithological character, geological structure and topological situation were illustrate in great detail. Structural dynamic characteristics were also analyzed adequately.	Confirmation of geological stability, difficulty level in terms with economic and technical level for structural construction	• Collection of distinct pictures and drawings to confirm the current condition • Hearings with experts regarding geological adequacy and stability for structural constructions • Field investigation	Geological survey prior to construction to select the tower locations.
Land acquisition	Yes	• 292ha of land is required for the PSP construction, stockyard, road development and others, out of which 234ha falls in the forest that requires official procedures for the FC. The rest 58ha is non-forest and private land, of which 34ha shall be transferred from the I&W Dept, 24ha shall be remporarily used or leased. • (Locations of government land and private land within the project area. Their present use is not mentioned either => needs to be identified)	• Identify the ROW • Identify if there is private land in the ROW • Identify the present land use	Collect relevant laws and regulations	Elaborate draft ARAP based on the survey results (if there is private land which is required for the project)
Disturbance to Poor People	No	• (No investigation and analyses on the impacts on the poor people are described => needs to be identified)	• Identify if there are people below poverty line among the affected peole • Identify if there is private land in the ROW and their present	• Collect relevant laws and regulations • Conduct socioeconomic survey	• Elaborate livelihood restoration measures based on the survey results (if required) • Develop permanent roads which local people can use even
	Yes	• Development / pagement of construction roads may bring positive impacts to the local economy such as better access to social services and local market throughout a year. • The project implementation will create local			

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
		engagement and commercial opportunities with the outside people for the construction work.	use		after the constrution period
Disturbance to Ethnic Minority Groups and Indigenous People	Yes	- Existence of scheduled castes and scheduled tribes in the study area are confirmed through the official results of the Population Census 2011. - (It remains unknown if there are specific people who need protection and assistance, their living places and population => needs to be identified)	- Identify if there are people who require protection and assistance - Identify if there are negative impacts	- Interview with village heads - Interview with local people	Elaborate livelihood assistance measures based on the survey results (if required)
Deterioration of Local Economy such as Losses of Employment and Livelihood Means	Yes	- There are people who do fishing in the existing irrigation reservoir. The construction work may affect the fishery there negatively (fishing volume may be reduced or their activities may totally be suspended) resulting in their livelihood losses. The fishing activities at downstreammay be affected. - (It remains unknown the living locations and number of the affected population => needs to be identified)	- Identify livelihoods and occupations of the household affected by the project	- Collect information on local engagement and hosuehold income - Conduct socioeconomic survey - Interview with local people	Elaborate livelihood restoration measures based on the survey results (if required)
	No	- (It is unknown if there are any livelihood activities conducted on the private land which is anticipated to be requisitioned temporarily. => needs to be identified)			
Land Use and Utilization of Local Resources	Yes	- Out of the required land (292ha), 234ha is forest area that requires official procedures for the FC. There are plantation area where sal trees and butea trees are grown in the forest land near the planned upper reservoir area, which will be affected by the project. The remaining 58ha is non-forest and private land, of which the tenure of 34ha will be transferred from the I&W Dept, and the other 24ha will be temporarily used or leased. - (The current land use of 58ha can be disturbed until the end of construction period due to the requisition of non-forest land and private land. Locations of private land and their present use, however, are unknown. => needs to be identified)	- Present land use - Identify livelihoods and occupations of the household affected by the project	- Collect information on local engagement and hosuehold income Interview with the target households	Examine the countermeasures if the erection of transmission towers affect local grazing activities and etc.
Disturbance to Water Usage, Water Rights, etc.	No	- (It is unknown if there are alternative water sources for agriculture and drinking purposes such as water intake from wells and other sources. => needs to be identified)	- Present use of domestic water and agricultural water	- Conduct socioeconomic survey - Interview with local people	- Conduct countermeasures to prevent water pollution during construction period

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
					• Satisfy the waste water standard by installing the waste water treatment facilities
Disturbance to the Existing Social Infrastructure and Services	Yes	• Traffic volume will increase during contruction period. • Development / pagement of construction roads may bring positive impacts to the local economy such as better access to social services and local market throughout a year.	• Identify present traffic volume	• Collect statistic data of traffic volumes	• Develop permanent roads which local people can use even after the constrution period • Examine vehicle transportation schedule during the construction peiod
Misdistribution of Benefits and Losses	No	• Unfairness between local people in the surrounding area benefited through the improvement of social infrastructure and services, and those whose livelihood means are affected may occur • (It remains unknown if there are local people who lose their livelihood means or not because no primary interview is conducted yet. => needs to be identified)	• Identify livelihoods and occupations of the household affected by the project	• Collect information on local engagement and hosuehold income • Group interview with local people	• Elaborate compensation and livelihood restoration measures based on the survey results (if required)
Local Conflicts of Interest	Yes	• An influx of outside people will reach 4,000 in total (1,000 project relevant people (200 technical people and 800 construction workers) and their family members, and subordinate people). Without appropriate countermeasures, local conflicts between local people and outside people may occur.	• Identify the locations and facilities of inbound people	• Interview with WBSEDCL	• Reflect countermeasures into the project plan
Cultural Heritage	No	• (It remains unknown if there are any historical, cultural or archeaological sites in and around the project site registered according to the Indian laws. => needs to be identified)	• Identify if there are any historical, cultural or archeaological sites in and around the project site registered according to the Indian laws.	• Collect literature and information	• Reflect countermeasures into the project plan (if required)
Landscape	No	• No specific landscape is so far expected in and around the project site • (It remains unknown if rural landscape may be affected due to the tree felling in the construction workd. => needs to be identified)	• Identify if there are impacts to the landscape	• Visual confirmation through digital image	-
Gender	No	• (Countermeasures are examined. However, it remains	• Identify the gender	• Collect relevant laws	• Elaborate livelihood

Item	Results of the EIA (submitted to the MoEFCC in June 2016 for EC)		Survey TOR under the Preparatory Survey		
	Studied or not	Results of Study and Prediction	Survey Item	Survey Method	Possible Countermeasures
		unknown if there are local people who are affected or not because no primary interview is conducted yet. => needs to be identified)	among the affected people ・ Access to health facilities	and regulations ・ Conduct socioeconomic survey	assistance measures based on the survey results (if required)
Children's Rights	No	・ (Possible child labor is anticipated. However, it remains unknown if there are children who are affected or not because no primary interview is conducted yet. => needs to be identified)	・ Identify the number of the project affected children and the local sitaution they are faced with ・ Infant and childr mortality rates ・ Access to health facilities ・ Immunization rates ・ Education status	・ Collect relevant laws and regulations ・ Conduct socioeconomic survey ・ Group interview with local people	・ Elaborate assistance measures based on the survey results (if required)
Infectious Diseases	Yes	・ Occurrence of infectious diseases is anticipated triggered by pollutions and mosquitoes created by inappropriate treatment of discharged water and wastes, and massive influx of construction workers.	・ Not particularly	・ Not particularly	・ Develop the work and sanitation plan during construction period
Work Environment (Including Work Safety)	Yes	・ Risks of accidents are high through the construction work. ・ Accidents can also occur during maintenance work.	・ Not particularly	・ Not particularly	・ Develop the work and safety plan during constrcution period and operation period.
Accidents	Yes	・ Accidents may occur due to the constrution work. ・ Traffic accidents may occur due to the increase of traffic volume. ・ Accidents can occur during maintenance work.	・ Not particularly	・ Not particularly	・ Develop countermeasures to prevent accidents and responses to them

source: JICA Study Team

11.6 ENVIRONMENTAL AND SOCIAL SURVEY RESULTS

11.6.1 Pollution Control

(1) Ambient Air Quality

The National Ambient Air Quality Standards of India and guideline value of World Health Organization (WHO) are given in Table 11.6.1-1.

Table 11.6.1-1 National Ambient Air Quality Standards (amended in 2009)

Pollutants	Time Weighted Average	Industrial, Residential, Rural and Other Area*	Ecologically Sensitive Area	Method
SO_2 ($\mu g\ m^{-3}$)	Annual	50 (20)	20	- Improved west & Gacke method - Ultraviolet fluorescence method
	24 hours	80 (500)	80	
NO_2 ($\mu g\ m^{-3}$)	Annual	40 (40)	30	- Modified Jacab&Hochheister method - Chemiluminescene method
	24 hours	80 (200)	80	
PM10 ($\mu g\ m^{-3}$)	Annual	60 (20)	60	- Gravimetric method - TEM - Beta attenuation method
	24 hours	100 (50)	100	
PM2.5 ($\mu g\ m^{-3}$)	Annual	40 (10)	40	
	24 hours	60 (25)	60	

source: NATIONAL AMBIENT AIR QUALITY STATUS & TRENDS (2012), CPCB
note * WHO Guideline Values (2017)

There are no major sources of air pollution in the project area. The sources of air pollution in the region are vehicular traffic, dust arising from unpaved village roads and domestic fuel burning. Distant View of the Project Site is showed at Figure 11.6.1-1. According to the EIA Report, PM10, SO_2 and NOx were considerably lower than the Indian Standard at 4 points of the Project Site (near upper dam site, near lower dam site, Baghmundi Village and downstream of lower dam site) measured in summer, winter and monsoon season, respectively from 2013 to 2014.

Figure 11.6.1-1 Distant View of the Project Site

In this survey, PM10, SO_2 and NOx (as NO_2) were measured in the same points mentioned above to grasp the current air condition from December 2017 to January 2018. The work of monitoring of ambient air quality is under progress. The results are summarized in Table 11.6.1-2

Not be disclosed per infringement of portrait right.

(a) Gosaidi Village (b) Baghmundi Village (c) Near Upper Dam (d) Manga Village

Figure 11.6.1-2 Air Sampling Activities

Table 11.6.1-2 Analyses Results of Ambient Air Quality

Station	Average	Maximum	Minimum
PM10			
Near Upper Reservoir Site	33.0	40.5	28.0
Near Lower Reservoir Site	31.4	33.9	26.7
Near Village Baghmundi	36.9	42.4	31.0
Downstream of Lower Reservoir	31.8	35.5	28.4
SO_2			
Near Upper Reservoir Site	15.3	16.4	13.7
Near Lower Reservoir Site	15.5	16.8	14.3
Near Village Baghmundi	16.5	17.5	15.6
Downstream of Lower Reservoir	14.7	16.2	12.9
NO_2			
Near Upper Reservoir Site	20.6	23.1	18.9
Near Lower Reservoir Site	22.6	24.6	20.9
Near Village Baghmundi	25.7	28.0	23.6
Downstream of Lower Reservoir	21.5	22.4	20.3

source: JICA Study Team

Based on the findings of the ambient air quality survey, it can be concluded again that the ambient air quality is quite good in the area. The values of these parameters were well below the permissible limits specified for residential, rural and other areas. The absence of industries, low vehicular traffic and low population density can be attributed for good ambient air quality in the project area. Dust was generated at construction site of Purulia PSP, which remained temporary. Similar case is anticipated in this project too.

(2) Water Quality

Turga river sub basin is a part of Subarnarekha river system, originates from the Ayodhya hills in West Bengal. It is flowing in north to south and joins Sobha River. Water Sampling was conducted at seven sites. The details of locations are given in Table 11.6.1-3 and the map showing location of water quality monitoring stations is enclosed as Figure 11.6.1-3.

Table 11.6.1-3 Details of Locations for water sampling

STATION CODE	LOCATION	LATITUDE	LONGITUDE
W1	Dam Site Upper Dam (River Water)	23°12'47.41"N	86° 4'11.26"E
W2	300m Downstream of Upper Dam (River Water)	23°12'37.95"N	86° 4'16.41"E
W3	500m Upstream of Upper Dam (River Water)	23°13'02.73"N	86° 4'03.11"E
W4	Reservoir upstream of Lower Dam axis (River Water)	23°12'02.43"N	86° 4'36.92"E
W5	Downstream of Lower Dam site	23°11'36.80"N	86° 4'37.15"E
W6	Ranga village (Ground water, bore well) near to upper reservoir	23°14'06.30"N	86° 4'32.87"E
W7	Gosiati Village (Ground water, bore well)	23°11'44.03"N	86° 3'58.92"E

Figure 11.6.1-3 Sampling location map of water quality monitoring stations

Water temperature was recorded with the help of graduated mercury thermometer. In case of water, care was taken in measuring the temperature as it was recorded from surface, column and near the bottom of the river. Average values of these readings were computed for final results. A 20 m stretch of the river was measured and marked at both ends. A float was thrown at upper end and the time taken by the float to travel the marked distance, was recorded by a stop watch. Three replicates were obtained and averaged for final results. For monitoring turbidity, water samples were collected in sampling bottles from different sites in the field and brought to the laboratory for analysis. The turbidity was recorded with the help of digital turbidity meter (TN 100; Eutech). The pH was recorded with the help of pH Scan (Eutech) and pH meter (EI – 132 E) in the field. The total dissolved solids were measured with the help of TDScan 1 (Eutech) at each site. Similarly, Electrical conductivity was recorded with the help of TDScan 3 (Eutech) at the sites. Dissolved oxygen was measured by iodometric titration method using Oxygen test kit (Aquamerck). Total alkalinity, alkalinity as carbonates and bicarbonates, total hardness, Ca and Mg contents, and chloride were measured with the help of APHA (2005) and Adoni (1985). Nitrate (NO_3-N), Silicate and phosphate (PO_4-P) were measured by photometric method using UV/visible spectrophotometer (Ultrospec 3000). Other ions like Na, and K and a few heavy metals (Fe, Cu, Cd) were detected by Atomic Absorption Spectrometry (AA 6300). The results of water quality monitoring conducted for winter season in November 2017 is given in Table 11.6.1-4. The water quality standards are given in Table 11.6.1-5.

Table 11.6.1-4 Water quality characteristics of Turga River and other water bodies in the survey Area

Parameters	Sampling Points						
	W1	W2	W3	W4	W5	W6	W7
Water Temperature (°C)	29	28	30	31	29	28	26
pH	7.3	7.1	7.4	7.1	6.5	7.4	6.9
Dissolved Oxygen (mg L^{-1})	7.2	6.5	6.3	6.3	6.1	6.4	7.0
Electrical Conductivity (μS)	120.6	126.9	130.2	126.9	149.0	225.1	252.6
TDS (mg L^{-1})	95.2	92.0	82.0	89.1	110	220	180
Total Hardness (mg L^{-1})	118	120	112	126	123	160	130
Calcium (mg L^{-1})	22	24	26.8	24.3	27.0	21.68	17.31
Magnesium (mg L^{-1})	10.72	14.2	10.0	15.10	11.23	27.91	15.79
Total Alkalinity (mg L^{-1})	90.0	92.0	98.0	90.0	99.00	126.78	128.64
Chlorides (mg L^{-1})	42.0	44	44.0	42.0	46.00	39	38
Nitrates (mg L^{-1})	0.28	0.36	0.34	0.32	0.29	0.39	0.42
Phosphates (mg L^{-1})	0.63	0.22	0.24	ND	ND	<0.04	<0.04
Silicates (mg L^{-1})	6.20	4.30	5.0	5.01	5.0	8.0	9.20
Sulphate (mg L^{-1})	8	7.4	9	13	11	28	21
Sodium (mg L^{-1})	3.15	3.2	2.98	3.82	3.26	3.4	3.8
Potassium (mg L^{-1})	1.63	2.13	1.4	1.80	1.20	1.84	2.66
Iron (mg L^{-1})	0.06	0.08	0.15	0.20	0.20	0.06	0.04
Cadmium (mg L^{-1})	0.003	0.003	ND	0.001	0.012	<0.001	<0.001
Copper (mg L^{-1})	0.013	0.012	0.008	0.011	0.012	<0.01	<0.01
Mercury (mg L^{-1})	BDL*	BDL	BDL	BDL	BDL	BDL	BDL
Chromium (mg L^{-1})	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BOD, (mg L^{-1})	1.0	1.5	2.0	2.0	2.2	0.5	0.6
COD (mg L^{-1})	2.3	3.0	3.8	4.0	4.3	1.3	1.5

note: *BDL: Below Detection Limit

Table 11.6.1-5 National Drinking Water Quality Standards

Item	Acceptable	Cause for Rejection	WHO (2011)	USEPA (1996)
Turbidity (JTU scale)	**2.5**	**10**	—	**1 (NTU)**
Color (Pt-Co scale)	**5.0**	**25**	—	**5 (color units)**
Taste & Odor (mg L^{-1})	**Unobjectionable**			**3 (TON)**
pH	**7.0 - 8.5**	**6.5 - 9.2**	—	**6.5 – 8.5**
TDS (mg L^{-1})	**500**	**1500**	**500**	**1,000**
Total hardness (mg L^{-1})	**200**	**600**	—	—
Cl (mg L^{-1})	**200**	**1000**	—	—
SO_4 (mg L^{-1})	**200**	**400**	**250**	**250**
F (mg L^{-1})	**1.0**	**1.5**	**1.5**	**2.0**
NO_3 (mg L^{-1})	**45**	**45**	**50**	**10**
Ca (mg L^{-1})	**75**	**200**	—	**250**
Mg (mg L^{-1})	**30**	**150**	—	—

Item	Acceptable	Cause for Rejection	WHO (2011)	USEPA (1996)
Fe (mg L^{-1})	**0.1**	**1.0**		**0.3**
Mn (mg L^{-1})	**0.05**	**0.5**	—	**0.05**
Cu (mg L^{-1})	**0.05**	**1.5**	**2.0**	**1.0**
Zn (mg L^{-1})	**5.0**	**15.0**	—	**5**
Phenol (mg L^{-1})	**0.001**	**0.002**	—	—
MBAS (mg L^{-1})	**0.2**	**1.0**	—	**0.5**
Oil (mg L^{-1})	**0.01**	**0.3**	—	—
As (mg L^{-1})	**0.05**	**0.05**	**0.01**	**0.01**
Cd (mg L^{-1})	**0.01**	**0.01**	**0.003**	**0.005**
Cr^{+6} (mg L^{-1})	**0.05**	**0.05**	**0.05 (Total Cr)**	**0.1 (Total Cr)**
CN (mg L^{-1})	**0.05**	**0.05**	—	**0.2**
Pb (mg L^{-1})	**0.1**	**0.1**	**0.01**	**0.015**
Se (mg L^{-1})	**0.01**	**0.01**	**0.04**	**0.05**
Hg total (mg L^{-1})	**0.001**	**0.001**	**0.006 (as inorganic-Hg)**	**0.002**
PAH (μg L^{-1})	**0.2**	**0.2**	—	—

source: http://www.mdws.gov.in/sites/default/files/Drinking_water_quality_standards.pdf (as of December 2017)

The pH level in the project area of Turga Pumped Storage project ranged from 6.5 to 7.4 at various sampling sites covered as a part of the study. The pH level indicates neutral to marginally alkaline nature of the water, and is within the permissible limit specified for meeting drinking water requirements. The TDS level ranged from 82 to 220 mg L^{-1}, in winter season, which is well below the permissible limit of 500 mg L^{-1} specified for drinking water. The TDS level was found to be lowest in monsoon season. This trend was observed for various cations and anions monitored as a part of the study. This could be attributed to higher discharges in monsoon months. The hardness level ranged from 112 to 60 mg L^{-1} in various seasons monitored as a part of the study. The hardness level was well below the permissible limit of 200 mg L^{-1} specified for drinking water. Hardness is caused by divalent metallic cations. The principal hardness causing cations are calcium, magnesium, strontium and ferrous and iron. The low levels of calcium and magnesium are mainly responsible for the soft nature of water. Alkalinity of water is a measure of its capacity to neutralize acids. The alkalinity of natural water is due primarily because of the salts of weak acids. The alkalinity was observed to be lower than the total hardness in all the water sampling stations monitored as a part of the study. Chlorides occur in all natural waters in widely varying concentrations, chlorides is available in natural water, mainly through solvent power of water, which dissolves chlorides from top soil and deeper formations. The chlorides level ranged from 38 to 41 mg L^{-1}, which is well below the permissible limit of 200 mg L^{-1}, specified for meeting drinking water requirements. Sulphate ion is one of the major anions occurring in natural water. It is an important parameter because of its cathartic affect, when it is present in higher concentration. The sulphate level at various sampling stations ranged from 8 to 28 mg L^{-1} in various samples monitored for three seasons as a part of the study. The sulphate was found to be well below the permissible limit of 200 mg L^{-1} specified for drinking water purposes. The concentration of nitrates at various sampling locations was observed range from 0.28 to 0.42 mg L^{-1}. The concentration of various cations, e.g. sodium, potassium, calcium and magnesium was observed to be quite low which is also reflected by the low TDS level. Iron was found to be well below the permissible limit of 1 mg L^{-1} specified for drinking water purposes. The concentration of various heavy metals was found to be well below the permissible limits. Concentration of phenolic compounds and oil and grease as expected in a region with no major sources of water pollution from domestic or industrial sources was observed to be quite low. The BOD values are well within the permissible limit, which indicates the absence of organic pollution loading. This is mainly due to the low population density and absence of industries in the area. The low COD values also indicate the absence of chemical pollution loading in the area. The marginal quantity of pollution load which enters Turga nalla, gets diluted. The DO level ranged from 6.1 to 7.2 mg L^{-1} at various sampling locations monitored for winter season as a part of the study. The DO levels indicate low organic pollution in the catchment area. This is expected as the site has low population density and virtually no industries. Thus, pollution loading is low in the catchment area, which is reflected in low BOD and high DO Values the excellent quality of water in the survey area.

(3) Soil Quality

Distribution of soil at the project site can roughly be divided into three types below according to the slope of ground surface.

1) Gentle Slope Area (inclination angle: 5 ° or less)

Red soils called "Alfisols" by United States Department of Agriculture (USDA) classification developed on weathering layer of the rock as a base material. The B horizon developed by clay accumulation occurs due to the movement of gravitational water. Streaky deposition of iron oxide by repeated dry and wet condition is often observed. Clay minerals are mainly composed of kaolinite and soil structure is poorly developed. The distribution of Alfisols can be recognized everywhere in the project area without dependence on the relative elevation difference.

2) Middle Slope Area (inclination angle: 5 ° - 25 °)

Soil development has just started from the bed rock, and it corresponds to "Inceptisols" by USDA taxonomic classification. It shows "slightly soil on rock" condition and accumulation of aluminum, iron and clay is undeveloped.

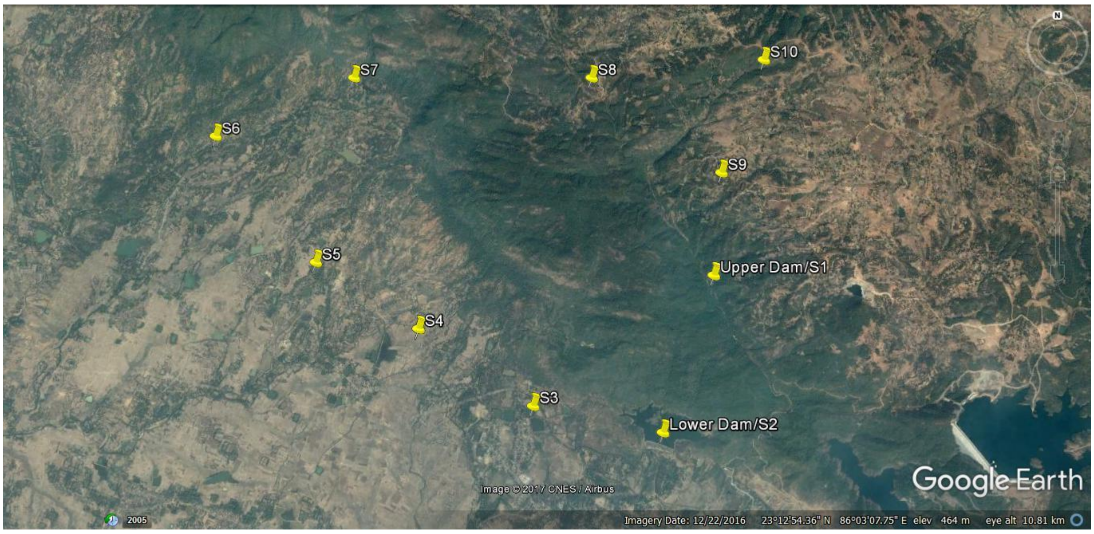
3) Steep Slope Area (inclination angle: more than 25 °)

It is almost the situation of raw soil which has not progressed so far from the rock, and it corresponds to Lithic subgroup in USDA and Lithosol in Food and Agriculture Organization (FAO) classification.

Gentle Slope Area　　Middle Slope Area　　Steep Slope Area

Figure 11.6.1-4　Comparison of soil profiles in the project area

In this study, 9 points of Alfisols were selected to grasp their nutrients conditions. The soil samples were collected from their surface (0 – 10 cm depth) in November 2017. The locations of each sampling points are given in Figure 11.6.1-5 and the results of analysis are shown in Table 11.6.1-6 respectively.



Station Code	Location	Coordinates: Latitude	Coordinates: Longitude
S1	Upper Dam Site	23° 12' 47.41" N	86° 04' 11.26" E
S2	Lower Dam Site	23° 11' 51.77" N	86° 03' 50.83" E
S3	Baghmundi	23° 11' 59.69" N	86° 03' 01.49" E
S4	Chorda	23° 12' 28.99" N	86° 02' 15.64" E
S5	Khirabera	23° 12' 53.34" N	86° 01' 34.54" E
S6	Nishchintpur	23° 13' 40.77" N	86° 00' 52.57" E
S7	Baredi	23° 14' 02.85" N	86° 01' 48.05" E
S8	Saldi	23° 14' 00.05" N	86° 03' 24.30" E
S9	Ranga	23° 14' 06.30" N	86° 04' 32.87" E
S10	Telia Bhasa	23° 13' 24.28" N	86° 04' 14.78" E

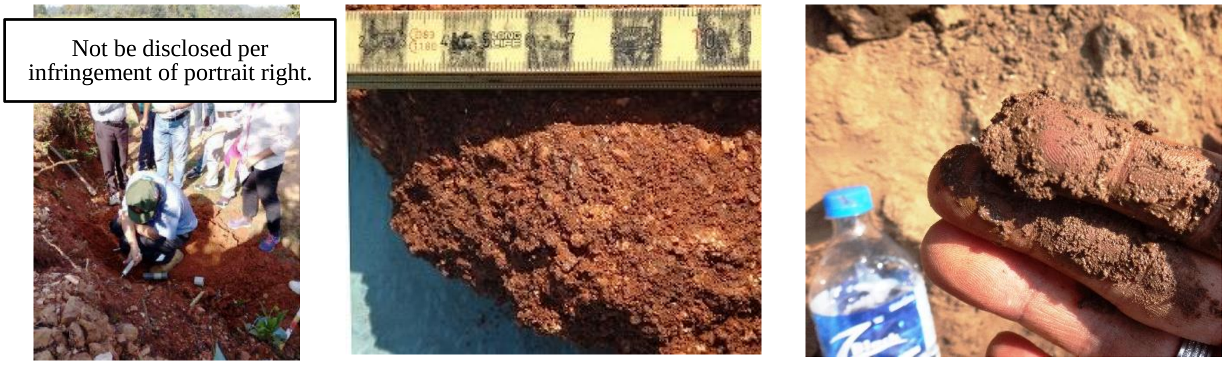
Figure 11.6.1-5　Detail of Soil Sampling Location

Table 11.6.1-6 Soil quality in the catchment area as monitored in winter season

Parameters	Stations									
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**
pH (1:2.5)	6.9	7.1	7.2	7.0	7.4	7.2	7.4	6.7	6.9	7.1
EC (mS m^{-1})	10	15	16	17	20	20	17	18	15	11
Nitrogen (kg-N ha^{-1})	260	210	315	295	320	310	320	290	230	260
Phosphates (kg-P ha^{-1})	180	150	145	180	200	170	230	21	200	190
Potassium (kg-K ha^{-1})	12	18	10	12	20	20	17	18	15	15
Org. matter (%)	1.0	1.1	1.6	1.6	0.9	1.5	0.9	1.0	1.0	1.7

The soils are in neutral range. The EC level are low. The EC levels indicate that the salt content in the soils is low. The level of various nutrients and organic matter indicates low to moderate soil productivity.

In terms of soil physical property, on the other hand, it is peculiar characteristics that soil hardness is remarkably high because solid phase is greatly tight. Results of corn penetrator test indicated almost more than 25 mm and suggested that solid and dense structure might interfere with elongation of plant roots. This soil compaction didn't derive from clay accumulation, mainly caused by iron and aluminum enrichment which was commonly observed in sub-/tropical area. Palpation indicated less clay content to meet sandy loam soil texture (Figure 11.6.1-6).



Not be disclosed per infringement of portrait right.

Corn penetrator test

Solid and dense soil structure

Simple particle size distribution test

Figure 11.6.1-6 Soil Physical Study in the Project Area

(4) Ambient Noise Level

The noise levels were monitored continuously for day time for 6 AM to 9 PM at each location and hourly equivalent noise level was measured. Sound Pressure Level (SPL) measurement in the ambient environment was made using sound pressure level meter. The sampling was conducted for one season. The ambient noise level monitoring results, which were observed during the field survey in winter are in Table 11.6.1-7. The ambient noise standards for various categories is given in Table 11.6.1-8.

Table 11.6.1-7 Hourly Equivalent Noise Levels (unit: dB)

Hour	Near Upper Dam Site	Near Lower Dam Site	Village Baghmundi	Downstream of Lower Dam Site
6-7 AM	37	37	38	37
7-8 AM	38	39	40	38
8-9 AM	40	40	42	40
9-10 AM	42	42	42	40
10-11 AM	42	44	42	42
11-12 Noon	40	42	45	41
12 Noon - 1 PM	39	42	42	44
1-2 PM	41	42	43	43
2-3 PM	42	43	42	42
3-4 PM	40	42	42	44
4-5 PM	40	42	46	44
5-6 PM	42	44	45	43
6-7 PM	43	45	42	46
7-8 PM	43	42	44	45
8-9 PM	38	40	45	40
Leq day	**40.5**	**41.7**	**42.7**	**41.3**

Table 11.6.1-8 National Standards of Ambient Noise

Category of Area	Limits in dB (A) Leq	
	Day time	Night time
Industrial Area	**75**	70
Commercial Area	**65**	55
Residential Area	**55**	45
Silence Zone	**50**	40

notes:

1. Day time 6 AM and 9 PM
2. Night time is 9 PM and 6 AM
3. Silence zone is defined as.Environment (Protection) Third Amendment Rules, 2000 Gazettee notification, Government of India, date 14.2.2000.

In Purulia PSP's case, noise occurred during construction work, and vibration was observed when dynamites were used. Similar case is anticipated in this project too.

11.6.2 Natural Environment

(1) Summary of Natural Condition in West Bengal State

1) Designation State of National Parks and Protected Areas

Protected areas in West Bengal are given in Table 11.6.2-1. The State designated 6 national parks, 15 wildlife reserves, 2 elephant reserves and 2 tiger reserves, respectively.

Table 11.6.2-1 Protected Area in West Bengal

Classification	Name	Area (km^2)	Established
National Park	Sunderban National Park	1330.10	1984
	Neora Valley National Park	159.89	1986
	Singalila National Park	78.60	1986
	Buxa National Park	117.10	1992
	Gorumara National Park	79.45	1992
	Jaldapara National Park	216.51	2014
Wildlife Reserve	Senchal Wild Life Sanctuary	38.88	1976
	Chapramari Wild Life Sanctuary	9.6	1976
	Haliday Island Wild Life Sanctuary	5.95	1976
	Lothian Island Wild Life Sanctuary	38.0	1976
	Mahananda Wild Life Sanctuary	158.04	1976
	Sajnakhali Wild Life Sanctuary	362.4	1976
	Ballavpur Wild Life Sanctuary	2.02	1977
	Bethuadahari Wild Life Sanctuary	0.67	1980
	Bibhuti Bhusan Wild Life Sanctuary	0.64	1980
	Ramnabagan Wild Life Sanctuary	0.14	1981
	Chintamani Kar Bird Sanctuary	0.07	1982
	Jorepokhri Salamander Wild Life Sanctuary	0.04	1985
	Raiganj Wild Life Sanctuary	1.3	1985
	Buxa Wild Life Sanctuary	267.92	1986
	West Sunderban Wild Life Sanctuary	556.45	2013
Elephant Reserve	Mayurjharna Elephant Reserve	414.06	2002
	Eastern Dooars Elephant Reserve	978.00	2002
Tiger Reserve	Sunderban Tiger Reserve	2584.89	1973
	Buxa Tiger Reserve	757.90	1983

Source: JICA Study Team

Most of the protected areas in West Bengal are located in Darjeeling District, Jalpaiguri District and Cooch Bihar District surrounded by Bhutan, Nepal and Bangladesh in the northeast eastern part, and are located in a remote area of about 800 km from the Survey area. The Sunderbans National Park including the Bengal Tiger Reserve is located near the border with Bangladesh in the southeast eastern part, five wildlife reserves such as Sajnakhali Wild Life Sanctuary and Ballavpur Wild Life Sanctuary are located in the east or northeast 200-300 km away, respectively.

2) Summary of Flora and Fauna Inhabiting

i) Floral Aspect

From a phytogeographic viewpoint, the southern part of West Bengal can be divided into two regions: the Gangetic plain and the littoral mangrove forests of the Sundarbans. Much of the vegetation of the western part of the state has similar species composition with the plants of the Chota Nagpur plateau in the adjoining state of Jharkhand. The predominant commercial tree species is *Shorea robusta*, commonly known as the ‘Sal’ tree. The coastal region of Purba Medinipur exhibits coastal vegetation; the predominant tree is the Casuarina. A notable tree from the Sundarbans is the ubiquitous Sundari (*Heritiera fomes*), from which the forest gets its name. The distribution of vegetation in northern West Bengal is dictated by elevation and precipitation. For example, the foothills of the Himalayas, the Dooars, are densely wooded with Sal and other tropical evergreen trees. Above an elevation of 1,000 meters (3,300 ft.), the forest becomes predominantly subtropical. In Darjeeling, which is above 1,500 meters (4,900 ft.), temperate forest trees such as oaks, conifers, and rhododendrons predominate.

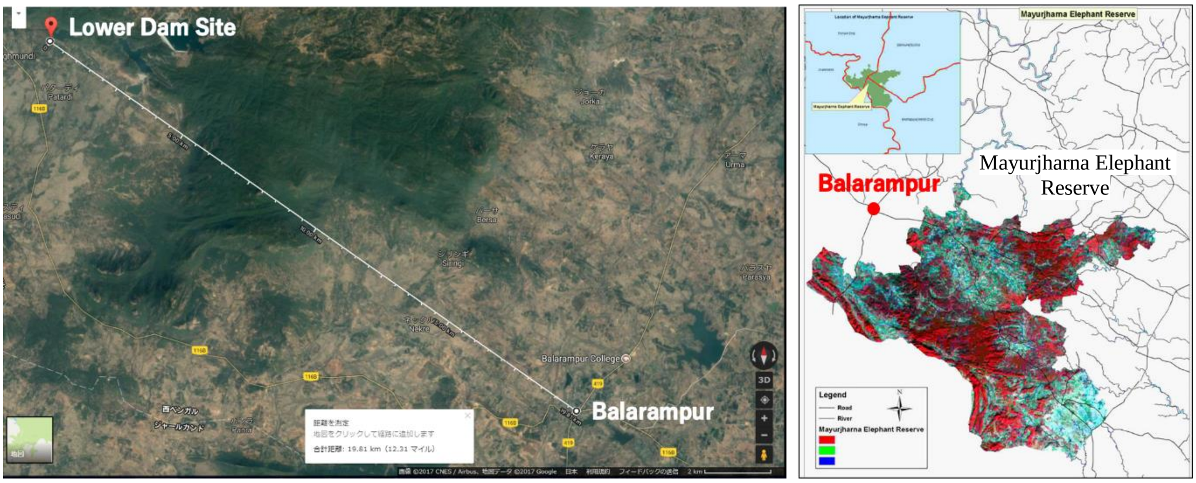
ii) Faunal Aspect

Extant wildlife include Indian rhinoceros, Asian elephant, deer, leopard, gaur, tiger, and crocodiles, as well as many bird species. Migratory birds come to the state during the winter. The high-altitude forests of Singalila National Park shelter barking deer, red panda, chinkara, takin, serow, pangolin, minivet, and kalij pheasants. The Sundarbans are noted for a reserve project devoted to conserving the endangered Bengal tiger although the forest hosts many other endangered species such as the Gangetic dolphin, river terrapin, and estuarine crocodile. The mangrove forest also acts as a natural fish nursery, supporting coastal fishes along the Bay of Bengal. Recognizing its special conservation value, the Sundarbans area has been declared a Biosphere Reserve.

(2) Summary of Natural Environment in the Survey Area

1) Positional Relationship between the Project Site and Protected Areas Designated by Indian Laws or International Treaties and Conventions

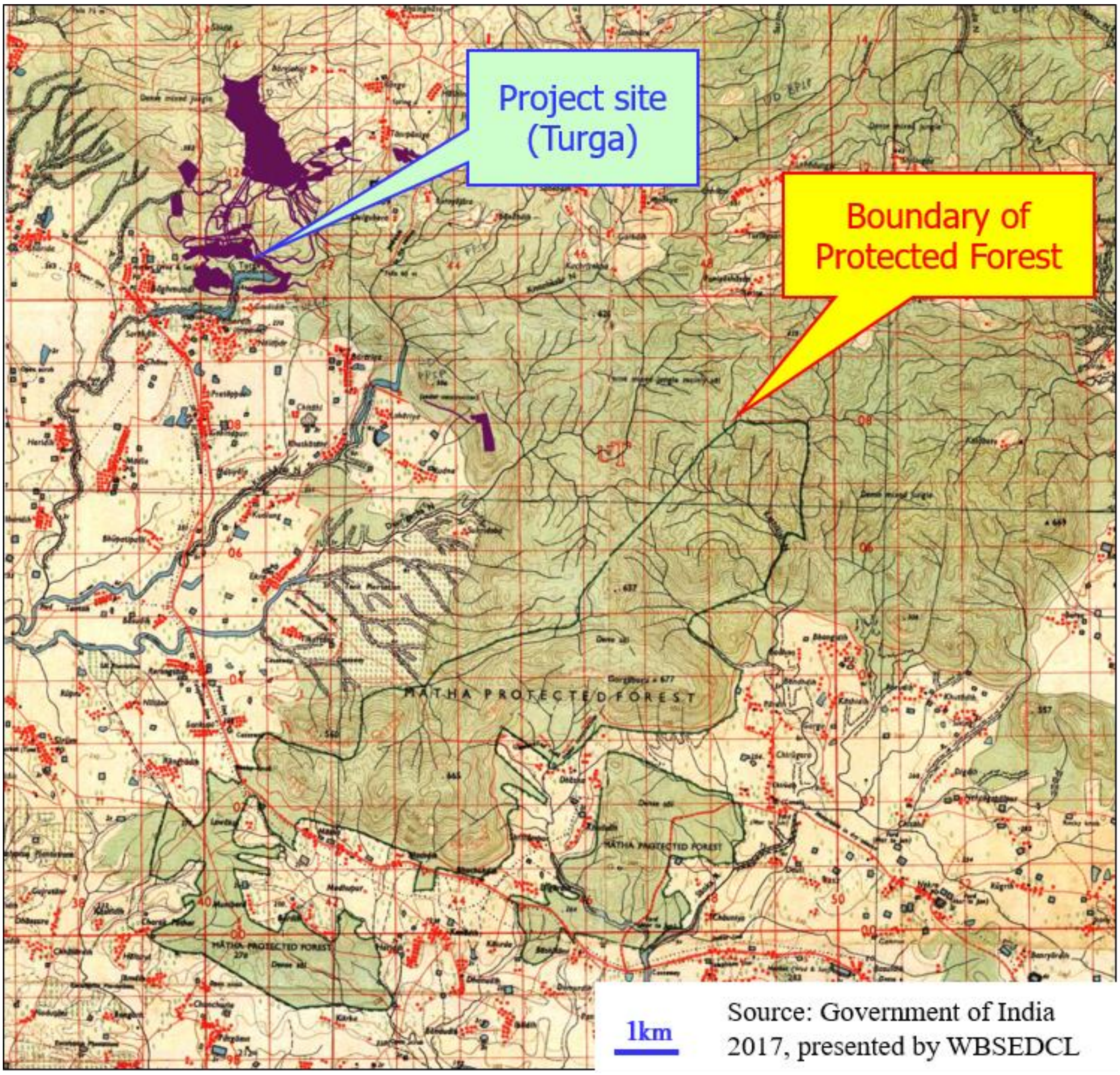
The nearest protected area from the Project site is Mayurjharna Elephant Reserve spreading across the boundaries of Paschim Medinipur District, Bankura District and Purulia District. The boundary of the reserve area is not clear and there are slight differences depending on the existing materials and literatures, but the distance from the Project site to Balarampur, which is the closest town from the elephant reserve, about 20 km in a crow line (see Figure 11.6.2-1 on the left) and Mayurjharna Elephant Reserve is situated further way down southeast (Figure 11.6.2-1 on the right). Based on the above, the Project area is never located within any protected areas designated by the country's laws or international treaties and conventions.



note: Distance between the lower dam and Balarampur around 20 km (Left side). The reserve area is located way down southeast. Source: Ranging on Google Earth (the left) and Official HP (http://www.wildbengal.com/ , the right)

Figure 11.6.2-1 Positional Relationship between Survey area and Mayurjharna Elephant Reserve

Figure 11.6.2-2 overleaf is a part of survey result of existing forest condition in Purulia District by MoEFCC in 2017 on Forest Base Map published by Government of India in 1975. This map clearly shows the boundary of protected forest in Ajodhaya Hill. According to Indian Forest Service (IFS), the highest position of government officer engaged in forest management in India, situation of the protected forest has never changed after established by the government to the present. As indicated by this map obviously, the project site is not located in any protected forest area.



Source: Government of India 2017, presented by WBSEDCL

Figure 11.6.2-2 Positional Relationship between Project Site and Protected Forest

2) Terrestrial Ecological Aspects

i) Floral Aspect

During the present survey, a total of 186 plant species belonging to 163 genera and 63 families were recorded at various sampling sites. Based on habit wise classification 60 are trees, 36 shrubs, 53 herbs, 14 climbers, 15 grasses, 4 sedges, 2 parasites and 2 orchids. Some terrestrial pteridophytic species like Adiantum, Marselia, Lygodium, Pteris, etc were also observed in damp, swampy and moist areas. The list of floral species observed at various sampling locations and surrounding of project area in winter season is enlisted in Table 11.6.2-2.

Table 11.6.2-2 List of Recorded Species from the Survey Area

No.	Plant Species	Local Name	Family	Habit
1	*Cissampelos pareira*	Eknadi	Menispermaceae	Climber
2	*Dioscorea bulbifera*	Chuprialu	Dioscoreaceae	Climber
3	*Dioscorea hamiltoni*	-	Dioscoreaceae	Climber
4	*Butea superba*	Lat Plas	Fabaceae	Climber
5	*Cayratia trifolia*	Aml lata	Vitaceae	Climber
6	*Combretum decandrum*	Atena	Combretaceae	Climber
7	*Cryptolepis buchanani*	-	Asclepiadaceae	Climber
8	*Derris scandens*	Noalata	Fabaceae	Climber
9	*Hoya pendula*	-	Asclepiadaceae	Climber
10	*Millettia* sp	Bakar	Fabaceae	Climber
11	*Mucuna pruriens*	Alkushi	Fabaceae	Climber
12	*Pueraria tuberosa*	Tirra	Fabaceae	Climber
13	*Smilax prolifera*	-	Smilacaceae	Climber
14	*Stephania hernandifolia*	Khandi	Menispermaceae	Climber
15	*Bothriochloa pertusa*	-	Poaceae	Grass
16	*Chloris barbata*	-	Poaceae	Grass
17	*Chrysopogon aciculatus*	-	Poaceae	Grass
18	*Chrysopogon serrulatus*	-	Poaceae	Grass
19	*Cynodon dactylon*	-	Poaceae	Grass
20	*Dichanthium annulatum*	-	Poaceae	Grass
21	*Digitaria sanguinalis*	-	Poaceae	Grass
22	*Eragrostis cynosuroides*	-	Poaceae	Grass
23	*Eragrostis unioloides*	-	Poaceae	Grass
24	*Kyllinga brevifolia*	-	Poaceae	Grass
25	*Oplismenus compositus*	-	Poaceae	Grass
26	*Paspalidium flavidum*	-	Poaceae	Grass
27	*Sacciolepis indica*	-	Poaceae	Grass
28	*Sporobolus diander*	-	Poaceae	Grass
29	*Cyrtococcum accrescens*	-	Poaceae	Grass
30	*Achyranthes aspera*	Bankhat/Apang	Amaranthaceae	Herb
31	*Ageratum conyzoides*	-	Asteraceae	Herb
32	*Alternanthera sessilis*	-	Amaranthaceae	Herb
33	*Andrographis paniculata*	Kalmegh	Acanthaceae	Herb
34	*Anisochilus carnosus*	-	Lamiaceae	Herb
35	*Anisomeles indica*	-	Lamiaceae	Herb
36	*Argemone mexicana*	Shialkanta	Papaveraceae	Herb
37	*Bidens pilosa*	-	Asteraceae	Herb
38	*Biophytum reinwarrdtii*	-	Oxalidaceae	Herb
39	*Blepharis maderaspatensis*	-	Acantaceae	Herb
40	*Boerhavia diffusa*	Punarnava	Nyctaginaceae	Herb
41	*Cassia tora*	-	Caesalpiniaceae	Herb
42	*Centella asiatica*	Thankuni	Apiaceae	Herb
43	*Coleus aromaticus*	-	Lamiaceae	Herb
44	*Colocasia esculenta*	Kachu	Araceae	Herb
45	*Corchorus aestuans*	-	Tiliaceae	Herb
46	*Costus speciosus*	-	Zingiberaceae	Herb
47	*Curcuma longa*	-	Zingiberaceae	Herb
48	*Desmodium diffusum*	-	Fabaceae	Herb
49	*Eclipta alba*	-	Asteraceae	Herb
50	*Elephantopus scaber*	Majorjhuti	Asteraceae	Herb
51	*Euphorbia hirta*	-	Euphorbiaceae	Herb

No.	Plant Species	Local Name	Family	Habit
52	*Evolvulus numlaria*	-	Convolvulaceae	Herb
53	*Gomphrena globosa*	-	Amaranthaceae	Herb
54	*Hedychium coronarium*	-	Zingiberaceae	Herb
55	*Hedyotis sp*	-	Rubiaceae	Herb
56	*Hyptis suaveolens*	-	Lamiaceae	Herb
57	*Justicia simplex*	-	Acanthaceae	Herb
58	*Kickxia ramosissima*	-	Plantaginaceae	Herb
59	*Leonotis nepetifolia*	-	Lamiaceae	Herb
60	*Ludwigia repens*	-	Onagraceae	Herb
61	*Majus rugosus*	-	Scrophulariaceae	Herb
62	*Martynia anua*	-	Martyniaceae	Herb
63	*Melilotus indica*	-	Fabaceae	Herb
64	*Mentha arvensis*	Pudina	Lamiaceae	Herb
65	*Ocimum gratissimum*	-	Lamiaceae	Herb
66	*Oldenlandia corymbosa*	-	Rubiaceae	Herb
67	*Oxalis corniculata*	-	Oxalidaceae	Herb
68	*Persicarea barbata*	-	Polygonaceae	Herb
69	*Phyllanthus urinaria*	-	Euphorbiaceae	Herb
70	*Pilea microphylla*	-	Urticaceae	Herb
71	*Ruellia prostrata*	-	Acanthaceae	Herb
72	*Sida acuta*	Kureta	Malvaceae	Herb
73	*Hemidesmus indicus*	-	Asclepiadaceae	Herb
74	*Sida cordata*	-	Malvaceae	Herb
75	*Spilanthes paniculata*	-	Asteraceae	Herb
76	*Urena lobata*	-	Malvaceae	Herb
77	*Veronica anagallis -aquatica*	-	Plantaginaceae	Herb
78	*Zornia diphylla*	-	Fabaceae	Herb
79	*Parthenium hysterophorus*	-	Asteraceae	Herb
80	*Celosia argetea*	-	Amaranthaceae	Herb
81	*Cyanotis axillaris*	-	Commelinaceae	Herb
82	*Nymphaea nouchali*	Shapla	Nymphaeaceae	Herb
83	*Curculigo orchioides*	-	Hypoxidaceae	Orchid
84	*Geodorum densiflorum*	-	Orchidaceae	Orchid
85	*Cuscuta reflexa*	Sarnalata	Cuscutaceae	Parasite
86	*Loranthus longiflorus*	-	Loranthacaea	Parasite
87	*Carex cruciata*	-	Cyperaceae	Sedge
88	*Carex filicina*	-	Cyperaceae	Sedge
89	*Cyperus rotundus*	-	Cyperaceae	Sedge
90	*Fimbristylis monostachya*	-	Cyperaceae	Sedge
91	*Abelmoschus moschatus*	Mushkdana	Malvaceae	Shrub
92	*Abroma angusta*	Ulat kambal	Sterculiaceae	Shrub
93	*Abutilon indicum*	-	Malvaceae	Shrub
94	*Agave sisalana*	-	Agavaceae	Shrub
95	*Allophyllus cobbe*	-	Sapindaceae	Shrub
96	*Annona squamosa*	Annanas	Annonaceae	Shrub
97	*Asparagus racemosus*	Satmuli	Liliaceae	Shrub
98	*Bauhinia vahlii*	-	Caesalpiniaceae	Shrub
99	*Bixa orellana*	-	Bixaceae	Shrub
100	*Calotropis gigantean*	Madar	Asclepiadaceae	Shrub
101	*Carissa spinarum*	Auka Kuli/huka	Apocynaceae	Shrub
102	*Cassia occidentalis*	-	Caesalpiniaceae	Shrub
103	*Chromolaena odoratum*	-	Asteraceae	Shrub
104	*Clerodendrum viscosum*	Ghato	Verbenaceae	Shrub
105	*Combretum roxburghii*	-	Combretaceae	Shrub
106	*Datura fastuosa*	-	Solanaceae	Shrub
107	*Flemingia strobilifera*	-	Fabaceae	Shrub
108	*Glycosmis pentaphylla*	-	Rutaceae	Shrub

No.	Plant Species	Local Name	Family	Habit
109	*Helicteris isora*	Marodphali	Sterculiaceae	Shrub
110	*Ipomoea carnea*	Beshram	Convolvulaceae	Shrub
111	*Lantana indica*	Lantana	Verbenaceae	Shrub
112	*Leea alata*	Kukur jiwa	Leeaceae	Shrub
113	*Maytenus senegalensis*	-	Celastraceae	Shrub
114	*Mimosa rubicaulis*	-	Mimosaceae	Shrub
115	*Piper longum*	-	Piperaceae	Shrub
116	*Randia dumetorum*	Maidan	Rubiaceae	Shrub
117	*Solanum torvum*	-	Solanaceae	Shrub
118	*Tephrosia purpurea*	-	Fabaceae	Shrub
119	*Thespesia lampas*	Bankapas	Malvaceae	Shrub
120	*Vitex negundo*	Sandbhalu	Verbenaceae	Shrub
121	*Woodfordia fruticosa*	Dhai	Lythraceae	Shrub
122	*Zizyphus mauritiana*	Ber	Rhamnaceae	Shrub
123	*Zizyphus oenoplia*	Shiakul	Rhamnaceae	Shrub
124	*Cassia mimosoides*	-	Mimosaceae	Shrub
125	*Clausena heptaphylla*	-	Rutaceae	Shrub
126	*Pogostemone plectranthoide*	-	Lamiaceae	Shrub
127	*Acacia catechu*	Khair	Mimosaceae	Tree
128	*Adina cordifolia*	Haldu	Rubiaceae	Tree
129	*Aegle marmelos*	Bel	Rutaceae	Tree
130	*Aglaia roxburghiana*	Priyangru	Meliaceae	Tree
131	*Albizia odoratissima*	Jang Siris	Mimosaceae	Tree
132	*Albizia procera*	Safed Siris	Mimosaceae	Tree
133	*Albizzia lebbek*	Kala siris	Mimosaceae	Tree
134	*Altsonia scholaris*	Saptparni	Apocynaceae	Tree
135	*Artocarpus lacucha*	Dhao	Moraceae	Tree
136	*Azadirachta indica*	Neem	Meliaceae	Tree
137	*Barringtonia actangula*	Neora	Myrtaceae	Tree
138	*Bauhinia purpurea*	Rakta Kanchan	Caesalpiniaceae	Tree
139	*Bauhinia variegata*	Khairwal	Caesalpiniaceae	Tree
140	*Bombax ceiba*	Semul	Bombacaeae	Tree
141	*Boswellia serrata*	Shalga	Burseraceae	Tree
142	*Bridelia retusa*	Kassi	Euphorbiaceae	Tree
143	*Buchanania latifolia*	Piyal	Anacardiaceae	Tree
144	*Butea monosperma*	Palas	Papilionaceae	Tree
145	*Canthium glabrum*	-	Rubiaceae	Tree
146	*Casearia graveolens*	Chilla	Flacourticeae	Tree
147	*Cassia fistula*	Sonari	Rubiaceae	Tree
148	*Cordia rothii*	Liar	Boraginaceae	Tree
149	*Croton caudatus*	Putla	Euphorbiaceae	Tree
150	*Dalbergia sissoo*	Sisham	Fabaceae	Tree
151	*Diospyros melanoxylon*	Tendu	Ebenaceae	Tree
152	*Ficus auriculata*	Dumur	Moraceae	Tree
153	*Ficus bengalensis*	Bargad	Moraceae	Tree
154	*Ficus racemosa*	Gular	Moraceae	Tree
155	*Ficus semicordata*	-	Moraceae	Tree
156	*Flacourtia jangomas*	Coffe plum	Flacouticeae	Tree
157	*Garuga pinnata*	Kharpat	Burseraceae	Tree
158	*Gmelina arborea*	Gambari	Verbenaceae	Tree
159	*Holarrhena pubescens*	Kurchi	Apocynaceae	Tree
160	*Holoptelea integrifolia*	-	Ulmaceae	Tree
161	*Lagerstrmoea parviflora*	Sidda	Lythraceae	Tree
162	*Lannea coromandelica*	Doka	Anacardiaceae	Tree
163	*Madhuca indica*	Mahwa	Sapotaceae	Tree
164	*Mallotus philippinensis*	Kamla	Euphorbiaceae	Tree
165	*Mangifera indica*	Aam	Anacardiaceae	Tree

No.	Plant Species	Local Name	Family	Habit
166	*Melia azedarach*	Bakayan	Meliaceae	Tree
167	*Oroxylum indicum*	Sonpatti	Bignoniaceae	Tree
168	*Phoenix sylvestris*	Khajur	Arecaceae	Tree
169	*Phyllanthus emblica*	Amloki	Euphorbiaceae	Tree
170	*Pongamia pinnata*	Papri	Papilionaceae	Tree
171	*Rhus chinensis*	Amlio	Anacardiaceae	Tree
172	*Schleichera oleosa*	Kusum	Sapindaceae	Tree
173	*Semecarpus anacardium*	Bhela	Anacardiaceae	Tree
174	*Shorea robusta*	Sal	Dipterocarpaceae	Tree
175	*Spondias pinnata*	Amra	Anacardiaceae	Tree
176	*Sterculia urens*	Kullu	Sterculiaceae	Tree
177	*Streblus asper*	Sahora	Moraceae	Tree
178	*Syzygium cumini*	Kala Jamb	Myrtaceaer	Tree
179	*Tectona grandis*	Teak	Verbenaceae	Tree
180	*Terminalia arjuna*	Arjun sal	Combretaceae	Tree
181	*Terminalia bellirica*	Bahera	Combretaceae	Tree
182	*Terminalia chebula*	Haritaki	Combretaceae	Tree
183	*Terminalia tomentosa*	Asan	Combretaceae	Tree
184	*Alangium salvifolium*	Ankolamu	Alangiaceae	Tree
185	*Ficus hispida*	Dumar	Moraceae	Tree
186	*Wendlandia exserta*	-	Rubiaceae	Tree

Source: JICA Study Team

Endemic and endangered flora, and useful plants distributed in the survey area will be outlined as follows.

a) Endemic Flora

With such a wide area and distinct biogeographic regions, West Bengal bound to have many endemic taxa. Chatterjee (1940)[16] has discussed some new or endemic plant taxa from different districts of West Bengal such as *Cadenthera ulginosa var. birbhumensis*, *Cuscuta sharmanum*, *Hydrocotyle himalaica*, *Hypericum assamacum* and *Dalbergia duarensis*. Besides these newly described endemic species, some endemic species viz., *Acer osmastonii*, *Begonia rubella, Calamus inermis*, *Cymbidium eburnum*, etc. are described from the extreme Northern boundary of West Bengal. Since entire Purulia district and Midnapur districts constitute the western undulating uplands and plateau, there is no possibility that these plants may occur in the project area.

b) Endangered Flora

As per Red Data Book of India, no rare and endangered species are reported from the project area such as *Acer osmastonii*, *Begonia rubella*, *B. satrapsis*, *Calamus inermis*, *Codonopsis affinis*, *Cymbidium eburnum*, *Phoenix rupicola*, etc. from northern parts of West Bengal. Since these species are distributed above 600 m elevation in northern and southern parts of West Bengal, hence these species are not observed in the proposed Turga Pumped Storage Project area and its surroundings.

c) Useful Plants

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[16] Ramananda Chatterji (1940), The Bratachāri movement, Bengal Bratachari Society

Since time immemorial the local people have been using large number of wild plant resources as medicinal value, edible plants, fodder, timber, etc. Some of examples are shown in Figure 11.6.2-3. Ajodhya Hill area rising above Baghmundi and adjoining area in Purulia district are rich in diversity of medicinal plants (see Table 11.6.2-3). Many tribal population or local people inhabited in the various pockets of the forest areas, use these plants for curing their diseases. However, a literature survey reveals that the existing information is insufficiently documented with regard to their floral wealth used in curing diseases. Different parts of medicinal plant species were used by local tribe as medicine. Besides, a variety of wild edible plants occurs in the project and influence area (see Table 11.6.2-4). The cultivation of such plants is not practiced by local people in the area and they rely on the forest around them for their supply. Important and preferable fodder yielding plants of the area in winter season are *Shorea robusta*, *Bauhinia variegata*, *Desmodium gangeticum*, *Ficus auriculata*, *F. racemosa*, *F. semicordata* etc. Furthermore, the most important and durable timber yielding species of the area are *Shorea robusta*, *Terminalia tomentosa* (Asan), *Schleichera trijuga* (Kusum), *Mangifera indica* (Aam) and *Tectona grandis* (Teak). For fire-wood, villagers usually trek long distances for their domestic needs. The commonly used Fuel-wood species are *Butea monosperma*, *Holarrhena pubescens*, *Diospyros melanoxylon*, *Lagerstroemia parviflora*, *Mallotus philippinensis*, *Terminalia bellerica*, etc. Because all plants mentioned above is widely distributed in Ajodhya hill, there is no specific negative impact expected to the flora by project activities.

Azadirachta indica (Medicine) Phyllanthus emblica (Medicine) Mentha arvensis (Medicine)

Ficus auriculata (Food) *Spondias pinnata* (Food) *Semicarpus anacardium* (Food)

Figure 11.6.2-3 Some of Useful Plants Observed in Turga Pumed Storage Project Area

Table 11.6.2-3 List of Medicinal Plants and Their Uses Found in the Turga Pumped Storage Project Area

No.	Botanical Name	Local name	Plant parts used	Medicinal uses
1	*Abelmoschus moschatus*	Mushkdana	Leave & roots	The decoction of seeds is given internally for vomiting disorder and leave paste is used to cure of itch.
2	*Abroma angusta*	Ulat kambal	Leave	Fried leaves are used as remedy for Abortifacient, jaundice and piles.
3	*Achyranthes aspera*	Bankhat	Whole plant	Decoction of seed is used as an antidote against snake, scorpion, dog and cat bite. Leaf juice & paste with a pinch of salt is applied to cure skin infection due to ring worm.
4	*Andrographis paniculata*	Kalmegh	Leave	The leave of this plant are used as a tonic (leaf-juice, mixed with water and preserved) for digestive disorders.
5	*Artemisia nilagirica*	Teetapati	Leave, Roots	Leaf and root paste are mixed with water and fed at empty stomach at morning to cure asthma and intestinal parasites.
6	*Asparagus racemosa*	Satmuli	Leave and fruits	Paste is given to cure despepsia, constipation and enxiety
7	*Azadirachta indica*	Neem	Leave, fruit	Soft, new born leaves of the plant are eaten after boiling during the months of December to April. It is believed to stimulate digestive system and cures skin disease, stomach problem & blood purifying.
8	*Bauhinia purpurea*	Rakta Kanchan	Root & flower	Root paste is applied externally to cure joint pain and flower is used as Carminative
9	*Butea monosperma*	Palash	Root, bark, latex, seed	Root & seed paste is used to cure skin diseases. Latex mixed with honey is recommended to cure piles and stomach trouble, Astringent. Decoction of bark is taken to cure diarrhea.
10	*Cissampelos pareira*	Aknadi	Roots	Roots are collected, washed thoroughly and filtered extract is taken as medicine after mixing a little amount of sugar and water with it at alternate days for curing of fever and female periodic problem.
11	*Clerodendrum viscosum*	Ghato	Leave, flower, Roots	Extract of leaves, flowers and roots, mixed with water are taken for the treatment of intestinal tract infection (vermifuge or anthelmintic)
12	*Cuscuta reflexa*	Sarnalata	Whole plant	The juice of the plant, mixed with the juice of *Saccharum officinarum*, is used in the treatment of jaundice.
13	*Cyperus rotundus*	Mutha ghas	Tuber	Tuber is in uses to cure chronic dysentery and indigestion
14	*Evolvulus alsinoides*	Sankhpuspi	Whole plant	Juice of the whole plant (tonic) is used as diuretic and treatment of fever, cough & cold (usually administrated with holi basil)
15	*Helicteres isora*	Marodphali	Fruits & roots	Fruit is boiled with sesamum (til) oil, cooled and then the filtered oil (2-3 drops) is poured into the ear for odalgesic diseases. The decoction of the root mixed with turmeric powder is applied externally to treat cut and wounds.
16	*Holarrhena pubescens*	Kuruchi	Bark, seed & flower	Stem bark infusion with honey is taken once a day for treatment of dysentery. Bark and seeds of the plant and black pepper are mixed together and powder is taken orally to treat malarial fever.
17	*Leonotis nepetaefolia*	Bonga taini	Leave and flower	Decoction of leaf and flower is given to breast inflammation and burns
18	*Mintha arvensis*	Carminative	Leave	Leaves of this plant are used from ancient days by the villagers as a 'Medicine' which can be eaten as such way by chewing, preparing an extract from green leave, preparing sauce (Chatani). It is used as carmative & digestive tonic.
19	*Phyllanthus emblica*	Amloki	Fruit	Ripe fruit of this plant is eaten during winter season as protective and curative agent for digestive problem and it is also a Vitamin C rich fruit.
20	*Rubia cordifolia*	Manjistha	Leave and roots	Leaves and root paste are used to heal cuts and wounds.
21	*Semicarpus anacardium*	Bhela	Fruit & seed	Fruits of the tree are eaten to cure of anthelmintic. Extracted seed oil is massaged twice a day for one week for body pain.
22	*Sida corda*	-	Whole plant	Leave, flower and root are crushed and the paste mixed with water used for control of blood vomiting

No.	Botanical Name	Local name	Plant parts used	Medicinal uses
23	*Spilanthus paniculata*	Akarkara	Leave and flower	Fresh young leaves and flowers are chewed at early morning preferably in empty stomach to treat Toothache
24	*Terminalia bellirica*	Bahera	Fruits	Half ripe fruit is used as purgative. Decoction of the green fruit is used for cough. Pulp of the fruit is useful in dysenteric-diarrhoea, and piles.
25	*Terminalia chebula*	Haritaki	Fruit and seeds	One teaspoonful of fruit powder is given with warm water once daily before going to bed for digestive problem and laxative.
26	*Thespesia lampas*	Bankapas	Fruit and seed	Paste of fruit mixed with water taken for bodyache and muscle pain
27	*Vitex negundo*	Nishindha	Leave and flower	Juice of tender leaves is used for treatment of cold and fever. Powdered flower are given with milk to treat vermifuge, diarrhoea and cardiac disorders.
28	*Woodfordia fruticosa*	Dhai	Flower and leave	Stimulant in seminal weakness, pregnancy, astringent, leave paste is used in diarrhea, dysentery problem.

Source: JICA Study Team

Table 11.6.2-4 Some of Food Plants Observed in Turga Pumped Storage Project area

Species	Local Name	Family	Part used
Aegal marmelos	Bael	Rutaceae	Fruit
Bauhinia purpurea	Rakto Chandan	Caesalpiniaceae	Flower buds
B. variegata	Gaiwral	Caesalpiniaceae	Flower buds
Bombax ceiba	Simul	Bombacaceae	Fruits
Boswellia serrata	Shalga	Burseraceae	Fruits
Carissa spinarum	Huka	Apocynaceae	Fruits
Chenopodium album	Bhetu	Chenopodiaceae	Leaves
Colocasia esculenta	Kachu	Araceae	Tubers
Dioscorea bulbifera	Chuprialu	Dioscoreaceae	Fruits
Ficus auriculata	Dumur	Moraceae	Figs
Madhuca indica	Mohua	Sapotaceae	Seeds
Nymphaea nouchali	Shapla	Nymphaeaceae	Stem
Phyllanthus emblica	Amloki	Euphorbiaceae	Fruits
Randia dumatorum	Madan	Rubiaceae	Fruits
Schleichera trijuga	Kusum	Sapindaceae	Fruits
Spondias pinnata	Amra	Anacardiaceae	Fruits
Zizyphus mauritiana	Ber	Rhamnaceae	Fruits
Zizyphu oenoplea	Ber	Rhamnaceae	Fruits

Source: JICA Study Team

ii) Faunal Aspect

Although inhabitation of artiodactyla including barking deer were described in the EIA Report and DFR, the existence were not confirmed in this survey from the results of interview with District Forest Officer (DFO) and local residents, and observation records of wildlife consolidated by DFO. Therefore, the description doesn't be mentioned in the following table. In addition, Pangolin (*Manis crassicaudata*) and Geoemydidae are also exclude for the just same reason.

a) Mammals

Table 11.6.2-5 lists the main mammals inhabited in the survey area based on visual observations at the surveyed site, historical documents, survey data possessed by DFO, and existing EIA reports.

Table 11.6.2-5 List of Mammal species reported in Turga Pumped Storage Project area

Common name	Family	Scientific name	Conservation Status	
			IUCN	IWPA
Rhesus macaque	Cercopithecidae	*Macacamulatta*	LC	II
Common Langur	Colobidae	*Presbytia entellus*	LC	II
Jungle Cat	Felidae	*Felischaus*	LC	II
Golden Jackal	Canidae	*Canisaureus*	LC	II
Indian Fox	Canidae	*Vulpesbengalensis*	LC	III
Common Mongoose	Herpestidae	*Herpestesedwardsii*	LC	IV
Wild Boar	Suidae	*Susscrofa*	LC	III
Indian Hare	Leporidae	*Lepusnigricollis*	LC	IV
Sahi- Porcupine	Hystricidae	*Atherurusmacrourus*	LC	IV
Indian Palm Squirrel	Sciuridae	*Funambuluspalmarum*	LC	IV
Five Stripped Squirrel	Sciuridae	*Funambuluspennantii*	LC	II
Bandicoot Rat	Muridae	*Bandicotabengalensis*	LC	V
Indian house rat	Muridae	*Rattusrattus-refescena*	LC	V
Indian Field Rat	Muridae	*Musbooduga*	LC	V
Long-tailed Tree Mouse	Muridae	*Vandeleuriaoleracea*	LC	-
Indian Bush Rat	Tupaiidae	*Golundaellioti*	LC	V
House Shrew	Tupaiidae	*Suncusmurinus*	LC	-
Indian Flying Fox	Pteropodidae	*Pteropusgiganteus*	LC	V
Short-nosed Fruit Bat	Pteropodidae	*Cynopterus sphinx sphinx*	LC	IV

Common name	**Family**	**Scientific name**	**Conservation Status**	
			IUCN	**IWPA**
Bearded Sheath Tailed Bat	Emballonuridae	*Taphozousmelanopogo n*	LC	V
Indian Pygmy Bat	Vespertilionidae	*Pipistrellustenuis*	LC	V
Yellow House Bat	Vespertilionidae	*Scotophiluskuhlii*	LC	V

Note: Recorded only from Forest Working Plan, however, not direct cited.

Source: JICA Study Team

Mammalian fauna of the surroundings of the survey area comprises of more than 25 species that come from 16 families. Rhesus Macaque and Common Langur inhabit forested as well as settlement areas and are common in their presence. All the members of cat family mentioned below prefer to inhabit the lower and open areas in the region. Jungle Cat is sighted frequently by villagers near settlement area at day time. Jackal covers a wide range of habitat and spotted by villagers frequently in and around the settlement. Wild Boar is a nocturnal animal and raids agricultural fields at night. It is found in inner and open forest areas. Grey Mongoose, Brush-tailed Porcupine, Indian Hare prefer to inhabit scrub forests while Pangolin is predominant in the Sal and mixed forest to meet its food requirement, feeds on ants. Tree Shrew is widely distributed in the area, found in forest as well as settlement areas.

b) Avi-Fauna

A total number of 66 species of birds have been reported based on secondary data sources. The species belonging to families Anatidae, Ardeidae, Charadridae, Rallidae, Phalacroco racidaeetc are common in lower region in open places and wetland while members of Picidae, Megailaimidae, Strigidae, etc are inhabitants of woody forests in the catchment. Dominant bird species observed during the survey are Blue jay, dove, myna, house crow, house sparrow, lapwing, little egret and grey wagtail etc. The list of bird species found in study area is given in Table 11.6.2-6.

Table 11.6.2-6 List of Avi-Fauna reported in the in Turga Pumped Storage Project area

Family/Scientific Name	**Common Name**	**Residential Status***	**Threat Status****
Accipitridae			
Accipiter badius(Gmelin)	Shikra	R	LC
Gyps bengalensis	Bengal Vulture	R	LC
Aquila refax	Towny Eagle- Oukab	R	LC
Anatidae			
Sarkidiornismelanotos	Comb Duck	R	LC
Ardeidae			
Egrettagarzetta (Linnaeus)	Little Egrets	R	LC
Egrettaintermedia	Intermediate Egret	R	LC
*Bubulcus*coromandus (Linnaeus)	Cattle Egret	R	LC
Ardeolagrayii (Linnaeus)	Indian Pond Heron	R	LC
Burhinidae			
Burhinusoedicnemus	Indian Stone-curlew	R	LC
Capitonidae			
Megalaimahaemacephala	Coppersmith Barbet	R	LC
Cisticolidae			
Priniasocialis	Ashy Prinia	R	LC

Family/Scientific Name	Common Name	Residential Status*	Threat Status**
Ciconiidae			
Mycterialeucocephala	Painted Stork	LM	LC
Anastomusoscitans	Asian Openbill	LM	LC
Phalacrocoracidae			
Phalacrocoraxniger(Vieillot)	Little Cormorant	R	LC
*Phalacrocoraxfuscicollis*Stephens	Indian Shag /Cormorant	R	LC
Columbidae			
*Columba livia*Gmelin	Blue Rock Pigeon	R	LC
Treronphoenicoptera	Harial -green pigeon		
Streptopeliasenegalensis (Linnaeus)	Little Brown Dove	R	LC
Streptopeliadecaocto	EuraisionCollor dove	R	LC
Streptopeliachinensis	Spotted Dove	R	LC
Corvidae			
*Corvusmacrorhynchos*Wagler	Jungle Crow	R	LC
*Corvussplendens*Vieillot	House Crow	R	LC
Dendrocittavagabunda(Latham)	Indian Treepie	R	LC
Cuculidae			
Eudynamysscolopacea(Linnaeus)	Asian Koel	R	LC
Centropussinensis(Stephens)	Greater Coucal	R	LC
Hierococcyxvarius(Vahl)	Brainfever Bird	R	LC
Strigidae			
Athenebrama(Temminck)	Spotted Owlet	R	LC
Bubo benghalensis(Linnaeus)	Indian Eagle-Owl	R	LC
Alcedinidae			
Alcedoatthis(Linnaeus)	Small Blue Kingfisher	R	LC
Halcyon smyrnensis(Linnaeus)	White breasted	R	LC
Daniidae			
Laniuscristatus	Brown Shrike	R	LC
Muscicapidae			
Copsychussaularis	Oriental magpie-robin	R	LC
Meropidae			
*Meropsorientalis*Latham	Small green Bee-eater	R	LC
Family : Coraciidae			
Coraciasbenghalensis(Linnaeus)	Indian Roller-Blue jay	R	LC
Family : Upupidae			
*Upupaepops*Linnaeus	Common Hoopoe	R	LC
Family : Picidae			
Dendrocoposnanus(Vigors)	Brown-capped Pygmy	R	LC
Dendrocoposmahrattensis(Latham)	Yellow-fronted Pied	R	LC
Dinopiumbenghalense(Linnaeus)	Lesser Golden-backed	R	LC
Family: Passeridae			
Subfamily : Passerinae			
Passer domesticus(Linnaeus)	House Sparrow	R	LC
Subfamily : Ploceinae			
PloceusPhilippinus(Linnaeus)	Baya Weaver	R	LC
Family : Motacillidae			
*Anthusrufulus*Vieillot	Paddyfield Pipit	R	LC
Family : Pycnonotidae			
Pycnonotuscafer(Linnaeus)	Red-vented Bulbul	R	LC
Family : Laniidae			
Turdoidescaudatus(Dumont)	Common Babbler	R	LC

Family/Scientific Name	Common Name	Residential Status*	Threat Status**
Turdoidesstriatus(Dumont)	Jungle Babbler	R	LC
Orthotomussutorius(Pennant)	Common Tailorbird	R	LC
Phylloscopusfuligiventer	Smoky Warbler	R	LC
Family : Nectariniidae			
Nectariniaasiatica(Latham)	Purple Sunbird	R	LC
Family:Phasianidae			
Francolinuspondicerianus(Gmelin)	Grey Francolin-Teeter	R	LC
*Pavocristatus*Linnaeus	Marrah Peacock	R	LC
Family : Charadriidae			
Vanellusindicus(Boddaert)	Red-wattled Lapwing	R	LC
Metopidiusindicus	Bronjed winged jacana		
Psittaculidae			
Psittaculakrameri(Scopoli)	Rose-ringed Parakeet	R	LC
Sturnidae			
Acridotheresfuscus(Wagler)	Jungle Myna	R	LC
Acridotherestristis(Linnaeus)	Common Myna	R	LC
Sturnus contra Linnaeus	Asian Pied Starling	R	LC
Sturnuspagodarum(Gmelin)	Brahminy Starling	R	LC
Gracupica contra(Linnaeus)	Pied Myna	R	LC
Family : Dicruridae			
*Dicrurusmacrocercus*Vieillot	Black Drongo	R	LC
Dicruruscaerulescens(Linnaeus)	White-bellied Drongo	R	LC
Dicrurusleucophaeus	Ashy drongo	R	LC
Family : Oriolidae			
Oriolusoriolus(Linnaeus)	Eurasian Golden Oriole	R	LC
Orioluskundoo	Indian Golden Oriole	M	LC
Estrildidae			
Lonchuramalabarica	Indian Silverbil	R	LC
Irenidae			
Chloropsis cochinchinensis	Blue-winged Leaf Bird	R	LC
Megalaimidae			
Megalaimahaemacephala	Coppersmith Barbet	R	LC

*Residential status: R- Resident; LM-Local Migrant; M-Migrant

**Threat Status: LC- Least Concern, according to Indian category quoted from “The Red Data Book on Indian Animals (Edited and Directed by Zoological Survey of India, Calcutia, 1994)”

c) Reptiles and Amphibians

The presence of a total of 18 species of Reptiles and Amphibians grouped under 10 families could be confirmed in the surrounding areas of proposed project from different sources including direct sightings and by interviewing local people (Table 11.6.2-7).

Table 11.6.2-7 List of Reptiles & Amphibians reported in Turga Pumped Storage Project Area

Scientific Name	Common Name	Family	Status WPA/IUCN**
Hemidactylisbrooki	House Gecko	Gekkonidae	-
Gekko gecko	lizard	Gekkonidae	-
Eublepharishardwickii	Hill lizard	Gekkonidae	- / LC
Calotesversicolor	Kakru Garden	Agamidae	-

Scientific Name	Common Name	Family	Status WPA/IUCN**
Psammophilusblanfordanus	Rock Agama	Agamidae	IV/ LC
Varanusbengalensis	Moniter Lizard	Varanidae	II /LC
Mabuyacarinata	Common skink	Scincidae	- / LC
Ptyasmucosus	Rat Snake Dhamna	Colubridae	IV /LC
*Najanaja***	Indian /Ayang Cobra	Elapidae	II / LC
*Viperarusseli***	Viper	Elapidae	IV/ LC
*Xenochrophispiscator***	Common Water Snake	Colubridae	IV/ LC
Amphiesmastolata	Buff-striped keelback	Colubridae	IV / -
Lycodonjara	Twin-spotted Wolf Snake	Colubridae	IV / LC
Bungarusfasciatus	Sakhamuti- Banded krait	Elapidae	IV/LC
Bufomelanostictus	Common indian toad	Bufonidae	IV/LC
Bufoviridis	Common toad	Bufonidae	IV/LC
Ranaspp	Common Frog	Ranidae	IV/LC
Laloulapulchera	Banded Tree Frog	Microphylidae	IV/LC

source: JICA Study Team

* WPA: Wildlife (Protection) Act 1972; LC: Least Concerned, NT: Near Threatened, VU: Vulnerable

**Secondary data based

d) Insects (butterflies)

Insects are the most numerous, and dominant life forms on the earth. Among insects butterflies are considered as environment indicator which plays important role in pollination. The butterflies sighted in the area are shown in Table 11.6.2-8. The insect fauna listed consists of mostly ‘common’ and generalist species as none of them is threatened globally as per the IUCN Red list 2014.

Table 11.6.2-8 List of Butterfly species spotted in Turga Pumed Storage Project Area

Common Name	Scientific Name	Family	Occurrence Season*		
			PM	S	M
Common Indian Crow	*Euploea core core(Cramer)*	Danaidae	+	+	+
Indian Palm Bob	*Suastusgremius*	Hesperidae	-	-	+
Grass Demon	*Udaspesfolus*	Hesperidae	-	-	+
Plum Judy	*Abisaraecherius*	Lycaenidae	-	-	+
Large Oak Blue	*Arhopalaamantes*	Lycaenidae	-	-	+
Elbowed Pierrot	*Caletaelnanoliteia*	Lycaenidae	+	-	-
Forget-me-not	*Catochrysopsstrabo*	Lycaenidae	-	-	+
Dark Cerulean	*Jamidesbochus*	Lycaenidae	+	-	+
Common Cerulean	*Jamidesceleno*	Lycaenidae	+	-	+
Yamfly	*Loxuraatymnus*	Lycaenidae	-	-	+
Common Acacia Blue	*Surendraquercetorum*	Lycaenidae	-	-	+
Assam Pierrot	*Tarucusvenosus*	Lycaenidae	+	-	-
Tawny Coster	*Acraeaviolae (Fabricius)*	Nymphalidae	-	+	+
Colour Sergeant	*Athymanefte*	Nymphalidae	-	+	+
Common Sergeant	*Athymaperius (Linnaeus)*	Nymphalidae	-	+	+
Leopard Lacewing	*Cethosiacyane*	Nymphalidae	-	-	+
Common / Plain Tiger	*Danauschrysippus (Linn.)*	Nymphalidae	-	+	+
Striped Tiger	*Danausgenutia (Cramer)*	Nymphalidae	-	+	+
Gaudy Baro	*Euthalialubentina*	Nymphalidae	-	-	+
Great Eggfly	*Hypolimnasbolina (Linn.)*	Nymphalidae	+	+	-
DanaidEggfly	*Hypolimnasmissipus(Linn.)*	Nymphalidae	+	+	-

Common Name	**Scientific Name**	**Family**	**Occurrence Season***		
			PM	**S**	**M**
Peacock pansy	*Junonia almanac (Linnaeus)*	Nymphalidae	+	+	+
Blue Pansy	*Junoniaorithya (Linn.)*	Nymphalidae	+	+	+
Bright-eye Bushbrown	*Mycalesis patina*	Nymphalidae	+	-	-
Common Bushbrown	*Mycalesisperseus*	Nymphalidae	+	-	+
Glassy Tiger	*Paranticaaglea*	Nymphalidae	+	-	+
Common Leopard	*Phalantaphalantha(Drury)*	Nymphalidae	+	+	-
Common Baronet	*Euthalianais(Baronet)*	Nymphalidae	+	+	+
Grey Count	*Tanaecialepidea*	Nymphalidae	-	-	+
Common Fourring	*Ypthimahubneri*	Nymphalidae	+	+	+
Himalayan Fivering	*Ypthimasakra*	Nymphalidae	-	+	+
Common Mime	*Chilasaclytia*	Papilionidae	+	-	+
Glassy Bluebottle	*Graphiumcloanthus*	Papilionidae	+	+	-
Common Jay	*Graphiumdoson (C.&R. Felder)*	Papilionidae	+	+	+
Common Sailer	*Neptishylas*	Papilionidae	+	+	+
Common Rose	*Pachlioptaaristolochiae*	Papilionidae	+	-	+
The Blue Mormon	*Papiliopolymnestor*	Papilionidae	+	+	-
Common Mormon	*Papiliopolytes*	Papilionidae	+	+	+
Great Zebra	*Pathysaxenoclesphrontis -*	Papilionidae	-	-	
Yellow Helen	*Pricepsnepheluschoan*	Papilionidae	+	-	+
Orange Albatross	*Appiasnero*	Pieridae	+	-	-
Pioneer	*Belenoisaurota*	Pieridae	+	-	-
Common Emigrant	*Catopsilia Pomona (Fabricius)*	Pieridae	-	+	+
Mottled Emigrant	*Catopsiliapyranthe (Linnaeus)*	Pieridae	-	+	+
The Common Gull	*Ceporanerissaphryne (Fabricius)*	Pieridae	-	+	+
Red Spot Jezebel	*Deliasdescombesi*	Pieridae	+	+	-
Common Jezebel	*Delias eucharis*	Pieridae	+	+	+
Small Grass Yellow	*Euremabrigitta (Cramer)*	Pieridae	+	+	+
Common Grass Yellow	*Euremahecabe (Linnaeus)*	Pieridae	+	+	+
Psyche	*Leptosianina*	Pieridae	+	-	-
Common Wanderer	*Pareroniavaleria*	Pieridae	-	-	+

source: JICA Study Team

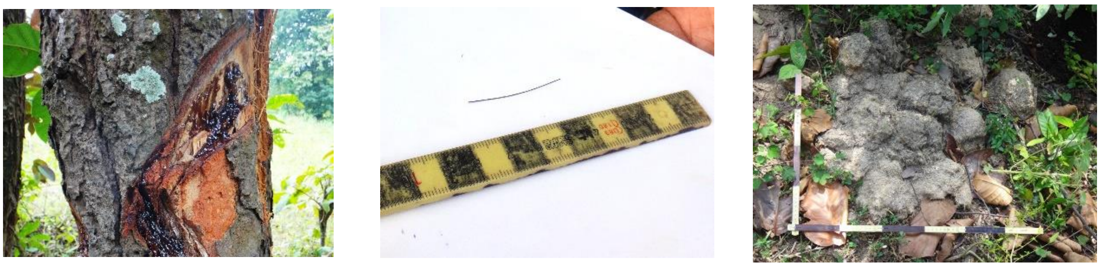
* M: Monsoon Season, PM: Post-monsoon Season, S: Summer Season

3) Seasonal Migration of Asian Elephant

As mentioned above, there is no habitat of Asian Elephant (*Elephas maximus*) in and around the project area. However, the elephants are very common wild animal to local villagers and their migrations are sometimes witnessed seasonally, especially the harvesting season. Therefore, field survey was conducted in October and November 2017 in order to trace and confirm elephants' migration paths. As a result, field signs such as droppings, mud stains on trees, footprints and food marks were observed and revealed that the elephants often passed through the area (see Figure 11.6.2-4). Consequently,

Figure 11.6.2-5 illustrates the estimated migration paths of the elephants by connecting the observed field signs.

a) Footprint (probably fore foot) b) Footprint (probably rear foot) c) Food mark (tree root)



d) Food mark (tree bark) e) Skin hair (attached to a tree bark) f) Droppings

Figure 11.6.2-4 Field Signs of Asian Elephants' Migration in the Project Area

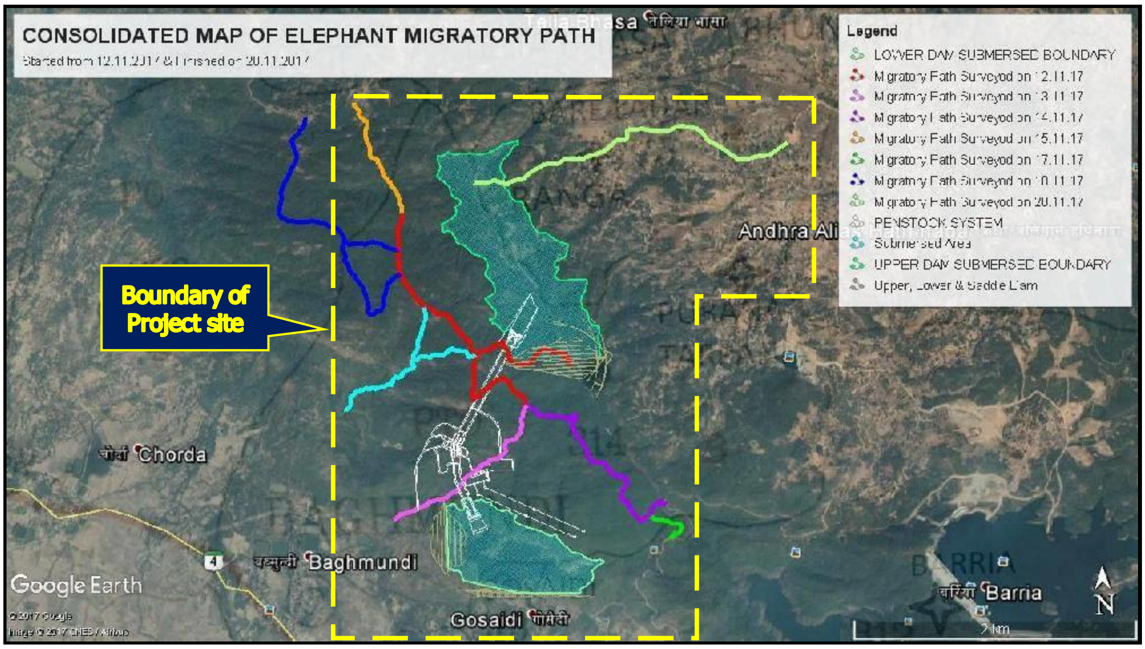
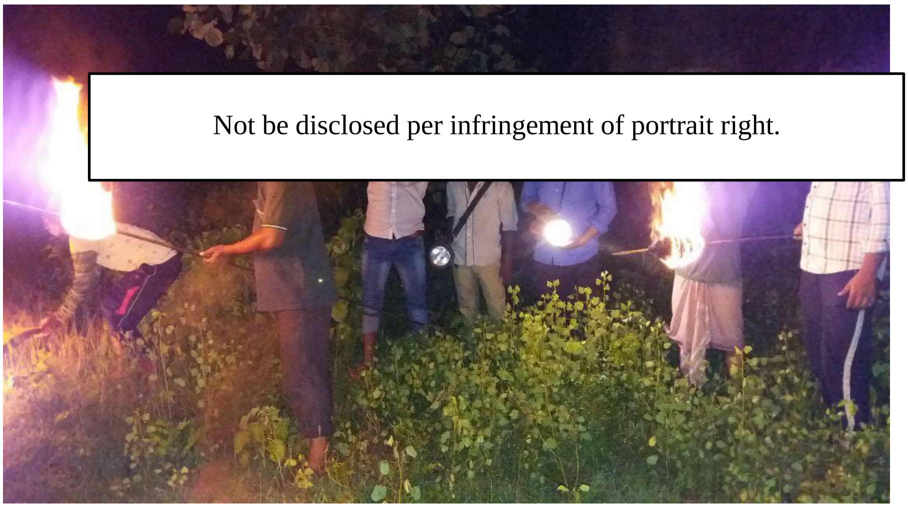


Figure 11.6.2-5 Estimated Elephants' Migration Paths in the Project Area

For some time DFO has instructed the local residents to take countermeasures when elephants appeared and has also established a communication system. In event of elephant entering the project area, their migration could be controlled by organized 'Hulla party' (Figure 11.6.2-6), and DFO also supplies of material to the villagers to drive away wild animals, especially elephants.



Not be disclosed per infringement of portrait right.

Figure 11.6.2-6 Organized Hulla Party by Local Residents

Figure 11.6.2-7 indicates communication system when villagers find the elephants. During the construction period, a contractor must follow instructions and direction by DFO / appropriate authorities and shall join this communication system with stakeholder committee to avoid the elephants from intruding into the project area. It can be expected that the system will be further strengthened by the contractor's cooperation. Besides, the composition of the stakeholder committee will be local residents, Block Development Officer (BDO), DFO, policeman under the jurisdiction, contractor and WBSEDCL. In the committee, it is expected that DFO who directs mitigation of Man-Animal conflict will assume chairman, BDO who has charge of regional development will be Joint chairman, and WBSEDCL will participate as an observer, respectively. In addition, it is recommended that the committee should obtain advices from researchers and/or experts who are well aware of biology and living condition of Asian elephant in and around Purulia District as the occasion arises.

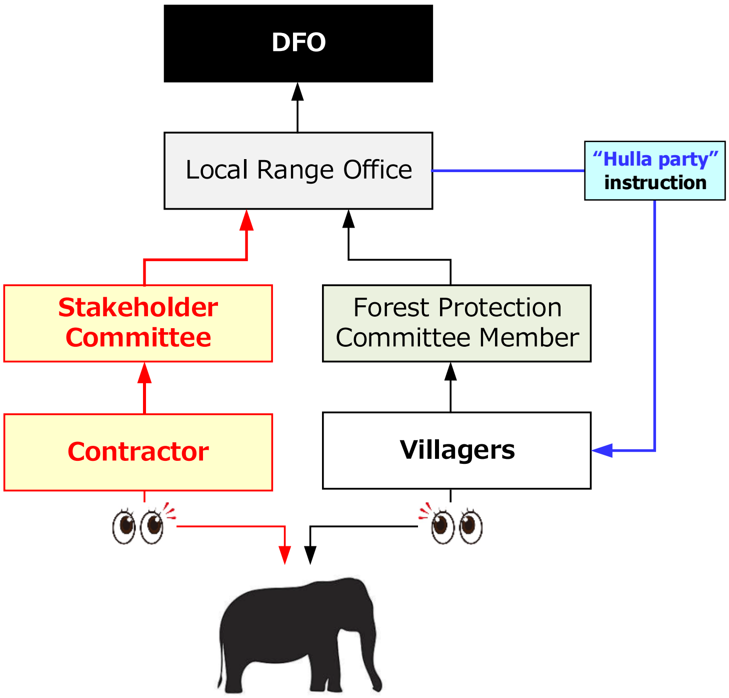


Figure 11.6.2-7 Schematic Diagram of communication system for elephants

Migration of the elephants lies mainly outside the location of project components especially outside open construction activities. So that there is less possibility that the project will not any affect to their ecological activities. However, DFO will give a full account of the existing countermeasures to construction workers in order to prevent damages of physical contact with Asian elephants during construction phase. On this occasion, inhabitant situation of rare species such as Asian elephant and necessary efforts for conservation (e.g. collision-free coexistence of human with wildlife by edification and promotion of Community Based Management for the wild animals, prevention of injury to individuals and groups, avoidance of disturbing habitats and corridors, etc.) should be explained well.

Incidentally, Asian elephants were observed before the construction of Purulia PSP, until about two decades ago. Therefore relevant regulatory agencies directed to fence parts of the quarry area (see Figure 11.6.2-8). However, it is said that the elephants detoured and didn't access the construction area in fact, and migrated again seasonally after beginning of operation.

Former Quarry Area of Purulia PSP Construction

Stone Fence Built Around the Quarry Area

Figure 11.6.2-8 Example of Fence to Avoid Elephants from Entering into the Project Site

11.6.3 Social Environment

(1) Land Acquisition

As a result of alternative examination from technical, financial, environmental, and social aspects in DPR and EIA (See 11.4), land use and diversion under the final project design has remained minimum as small as 292 ha (234 ha forest land and 58 ha non-forest land) for the construction of the pumped storage power plant and its relevant facilities, and another 7.82 ha for the ROW of the transmission lines and towers (length: 1.7 km and width: 46 m[17]). There is no involuntary resettlement anticipated by such land use under the project.

As per 234 ha of forest land that will be diverted for the project, WBSEDCL applied FC to MoEFCC,

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[17] The maximum width of RoW corridor is calculated based on tower design, span, and wind speed, maximum sag of conductor and its swinq plus other requirement of electric safety. According to the MOEF Guideline No. F.NO. 7-25 / 2012 -FC dt 05/05/2014, width of Right of Way for 400 kV D/C line under standard conditions is considered as 46m.

which is in process as of April 2018. Out of 58 ha non-forest land, 34 ha government land that belongs to the Irrigation & Waterways Department will be transferred to WBSEDCL. Another 24 ha non-forest land is either WBSEDCL's land or private land, all of which are planned as clay core collection area. It is uncertain yet before the detailed technical survey, and it depends on the quantity and quality of soil collected in the forest land, if it is necessary to use these non-forest land areas. Out of WBSEDCL's land, local people unauthorizedly use 4.98 ha of Kudna village for agricultural purpose and they will lose their livelihood means, crops and their income source if WBSEDCL decides to use the area. On the other hand, contractors will conclude individual contracts for land use with private land owners upon their prior consensus, so that there will be no involuntary or forcible land use anticipated. Details are described in 11.14.

As for 7.82 ha of forest land for ROW of T/L, it will be obtained during construction period.

(2) Poor People

Most of the local communities in the project impacted area are found below poverty line. Their rights and equal opportunities are secured by law, and they are assisted and subsidized by various social welfare programs from the Central and State Governments.

WBSEDCL has carefully examined the local context and living standards in the impacted area during the technical survey for DPR and EIA, which led them to choose the alternative that will cause the least adverse impact on the residents including the poor. However, there is a possibility of loss of livelihood means, crops and their income source at non-forest WBSEDCL land most of whom are below poverty line if clay is extracted there.

There have been numerous positive impacts on their livelihood brought by the construction and operation of the Purulia PSP, such as working opportunities and local business opportunities, as well as WBSEDCL's CSR activities with which local infrastructure such as road, education facilities and health facilities have been improved up to present. Following the Purulia's good practices, WBSEDCL has a clear idea that they will work on the local area development plan which has been developed as part of this project and such local contributions through their CSR budget during construction works and operation phase.

(3) Ethnic Minority Groups and Indigenous People

Along with general caste and the Scheduled Castes (SC), there are the Scheduled Tribe (ST)[18] residing in the project impacted area. In the eight villages where project facilities (both permanent and temporary) are planned, 3,532 (27.7%) out of the total population 12,763 were STs in the Population Census 2011[19]. Majority of STs in the project site is Santal, and some are Bhumij[20].

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[18] "Scheduled Tribes" is defined in the Constitution as "such tribes or tribal communities or parts of or groups within such tribes or tribal communities as are deemed," and they are specified by public notification (see the articles 342 and 366).

[19] There were 34 thousand STs (25.1% of total population 0.136 million) in the entire Baghmundi Block, and 0.532 million STs (18.5% of total population 2.557 million) in Purulia District.

[20] They are classified as in the Part XVI (West Bengal) of the Constitution (Scheduled Tribes) Order 1950. According to the

Although they are identified by law as distinct tribe and recognized of their identify by others[21], it is concluded that the OP 4.10 (indigenous People) of World Bank's Safeguard Policy is not applicable to the project for the following rationale, 1) there is no distinct or different feature as indigenous people from the rest of residents in the target eight villages confirmed; 2) there is no collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources there observed or confirmed among the Santhal people in the group interviews, social survey and public consultation;3) there is no customary cultural, economic, social or political system detached from the rest residents in the surrounding area. Their villages are connected by local road network and physically accessible from the block capital and other neighboring villages although they are remote. They are well informed of local events such as elections and town meetings by BDO and GPO through local communicators if no phone is available. They purchase goods and services at local markets as the rest of the people does, wear clothes same as others and live close to them each other. STs's rights for their participation in the Indian society is secured by law in West Bengal[22]. 3) *protection*: ST populations below poverty line are recipients of social welfare programs for socially vulnerable people, and subsidies from the Central and State Governments. *5) language and culture*: except the illiterate, Santhal people speak both Santali (*Olchiki*) and Bengali as their primary and secondary languages. Bhumij people, on the contrary, speak Bengali as their first language.

Knowing the facts that those living in the uphill area collect non-timber forest products (NTFP) for domestic purpose[23] and income generation, WBSEDCL carefully examined the project design and layout to avoid adverse impact to the tribe. Prior to the application for the FC, WBSEDCL officially requested District Magistrate of Purulia if there were any people including STs with forest rights in the forest land diverted under the project, as required in the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act. Extent of forest land occupied for habitation and self-cultivation, leased / granted land, rights over NTFPs, community rights for forest, fish, water bodies, traditional resource access for nomadic and pastoralist, etc. were all investigated to confirm that there is no person who are affected and no objection letters were submitted by them. In terms of rights over NTFP, the surrounding forest land will remain available, along with the forest land to be diverted as the project site, for them to continue NTFP collection during construction period, so that adverse impact is not anticipated (or remain minimum if so) when they explore alternative forest

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Population Census 2011, large number of Santal populations are found in several states: 2.5 million in West Bengal, 2.75 million in Jharkhand, 0.89 million in Odisha, 0.4 million in Bihar, and 2,900 in Tripura. Bhumij are also found in West Bengal, Jharkhand and Odisha (0.38 million, 0.21 million and 0.28 million respectively).

[21] According to the West Bengal Scheduled Castes and Scheduled Tribes (Identification) Act, 1994, any person belonging to any of the tribes or tribal communities or parts or groups within tribes or tribal communities and resident in the locality specified in relation to them are identified, by a certificate, to be members of the Scheduled Tribe.

[22] Their seats in services and posts are reserved as in the West Bengal Scheduled Castes and Scheduled Tribes (Reservation of Vacancies in Services and Posts) Act, 1976.

[23] Including STs, almost all populations in the project site use fuelwood as source of energy for cooking. LPG and electricity are rarely used for cooking.

products outside of the construction site. The footpath in the forest land which local people including Santhal tribe often use for carrying non-forest products to the local market in Baghmundi town has been avoided in order not to do any harm to their livelihood activities.

However, there still left a possibility of loss of livelihood means, crops and income sources at WBSEDCL land among whom are Santhal. Details are described in 11.14.

(4) Local Economy

There is a possibility of loss of livelihood means at non-forest WBSEDCL land. For the rest local communities, there will be least adverse impact anticipated to their economy. Instead, positive impact is anticipated such as work and business opportunities during the construction period. In case of Purulia PSP, not only the direct work opportunities for 2,000 people and direct / indirect business opportunities for local people during the construction period, but also tourism and recreation were enhanced as reservoirs are popular among local picnickers after the commencement of operation. Similar positive impact is expected during the operation phase.

(5) Land Use and Utilization of Local Resources

Approximately 240 ha of forest land will be diverted for Turga PSP and ROW of transmission line and towers. In addition, there may be temporary non-forest land use (private land and WBSEDCL land) to collect clay core materials, if the quantity and quality of soil collected in the forest land does not reach the expected level.

(6) Water Usage, Water Rights, etc.

Irrigation water and drinking water is currently taken from the existing irrigation reservoir which will be expanded as the lower reservoir. Peoples residing nearby do fishing from time to time occasionally for self-consumption and commercial purpose. Since the income generated from fishing activities fluctuates day by day and season by season, local people have other occupations as their primary sources of income. To construct a coffer dam next to the lower reservoir is one of such countermeasures reflected in the project design that ensures availability of drinking water, irrigation water, and enables fishing activities to be continued during the construction period. The actual impact is, however, unknown yet and monitoring during the construction period will be required.

(7) Existing Social Infrastructure and Services

Possible increase in traffic accidents by increased traffic load in the Project area vicinity roads. On the other hand, positive impact is anticipated through infrastructure development during both the construction period and operation period with which local economy will keep enhanced with better access to social services and local market throughout a year in the operation period. In case of Purulia PSP, WBSEDCL has been still working on their CSR activities in which they develop road, school and health facilities even after the construction was over.

(8) Social Institutions such as Social Infrastructure and Local Decision-making Institutions

There will be least adverse impact anticipated.

(9) Misdistribution of Benefits and Losses

There will be least adverse impact anticipated. WBSEDCL has elaborated the local area development plan, with which the entire project impacted area and surrounding area will be benefited. There is an established mechanism of grievance at the Block Development Office, which is accessible to local people without difficulty.

(10) Local Conflicts of Interest

According to the EIA, influx of outside people will reach 4,000 in total (1,000 project relevant people (200 technical people and 800 construction workers) and their family members, and subordinate people). Contractors will conduct guidance for the outside workers to get adopted in the local context.

(11) Cultural Heritage

There is a Hindu temple called Ram Mandir at the planned lower dam axis (or very close to it). To avoid accidents and ensure safety during dam construction period, it is recommended (or unavoidable) to shift it away temporarily. WBSEDCL considers permanent relocation of the temple on the concrete-surfaced place at higher elevation with approach stairs for easier access of local people. According to the interview with the local people from Gosaidi village and the priest who serves at the temple, there is no problem from religious perspective if the temple is relocated.

There is a place of worship nearby called Vaishno Devi and it is confirmed that it will not be affected by the lower reservoir construction.

(12) Landscape

There will be least adverse impact anticipated. Most of the project facilities will be constructed underground, and the overhead transmission line will be extended in the forest land along with the ridge.

(13) Gender

There will be least adverse impact anticipated. In Purulia PSP’s case, there were working opportunities given to women as well, most of which were unskilled ones. Strongly facilitated and supported by BDO, women in Baghmundi Block have organized self-help groups in which they work on handicrafts, grocery shops, credit schemes, etc. Such group mechanism can be made use of for enhancing positive impacts by the project.

(14) Children’s Rights

According to the Child Labour (Prohibition and Regulation) Amendment Act, 2016, children below 18 years are not allowed to be involved in the construction work of the project as power generation industry work is one of the hazardous processes which they must not be involved. To deal with inflammable substances or explosives is not allowed either. WBSEDCL strongly states that they abide the law and will never allow children to be involved in the project.

(15) Infectious Diseases

According to the result of household interview, there are infectious diseases such cough, cold, malaria, tuberculosis and diarrhea among the local communities. An inflow of construction workers may increase such cases if any prevention measures are not undertaken. Malaria was reported during the construction period of Purulia PSP, when mosquito nets and medicines were provided to the local people.

(16) Work Environment

During the site preparation and construction works, dust, noise, vibration will occur although limited scale. Considering the staying period of one camp, it is not expected to have serious deterioration of the workers' camp. Accidents may occur in the construction site if there is no prevention measure taken.

11.6.4 Others

(1) Accidents

In the construction period, increase of traffic volume may cause traffic accidents if there are no appropriate controlling measures are taken especially during the schooling time. Forest fire can occur if no management measure is taken for controlling the causes of fire, such as disposal of tobacco by construction workers', etc. In the operation phase, accidents at reservoirs and other related facility area may occur if appropriate measures such entry restriction are not taken. Accidents shall be prevented with proper prevention guidelines and its enforcement.

(2) Cross-boundary Impact and Climate Change

The amount of CO_2 emission from Turga PSP has been estimated based on the formula provided by JICA, which results in annual increase of 556,312 t-CO_2 (Details are described in Annex 11-2).

11.7 ENVIRONMENTAL IMPACT EVALUATION

The results of environmental and social impact assessment including evaluation results in the scoping of Turga PSP and transmission lines are summarized in Table 11.7-1 and Table 11.7-2 respectively.

Table 11.7-1 Results of Environmental and Social Impact Assessment for the Turga PSP

Item	Impact		Assessment based				Results
			Scoping		Survey result		
			Pre-/ construction Phase	Operation phase	Pre-/ construction Phase	Operation phase	
Pollution Controll	1	Air Quality	B-	D	B-	D	**Construction phase:** Dust will be generated in the land preparation and other construction work, but the impact will remain temporary. Generation of air pollutants (SOx, NOx, etc.) could be expected from the operation of heavy machinery and trucks, but the impact will stay within the surrounding area. **Operation phase:** SOx, NOx, PM/dust will not be generated by

Item		Impact	Assessment based				Results
			Scoping		Survey result		
			Pre- / construction Phase	Operation phase	Pre- / construction Phase	Operation phase	
							the operation of the power plant.
	2	Water Quality	B-	C-	B-	D	**Construction phase:** Water turbidity will be caused by the excavation work, but the impact will be temporary. There might be impacts caused by the concrete wastewater and oil-containing wastewater if not controlled. **Operation phase:** Possibility of water turbidity through the adverse impact on aquatic life caused by elevation difference of two dam sites will be predicted.
	3	Soil Quality	B-	D	B-	D	**Construction phase:** Soil pollution will possibly be caused by leakage of lubricants and fuel oil from construction vehicles and machinery. **Operation phase:** There is no specific negative impact anticipated as no case of soil pollution has been confirmed in the operation of the existing power plant facilities in Turga PSP and with the limited number of personnel at work there.
	4	Sediment	B-	C-	B-	D	**Construction phase:** Sediment pollution would possibly be caused if construction wastewater flows into the lower dam. **Operation phase:** Adverse impacts on aquatic life could not be caused by elevation difference of two dam sites.
	5	Noise and Vibration	B-	D	B-	D	**Construction phase:** Noise and vibration could be caused by the operation of heavy machinery and trucks, and use of dynamite. But it will be limited to the surrounding area. **Operation phase:** Noise and vibration will not be experienced on the surface as the power plant will be constructed underground.
	6	Odor	C-	D	B-	D	**Construction phase:** Bad odors from rotten waste may occur in the case that domestic waste from the workers' camp is not appropriately treated, but this would be very local. **Operation phase:** There is no occurrence of odor from domestic waste anticipated as the number of personnel at work in the power plant facilities is limited.
	7	Waste	B-	B-	B-	B-	**Construction phase:** General (domestic), industrial and hazardous wastes would be generated during the construction work. **Operation phase:** General (domestic) waste, Industrial and hazardous wastes would not be generated.
	8	Subsidence	D	D	D	D	The impact is unknown at this moment. It will be identified in due course during the geological survey.
Natural Environment	9	Protected areas	D	D	D	D	There is no specific negative impact expected.
	10	Ecosystem	A-	C+	B-	D	**Construction phase:** Forest land which accumulates approximately 7.0 - 12.8 tons CO_2 will be diverted.* Deforestation accompanying construction works will likely affect mammals of Cercopithecidae and Felidae, and birds of Picidae and Strigidae inhabiting in the forest area. Furthermore, there is a possibility that migration pathes of local elephants will be changed by sound and vibrarion in the construction phase. But impact on elephants' ecosystem may be not serious because the migrations are found seasonally and there is a myriad of bypass in the hill area. Besides, there is no endemic species in the project area, so that wildlife may move to nearby forests and water bodies with similar ecosystems in conjunction with noise, vibration, worker and vehicle trafics in the construction phase. **Operation phase:** There is no specific negative impact expected
	11	Hydrosphere	C-	C-	D	D	There is no specific negative impact expected.
	12	Topography and Geology	B-	C-	B-	D	The impact is unknown at this moment. It will be identified in due course during the geological survey.

Item	Impact		Assessment based				Results
			Scoping		Survey result		
			Pre-/ construction Phase	Operation phase	Pre-/ construction Phase	Operation phase	
Social Environment	13	Land acquisition	C-	D	A-	N/A	There will be no permanent land acquisition or resettlement under the project. An official letter for the Forest Clearance (Stage-I) of 234 ha of forest land diversion was issued in April 2018. **Construction phase:** 34 ha of non-forest land (irrigation reservoir) will be transferred from the Irrigation & Waterways Deprt. Another 24 ha non-forest land may possibly be used as borrow area. Although possibility of loss of livelihood means may also occur due to the land utilization at theWBSEDCL owned land in Kudna, no involuntary resettlement is anticipated by any of the above land use under the project. **Operation phase:** There is no specific negative impact anticipated.
	14	Disturbance to Poor People	C-/+	B+	B-/+	D	**Construction phase:** Most of the affected people and local communities in the project impacted area are below poverty line. The project design carefully examined by WBSDCL will cause the least adverse impact on the residents including the poor. Following the good practices in Purulia PSP, WBSEDCL will do local contributions by CSR activities, alongside the local area development activities planned under the project. **Operation phase:** There is no specific negative impact anticipated as WBSEDCL will conduct CSR activities and look after the affected people.
	15	Disturbance to Ethnic Minority Groups and Indigenous People	C	C	B-/+	D	**Construction phase:** There are the Scheduled Tribe (ST) residing in the project impacted area, majority of whom are Santhal and some are Bhumij. World Bank's Safeguard Policy (OP4.10) for indigenous peoples is not applied to them sinse 1) they do not show distinct indigenous cultural features different from the rest of the residents, 2) their collective attachment were not confirmed to geographically distinct habitats or ancestral territories in the project area and to the natural resources there, 3) they do not have customary cultural, economical, social, or political institutions separate from the rest local community, 4) the STs below poverty line are covered under social welfare program by the central and state governments, and 5) they speak Bengali in addition to their own language (Santhali or *Olchiki*) except the illiterate. Their forest rights were officially reviewed and no-objection letter has been collected. However, there still left a possibility of loss of livelihood means at non-forest government land among whom are Santhal. Following the good practices in Purulia PSP, WBSEDCL will do local contributions during construction works, which will bring benefits to all local people including STs. **Operation phase:** There is no specific negative impact anticipated as WBSEDCL will conduct CSR activities and look after the affected people
	16	Deterioration of Local Economy	B-/+	B-/+	B-/+	B+	**Construction phase:** Possibility of loss of livelihood means at non-forest WBSEDCL land. Whereas for the rest local communities, there will be least adverse impact anticipated to the local economy. Instead, positive impact is anticipated such as job opportunities and business opportunities directly and indirectly during the construction period. **Operation phase:** In case of Purulia PSP, tourism and recreation were enhanced as reservoirs are popular among local picnickers after the commencement of operation. The same (or similar) positive impact is anticipated during operation phase. Local economy will keep enhanced as better access to social services and local market throughout a year.
	17	Land Use and Utilization of Local Resources	B-	B-/+	B-	D	**Construction phase:** 234 ha of forest land will be altered. There may be non-forest land use for 24 ha to collect clay core materials, if the quantity and quality of soil collected in the forest land does not reach the expected level. Out of 24 ha, 14.761 ha of private lands may be leased for certain period during construction period, and so are 9.55 ha of WBSEDCL's former Purulia PSP's borrow areas. **Operation phase:** There is no specific negative impact expected

Item	Impact		Assessment based				Results
			Scoping		Survey result		
			Pre-/ construction Phase	Operation phase	Pre-/ construction Phase	Operation phase	
	18	Disturbance to Water Usage, Water Rights, etc.	B-	C	C/D	D	**Construction phase:** Irrigation water and drinking water currently taken at the existing irrigation reservoir will be kept available by constructing a coffer dam next to the lower reservoir. People residing nearby do fishing from time to time occasionally for self-consumption and commercial purpose. Coffer dam will make it possible to continue fishing activities during the construction period, while the actual impact is unknown yet and monitoring is required during the construction period. **Operation phase:** There is no specific negative impact expected
	19	Disturbance to the Existing Social Infrastructure and Services	B-	B+	B-/+	B+	**Construction phase:** Possible increase in traffic accidents by increased traffic load in the Project area vicinity roads. On the other hand, positive impact is anticipated such as infrastructure development during the construction period. WBSEDCL has been working on their CSR activities even after the construction of Purulia PSP, in which they developed road, school and health facilities. **Operation phase:** There will be least adverse impact anticipated. In case of Purulia PSP, tourism and recreation were enhanced as reservoirs are popular among local picnickers after the commencement of operation. The same (or similar) positive impact is anticipated during operation phase. Local economy will keep enhanced as better access to social services and local market throughout a year.
	20	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	D	D	N/A	N/A	There will be least adverse impact anticipated.
	21	Misdistribution of Benefits and Losses	B-	B-	D	D	There will be least adverse impact anticipated. WBSEDCL has elaborated the local area development plan, with which the entire project impacted area and surrounding area will be benefited. There is an established mechanism of grievance at the Block Development Office, which is accessable to local people without difficulty.
	22	Local Conflicts of Interest	B-	B-	B-/+	D	**Construction phase:**According to the EIA, influx of outside people will reach 4,000 in total (1,000 project relevant people (200 technical people and 800 construction workers) and their family members, and subordinate people). Contractors will conduct guidance for the outside workers to get adopted in the local context. **Operation phase:** There is no specific negative impact expected
	23	Cultural Heritage	B-	C	B-	D	**Construction phase:** There is a small Hindu temple on the left bank ridge of the planned lower reservoir. Since it is located on the dam axis, the dam construction work will likely affect the temple and people who visit it. It is better to shift it away during construction period and rebuild it at higher elevation. According to the interview with the local people residing nearby (Gosaidi village) and the priest who serves at the temple, there is no problem from religious perspective if the temple is relocated. **Operation phase:** There is no specific negative impact expected
	24	Landscape	C	C	D	D	There will be least adverse impact anticipated as most of the project facilities will be constructed underground.
	25	Gender	C	C	B+	D	There will be least adverse impact anticipated. In Purulia PSP's case, there were job opportunities given to women as well, most of which were unskilled ones. Facilitated and supported by BDO, women in Baghmundi Block are presently active in self-help group activities in which they work on handicrafts, grocery shops, credit schemes, etc. Such group mechanism can be made use of for enhancing positive impacts by the project.
	26	Children's Rights	C	C	D	D	**Construction phase:** WBSEDCL will stricly abide the Indian law on child labor. **Operation phase:** No particular negative impact is predicted.

Item	Impact		Assessment based				Results
			Scoping		Survey result		
			Pre-/ construction Phase	Operation phase	Pre-/ construction Phase	Operation phase	
	27	Infectious Diseases	B-	D	B-	D	**Construction phase:** An inflow of construction workers may cause / increase diseases if any prevention measures are not undertaken. **Operation phase:** No particular negative impact is predicted.
	28	Work Environment (Including Work Safety)	B-	B-	B-	B-	**Construction phase:** During the site preparation and construction works, dust, noise, vibration will occur although limited scale. Environment of workers' camp or accommodation facilities shall be properly managed with proper hygiene guidelines and its enforcement. **Operation phase:** Workers may get involved in accidents while at work.
Other	29	Accidents	B-	B-	B-	B-	**Construction phase:** Increase of traffic volume may cause traffic accidents if there are no appropriate controlling measures are taken especially during the schooling time. Forest fire can occur if any management measures are taken for controlling the causes of fire, such as disposal of Tabaco by construction workers', etc. Accidents shall be prevented with proper prevention guidelines and its enforcement. **Operation phase:** Accidents at reservoirs and other related facility area may occur if appropriate measures such as entry restriction are not taken.
	30	Cross-boundary Impact and Climate Change	C-	C+	B-	D	The impact is calculated by the methodology directed by JICA Since the water in the reservoirs circulates continuously between the upper dam and the lower dam, remarkable gas generation under anaerobic conditions such as methane (CH_4) is not foreseen.

source: JICA Study Team

Note 1.
A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (Further examination is needed, and the impact may be clarified as the study progresses.)
D: No impact is expected.

Note. 2.
* Carbon stock was roughly estimated by using enumeration data for diversion of forest land in 31 July 2017 by WBSEDCL. Source for obtaining the data was http://forestsclearance.nic.in/viewreport.aspx?pid=FP/WB/HYD/8214/2014

Carbon stock in CO_2 equivalent per tree = [SV (m^3)] × [WD (kg m^{-3})] × [EF] × (1+[R]) × [CF] × (44/12)

Where;
SV: Stem Volume (m^3), calculated by function programmed by Forestry and Forest Products Research Institute (FFPRI), Japan; http://www.ffpri.affrc.go.jp/database/stemvolume/index.html
WD: Wood Density (kg m^{-3}), quoted from Global Wood Density Database http://datadryad.com/bitstream/handle/10255/dryad.235/GlobalWoodDensityDatabase.xls?sequence=1
EF: Expansion Factor, 1.37 was used following FFPRI on a temporary basis
R: Root Short Ratio, 0.26 was used following FFPRI on a temporary basis
CF: Carbon fraction of tree biomass, the default value of 0.50 was used following IPCC GPG

All values were rounded off at the first decimal place.

Table 11.7-2 Results of Environmental and Social Impact Assessment for the Transmission Line and the related facilities

Item	Impact		Assesment based				Results
			Scoping		Survey result		
			Pre-/ construction Phase	Operation phase	Pre-/ construction Phase	Operation phase	
Pollution Controll	1	Air Quality	B-	D	B-	D	**Construction phase:** Production of dust is expected by land preparation and other construction work, but the impact will be temporary. Generation of air pollutants (SOx, NOx, etc.) is predicted from the operation of heavy machinery and trucks, but the impact will be limited to only the surrounding area. **Operation phase:** air pollutants (SOx, NOx, etc.) will not be

Item	Impact		Assesment based				Results
			Scoping		Survey result		
			Pre-/ construction Phase	Operation phase	Pre-/ construction Phase	Operation phase	
							generated by the operation of the T/L.
	2	Water Quality	B-	D	B-	D	**Construction phase:** Soil runoff may occur from the exposed soil to the embankments and cut slopes, which may cause water turbidity. The impact will however be temporary. The impact of domestic wastewater and oil-containing wastewater is also expected. **Operation phase:** No specific impact on water quality is expected.
	3	Noise & Vibration	B-	D	B-	D	**Construction phase:** Noise caused by heavy machinery and trucks is predicted. Noise and vibration during the incubation period and breeding season may affect the breeding of birds. **Operation phase:** No specific noise and vibration is expected.
Natural Environment	4	Protected area	D	D	D	D	**Construction phase:** There is no specific negative impact expected **Operation phase:** There is no adverse impacts to any protected areas.
	5	Ecosystem	C-	B-	B-	D	**Construction phase:** Deforestation accompanying construction works will likely affect mammals of Cercopithecidae and Felidae, and birds of Picidae and Strigidae inhabiting in the forest area. Besids, there is a possibility that migration pathes of local elephants will be changed by sound and vibrarion in the construction phase. But impact on elephants' ecosystem may be not serious because the migrations are found seasonally and there is a myriad of bypass in the hill area. **Operation phase:** There will be least adverse impact anticipated to the migration of birds because the height of the steel tower to be constructed will be about 80 m.
	6	Topography & Geology	C-	C-	B-	D	**Construction phase:** Excavation works while construction of access roads, transmission tower site is risky activities with regard to raising erosion risk. **Operation phase:** No specific impact on topography and geology is expected.
Social Environment	7	Land acquisition	C	D	B-	N/A	There will be no permanent land acquisition or resettlement under the project. **Construction phase:** 7.82 ha forest land clearance (1.7 km-long and 46 m-wide) will be under the FC from the Forest Department of West Bengal State / Eastern Region MoEFCC for the ROW of the transmission lines and towers. WBSETCL will apply FC based on their technical survey results. **Operation phase:** No specific impact is anticipated.
	8	Disturbance to Poor People	C	C	D	D	There will be least adverse impact anticipated.
	9	Disturbance to Ethnic Minority Groups and Indigenous People	C	C	D	D	There will be least adverse impact anticipated.
	10	Deterioration of Local Economy	C	C	D	D	There will be least adverse impact anticipated.
	11	Land Use and Utilization of Local Resources	B-	D	B-	N/A	**Construction phase:** 7.82 ha of forest land will be altered. **Operation phase:** There is no specific negative impact expected
	12	Disturbance to Water Usage, Water Rights, etc.	C	C	D	D	There will be least adverse impact anticipated.
	13	Disturbance to the Existing Social Infrastructure and Services	B-	D	B-/+	D	**Construction phase:** Possible increase in traffic accidents by increased traffic load in the Project area vicinity roads. On the other hand, positive impact is anticipated such as infrastructure development during the construction period. **Operation phase:** There will be least adverse impact anticipated.
	14	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	D	D	N/A	N/A	There will be least adverse impact anticipated.
	15	Misdistribution of	C	C	D	D	There will be least adverse impact anticipated.

Item	Impact		Assesment based				Results
			Scoping		Survey result		
			Pre- / construction Phase	Operation phase	Pre- / construction Phase	Operation phase	
		Benefits and Losses					
	16	Local Conflicts of Interest	C	C	D	D	There will be least adverse impact anticipated.
	17	Cultural Heritage	C	C	D	D	There will be least adverse impact anticipated.
	18	Landscape	C	C	D	D	There will be least adverse impact anticipated as the overhead transmission line will be extended in the forest land.
	19	Gender	C	C	B+	D	There will be least adverse impact anticipated. In Purulia PSP's case, there were job opportunities given to women as well, most of which were unskilled ones. Facilitated and supported by BDO, women in Baghmundi Block are presently active in self-help group activities in which they work on handicrafts, grocery shops, credit schemes, etc. Such group mechanism can be made use of for enhancing positive impacts by the project.
	20	Children's Rights	C	C	D	D	**Construction phase:** WBSETCL will stricly abide the Indian law on child labor. **Operation phase:** No particular negative impact is predicted.
	21	Infectious Diseases	B-	D	B-	D	**Construction phase:** An inflow of construction workers may cause / increase diseases if any prevention measures are not undertaken. **Operation phase:** No particular negative impact is predicted.
	22	Work Environment (Including Work Safety)	B-	B-	B-	B-	**Construction phase:** During the site preparation and construction works, dust, noise, vibration will occur although limited scale. Environment of workers' camp or accommodation facilities shall be properly managed with proper hygiene guidelines and its enforcement. **Operation phase:** Workers may get involved in accidents while at work.
Other	23	Accidents	B-	B-	B-	B-	**Construction phase:** Increase of traffic volume may cause traffic accidents if there are no appropriate controlling measures are taken especially during the schooling time. Forest fire can occur if any management measures are taken for controlling the causes of fire, such as disposal of Tabaco by construction workers', etc. Accidents shall be prevented with proper prevention guidelines and its enforcement. **Operation phase:** Accidents at reservoirs and other related facility area may occur if appropriate measures such as entry restriction are not taken.
	24	Cross-boundary Impact and Climate Change	C-	D	B-	D	**Construction phase:** CO_2 will be produced from the construction work although the emission is anticipated to be limited and negligible. No impact on climate change is anticipated. **Operation phase:** Transmission line will not cross the boundary. No CO_2 will be produced by the operation of transmission line.

source: JICA Study Team

note:
A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (Further examination is needed, and the impact may be clarified as the study progresses.)
D: No impact is expected.

11.8 MITIGATION MEASURES

The major environmental impact, mitigation measures, responsible organization, and expenses for each environmental item during the construction and operation phases for the power plant and transmission line are shown Table 11.8-1 and Table 11.8-2, respectively.

Table 11.8-1 Mitigation Measures for Turga PSP

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
Pre- / Construction Stage						
1	Air Quality	1) Production of dust is expected by land preparation and other construction work 2) Generation of dust is expected by land preparation and transportation of excavated soil by dump truck 3) Generation of air pollutions (SO_x and NO_x, etc.) is expected from the operation of heavy machinery and trucks.	1) Access roads will be developed which avoid local people's moving route. 2) Watering the access roads and construction site for dust suppression, especially in the dry season, and using cover sheets on trucks for the transportation of soil, and wind barriers will be applied to reduce dust generation. 3) Speed limits will be applied for vehicles. For mitigation of pollutant emissions, periodic maintenance and management of all the construction machinery and vehicles will be conducted to reduce exhaust gas discharged from construction machinery and vehicles.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
2	Water Quality	1) Water turbidity anticipated by excavation work 2) Discharged water from concrete plan 3) Domestic wastewater and oil-containing	1) - Oil and chemical materials will be collected into collecting sink storage to prevent permeation into the ground. - A package domestic waste water treatment plant and mobile water-closets with composite septic tank will be constructed in the worker's camp and construction area. - Every discharge water will be discharged after purification to comply with environmental standard. 2) Domestic wastewater treatment facility for workers, such as a septic tank and an oil separator for oily run-off water, will be installed in the worker's camp and construction area. 3) Water contaminant or suspended materials caused by	Contractor	WBSEDCL	Expenses included in contract cost by contractor

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
			construction works will be purified by construction of settling pond (primary treatment). 4) Miscellaneous household waste water drained from worker camps will be purified by about 90% by setting of septic tank and other equipment (secondary treatment).			
3	Soil Quality	Leakages of oil and chemical materials at the construction site.	1) Maintenance of vehicles/machinery will be regularly conducted. 2) Oil and chemical materials will be stored in an appropriate storage site to prevent any permeation into the ground.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
4	Sediment	1) Uncontrolled disposal of wastes 2) Transported organic materials due to water circulation between upper and lower reservoirs	1) Oil and chemical materials will be stored in an appropriate storage site to prevent any permeation into the ground. Solid and liquid wastes will be disposed in compliance with related regulations. No waste or packaging will be left on site. 2) Water quality monitoring and setting optimal volume/rate of water circulation	Contractor	WBSEDCL	Expenses included in contract cost by contractor
5	Noise and Vibration	1) Heavy machinery and trucks 2) Personnel transportation vehicles 3) Blasting and drilling activities	1) Maintain heavy equipment and construction equipment with muffler and carry out regular maintenance and inspection. 2) Construction vehicles are equipped with muffler mufflers recommended by manufacturers. 3) Refrain from unnecessary warming-up of construction equipment or vehicles. 4) - Establish a sign board describing measures to mitigate noise and make public notices to the surrounding residents. - Blasting work is to be carried out during the day time and work hours are to be informed to the residents.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
6	Odor	1) Domestic solid waste 2) Domestic waste water	1) Workers will be instructed to classify and collect garbage 2) Illegal waste disposal shall be prohibited. 3) Garbage will be disposed on a periodic basis to ensure that odor by putrefaction is not produced. 4) Domestic waste will be collected daily and separated systematically at source; different types of waste will be stored and disposed of separately. 5) A package domestic waste water treatment plant will be constructed.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
7	Waste	1) Domestic waste 2) Industrial and hazardous waste	1) Segregating waste at collection, recycling and reusing waste will be promoted 2) Non-recyclable waste will be disposed at appropriate sites Different types of waste (e.g. hazardous waste, domestic waste) will be collected and disposed of separately. 3) To reduce the amount of solid waste discharged from workers during the construction work, efforts will be taken to employ	Contractor	WBSEDCL	Expenses included in contract cost by contractor

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
			local workers wherever possible, so that the amount of household waste at the plant will be minimized			
8	Ecosystem	1) Seasonal migration of Asian Elephants (*Elephas maximus*) in and around the project site in harvesting period 2) Disturbance of fauna/avi-fauna due to deforestation 3) Progress of forest decline accompanying deforestation	1) Sharing and fully understanding of exclusion method/procedure and strengthening communication system among DFO, residents and constructor according to routine or established practice. In addition, stakeholder committee consisting of DFO, BDO, local residents, contractor, police and WBSEDCL will be organized to apply necessary measures for the elephants' migration. The committee will consult with academic experts to obtain advices as necessary. 2) At the present stage it doesn't reveal the extent of impacts. Accordingly, biological monitoring should be taken at least for typical mammals and birds in and around the site. 3) New-created forest edge by construction works tends to dry out. Accordingly, local trees or shrub with lianas are to be considered as appropriate to plant along the forest edge as mantle or fringe vegetation in order not to degrade forest ecosystem.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
9	Topography and geology	Excavation works while construction of access roads, transporting / storing of excavation and topsoil, blasting activities at material borrow site or any other area are risky activities with regard to raising erosion risk.	- Netting, and rock bolting will be employed, where necessary to provide stability of the cut slopes. - Topsoil will be stripped and stored and will be watered and vegetated when necessary and roads will be constructed ensuring soils not to slip down from the slopes.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
10	Land acquisition and Resettlement	1) Diversion of forest land*	1)-1 The project area shall be fully and effectively demarcated and fenced.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
			1)-2 Alternative plantation works will be conducted based on the compensatory afforestation list as attached to the FC application.	Forest Department, Government of West Bengal	Forest Department, Government of West Bengal	WBSEDCL (Cost will be estimated by Forest Department at Stage-II of FC.)
		2) Possibility of temporary use of non-forest private land	2)-1 Lease contract will be concluded with land owners.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
			2)-2 Local area development plan will be implemented as described in SIA for the benefit of entire project area.	Block Development Office	WBSEDCL	by WBSEDCL (Cost not be disclosed per internal

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
						corporate information
		3) Possibility of loss of livelihood means at non-forest WBSEDCL land (project affected people)	3)-1 Crop compensation with top-up payment	Contractor	WBSEDCL	Approximately Rs. 950,000 Expenses included in contract cost by contractor
			3)-2 Livelihood restoration / improvement activities will be conducted as described in ARAP.	Block Development Office	WBSEDCL	Approximately Rs. 1.9 million by WBSEDCL
11	Poor People	1) Possibility of loss of livelihood means at non-forest WBSEDCL land (project affected people)	1) Local area development plan will be implemented as described in SIA for the benefit of entire project area.	Block Development Office	WBSEDCL	by WBSEDCL (Cost not be disclosed per internal corporate information
		2) Enhancement of local communities	2)-1 Engagement of local people will be promoted to support their livelihood.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
			2)-2 Local area development plan will be implemented as described in SIA for the benefit of entire project area.	Block Development Office	WBSEDCL	by WBSEDCL (Cost not be disclosed per internal corporate information
12	Ethnic Minority Groups and Indigenous People	1) Possibility of loss of livelihood means at non-forest WBSEDCL land (project affected people)	1) Livelihood restoration / improvement activities will be conducted as described in ARAP.	Contractor	WBSEDCL	Approximately Rs. 1.9 million by WBSEDCL
		2) Enhancement of local communities	2)-1 Engagement of local people will be promoted to support their livelihood.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
			2)-2 Local area development plan will be implemented as described in SIA for the benefit of entire project area.	Block Development Office	WBSEDCL	by WBSEDCL (Cost not be disclosed per internal corporate information
13	Local Economy	1) Possibility of loss of livelihood	1) Livelihood restoration / improvement activities will be	Contractor	WBSEDCL	Approximately

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
		means (direct affected people)	conducted as described in ARAP.			Rs. 1.9 million by WBSEDCL
		2) Enhancement of local communities	2)-1 Engagement of local people will be promoted to support their livelihood.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
			2)-2 Local area development plan will be implemented as described in SIA for the benefit of entire project area.	Block Development Office	WBSEDCL	by WBSEDCL (Cost not be disclosed per internal corporate information
14	Land use and utilization of local resources	1) Diversion of forest land*	1)-1 The project area shall be fully and effectively demarcated and fenced.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
			1)-2 Alternative plantation works will be conducted based on the compensatory afforestation list as attached to the FC application.	Forest Department, Government of West Bengal	Forest Department, Government of West Bengal	WBSEDCL (Cost will be estimated by Forest Department at Stage-II of FC.)
		2) Temporary use of non-forest land	2)-1 private land: Lease equivalent to full replacement value or higher with land owners.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
			2)-2 WBSEDCL land: former Purulia PSP's borrow land will be reused.	Contractor	WBSEDCL	Approximately Rs. 950,000 for crop compensation.
15	Water Usage, Water Rights, etc.	1) Irrigation reservoir will be expanded as lower reservoir, and water and drinking water will be provided from the saddle dam during the construction period.	1) Monitor the water amount collected for irrigation and drinking purposes, and provide water supply if there is any water shortage	Contractor	WBSEDCL	Expenses included in contract cost by contractor
		2) People residing nearby do fishing at the irrigation reservoir from time to time occasionally for self-consumption and commercial purpose, which will be shifted to the coffer dam.	2) Local area development plan will be implemented as described in SIA for the benefit of entire project area including fishermen.	Block Development Office	WBSEDCL	by WBSEDCL (Cost not be disclosed per internal corporate information

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
16	Existing Infrastructure and Services	- Increase in traffic accidents by increased traffic load in the Project area vicinity roads	- To decrease traffic load, transportation of personnel will be conducted by buses - Time control of traffic especially during the schooling time	Contractor	WBSEDCL	Expenses included in contract cost by contractor
		Enhancement of local infrastructure	Infrastructure such as roads will be improved.			
17	Local Conflicts	Influx of outside people may cause conflicts with local communities.	Purulia PSP's labor camp shall be reused to accommodate such outside workers. Contractors will conduct guidance for them to respect local people's culture and practices for getting adopted in the local context. Their behavior will be monitored by the contractors. Local people may directly go to BDO for their concerns, complaints and grievance redress as it is one of BDO's roles and functions to receive them. If such local reports are shared with WBSEDCL, it shall be recorded and monitored until they are solved.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
18	Cultural Heritages	There is a small Hindu temple on the left bank ridge of the planned lower reservoir, which will likely be affected by the dam construction work.	The temple will be relocated to higher elevation by constructing an elevation made by concrete, and improved. The whole process shall be shared with local people and priest, and their opinions shall be taken into account.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
19	Infectious Diseases	An influx of construction workers may increase infectious disease.	- Occupational health and safety trainings will be provided -Periodic medical check will be conducted - Mosquito net and medicine shall be provided for prevention	Contractor	WBSEDCL	Expenses included in contract cost by Contractor
20	Work Environment	Health and safety	-Occupational health and safety trainings will be provided, -Necessary protective equipment will be provided, -Cautionary signs for occupational health and safety will be placed on required points on site. -Equipment and machinery will be checked and maintained regularly, -Measures will be taken to prevent possible fire risk in construction site and surrounding areas.	Contractor	WBSEDCL	Expenses included in contract cost by Contractor
21	Accidents	Accidents	- Safe driving trainings, against Project area accidents, will be provided, -Traffic signs will be placed on site and compliance to traffic rules will be monitored -Necessary protective equipment will be provided, -Equipment and machinery will be checked and maintained regularly, - Measures will be taken to prevent possible fire risk in construction site and surrounding areas. - Transportation of heavy trucks and vehicles during peak hours	Contractor	WBSEDCL	Expenses included in contract cost by Contractor

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
			during morning and evening time and children's schooling time will be avoided as much as the construction schedule allows for not deteriorating traffic jams,			
22	Cross-boundary impacts and Climate change	1) Greenhouse gas emissions 2) Deforestation attendant upon construction works	1) Vehicles will be regularly maintained and repaired. 2) Compensatory afforestation with periodical growing monitoring should be conducted properly according to Forest (Conservation) Act, 1980.	Contractor	WBSEDCL	Expenses included in contract cost by contractor
Operation Phase						
1	Waste	Domestic/Industrial and hazardous waste	- Different types of waste (e.g. hazardous waste, domestic waste) will be collected and disposed of separately, - Efforts will be taken to employ local workers wherever possible to reduce household wastes -"Solid and Hazardous Waste Management Plan" will be implemented.	WBSEDCL	WBSEDCL	Expenses to be paid by WBSEDCL
2	Work Environment	- Health and safety	-Occupational safety trainings will be provided, -Necessary protective equipment will be provided, -Equipment and machinery will be checked and maintained regularly,	WBSEDCL	WBSEDCL	Expenses to be paid by WBSEDCL
3	Accidents	-Accidents	-Cautionary signs for occupational safety will be placed on required points on site. -Preparing a manual of accident prevention measures and ensuring its implementation -Vehicles and equipment will be regularly maintained and repaired.	WBSEDCL	WBSEDCL	Expenses to be paid by WBSEDCL

Note 1: The format is given according to the JICA Guidelines.

Note 2: ***Diversion of forest land**

Monetary compensation should be provided to Forest Department towards the cost of forest land to be diverted and compensatory afforestation. Before starting any activity within the Forest area, Forest Clearance must be obtained as per the Forest Conservation Act, 1980 and it's amendments from the State Forest Department. An action plan for tree cutting should be prepared to avoid uncontrolled and indiscriminate tree cutting. Appropriate compensatory plantation should be initiated to compensate for the vegetation loss due to cutting of trees for site clearing. For trees to be cut, sufficient compensatory plantation should represent approximately 2 times the number of trees felled. Preferential mixed plantation consisting of flowering shrubs and evergreen ornamental trees with less timber and fruit value should be carried out. Under the plantation programme, more valuable tree species should be planted in place of existing non-valuable mono crops in the project area, if any.

Source: JICA Study Team

Table 11.8-2 Mitigation Measures for Transmission Line

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
Pre- / Construction Stage						
1	Air Quality	1) Production of dust is expected by land preparation and other construction work.	1) For dust mitigation, access roads will be developed which avoid local people's moving route.	Contractor	WBSETCL	Expenses included in

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
		2) Generation of dust is expected by land preparation and transportation of excavated soil by dump truck, and generation of air pollutions (SOx and NOx, and etc.) is expected from the operation of heavy machinery and trucks	2) Watering the access roads and construction site for dust suppression, especially in the dry season, and using cover sheets on trucks for the transportation of soil, and wind barriers will be applied to reduce dust generation. 3) Speed limits will be applied for vehicles. 4) For mitigation of pollutant emissions, periodic maintenance and management of all the construction machinery and vehicles will be conducted to reduce exhaust gas discharged from construction machinery and vehicles.			contract cost by contractor
2	Water Quality	1) Water turbidity caused by excavation and digging activities 2)Wastewater sourced from concrete production, digging of cores and use of oils	1) Oil and chemical materials will be collected into collecting sink storage to prevent permeation into the ground. 2) A package domestic waste water treatment plant and mobile water-closets with composite septic tank will be constructed in the worker's cam and construction area. 3) Every discharge water will be discharged after purification to comply with environmental standard. 4) A domestic wastewater treatment facility for workers, such as a septic tank and an oil separator for oily run-off water, will be installed in the worker's camp and construction area.	Contractor	WBSETCL	Expenses included in contract cost by contractor
3	Noise and Vibration	1) Heavy machinery and trucks 2) Digging and drilling activities	1) Maintain heavy equipment and construction equipment with muffler and carry out regular maintenance and inspection. 2) Construction vehicles are equipped with muffler mufflers recommended by manufacturers. 3) Refrain from unnecessary warming-up of construction equipment or vehicles. 4) Establish a sign board describing measures to mitigate noise and make public notices to the surrounding residents.	Contractor	WBSETCL	Expenses included in contract cost by Contractor
4	Ecosystem	1) Seasonal migration of Asian Elephants (*Elephas maximus*) in and around the project site in harvesting period 2) Disturbance of fauna/avi-fauna due to deforestation 3) Progress of forest decline accompanying deforestation	1) Sharing and fully understanding of exclusion method/procedure and strengthening communication system among DFO, residents and constructor according to routine or established practice. In addition, stakeholder committee consisting of DFO, BDO, local residents, contractor, police and WBSEDCL will be organized to apply necessary measures for the elephants' migration. The committee will consult with academic experts to obtain advices as necessary. 2) At the present stage it doesn't reveal the extent of impacts. Accordingly, biological monitoring should be taken at least for typical mammals and birds in and around the site. In addition, it is considered that existence of the nesting within a fixed distance from the transmission line (e.g. about 50 m, determined depending on the species) and suppression of construction accompanying noises and vibration at that periods will be taken as countermeasures. Mitigation measures for bird	Contractor	WBSETCL	Expense included in contract cost by contractor

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
			strikes will be considered as necessary. 3) New-created forest edge by construction works tends to dry out. Accordingly, local trees or shrub with lianas are to be considered as appropriate to plant along the forest edge as mantle or fringe vegetation in order not to degrade forest ecosystem.			
5	Topography and geology	Excavation works while construction of transmission tower site are risky with regard to raising erosion.	Embankments for tower foundation will be covered with vegetation after soon construction activities.	Contractor	WBSETCL	Expenses included in contract cost by Contractor
6	Land acquisition	There will be no land acquisition. But ROW clearance 7.82 ha of forest land only.	1) FC will be obtained from the Forest Department of West Bengal State / Eastern Region of MoEFCC, and expenses for compensatory afforestation will be paid.	WBSETCL	WBSETCL	WBSEDCL
			2) The project area shall be fully and effectively demarcated and fenced.	Contractor	WBSETCL	Expenses included in contract cost by contractor
			3) Alternative plantation works will be conducted based on the compensatory afforestation list as attached to the FC application.*	Forest Department, Government of West Bengal	Forest Department, Government of West Bengal	WBSEDCL (Cost will be estimated by Forest Department at Stage-II of FC.)
7	Land use and utilization of local resources	1) ROW clearance of 7.82 ha forest land	1) FC will be obtained from the Forest Department of West Bengal State / Eastern Region of MoEFCC, and expenses for compensatory afforestation will be paid.	WBSETCL	WBSETCL	WBSEDCL
			2) The project area shall be fully and effectively demarcated and fenced.	Contractor	WBSETCL	Expenses included in contract cost by contractor
			3) Alternative plantation works will be conducted based on the compensatory afforestation list as attached to the FC application.*	Forest Department of West Bengal State	Forest Department of West Bengal State	WBSEDCL (Cost will be estimated by Forest Department at Stage-II of FC.)

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
8	Existing social infrastructure and services	- Increase in traffic accidents by increased traffic load in the Project area vicinity roads	- To decrease traffic load, transportation of personnel will be conducted by buses - Time control of traffic especially during the schooling time	Contractor	WBSETCL	Expenses included in contract cost by contractor
9	Infectious Diseases	An influx of construction workers may increase infectious disease.	- Occupational health and safety trainings will be provided -Periodic medical check will be conducted - Mosquito net and medicine shall be provided for prevention	Contractor	WBSETCL	Expenses included in contract cost by Contractor
10	Work Environment	-Health and safety	1)2)-Occupational health and safety trainings will be provided, -Necessary protective equipment will be provided, -Cautionary signs for occupational health and safety will be placed on required points on site. 3)-Equipment and machinery will be checked and maintained regularly, 4)-Measures will be taken to prevent possible fire risk in construction site and surrounding areas.	Contractor	WBSETCL	Expenses included in contract cost by Contractor
11	Accidents	-Accidents	- Safe driving trainings, against Project area accidents, will be provided, -Traffic signs will be placed on site and compliance to traffic rules will be monitored -Necessary protective equipment will be provided, -Equipment and machinery will be checked and maintained regularly, - Measures will be taken to prevent possible fire risk in construction site and surrounding areas. - Transportation of heavy trucks and vehicles during peak hours during morning and evening time and children’s schooling time will be avoided as much as the construction schedule allows for not deteriorating traffic jams,	Contractor	WBSETCL	Expenses included in contract cost by Contractor
12	Cross-boundary impacts and Climate change	Greenhouse gas emissions	-Vehicles will be regularly maintained and repaired.	Contractor	WBSETCL	Expenses included in contract cost by Contractor
Operation Phase						
1	Work Environment	-Health and safety	-Occupational safety trainings will be provided, -Necessary protective equipment will be provided, -Equipment and machinery will be checked and maintained regularly,	WBSETCL	WBSETCL	WBSETCL
2	Accidents	-Accidents	-Cautionary signs for occupational safety will be placed on required points on site.	WBSETCL	WBSETCL	WBSETCL

No	Items (Impacts)	Sources of Potential Impact	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
			-Preparing a manual of accident prevention measures and ensuring its implementation -Vehicles and equipment will be regularly maintained and repaired.			

Note 1: The format is given according to the JICA Guidelines.

Note 2: *Compensatory afforestation (excerpt from HANDBOOK OF Forest (Conservation) Act, 1980 and Forest (Conservation) Rules, 2003, issued in 2004)

Tree cutting is to proceed only after all the legal requirements including Formal Clearances are completed and a subsequent written order is issued to the Project Proponent/ Contractor. Appropriate compensatory plantation should be carried out to compensate for the vegetation loss due to cutting of trees for site clearing. For trees to be cut, sufficient compensatory plantation, about two times the number of trees felled, will be carried out. Compensatory afforestation and reforestation will follow preferences for mixed plantations consisting of flowering shrubs and evergreen ornamental trees with less timber and fruit value. Under the plantation programme, more valuable tree species will be planted in place of existing non-valuable mono crops in the project area, where appropriate.

Source: JICA Study Team

As per compensatory afforestation, it is WBSEDCL who bear the cost for purchasing seeds and seedlings, and the Forest Department, Government of West Bengal will plant them. The sites for compensatory afforestation have been already identified and earmarked in Purulia District for 75.1 ha and Jalpaiguri District for the rest 158.9 ha. Detail descriptions with satellite images downloaded from the website of MoEFCC[24] are enclosed as Figure 11.8-1 and Table 11.8-3. On the other hand, although WBSEDCL will pay for compensatory afforestation in the ROW of transmission lines and towers, it is WBSETCL who will apply for the FC to the Forest Department based on the results of detailed survey. Forest Department will choose the sites for afforestation and conduct plantation works and will monitor the growth of plants on site.

MoEFCC stipulates that appropriate compensatory plantation should be carried out to compensate for the vegetation loss due to cutting of trees for site clearing. For trees to be cut, sufficient compensatory plantation, about two times the number of trees felled, will be carried out. Comprehensive scheme for compensatory afforestation will be formulated by West Bengal Forest Department and submitted to the Central Government, but concrete methods such as trees composition and density of planting are not clarified as of the end of May 2018. In general, compensatory afforestation and reforestation will follow preferences for mixed plantations consisting of flowering shrubs and evergreen ornamental trees with less timber and fruit value. Under the plantation programme, more valuable tree species will be planted in place of existing non-valuable mono crops in the project area, where appropriate.

Figure 11.8-1 Positional Relationship between Project Site and Compensatory Afforestation Sites

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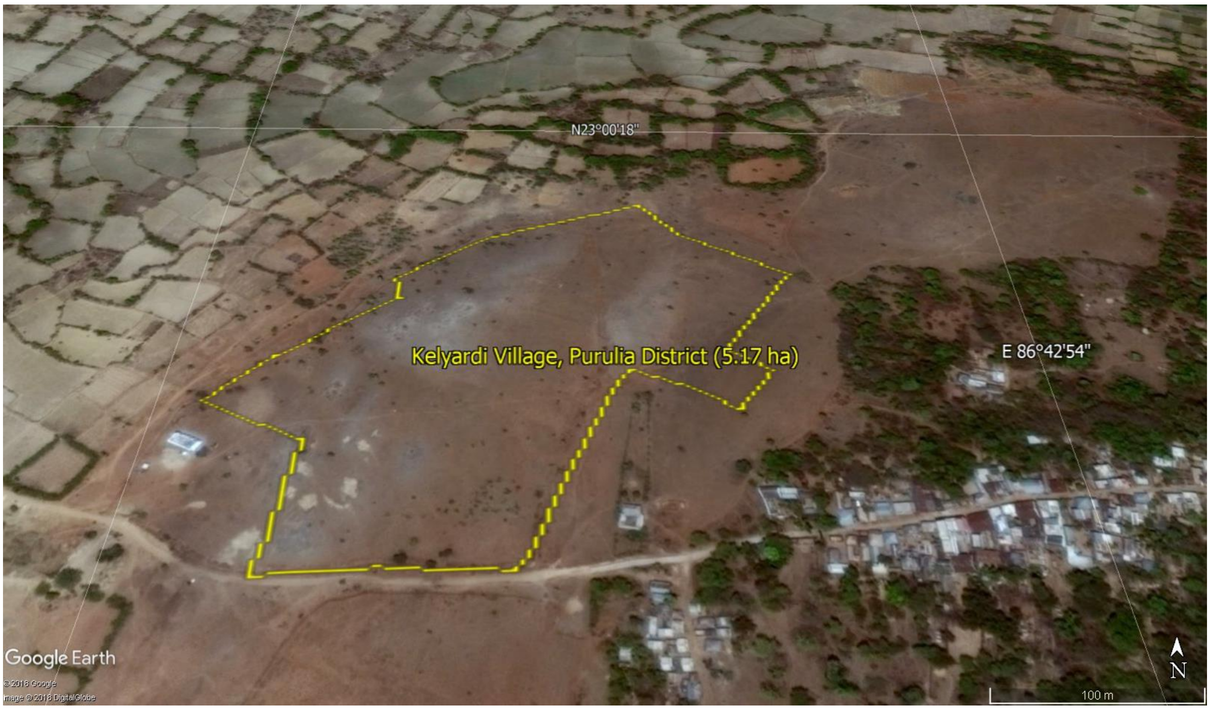
[24] http://forestsclearance.nic.in/viewreport.aspx?pid=FP/WB/HYD/8214/2014

Table 11.8-3 Details of land identified for Compensatory Afforestation

1. Purulia District

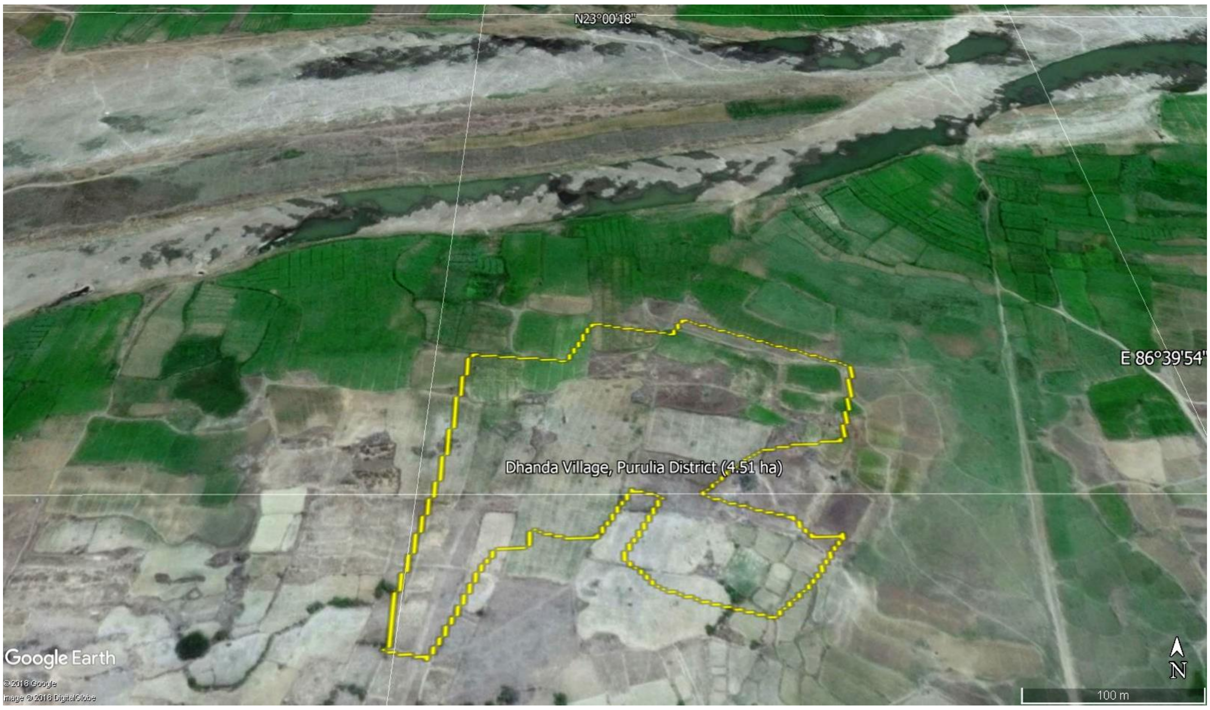
1.1. Village: Durku, Area (in ha.): 8.63, Khasra details: JL No. 4, Plot No. 412

1.2. Village: Kelyardi, Area (in ha.): 5.17, Khasra details: JL No. 106, Plot No. 441

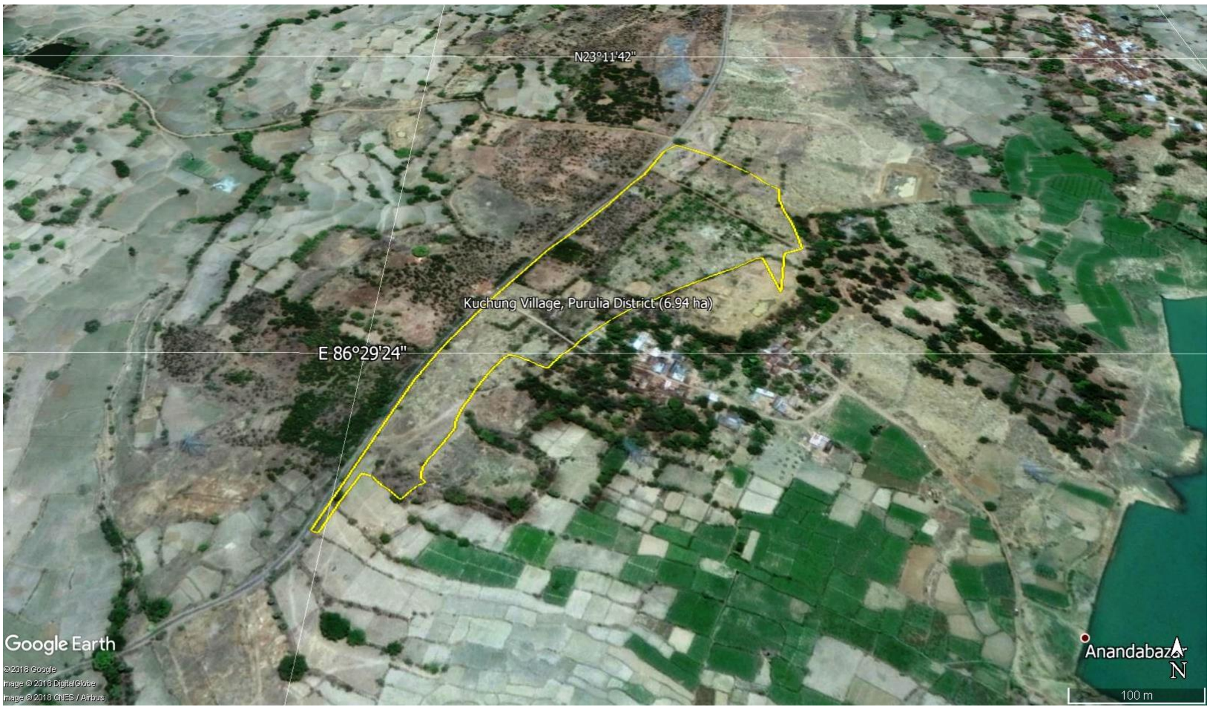


1. Purulia District (Continued)

1.3. Village: Dhanda, Area (in ha.): 4.51, Khasra details: Block- Manbazar II, JL- 261, Plot-288



1.4. Village: Kuchung, Area (in ha.): 6.94, Khasra details: Block-Puncha, JL-20, Plot-2489



1. Purulia District (Continued)

1.5. Village: Dhabani, Area (in ha.): 5.18, Khasra details: Block-Puncha, JL-8, Plot-789, and

1.6. Village: Dhabani, Area (in ha.): 4.39, Khasra details: Block-Puncha, JL-8, Plot-1717

1.7. Village: Hariharpur, Area (in ha.): 6.11, Khasra details: Block-Puncha, JL-30, Plot-1270

1. Purulia District (Continued)

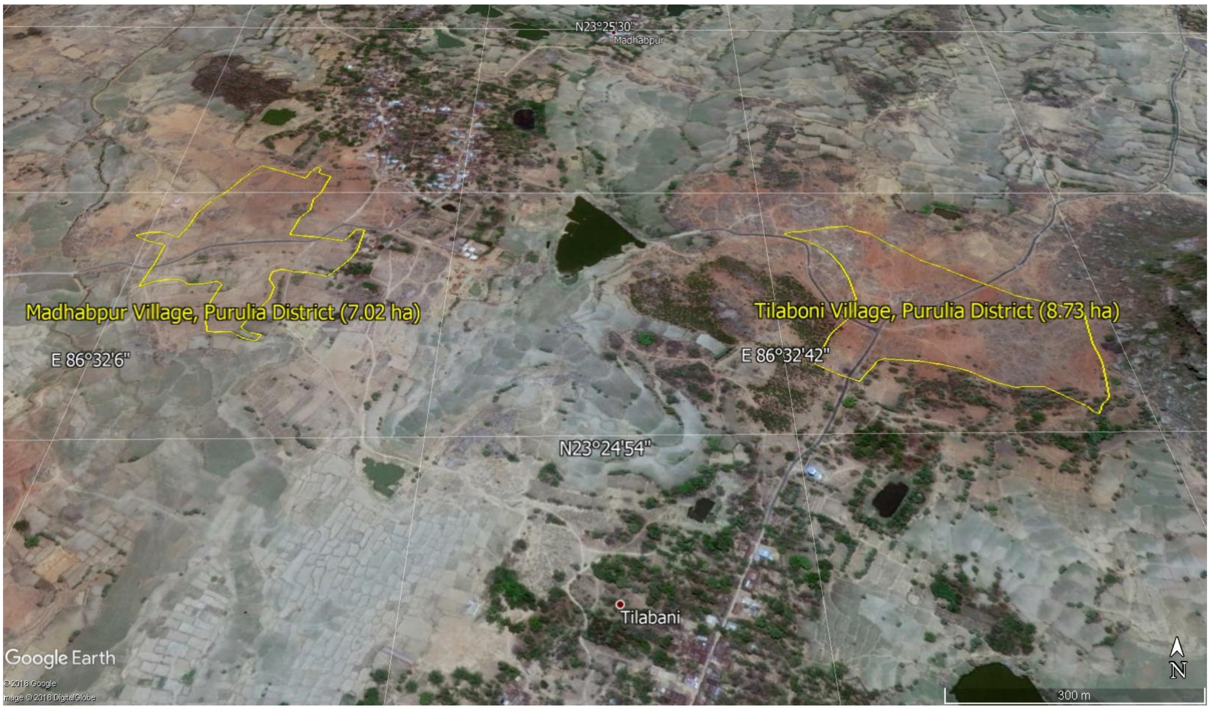
1.8. Village: Mangura Lalpur, Area (in ha.): 8.76, Khasra details: Block-Hura, JL-72, Plot-631

1.9. Village: Saharjuri, Area (in ha.): 9.66, Khasra details: Block-Hura, JL-22, Plot-487

1. Purulia District (Continued)

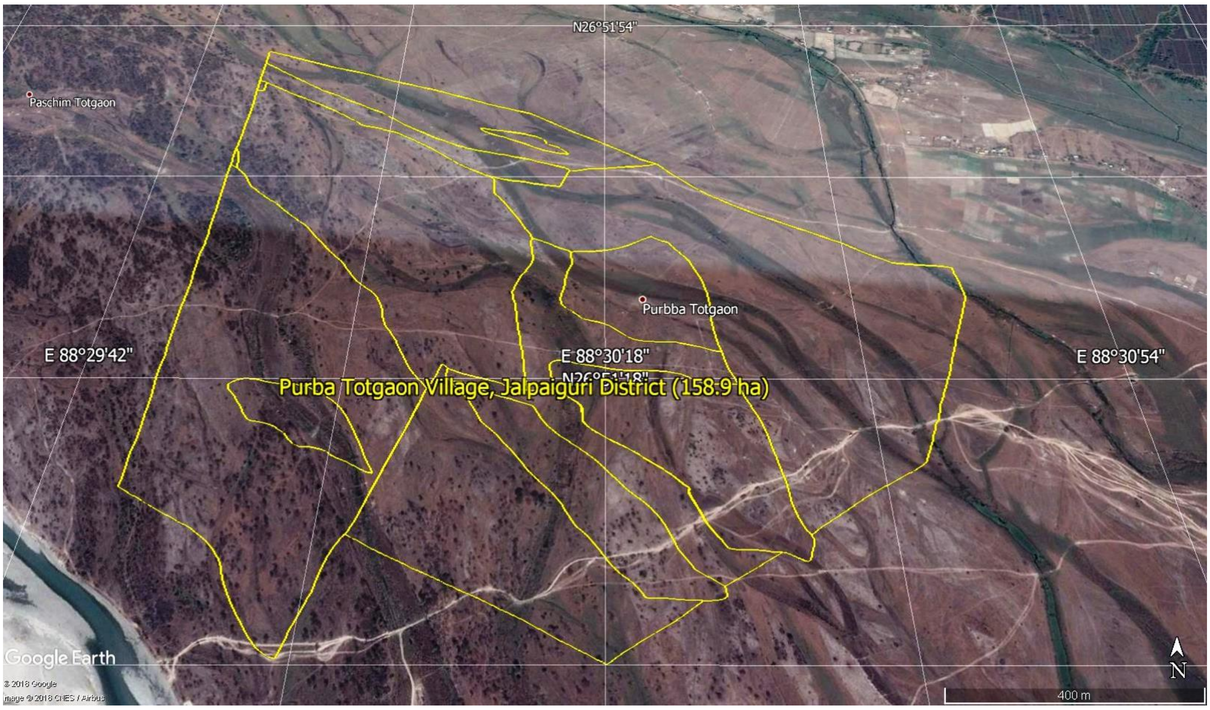
1.10. Village: Madhabpur, Area (in ha.): 7.02, Khasra details: Block-Hura, JL-5, Plot-2150, and

1.11. Village: Tilaboni, Area (in ha.): 8.73, Khasra details: Block-Hura, JL-4, Plot-1111



2. Jalpaiguri District

2.1. Purba Totgaon, Area (Total in ha.): 158.9, Khasra details: Block-Mal, JL-2, Plots - 24 to 38



As of the end of May 2018, detailed information on compensatory afforestation such as composition of tree species and planting density has not been clarified. Accordingly, in conformity with calculating method of carbon stock derived by JICA Project "The preparatory survey on West Bengal integrated forestry development and biodiversity conservation project" (2011)[25], estimated amount of carbon sequestration in Purulia and Jalpaiguri District by the compensatory afforestation on the Turga PSP are shown in Table 11.8-4 just as reference values. Note again that the estimated values never can compare directly at the moment with carbon stock amount in the forest land which will be diverted for the project due to luck of detailed information of the afforestation method.

Table 11.8-4 Estimated Carbon Sequestration by Compensation Afforestation
(100 t-CO$_2$ equiv.)

District (area in ha)	Afforestation model*	Age of tree (stand age)					
		5th y.o.	10th y.o.	15th y.o.	20th y.o.	30th y.o.	40th y.o.
Purulia (75.1 ha)	Plantation of Sal (*Shorea robusta*) and associate species in South Bengal	11.93	16.92	11.78	15.68	23.52	23.54
	Quick growing and small timber spp. plantation in South Bengal	11.94	16.92	11.78	15.68	23.52	23.53
Jalpaiguri (158.9 ha)	Miscellaneous Plantation in North Bengal	25.27	35.87	24.97	33.14	49.74	49.79
	Sal and associate plantation in North Bengal	25.31	35.90	25.01	33.25	49.73	49.73

source: JICA Study Team

* Note: Main condition of species, activities and allometric equations are given below;

- Plantation of Sal and associate species in South Bengal
  - Sal (*Shorea robusta*)
    Rotation: 40 years, Thinning: 5th, 15th, 25th years, Thinning grade: 50 %, Density of Stem Wood: 0.72,
    Stem Volume = 0.00389 - 0.27516*(DBH) + 6.90733*(DBH)^2,
    Girth = 7.776086957 + 2.232865613t -1.938735178*10-2*t2
  - Associates Plants
    Rotation: 50 years, Thinning: 5th, 15th, 25th years, Thinning grade: 50 %, Density of Stem Wood: 0.64
- Quick growing and small timber spp. plantation in South Bengal
  - *Terminalia belerica*, *Pterocapus marsupium* and *Terminalia chebula*
    Rotation: 50 years, Thinning: 5th, 15th, 30th years, Thinning grade: 50 %, Density of Stem Wood: 0.64
- Miscellaneous Plantation in North Bengal
  - *Tectona grandis*
    Rotation: 60 years, Thinning: 5th, 15th, 30th years, Thinning grade: 50 %, Density of Stem Wood: 0.72
  - Associates Plants
    Rotation: 60 years, Thinning: 5th, 15th, 30th years, Thinning grade: 50 %, Density of Stem Wood: 0.64
- Sal and associate plantation in North Bengal
  - Sal (*Shorea robusta*)
    Rotation: 60 years, Thinning: 5th, 15th, 30th years, Thinning grade: 50 %, Density of Stem Wood: 0.72,
    Above-ground biomass volume (kg/tree) = 0.00389- 0.27516*(DBH) + 6.90733*(DBH)^2,
    Girth = -5.761632384 ·10-3*(age)^2 +1.3260032968*(age) + 1.204879772
  - Associates Plants
    Rotation: 60 years, Thinning: 5th, 15th, 30th years, Thinning grade: 50 %, Density of Stem Wood: 0.64
- Planting interval is 2.5*2.5 m (1,600 plants ha^{-1})

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[25] http://libopac.jica.go.jp/images/report/12040226.pdf

11.9 ENVIRONMENTAL MONITORING PLAN

Apart from the EMP which is part of the EIA submitted to MoEFCC in June 2016 for EC, the major environmental impact, monitoring parameters, monitoring method, responsible organization and expenses for each item during the construction and operation phases for the Turga PSP and transmission line are listed in Table 11.9-1 and Table 11.9-2. Furthermore Draft Monitoring Format of Environmental and Social Considerations, and Environmental Check List are attached as Annex 11-3 and 11-4, respectively.

Table 11.9-1 Environmental Monitoring Plan for Turga PSP

No	Significant Impact to be Monitored	Monitored Parameter	Monitoring Method			Implementing Organization	Responsible Organization	Cost
			Method of Collecting and Analyzing Data	Location	Duration and Frequency			
Pre- / Construction Stage								
1	Air Quality	PM10, SO_2 and NO_2	Indian official analytical method	Upper Dam Site, Near Lower Dam Site, Baghmundi Village and Downstream of Lower Dam Site	3 times a year (Seasonal) and upon complaint	Contractor	WBSEDCL	Expenses included in contract cost by contractor
2	Water Quality	Surface water quality. Parameters provided in related Drinking water quality standards of India	Indian official analytical method	Upper reservoir dam site (River Water), Downstream of Upper Dam (River Water), Upstream of Upper Dam (River Water), Reservoir upstream of Lower Dam axis (River Water), Downstream of Lower Dam site, Ranga village (Ground water, bore well) near to upper reservoir, Gosiati Village (Ground water, bore well)	3 times a year (Seasonal)	Contractor	WBSEDCL	Expenses included in contract cost by contractor
3	Soil Quality	Total organic carbon, oil and grease contents	Indian official analytical method	Upper reservoir dam site, Dumping site of outlet, Auxiliary site and material exploitation site	Whenever necessary	Contractor	WBSEDCL	Expenses included in contract cost by contractor
4	Sediment	Color, odor and pH value	Visual investigation, smell and electrode method	Upper and lower reservoir dam	3 times a year (Seasonal)	Contractor	WBSEDCL	Expenses included in contract cost by contractor
5	Noise and Vibration	Noise and vibration level	On site measurement	Near Upper Dam Site, Near Lower Dam Site, Bagumundi Village and Downstream of Lower Dam Site	3 times a year (Seasonal)	Contractor	WBSEDCL	Expenses included in contract cost by contractor
6	Odor	Parameters given in Indian Standard	On site measurement	Worker’s Camp site	Monthly	Contractor	WBSEDCL	Expenses included in

No	Significant Impact to be Monitored	Monitored Parameter	Monitoring Method			Implementing Organization	Responsible Organization	Cost
			Method of Collecting and Analyzing Data	Location	Duration and Frequency			
								contract cost by contractor
7	Wastes	Solid and hazardous wastes	Visual investigation	Worker's Camp site and Construction sites	Monthly	Contractor	WBSEDCL	Expenses included in contract cost by contractor
8	Ecosystem	Witness record of wildlife migration including Asian elephant	Information sharing among the stakeholders	Every place in and around the project site	Monthly reporting	Reporting by contractor	WBSEDCL	Expenses included in contract cost by contractor
9	Topography and Geology	Changing topography and Possible erosions	On-site erosion and runoff	Construction areas (including access roads) and storage areas	Monthly	Contractor	WBSEDCL	Expenses included in contract cost by contractor
10	Land Acquisition	Compensatory afforestation	- Payment for seeds/ seedlings of compensation plantation by WBSEDCL - Record of compensation plantation by Forest Department	Purulia District and Jalpaiguri District	2 times a year during the plantation period	Forest Department, Government of West Bengal	Forest Department, Government of West Bengal	Forest Department, Government of West Bengal
		Lease / temporary use of non-forest private land	- Number and area of private land to be leased / used - Land owners - Record of consultation and lease contracts Actual payment for lease contracts	Private land for lease / temporary use as borrow area	During land lease / use process, (quarterly or other timing depending on the progress)	Contractor	WBSEDCL	Expenses included in contract cost by contractor
			- Local area development plan	Venues for such activities	During the activities (quarterly or other timing depending on the progress	Block Development Officer	BDO	- BDO
		Loss of livelihood means at non-forest WBSEDCL land	- Number of the affected households and people - Record of consultation Actual payment of	Kudna WBSEDCL land for borrow area where livelihood activities (crop, vegetable	Prior to the land use (quarterly or other timing depending on the progress)	Contractor	WBSEDCL	Expenses included in contract cost by contractor

No	Significant Impact to be Monitored	Monitored Parameter	Monitoring Method			Implementing Organization	Responsible Organization	Cost
			Method of Collecting and Analyzing Data	Location	Duration and Frequency			
			compensation	production, etc.) are conducted				
			Livelihood restoration / improvement activities	Venues for such activities	During the activities (quarterly or other timing depending on the progress	Block Development Officer	BDO	BDO
11	Poor people	Household economy (income and expenditure) of the affected people whose private land are leased out / temporarily used as borrow area, and who lose livelihood means accordingly	Local area development plan	Venues for such activities	During land lease / use process, (quarterly or other timing depending on the progress)	Block Development Officer	BDO	- BDO
		Local engagement	- Number of employed local people at the construction site Record of engagement and wage / salary payment	Construction site office	2 times a year	Contractor	WBSEDCL	- Cost included in the contract
		Local area development plan	- Number of activities Record of activity implementation	Block Development Office	2 times a year	Block Development Officer	BDO	- BDO
12	Ethnic Minority Groups and Indigenous People	Household economy (income and expenditure) of the affected people who lose livelihood means accordingly	- Local area development plan	Venues for such activities	During land lease / use process, (quarterly or other timing depending on the progress)	Block Development Officer	BDO	- BDO
		Local engagement	- Number of employed local people at the construction site - Record of engagement and wage / salary payment	Construction site office	2 times a year	Contractor	WBSEDCL	- Cost included in the contract
		Local area development plan	- Number of activities - Record of activity implementation	Block Development Office	2 times a year	Block Development Officer	BDO	- BDO

No	Significant Impact to be Monitored	Monitored Parameter	Monitoring Method			Implementing Organization	Responsible Organization	Cost
			Method of Collecting and Analyzing Data	Location	Duration and Frequency			
13	Local Economy	Household economy (income and expenditure) of the affected people who lose livelihood means accordingly	- Local area development plan	Venues for such activities	During the activities (quarterly or other timing depending on the progress	Block Development Officer	BDO	- BDO
		Local engagement	- Number of employed local people at the construction site - Record of engagement and wage / salary payment	Construction site office	2 times a year	Contractor	WBSEDCL	- Cost included in the contract
		Local area development plan	- Number of activities - Record of activity implementation	Block Development Office	2 times a year	Block Development Officer	BDO	- BDO
14	Land Use and Utilization of Local Resources	Compensatory afforestation	- Payment for seeds/ seedlings of compensation plantation by WBSEDCL - Record of compensation plantation by Forest Department	Purulia District and Jalpaiguri District	2 times a year during the plantation period	WBSEDCL and Forest Department, Government of West Bengal	Forest Department, Government of West Bengal	Forest Department, Government of West Bengal
		Lease / temporary use of non-forest private land as borrow area	- Number and area of private land to be leased / used - Number of the affected households and people - Record of consultation and lease contracts Actual payment for lease contracts	Private land for lease / temporary use as borrow area	During land lease / use process, (quarterly or other timing depending on the progress)	Contractor	WBSEDCL	Expenses included in contract cost by contractor

No	Significant Impact to be Monitored	Monitored Parameter	Monitoring Method			Implementing Organization	Responsible Organization	Cost
			Method of Collecting and Analyzing Data	Location	Duration and Frequency			
			- Number of the affected households and people - Record of consultation Actual payment of compensation	Kudna WBSEDCL land for borrow area where livelihood activities (crop, vegetable production, etc.) are conducted	Prior to the land use (quarterly or other timing depending on the progress)	Contractor	WBSEDCL	Expenses included in contract cost by contractor
15	Water Usage, Water Rights, etc.	Amount of irrigation water and drinking water	- Hearing from local people - Records at I&W Department Records at Public Health Engineering Department	- Random interview with local people - I&W Department Public Health Engineering Department	2 times a year (1 time during planting season, another 1 time before harvesting season)	Contractor	WBSEDCL	Expenses by Contractor
		Fish intake	Local area development plan	Venues for such activities	During the activities (quarterly or other timing depending on the progress	Block Development Officer	BDO	BDO
16	Existing Social Infrastructure and Services	Traffic volume	Record of numbers of cars being used	Project site	Continuous records	Contractor	WBSEDCL	Cost included in the contract
		Infrastructure developed under the project	Record of construction	Project site	2 times a year	Contractor	WBSEDCL	Expenses by Contractor
17	Local Conflicts of Interest	- Number of grievance redresses - Number of meetings held in the neighborhood	Record of complaints	Project site BDO Office	Quarterly	Contractor	WBSEDCL	Expenses by Contractor
18	Cultural Heritages	- Relocation of Hindu Temple	- Record of consultation Record of relocation process	Construction site office	2 times a year during the process	Contractor	WBSEDCL	Cost added to the contract
19	Infectious Diseases	- Number of diseases and infection - Results of health checkups	- Labor health records - Records of measures (such as number of mosquito net and medicine provided, depending on the situation)	Related institutions	Once a year	Contractor	WBSEDCL	Cost included in the contract
20	Work Environment	- Health and Safety	- Observation and inspection	All work places	Daily, monthly	Contractor	WBSEDCL	Cost included in the contract

No	Significant Impact to be Monitored	Monitored Parameter	Monitoring Method			Implementing Organization	Responsible Organization	Cost
			Method of Collecting and Analyzing Data	Location	Duration and Frequency			
21	Accidents	- No. of traffic accidents - No. of accidents human and fire cases	- Record of accidents	Contractor's office	Continuous records	Contractor	WBSEDCL	Expenses by Contractor
22	Cross-boundary impacts and Climate change	- Amount of CO_2 emissions	- Record of machinery maintenance	Contractor' officer	Continuous records (every day)	Contractor	WBSEDCL	Expenses by Contractor
		- Periodical tree growing monitoring	- Monitoring record	Compensatory afforestation area	2 times a year, for 2 years (see Note 2)	DFO	DFO	WBSEDCL
Operation Stage								
1	Waste	- Solid and hazardous wastes	- Visual investigation	Worker's Camp site and Construction sites	Monthly	WBSEDCL	WBSEDCL	WBSEDCL
2	Work Environment	- Health and Safety	- Observation and inspection	All work places	Daily, monthly	WBSEDCL	WBSEDCL	WBSEDCL
3	Accidents	- Counter measures for traffic, labor, fire accidents	- Record of accidents - Check of Cautionary signs placed on required points on site.	Project site	Continuous records	WBSEDCL	WBSEDCL	WBSEDCL

source: JICA Study Team

Note 1: The format is given according to the JICA Guidelines.

Note 2: Base a supposition on plantations of Sal (S*horea robusta*) and associate species for compensatory afforestation. Monitoring frequency and years are decided referencing Hemant Kumar Pandey (2013, http://www.teriuniversity.ac.in/mct/pdf/assignment/Hemant-Kumar-Pandey.pdf).

Table 11.9-2 Environmental Monitoring Plan for Transmission Line

No	Items (Impacts)	Monitored Parameter	Monitoring Method			Implementing Organization	Responsible Organization	Cost
			Method of Collecting and Analyzing Data	Location	Duration and Frequency			
Pre- / Construction Stage								
1	Air Quality	PM10, SO_2 and NO_2	Indian official analytical method・	Upper Dam Site, Near Lower Dam Site, Bagumundi Village and Downstream of Lower Dam Site	3 times a year (Seasonal) and upon complaint	Contractor	WBSETCL	Expenses included in contract cost by contractor
2	Water Quality	Surface water quality. Parameters provided in related Drinking water quality standards of India	Indian official analytical method	Upper reservoir dam site (River Water), Downstream of Upper Dam (River Water), Upstream of Upper Dam (River Water), Reservoir upstream of Lower Dam axis (River Water), Downstream of Lower Dam site, Ranga village (Ground water, bore well) near to upper reservoir, Gosiati Village (Ground water, bore well)	3 times a year (Seasonal)	Contractor	WBSETCL	Expenses included in contract cost by contractor
3	Noise and Vibration	Color, odor and pH value	Visual investigation, smell and electrode method	Upper and lower reservoir dam	3 times a year (Seasonal)	Contractor	WBSETCL	Expenses included in contract cost by contractor
4	Ecosystem	Witness record of wildlife migration including Asian elephant	Information sharing among the stakeholders	Every place in and around the project site	Monthly reporting	Reporting by contractor	WBSETCL	Expenses included in contract cost by contractor
5	Topography and geology	Solid and hazardous wastes	Visual investigation	Worker's Camp site and Construction sites	Monthly	Contractor	WBSETCL	Expenses included in contract cost by contractor
6	Land Acquisition	Compensation afforestation	- Payment for seeds/ seedlings of compensation plantation by WBSEDCL Record of compensation plantation by Forest Department	Not decided yet	2 times a year during the plantation period	Forest Department, Government of West Bengal	Forest Department, Government of West Bengal	Forest Department, Government of West Bengal
7	Land Use and Utilization of	Compensation afforestation	- Payment for seeds/ seedlings of	Not decided yet	2 times a year during the	Forest Department, Government of	Forest Department,	Forest Department,

No	Items (Impacts)	Monitored Parameter	Monitoring Method			Implementing Organization	Responsible Organization	Cost
			Method of Collecting and Analyzing Data	Location	Duration and Frequency			
	Local Resources		compensation plantation by WBSEDCL Record of compensation plantation by Forest Department		plantation period	West Bengal	Government of West Bengal	Government of West Bengal
8	Existing Social Infrastructure and Services	Traffic volume	Record of numbers of cars being used	Project site	Continuous records	Contractor	WBSETCL	Cost included in the contract
9	Infectious Diseases	- Number of diseases and infection Results of health checkups	- Labor health records Records of measures (such as number of mosquito net and medicine provided, depending on the situation)	Related institutions	Once a year	Contractor	WBSETCL	Cost included in the contract
10	Work Environment	Health and Safety	Observation and inspection	All work places	Daily, monthly	Contractor	WBSETCL	Cost included in the contract
11	Accidents	- No. of traffic accidents No. of accidents human and fire cases	Record of accidents	Contractor's office	Continuous records	Contractor	WBSETCL	Expenses by Contractor
12	Cross-boundary impacts and Climate change	- Amount of CO_2 emissions	Record of machinery maintenance	Contractor' officer	Continuous records (every day)	Contractor	WBSETCL	Expenses by Contractor
Operation Stage								
1	Work Environment	- Health and Safety	Observation and inspection	All work places	Daily, monthly	WBSETCL	WBSETCL	WBSETCL
2	Accidents	- Counter measures for traffic, labor, fire accidents	- Record of accidents Check of Cautionary signs placed on required points on site.	Project site	Continuous records	WBSETCL	WBSETCL	WBSETCL

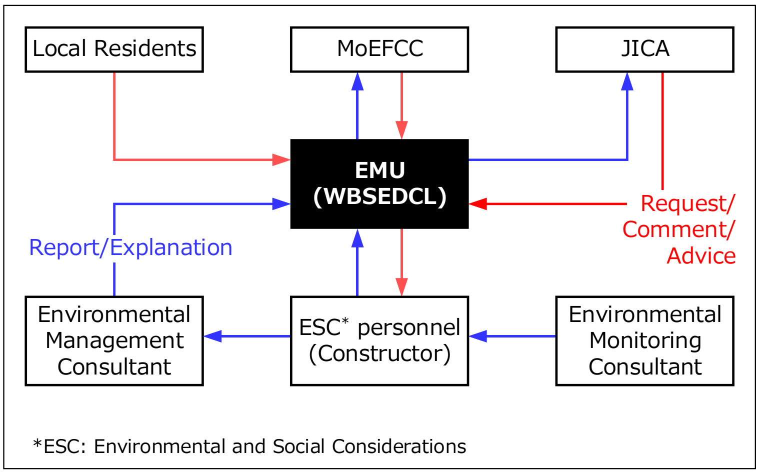
source: JICA Study Team

note: The format is given according to the JICA Guidelines.

11.10 IMPLEMENTATION MECHANISM

11.10.1 Construction Period

During the construction period, WBSEDCL, the implementation organization of this project, carefully grasps all the construction work under the supervision of the consultant, and let construction contractors fully understand the necessity of environmental conservation and conduct adequate the conservation measures. In order to achieve this objective, prior to the construction work, an environmental management unit (tentatively named "EMU") will organize consisting of persons in charge of WBSEDCL and assign experts dedicated to environmental management work. EMU shall include environmental sanitation teams, disaster control teams, wildlife protection teams, complaint response teams, etc. In addition, the person responsible for the wildlife protection will join the Stakeholder Committee organized in preparation for encounters with elephants. Also prior to construction, EMU will discuss environmental conservation measures with construction supervisors and contractors, and establishes appropriate environmental conservation measures methods. Once construction is started, the inflow of a large number of construction workers and construction vehicles is assumed, so the complaint response team treats all requests from local residents and takes appropriate measures. In addition, the EMU will explain the construction outline, construction schedule, environmental conservation measures to neighboring municipalities, incorporate the needs of the residents, and modify and implement environmental conservation measures as necessary. On the other hand, in order to attach consent to implementation of the environmental management plan and confirmation of necessary environmental conservation measures project, the contractor must periodically submit the report to the supervisor of the construction and the department in charge of the environmental management organization. The department in charge of the environmental management organization regularly holds briefing sessions for the local municipalities, grasps their complaints, reports on their complaints and monitoring results to MoEFCC, JICA and related organizations (such as DFO and BDO offices). In the unlikely event of environmental problems accompanying construction, EMU will promptly hear opinions from the contractor and investigate the cause. Figure 11.10.1-1 shows that the implementation structure and management flow of environmental monitoring.

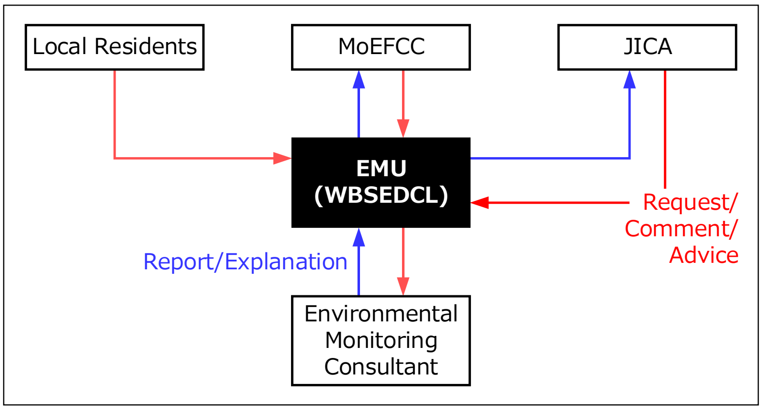


source: JICA Survey Team

Figure 11.10.1-1 Implementation system of Environment Management and Monitoring in the Construction Phase

11.10.2 Operation Period

EMU will function continuously from the construction period and carry out environmental management issues properly. In addition, environmental consultants are employed as executor of concrete affairs. EMU will report implementation and progress of the environmental management plan and monitoring to the chief executive of the project according to specified procedure. In the meantime, the complaint response team in EMU will grasp requests and complaints of local resident thorough regular meetings. The meeting records with local residents' opinions will be reported to MoEFCC, JICA and related organizations (see Figure 11.10.2-1).



source: JICA Survey Team

Figure 11.10.2-1 Implementation system of Environment Management and Monitoring in Operation Phase

11.11 STAKEHOLDER MEETINGS

11.11.1 Key Informant Interview

A key informant interview with Panchayats of Ajodhya and Baghmundi area were conducted in October 2017. Representatives from two Gram Panchayat Offices welcomed the project implementation and expressed their willingness toward the local consultations planned in November 2017 and February 2018. They also reminded that the project should go along with local area development activities as they stated in the Public Hearing that was officially conducted in February 2016 (See the proceedings as in the Annex 11-5 "Volume-IV: Report on Proceedings of Public Hearing, and Annex 11-6 Volume-II: SIA Report). The participants and contents of discussions in the key informant interviews are summarized as in the table below.

Table 11.11.1-1 Outline of Key Informant Interview (Representatives' Meeting)

Date	12 October, 2017
Venue	Ajodhya Gram Panchayat Office and Baghmundi Development Office
Time	10:00 - 11:00, 15:00 - 16:00 (Note) Two meetings were held separately at upper reservoir area and lower reservoir area due to geographical remoteness.
Participants	Local representatives ・ Ajodhya Gram Panchayat ・ Baghmundi Gram Panchayat

	・ Baghmundi Panchayat Samity ・ Local residents Administrative Officers ・ Block Development Officer ・ Sub-inspector, Bagmundi Police Station Executing Agency (WBSEDCL) ・ Assistant Chief Engineer, Kolkata Headquarters ・ Assistant Engineer, Baghmundi Office JICA Study Team ・ Environment Sub-team ・ WAPCOS (25 people in total)
Agenda	・ Explain the project outline ・ Share the anticipated impact ・ Survey schedule and contents ・ Request for cooperation toward the survey implementation
Opinions	・ Willing to have new project, and to support the upcoming survey. ・ Benefits brought by the construction of former PPSP were not felt suffficient to the local communities. ・ Local impacts such as infrastructure development should have been provided more in former PPSP. ・ More job opportunities are expected. ・ Better health care service is expected along with the implementation of new project. ・ Better communication network is expected. ・ Better drinking water provision is expected.

source: JICA Study Team

11.11.2 Group Interviews with Local People

Group interviews with local people were conducted in November 2017. Due to the remoteness and limited availability of transportation means between upper reservoir area and lower reservoir area, the interviews were conducted in two different venues: Ajodhya Gram Panchayat Office (upper reservoir area) and Baghmundi Development Office (lower reservoir area). To secure variety of participants from complex and diverse local societies, BDO called self-help groups and Gram Panchayat Office by phone, local communicators (youth volunteers) informed local people, and villagers shared information among them, which made it possible for SCs, STs and general caste to attend the meeting. The interviews were made by village to learn specific local information. Female and male were separately interviewed to collect gender specific issues and opinions on the project.

The project outline, anticipated impacts and survey schedule were shared in the interviews. Stakeholders were already well aware of the likely impacts caused by the project implementation as they were informed in the Public Hearing of February 2016. They were also aware of and expected positive impacts on local economy as Purulia PSP has brought during its construction period and since its operation in 2008. The participants for the group interviews and contents of discussions are summarized as in the following tables. The minutes of meetings are attached to this report as in the Annex 11-7.

Table 11.11.2-1 Outline of Group Interview with Local Residents (Upper Reservoir Area)

Date	27 November, 2017
Venue	Ajodhya Gram Panchayat Office
Time	11:40 – 15:30
Participants	Local residents ・ 27 people (9 males and 18 females from 6 villages): 10 groups

	Administrative Officers ・ Block Development Officer (1) ・ Sub-inspector, Bagmundi Police Station (1) Executing Agency (WBSEDCL) ・ Assistant Engineers, Kolkata Headquarters (2) ・ Assistant Engineer, Baghmundi Office (1) JICA Study Team ・ Team members (3) ・ Local consultant (WAPCOS) (4) (60 people in total)
Agenda	・ Explain the project outline ・ Share the anticipated impact ・ Learn the local socioeconomic status ・ Hear individual opinions on the project implementation ・ Impact of former PPSP
Opinions	・ Willing to have new project. ・ Vocational trainings such as tailoring are expected. It will help get out of dependency on forest resources. ・ Purulia PSP brought electricity, upgraded roads, and improved communication network. More guests on picnic keep coming to visit reservoirs, which gives local people opportunities to raise their income. ・ Improvement of irrigaiton water and drinking water is expected, since accute water crisis during summer occurs. ・ Information on the local area development measures should be shared.

source: JICA Study Team

Table 11.11.2-2 Outline of Group Interview with Local Residents (Lower Reservoir Area)

Date	28 November, 2017
Venue	Baghmundi Gram Panchayat Office
Time	11:10 – 16:00
Participants	Local residents ・ 47 people (7 males and 40 females from 10 villages): 12 groups Administrative Officers ・ Joint Block Development Officer (1) Executing Agency (WBSEDCL) ・ Additional Chief engineer & Pojrect Site in Charge (PPSP) (1) ・ Assistant Engineers, Kolkata Headquarters (2) ・ Assistant Engineer, Baghmundi Office (1) JICA Study Team ・ Team member (1) ・ Local consultant (WAPCOS) (3) (36 people in total)
Agenda	・ Explain the project outline ・ Share the anticipated impact ・ Learn the local socioeconomic status ・ Hear individual opinions on the project implementation ・ Impact of Purulia PSP
Opinions	・ Willing to have new project. More development is expected. ・ Purulia PSP did not bring benefits to all local residents. ・ Plastic plates which picnic tourits bring for meals should be prohibitied. Instead, organic plates created by local people can be sold, which generates local income. ・ Hospital shoulld be developed. ・ Information on the local area development measures should be shared.

source: JICA Study Team

11.11.3 Public Consultation

Another stakeholder meeting, public consultation was conducted in February 2018. Following the group interviews of November 2017, BDO called self-help groups comprised of locals and Gram Panchayat Office, local communicators informed residents, and villagers shared information among them to secure participants from SCs, STs and general caste. The project outline, anticipated impacts, livelihood restoration activities, land area development activities, and WBSEDCL's accumulated CSR activities associated with PPSP were presented in the meeting. Participants requested ecological restoration, construction of bathing ghat for locals, drinking water facilities, job generation and vocational training, infrastructure improvement of the temple under dam axis. The outline of discussions is summarized in the following tables. Presentation material is attached as Annex 11-8[26], and details of issues raised by the participants and responses from WBSEDCL are recorded in the minutes attached to this report with attendance list (Annex 11-9).

Table 11.11.3-1　Outline of Public Consultation (Upper Reservoir Area)

Date	21February 2018
Venue	Ajodhya GP Office
Time	11:00 to 13:00
Participants	Local residents ・ 41 people (19 males and 22 females from 16 villages) Administrative / Technical Officers ・ Block Development Officer (1) ・ Forest Officer and Range Officer (Ajodhya Range Office) (2) Executing Agency (WBSEDCL) ・ Assistant Engineer, Kolkata Headquarters (1) ・ Assistant Engineer, Baghmundi Office (1) JICA Study Team ・ Team members (4) ・ Local consultant (WAPCOS) (3) (53 people in total)
Agenda	Share the results of supplemental environmental survey (focused on elephant survey) and social survey Propose protection measures for elephant Present livelihood improvement activities and local area development plan that reflect feedbacks from group interview of Nov 2017 Present mitigation measures taken in the planning of Turga PSP Share WBSEDCL's CSR activities for PPSP and good practices of PPSP Q&A and opinions from participants
Opinions	・ Happy about the fact that most of the suggestions raised in the group interview of Nov 2017 are well taken and reflected into the plan. All the countermeasures should be realized. ・ Welcome the proposed project as it will lead to better earning sources although collection of NTFPs in the project site will be affected.

source: JICA Study Team

Table 11.11.3-2　Outline of Public Consultation (Lower Reservoir Area)

Date	22 February 2018
Venue	Baghmundi GP Office
Time	12:00 to 14:00
Participants	Local residents ・ 56 people (5 males and 51 females from 10 villages) Administrative / Technical Officers ・ Block Development Officer (1) ・ Forest Officer and Range Officer (Baghmundi Range Office) (2) Executing Agency (WBSEDCL) ・ Additional Chief engineer & Pojrect Site in Charge (PPSP) (1) ・ Assistant Engineer, Kolkata Headquarters (1)

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[26] It is English version which is attached to this report. It was presented in both English and Bengali as well and verbally explained in Bengali. To the illiterate people. Youth volunteer helped them interpret in local language to ensure their understandings.

	・ Assistant Engineer, Baghmundi Office (1) JICA Study Team ・ Team members (4) ・ Local consultant (WAPCOS) (3) (68 people in total)
Agenda	Share the results of supplemental environmental survey (focused on elephant survey) and social survey Propose protection measures for elephant Present livelihood improvement activities and local area development plan that reflect feedbacks from group interview of Nov 2017 Present mitigation measures taken in the planning of Turga PSP Share WBSEDCL's CSR activities for PPSP and good practices of PPSP Q&A and opinions from participants
Opinions	・ Request for a bathing ghat for women, drainage system and improvement of drinking water facilities. ・ Request for job opportunities, equipment and skill development training ・ Request for relocation of temple.

source: JICA Study Team

11.12 NECESSITY OF LAND ACQUISITION AND RESETTLEMENT

11.12.1 Land Acquisition and Requisition

The land acquisition and requisition under the final project design will be 292 ha for the construction of the pumped storage power plant and its relevant facilities, and another 7.82 ha for the ROW of the transmission lines and towers.

The following table shows the land usages for the project and their present land category.

Table 11.12.1-1 Usage of the Project Land & their Present Use

(Unit: ha)

Component		Total land for acquisition and requisition	Land category		
			Forest land	Non-forest land	
				Government	Private
1. Turga PSP		291.416	233.416	0	0
a.	Submergence area (lower & upper reservoirs)	146.589	112.900	33.689	0
b.	Civil structures	16.332	16.332	0	0
c.	Construction facilities	18.387	18.387	0	0
d.	Stockpile, processing and disposal area	18.600	18.600	0	0
e.	Project roads (permanent & temporary)	21.970	21.970	0	0
f.	Rock quarry area	18.600	18.600	0	0
g.	Borrow area	42.401	18.090	9.55	14.761
h	Other project components	8.537	8.537	0	
2. ROW of Transmission line		7.820	7.820	0	0
3. TOTAL		299.236	241.236	43.239	14.761

source: WBSEDCL

note 1: The non-forest land for the submergence area, 33.689 ha, is the irrigation reservoir presently located where lower reservoir will be developed. The reservoir belongs to the I&W Dept.

Note 2: The borrow area (24.311 ha) is comprised of WBSEDCL's former borrow area used in the construction of Purulia PSP (9.55 ha) and private land (14.761 ha).

Note 3: Breakups of each component are different from those written in the DPR and EIA submitted to the GOI in 2016. The figures shown in the above table are the latest and final ones that reflect the results of MOEFCC's site inspection conducted in November 2017.

11.12.2 Procedures for Land Diversion

Forest Clearance (FC) from the GOI for the 234 ha of forest land, which is expected for the construction of Turga PSP and related facilities, is part of the Environmental Clearance (EC) and pre-requisite for the project as stipulated in the relevant legislative procedures in India. The Forest Advisory Committee meeting was held on 25 January 2018, and the issuance of the Stage-I clearance is expected shortly. After obtaining Stage-I FC, WBSEDCL shall take necessary steps to obtain Stage-II FC from MoEFCC.

As per the FC for ROW of transmission lines and towers, given the condition that the clearance area remains small-scale, procedures for FC are not required prior to the construction, and it will be obtained from the Forest Department, Government of West Bengal. It is WBSETCL which will apply the FC, and expenses for compensatory afforestation will be paid by WBSEDCL.

Apart from the above two different FCs obtained from two different official levels, the usage of former borrow area for the construction of Purulia PSP, which WBSEDCL owns the land, and that of private area remain uncertain. Once they find it necessary to utilize such non-forest land, the implementation schedule will be fixed. The non-forest government land belongs either to WBSDEDCL or the I&W Dept. The irrigation reservoir that belongs to the I&W Dept. will be expanded as the lower reservoir. Once the FC is issued, WBSEDCL will take necessary actions to transfer the land right from I&W Dept. prior to the construction work commences. The rest non-forest government land belongs to WBSEDCL, all of which were used as borrow area for the construction of Purulia PSP.

11.12.3 Alternative Land for Compensatory Afforestation

WBSEDCL requested to the Land Department of West Bengal State to find available government land for compensatory afforestation for the diversion of 234ha forest land. The Land Department proposed a long list of land totaling 400ha, all of which were visited by the Divisional Forest Officers (DFOs) from the Forest Department (FD) of West Bengal State to confirm if they are suitable for plantation and their availability. Consequently alternative 234 ha have been earmarked (75.1 ha in Purulia District and 158.9 ha in Jalpaiguri District) by them.

11.12.4 Resettlement

There is no involuntary resettlement anticipated by such land use under the project.

11.13 LEGAL FRAMEWORK FOR LAND ACQUISITION AND REQUISITION, AND RESETTLEMENT

11.13.1 Institutional, legal and policy framework in India

Major legal documents on land acquisition, resettlement and compensation related to the Project are listed in Table 11.13.1-1 and Table 11.13.1-2

Table 11.13.1-1 Central Acts under Land Acquisition and Requisition, Resettlement and Compensation

Issue	Name of Legal Documents	Year (last amendment)
Land Acquisition, Resettlement and Rehabilitation	Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	2013
	Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Amendment) Ordinance, 2015	2015
	Land Acquisition Act (repealed)	1894
	National Rehabilitation and Resettlement Policy (repealed)	2007
Living Rights	The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006	2006
	The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Amendment Rules, 2012	2012
Right of Way Compensation	Indian Telegraph Act, 1885	2006
	The Electricity Act, 2003	2003

source: JICA Sturdy Team

Table 11.13.1-2 State Acts under Land Acquisition and Requisition, and Compensation

Issue	Name of Legal Documents	Year (last amendment)
Land Acquisition and Requisition, and Compensation	Land Acquisition (West Bengal Amendment) Act, 1997	2011
	The West Bengal Land (Requisition and Acquisition) Re-Enacting Act, 1977	2011
	The West Bengal Land (Requisition & Acquisition) Act, 1948 ‘Act II of 1948)	2011
	The West Bengal Land Acquisition Act, 1894 (Act I, 1894)	2011
	The West Bengal Land Development and Planning Act, 1948	1948
	The West Bengal Acquisition and Settlement of Homestead Land Act, 1969	1969
	The West Bengal Requisitioned Land (continuance of Power) Act, 1951 (Act VIII of 1951)	1951

source: JICA Sturdy Team

(1) Land Acquisition, Rehabilitation and Resettlement

Land Acquisition Act stipulates the official procedures for land acquisition for public purpose. The National Rehabilitation and Resettlement Policy describes the necessity to avoid involuntary resettlement caused by land acquisition promote minimization of adverse impact, and examine countermeasures for protecting socially vulnerable people. These two legal documents were repealed and replaced by the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013. The new Act stipulates not only land acquisition but resettlement, rehabilitation and fair compensation[27], based on which project proponents are mandated to conduct a social impact assessment (SIA) and develop a social impact management plan (SIMP) except those cases without resettlements. The project affected people are entitled to appeal for redress and grievance to the District Collector within 60 days after the implementation of SIA. The rights of SCs and STs are well secured and protected under the Act.

(2) Forest Rights

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act was

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[27] The new Act is not applied to the land acquisition stipulated in the following laws: The Land Acquisition (Mines) Act, 1885, The Indian Tramways Act, 1886, The Damodar Valley Corporation Act, 1948, The Resettlement of Displaced Persons (Land Acquisition) Act, 1948, The Requisitioning and Acquisition of Immovable Property Act, 1952, The National Highways Act, 1956, The Coal Bearing Areas Acquisition and Development Act, 1957, The Ancient Monuments and Archaeological Sites and Remains Act, 1958, The Atomic Energy Act, 1962, The Petroleum and Minerals Pipelines (Acquisition of Right of User in Land) Act, 1962, The Metro Railways (Construction of Works) Act, 1978, The Railways Act, 1989, The Electricity Act, 2003.

stipulated in 2006 to secure the forest rights of STs and others who are traditional forest dwellers.

(3) ROW Compensation

The project proponents shall do as little damage as possible to the properties where telegraph lines are placed and maintained. They shall pay full compensation to all persons interested for any damage, detriment and inconvenience caused by the project.

Where any trees standing or lying near overhead lines, structures and others interrupt (or likely to interrupt), the project proponents shall apply to the relevant authority for removing trees or dealing with in such other way. The persons interested in the tree shall be awarded with such compensation as deemed reasonable or the recovery of the same.

11.13.2 Key Principles of JICA Policies on Involuntary Resettlement

The key principle of JICA policies on involuntary resettlement is summarized below.

- Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
- When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.
- People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.
- Compensation must be based on the full replacement cost as much as possible.
- Compensation and other kinds of assistance must be provided prior to displacement.
- For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.
- In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.
- Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.
- Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Above principles are complemented by World Bank OP 4.12, since it is stated in the JICA Guidelines that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows.

- Affected people are to be identified and recorded as early as possible to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.
- Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.
- Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.
- Provide support for the transition period (between displacement and livelihood restoration.
- Attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.
- For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed Financial Plan etc.

11.13.3 Differences between Indian Legislation and JICA Policies

In addition to the compliance with the Indian laws and regulations, social considerations that meet the standards required in the JICA Guidelines are expected as pre-requisites if the WBSEDCL seeks an opportunity of obtaining a Japanese ODA loan to implement the project. Differences between the Indian legal documents and the JICA Guidelines are described in the table below.

Table 11.13.3-1 Differences between Indian Legislation and JICA Guidelines

Issue	Provisions in Indian Laws	JICA Guidelines for Environmental and Social	Differences
Avoidance of involuntary resettlement	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.	No gap
Minimization of involuntary resettlement	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken.	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken.	No gap

Issue	Provisions in Indian Laws	JICA Guidelines for Environmental and Social	Differences
Restoration and improvement of livelihoods	・ A family as a unit will receive R&R grant over and above the compensation and those who are not entitled to compensation. *Section: 31* ・ Homeless entitled to constructed house, land for land in irrigation projects in lieu of compensation, in case of acquisition for urbanization 20% of developed land reserved for owners at a price equal to compensation' jobs or onetime payment or annuity for 20 years' subsistence grant, transportation, land and house registered on joint name husband and wife, etc. *Second Schedule* ・ Provision for infrastructural amenities in resettlement areas. *Section: 32 and Third Schedule*	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.	No gap
Compensation at replacement value	・ The Collector shall take possession of land after ensuring that full payment of compensation as well as rehabilitation and resettlement entitlements are paid within three months for the compensation and a period of six months for the monetary part of rehabilitation and resettlement entitlements. *Section: 38. (1)* ・ Recognizes 3 methods and whichever is higher will be considered which will be multiplied by a factor given in *The First Schedule*. Compensation given earlier will not be considered; If rates not available floor price can be set; Steps to be taken to update the market value. *(Section 26 and The First Schedule)* Provision for employment, fishing rights, annuity policy etc. *(Section: 31 and The Second Schedule)*	Compensation must be based on the full replacement cost as much as possible. Replacement cost is the amount calculated before displacement which is needed to replace an affected asset without depreciation.	It is necessary to make sure that the total amount of compensation is equivalent to the full replacement value (without depreciation) or more.
Compensation prior to displacement	・ The Collector shall be responsible for ensuring that the rehabilitation and resettlement process is completed in all its aspects before displacing the affected families. *Section: 38. (2)*	Compensation and other kinds of assistance must be provided prior to displacement.	No gap
Participation and consultation	・ Consultation with Panchayat, Municipality, to carry out SIA. *(Section: 4. (1))* ・ Public hearing for Social Impact Assessment. *Section: 5.* ・ Discussion on and Public hearing for Draft Rehabilitation and Resettlement Scheme *Section: 16. (4). and (5).*	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.	Stakeholder meeting shall be held at two stages during the planning period: scoping draft and draft final report.
		In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	
Grievance redress mechanism	・ Establishment of Land Acquisition, Rehabilitation and Resettlement Authority for disposal of disputes relating to land acquisition, compensation, rehabilitation and resettlement. *Section: 51. (1). and Section: 64.* ・ The Requiring Body or any person aggrieved by the Award passed by an Authority under section 69 may file an appeal to the High Court within sixty days from the date of award. *Section: 74. (1). and (2).*	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	No gap
Resettlement plan	・ Preparation of Rehabilitation and Resettlement Scheme including time line for implementation. *Section: 16. (1) and (2).* ・ Separate development plans to be prepared. *Section 41*	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public.	No gap
		For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, an abbreviated resettlement plan is to be prepared. (WB OP4.12 para.25)	ARAP needs to be developed if the given condition is applicable.
Information	・ The draft Rehabilitation and Resettlement	For projects that entail large-scale	No gap

Issue	Provisions in Indian Laws	JICA Guidelines for Environmental and Social	Differences
disclosure	Scheme prepared shall be made known locally by wide publicity in the affected area and discussed in the concerned Gram Sabhas or Municipalities and in website. *Section: 16. (4)* ・ The approved Rehabilitation and Resettlement Scheme to be made available in the local language to the Panchayat, Municipality or Municipal Corporation and in website. *Section: 18.*	involuntary resettlement, resettlement action plans must be prepared and made available to the public. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.	
Implementation of social impact assessment	・ Social Impact Assessment is must before taking final decision on acquisition of land followed by preparation of R&R Scheme. ・ While the policy does not specify any requirement for screening of the project at an early stage for resettlement impacts and risks, it requires carrying out social impact assessment before any proposal for land acquisition *(Section-16).* ・ Carry out census of affected people and their assets to be affected, livelihood loss and common property to be affected; R&R scheme including time line for implementation. *(Section: 16. (1) and (2)).*	Affected people are to be identified and recorded as early as possible to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers who wish to take advantage of such benefits. (WB OP4.12 para.16)	No gap
Traditional rights and residence rights	The Act recognizes *Section: 3. (c)* ・ a family which does not own any land but belong to the family of an agricultural laborer, tenant, share-croppers, or artisans or working in affected area for three years prior to the acquisition of the land. ・ the Scheduled Tribes and other traditional forest dwellers who have lost any of their forest rights ・ family whose primary source of livelihood for three years prior to the acquisition of the land is dependent on forests or water bodies and includes gatherers of forest produce, hunters, fisher folk and boatmen ・ a family residing or earning livelihoods on any land in the urban areas for preceding three years or more prior to the acquisition of the land	Eligibility of benefits includes the PAPs who have formal legal rights to the land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to the land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 para.15)	No limit shall be imposed regardless of how long they reside the site. On the other hand, there shall be a cut-off-date (or alternative) to identify the project affected people and to prevent influx of encroachers
Identification of the affected people	N/A	Persons who encroach on the area after the cut-off date are not entitled to compensation or any other form of resettlement assistance (WB OP4.12 para.15)	The COD or alternatives shall be declared to prevent influx of encroachers.
Minimization of adverse impact on host community	N/A	Adverse impacts on host communities should be minimized. (WB OP4.12 para.13 (b))	The degree of impact caused to the host communities shall be assessed if the given condition is applicable.
Land-based resettlement	・ Land for land in case of irrigation projects to the land owners losing agricultural land. Land for land in every project to land owners belong to SC and ST community up to 2.5 acres of land. *Section: 31* and The Second Schedule ・ Provision of housing units in case of displacement. Offer for developed land. *Section: 31 and The Second Schedule*	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 para.11)	No gap
Assistance during transition period	N/A	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 para.6 I (i))	Assistance during transitional period shall be examined if the given condition is applicable.
Assistance for vulnerable people	・ Landless people are considered and eligible for R&R grants. *Section: 16. (2).* ・ Widows, divorcees, abandoned women	Appropriate consideration must be given to vulnerable social groups, such as women, children, the elderly, the poor,	No gap

Issue	Provisions in Indian Laws	JICA Guidelines for Environmental and Social	Differences
	will be considered as separate family and entitled to R&R provisions *Section: 3. (m)* ・ Homeless entitled to constructed house and landless entitled to land in irrigation project. *Second Schedule* ・ Special provision for Scheduled Caste / Scheduled Tribe; *Section: 41.* ・ Additional provisions for SC&ST for land for land in irrigation projects, additional sum over and above the subsistence grant. *Second Schedule*	and ethnic minorities, all members of which are susceptible to environmental and social impacts and may have little access to decision-making processes within society.	
Monitoring	・ The Rehabilitation and Resettlement Committee, to monitor and review the progress of implementation of the Rehabilitation and Resettlement scheme and to carry out post-implementation social audits in consultation with the Gram Sabha in rural areas and municipality in urban areas. *Section: 45. (1)* ・ Set up National and State-level Monitoring Committee to review and monitor progress. *Section 48-50*	In cases where sufficient monitoring is deemed essential for appropriate social considerations, project proponents must ensure that project plans include feasible monitoring plans. Project proponents should make efforts to make the results of the monitoring process available to local project stakeholders.	No gap
Cost for resettlement	The requiring body shall bear the cost of acquisition covering compensation and R&R cost. *Section: 19. (2) and Section 95. (1)*	The full costs of resettlement activities necessary to achieve the objectives of the project are included in the total costs of the project. (WB OP4.12 para.20)	No gap

source: JICA Study Team

11.13.4 The Policy Framework under the Project

As a result of technical survey for DPR, permanent acquisition of private land or involuntary resettlement have been avoided by identifying alternative and feasible designs that have the least adverse impact on the project impacted area. While the adverse impact has been minimized, temporary land use may occur during certain time in the construction phase for exploiting construction materials, which may lead to the lease of private land, losses of livelihood means and their income and food resources. WBSEDCL has a clear idea that they exploit the forest land first, and will not explore any land owned or used by local residents until they find it difficult to collect sufficient quantity and quality of soil within the forest land to the expected level.

If it is found necessary to lease non-forest private land as borrow area, contractors will conclude individual contracts with the land right holders[28]. In case the owners of andidate private land reject the offers and conditions, the contractors must explore alternative land and no involuntary or forcible land use is anticipated. WBSEDCL will not exercise public power for the private land use, and monitor if contracts are concluded without unreasonable conditions for land owners.

On the contrary, WBSEDCL land in Kudna village, former borrow area of Purulia PSP, has been used for years by local people for agricultural purpose without land tenure. They will be affected by the project implementation if WBSEDCL finds it unavoidable to use their Kudna land, and they are eligible for crops compensation as well as rehabilitation of their livelihood means as described in the

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[28] It was confirmed in this preparatory survey that five households of four locations (three households in two locations of Hatinada village, and two households in two locations of Gosaidi) would be candidate owners for private land use. WBSEDCL considers potential use of another private land in Kudna village (7 ha), which has not identified yet as of April 2018.

abbreviated resettlement action plan (“ARAP”) which has been compiled in accordance with Indian acts and JICA’s policy, address the issue of land use. The ARAP will be translated into local languages and disclosed for the reference of the affected people as well as other interested groups.

As seen in the Table 11.13.3-1, there are least gaps between the legal framework of India and West Bengal State, and JICA’s Policy. The WBSEDCL is expected to be compliant to and consistent with her country’s statutes and good practices as well as JICA’s policy to help ensure that affected people are able to rehabilitate themselves to at least their pre-project condition.

WBSEDLC has decided that they will not declare the cut-off-date[29] prior to the project implementation, since it will be fixed after the construction starts whether they have to go on to the use of non-forest land. Once the necessity to exploit the construction materials on such land is confirmed, WBSEDCL will hold consultations with the affected people and will make prior payment of compensation through contractors. The official information about the affected people will be updated by the District Magistrate and BDO. Livelihood restoration activities will be conducted through the Block Development Office of Baghmundi financed and monitored by WBSEDCL.

The following issues shall be the principles and policy framework for this project mutually confirmed by both sides.

(1) Compensation

- Compensation and rehabilitation support will be provided to the affected people, that is, any person or household which on account of project implementation would have his, her or their:
  - Standard of living adversely affected;
  - Interest in any land;
  - Income earning opportunities adversely affected; or
  - Social and cultural activities and relationships affected or any other losses that may be identified during the process of land use.
- All affected people will be eligible for compensation and rehabilitation assistance, irrespective of tenure status, social or economic standing and any such factors that may discriminate against achievement of the objectives outlined above. Lack of legal rights to the assets will not bar the affected people from entitlements to such compensation and rehabilitation measures.
- All the affected people cultivating land within the project impacted areas as of the date of the latest census and inventory of lost assets, are entitled to compensation for their lost products and means of livelihoods, and restoration of incomes will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity and production levels.

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[29] The “cut-off date” makes owners/users of the land eligible to be categorized as the affected people and be eligible to the project entitlements.

- Compensation for the affected people who are dependent on agricultural activities will be land-based wherever possible. Land-based strategies may include provision of replacement land, ensuring greater security of tenure, and upgrading livelihoods of people without legal land titles. If replacement land is not available, other strategies may be built around opportunities for re-training, skill development, waged work, or self-employment. Solely cash compensation will be avoided as an option if possible, as this may not address losses that are not easily quantified, such as access to services and traditional rights, and may eventually lead to those populations being worse off than without the project.

(2) Assistance

- Assistance will be provided not only for immediate losses, but for their transition period for the restoration of the livelihood and standards of living of the affected people.
- The ARAP takes into consideration the needs of those most vulnerable to the adverse impacts (including the poor, those without legal title to land, tribes, women, children, elderly and disabled) and ensure they are considered in the planning process and mitigation measures identified. Assistance should be provided to help them improve their socio-economic status.

(3) Participation

- The affected people will be involved in the process of developing and implementing the ARAP.
- The affected people and their communities will be consulted about the project, the rights and options available to them, and proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made.

(4) Institutional Arrangements

- Adequate budgetary support will be fully committed and made available by WBSEDCL to cover the costs of land use, compensation and income restoration measures within the agreed implementation period.
- Payment of compensation, and start of the livelihood rehabilitation activities of PAPs, will be completed prior to relevant construction activities.
- Organization and administrative arrangements for the effective preparation and implementation of the ARAP will be identified and in place prior to the commencement of the process.
- Appropriate reporting (including auditing and redress functions), monitoring and evaluation mechanisms, will be identified and set in place.

11.14 SCOPE OF SOCIAL IMPACT

Characteristics of the affected people and their villages were identified through initial survey on population census, asset inventory and household survey, and their village profiles through focus group discussion of other villages and key informant interview with the BDO in November 2017. The preliminary results from the social survey before the official updates are summarized as below.

11.14.1 Population Census

Out of former borrow area of Purulia PSP, all of which belong to WBSEDCL, it was found in the social survey that five households use the former borrow area in Kudna village for agricultural purpose such as paddy. Their livelihood means and crops will be affected if Kudna's borrow land is used in the project. The potential affected households and their members are shown in the table below.

Table 11.14.1-1 Number of the Affected Households and their People

(Unit: number)

Type of affected people	Village	Legal		Unauthorized (encroached)		TOTAL	
		Household	Person	Household	Person	Household	Person
Cultivators of government land (LCA-1)	1	0	0	5	25	5	25

source: JICA Sturdy Team

note: WBSEDCL will conduct local consultations to officially identify the number of the affected households and people with information provided by the District Magistrate, if they find they must explore non-forest land to temporarily use as borrow area. The numbers in the table are the snapshot collected in the initial baseline survey as of November 2017.

It is uncertain yet, however, at the timing of pre-construction period, whether non-forest land is used for exploiting clay core materials for the construction. There needs further geological investigation, soil sampling test and actual excavation to confirm if the earmarked forest land as borrow area can provide all the required amount and quality of clay core construction materials. WBSEDLC will fix the number of affected people after the construction starts when they find they must go on to the use of WBSEDCL land. They will update the census based on the official information collected at the District Magistrate Office and Land Revenue Department.

11.14.2 Asset Inventory

(1) Land likely to be used in the project

The following table summarizes the WBSECL land which will possibly be utilized in the project, and their present use as stated by the potentially affected households. There will be no building, tree, or cattle affected by the project. WBSEDCL will make payment to the affected households based on the policy framework as defined in this report and the ARAP (See Annex 11-10).

Table 11.14.2-1 Assets likely Impacted under the Project

Land use in the project			Affected Land (ha)		No of Affected HH	Land condition and products as stated by the affected households		
Village	Purpose	Location ID	Gov land	Pvt land		Condition	Product	Product purpose
Kudna	Borrow area	Kudna (LCA1)	4.98	-	5	farmland	Paddy	self-consumption / commercial

source: WBSDCL and JICA Study Team

note: WBSEDCL will conduct local consultations to officially identify the number of the affected households and people with information provided by the District Magistrate, if they find they must explore non-forest land to temporarily use as borrow area. The number of affected households, land condition and products are as stated by the interviewed households collected in the initial baseline survey as of November 2017

(2) Products

It was unable to collect accurate amount of products which the target households generated through their farming activities on Kudna WBSEDCL land and their monetable values, since they did not count how many kgs of paddy and vegetables they consumed at home and how many kgs they sold at local market.

In addition to paddy, wheat, kalai, tomato and onion are also grown as per the official data collected from the Office of the Assistant Director of Agriculture of Baghmundi Block. Their yields are given in Table 11.14.2-2. Their seeds are supplied by the Government of West Bengal and are available at various government-registered seeds shops. Their agriculture products are sold at CPC, FPO and public market.

Table 11.14.2-2 Yields of various Crops in the project surrounding area

S.No	Name of the Crop	Yield (Quintal/ha)
1.	Wheat	25
2.	Kalai	9.5
3.	Tomato	31
4.	Onion	37
5.	Paddy	51

source: Office of the Assistant Director of Agriculture

11.14.3 Household Survey

The following table summarizes the socioeconomic status of the potential affected households likely to be impacted according to the respondents' statements.

Table 11.14.3-1 Profile Summary of the Affected Households and their People

Living village	caste / tribe	language	Household members			occupation		monthly income (Rs.)
			Total	male	female	Primary	Secondary	
Kudna	General	Bengali	6	4	2	driver, operator	farmer	27,000
Kudna	ST (Santhal)	Santhali / Bengali	5	1	4	farmer	laborer	3,000
Kudna	ST (Santhal)	Santhali / Bengali	4	1	3	farmer	laborer	3,000
Kudna	ST (Santhal)	Santhali / Bengali	4	3	1	laborer	farmer	5,000
Kudna	ST (Santhal)	Santhali / Bengali	6	4	2	farmer	laborer	5,000
TOTAL			25	13	12			

source: JICA Sturdy Team

note: WBSEDCL will conduct local consultations to officially identify the number of the affected households and people with information provided by the District Magistrate, if they find they must explore non-forest land to temporarily use as borrow area. The numbers in the table are the snapshot collected in the initial baseline survey as of November 2017

Details of household socioeconomic condition are described in the ARAP (Annex 11-10).

11.14.4 Socially Vulnerable People

Among the affected people, there are Santhal people who belong to the Scheduled Tribe as well as general caste. Santhal people are commonly seen in Nepal, Bangladesh, and several parts of North India (Bihar, Jharkhand, West Bengal, Odisha and Tripura). They wear normal clothes as rest of the local residents. Santal people speak Santali as their first language and Bengalese as their second. The illiterate among them, most of them are female elderly, only speak Santali. They often collect NTFP and sell them at local market in Baghmundi town. Their villages are connected by local road network and accessible from other villages. Their identification, their forest rights, and reservation of vacancies in services and posts are secured and protected by the Constitution and domestic laws[30]. People who are below poverty line are assisted and subsidized by various social welfare programs from the Central and State Governments. For example, under the Individual Household Latrine (IHHL) Scheme of the GOI, Rs. 10,000 is given to each household for latrine construction.

11.15 COMPENSATION PLAN TO RECOVER ASSET AND LIVELIHOOD TO BE TEMPORARY LOST

11.15.1 Entitlement Matrix

Based on the compensation policy for the losses caused by the project and livelihood restoration activities, the entitlement matrix has been drafted as in the table below:

Table 11.15.1-1 Entitlement Matrix

Type of loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation Package)	Implementation issues/Guidelines	Responsible Organization
Loss of access to cultivable land by cultivator	Cultivators (unauthorized) of WBSEDCL land	- Crop / vegetable compensation equivalent to higher values of either 1) government prices at the time of compensation, or 2) annual average market prices - Double harvesting times - Additional grant (20%) for the expenses (manpower, fertilizer, materials, seeds, seedlings etc.)	<Assessment> - Assessment of quantity and quality of land - Assessment of market value of crops / vegetables <Entitlement> - Updating of title of the affected persons - APs will be fully informed of the entitlements and procedures regarding payments in prior <Payment> - Prior payment	<Assessment> Dept. of Agriculture <Entitlement> Contractor (supervised by WBSEDCL) <Payment> Contractor (supervised by WBSEDCL)

source: JICA Sturdy Team

Note : Existing local government regulations of Purulia District for compensation calculations for crops and vegetables will be used where ever available.

11.15.2 Compensation for Temporary Losses

For the project, the losses and entitlements of the affected people are crops and/or vegetables on the WBSEDCL land in Kudna, and their livelihood means (cultivation).

Crop compensation that is commonly practiced in Purulia District reflects the government rate that

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[30] The West Bengal Scheduled Castes and Scheduled Tribes (Identification) Act, 1994, The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006, The West Bengal Scheduled Castes and Scheduled Tribes (Reservation of Vacancies in Services and Posts) Act, 1976.West be

offsets fluctuation of selling prices at market for the benefit of farmers. However, it does not concern other cost borne for soil improvement, fertilizers, pesticide, chemicals, tools, manpower, etc.

Crop compensation for the project financed by JICA shall be calculated based on the following formula: X*2*1.2

X: Harvests' value to be lost. It is one harvest season per year in the project area.
2: Two times of harvest
1.2: 120% including top-up payment to enhance compensation (20% covers expenses borne for other than crops such as fodder, manpower, pesticide, fertilizer, etc).

The main crop grown in the non-forest land that may be utilized for extracting clay is paddy. Average crop yield for paddy is 51 quintals per ha, and its government rate is Rs. 1,550 per quintal according to the Office of the Assistant Director of Agriculture of Baghmundi Block. Their seeds are supplied from Government of West Bengal and are available at various Government registered seeds shops. Their agriculture products are sold at CPC, FPO and public market.

With an assumption that WBSEDCL land in Kudna currently used as farmland is utilized in the project for clay core exploitation, the compensation amount will be as Rs. 0.95 million as estimated at 2017/18 price as in Table 11.15.2-1. Price escalation shall be considered at 10% per annum.

Table 11.15.2-1 Estimation of Crop Compensation

Affected Land			(a)	(b)	(‘c)	(d)=(a)*(b)*(x+1)*(‘c)	(‘e)=(d)*0.2	(f)=(d)+(‘e)
Village	Gov land (ha)	Pvt land (ha)	Average crop yield for Paddy (Quintal / ha)	Production One Season (Quintal / ha)	Govt Rate of Paddy / Quintal (Rs. / quintal)	Compensation for Two Crops (Rs.)	Top-up (20% for fodder, manpower etc. Rs)	TOTAL (Rs.)
Kudna	4.98	0	51	610.98	1,550	787,338	157,468	944,806

source: JICA Study Team

note: the average crop yield for paddy and government rate of paddy per quintal are as of 2017/18 collected from the Department of Agriculture.

11.15.3 Livelihood Restoration Activities

Following activities are proposed for the affected people and local communities:

(1) Training for Skill Development

One member of each family, either male or female, shall be given training for skill development. It is suggested to provide ITI Training at the Government ITI located at Purulia.

A scholarship provision of Rs. 15,000 per year for meeting their fee and study material requirement at the ITI along with Rs. 5,000 per year for meeting their hostel expenses for a period of one year is being made for one member of each five affected families. Hence five students are proposed to be covered under this scheme. The ITI show provide training in additional fields like tailoring, incense stick making, etc. along with the training like carpenter, electrician, mechanic and computer typing, etc. keeping in in mind the target families to help enhance the current livelihood status of the surrounding area villages.

A total amount of Rs. 375,000 may be earmarked for providing scholarships, details of which are given in Table 11.15.3-1.

Table 11.15.3-1 Details of ITI Expenditure per temporarily affected family

S.No.	Activities	Amount (Rs.)
1	Hostel expenses (@ Rs.5,000/month x 5 students x 1 year)	300,000
2	Fees/course material (@ Rs.15,000/year x 5 students for 1 year)	75,000
	Total	375,000

source: JICA Survey Team

(2) Training and Extension Courses for Farmers

Since farming is widely done by the project surrounding villages hence training to the farmers shall be imparted. The training shall include the following aspects of environmental protection:

Table 11.15.3-2 Training and Extension Courses for Farmers

No.	Program	Measures
1	Prevention of spread of water related diseases	・ Hygine and personal health care ・ Control of water spills, pudding etc. ・ Prevention and prophylactic measures for control of vectors ・ Disposal of human waste ・ Disposal of drainage water
2	Safe use of agro-chemicals	Control of weeds in channels ・ Methods of cleaning and disposal of weeds ・ Detrimental environmental effects of agro-chemicals ・ Information on biological weed control. Pest control ・ Specific uses of pesticides and its optimization ・ Residual degradability ・ Effect on untargeted species ・ Safety procedures during application ・ Rate and frequency of application ・ Disposal of packing material and surpluses ・ Storage of chemicals Fertilizer use ・ Type, dosage, application techniques, timing and frequency of application and its relationship with type of soils; ・ Disposal or storage of packing materials and surpluses. ・ Topics to be covered under Environmental conservation programmes are: ・ Protection of forest or trees ・ Control of tree felling of fuel wood and timber ・ Advice on establishment of village woodlot ・ Soil conservation measures. ・ Such training courses can be organized by Agriculture Department, state government of West Bengal ・ Information on cropping measures such as weeding, rotational cropping, cleaning of bunds, etc.
3	Environmental conservation program	Dissemination

source: JICA Survey Team

A lumpsum amount of Rs. 1.5 million shall be earmarked and given to the Agriculture Department to train the residents of the surrounding villages.

Apart from the livelihood restoration activities, local area development plan is proposed in SIA and submitted to the GOI as part of EIA report (See Annex 11-6). For Turga PSP, the local area development plan includes upgradation of education facilities, scholarship for students, improvement of public health facilities, community toilets, portable water facilities, new ponds, playground, etc.

There have been numerous positive impacts on their livelihood brought by the construction and operation of the Purulia PSP, such as working opportunities and local business opportunities, as well as WBSEDCL's CSR activities with which local infrastructure such as road, education facilities and health facilities have been improved up to present.

11.16 GRIEVANCE REDRESS MECHANISM

A site-specific procedure shall be developed for receiving complaints, logging in the GRS logbook for recording and registering purpose, investigation, and analysis and responding to the affected people.

11.16.1 Focal Point for Grievance

Grievance focal person shall be BDO of Baghmundi Block to implement the GRS procedure fairly, equally effectively. He will receive the complaints in verbal or with letter from the affected households directly and indirectly. The complaint shall be recorded and registered accordingly and deliver the message to the Project Site Office promptly.

11.16.2 Project Site in charge

Site based grievance redress team shall be the Chief Engineer cum Project Site in charge at the Project Site office of WBSEDCL. He will review the any complaint and concerns and find a solution to ease the degree of complaints, which will be agreed and accepted by the affected people. In this stage, many issues shall be resolved as possible locally.

11.16.3 Grievance Redress Committee

If the case is not addressed to the affected people's satisfaction, P.S.I.C shall proceed to submit the issue to Grievance Redress Committee for further review.

GRC is the highest authority to make final decision within project specific Grievance Redress System on the received issues which cannot be sorted out up to P.S.I.C. level. GRC will be comprised of District Magistrate of Purulia District, WBSEDCL, Department Power of WBS, Police Administration Office, BDO and Gram Panchayat.

11.16.4 Unsolved Issue

If the case is still not resolved by GRC, the affected people can proceed through juridical system such as appealing on court for final resolution.

11.17 IMPLEMENTATION ARRANGEMENTS

Since the results of the initial baseline survey are preliminary ones, WBSEDCL will update the list of affected people by conducting the DMS, based on the official information collected at the District Magistrate Office and Land Revenue Department when they find they must go on to the use of non-forest WBSEDCL land. Analysis on socio-economic situation of the affected people who cultivate Kudna land will be officially updated by the District Magistrate and BDO.

Although the Project may generate social impacts, it will be only minor impacts at small-scale. The DMS will be undertaken prior to starting the use of Kudna borrow area. The objective of the DMS will be a) to identify land and products to be compensated and to collect detailed data of all affected households concerning such losses and compensation cost, and b) to collect socio-economic data of all affected households with a view to identifying losses of livelihood and specific needs for livelihoods restoration.

With the results of DMS, accurate scope of impacts will be identified and detail compensation rates and rehabilitation measures will be prepared. The information shall be incorporated into the revised ARAP. The revised ARAP will be translated into Bengali language and disclosed to the affected people and villages at BDO Office.

Compensation payments will be done according to the official information and the policy framework agreed in the ARAP. This step should be completed prior to the land use. WBSEDCL will ensure appropriate coordination between relevant authorities and organizations and monitor the affected people are well treated as agreed. BDO will conduct the livelihood restoration activities on behalf of WBSEDCL. All the payment will be done directly / indirectly by WBSEDCL.

11.18 IMPLEMENTATION SCHEDULE

Crop compensation shall be paid prior to the land use, and livelihood restoration activities will be finalized upon identification of the affected people by the District Magistrate and BDO. The implementation schedule of crop compensation and livelihood restoration activities will be however decided according to the results of further geological investigation, soil sampling test and actual excavation to confirm if the earmarked forest land as borrow area can provide all the required amount and quality of clay core construction materials.

11.19 BUDGET AND FINANCIAL SOURCE

All the expenditure shall be borne and paid by WBSEDCL. Crop compensation will be paid through contractor, whereas the budget for livelihood restoration activities will be allocated from WBSEDCL to BDO, and BDO will conduct them on behalf of WBSEDCL.

The total amount is estimated approximately Rs. 2.8 million as in the table below. The number of affected households for compensation and those covered under the livelihood restoration activities will be finalized according to the official identification, and the budget will be estimated accordingly with consideration of price escalation too.

Table 11.19-1 Cost Estimate for Crop Compensation and Trainings for Income Restoration

No	Item	Cost (Rs.)
A	Crop compensation for the affected people	944,806
B	Livelihood Restoration Activities	1.875,000
	1. Skill development trainings	375,000
	(1) Hostel expenses (@ Rs.5,000/month x 5 students x 1 year)	300,000
	(2) Fees/course material (@ Rs.15,000/year x 5 students for 1 year)	75,000
	2. Training and Extension Courses for Farmers	1,500,000
	(1) Prevention of spread of water related diseases	Lump sum
	(2) Safe use of agro-chemicals	
	(3) Environmental conservation program	
Total		2,819,806

source: JICA Study Team

11.20 MONITORING MECHANISM AND MONITORING FORM

Internal monitoring will be carried out by WBSEDCL periodically during the whole land use process conducted by the contractor. Internal monitoring will take place on a quarterly basis or other timing depending on the progress. Livelihood restoration activities will be conducted by BDO on behalf of WBSEDCL. WBSEDCL will monitor the activities during the implementation period quarterly or other timing depending on the progress. A draft monitoring form is attached to the ARAP (Annex 11-10) for further review and modification prior to the ARAP implementation.

11.21 DISCUSSION WITH LOCAL PEOPLE

All the consultation process in this preparatory survey is as described in the above 11.11. An official public hearing was already conducted in February 2016 as part of the EIA implementation, so that all the consultations under this survey focused upon collection of local voices. The fact that there would be no involuntary land acquisition or resettlement, and whether non-forest land is used would be confirmed in due course of time were repeated to collect their full understandings.

In the key informant interview, group interviews with local people, and public consultation, there was no opinion against the project implementation, or comment on the complensation package that would require additional actions. Their opinions have been reflected in the local area development plan elaborated in the EIA, livelihood restoration activities under this survey and CSR activities.

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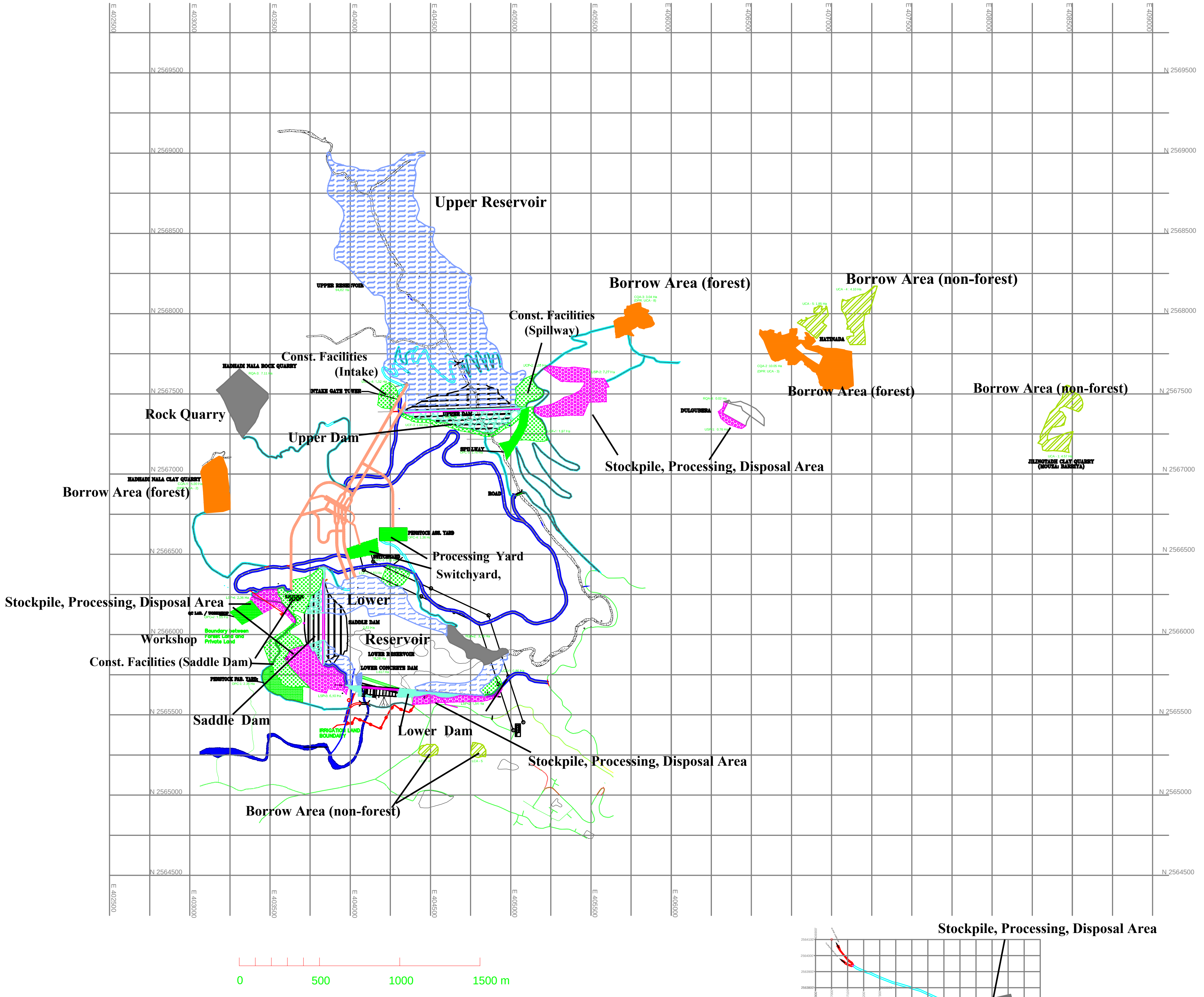
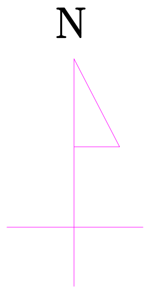


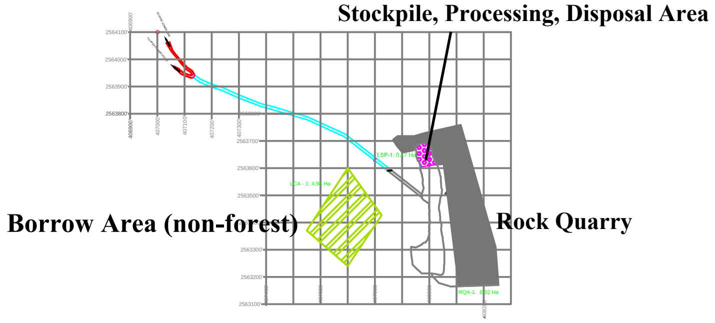


	NON - FOREST LAND REQUIREMENT FOR BORROW AREA (AREA IN HA)	
	DESCRIPTION	AREA (Ha)
1	UCA–1(JILINGTADH CQA, WBSEDCL)	4.570
2	UCA–4 & 5 (HATINADA CQA, PVT.)	5.945
3	LCA–1 (KUDNA CQA, WBSEDCL)	4.980
4	LCA–4 & 5 (GOSAIDHI CQA, PVT.)	1.816
5	KUDNA (PVT. NOT YET IDENTIFIED)	7.000
	TOTAL AREA	24.311

LEGENDS

SL. NO.	DESCRIPTION	LEGEND
1	SUBMERGENCE AREA (LOWER AND UPPER RESERVOIR)	▨
2	CIVIL STRUCTURES ROCKFILL CONCRETE UNDERGROUND	 ▨ 🟦 ▨
3	CONSTRUCTION FACILITIES	▨
4	STOCKPILE, PROCESSING AND DISPOSAL AREA	▨
5	PROJECT ROADS PERMANENT TEMPORARY	 ☐ ☐
6	ROCK QUARRY AREA	⬛
7	OTHER PROJECT COMPONENTS	🟩
8	BORROW AREA FOREST NON–FOREST	 🟧 ▨

	FOREST LAND REQUIREMENT (AREA IN HA)	
	DESCRIPTION	AREA (Ha)
1	SUBMERGENCE AREA (LOWER AND UPPER RESERVOIR)	112.900
2	CIVIL STRUCTURES	16.332
3	CONSTRUCTION FACILITIES	18.387
4	STOCKPILE, PROCESSING AND DISPOSAL AREA	18.600
5	PROJECT ROADS (PERMANENT AND TEMPORARY)	21.970
6	ROCK QUARRY AREA	18.600
7	OTHER PROJECT COMPONENTS	8.537
8	BORROW AREA	18.090
	TOTAL AREA	233.416
	SAY	234



WEST BENGAL STATE ELECTRICITY DISTRIBUTION CO. LTD.
1000 MW TURGA PUMPED STORAGE PROJECT, PURULIA
GEO–REFERENCE MAP OF LAND USE PATTERN
CO–ORDINATE: UTM / WGS 84

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Annexure 11-2

Calculation of CO_2 Emission for the Turga PSP

1. Methodology

JICA Climate-FIT (Mitigation) Climate Finance Impact Tool for Mitigation Ver. 2.0 (March/2014) includes no formulas on the emission from pumped storage plants. After the directives by JICA it is determined to adopt the below calculations.

1) BE: Baseline Emission

BE ＝EGy×EFelec

2) PE: Project Emission

PE ＝PEm + PEp

PEm: CO_2 emission caused by CH_4 from reservoirs

PEm＝(EFres × EGy)/1000

PEp: CO_2 emission induced from pumping power consumption of PSP

PEp ＝Eｐ× EFelec

Eｐ: Power consumption of pumping for PSP

EFres : Default emission factor for emissions from reservoirs of hydro power plants.

Here it defines reduction of CO_2 emission as BE－PE above.

2. Result of calculation

1) Baseline Emission

BE=EGy × EF elec

Here, EGy= 1,000 MW × 5 Hr/day × 365 days = 1,825,000 MWH/yr

EF elec = 0.82 tCO_2/MWH

(source; IGES List of Grid Emission Factors, grid CO_2 emission for India as of 2017/11/01)

Thus,

BE=1,496,500 tCO_2/Yr

2) Project Emission

PE=Pem + Pep

2-1) Pem; CO_2 emission caused by CH_4 from reservoirs

Pem = PFres × EGy/1000

PFres; In the calculation sheet (JICA Climate-FI 15. Renewable Energy / Hydropower and Others), PSP is the project which falls on “NO” for category “The project is a development of hydro power plant and CH4 emission from reservoirs of hydro power plants is significant”. Then, JICA Climate- FI 15 gives PFres = 0

None the less Turga PSP is in the continuous running water system, the emission of CH_4 is

unable to calculate in the materials that it is concluded PFres = N/A.
In conclusion, Pem = 0

2-2) PEp: CO_2 emission induced from pumping power consumption of PSP
PEp= Ep × EF elec
Ep;　Power consumption of pumping for PSP
EP= “Power consumption of pumping for PSP”＝ pumping energy for PSP, thus, using the efficiency for Turga PSP of 72.9%, the power consumption shall be
1,825,000/72.9% = 2,503,429 MWH/Yr
EF elec is the grid CO_2 emission for pumping energy.
EF elec=　0.82 tCO_2/MWH (source: same as 2. 1)
Thus,
Pep =　2,052,812　tCO_2/Yr

In conclusion,
2-1), 2-2) provides the total reduction of CO_2 emission by Turga PSP as
BE-PE = 1,496,500－2,052,812
= —556,312　tCO_2/Yr (—1,524 tCO_2/day)
(Annual increase as 556,312 tCO_2)

For reference,
If we use EF elec = 0.8950 tCO_2/MWH　(JICA Climate-FIT, Table4, 2014/3),
then,
BE-PE=　1,633,375—2,240,569= — 607,194 tCO2/Yr .
This is no major difference with above output (—556,312　tCO_2/Yr).

3. Future tasks to consider

The above calculation utilizes “Indian grid CO_2 emission” for Base Line emission, which is 0.82 tCO_2/MWH from materials. However, if (assumingly) coal thermal power plants provide peaking power and gives Baseline Emission, then such coal thermal power plants would not only generate power during peak time but also would have to generate during whole day as a “base load” and go out CO_2 emission at all times of generation. This increase of emission by coal thermal power plants would narrower the discrepancy against the emissions caused by PSP.

The adopted calculation (BE- PE) above is based on only “PSP generating hours & generated energy” and “PSP pumping hours & pumping energy”, and not considers such cases of coal thermal power plant operations that emit CO_2 around the clock as a Baseline Emission. Thus the current adopted methodology does not accurately count the BE-PE.

(For reference, existing CDM emission methodology such as ACM0002 “Grid-connected electricity generation from renewable sources” exclude PSPs.)

Monitoring form (TPSP, Draft)

I. Pre-/Construction stage

i. Air Quality

(a) SO_2

Date……………………………………………

Location*	24 hours average value	National standard	WHO Guideline
A1	µg m^{-3}	80 µg m^{-3} (Industrial, Residential, Rural and Other Area)	500 µg m^{-3} (Industrial, Residential, Rural and Other Area)
A2	µg m^{-3}		
A3	µg m^{-3}		
A4	µg m^{-3}		

(b) NO_2

Date……………………………………………

Location*	24 hours average value	National standard	WHO Guideline
A1	µg m^{-3}	80 µg m^{-3} (Industrial, Residential, Rural and Other Area)	200 µg m^{-3} (Industrial, Residential, Rural and Other Area)
A2	µg m^{-3}		
A3	µg m^{-3}		
A4	µg m^{-3}		

(c) PM10

Date……………………………………………

Location*	24 hours average value	National standard	WHO Guideline
A1	µg m^{-3}	100 µg m^{-3} (Industrial, Residential, Rural and Other Area)	100 µg m^{-3} (Industrial, Residential, Rural and Other Area)
A2	µg m^{-3}		
A3	µg m^{-3}		
A4	µg m^{-3}		

ii. Water Quality

(a) Natural Water

Date……………………………………………

No	Monitoring Item	Location**

		W1	W2	W3	W4	W5	W6	W7
1	Water Temperature (°C)							
2	pH							
3	DO (mg L^{-1})							
4	EC (mS m^{-1})							
5	TDS (mg L^{-1})							
6	Total Hardness (mg L^{-1})							
7	Ca (mg L^{-1})							
8	Mg (mg L^{-1})							
9	Alkalinity (mg L^{-1})							
10	Cl (mg L^{-1})							
11	NO_2 (mg L^{-1})							
12	NO_3 (mg L^{-1})							
13	PO_4 (mg L^{-1})							
14	Total Si (mg L^{-1})							
15	SO_4 (mg L^{-1})							
16	Na (mg L^{-1})							
17	Total P (mg L^{-1})							
18	Fe (mg L^{-1})							
19	Cd (mg L^{-1})							
20	Cu (mg L^{-1})							
21	Total Hg (mg L^{-1})							
22	Total Cr (mg L^{-1})							
23	BOD5 (20 °C, mg L^{-1})							
22	COD (mg L^{-1})							
23	Oil and Grease							

** Location (fixed point observation)

W1: Dam Site Upper Dam (River Water)

W2: 300m Downstream of Upper Dam (River Water)

W3: 500m Upstream of Upper Dam (River Water)

W4: Reservoir upstream of Lower Dam axis (River Water)

W5: Near Lower Reservoir Site (Reservoir Water)

W6: Ranga village near to upper reservoir (Ground water from bore well)

W7: Gosiati Village (Ground water from bore well)

Reference Value: National Drinking Water Quality Standards

Item	Acceptable	Cause for Rejection	WHO (2011)	USEPA (1996)
Turbidity (JTU scale)	2.5	10	—	1 (NTU)
Color (Pt-Co scale)	5.0	25	—	5 (color units)
Taste & Odor (mg L^{-1})	Unobjectionable			3 (TON)
pH	7.0 - 8.5	6.5 - 9.2	—	6.5 – 8.5

TDS (mg L^{-1})	500	1500	500	1,000
Total hardness (mg L^{-1})	200	600	—	—
Cl (mg L^{-1})	200	1000	—	—
SO_4 (mg L^{-1})	200	400	250	250
F (mg L^{-1})	1.0	1.5	1.5	2.0
NO_3 (mg L^{-1})	45	45	50	10
Ca (mg L^{-1})	75	200	—	250
Mg (mg L^{-1})	30	150	—	—
Fe (mg L^{-1})	0.1	1.0		0.3
Mn (mg L^{-1})	0.05	0.5	—	0.05
Cu (mg L^{-1})	0.05	1.5	2.0	1.0
Zn (mg L^{-1})	5.0	15.0	—	5
Phenol (mg L^{-1})	0.001	0.002	—	—
MBAS (mg L^{-1})	0.2	1.0	—	0.5
Oil (mg L^{-1})	0.01	0.3	—	—
As (mg L^{-1})	0.05	0.05	0.01	0.01
Cd (mg L^{-1})	0.01	0.01	0.003	0.005
Cr^{+6} (mg L^{-1})	0.05	0.05	0.05 (total Cr)	0.1 (total Cr)
CN (mg L^{-1})	0.05	0.05	—	0.2
Pb (mg L^{-1})	0.1	0.1	0.01	0.015
Se (mg L^{-1})	0.01	0.01	0.04	0.05
Hg total (mg L^{-1})	0.001	0.001	0.006 (as inorg.-Hg)	0.002
PAH (μg L^{-1})	0.2	0.2	—	—

Source: http://www.mdws.gov.in/sites/default/files/Drinking_water_quality_standards.pdf (as of December 2017)

(b) Waste Water (as necessary)

Date……………………………………………

No	Monitoring Item	Location***			
		WW1	WW2	WW3	WW4
1	Water Temperature (°C)				
2	pH				
3	BOD3 (27 °C, mg L^{-1})				
4	COD (mg L^{-1})				
5	Oil and Grease (mg L^{-1})				
6	Suspended Solid (mg L^{-1})				
7	Dissolved Solids (mg L^{-1})				
8	Phenolic comp. (mg L^{-1})				
9	NH_4-N (mg L^{-1})				
10	Total N (mg L^{-1})				
11	Cyanide (as CN, mg L^{-1})				
12	Cr (as Cr^{6+}, mg L^{-1})				
13	Cr (as total Cr, mg L^{-1})				
14	Cu (mg L^{-1})				
15	Pb (mg L^{-1})				
16	Ni (mg L^{-1})				
17	Zn (mg L^{-1})				

18	As (mg L^{-1})				
19	Total Hg (mg L^{-1})				
20	Cd (mg L^{-1})				
21	Se (mg L^{-1})				
22	F (mg L^{-1})				
23	B (mg L^{-1})				
24	Cl (mg L^{-1})				
25	Na (mg L^{-1})				
26	SO_4 (mg L^{-1})				

*** 4 sampling location will be set in the construction site in detailed survey period.
Monitoring of waste water quality shall be conducted as fixed point observation.

Reference Value: Waste Water Quality Standards (Environment Protection Rules, 1986)

Item	mg L^{-1} unless specified			
	Primary Treatment	Treated Effluent		
		Into Inland Surface Waters	On Land for Irrigation	Into Marine Coastal Areas
Temperature (°C)	45	40 1)	—	45 2)
pH	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
BOD3 (27 °C, mg L^{-1})	—	30	100	100
COD (mg L^{-1})	—	250	—	250
Oil and Grease (mg L^{-1})	20	10	10	20
Suspended Solid (mg L^{-1})	—	100	200	100 3)
Dissolved Solids (mg L^{-1})	—	2,100	2,100	—
Phenolic comp. (mg L^{-1})	5.0	1.0	—	5.0
NH_4-N (mg L^{-1})	50	50	—	50
Total N (mg L^{-1})	—	100	—	100
Cyanide (as CN, mg L^{-1})	20	0.2	0.2	0.2
Cr (as Cr^{6+}, mg L^{-1})	2.0	—	—	—
Cr (as total Cr, mg L^{-1})	2.0	2.0	—	2.0
Cu (mg L^{-1})	3.0	3.0	—	3.0
Pb (mg L^{-1})	1.0	0.1	—	0.1
Ni (mg L^{-1})	3.0	3.0	—	5.0
Zn (mg L^{-1})	15	5.0	—	15
As (mg L^{-1})	0.2	0.2	0.2	0.2
Total Hg (mg L^{-1})	0.01	0.01	0.01	0.01
Cd (mg L^{-1})	1.0	—	—	—
Se (mg L^{-1})	0.05	0.05	0.05	0.05
F (mg L^{-1})	15	2.0	—	15

B (mg L^{-1})	2.0	2.0	2.0	—
Salinity (as % Na)	—	—	60	—
SO_4 (mg L^{-1})	—	1,000	—	1,000

1) Shall not exceed 40 C in any section of the stream within 15 meters downstream from the effluent outlet

2) 45C at the point of discharge

3) For process waste waters: 100 mg L^{-1}. For cooling water effluents 10 per cent above total suspended matter of influent cooling water

iii. Soil Quality

Date……………………………………………

Monitoring Item	Unit	Location****			
		S1	S2	S3	S4
Total organic carbon	g kg^{-1}				
Oil and grease	mg kg^{-1}				

**** Location (fixed point observation, 0 - 15 cm depth)

W1: Upper reservoir dam site
W2: Dumping site of outlet
W3: Auxiliary site
W4: Material exploitation site

iv. Sediment

Date……………………………………………

Monitoring Item	Unit	Location****			
		SE-U1	SE-U2	SE-L2	SE-L2
Color	Hue/Chroma/Value 1)				
Odor	Threshold Odor Number				
pH	—				

1) According to values of standard soil color chart

**** Location (fixed point observation, 0 - 15 cm depth from the sediment surface)

SE-U1: Upper reservoir dam site (1)
SE-U2: Upper reservoir dam site (2)
SE-L1: Lower reservoir dam site (1)
SE-L1: Lower reservoir dam site (2)

v. Noise and Vibration

(a) Ambient Noise Level (dB (A) Leq)

Date…………………………………………

Time		Location*****			
From	To	AN1	AN2	AN3	AN4
06 a.m.	07 a.m.				
07 a.m.	08 a.m.				
08 a.m.	09 a.m.				
09 a.m.	10 a.m.				
10 a.m.	11 a.m.				
11 a.m.	12 p.m.				
12 p.m.	01 p.m.				
01 p.m.	02 p.m.				
02 p.m.	03 p.m.				
03 p.m.	04 p.m.				
04 p.m.	05 p.m.				
05 p.m.	06 p.m.				
06 p.m.	07 p.m.				
07 p.m.	08 p.m.				
08 p.m.	09 p.m.				
dB(A) Leq day					

***** Location (fixed point observation)

AN1: Near Upper Dam Site

AN2: Near Lower Dam Site

AN3: Village Baghmundi

AN4: Downstream of Lower Dam Site

Reference Value: National Standards of Ambient Noise

Category of Area	**Limits in dB (A) Leq**	
	Day time	**Night time**
Industrial Area	**75**	70
Commercial Area	**65**	55
Residential Area	**55**	45
Silence Zone	**50**	40

Notes:
1. Day time 6 AM and 9 PM
2. Night time is 9 PM and 6 AM
3. Silence zone is defined as.Environment (Protection) Third Amendment Rules, 2000 Gazettee notification, Government of India, date 14.2.2000.

(b) Vibration (Dominant Excitation Frequency, Hz)

Date……………………………………………

Time		AN1			AN2			AN3			AN4		
From	To	< 8	8 - 25	> 25	< 8	8 - 25	> 25	< 8	8 - 25	> 25	< 8	8 - 25	> 25
06 a.m.	07 a.m.												
07 a.m.	08 a.m.												
08 a.m.	09 a.m.												
09 a.m.	10 a.m.												
10 a.m.	11 a.m.												
11 a.m.	12 p.m.												
12 p.m.	01 p.m.												
01 p.m.	02 p.m.												
02 p.m.	03 p.m.												
03 p.m.	04 p.m.												
04 p.m.	05 p.m.												
05 p.m.	06 p.m.												
06 p.m.	07 p.m.												
07 p.m.	08 p.m.												
08 p.m.	09 p.m.												

***** Location (fixed point observation)

AN1: Near Upper Dam Site

AN2: Near Lower Dam Site

AN3: Village Baghmundi

AN4: Downstream of Lower Dam Site

Reference Value: National Standards of Vibration

Type of structures	Dominant excitation frequency, Hz		
	< 8	8 - 25	> 25
Domestic houses/structures	5	10	15
Industrial building	10	20	25
Objects of historical importance and Sensitive structures	2	5	10

Permissible limit of ground vibration prescribed by Directorate General of Mines Safety (DGMS, 1997)

vi. Waste and Odor

Date……………………………………………

Station (Point)	Discharge amount		Rate of recycle/Reuse	
	Industrial (ton)	Domestic (kg)	Industrial (%)	Domestic (%)
Construction sites				
Odor	☐ Acceptable	☐ Not-acceptable	☐ Acceptable	☐ Not-acceptable
Camp area				
Odor	☐ Acceptable	☐ Not-acceptable	☐ Acceptable	☐ Not-acceptable

vii. Ecosystem

(a) Threatened Species listed in IUCN as CR, EN and VU (especially, Elephant)

Date……………………………………………

Date & Time	Total No. of INDVs	Species Name and No. of individuals	

(b) Others (No Threatened Species, Migratory Birds, Reptiles, Amphibians, etc., as necessary)

Date……………………………………………

Scientific name	Local name	English name	Total No. of individuals	Conservation Status		Remarks
				IUCN	Local	

viii. Topography and Geology

Date……………………………………………

Check items	Disposal	Slope of Access-Roads	Reservoir Bank
Erosion (+3 / +2 / +1/ 0)			
Vitality Indicator (Plant) (+2 /+1 / 0 / -1 / -2)			
Others (Remarks, if any)			

ix. Cross-boundary impacts and Climate change (Record of machinery maintenance)

Date	Machinery name	ID No.	Content of maintenance

x. Disturbance to the poor, Indigenous People, Local Economy (simultaneously)

-Household Economy

- Interview with the affected people

- Local engagement

Records of workers at construction site office

- Land area development plan

Records at the Block Development Office

xi. Disturbance to Water Usage, Water Rights

Amount of irrigation water and drinking water

- Random interview with local people
- Records at the I&W Department
- Records at the PHED

xii. Disturbance to Existing Social Infrastructure and Services

- Traffic volume (vehicles and others used for the transportation and construction work)
- Records at the Project Site

- Infrastructure developed under the project
- Records at the Project Site

xiii. Local Conflict of Interest

- Record of numbers of grievance redress
- Record of meetings held in the neighborhoods
- Records of complaints at the project site

xiv. Cultural Heritages

- Relocation of Hindu Temple
- Records of consultation and relocation process at the project site

xv. Infectious diseases

- Number of diseases and infection
- Results of health checkups
- Monitor the labour health record through medical check-ups and measures

xvi. Work Environment (daily and monthly)

- Health and safety
- Monitor record of trainings on health and safety
- observation and inspection on site
- workers’ health condition and medical check-ups’ record
- number of accidents and their working hours

xvii. Accidents (simultaneously)

- Number of traffic accidents
- No of accidents (human and fire cases)
- Monitor the record of accidents

II. Operation stage

i. Water Quality: Natural Water

Date…………………………………………

No	Monitoring Item	Location**						
		W1	W2	W3	W4	W5	W6	W7
1	Water Temperature (°C)							
2	pH							
3	DO (mg L^{-1})							
4	EC (mS m^{-1})							
5	TDS (mg L^{-1})							
6	Total Hardness (mg L^{-1})							
7	Ca (mg L^{-1})							
8	Mg (mg L^{-1})							
9	Alkalinity (mg L^{-1})							
10	Cl (mg L^{-1})							
11	NO_2 (mg L^{-1})							
12	NO_3 (mg L^{-1})							
13	PO_4 (mg L^{-1})							
14	Total Si (mg L^{-1})							
15	SO_4 (mg L^{-1})							
16	Na (mg L^{-1})							
17	Total P (mg L^{-1})							
18	Fe (mg L^{-1})							
19	Cd (mg L^{-1})							
20	Cu (mg L^{-1})							
21	Total Hg (mg L^{-1})							
22	Total Cr (mg L^{-1})							
23	BOD5 (20 °C, mg L^{-1})							
22	COD (mg L^{-1})							
23	Oil and Grease							

** Location (fixed point observation)

W1: Dam Site Upper Dam (River Water)
W2: 300m Downstream of Upper Dam (River Water)
W3: 500m Upstream of Upper Dam (River Water)
W4: Reservoir upstream of Lower Dam axis (River Water)
W5: Near Lower Reservoir Site (Reservoir Water)
W6: Ranga village near to upper reservoir (Ground water from bore well)
W7: Gosiati Village (Ground water from bore well)

Reference Value: National Drinking Water Quality Standards

Item	Acceptable	Cause for Rejection	WHO (2011)	USEPA (1996)
Turbidity (JTU scale)	2.5	10	—	1 (NTU)

Color (Pt-Co scale)	5.0	25	—	5 (color units)
Taste & Odor (mg L^{-1})	Unobjectionable			3 (TON)
pH	7.0 - 8.5	6.5 - 9.2	—	6.5 – 8.5
TDS (mg L^{-1})	500	1500	500	1,000
Total hardness (mg L^{-1})	200	600	—	—
Cl (mg L^{-1})	200	1000	—	—
SO_4 (mg L^{-1})	200	400	250	250
F (mg L^{-1})	1.0	1.5	1.5	2.0
NO_3 (mg L^{-1})	45	45	50	10
Ca (mg L^{-1})	75	200	—	250
Mg (mg L^{-1})	30	150	—	—
Fe (mg L^{-1})	0.1	1.0		0.3
Mn (mg L^{-1})	0.05	0.5	—	0.05
Cu (mg L^{-1})	0.05	1.5	2.0	1.0
Zn (mg L^{-1})	5.0	15.0	—	5
Phenol (mg L^{-1})	0.001	0.002	—	—
MBAS (mg L^{-1})	0.2	1.0	—	0.5
Oil (mg L^{-1})	0.01	0.3	—	—
As (mg L^{-1})	0.05	0.05	0.01	0.01
Cd (mg L^{-1})	0.01	0.01	0.003	0.005
Cr^{+6} (mg L^{-1})	0.05	0.05	0.05 (total Cr)	0.1 (total Cr)
CN (mg L^{-1})	0.05	0.05	—	0.2
Pb (mg L^{-1})	0.1	0.1	0.01	0.015
Se (mg L^{-1})	0.01	0.01	0.04	0.05
Hg total (mg L^{-1})	0.001	0.001	0.006 (as inorg.-Hg)	0.002
PAH (μg L^{-1})	0.2	0.2	—	—

Source: http://www.mdws.gov.in/sites/default/files/Drinking_water_quality_standards.pdf (as of December 2017)

ii. Subsidence (Record of pumping water volume, as necessary)

Date	Time		Purpose	Total volume (m^3)	Water level (m)		Water temp. (℃)
	From	To			Static	Pumping	

iii. Waste and Odor

Date……………………………………………

Station (Point)	Discharge amount		Rate of recycle/Reuse	
	Industrial (ton)	Domestic (kg)	Industrial (%)	Domestic (%)
Operation space				
Odor	☐ Acceptable	☐ Not-acceptable	☐ Acceptable	☐ Not-acceptable
Office area				
Odor	☐ Acceptable	☐ Not-acceptable	☐ Acceptable	☐ Not-acceptable

iv. Topography and Geology

Date……………………………………………

Check items	Disposal	Slope of Access-Roads	Reservoir Bank
Erosion (+3 / +2 / +1/ 0)			
Vitality Indicator (Plant) (+2 /+1 / 0 / -1 / -2)			
Others (Remarks, if any)			

v. Work Environment (daily and monthly)

- Health and safety

Observation and inspection on site

vi. Accidents (simultaneously)

- Countermeasures for traffic, labor, fire accidents.

Records of accidents

Check of cautionary signs placed on required points on site

Monitoring form (Transmission Line, Draft)

I. Construction stage

i. Air Quality

(a) SO$_2$

Date……………………………………………

Location*	24 hours average value	National standard	WHO Guideline
A1	µg m^{-3}	80 µg m^{-3} (Industrial, Residential, Rural and Other Area)	500 µg m^{-3} (Industrial, Residential, Rural and Other Area)
A2	µg m^{-3}		
A3	µg m^{-3}		
A4	µg m^{-3}		

(b) NO$_2$

Date……………………………………………

Location*	24 hours average value	National standard	WHO Guideline
A1	µg m^{-3}	80 µg m^{-3} (Industrial, Residential, Rural and Other Area)	200 µg m^{-3} (Industrial, Residential, Rural and Other Area)
A2	µg m^{-3}		
A3	µg m^{-3}		
A4	µg m^{-3}		

(c) PM10

Date……………………………………………

Location*	24 hours average value	National standard	WHO Guideline
A1	µg m^{-3}	100 µg m^{-3} (Industrial, Residential, Rural and Other Area)	100 µg m^{-3} (Industrial, Residential, Rural and Other Area)
A2	µg m^{-3}		
A3	µg m^{-3}		
A4	µg m^{-3}		

ii. Water Quality

(a) Natural Water

Date……………………………………………

No	Monitoring Item	Location**

		W1	W2	W3	W4	W5	W6	W7
1	Water Temperature (°C)							
2	pH							
3	DO (mg L^{-1})							
4	EC (mS m^{-1})							
5	TDS (mg L^{-1})							
6	Total Hardness (mg L^{-1})							
7	Ca (mg L^{-1})							
8	Mg (mg L^{-1})							
9	Alkalinity (mg L^{-1})							
10	Cl (mg L^{-1})							
11	NO_2 (mg L^{-1})							
12	NO_3 (mg L^{-1})							
13	PO_4 (mg L^{-1})							
14	Total Si (mg L^{-1})							
15	SO_4 (mg L^{-1})							
16	Na (mg L^{-1})							
17	Total P (mg L^{-1})							
18	Fe (mg L^{-1})							
19	Cd (mg L^{-1})							
20	Cu (mg L^{-1})							
21	Total Hg (mg L^{-1})							
22	Total Cr (mg L^{-1})							
23	BOD5 (20 °C, mg L^{-1})							
22	COD (mg L^{-1})							
23	Oil and Grease							

** Location (fixed point observation)

W1: Dam Site Upper Dam (River Water)

W2: 300m Downstream of Upper Dam (River Water)

W3: 500m Upstream of Upper Dam (River Water)

W4: Reservoir upstream of Lower Dam axis (River Water)

W5: Near Lower Reservoir Site (Reservoir Water)

W6: Ranga village near to upper reservoir (Ground water from bore well)

W7: Gosiati Village (Ground water from bore well)

Reference Value: National Drinking Water Quality Standards

Item	Acceptable	Cause for Rejection	WHO (2011)	USEPA (1996)
Turbidity (JTU scale)	2.5	10	—	1 (NTU)
Color (Pt-Co scale)	5.0	25	—	5 (color units)
Taste & Odor (mg L^{-1})	Unobjectionable			3 (TON)
pH	7.0 - 8.5	6.5 - 9.2	—	6.5 – 8.5

TDS (mg L^{-1})	500	1500	500	1,000
Total hardness (mg L^{-1})	200	600	—	—
Cl (mg L^{-1})	200	1000	—	—
SO_4 (mg L^{-1})	200	400	250	250
F (mg L^{-1})	1.0	1.5	1.5	2.0
NO_3 (mg L^{-1})	45	45	50	10
Ca (mg L^{-1})	75	200	—	250
Mg (mg L^{-1})	30	150	—	—
Fe (mg L^{-1})	0.1	1.0		0.3
Mn (mg L^{-1})	0.05	0.5	—	0.05
Cu (mg L^{-1})	0.05	1.5	2.0	1.0
Zn (mg L^{-1})	5.0	15.0	—	5
Phenol (mg L^{-1})	0.001	0.002	—	—
MBAS (mg L^{-1})	0.2	1.0	—	0.5
Oil (mg L^{-1})	0.01	0.3	—	—
As (mg L^{-1})	0.05	0.05	0.01	0.01
Cd (mg L^{-1})	0.01	0.01	0.003	0.005
Cr^{+6} (mg L^{-1})	0.05	0.05	0.05 (total Cr)	0.1 (total Cr)
CN (mg L^{-1})	0.05	0.05	—	0.2
Pb (mg L^{-1})	0.1	0.1	0.01	0.015
Se (mg L^{-1})	0.01	0.01	0.04	0.05
Hg total (mg L^{-1})	0.001	0.001	0.006 (as inorg.-Hg)	0.002
PAH (µg L^{-1})	0.2	0.2	—	—

Source: http://www.mdws.gov.in/sites/default/files/Drinking_water_quality_standards.pdf (as of December 2017)

(b) Waste Water (as necessary)

Date…………………………………………

No	Monitoring Item	Location***			
		WW1	WW2	WW3	WW4
1	Water Temperature (°C)				
2	pH				
3	BOD3 (27 °C, mg L^{-1})				
4	COD (mg L^{-1})				
5	Oil and Grease (mg L^{-1})				
6	Suspended Solid (mg L^{-1})				
7	Dissolved Solids (mg L^{-1})				
8	Phenolic comp. (mg L^{-1})				
9	NH_4-N (mg L^{-1})				
10	Total N (mg L^{-1})				
11	Cyanide (as CN, mg L^{-1})				
12	Cr (as Cr^{6+}, mg L^{-1})				
13	Cr (as total Cr, mg L^{-1})				
14	Cu (mg L^{-1})				
15	Pb (mg L^{-1})				
16	Ni (mg L^{-1})				
17	Zn (mg L^{-1})				

18	As (mg L^{-1})				
19	Total Hg (mg L^{-1})				
20	Cd (mg L^{-1})				
21	Se (mg L^{-1})				
22	F (mg L^{-1})				
23	B (mg L^{-1})				
24	Cl (mg L^{-1})				
25	Na (mg L^{-1})				
26	SO_4 (mg L^{-1})				

*** 4 sampling location will be set in the construction site in detailed survey period. Monitoring of waste water quality shall be conducted as fixed point observation.

Reference Value: Waste Water Quality Standards (Environment Protection Rules, 1986)

Item	**mg L^{-1} unless specified**			
	Primary Treatment	**Treated Effluent**		
		Into Inland Surface Waters	**On Land for Irrigation**	**Into Marine Coastal Areas**
Temperature (°C)	45	40 1)	—	45 2)
pH	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
BOD3 (27 °C, mg L^{-1})	—	30	100	100
COD (mg L^{-1})	—	250	—	250
Oil and Grease (mg L^{-1})	20	10	10	20
Suspended Solid (mg L^{-1})	—	100	200	100 3)
Dissolved Solids (mg L^{-1})	—	2,100	2,100	—
Phenolic comp. (mg L^{-1})	5.0	1.0	—	5.0
NH_4-N (mg L^{-1})	50	50	—	50
Total N (mg L^{-1})	—	100	—	100
Cyanide (as CN, mg L^{-1})	20	0.2	0.2	0.2
Cr (as Cr^{6+}, mg L^{-1})	2.0	—	—	—
Cr (as total Cr, mg L^{-1})	2.0	2.0	—	2.0
Cu (mg L^{-1})	3.0	3.0	—	3.0
Pb (mg L^{-1})	1.0	0.1	—	0.1
Ni (mg L^{-1})	3.0	3.0	—	5.0
Zn (mg L^{-1})	15	5.0	—	15
As (mg L^{-1})	0.2	0.2	0.2	0.2
Total Hg (mg L^{-1})	0.01	0.01	0.01	0.01
Cd (mg L^{-1})	1.0	—	—	—
Se (mg L^{-1})	0.05	0.05	0.05	0.05
F (mg L^{-1})	15	2.0	—	15

B (mg L^{-1})	2.0	2.0	2.0	—
Salinity (as % Na)	—	—	60	—
SO_4 (mg L^{-1})	—	1,000	—	1,000

1) Shall not exceed 40 C in any section of the stream within 15 meters downstream from the effluent outlet

2) 45C at the point of discharge

3) For process waste waters: 100 mg L^{-1}. For cooling water effluents 10 per cent above total suspended matter of influent cooling water

iii. Soil Quality

Date……………………………………………

Monitoring Item	Unit	Location****			
		S1	S2	S3	S4
Total organic carbon	g kg^{-1}				
Oil and grease	mg kg^{-1}				

**** Location (fixed point observation, 0 - 15 cm depth)

W1: Upper reservoir dam site
W2: Dumping site of outlet
W3: Auxiliary site
W4: Material exploitation site

iv. Noise and Vibration

(a) Ambient Noise Level (dB (A) Leq)

Date……………………………………………

Time		Location*****			
From	To	AN1	AN2	AN3	AN4
06 a.m.	07 a.m.				
07 a.m.	08 a.m.				
08 a.m.	09 a.m.				
09 a.m.	10 a.m.				
10 a.m.	11 a.m.				
11 a.m.	12 p.m.				
12 p.m.	01 p.m.				
01 p.m.	02 p.m.				
02 p.m.	03 p.m.				
03 p.m.	04 p.m.				

04 p.m.	05 p.m.				
05 p.m.	06 p.m.				
06 p.m.	07 p.m.				
07 p.m.	08 p.m.				
08 p.m.	09 p.m.				
dB(A) Leq day					

***** Location (fixed point observation)

AN1: Near Upper Dam Site

AN2: Near Lower Dam Site

AN3: Village Baghmundi

AN4: Downstream of Lower Dam Site

Reference Value: National Standards of Ambient Noise

Category of Area	**Limits in dB (A) Leq**	
	Day time	**Night time**
Industrial Area	**75**	70
Commercial Area	**65**	55
Residential Area	**55**	45
Silence Zone	**50**	40

Notes:

1. Day time 6 AM and 9 PM
2. Night time is 9 PM and 6 AM
3. Silence zone is defined as.Environment (Protection) Third Amendment Rules, 2000 Gazettee notification, Government of India, date 14.2.2000.

(b) Vibration (Dominant Excitation Frequency, Hz)

Date…………………………………………

Time		AN1			AN2			AN3			AN4		
From	To	< 8	8 - 25	> 25	< 8	8 - 25	> 25	< 8	8 - 25	> 25	< 8	8 - 25	> 25
06 a.m.	07 a.m.												
07 a.m.	08 a.m.												
08 a.m.	09 a.m.												
09 a.m.	10 a.m.												
10 a.m.	11 a.m.												
11 a.m.	12 p.m.												
12 p.m.	01 p.m.												
01 p.m.	02 p.m.												
02 p.m.	03 p.m.												
03 p.m.	04 p.m.												

04 p.m.	05 p.m.												
05 p.m.	06 p.m.												
06 p.m.	07 p.m.												
07 p.m.	08 p.m.												
08 p.m.	09 p.m.												

***** Location (fixed point observation)

AN1: Near Upper Dam Site

AN2: Near Lower Dam Site

AN3: Village Baghmundi

AN4: Downstream of Lower Dam Site

Reference Value: National Standards of Vibration

Type of structures	Dominant excitation frequency, Hz		
	< 8	8 - 25	> 25
Domestic houses/structures	5	10	15
Industrial building	10	20	25
Objects of historical importance and Sensitive structures	2	5	10

Permissible limit of ground vibration prescribed by Directorate General of Mines Safety (DGMS, 1997)

v. Waste and Odor

Date……………………………………………

Station (Point)	Discharge amount		Rate of recycle/Reuse	
	Industrial (ton)	Domestic (kg)	Industrial (%)	Domestic (%)
Construction sites				
Odor	□ Acceptable	□ Not-acceptable	□ Acceptable	□ Not-acceptable
Camp area				
Odor	□ Acceptable	□ Not-acceptable	□ Acceptable	□ Not-acceptable

vi. Ecosystem

(a) Threatened Species listed in IUCN as CR, EN and VU (especially, Elephant)

Date……………………………………………

Date & Time	Total No. of INDVs	Species Name and No. of individuals	

(b) Others (No Threatened Species, Migratory Birds, Reptiles, Amphibians, etc., as necessary)

Date……………………………………………

Scientific name	Local name	English name	Total No. of individuals	Conservation Status		Remarks
				IUCN	Local	

vii. Topography and Geology

Date……………………………………………

Check items	Disposal	Slope of Access-Roads	Reservoir Bank
Erosion (+3 / +2 / +1/ 0)			
Vitality Indicator (Plant) (+2 /+1 / 0 / -1 / -2)			
Others (Remarks, if any)			

viii. Cross-boundary impacts and Climate change (Record of machinery maintenance)

Date	Machinery name	ID No.	Content of maintenance

ix. Disturbance to the poor, Indigenous People, Local Economy (simultaneously)

-Household Economy

Interview with the affected people

Local engagement

Records of employees at construction site office

- Land area development plan

Records at the Block Development Office

x. Disturbance to Existing Social Infrastructure and Services

- Traffic volume (vehicles and others used for the transportation and construction work)

Records at the Project Site

xi. Infectious diseases

- Number of diseases and infection
- Results of health checkups

Monitor the labour health record through medical check-ups and measures

xii. Work Environment (daily and monthly)

- Health and safety

Monitor record of trainings on health and safety, observation and inspection on site, workers' health condition and medical check-ups' record, number of accidents and their working hours

xiii. Accidents (simultaneously)

- Number of traffic accidents
- No of accidents (human and fire cases)

Monitor the record of accidents

II. Operation stage

i. Work Environment (daily and monthly)

- Health and safety

Observation and inspection on site

ii. Accidents (simultaneously)

- Countermeasures for traffic, labor, fire accidents.

Records of accidents

Check of cautionary signs placed on required points on site

Environmental Checklist (Turga PSP)

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) Y (c) Y (d)N/A	(a) Prepared and submitted to MoEFCC in 2016 (b) MoEFCC has given Environmental Clearance with conditions in June 2016. (c) Given a condition to obtain Forest Clearance (FC, Stage I). There held a Forestry Advisory Committee Meeting in Delhi on 25 January 2018, in which the application for FC was discussed. (d) N/A
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) Public Hearing was organized on 2 February 2016 as required by the Indian law as part of EIA. During the JICA preparatory survey, group interviews were conducted in November 2017, which will be followed by a public consultation planned in February 2018. Key informant interviews with local administration officers and household interview with potentially affected people were also conducted in November 2017. Contents of the project and the potential impacts have been explained to obtain understanding of local people. There were active participation and comments of stakeholders, and WBSEDCL responded to each question and comment. Local voices were heard and reflected into the plan. (b) Their views and ideas have been reflected to mitigation measures to the project impacts in the final project design to minimize physical impacts in the project area.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a)Y	(a) Alternative plans were examined to avoid and minimize adverse impacts to natural and social environment in the initial technical survey for DPR.
2 Pollution Control	(1) Water Quality	(a) Does the water quality of dam pond/reservoir comply with the country's ambient water quality standards? Is there a possibility that proliferation of phytoplankton and zooplankton will occur? (b) Does the quality of water discharged from the dam pond/reservoir comply with the country's ambient water quality standards? (c) Are adequate measures, such as clearance of	(a) Y (b) Y (c) Y	(a) Quality of upper/lower dam complies with National Quality Standards. There is no possibility of eutrophication caused by aquatic creature because reservoir water circulates continually. (b) There is no water discharge from upper dam as the type of dam is Pumped storage plant. (c) Salvaging of vegetation in the upper reservoir foundation is to be

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		woody vegetation from the inundation zone prior to flooding planned to prevent water quality degradation in the dam pond/reservoir? (d) Is there a possibility that reduced the river flow downstream will cause water quality degradation resulting in areas that do not comply with the country's ambient water quality standards? (e) Is the discharge of water from the lower portion of the dam pond/reservoir (the water temperature of the lower portion is generally lower than the water temperature of the upper portion) planned by considering the impacts to downstream areas?	(d) N (e) N	carried out prior to flooding. (d) This project does not need to use water of existing river except for initial flooding. (e) Same reason of (b)
	(2) Wastes	(a) Are earth and sand generated by excavation properly treated and disposed of in accordance with the country's regulations?	(a)Y	(a) Any slope or disposal area shall be reinforced with plantation or other means to minimize soil run-off based on regulations.
3 Natural Environment	(1) Protected Areas	(b) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) It is not anticipated that the project activities will give adverse impacts to the protected areas because these areas are being designated far away more than 20 km from project site.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) Is there a possibility that the project will adversely affect downstream aquatic organisms, animals, plants, and ecosystems? Are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that installation of structures, such as dams will block the movement of the migratory fish species (such as salmon, trout and eel those move between rivers and sea for spawning)? Are adequate measures taken to reduce the impacts on these species?	(a) N (b) N (c) N (d) N	(a) There is no vulnerable areas within project site. (b) Seasonal migration of Asian Elephants (*Elephas maximus*) listed at IUCN Red Data are found in and around the project site. However, But there is no habitat in the site and there is a myriad of bypass for them in the hill area. Furthermore adequate preventive measures could be taken by villagers and constructor at the initiative of DFO. (c) It is not anticipated that the project significantly affect the ecosystem. There is no water discharge from upper dam as the type of dam is Pumped storage plant. (d) There is no anadromous fishes and migratory fishes in waterbodies in the project site.

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(3) Hydrology	(a) Is there a possibility that hydrologic changes due to the installation of structures, such as weirs will adversely affect the surface and groundwater flows (especially in "run of the river generation" projects)?	(a) N	(a) There is no installation of any structure such as weirs.
	(4) Topography and Geology	(a) Is there a possibility that reductions in sediment loads downstream due to settling of suspended particles in the reservoir will cause impacts, such as scouring of the downstream riverbeds and soil erosion? Is there a possibility that sedimentation of the reservoir will cause loss of the storage capacity, water logging upstream, and formation of sediment deposits at the reservoir entrance? Are the possibilities of the impacts studied, and adequate prevention measures taken? (b) Is there a possibility that the project will cause a large-scale alteration of the topographic features and geologic structures in the surrounding areas (especially in run of the river generation projects and geothermal power generation projects)?	(a) N (b) N	(a) There will not any impact on sediment loads in lower dam or downstream because water will be taken from lower dam and upper reservoir by water intake structure and pumps in which process flowing of sediment materials will not be expected. (b) Although this project utilizes 12.66 km^2 of catchment area, construction work with large-scale alteration of the topographic features and geologic structures are not involved.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to the land use? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studiest? (d) Are the compensations going to be paid prior to the land use? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty	(a)N (b)Yes (c)Yes (d)Yes (e)Yes (f)Yes	(a) There will be no involuntary resettlement anticipated as land acquisition of non-forest area was avoided as a result of alternative examination. (b) There are local farmers who unauthorizedly cultivate WBSEDCL owned land. Their crops will be compensated prior to the land use as borrow area (only if the land is required for the project). (c) Crop compensation shall be conducted. Livelihood restoration activities will be conducted for the unauthorized farmers alongside the land area development plan as described in SIA. (d) Crop compensation shall be paid before the land is used as borrow area (only if the land is required for the project). (e) ARAP has been developed. (f) ARAP has been developed.

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to the land use? (h) Is the organizational framework established to properly implement the land use? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts? (j) Is the grievance redress mechanism established?	(g)Not yet (h)Yes (i)Yes (j)Yes	(g) It will be done when it is found the land is required for the project. (h) ARAP has been prepared. (i) ARAP and monitoring plan are developed. (j) The existing local grievance redress mechanism will be utilized.
	(2) Living and Livelihood	(a) Is there any possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there any possibility that the project causes the change of land uses in the neighboring areas to affect adversely livelihood of local people? (c) Is there any possibility that the project facilities adversely affect the traffic systems? (d) Is there any possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (e) Is the minimum flow required for maintaining downstream water uses secured? (f) Is there any possibility that reductions in water flow downstream or seawater intrusion will have impacts on downstream water and land uses? (g) Is there any possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? (h) Is there any possibility that fishery rights, water usage rights, and common usage rights, etc. would be restricted?	(a)Y (b)Y (c)Y (d)Y (e)N/A (f)N/A (g)Y (h)Y	(a) Non-forest WBSDCL land use may occur, which may result in loss of livelihood means of the unauthorized farmers. ARAP has been prepared. (b) There may be non-forest land use to collect clay core materials, if the quantity and quality of soil collected in the forest land does not reach the expected level. WBSEDCL's land may be used during construction period. (c) During the construction, temporal increase in traffic volume is predicted in the roads near the project site. On the other hand, access road will benefit to local people in transporting crops and forest products in the mountain. (d) Due to the increase of construction workers in the project area, the increase of infectious diseases may occur. However, health and safety will be prioritized for local people and also construction workers. Necessary prevention measures will be taken against infectious diseases. (e) N/A (f) N/A (g) Malaria is one of diseases observed in project site area; thus, if any prevention measures are not taken upon inflow of numbers of construction workers, the case of Malaria can be increased. It is necessary to take prevention measures. (h) People residing nearby do fishing from time to time occasionally for self-consumption and commercial purpose. To construct a coffer dam next to the lower reservoir is one of the countermeasures that ensures availability of drinking water, irrigation water, and enables fishing activities to be continued during the construction period. However, the impact remains unknown.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and	(a)Y	(a) There is a small Hindu temple on the left bank ridge of the planned lower reservoir, which needs to be relocated. According to the

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?		interview with the local people residing nearby and the priest who serves at the temple, there is no problem from religious perspective if the temple is relocated.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)N/A	(a) There will be least adverse impact anticipated as most of the project facilities will be constructed underground.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a)Y (b)Y	(a) Possibility of loss of livelihood means at non-forest government land (direct affected people). Along with general caste, the Santhal people who are the Scheduled Tribe (ST) included among them. For the rest local communities, the project design and layout has been carefully examined to avoid adverse impact to them. (b) Their human rights and equal opportunities are secured by law, and they are assisted and subsidized by various social welfare programs from the Central and State Governments.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a)Y (b)Y (c)Y (d)Y	(a) Health and safety will be prioritized in accordance with the Indian legislation. (b) Health and safety will be prioritized in accordance with the Indian legislation. (c) WBSEDCL will implement it through the contract with construction companies. (d) WBSEDCL will implement it through the contract with construction companies.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate	(a)Y. (b)N.	(a) Air pollution, noise, water contamination and wastes are anticipated during construction stage, but watering on road, using low noise/vibration equipment, setting sedimentation pond or promoting recycling and reuse will decrease its impacts. (b) No impact to surrounding natures is anticipated as the almost of big civil works will be done underground.

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		measures considered to reduce the impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(c)Y	(c) Inflow of outside construction workers in the project site may cause some conflicts with local people due to such as the difference in the custom and the pandemic of infectious diseases. Increase of traffic volume may cause traffic accidents. Countermeasures will be taken for education on living and sanitation and health check for construction workers, and time control of traffic volume, and others.
	(2) Accident Prevention Measures	(a) Is a warning system established to alert the inhabitants to water discharge from the dam?	(a) not yet	(a) N/A
	(3) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a)Y. (b)Y (c)Y (d)Y	(a) Compiling the environmental monitoring plan and its implementation is mandatory, and items with possible adverse impact will be monitored. (b) Air quality, water quality, soil, sediment, noise, odor, waste, ecosystem, hydrology, topography and geography, land use, water right and use and other environmental indicators will be monitored. Monitoring method and frequency is described in the monitoring form. (c) Monitoring will be conducted by executing agency, WBSEDCL, except while contractors are employed. (d) Monitoring report system will be submitted by contractors to the Consultant and WBSEDCL periodically. WBSEDCL will review contractors' periodic reports.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects in the mountains including large areas of deforestation). (b) In the case of dams and reservoirs, such as irrigation, water supply, and industrial water purposes, where necessary, pertinent items described in the Agriculture and Water Supply checklists should also be checked. (c) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities).	(a)N (b)N (c)N	(a)N/A (b)N/A (c)Environmental check list for power transmission line is already prepared.
	Note on Using	(a) If necessary, the impacts to transboundary or	(a)N.	(a) No impacts to global issues as exhaust gas from construction of

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	Environmental Checklist	global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).		PSPP will remain negligible level.

N/A=Not Applicable

Note 1: Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are requested to be made.

In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).

Note 2: Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Table 7-1　Environmental Checklist (Transmission Line)

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a)N/A (b)N/A (c)N/A (d)Y	(a) N/A (b) N/A (c) N/A (d) Forest clearance will be required from the Forest Department of West Bengal State
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a)Y (b)Y	(c) Public Hearing was organized on 2 February 2016 as required by the Indian law as part of EIA. During the JICA preparatory survey, group interviews were conducted in November 2017, which will be followed by a public consultation planned in February 2018. Up to the end of January 2018, contents of the project and the potential impacts have been explained to obtain understanding of local people. Key informant interviews with local administration officers and household interview with potentially affected people were also conducted in November 2017. There were active participation and comments of stakeholders, and WBSEDCL responded to each question and comment. (d) Their views and ideas have been reflected to mitigation measures to the project impacts in the final project design to minimize physical impacts in the project area.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a)Y	(b) Alternative plans were examined to avoid and minimize adverse impacts to natural and social environment in the initial technical survey for DPR.
2 Pollution Control	(1) Water Quality	(a) Is there any possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? If the water quality degradation is anticipated, are adequate measures considered?	(a) Y	(a) Although the impact will be temporary, soil runoff may occur from the exposed soil to the embankments and cut slopes, which may cause water turbidity. Embankments will be physically stable and in case of necessity, planting will be applied.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international	(a) N	(a) Protected area is designated far from more than 20 km from the project area. Considering the distance from Project area and specific habitat

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		treaties and conventions? Is there a possibility that the project will affect the protected areas?		inventories on the fauna, flora within the project site, no direct adverse impact to the National Park Area is predicted.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate measures taken to prevent disruption of migration routes and habitat fragmentation of wildlife and livestock? (e) Is there any possibility that the project will cause the negative impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystem due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In cases where the project site is located in undeveloped areas, is there any possibility that the new development will result in extensive loss of natural environments?	(a) N (b) Y (c) N (d) Y (e) N (f) N	(a) There is no vulnerable areas within project site. (b) Seasonal migration of Asian Elephants (*Elephas maximus*) are found in and around the project site. However, there is no habitat in the site and there is a myriad of bypass for them in the hill area. (c) It is not anticipated that the project significantly affect the ecosystem. There is no water discharge from upper dam as the type of dam is Pumped storage plant. (d) There is no anadromous fishes and migratory fishes in waterbodies in the project site. (e) Some portion of forest area will be submerged, but it is not anticipated that destruction of forest is not risen. (f) Similar project (Purulia PSP) had already completed in so close location. There is no possibility that the new development will cause an extensive loss of natural environments.
	(3) Topography and Geology	(a) Is there any soft ground on the route of power transmission and distribution lines that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there any possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a) N (b) N (c) N	(a) Soft ground is not expected on the route of transmission line and no possibility of erosion in civil works for wiring transmission line. Excavation works while construction of transmission tower site, however, may face with small-scale erosion risks. To minimize them, netting, and rock bolting will be employed, where necessary to provide stability of the cut slopes. Embankments will be physically stable, and planting will be applied if necessary. (b) No big cutting or filling earth is anticipated. (c) No big cutting or filling earth is anticipated. Soil runoff may occur from the exposed soil to the embankments and cut slopes, which may cause water turbidity. The impact will however be temporary.

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(k) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (l) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (m) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (n) Are the compensations going to be paid prior to the resettlement? (o) Are the compensation policies prepared in document? (p) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (q) Are agreements with the affected people obtained prior to resettlement? (r) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (s) Are any plans developed to monitor the impacts of resettlement? (t) Is the grievance redress mechanism established?	(a)N/A (b)N/A (c)N/A (d)N/A (e)N/A (f)N/A (g)N/A (h)N/A (i)N/A (j)N/A	(b) N/A (b)N/A (c)N/A (d)N/A (e)N/A (f)N/A (g)N/A (h)N/A (i)N/A (j)N/A
	(2) Living and Livelihood	(a) Is there any possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there any possibility that the project causes the change of land uses in the neighboring areas to affect adversely livelihood of local people? (c) Is there any possibility that the project facilities adversely affect the traffic systems? (d) Is there any possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the	(a) N/A (b) N/A (c)Y (d)Y	(a) N/A. (b) N/A. (c) During the construction, temporal increase in traffic volume is predicted in the roads near the project site. On the other hand, access road will benefit to local people in transporting crops and forest products in the mountain. (d) Due to the increase of construction workers in the project area, the increase of infectious diseases may occur. However, health and safety will be prioritized for local people and also construction workers. Necessary prevention measures will be taken against infectious diseases. (e) N/A

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		project? Are adequate considerations given to public health, if necessary? (e) Is the minimum flow required for maintaining downstream water uses secured? (f) Is there any possibility that reductions in water flow downstream or seawater intrusion will have impacts on downstream water and land uses? (g) Is there any possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? (h) Is there any possibility that fishery rights, water usage rights, and common usage rights, etc. would be restricted?	(e)N/A (f)N/A (g)Y (h)N/A	(f) N/A (g) Malaria is one of diseases observed in project site area; thus, if any prevention measures are not taken upon inflow of numbers of construction workers, the case of Malaria can be increased. It is necessary to take prevention measures. (h) N/A
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a)N/A	(a) N/A.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)N/A	(a) There will be least adverse impact anticipated as most of the project facilities will be constructed underground.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a)Y (b)Y	(a) Along with general caste, the Santhal people who are the Scheduled Tribe (ST) included among them. For the rest local communities, the project design and layout has been carefully examined to avoid adverse impact to them. (b) Their human rights and equal opportunities are secured by law, and they are assisted and subsidized by various social welfare programs from the Central and State Governments.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and	(a)Y (b)Y (c)Y (d)Y	(a) Health and safety will be prioritized in accordance with the Indian legislation. (b) Health and safety will be prioritized in accordance with the Indian legislation. (c) WBSEDCL will implement it through the contract with construction companies. (d) WBSEDCL will implement it through the contract with construction companies.

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?		
5 Others	(1) Impacts during Construction	(d) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (e) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts? (f) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(a) Y. (b) N. (c) Y	(a) Air pollution, noise, water contamination and wastes are anticipated during construction stage, but watering on road, using low noise/vibration equipment, setting sedimentation pond or promoting recycling and reuse will decrease its impacts. (b) No impact to surrounding natures is anticipated as the almost of big civil works will be done underground. (c) Inflow of outside construction workers in the project site may cause some conflicts with local people due to such as the difference in the custom and the pandemic of infectious diseases. Increase of traffic volume may cause traffic accidents. Countermeasures will be taken for education on living and sanitation and health check for construction workers, and time control of traffic volume, and others.
	(3) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a)Y. (b)Y (c)Y (d)Y	(a) Compiling the environmental monitoring plan and its implementation is mandatory, and items with possible adverse impact will be monitored. (b) Air quality, water quality, soil, sediment, noise, odor, waste, ecosystem, hydrology, topography and geography, land use, water right and use and other environmental indicators will be monitored. Monitoring method and frequency is described in the monitoring form. (c) Monitoring will be conducted by executing agency, WBSEDCL, except while contractors are employed. (d) Monitoring report system will be submitted by contractors to the Consultant and WBSEDCL periodically. WBSEDCL will review contractors' periodic reports.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Road checklist should also be checked.	(a)N	(a) Checklist for Turga PSPP covers access roads as well, therefore it is unnecessary to add items described in the Road Checklist to this Checklist.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed, (e.g., the project includes factors that may cause problems, such as	(a)N	(a) Impacts to global issues as exhaust gas from construction of T/L will remain negligible level.

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).		

N/A=Not Applicable

Note 1: Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are requested to be made.

In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).

Note 2: Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Annexure 11-10

ABBREVIATED RESETTLEMENT ACTION PLAN

FOR

TURGA PUMPED STORAGE PROJECT

(FINAL DRAFT)

April 2018

Table of Contents

ABBREVIATIONS

ARAP	Abbreviated Resettlement Action Plan
BDO	Block Development Officer
CSR	Corporate Social Responsibility
DMS	Detailed Measurement Survey
DPR	Detailed Project Report
EC	Environmental Clearance
EIA	Environmental Impact Assessment
EMP	Environmental Monitoring Plan
FC	Forest Clearance
FD	Forest Department
GIS	Gas Insulated Switchgear
GOI	Government of India
GOJ	Government of Japan
GPS	Global Positioning System
GRC	Grievance Redress Committee
GRS	Grievance Redress System
I&W Dep	Irrigation and Waterways Department
IHHL	Individual Household Latrine
JICA	Japan International Cooperation Agency
MOEFCC	Ministry of Environment, Forest and Climate Change
MW	Megawatt
NTFP	Non-Timber Forest Product
ODA	Official Development Assistance
PPSP	Purulia Pumped Storage Project
P.S.I.C.	Project Site in charge
SC	Scheduled Caste
SIA	Social Impact Assessment
ST	Scheduled Tribe
WBSEB	West Bengal State Electricity Board
WBSEDCL	West Bengal State Electricity Distribution Company Limited
WBSETCL	West Bengal State Electricity Transmission Company Limited

1 INTRODUCTION

With the fourth biggest population and fifth biggest economic volume in India, West Bengal State is expecting a steep increase in the power demand and the generation capacity. The peak demand in 2015 reached 7,544 MW, and that of 2019 is expected to be as much as 11,172 MW. Though the power supply in the State is rather stable in comparison with national average, there has been a need to enhance the supply capacity at peak hours by making use of surplus power, and to further improve the quality of power supply for immediate response.

For the supply of electricity during peak hours, pumped storage power generation is considered as one of the most appropriate methods since it can raise the output in a short time and allows the surplus electricity to be utilized during off-peak hours where certain level of base power source is secured. Former West Bengal State Electricity Board (WBSEB)[1] conducted a technical survey for pumped storage power plants in 1979, in which they identified, evaluated, screened, and prioritized the potential development sites within the State. Among the four most prioritized sites for pumped storage power plant[2], the Purulia site was selected to develop a pumped storage power plant and started its operation in 2008.

Following the success of Purulia Pumped Storage Project (PPSP) in not only enforcement of electricity supply itself, but also the associated local area development activities, WBSEDCL stepped forward to the second most potential pumped storage power plant, i.e., Turga PSP. They elaborated the Detailed Project Report (DPR) in which environmental and social adverse impacts were carefully avoided and minimized to the maximum extent possible. An environmental impact assessment (EIA) (associated with social impact assessment (SIA), environmental monitoring plan (EMP) and public hearing) was conducted in 2015 and 2016, to which the Environmental Advisory Committee (EAC) of the Ministry of Environment, Forest and Climate Change (MoEFCC) gave a recommendation for an environmental clearance (EC) in June 2016. Forest clearance (FC) (stage-1), which was given as a condition for obtaining the EC, is expected to be issued following the decision in the Forestry Advisory Committee (FAC) held on 25 January 2018. WBSEDCL will apply for the issuance of the EC to the MOEFCC as soon as they receive the FC.

The GOI requested JICA to extend its yen-loan assistance to Turga PSP, and J-Power proceeded with a technical study commissioned by JICA, in which environmental and social surveys were included as one of the most critical study items. This abbreviated resettlement

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[1] WBSEB was unbundled into WBSETCL and WBSEDCL in April 2007.

[2] Purulia, Turga, Kathlajal and Bandhu.

action plan (ARAP) is developed as one of the environmental and social documents prepared for JICA to appraise the project, and WBSEDCL is expected to be compliant with the guiding principles of the plan and implement it accordingly.

2 OBJECTIVES

The ARAP is developed with objectives of 1) providing information and data on the level and kinds of social impact likely caused by the project implementation, especially impact on land use, local livelihoods and communities; 2) setting out the policy framework and guiding principles on such social impact (for both predicted ones and unforeseen ones) in compliance with the Indian laws and regulations, and the JICA Guidelines for Environmental and Social Considerations (issued in April 2010), and; 3) planning the required actions based on the entitlements given under the above policy framework and guiding principles.

3 LIMITATION

The ARAP is based on the proposed construction of Turga PSP, and 400kV transmission lines from switchyard to the GIS substation with presently available technical design and primary data collection results collected during the survey period from October 2017 to March 2018.

Losses of livelihood means and income due to potential use of non-forest WBSEDCL land have been identified as a result of consultation with WBSEDCL and interviews with affected household members. The WBSEDCL land is located in Kudna and those households who cultivate unauthorizedly were interviewed and their geographical locations were also identified by GPS. Not only the affected households, group interviews with residents were held in November 2017 followed by public consultations in February 2018, in which livelihood restoration activities, compensation for the affected people, and local area development plan were discussed.

The ARAP has been developed for prior consent between JICA and WBSEDCL for Turga PSP project to be eligible for Japanese ODA Loan. As of April 2018, however, it is uncertain if non-forest land (private land and WBSEDCL land) are utilized or not for borrow area purpose, since it depends on the quantity and quality of soil exploited in forest land. WBSEDCL will monitor the progress of construction work and make decisions when the time comes. Along with the finalization of land use plan, a detailed measurement survey (DMS) shall be conducted by the contractors (supervised by WBSEDCL and the Consultant) in consultation with the Land Department and Agriculture Department to assess the values of crops and other agricultural products and examine the compensation amount, based on the compensation framework and principles described in this plan which are compliant with the Indian laws and regulations, and the JICA Guidelines.

4 OUTLINE OF PROJECT COMPONENTS THAT MAY CAUSE SOCIAL IMPACTS

This project is comprised of the following four components from (1) to (4).

(1) Construction of a pumped storage power generation facilities (upper reservoir, lower reservoir, power intake, intake tunnel, penstock, tailrace tunnel, tailrace outlet, underground powerhouse (output: 250 MW *4), etc.)
(2) Procurement and collection of construction materials and installation works
(3) Extension of transmission lines and towers (approximately 1.7km from the switchyard to the existing power substation
(4) Provision of consultancy services (detailed design, assistance for tenders, supervision of construction works, etc.)

According to the WBSEDCL, the Project will require approximately 300 ha of land, of which 292 ha will be diverted for the pumped storage power plant and associated facilities[3], and 7.82 ha for ROW of transmission lines and tower locations. 292 ha for Turga PSP is comprised of 234 ha of forest land, 58 ha of non-forest land (34 ha of irrigation reservoir that presently belongs to the Irrigation & Waterways Department (I&W Dept.), and 24 ha of WBSEDCL's land and private land). The tenure of the irrigation reservoir will be transferred to WBSEDCL, and 24 ha may be temporarily used or leased. The submergence area for upper and lower reservoirs is 146.589 ha. The lower reservoir is planned to be developed by expanding the existing irrigation reservoir.

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[3] The usages of the required land (292 ha) are: 146.589 ha for upper and lower reservoirs, 16.332 ha for civil structures, 16.332 ha for construction facilities, 18.60 ha of stockpile, processing and disposal areas, 21.97 ha for project roads (permanent and temporary), 18.60 ha for rock quarry areas 42.401 ha for borrow areas (clay areas), and 8.537 ha for other project components.

5 NECESSITY OF LAND USE PATTERN AND RESETTLEMENT

5.1 LAND USE PATTERN

There will be no permanent land acquisition under the project. The land use under the final project design will be 292 ha for the construction of the pumped storage power plant and its relevant facilities, and another 7.82 ha for the right of way (ROW) of the transmission lines and towers (1.7 km long and 46 m wide)[4].

The following table shows the land usages for the project and their present land category.

Table 5-1 Land Use Plan under the Project & their Present Use

(Unit: ha)

Component		Land use	Present land classification		
			Forest land	Non-forest land	
				Government	Private
1. Turga PSP		291.416	233.416	0	0
a.	Submergence area (lower & upper reservoirs)	146.589	112.900	33.689	0
b.	Civil structures	16.332	16.332	0	0
c.	Construction facilities	18.387	18.387	0	0
d.	Stockpile, processing and disposal area	18.600	18.600	0	0
e.	Project roads (permanent & temporary)	21.970	21.970	0	0
f.	Rock quarry area	18.600	18.600	0	0
g.	Borrow area	42.401	18.090	9.55	14.761
h	Other project components	8.537	8.537	0	0
2. ROW of Transmission line		7.820	7.820	0	0
3. TOTAL		299.236	241.236	43.239	14.761

Source: WBSEDCL

Note 1: The non-forest land for the submergence area, 33.689 ha, is the irrigation reservoir presently located where lower reservoir will be developed. The reservoir belongs to the I&W Dept.
Note 2: The non-forest land for the borrow area (24.311 ha) is comprised of WBSEDCL's former borrow area used in the construction of Purulia PSP (9.55 ha) and private land (14.761 ha).
Note 3: Breakups of each component are different from those written in the DPR and EIA submitted to the GOI in 2016. The figures shown in the above table are the latest and final ones that reflect the results of MOEFCC's site inspection conducted in November 2017.

5.2 RESETTLEMENT

There is no involuntary resettlement anticipated by such land use under the project.

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[4] The maximum width of RoW corridor is calculated based on tower design, span, and wind speed, maximum sag of conductor and its swinq plus other requirement of electric safety. According to the MOEF Guideline No. F.NO. 7-25 / 2012 - FC dt 05/05/2014, width of ROW for 400 kV D/C line under standard conditions is considered as 46m.

6 POTENTIAL SOCIAL IMPACTS

In the process of and as a result of the technical survey for DPR, permanent acquisition of private land or involuntary resettlement have been avoided by identifying alternative and feasible designs that have the least adverse impact on the project impacted area.

For the Turga PSP construction, 234 ha of forest land will be diverted for project facilities, permanent and temporary roads, installation and processing of construction facilities, stockpile, disposal, rock quarry area and borrow area. ROW clearance for another 7.82 ha of forest land will be obtained for transmission lines and towers.

Out of 58 ha of non-forest land, 24.311 ha of non-forest land (9.55 ha of WBSEDCL land and 14.761 ha of private land) may be utilized as borrow areas during construction period if the quantity and quality of soil collected in forest land is not sufficient. Among 14.761 ha of private land, two plots are located in Hathinada (total 5.945 ha), and another two in Gosaidi (1.82 ha)). The rest 7 ha of private land is planned in Kudna without being identified yet as of April 2018 but considered as an additional option to use as borrow area. When it is found necessary to use or lease private land in the non-forest area, contractor will negotiate with each and every land owner to conclude a lease contract with mutual consent on the conditions. Land owners have rights to deny or reject such temporary use if they do not wish, to which contractor must respect and search for alternative land. No involuntary or forced provision of private land is therefore anticipated. WBSEDCL will supervise if the contracts are concluded with fair and favorable conditions for land owners according to the Indian law.

Out of 9.55 ha of WBSEDCL land, it has been identified that one WBSEDCL's land in Kudna (4.98 ha) may potentially cause loss of livelihood means and income as local farmers have been cultivating paddy and vegetable there without tenure. When it is found necessary to use the Kudna borrow area under the project, they will lose their products, livelihood means and income, and the ARAP has been compiled in accordance with Indian acts and JICA's policy, address the issue of losses of products, livelihood means and income. The ARAP will be translated into local languages and disclosed for the reference of the affected people as well as other interested groups.

Table 6-1 Details of Planned Borrow Areas

No.	Location ID	Location	Land Category		Remarks
			WBSEDCL land	Private land	
1. Borrow area for upper reservoir					
a.	UCA-4	Hathinada	-	4.1 ha	Contractor will conclude a lease contract based on mutual consent with land owner.
b.	UCA-5	Hathinada	-	1.845 ha	ditto
2. Borrow area for lower reservoir					
a.	LCA-4	Gosaidi	-	1.006 ha	ditto
b.	LCA-5	Gosaidi	-	0.81 ha	ditto
c.	LCA-1	Kudna	4.98 ha	-	Local farmers grow crops and other agricultural products unauthorizedly
d.	Unidentified yet	Kudna	-	7 ha	-

Source: JICA Study Team

33.689 ha of non-forest land that belongs to the I&W Dept. presently used as the irrigation reservoir will be expanded as lower reservoir. Irrigation water and drinking water is currently taken at the existing irrigation reservoir where people residing nearby also do fishing from time to time. Construction of a coffer dam next to the lower reservoir is one of the countermeasures reflected in the project design that ensures availability of drinking water, irrigation water, and enables fishing activities to be continued during the construction period.

There are least gaps between the legal framework of India and West Bengal State, and JICA's Policy. WBSEDCL is expected to be compliant to and consistent with her country's statutes and good practices as well as JICA's policy to help ensure that affected people are able to rehabilitate themselves to at least their pre-project condition.

WBSEDCL has decided that they will not declare the cut-off-date[5] prior to the project implementation, since it will be fixed after the construction starts whether they have to go on to the use of non-forest WBSEDCL land. WBSEDCL has a clear idea that they exploit the forest land first, and will not explore any land owned or used by local residents until they find it difficult to collect sufficient quantity and quality of soil within the forest land to the expected level. However, once the necessity to exploit the construction materials on WBSEDCL land is confirmed, WBSEDCL will hold consultations with the affected people and will make prior payment of compensation through contractors. The updated and latest official information on the affected people will be collected by the District Magistrate and Block Development Officer (BDO) of Baghmundi. Livelihood restoration activities will be conducted through BDO financed by WBSEDCL.

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[5] The "cut-off date" makes owners/users of the land eligible to be categorized as the affected people and be eligible to the project entitlements.

7 POLICY FRAMEWORK UNDER THE PROJECT

The following issues shall be the principles and policy framework mutually confirmed by both sides.

7.1 COMPENSATION

Compensation and rehabilitation support will be provided to the affected people, that is, any person or household which on account of project implementation would have his, her or their:

- Standard of living adversely affected;
- Interest in any land;
- Income earning opportunities adversely affected; or
- Social and cultural activities and relationships affected or any other losses that may be identified during the process of land requisition.

All affected people will be eligible for compensation and rehabilitation assistance, irrespective of tenure status, social or economic standing and any such factors that may discriminate against achievement of the objectives outlined above. Lack of legal rights to the assets lost or adversely affected tenure status and social or economic status will not bar the affected people from entitlements to such compensation and rehabilitation measures.

All the affected people cultivating land within the project impacted areas as of the date of the latest census and inventory of lost assets, are entitled to compensation for their lost products and means of livelihoods, and restoration of incomes will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity and production levels.

Compensation for the affected people who are dependent on agricultural activities will be land-based wherever possible. Land-based strategies may include provision of replacement land and upgrading livelihoods of people without legal land titles. If replacement land is not available, other strategies may be built around opportunities for re-training, skill development, wage employment, or self-employment. Solely cash compensation will be avoided as an option if possible, as this may not address losses that are not easily quantified, such as access to services and traditional rights, and may eventually lead to those populations being worse off than without the project.

7.2 ASSISTANCE

Assistance will be provided not only for immediate losses, but for their transition period for the restoration of the livelihood and standards of living of the affected people.

The ARAP takes into consideration the needs of those most vulnerable to the adverse impacts (including the poor, those without legal title to land, tribes, women, children, elderly and disabled) and ensure they are considered in planning and mitigation measures identified. Assistance should be provided to help them improve their socio-economic status.

7.3 PARTICIPATION

The affected people will be involved in the process of developing and implementing the ARAP.

The affected people and their communities will be consulted about the project, the rights and options available to them, and proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made.

7.4 INSTITUTIONAL ARRANGEMENTS

Adequate budgetary support will be fully committed and made available by WBSEDCL to cover the costs of land use, compensation and income restoration measures within the agreed implementation period.

Payment of compensation, and start of the livelihood rehabilitation activities of the affected people, will be completed prior to relevant construction activities.

Organization and administrative arrangements for the effective preparation and implementation of the ARAP will be identified prior to the commencement of the process.

Appropriate reporting (including auditing and redress functions), monitoring and evaluation mechanisms, will be identified and set in place.

8 FEATURES OF POTENTIALLY AFFECTED HOUSEHOLDS

The socioeconomic features of the local communities in the project impacted area were collected through group interviews of local people from the surrounding villages, and a verbal and written interview with the BDO, Bagmundi block.

In addition, based on the data and information given by WBSEDCL, the survey team shortlisted the households of potentially affected by the project implementation if non-forest

WBSEDCL land is used as borrow area as mentioned above, and their salient features were collected during the survey, namely; demographic profile, education, occupation, land tenure, assets, household infrastructure, etc. through the initial baseline survey comprised of population census, asset inventory and household socioeconomic survey.

The survey team was comprised of WBSEDCL (executing agency), JICA Study Team, WAPCOS (local consultant hired by JICA Team), and local coordinators well conversant with local language selected from the communities. Pre-test of the questionnaire was conducted at three households prior to the household interview survey, following which the prepared questionnaire was reviewed and revised to suit the local context as attached to this report. The interview survey itself was conducted between 24 to 29 November 2017 and 22 February 2018. A total of seventeen families were covered under the survey. The Team revisited some of them to correct discrepancies among raw data and collect missing information within the said period for compiling, systematizing and analyzing the data accurately. Out of the interviewed seventeen families covered under the survey, five households from Kudna village are identified as the potentially affected households whose livelihood means conducted unauthorizedly on WBSEDCL land may be lost.

8.1 DEMOGRAPHIC FEATURES

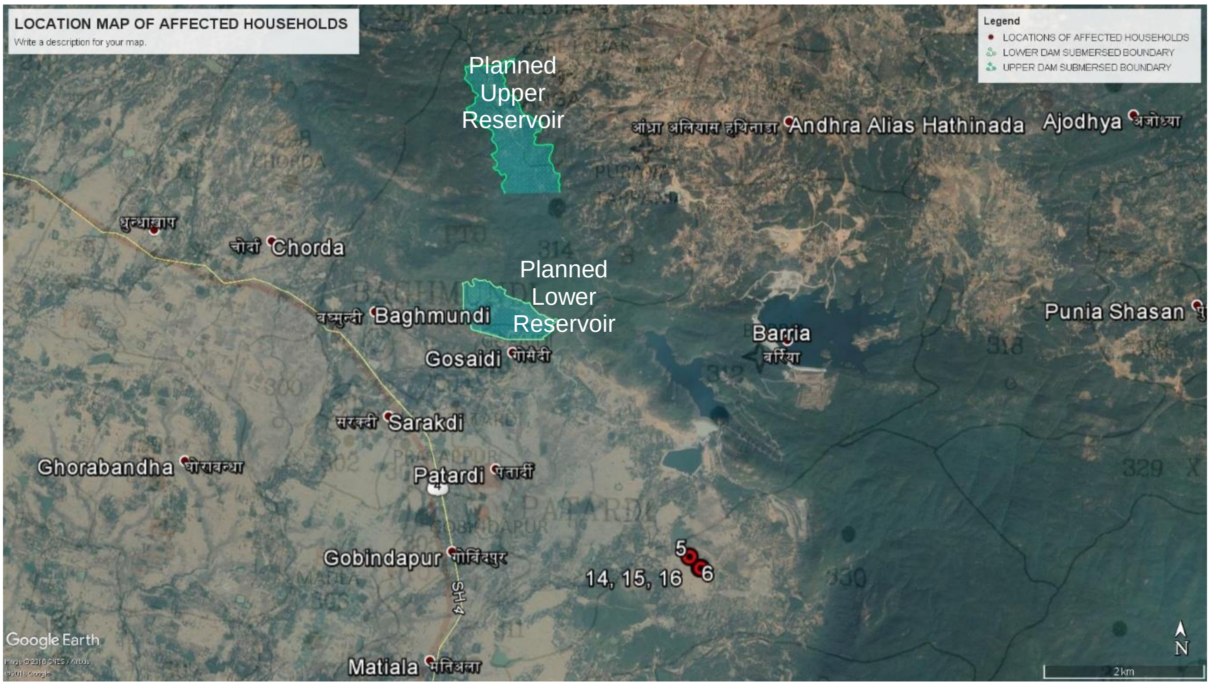
Among the five households, one belongs to general caste, and the rest four are Scheduled Tribe (Santhal). Out of 25 household members, 13 (52.0%) are male and 12 (48.0%) are female (Table 8-1). One (4.0%) is below 6 years old, 5 people (20.0%) from 7 to 14 years old, 10 people (40.0%) from 15 to 29 years old, 5 (20.0%) from 30 to 44 years old, 4 (16.0%) from 45 to 59 years old, and nobody is above 50 years old. Their living locations are shown in the map below (Figure 8-1).

Table 8-1 Basic Features of Potentially Affected Households

(Unit: number of household or person)

Living village	Private land for borrow area		No of HHs	Caste		No of people	Gender		Age distribution					
	Location	ID		Gen	ST		M	F	0-6 yrs	7-14 yrs	15-29 yrs	30-44 yrs	45-59 yrs	60 yrs <
Kudna	Kudna	LCA-1	5	1	4	25	13	12	1	5	10	5	4	0

Source: JICA Study Team



Source: JICA Study Team

Note: Out of seventeen surveyed households, serial numbers of five households from Kudna are “5”, “6”, “14”, “15”, and “16”.

Figure 8-1 Locations of Potentially Affected Households in Kudna

8.2 EDUCATION

In terms of literacy, 18 people (72.0%) are literate and 6 (24.0%) are illiterate. The rest one is under school age (below six years old). 9 people (36.0%) have attended school (the minimum education is Class 4th and the highest is undergraduate), another 9 (36.0%) are now attending school (as of November 2017 when the survey was conducted), and 6 (24.0%) never attended although education at government schools in the surveyed area are imparted for free.

Table 8-2 Literacy and Education Status

(Unit: number of person)

Living village	No of people	literacy			School attendance				highest education			
		literate	illiterate	Not yet school age	under school	attended before	currently attending	never	primary	junior-secondary	higher secondary	higher
Kudna	25	18	6	1	1	9	9	6	3	7	6	2

Source: JICA Study Team

Note: As of November 2017, one person was not yet at school age (under six years old). He is therefore not counted either “literate” or “illiterate.”

8.3 OCCUPATION AND PRODUCTS

All five households are involved in farming activities. Three of them have farming as their primary occupation whereas the other two have driver, operator, and laborer as their main income earners.

They grow paddy, one of them grows pulse too. All of whom grow agriculture products for self-consumption (domestic purpose), one of them also sell their products for commercial purposes. Annual volumes of paddy production differ by household. All of them depend on rainwater for irrigation.

All surveyed households collect NTFP throughout a year except rainy season as their main source of energy is fuelwood. Tree leaves are also collected for making indigenous plates for serving food. The selling price of fuelwood is Rs. 100 per bundle[6].

They also rear livestock at almost every household. Cows and goats are reared by all five households, followed by roosters (four households) and ducks (two households). Major purpose of keeping livestock is for self-consumption / domestic, and a few households sell them at local market.

8.4 ECONOMIC LEVEL

(1) Income Level

Income levels stated voluntarily by the households are varied. The minimum monthly household income is Rs. 3,000 (two households), followed by Rs. 5,000 (two households). All four households grow paddy and other agricultural products only for self-consumption. There is one household whose monthly income is Rs. 27,000. It is noted that the figures are not exact or accurate, as they work on their own (daily or seasonally) and no official income statement was given as evidence.

(2) Other information

Most of the potentially affected households are below poverty line. They are assisted and subsidized by various social welfare programs from the Central and State Governments. They have at least one “zero balance account” to receive government financial assistance. They are also entitled to purchase grains and pulses at “public distribution shops” at nominal rates.

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[6] One bundle consists 30 kg.

8.5 IMMOVABLE ASSET

(1) Land

According to the verbal explanation by the households, total land they own are also varied among them. The minimum land is 10 decimals, and the maximum is 100 decimals[7]. The rest three households have either 38, 55 or 70 decimals of land. Again, it is noted that the figures are not exact or accurate, as no official document was presented as evidence.

(2) Homestead Structure

All five households have kuccha (semi-structured with temporary materials made up of mud, dry leaves, straw and bamboo) structure of homestead.

(3) Trees

Trees owned by the households are in their peripheries, while trees reared in the surveyed villages are Boheda, Dumari, Dates, Custard Apple, Guava, Lemon, Karam, Mango, Saali and Teak.

8.6 MOVABLE ASSET

Four households have both mobile phones and bicycles. TV is owned by one.

8.7 INFORMATION SOURCES

Important information such as government assistance schemes, other issues and prior notice of meetings are imparted through civil volunteers, Village Pradhans, and Panchayat members. The official channel for information sharing is the Gram Panchayat Office. Two affected households collect information through newspaper, while one collects from TV.

8.8 HOUSING INFRASTRUCTURE

(1) Sources of Energy

All surveyed households are electrified except one. Firewood is the major source of cooking at all households.

(2) Water Supply

Common tube well is the major source of drinking water among four households. Water taken from pond or lake is used for domestic purpose among all households. Rainwater is used for irrigation purpose by all households.

(3) Sanitation Facility

One household has pit toilet (traditional pit latrine) at home, while the rest use open space. Liquid and solid domestic wastes are disposed at open space among all households.

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[7] One decimal is equal to 435.6 square feet or 40.46856 m^2.

8.9 COMMON DISEASES

Survey analysis elucidates that cold and cough are commonly found among the surveyed households. Malaria and diarrhea are also found among some of them. Medical facilities in the surveyed villages are subsidized by the Government and services are given for free if they are eligible under the schemes of West Bengal State and Central Government.

8.10 VULNERABILITY

Along with general caste, ST people (Santhal) are among the project affected households. Santhal people are commonly seen in Nepal, Bangladesh, and several parts of North India (Bihar, Jharkhand, West Bengal, Odisha and Tripura), and Bhumij people are found in West Bengal, Jharkhand and Odisha too. Their villages are connected by local road network and accessible from the block capital and other neighboring villages. They purchase goods and services at local markets, and wear clothes same as rest of the local residents. Santal people speak Santali (*Olchiki*) as their first language and Bengali as their second. The illiterate among them, most of them are female elderly, only speak Santali. They often collect NTFP and sell them at local market in Baghmundi town. Their identification, their forest rights, and reservation of vacancies in services and posts are secured and protected by the Constitution and domestic laws[8]. According to WBSEDLC and the BDO, most of the affected people and the communities in the project impacted area are below poverty line, and they are assisted and subsidized by various social welfare programs from the Central and State Governments. Under the Individual Household Latrine (IHHL) Scheme of the GOI, for instance, Rs. 10,000 is given to each household for latrine construction.

9 PROJECT AFFECTED PEOPLE AND THEIR ELIGIBILITY

The potential affected households and their people are summarized as in the table below.

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[8] The West Bengal Scheduled Castes and Scheduled Tribes (Identification) Act, 1994, The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006, The West Bengal Scheduled Castes and Scheduled Tribes (Reservation of Vacancies in Services and Posts) Act, 1976.

Table 9-1 Number of the Affected Households and their People

(Unit: number)

Type of affected people	No of Village	Legal		Unauthorized (encroached)		TOTAL	
		Household	Person	Household	Person	Household	Person
Cultivators of WBSEDCL land (LCA-1)	1	0	0	5	25	5	25

Source: JICA Sturdy Team

Note: WBSEDCL will conduct local consultations to officially identify the number of the affected households and people with information provided by the District Magistrate, if they find they must explore non-forest WBSEDCL land to use as borrow area. The numbers in the table are the snapshot collected in the initial baseline survey as of November 2017.

Among the borrow areas that belong to WBSEDCL which used to be PPSP's clay core exploited areas, five households state that they cultivate crops and vegetable at Kudna borrow area[9]. It may cause adverse impact on the local livelihoods if the cultivated land including private land are used for collecting construction materials. It is uncertain yet, however, at the timing of pre-construction period, whether non-forest land will be used for exploiting clay core materials for the construction. There needs further geological investigation, soil sampling test and actual excavation to confirm if the earmarked forest land as borrow area can provide all the required amount and quality of clay core construction materials. WBSEDCL has a clear-cut idea that they will exploit the forest land first, followed by the government land, and requisition of non-forest private land is their last. The affected households will therefore be finally confirmed along with the construction progress in due course of time.

9.1 ENTITLEMENT MATRIX

Based on the compensation policy for the losses caused by the project and livelihood restoration activities, the entitlement matrix has been drafted as in the table below:

Table 9-2 Entitlement Matrix

Type of loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation Package)	Implementation issues/Guidelines	Responsible Organization

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[9] It was not easy for the respondents to state accurate land area to be likely leased. Those who stated that they cultivate the affected land do not have a clear idea either how much amount of products they generate by their farm activities as all of them consume their products at home and sell the rest at local market.

Type of loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation Package)	Implementation issues/Guidelines	Responsible Organization
Loss of access to cultivable land by cultivator	Cultivators (unauthorized) of WBSEDCL land	- Crop / vegetable compensation equivalent to higher values of either 1) government prices at the time of compensation, or 2) annual average market prices - Double harvesting times - Additional grant (20%) for the expenses (manpower, fertilizer, materials, seeds, seedlings etc.)	<Assessment> - Assessment of quantity and quality of land - Assessment of market value of crops / vegetables <Entitlement> - Updating of title of the affected persons - APs will be fully informed of the entitlements and procedures regarding payments in prior <Payment> - Prior payment	<Assessment> Dept. of Agriculture <Entitlement> Contractor (supervised by WBSEDCL) <Payment> Contractor (supervised by WBSEDCL)

Source: JICA Sturdy Team

Note: Existing local government regulations of Purulia District for compensation calculations for crops and vegetables will be used where ever available.

9.2 COMPENSATION FOR LOSSES OF LIVELIHOOD MEANS AND INCOME

For the project, the losses and entitlements of the affected people are crops and/or vegetables on the WBSEDCL owned land, and livelihood means (cultivation).

The following table summarizes the WBSEDCL land possibly utilized in the project. There will be no building, tree, or cattle affected by the project. WBSEDCL will pay the compensation based on the policy framework as defined in the ARAP if the land is used.

Table 9-3 Assets likely Impacted under the Project

Land use in the project			Affected Land (ha)		No of Affected HH	Land condition and products as stated by the affected households		
Village	Purpose	Location ID	Gov land	Pvt land		Condition	Product	Product purpose
Kudna	Borrow area	Kudna (LCA1)	4.98	-	5	farmland	Paddy	self-consumption / commercial

Source: WBSEDCL and JICA Sturdy Team

Note: WBSEDCL will conduct local consultations to officially identify the number of the affected households and people with information provided by the District Magistrate, if they find they must explore non-forest land to temporarily use as borrow area. The number of affected households, land condition and products are as stated by the interviewed households collected in the initial baseline survey as of November 2017

10 VALUATION OF ASSETS AND COMPENSATION FOR LOSSES

Crop compensation that is commonly practiced in Purulia District reflects the government rate that offsets fluctuation of selling prices at market for the benefit of farmers, but it does not concern other cost borne for soil improvement, fertilizers, pesticide, chemicals, tools, manpower, etc.

Crop compensation for the project shall be calculated based on the following formula:

X*2*1.2

X: Harvests' value to be lost. It is one harvest season per year in the project area.

2: Two times of harvest

1.2: 120% including top-up payment to enhance compensation (20% covers expenses borne for other than crops such as fodder, manpower, pesticide, fertilizer, etc).

The main crop grown in the non-forest land that may be utilized temporarily for extracting clay is paddy. Average crop yield for paddy is 51 quintals per ha, and its government rate is Rs. 1,550 per quintal according to the Office of the Assistant Director of Agriculture of Baghmundi Block[10]. Their seeds are supplied from Government of West Bengal and are available at various Government registered seeds shops. Their agriculture products are sold at CPC, FPO and public market.

With an assumption that the Kudna clay area is used, the compensation amount has been estimated as approximately Rs. 950,000 as at 2017/18 price as shown in Table 10-1. Price escalation shall be considered at 10% per annum

Table 10-1 Estimation of Crop Compensation

Affected Land			(a)	(b)	('c)	(d)=(a)*(b) *(x+1)*('c)	('e)=(d)*0.2	(f)=(d)+('e)
Village	Gov land (ha)	Pvt land (ha)	Average crop yield for Paddy (Quintal / ha)	Production One Season (Quintal / ha)	Govt Rate of Paddy / Quintal (Rs. / quintal)	Compensation for Two Crops (Rs.)	Top-up (20% for fodder, manpower etc. Rs)	TOTAL
Kudna	4.98	-	51	610.98	1,550	787,338	157,468	944,806

Source: JICA Study Team

Note: the average crop yield for paddy and government rate of paddy per quintal are as of 2017/18 collected from the Department of Agriculture.

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[10] Wheat, kalai, tomato and onion are also grown in the project site. As per the official data collected from the Office of the Assistant Director of Agriculture of Baghmundi Block, average crop yield (quintal /ha) for them are 25, 9.5, 31, and 37 respectively.

11 LIVELIHOOD RESTORATION ACTIVITIES

People identified as affected people whose crops and vegetables will be lost by having borrow areas in non-forest WBSEDCL land are entitled to receive compensation and livelihood assistance from WBSEDCL.

Livelihood restoration provides necessary arrangements for improving or at least restoring the livelihoods and standards of living of affected people in the project community, which will ensure the compensation and other assistance are provided in a transparent and equal way. Livelihood restoration will include offering in the form of cash compensation if it is appropriate, and other assistance deemed as necessary to affected people. Opportunities shall be given to affected households to participate in negotiation process for defining reasonable prices of the used land and their products.

The livelihood restoration initiatives shall be considered followings.

- Involvement of affected person in the opportunities for the construction and operation period of the project which shall security their jobs toward sustainable life.
- Arrangement of providing trainings and extension courses for farmers
- Participation of affected people and local communities inclusive of interested parties and contribution of their opinions in establishment of restoration mechanism.

Following activities are proposed for the affected people and local communities:

(1) Training for Skill Development
One member of each family, either male or female, shall be given training for skill development. It is suggested to provide ITI Training at the Government ITI located at Purulia.

A scholarship provision of Rs. 15,000 per year for meeting their fee and study material requirement at the ITI along with Rs. 5,000 per year for meeting their hostel expenses for a period of one year is being made for one member of each 5 affected households. Hence 5 students are proposed to be covered under this scheme. The ITI shall provide training in additional fields like tailoring, incense stick making, etc. along with the training like carpenter, electrician, mechanic and computer typing, etc. keeping in in mind the target families to help enhance the current livelihood status of the surrounding area villages.

A total amount of Rs. 375,000 may be earmarked for providing scholarships, details of which are given in Table 11-1.

Table 11-1 Details of ITI Expenditure per temporarily affected family

S.No.	Activities	Amount (Rs.)
1	Hostel expenses (@ Rs.5,000/month x 5 students x 1 year)	300,000
2	Fees/course material (@ Rs.15,000/year x 5 students for 1 year)	75,000
	Total	375,000

Source: JICA Survey Team

(2) Training and Extension Courses for Farmers

Since farming is widely done by the project surrounding villages hence training to the farmers shall be imparted. The training shall include the following aspects of environmental protection:

Table 11-2 Training and Extension Courses for Farmers

No.	Program	Measures
1	Prevention of spread of water related diseases	・ Hygine and personal health care ・ Control of water spills, pudding etc. ・ Prevention and prophylactic measures for control of vectors ・ Disposal of human waste ・ Disposal of drainage water
2	Safe use of agro-chemicals	Control of weeds in channels ・ Methods of cleaning and disposal of weeds ・ Detrimental environmental effects of agro-chemicals ・ Information on biological weed control. Pest control ・ Specific uses of pesticides and its optimization ・ Residual degradability ・ Effect on untargeted species ・ Safety procedures during application ・ Rate and frequency of application ・ Disposal of packing material and surpluses ・ Storage of chemicals Fertilizer use ・ Type, dosage, application techniques, timing and frequency of application and its relationship with type of soils; ・ Disposal or storage of packing materials and surpluses. ・ Topics to be covered under Environmental conservation programmes are: ・ Protection of forest or trees ・ Control of tree felling of fuel wood and timber ・ Advice on establishment of village woodlot ・ Soil conservation measures. ・ Such training courses can be organized by Agriculture Department, state government of West Bengal ・ Information on cropping measures such as weeding, rotational cropping, cleaning of bunds, etc.
3	Environmental conservation program	Dissemination

Source: JICA Survey Team

A lumpsum amount of Rs. 1.5 million shall be earmarked and given to the Agriculture Department to train the residents of the surrounding villages.

Apart from the livelihood restoration activities, local area development plan is proposed in SIA and submitted to the GOI as part of EIA for EC including upgradation of education facilities, scholarship for students, improvement of public health facilities, community toilets, portable water facilities, new ponds, playground, etc.

12 INSTITUTIONAL FRAMEWORK AND IMPLEMENTATION PROCESS

Since the results of the initial baseline survey are preliminary ones, WBSEDCL will update the list of affected people by conducting the DMS, based on the official information collected at the District Magistrate Office and Land Revenue Department when they find they must go on to the use of non-forest government land. Analysis on socio-economic situation of the affected people who cultivate Kudna land will be officially updated by the District Magistrate and BDO.

Although the Project may generate social impacts and it will be only minor impacts at small-scale, a DMS must be undertaken prior to starting the use of Kudna borrow area. The objective of the DMS will be a) to identify products to be compensated and to collect detailed data of all affected households concerning such losses and compensation cost, and b) to collect socio-economic data of all affected households with a view to identifying losses of livelihood and specific needs for livelihoods restoration, especially of vulnerable households.

With the results of DMS, accurate scope of impacts will be identified and detail compensation rates and rehabilitation measures will be prepared. The information shall be incorporated into the revised ARAP. The revised ARAP will be translated into Bengali language and disclosed to the affected people and villages at BDO Office.

During the construction stage, it is the contractors who will deliver the compensation payments according to the official information and the policy framework agreed in the ARAP. This step should be completed prior to the land use. WBSEDCL will ensure appropriate coordination between relevant authorities and organizations and monitor the affected people are well treated as agreed. BDO will conduct the livelihood restoration activities on behalf. All the payment will be done directly / indirectly by WBSEDCL.

13 IMPLEMENTATION SCHEDULE

The implementation schedule of crop compensation and livelihood restoration activities will be decided according to the results of further geological investigation, soil sampling test and actual excavation to confirm if the earmarked forest land as borrow area can provide all the required amount and quality of clay core construction materials. WBSEDCL has a clear-cut idea that they will exploit the forest land first, followed by their own land, and requisition of non-forest private land is their last.

Tentative implementation schedule for compensation, livelihood restoration activities, local area development activities and monitoring works are outlined in Figure 13-1. WBSEDCL will finalize who the affected households are, amount of compensation, and livelihood restoration activities in collaboration with BDO and Agriculture Department. Livelihood restoration activities will be carried out for the best interest of the affected people, and so will be the land area development activities for entire local people in the project site.

A Project Site Office will be established prior to the construction phase, simultaneously with the planning activities of the Project, and will remain active during the construction period.

Activities	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8
	L/A, C/S		Construction						Operation	
1.Detailed Design	🟧	🟧								
2.Local Consultation by BDO			🟧							
4.Updated ARAP submitted by WBSEDCL			🟧							
5. Compensation for the project affected people				🟧						
6. Livelihood Restoration Activities				🟨	🟨	🟨	🟨	🟨		
7. Local Area Development Activities			🟨	🟨	🟨	🟨	🟨	🟨		
8. Monitoring by WBSEDCL			🟧	🟧	🟧	🟧	🟧	🟧	🟧	

Source: JICA Study Team

Figure 13-1 Tentative Implementation Schedule

14 GRIEVANCE REDRESS

Affordable and accessible procedures for settlement of disputes arising from compensation payments; such grievance mechanisms should take into account the availability of judicial recourse and community and traditional dispute settlement mechanisms.

A site-specific procedure shall be developed for receiving complaints, logging in the GRS logbook for recording and registering purpose, investigation, and analysis and responding to the affected people.

Focal Point for Grievance

Grievance focal person shall be BDO of Baghmundi Block to implement the GRS procedure fairly, equally effectively. He will receive the complaints in verbal or with letter from the affected households directly and indirectly. The complaint shall be recorded and registered accordingly and deliver the message to the Project Site Office promptly.

Project Site in charge

Site based grievance redress team shall be the Chief Engineer cum Project Site in charge at the Project Site office of WBSEDCL. He will review the any complaint and concerns and find a solution to ease the degree of complaints, which will be agreed and accepted by the affected people. In this stage, many issues shall be resolved as possible locally.

Grievance Redress Committee

If the case is not addressed to the affected people's satisfaction, P.S.I.C shall proceed to submit the issue to Grievance Redress Committee for further review.

GRC is the highest authority to make final decision within project specific Grievance Redress System on the received issues which cannot be sorted out up to P.S.I.C. level. GRC will be comprised of District Magistrate of Purulia District, WBSEDCL, State Department of Power, Police Administration Office, BDO and Gram Panchayat.

Unsolved Issue

If the case is still not resolved by GRC, the affected people can proceed through juridical system such as appealing on court for final resolution.

15 COSTS AND BUDGET

All the expenditure shall be borne and paid by WBSEDCL. Crop compensation will be paid through contractor, whereas the budget for livelihood restoration activities will be allocated from WBSEDCL to BDO, and BDO will conduct them on behalf of WBSEDCL.

The total amount is estimated approximately Rs. 2.8 million. The number of affected households for compensation and those covered under the livelihood restoration activities will be revised according to the official identification, and the budget will be estimated accordingly with consideration of price escalation too.

Table 15-1 Cost Estimate for Crop Compensation and Trainings for Income Restoration

No	Item	Cost (Rs.)
A	Crop compensation for the affected people	944,806
B	Livelihood Restoration Activities	1,875,000
	1. Skill development trainings	375,000
	(1) Hostel expenses (@ Rs.5,000/month x 5 students x 1 year)	300,000
	(2) Fees/course material (@ Rs.15,000/year x 5 students for 1 year)	75,000
	2. Training and Extension Courses for Farmers	1,500,000
	(1) Prevention of spread of water related diseases	Lump sum
	(2) Safe use of agro-chemicals	
	(3) Environmental conservation program	
Total		2,819,806

Source: JICA Study Team

16 ARRANGEMENTS FOR MONITORING AND EVALUATION

Internal monitoring will be carried out by WBSEDCL periodically during the whole land use process conducted by the contractor. Internal monitoring will take place on a quarterly basis or other timing depending on the progress.

Livelihood restoration activities will be conducted by BDO on behalf of WBSEDCL. WBSEDCL will monitor the activities during the implementation period quarterly or other timing depending on the progress.

A draft monitoring form is attached to this ARAP and modification shall be done prior to the ARAP implementation.

17 CONSULTATIONS WITH AFFECTED PEOPLE

A series of consultation meetings held in the project area including one official public hearing in February 2016, group interviews in November 2017, and public consultation in February 2018. During discussion, the project summary was explained and local people’s concerns and potential impacts by the project were discussed. As a result, there are no objections against the project and no comments which require additional issue in compensation policy at this timing.

ANNEX 1 HOUSEHOLD SURVEY QUESTIONNAIRE

For the potential affected households only

Questionnaire No. ☐☐

WBSEDCL is planning to construct new pumped storage power plant in Bagmundi Community Development Block. We would like you to cooperate with us to carry out the household survey attention to the potential affected households. The survey results will help us develop a report that describe the degree of social impacts caused by the Project and income restoration strategies. Your cooperation in completing this survey by providing your valuable opinions and reviews will be highly appreciated.

Section 1- Particulars of Interviewed Household's Location			
1.1	**C.D.Block Name**	Bagmundi	1
		Others (specify:)	2
1.2	**Gram Panchayat Name:**	Ajodhya	1
		Bagmundi	2
		Others (specify:)	3
1.3	**Constituent Village Name:**	BHUNIGHRA	1
		TELIA BHASA	2
		SALDI	3
		SARAKDI	4
		PRATAPPUR	5
		PATARDI	6
		GOBINDAPUR	7
		MADLA	8
		BARRIA	9
		GOSAIDI	10
		BAGHMUNDI	11
		PURNA TANRPANIA	12
		RANGA	13
		BARE LOHAR	14
		Others (specify:)	15

Household's location *(please measure by GPS in order to plot their location on a map)*

Coordinates (Latitude / Longitude)	Altitude

Category of Household *(please select either of the following)*

Owners of private land to be requisitioned temporarily as clay core area	1
People / farmers who are likely to lose their livelihood means	2
Others (specify)	3

Answers to choose for Q2 to Q22 of Section A

	Choices	Code		Choices	Code
Answers to 2:	Household head	1	Answers to 12:	Literate	1
	Spouse	2		Illiterate	2
	Children	3			
	Children in law	4	Answers to 13:	Attended before	1
	Brother / sister in law	5		Currently attending	2
	Parent / parent in law	6		Never attended	3
	Grandparents	7			
	Grandchildren	8	Answers to 14:	Pre-school (before 1st yr)	1
	Other relatives	9		Primary (1st to 5th yr)	2
	Adopted child	10		Junior (6th to 8th yr)	3
	Non-relative	11		Higher secondary (9th to 12th)	4
	Others (specify)	12		> University / Collage	5
				Vocational	6
Answers to 3:	Male	1		Special institution for disabled	7
	Female	2		Others (specify)	8
Answers to 4:	Living together	1	Answers to 15:	Available at work	1
	Temporarily Away	2		Able to work and seeking	2
				Able to work but stay out of job	3
Answers to 6:	Single (never married)	1		Student	4
	Currently married	2		Household duties	5
	Widowed/Widower	3		Dependent	6
	Separated	4		Pensioner	7
	Divorced	5		Rentier	8
				Beggar	9
Answers to 7:	Hindu	1		Others (specify)	10
	Muslim	2			
	Christian	3	Answers to 19:	On foot	1
	Sikh	4		Bicycle	2
	Buddhist	5		Rickshaw	3
	Jain	6		Motorbike	4
	Others (specify)	7		Car/Jeep/Van	5
				Auto-rickshaw	6
Answers to 8	Scheduled Tribe (ST)	1		Bus / public transportation	7
	Scheduled Caste (SC)	2		Train	8
	OBC (Other Backward Class)	3		Boat / water transport	9
	General	4		Others (specify)	10
				No travel required	11
Answers to 10:	Hindi	1			
	Bengali	2	Answer to 20:	Daily basis	1
	Others (specify)	3		Monthly basis	2
				Seasonal basis	3
Answers to 11:	Hindi	1		Yearly basis	4
	Bengali	2		Others (specify)	5
	English	3			
	Others (specify)	4	Answers to 21(b)	Main worker (>6 months)	1
				Marginal 1 (3<6 months)	2
				Marginal 2 (<3 months)	3
				Non-worker	4

A. POPULATION CENSUS

A1. Household Identification

Please describe composition of your family and other people who reside together in the table below. If you have two or more households living together, please state all of them. ***(Include those living together in the same household and those who are supposed to return to the household but temporarily away due to seasonal work, working abroad, study, etc.; including extended family and non-relatives (house maids, baby sitters) who live together)***

	1	2	3	4	5(a)	5(b)	6	7	8	9	10	11	12	13	14
	Name of the household members starting with the head of the household	*Relation with Head*	*Sex*	*Living together or temporarily away*	*Date of Birth*	*Age (in yrs)*	*Current marital Status*	Religion	ST / SC / OBC, Gen	If SC or ST, write name of SC/ST	*Mother tongue*	*Other languages known*	*Literacy status*	Status of attendan ce	Highest educatio nal level attained
1		1													
2															
3															
4															
5															
6															
7															
8															
9															
10															

(Note) Please mark or tick the person who responds the interview survey.

(Note for 5) Please collect information on the date/month/year of birth (5(a)), based on which the enumerator can confirm the age of the respondent (5(b)). If the respondent is not clear about when he/she was born, fill 5(b) based on their age statement.

	1	15	16	17	18	19	20	21(a)	21(b)	22(a)	22(b)	22(c')
	Name	Current job status / non-economic status	*Primary Occupation 2017*	*Secondary Occupation 2017*	Distance from home to workplace (in km) (or school)	Mode of travel	*Work base (daily, monthly, seasonal, yearly etc.)*	*(If work daily) average no of working days per week during 2017*	*Total work period during 2016 (or in the past one year)*	*Daily income 2017*	*Monthly income 2017*	*Annual income 2016 (or in the past one year)*
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

(Note for 17) Please fill in if the respondent is involved in more than two occupations.

(Note for 22) Please collect information on the income based on the nature of their work. For instance, if the respondent is a daily labourer, the enumerator shall choose 22(a). If the respondent is a government staff, the enumerator shall choose 22(b). If the respondent is a farmer or he/she has a clear idea about their income 2016 (or the past one year), choose 22(c').

B. ASSET INVENTORY

1. Immovable Assets

Please describe the tenure status of land, structure and trees you own/use.

(1) Land

Please check (√) if you own/use either of listed land below (if you have other lands, specify what kind of lands they are).

Please provide approximate <u>area size of each land which you use</u> (also provide the amount of money that you paid to purchase the land you own, and that you currently pay yearly for rented land). Please state <u>if you have a legal document to own/use your land</u>.

Type of Land			1.Present status*1	2.Area (decimal)	3.Amount for purchase / annual rent (Rs.)	4.Location	5.Legitimacy to land (Yes -1, No -2)
a.	( )	Land plot for housing unit					
b.	( )	Home garden					
c.	( )	Yard					
d.	( )	Farm land					
e.	( )	Tree plantation area					
f.	( )	Pastureland					
g	( )	Fishpond					
h.	( )	Others (specify)					

Out of the above, the land area to be requisitioned or acquired	Type of land:	Area (decimal)	Value (Rs.)

Answers to1: Own -1, Rented from someone -2, Provided free from someone -3, Govt quarters / govt own -4, Private company quarters -5, Other -6

(2) Structure

Please check (√) if you own/use either of listed structures below in and out of your land (if you have other structures, specify what kind of structures they are).

Please provide approximate area size of each structure which you use (also provide the amount of money that you paid to purchase the structures you own, and that you currently pay yearly for their rent). Please state if you have a legal document to own/use your structure.

Type of Structure			1.Present status*1	2.Area (decimal)	3.Amount for purchase / annual rent (Rs.)	4.Location	5.Legitimacy to land (Yes -1, No -2)
a.	( )	Residence					
b.	( )	Shop (separate)					
c.	( )	Dwelling house (residence + shop)					
d.	( )	Cattle shed					
e.	( )	Farm house					
f.	( )	Others (specify)					

Out of the above, the structure and their area to be requisitioned or acquired	Type of structure	Area (decimal)	Value (Rs.)

Answers to1: Own -1, Rented from someone -2, Provided free from someone -3, Govt quarters / govt own -4, Private company quarters -5, Other -6

(3) Tree

Please check (√) if you own either of listed trees below within your land (if you have other trees, please specify what kind of tree they are).

Please also provide number of trees (also provide the amount of money that you paid to purchase the trees you own, and that you currently pay yearly for their rent). Please state if you have a legal document to own/use your trees.

Type of Tree			1.Present status*1	2.No of trees	3.Amount for purchase / annual rent (Rs.)	4.Location	5.Legitimacy to land (Yes -1, No -2)
a.	( )	Leave tree					
b.	( )	Fruit tree					
c.	( )	Bamboo tree					
d.	( )	Timber					
e.	( )	Others (specify)					

Out of the above, the trees and their numbers to be requisitioned or acquired	Type of tree:	Number of trees	Value (Rs.)

Answers: Own -1, Rented from someone -2, Provided free from someone -3, Govt quarters / govt own -4, Private company quarters -5, Other -6

(4) Type of Agriculture Products

Please choose products you harvest from your land and trees.
Please check (√) if you produce either of listed products below, and provide 1) seasonal production volume, 2) number of harvest per year, and 3) total production volume per year. If you have other products, please specify and add them in the box.

Type of Product			1		2	3	4	5	6
			Purpose		Unit price per kg	Product volume per season	Number of harvest per year	Total volume per year	Total value per year
			Domestic	Commercial	Rs.	Kg	No of times	Kg	Rs.
a.	( )	Paddy							
b.	( )	Vegetable							
c.	( )	Pulses							
d.	( )	Oil seeds							
e.	( )	Bamboo shoots							
f.	( )	Wheat							
g.	( )	Others (specify)							

Out of the above, the products to be requisitioned or acquired		Type of product:	Annual volume (kg)	Value (Rs.)

(5) Type of NTFP

Please choose NTFPs you collect from forests.

Please check (√) if you collect either of listed NTFPs below, and provide 1) Volume per day, 2) Volume per month, and 3) total production volume per year. If you have other NTFPs, please specify and add them in the box.

Type of NTFP			1		2(a)	2(b)	3	4	5
			Purpose		Unit price per kg	Volume per day	Volume per month	Total volume per year	Total value per year
			Domestic	Commercial	Rs.	Kg	Kg	Kg	Rs.
a.	( )	Fuelwood							
b.	( )	Spices							
c.	( )	Nuts							
d.	( )	Seeds							
e.	( )	Berries							
f.	( )	Mushroom							
g.	( )	Oils							
h.	( )	Foliage							
i.	( )	Leaves							
j.	( )	Medicinal plants							
k.	( )	Peat							
l.	( )	Dates							
m.	( )	Honey							
n.	( )	Others (specify)							

Out of the above, the products to be requisitioned or acquired			Type of NTFP	Annual volume (kg)	Value (Rs.)

(Note) Please collect information on the volume based on the nature of the work and convenience of the respondent. For instance, if the respondent collects NTFP daily and sell them at the market, the enumerator shall choose "volume per day". If the respondent sells NTFP at monthly basis, choose "volume per month".

2. Movable Assets

(1) Type of Livestock

Please choose livestock you keep at your farm.

Please check (√) if you raise livestock and fish either of listed animals below, and provide their numbers. If you have other livestock, please specify and add them in the box.

Type of Livestock			1		2	3	4
			Purpose		Unit price	Number	Total Value
			Domestic	Commercial	Rs.	No.	Rs.
a.	( )	Rooster / hen (chicken)					
b.	( )	Boar / sow (pig)					
c.	( )	Cow / bull (cattle)					
d.	( )	Water buffalo					
e.	( )	Goat					
f.	( )	Duck					
g.	( )	Fish					
h.	( )	Sheep					

(2) Home Assets

Please choose assets (home appliance, farm equipment, transportations).

Please check (√) if you have either of listed items below, and provide their numbers. If you have other assets, please specify and add them in the box.

Type of Assets			No	Type of Assets			No
a.	( )	Radio		k.	( )	Table Fan / ceiling fan	
b.	( )	TV		l.	( )	Car / Truck / Van	
c.	( )	Satellite TV Antenna		m.	( )	Motorbike	
d.	( )	Landline phone		n.	( )	Bicycle	
e.	( )	Mobile phone		o.	( )	Tractor / trailer	
f.	( )	PC (computer)		p.	( )	Canoe / boat	
g.	( )	Video / VCD /DVD player		q.	( )	Cart (bullock)	
h.	( )	Refrigerator		r.	( )	Plough	
I.	( )	NA		s.	( )	Seed planting machine	
j.	( )	NA		t.	( )	Others (specify)	
s							

(3) Other Movable Assets

Please add any other assets than those already stated in the above.

C. SOCIOECONOMIC CONDITION

C1. Housing Infrastructure

1. Characteristics of Housing Unit

Please choose about the housing unit that your household is occupying.

Pucca House	1
Kucha house	2
Wooden house	3
Bamboo	4
Hut	5
Other (specify)	6

Pucca House: houses, the walls and roof of which are made of permanent materials.
Kutcha House: Houses in which both walls and roof are made of materials, which have to be replaced frequently.

2. Source of energy

Please describe main source of energy for lighting, cooking and irrigation purposes that your household is using. If you have other facilities that require energy, please specify.

	Lighting	Cooking	Irrigation	Other:
Source of energy				

Answers: Electricity - 1, Kerosene -2, Candle -3, Battery -4, Generator (private) -5, Water mill (private) -6, Solar system -7, LPG -8, Liquid fuel -9, Biogas -10, Dried dung -11, Firewood -12, Charcoal -13, Coal -14

3. Source of water

Please choose main source of water for drinking, domestic and irrigation purposes from the answers below and write their number in each box.

	Drinking purpose	Domestic purpose	Irrigation purpose
Main source of water			

Answers: Tap water / piped -1, Tube well / deep well / shallow well / borehole -2, Protected well -3, Spring / pond / lake -4, Rivers / stream / canal -5, Waterfall / rain water -6, Bottled water -7, Tanker / truck -8, Other -9

4. Sanitation

Please describe conditions of sanitation

(1) Type of toilet at home

Dispose at open land	1
Discharge to river / pond / lake	2
Other (specify)	3
Bucket (surface latrine)	4
None	5
Other (specify)	6

(2) Liquid waste

Dispose at open land	1
Discharge to river / pond / lake	2
Other (specify)	3

(3) Solid waste

Please choose how solid wastes are disposed.

Regular public collection service provided (or others)	1
Regular private collection service available	2
Incinerate	3
Dispose at open land	4
Dispose to river / pond / lake	5
Other (specify)	6

C2. Information Source

What means of information do you have? (Please choose all that apply)

Radio	1
TV	2
Newspaper	3
Magazine	4
Internet (via smart phone, PC)	5
Temple	6
Neighbourhood	7
School (through children)	8
Panchayat	9
Other (specify)	10

C3. Common Diseases

Which diseases do your household members often suffer?

Cold	1
Cough	2
Malaria	3
Tuberculosis (TB)	4
HIV/AIDS	5
Diarrhea	6
Dysentery	7
Hepatitis A	8
Dengue fever	9
Diabetes	10
Heart disease	11
Cancer	12
Fitsulla	13
Typhoid	14
Jaundice	15
Other (specify)	16

C5. Household Income and Expenditure

1. Household Income

(1) Are you saving money?

Yes / No

(2) If answered “Yes”, for what purpose are you saving money?

2. Household Expenditure

(1) Please state how much you spend monthly and yearly (average) for the items given below as an entire household?

No	Expenditure Item	“0”	Don’t know	By government
1.	Food			
2.	Education			
3.	Living (including health and medical expenses)			

No	Expenditure Item	"0"	Don't know	By government
4.	Clothes			
5	Others (specify)			

(2) Do you currently borrow money?

1. Yes / No

2. If answered "Yes", for what purpose do you borrow money?

(3) Which sources do you use to borrow money when you are in need?

Close relatives	1
Relatives	2
Neighbours	3
Friends	4
Bank	5
Microcredit	6
Temple / Mosque	7
Other (specify)	8

Interviewer's Observation and Remarks (if any)

Accompanied by WBSDCL Yes No

Name and Signature of Interviewer …………….....

Date of Interview ……………………

Name of Supervisor:
(print) *(signature)*

Checked on DDMMYY

ANNEX 2 MONITORING FORM (DRAFT)

Date: (DD/MM/YY) Quarter (1/2/3/4) of Year (YYYY)

1. Progress of Land Acquisition and Resettlement

Activities				Unit	Planned Total	Progress in Quantity			Progress in %		Expected Date of Completion	Implementing Party
						During the Quarter	Till the Last Quarter	Up to the Quarter (Total Progress)	Till the Last Quarter	Up to the Quarter (Total Progress)		
1	Land Use Plan	1	Land Survey	%								DM, Land Dept
		2	Determination of the actual size and boundaries of the land for borrow area	%								Contractor
		3	Development of a scaled map	%								Contractor
2	Compensation	1	Local Consultations	Times								BDO
		2	Reconciliation on the crop values and other resources	%								Agri Dept
		3	Establishment of a grievance redress mechanism (GRM)	No of grievance received								BDO
				No of grievance								
		4	Litigation process (if any)	No of litigations raised								BDO, DM, WBSEDCL
				No of litigations reconciled								
		5	Payment of compensation including top-up payment	No of entitled persons								Contractor
				No of person received								
				Total paid amount								
3	Vacation of WBSEDCL land	1	Vacation of WBSEDCL by PAPs	No of PAPs to vacate								Contractor
				No of PAPs who vacated								
				Total area vacated								
4	Livelihood restoration activities	1	Livelihood restoration activities	No of activities								BDO
				No of entitled persons								
		2	Local engagement at construction site	No of villagers engaged								

2. Details of Local Consultations

No.	Date	Place / No of Participants	Contents of Consultation	Correspondences	Comments from Participants
1					
2					
3					

(ex. Public participation meetings, local consultation meetings, stakeholder meetings)

3. Details of Grievance Redress

No.	Date of Receipt of Complaints	Contents of Complaints	Correspondences	Resolved / Not Yet Resolved
1				
2				
3				

4. Implementation of Livelihood Restoration Activities

BDO will monitor the change of living standard of the PAPs. When PAPs are found that their living standard worsen, or whose present means of livelihood became not-viable, BDO, in coordination with other appropriate institutions, will provide necessary support within the framework of Indian legislation.

No.	Brief Description of the Implemented Livelihood Restoration Activities	Results during Report Period (No. of trainings implemented, No of Participants, etc.)	Location
1			
2			
3			

(ex. Education and other development inputs, rehabilitation of vulnerable groups)

5. Restoration of Livelihoods and Living Standard

Date of Survey:

No.	Description about Surveyed Area	No of Surveyed HH	No of HHs with Increased Income	No of HHs with Decreased Income	No of HHs with Unchanged Income	Types of Problems Encountered	Perceived Need for Additional Assistance
1							
2							
3							

6. Others

If there is any issues to be mentioned, please describe the details.

No.	Details of the issue	Causes of the problems and actions to be taken
1		
2		

CHAPTER 12

PROJECT CONSTRUCTION PLANNING

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CHAPTER 12 PROJECT CONSTRUCTION PLANNING

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CHAPTER 12 PROJECT CONSTRUCTION PLANNING

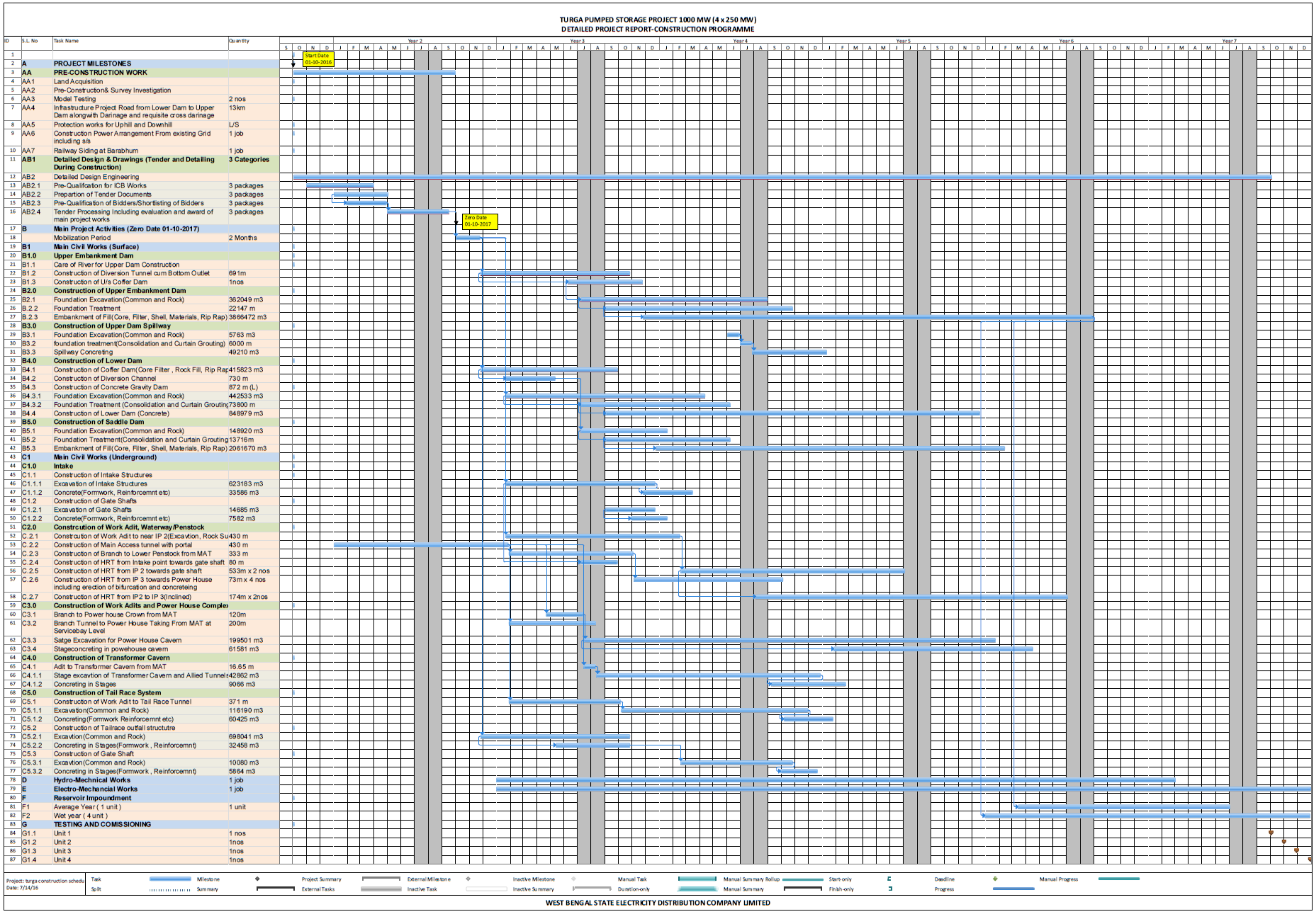
12.1 CONSTRUCTION SCHEDULE

12.1.1 DPR Schedule

According to the overall construction schedule on Detailed Project Report (DPR) issued by West Bengal State Electricity Distribution Company Limited (WBSEDCL) showing Figure 12.1.1-1, the excavation work of main access tunnel is commenced by the local contractor before Notice to proceed date (NTP) of the main civil work to accelerate the commencement operation date (COD). This work is one of the critical paths. And thirteen and half month for completion of the work is expected. So, it is reasonable to start the work separately by a local contractor before NTP taking into account the overall construction schedule. WBSEDCL also acknowledges that the separate implementation of the main access tunneling work is the key of the acceleration the COD. On the other hand, WBSEDCL has a plan to implement the work as a part of main civil work accordingly. In case of the latter the COD will be delay - 13.5 Months related to the schedule of DPR. Figure 12.1.1-2 shows the case of latter above for reference.

Each generator sequentially commences the commercial operation after one month of the COD for previous generator according to DPR schedule. But it is impossible to complete four generators commissioning works within 4 months. Because it takes three or four months to install each set of stators and rotors, furthermore it is impossible to install electrical equipment - Spiral casing, Runner, Generator in parallel by the two overheat travelling cranes. In this study JICA study team reviews and updates the overall construction schedule taking into account the required standard process duration for the consultant procurement and contractors' procurement for the contracts using JICA loan and the practical installation and commissioning schedule for the electrical equipment. In case of starting the tunnel excavation for the main access tunnel before the main civil work separately same as DPR schedule, the COD of the first generator is expected on July 2027 showing in Table 12.1.1-2. The next unit will operate 6 months later of the previous unit sequentially. The last unit will operate February 2029.

JICA study team recommends that the overall construction schedule shall be up-dated on Detailed Design phase taking into account the detailed schedule of each work item.



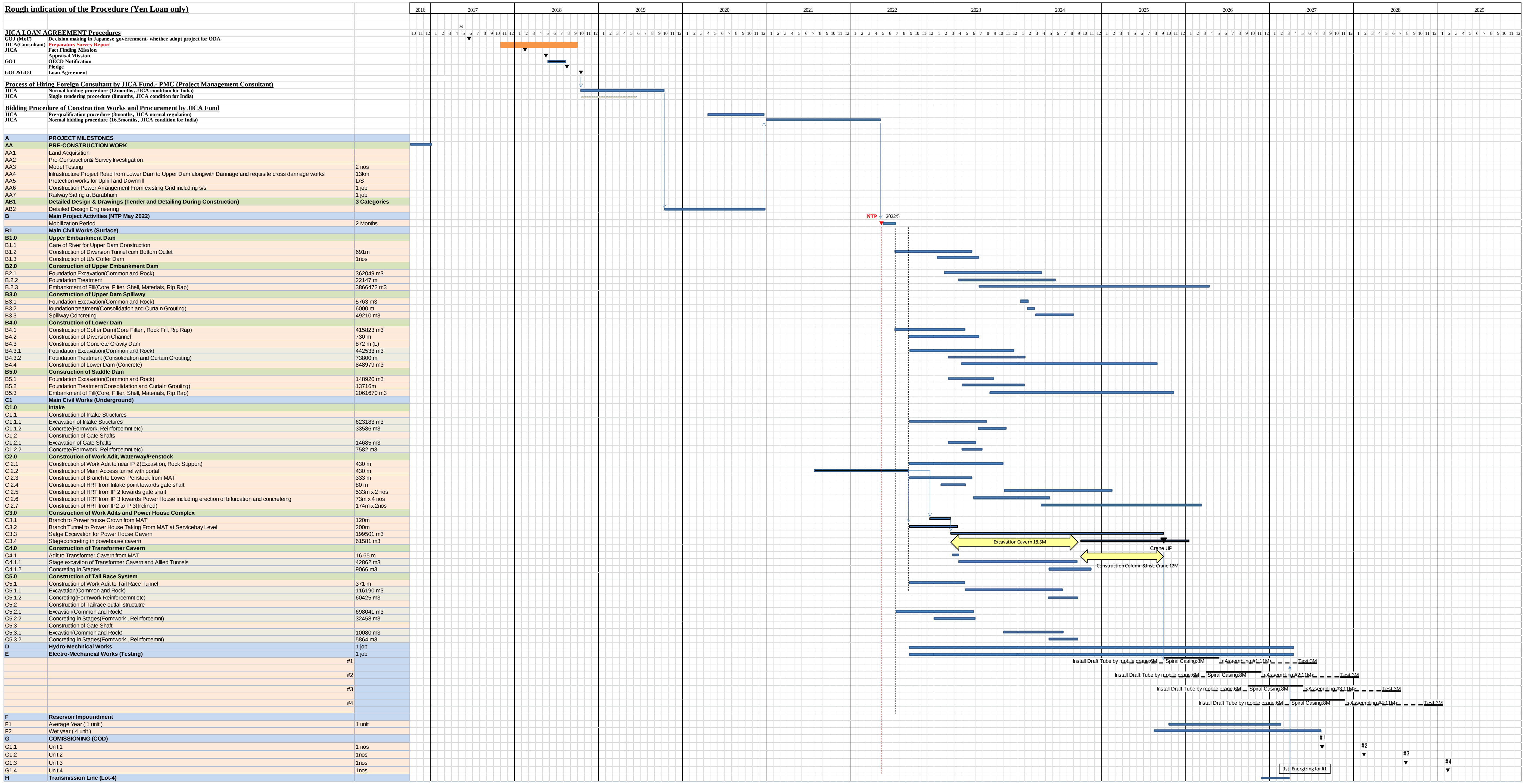
TURGA PUMPED STORAGE PROJECT 1000 MW (4 x 250 MW)
DETAILED PROJECT REPORT-CONSTRUCTION PROGRAMME

ID	S.L. No	Task Name	Quantity
1			
2	**A**	**PROJECT MILESTONES**	
3	**AA**	**PRE-CONSTRUCTION WORK**	
4	AA1	Land Acquisition	
5	AA2	Pre-Construction& Survey Investigation	
6	AA3	Model Testing	2 nos
7	AA4	Infrastructure Project Road from Lower Dam to Upper Dam alongwith Darinage and requisite cross darinage	13km
8	AA5	Protection works for Uphill and Downhill	L/S
9	AA6	Construction Power Arrangement From existing Grid including s/s	1 job
10	AA7	Railway Siding at Barabhum	1 job
11	**AB1**	**Detailed Design & Drawings (Tender and Detailing During Construction)**	**3 Categories**
12	AB2	Detailed Design Engineering	
13	AB2.1	Pre-Qualifcation for ICB Works	3 packages
14	AB2.2	Prepartion of Tender Documents	3 packages
15	AB2.3	Pre-Qualification of Bidders/Shortlisting of Bidders	3 packages
16	AB2.4	Tender Processing Including evaluation and award of main project works	3 packages
17	**B**	**Main Project Activities (Zero Date 01-10-2017)**	
18		Mobilization Period	2 Months
19	**B1**	**Main Civil Works (Surface)**	
20	**B1.0**	**Upper Embankment Dam**	
21	B1.1	Care of River for Upper Dam Construction	
22	B1.2	Construction of Diversion Tunnel cum Bottom Outlet	691m
23	B1.3	Construction of U/s Coffer Dam	1nos
24	**B2.0**	**Construction of Upper Embankment Dam**	
25	B2.1	Foundation Excavation(Common and Rock)	362049 m3
26	B.2.2	Foundation Treatment	22147 m
27	B.2.3	Embankment of Fill(Core, Filter, Shell, Materials, Rip Rap)	3866472 m3
28	**B3.0**	**Construction of Upper Dam Spillway**	
29	B3.1	Foundation Excavation(Common and Rock)	5763 m3
30	B3.2	foundation treatment(Consolidation and Curtain Grouting)	6000 m
31	B3.3	Spillway Concreting	49210 m3
32	**B4.0**	**Construction of Lower Dam**	
33	B4.1	Construction of Coffer Dam(Core Filter , Rock Fill, Rip Rap	415823 m3
34	B4.2	Construction of Diversion Channel	730 m
35	B4.3	Construction of Concrete Gravity Dam	872 m (L)
36	B4.3.1	Foundation Excavation(Common and Rock)	442533 m3
37	B4.3.2	Foundation Treatment (Consolidation and Curtain Grouting	73800 m
38	B4.4	Construction of Lower Dam (Concrete)	848979 m3
39	**B5.0**	**Construction of Saddle Dam**	
40	B5.1	Foundation Excavation(Common and Rock)	148920 m3
41	B5.2	Foundation Treatment(Consolidation and Curtain Grouting	13716m
42	B5.3	Embankment of Fill(Core, Filter, Shell, Materials, Rip Rap)	2061670 m3
43	**C1**	**Main Civil Works (Underground)**	
44	**C1.0**	**Intake**	
45	C1.1	Construction of Intake Structures	
46	C1.1.1	Excavation of Intake Structures	623183 m3
47	C1.1.2	Concrete(Formwork, Reinforcemnt etc)	33586 m3
48	C1.2	Construction of Gate Shafts	
49	C1.2.1	Excavation of Gate Shafts	14685 m3
50	C1.2.2	Concrete(Formwork, Reinforcemnt etc)	7582 m3
51	**C2.0**	**Constrcution of Work Adit, Waterway/Penstock**	
52	C.2.1	Constrcution of Work Adit to near IP 2(Excavtion, Rock Su	430 m
53	C.2.2	Construction of Main Access tunnel with portal	430 m
54	C.2.3	Construction of Branch to Lower Penstock from MAT	333 m
55	C.2.4	Construction of HRT from Intake point towards gate shaft	80 m
56	C.2.5	Construction of HRT from IP 2 towards gate shaft	533m x 2 nos
57	C.2.6	Construction of HRT from IP 3 towards Power House including erection of bifurcation and concreteing	73m x 4 nos
58	C.2.7	Construction of HRT from IP2 to IP 3(Inclined)	174m x 2nos
59	**C3.0**	**Construction of Work Adits and Power House Complex**	
60	C3.1	Branch to Power house Crown from MAT	120m
61	C3.2	Branch Tunnel to Power House Taking From MAT at Servicebay Level	200m
62	C3.3	Satge Excavation for Power House Cavern	199501 m3
63	C3.4	Stageconcreting in powehouse cavern	61581 m3
64	**C4.0**	**Construction of Transformer Cavern**	
65	C4.1	Adit to Transformer Cavern from MAT	16.65 m
66	C4.1.1	Stage excavtion of Transformer Cavern and Allied Tunnels	42862 m3
67	C4.1.2	Concreting in Stages	9066 m3
68	**C5.0**	**Construction of Tail Race System**	
69	C5.1	Construction of Work Adit to Tail Race Tunnel	371 m
70	C5.1.1	Excavation(Common and Rock)	116190 m3
71	C5.1.2	Concreting(Formwork Reinforcemnt etc)	60425 m3
72	C5.2	Construction of Tailrace outfall structutre	
73	C5.2.1	Excavtion(Common and Rock)	698041 m3
74	C5.2.2	Concreting in Stages(Formwork , Reinforcemnt)	32458 m3
75	C5.3	Construction of Gate Shaft	
76	C5.3.1	Excavtion(Common and Rock)	10080 m3
77	C5.3.2	Concreting in Stages(Formwork , Reinforcemnt)	5864 m3
78	**D**	**Hydro-Mechnical Works**	1 job
79	**E**	**Electro-Mechancial Works**	1 job
80	**F**	**Reservoir Impoundment**	
81	F1	Average Year (1 unit)	1 unit
82	F2	Wet year (4 unit)	
83	**G**	**TESTING AND COMISSIONING**	
84	G1.1	Unit 1	1 nos
85	G1.2	Unit 2	1nos
86	G1.3	Unit 3	1nos
87	G1.4	Unit 4	1nos

Project: turga construction schedu
Date: 7/14/16

WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED

Figure 12.1.1-1 Overall Construction Schedule on DPR



Rough indication of the Procedure (Yen Loan only)		
JICA LOAN AGREEMENT Procedures		
GOJ (MoF)	Decision making in Japanese goverenment- whether adopt project for ODA	
JICA(Consultant)	Preparatory Survey Report	
JICA	Fact Finding Mission	
	Appraisal Mission	
GOJ	OECD Notification	
	Pledge	
GOI &GOJ	Loan Agreement	
Process of Hiring Foreign Consultant by JICA Fund.- PMC (Project Management Consultant)		
JICA	Normal bidding procedure (12months, JICA condition for India)	
JICA	Single tendering procedure (8months, JICA condition for India)	
Bidding Procedure of Construction Works and Procurament by JICA Fund		
JICA	Pre-qualification procedure (8months, JICA normal regulation)	
JICA	Normal bidding procedure (16.5months, JICA condition for India)	
A	**PROJECT MILESTONES**	
AA	**PRE-CONSTRUCTION WORK**	
AA1	Land Acquisition	
AA2	Pre-Construction& Survey Investigation	
AA3	Model Testing	2 nos
AA4	Infrastructure Project Road from Lower Dam to Upper Dam alongwith Darinage and requisite cross darinage works	13km
AA5	Protection works for Uphill and Downhill	L/S
AA6	Construction Power Arrangement From existing Grid including s/s	1 job
AA7	Railway Siding at Barabhum	1 job
AB1	**Detailed Design & Drawings (Tender and Detailing During Construction)**	**3 Categories**
AB2	Detailed Design Engineering	
B	**Main Project Activities (NTP May 2022)**	
	Mobilization Period	2 Months
B1	**Main Civil Works (Surface)**	
B1.0	**Upper Embankment Dam**	
B1.1	Care of River for Upper Dam Construction	
B1.2	Construction of Diversion Tunnel cum Bottom Outlet	691m
B1.3	Construction of U/s Coffer Dam	1nos
B2.0	**Construction of Upper Embankment Dam**	
B2.1	Foundation Excavation(Common and Rock)	362049 m3
B.2.2	Foundation Treatment	22147 m
B.2.3	Embankment of Fill(Core, Filter, Shell, Materials, Rip Rap)	3866472 m3
B3.0	**Construction of Upper Dam Spillway**	
B3.1	Foundation Excavation(Common and Rock)	5763 m3
B3.2	foundation treatment(Consolidation and Curtain Grouting)	6000 m
B3.3	Spillway Concreting	49210 m3
B4.0	**Construction of Lower Dam**	
B4.1	Construction of Coffer Dam(Core Filter , Rock Fill, Rip Rap)	415823 m3
B4.2	Construction of Diversion Channel	730 m
B4.3	Construction of Concrete Gravity Dam	872 m (L)
B4.3.1	Foundation Excavation(Common and Rock)	442533 m3
B4.3.2	Foundation Treatment (Consolidation and Curtain Grouting)	73800 m
B4.4	Construction of Lower Dam (Concrete)	848979 m3
B5.0	**Construction of Saddle Dam**	
B5.1	Foundation Excavation(Common and Rock)	148920 m3
B5.2	Foundation Treatment(Consolidation and Curtain Grouting)	13716m
B5.3	Embankment of Fill(Core, Filter, Shell, Materials, Rip Rap)	2061670 m3
C1	**Main Civil Works (Underground)**	
C1.0	**Intake**	
C1.1	Construction of Intake Structures	
C1.1.1	Excavation of Intake Structures	623183 m3
C1.1.2	Concrete(Formwork, Reinforcemnt etc)	33586 m3
C1.2	Construction of Gate Shafts	
C1.2.1	Excavation of Gate Shafts	14685 m3
C1.2.2	Concrete(Formwork, Reinforcemnt etc)	7582 m3
C2.0	**Constrcution of Work Adit, Waterway/Penstock**	
C.2.1	Constrcution of Work Adit to near IP 2(Excavtion, Rock Support)	430 m
C.2.2	Construction of Main Access tunnel with portal	430 m
C.2.3	Construction of Branch to Lower Penstock from MAT	333 m
C.2.4	Construction of HRT from Intake point towards gate shaft	80 m
C.2.5	Construction of HRT from IP 2 towards gate shaft	533m x 2 nos
C.2.6	Construction of HRT from IP 3 towards Power House including erection of bifurcation and concreteing	73m x 4 nos
C.2.7	Construction of HRT from IP2 to IP 3(Inclined)	174m x 2nos
C3.0	**Construction of Work Adits and Power House Complex**	
C3.1	Branch to Power house Crown from MAT	120m
C3.2	Branch Tunnel to Power House Taking From MAT at Servicebay Level	200m
C3.3	Satge Excavation for Power House Cavern	199501 m3
C3.4	Stageconcreting in powehouse cavern	61581 m3
C4.0	**Construction of Transformer Cavern**	
C4.1	Adit to Transformer Cavern from MAT	16.65 m
C4.1.1	Stage excavtion of Transformer Cavern and Allied Tunnels	42862 m3
C4.1.2	Concreting in Stages	9066 m3
C5.0	**Construction of Tail Race System**	
C5.1	Construction of Work Adit to Tail Race Tunnel	371 m
C5.1.1	Excavation(Common and Rock)	116190 m3
C5.1.2	Concreting(Formwork Reinforcemnt etc)	60425 m3
C5.2	Construction of Tailrace outfall structutre	
C5.2.1	Excavtion(Common and Rock)	698041 m3
C5.2.2	Concreting in Stages(Formwork , Reinforcemnt)	32458 m3
C5.3	Construction of Gate Shaft	
C5.3.1	Excavtion(Common and Rock)	10080 m3
C5.3.2	Concreting in Stages(Formwork , Reinforcemnt)	5864 m3
D	**Hydro-Mechnical Works**	1 job
E	**Electro-Mechancial Works (Testing)**	1 job
	#1	
	#2	
	#3	
	#4	
F	**Reservoir Impoundment**	
F1	Average Year (1 unit)	1 unit
F2	Wet year (4 unit)	
G	**COMISSIONING (COD)**	
G1.1	Unit 1	1 nos
G1.2	Unit 2	1nos
G1.3	Unit 3	1nos
G1.4	Unit 4	1nos
H	**Transmission Line (Lot-4)**	

Figure 12.1.1-2 Revised Overall Construction Schedule

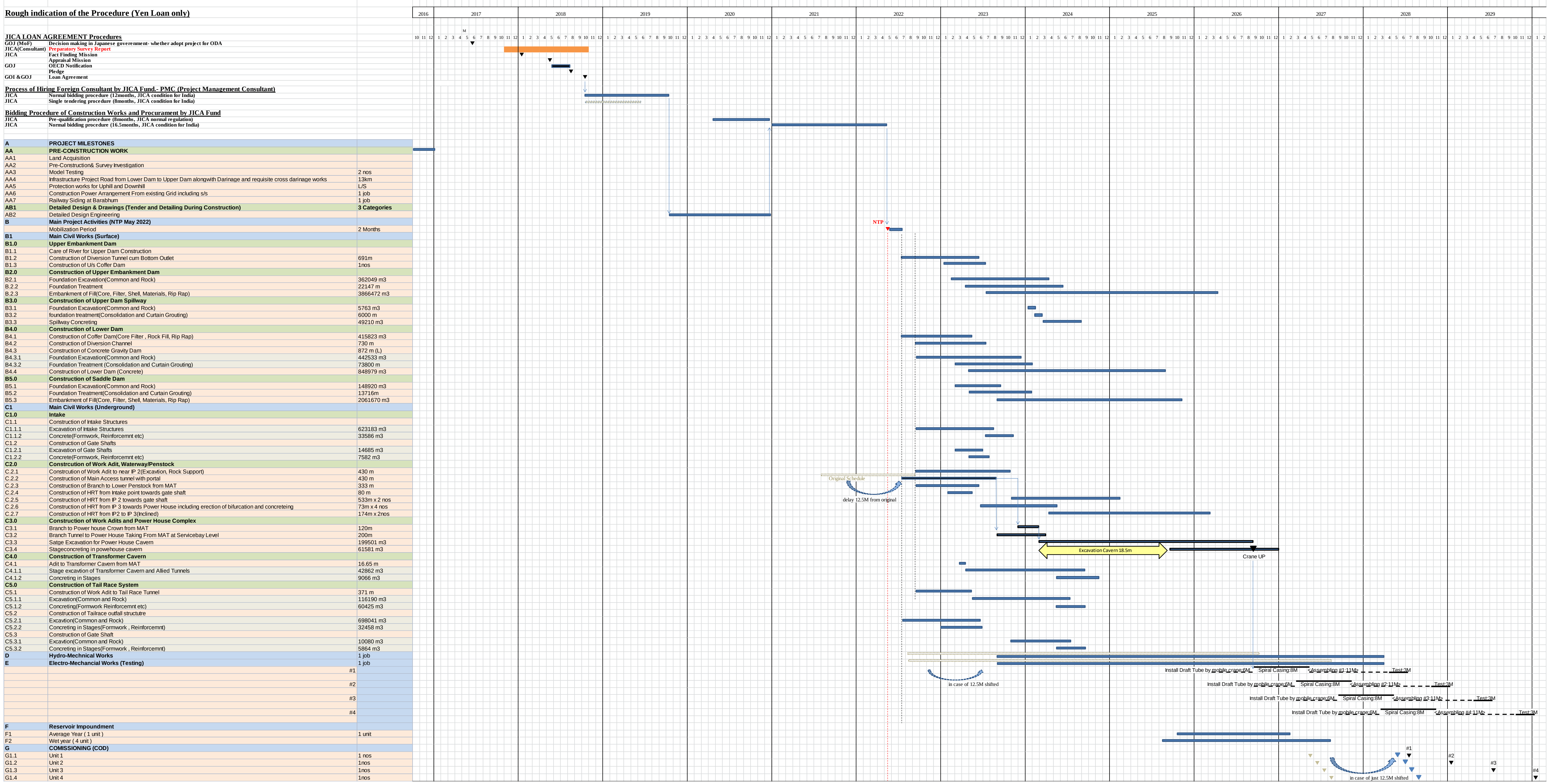
12.1.2 Reviewing Construction Schedule

Detail construction schedule will be generated on DD Phase for this project. Therefore, we could not review the detailed construction schedule, so JICA study team reviews and updates the overall construction schedule based on DPR. The critical path starts the beginning of the excavation work for the main access tunnel, and connects to the excavation work for Powerhouse cavern and the excavation work for Penstock. The embankment work for Upper reservoir dam is one of the critical paths. The estimated work rates for their excavation works and embankment work are applicable. WBSEDCL as the implementation board for the project understands the situation, and has the same idea of us. But, the excavation work for the main access tunnel and also the access road work have not yet started now. On the other hand, WBSEDCL has a plan to implement the works as a one part of the main civil work accordingly. In case of the latter the COD will be delay - 13.5 Months related to the schedule of DPR. Figure 12.1.2-1 shows the case of including the main access tunnel work on the main civil work for reference.

Each generator sequentially commences the commercial operation after one month of the COD for the previous generator according to DPR schedule. But it is impossible to complete four generators commissioning works within 4 months. Because it generally takes a half year to install each set of stators and rotors, furthermore it is impossible to install electrical-mechanical equipment - Spiral casing, Runner, Generator in parallel by the two overhead travelling cranes. In this study, JICA study team reviews and updates the overall construction schedule taking into account the standard required process duration for the consultant procurement and contractors' procurement of the contracts for JICA loan and the practical installation and commissioning schedule for the electrical-mechanical equipment. In case of starting the tunnel excavation for the main access tunnel before the main civil work separately same as DPR schedule, the COD of the first generator is expected on July 2027. The next unit will operate 6 months later of the previous unit sequentially. The last unit will operate February 2029.

Figure 12.1.2-2 shows the most accelerated schedule. JICA study team review not only the procurement schedule but also Civil work and Electrical work. The works for Main Access Tunnel and Access road can be carried out as one of the ODA loan coverage works in case of LCB scheme before NTP of the main civil work. On the schedule above, the draft tube liner pit is handed over to the electrical- mechanical contractor (LOT 3) from the civil contractor (LOT 1) four month forwarded. Furthermore the commissioning for fix speed and variable speed generators are shortened from six month to three month and four month. So totally 12 month forwarded schedule compared with the schedule on Figure 12.1.2-2 is proposed on this study. The commercial operation date of the first unit is expected around on August, 2026, and the last unit around on June, 2027.

The detailed construction schedule shall be updated on DD phase concerning the installation work and commissioning work taking into account the key dates of each LOT.



Rough indication of the Procedure (Yen Loan only)

JICA LOAN AGREEMENT Procedures

GOJ (MoF)	Decision making in Japanese goverenment- whether adopt project for ODA
JICA(Consultant)	Preparatory Survey Report
JICA	Fact Finding Mission
	Appraisal Mission
GOJ	OECD Notification
	Pledge
GOI &GOJ	Loan Agreement

Process of Hiring Foreign Consultant by JICA Fund.- PMC (Project Management Consultant)

JICA	Normal bidding procedure (12months, JICA condition for India)
JICA	Single tendering procedure (8months, JICA condition for India)

Bidding Procedure of Construction Works and Procurament by JICA Fund

JICA	Pre-qualification procedure (8months, JICA normal regulation)
JICA	Normal bidding procedure (16.5months, JICA condition for India)

A	**PROJECT MILESTONES**	
AA	**PRE-CONSTRUCTION WORK**	
AA1	Land Acquisition	
AA2	Pre-Construction& Survey Investigation	
AA3	Model Testing	2 nos
AA4	Infrastructure Project Road from Lower Dam to Upper Dam alongwith Darinage and requisite cross darinage works	13km
AA5	Protection works for Uphill and Downhill	L/S
AA6	Construction Power Arrangement From existing Grid including s/s	1 job
AA7	Railway Siding at Barabhum	1 job
AB1	**Detailed Design & Drawings (Tender and Detailing During Construction)**	**3 Categories**
AB2	Detailed Design Engineering	
B	**Main Project Activities (NTP May 2022)**	
	Mobilization Period	2 Months
B1	**Main Civil Works (Surface)**	
B1.0	**Upper Embankment Dam**	
B1.1	Care of River for Upper Dam Construction	
B1.2	Construction of Diversion Tunnel cum Bottom Outlet	691m
B1.3	Construction of U/s Coffer Dam	1nos
B2.0	**Construction of Upper Embankment Dam**	
B2.1	Foundation Excavation(Common and Rock)	362049 m3
B.2.2	Foundation Treatment	22147 m
B.2.3	Embankment of Fill(Core, Filter, Shell, Materials, Rip Rap)	3866472 m3
B3.0	**Construction of Upper Dam Spillway**	
B3.1	Foundation Excavation(Common and Rock)	5763 m3
B3.2	foundation treatment(Consolidation and Curtain Grouting)	6000 m
B3.3	Spillway Concreting	49210 m3
B4.0	**Construction of Lower Dam**	
B4.1	Construction of Coffer Dam(Core Filter , Rock Fill, Rip Rap)	415823 m3
B4.2	Construction of Diversion Channel	730 m
B4.3	Construction of Concrete Gravity Dam	872 m (L)
B4.3.1	Foundation Excavation(Common and Rock)	442533 m3
B4.3.2	Foundation Treatment (Consolidation and Curtain Grouting)	73800 m
B4.4	Construction of Lower Dam (Concrete)	848979 m3
B5.0	**Construction of Saddle Dam**	
B5.1	Foundation Excavation(Common and Rock)	148920 m3
B5.2	Foundation Treatment(Consolidation and Curtain Grouting)	13716m
B5.3	Embankment of Fill(Core, Filter, Shell, Materials, Rip Rap)	2061670 m3
C1	**Main Civil Works (Underground)**	
C1.0	**Intake**	
C1.1	Construction of Intake Structures	
C1.1.1	Excavation of Intake Structures	623183 m3
C1.1.2	Concrete(Formwork, Reinforcemnt etc)	33586 m3
C1.2	Construction of Gate Shafts	
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C.2.1	Constrcution of Work Adit to near IP 2(Excavtion, Rock Support)	430 m
C.2.2	Construction of Main Access tunnel with portal	430 m
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C.2.5	Construction of HRT from IP 2 towards gate shaft	533m x 2 nos
C.2.6	Construction of HRT from IP 3 towards Power House including erection of bifurcation and concreteing	73m x 4 nos
C.2.7	Construction of HRT from IP2 to IP 3(Inclined)	174m x 2nos
C3.0	**Construction of Work Adits and Power House Complex**	
C3.1	Branch to Power house Crown from MAT	120m
C3.2	Branch Tunnel to Power House Taking From MAT at Servicebay Level	200m
C3.3	Satge Excavation for Power House Cavern	199501 m3
C3.4	Stageconcreting in powehouse cavern	61581 m3
C4.0	**Construction of Transformer Cavern**	
C4.1	Adit to Transformer Cavern from MAT	16.65 m
C4.1.1	Stage excavtion of Transformer Cavern and Allied Tunnels	42862 m3
C4.1.2	Concreting in Stages	9066 m3
C5.0	**Construction of Tail Race System**	
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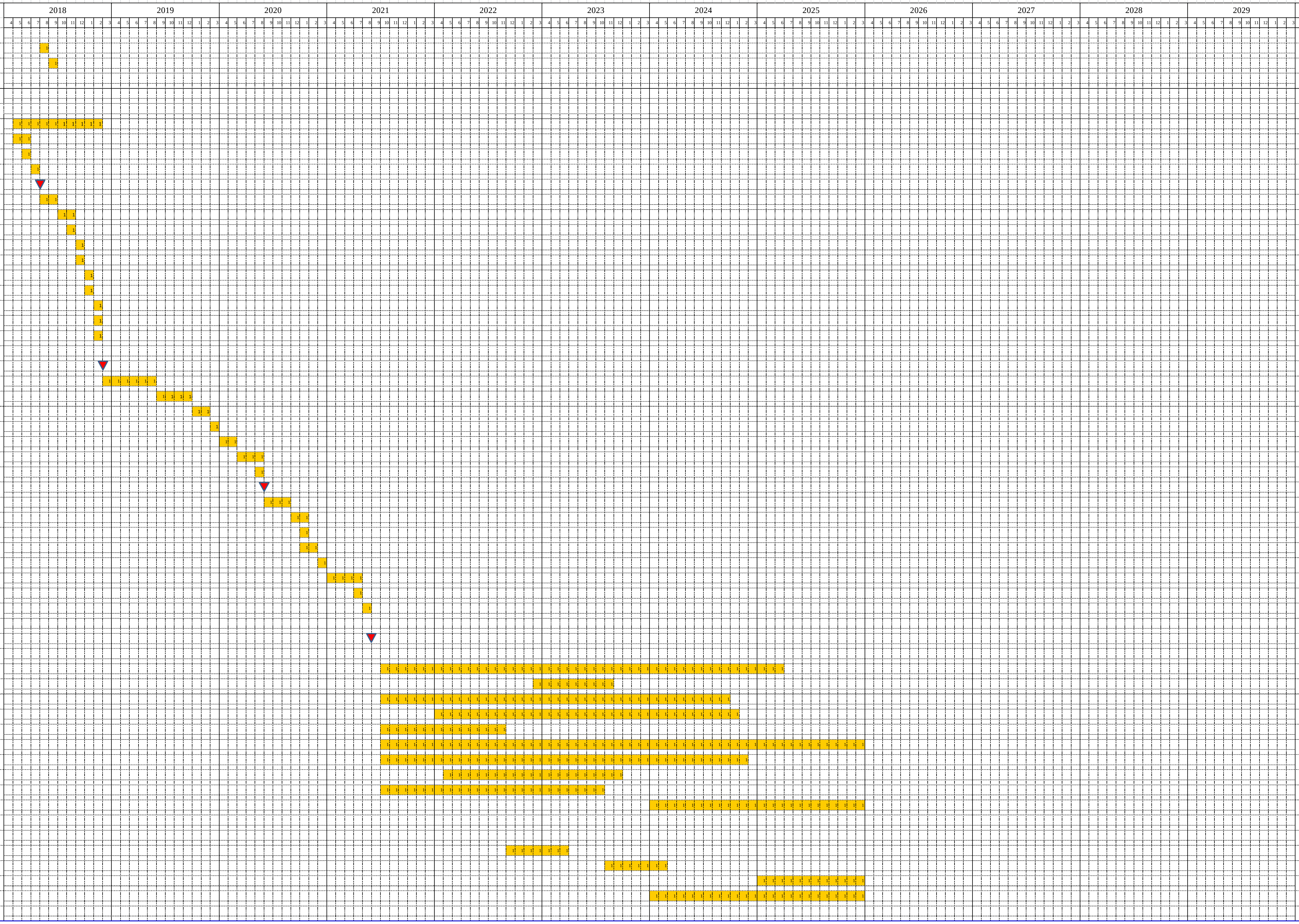
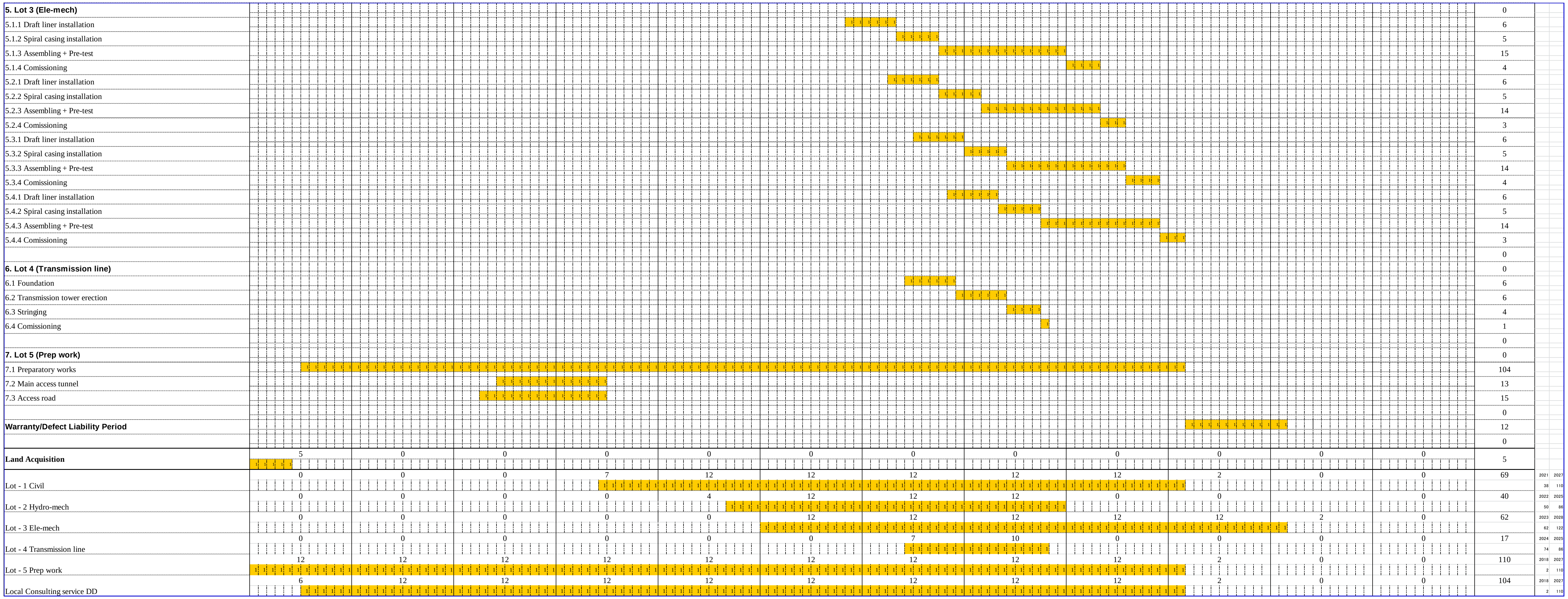
C5.1.1	Excavation(Common and Rock)	116190 m3
C5.1.2	Concreting(Formwork Reinforcemnt etc)	60425 m3
C5.2	Construction of Tailrace outfall structutre	
C5.2.1	Excavtion(Common and Rock)	698041 m3
C5.2.2	Concreting in Stages(Formwork , Reinforcemnt)	32458 m3
C5.3	Construction of Gate Shaft	
C5.3.1	Excavtion(Common and Rock)	10080 m3
C5.3.2	Concreting in Stages(Formwork , Reinforcemnt)	5864 m3
D	**Hydro-Mechnical Works**	1 job
E	**Electro-Mechancial Works (Testing)**	1 job
	#1	
	#2	
	#3	
	#4	
F	**Reservoir Impoundment**	
F1	Average Year (1 unit)	1 unit
F2	Wet year (4 unit)	
G	**COMISSIONING (COD)**	
G1.1	Unit 1	1 nos
G1.2	Unit 2	1nos
G1.3	Unit 3	1nos
G1.4	Unit 4	1nos

Figure 12.1.2-1   Construction Schedule Commencement after NTP (for reference)

Implementation Schedule



	Month
	0
Pledge	1
Signing of Loan Agreement	1
	0
Consulting Services	0
	0
1. Procurement of the Consultant	10
1.1 Drafting RFP, Short list	2
1.2 Approval by Receipient (WBSEDCL)	1
1.3 Concurrence by JICA	1
1.4 Issuance RFP	0
1.5 Proposal by the Consultant	2
1.6 Tech evaluation by Receipient (WBSEDCL)	2
1.7 Concurrence by JICA	1
1.8 Financial evaluation by Receipient (WBSEDCL)	1
1.9 Concurrence by JICA	1
1.10 Contract negotiation	1
1.11 Receipient (WBSEDCL) approval for award	1
1.12 Cabinet approval for award	1
1.13 Signing contract	1
1.14 Concurrence by JICA	1
	0
2. Commencement of the Consulting service	0
2.1 Site Survey & Design	6
2.2 Preparation of detailed qualification	4
2.3 PQ announcement	2
2.4 PQ floating/close	1
2.5 PQ evaluation and concurrence	2
2.6 Preparation of tender document	3
2.7 Concurrence for the tender documents by Receipient and JICA	1
2.8 Tender announcement	0
2.9 Tender floating	3
2.10 Tender opening and technical evaluation	2
2.11 Concurrence for the evaluation by Receipient and JICA	1
2.12 Price proposal opening and evaluation	2
2.13 Concurrence for the contract by Receipient and JICA	1
2.14 Contract negotiation	4
2.15 Concurrence for the contract by Receipient and JICA	1
2.16 L/C open, issuance	1
	0
Commencement of the Contract	0
3. Lot 1 (Civil)	0
3.1 Upper dam embankment	45
3.2 Upper dam spillway	9
3.3 Lower dam construction	39
3.4 Lower saddle dam embankment	34
3.5 Intake	14
3.6 Work adit, Penstock tunnel	54
3.7 Work adit, Power house	41
3.8 Transformer Cavern	20
3.9 Tail race system	25
3.10 Architectural works	24
	0
4. Lot 2 (Hydro-mech)	0
4.1Intake gate	7
4.2 Tailrace gate	7
4.3 Draft Gate	12
4.4 Penstock	24
	0



5. Lot 3 (Ele-mech)	0
5.1.1 Draft liner installation	6
5.1.2 Spiral casing installation	5
5.1.3 Assembling + Pre-test	15
5.1.4 Comissioning	4
5.2.1 Draft liner installation	6
5.2.2 Spiral casing installation	5
5.2.3 Assembling + Pre-test	14
5.2.4 Comissioning	3
5.3.1 Draft liner installation	6
5.3.2 Spiral casing installation	5
5.3.3 Assembling + Pre-test	14
5.3.4 Comissioning	4
5.4.1 Draft liner installation	6
5.4.2 Spiral casing installation	5
5.4.3 Assembling + Pre-test	14
5.4.4 Comissioning	3
	0
6. Lot 4 (Transmission line)	0
6.1 Foundation	6
6.2 Transmission tower erection	6
6.3 Stringing	4
6.4 Comissioning	1
	0
7. Lot 5 (Prep work)	0
7.1 Preparatory works	104
7.2 Main access tunnel	13
7.3 Access road	15
	0
Warranty/Defect Liability Period	12
	0

Land Acquisition	5	0	0	0	0	0	0	0	0	0	0	0	5		
Lot - 1 Civil	0	0	0	7	12	12	12	12	12	2	0	0	69	2021 38	2027 110
Lot - 2 Hydro-mech	0	0	0	0	4	12	12	12	0	0		0	40	2022 50	2025 86
Lot - 3 Ele-mech	0	0	0	0	0	12	12	12	12	12	2	0	62	2023 62	2028 122
Lot - 4 Transmission line	0	0	0	0	0	0	7	10	0	0	0	0	17	2024 74	2025 86
Lot - 5 Prep work	12	12	12	12	12	12	12	12	12	2	0	0	110	2018 2	2027 110
Local Consulting service DD	6	12	12	12	12	12	12	12	12	2	0	0	104	2018 2	2027 110

Figure 12.1.2-2 Best Practice Construction Schedule

12.2 RESERVOIR IMPOUNDING SCHEDULE

12.2.1 Reservoir Impounding Schedule in DPR

In the DPR, reservoir impounding schedule study was conducted for deciding the development schedule of the project. The power plant(s) would start its operation after the completion of impoundment for upper and lower reservoirs. The calculation of the impounding period was made based on the monthly inflow data recommended in the hydrological study.

Five scenarios were examined. Three scenarios for inflow data (average year, wet year and dry year) without considering of environmental flow for the downstream of lower reservoir, and two scenarios (average year and wet year) with consideration of environmental flow, were examined.

Following items below are about the filling calculation.

(1) Features of Reservoirs

1) Upper Reservoir

- Catchment Area : 8.29 km^2
- FRL : EL. 464.0 m
- MDDL (for pumped storage power plant (PSPP)) : EL. 444.4 m
- Vg (Gross Storage Capacity including irrigation and other purpose) : 21.6 × 10^6 m^3
- Vi (Storage Capacity for irrigation and other Purpose) : 1.5 × 10^6 m^3
- Ve (Effective (Live) Storage Capacity for PSPP) : 14.2 × 10^6 m^3
- Vd (Dead Storage Capacity) : 5.9 × 10^6 m^3

2) Lower Reservoir

- Catchment Area (Intermediate) : 12.66 km^2 (4.37 km^2)
- FRL : EL. 316.5 m
- MDDL (for pumped storage power plant (PSPP)) : EL. 280.4 m
- Vg (Gross Storage Capacity) : 18.0 × 10^6 m^3
- Ve (Effective (Live) Storage Capacity for PSPP) : 14.2 × 10^6 m^3
- Vd (Dead Storage Capacity) : 3.8 × 10^6 m^3

3) Necessary storage capacity for generating one (1) unit

Required live storage capacity

Ve' = Discharge (max.) × one (1) unit x generation time (5 hours)

$= 197 \times 1 \times 5 \times 60 \times 60 = 3.546 \times 10^6$ m^3 (total at upper and lower reservoirs)

The least necessary storage capacity

V (1) = Vd (upper) + Vd (lower) + Ve' = $(5.876 + 3.773 + 3.546) \times 10^6$ m^3=13.195×10^6 m^3

4) Necessary storage capacity for generating four (4) units

Required live storage capacity

$Ve' = 197 \times 4 \times 5 \times 60 \times 60 = 14.184 \times 10^6\ m^3$ (total at upper and lower reservoirs)

The least necessary storage capacity

$V (4) = Vd\ (upper) + Vd\ (lower) + Ve' = (5.876 + 3.773 + 14.184) \times 10^6\ m^3 = 23.833 \times 10^6\ m^3$

(2) Hydrological Data

1) Inflow before impounding

Monthly inflow series of upper and lower dams used for estimating the impending schedule of the project in the DPR are shown in Table 12.2.1-1 and Table 12.2.1-2 and summarized in Table 12.2.1-3.

Table 12.2.1-1 Monthly Inflow at Upper Dam (C.A.=8.29 km^2)

(Unit: MCM)

Year	June	July	Aug	Sep	Oct	Monsoon Total	Non Monsoon Total	Annual
1958	0.11	1.17	0.79	1.70	0.63	4.40	0.48	4.88
1959	0.10	1.15	0.78	1.20	0.78	4.00	0.44	4.44
1960	0.01	0.67	1.63	1.20	0.54	4.05	0.45	4.50
1961	0.57	0.01	0.94	1.75	0.87	4.14	0.46	4.60
1962	0.12	0.80	1.08	1.44	0.62	4.06	0.45	4.50
1963	0.14	0.93	1.45	1.15	0.63	4.29	0.47	4.77
1964	0.26	1.34	1.55	1.25	0.57	4.97	0.55	5.52
1965	0.13	1.39	1.32	0.67	0.33	3.85	0.42	4.27
1966	0.44	0.00	0.88	0.65	0.37	2.34	0.26	2.59
1967	0.00	0.00	1.74	3.10	0.87	5.71	0.63	6.34
1968	0.33	1.48	1.94	0.46	0.27	4.47	0.49	4.96
1969	0.00	0.53	0.60	1.14	0.40	2.66	0.29	2.95
1970	0.16	1.08	0.96	1.94	0.69	4.82	0.53	5.35
1971	0.50	1.20	2.30	0.77	0.39	5.16	0.57	5.73
1972	0.00	0.38	1.67	0.84	0.43	3.32	0.37	3.68
1973	0.08	0.99	1.05	1.35	0.67	4.14	0.46	4.60
1974	0.00	1.95	1.06	1.20	0.42	4.63	0.51	5.14
1975	0.11	0.38	0.02	1.55	0.56	2.63	0.29	2.92
1976	0.00	0.32	0.01	1.29	0.44	2.06	0.23	2.29
1977	0.36	0.78	0.54	0.86	0.36	2.90	0.32	3.22
1978	0.39	0.40	1.19	1.61	0.68	4.28	0.47	4.75
1979	0.18	0.63	0.69	0.63	0.34	2.47	0.27	2.74
1980	0.12	1.38	0.75	0.99	0.51	3.75	0.41	4.16
1981	0.14	1.22	1.24	1.09	0.38	4.08	0.45	4.53
1982	0.16	0.41	1.01	0.65	0.43	2.65	0.29	2.94
1983	0.06	0.71	0.82	1.63	0.68	3.89	0.43	4.32
1984	1.35	0.38	1.88	0.87	0.43	4.91	0.54	5.45
1985	0.18	1.36	1.49	1.60	0.82	5.45	0.60	6.05
1986	0.27	0.61	1.60	1.45	0.61	4.55	0.50	5.05
1987	0.06	1.28	1.45	1.24	0.45	4.48	0.49	4.97
1988	0.92	0.31	0.60	1.07	0.39	3.28	0.36	3.64
1989	0.51	0.79	1.46	1.07	0.42	4.24	0.47	4.71
1990	0.54	2.13	0.69	1.45	0.58	5.39	0.59	5.98
1991	0.00	0.90	1.74	0.89	0.35	3.88	0.43	4.31
1992	0.12	0.68	1.05	1.92	0.62	4.39	0.48	4.88
1993	0.42	0.37	0.57	1.73	0.69	3.78	0.42	4.19
1994	0.92	1.40	1.15	0.87	0.48	4.83	0.53	5.36
1995	0.26	0.88	2.09	1.69	0.66	5.59	0.62	6.21
1996	1.06	0.91	1.41	0.69	0.30	4.37	0.48	4.85
1997	0.32	1.24	2.47	1.05	0.43	5.50	0.61	6.11
1998	0.23	0.74	1.04	1.11	0.48	3.60	0.40	4.00
1999	0.41	1.15	1.62	1.41	0.58	5.17	0.57	5.74
2000	0.14	0.52	0.72	0.95	0.42	2.75	0.30	3.05
2001	0.66	0.99	0.87	0.66	0.30	3.47	0.38	3.85
2002	0.71	0.17	1.34	0.83	0.47	3.52	0.39	3.91
2003	0.00	0.49	1.28	0.75	0.56	3.08	0.34	3.42
2004	0.00	0.43	1.66	0.75	0.42	3.27	0.36	3.63
2005	0.03	0.79	0.70	0.82	0.41	2.75	0.30	3.06
2006	0.19	0.80	0.87	1.07	0.40	3.34	0.37	3.70
2007	0.09	1.80	1.44	1.44	0.48	5.25	0.58	5.82
2008	0.90	1.76	1.09	0.84	0.32	4.91	0.54	5.45
2009	0.00	0.95	1.13	1.56	0.55	4.19	0.46	4.65
2010	0.05	0.26	0.40	0.97	0.39	2.06	0.23	2.29
2011	1.07	0.52	2.59	1.26	0.48	5.92	0.65	6.58
2012	0.28	1.46	1.53	1.78	0.55	5.61	0.62	6.22
Average	0.29	0.86	1.20	1.20	0.51	4.06	0.45	4.51

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Table 12.2.1-2 Monthly Inflow at Lower Dam (C.A.=12.66 km^2)

(Unit: MCM)

Year	June	July	Aug	Sep	Oct	Monsoon Total	Non Monsoon Total	Annual
1958	0.16	1.79	1.21	2.59	0.96	6.71	0.74	7.45
1959	0.16	1.76	1.19	1.83	1.18	6.11	0.67	6.78
1960	0.01	1.03	2.49	1.83	0.82	6.18	0.68	6.86
1961	0.88	0.02	1.43	2.67	1.32	6.32	0.70	7.02
1962	0.19	1.23	1.65	2.19	0.94	6.20	0.68	6.88
1963	0.21	1.42	2.21	1.76	0.96	6.56	0.72	7.28
1964	0.40	2.05	2.36	1.91	0.86	7.59	0.83	8.43
1965	0.20	2.12	2.02	1.03	0.51	5.88	0.65	6.52
1966	0.66	0.00	1.34	0.99	0.57	3.57	0.39	3.96
1967	0.00	0.00	2.66	4.73	1.32	8.72	0.96	9.68
1968	0.51	2.26	2.96	0.70	0.41	6.82	0.75	7.57
1969	0.00	0.80	0.91	1.74	0.60	4.06	0.45	4.51
1970	0.25	1.64	1.46	2.96	1.05	7.36	0.81	8.17
1971	0.77	1.84	3.51	1.18	0.59	7.88	0.87	8.74
1972	0.00	0.58	2.55	1.29	0.66	5.07	0.56	5.63
1973	0.12	1.51	1.61	2.06	1.02	6.33	0.70	7.02
1974	0.00	2.97	1.62	1.83	0.65	7.07	0.78	7.84
1975	0.17	0.58	0.04	2.37	0.86	4.01	0.44	4.45
1976	0.00	0.49	0.02	1.96	0.67	3.15	0.35	3.50
1977	0.56	1.19	0.82	1.31	0.56	4.43	0.49	4.92
1978	0.59	0.61	1.82	2.46	1.05	6.53	0.72	7.25
1979	0.28	0.96	1.06	0.96	0.52	3.77	0.41	4.18
1980	0.18	2.11	1.14	1.51	0.78	5.73	0.63	6.35
1981	0.22	1.87	1.90	1.67	0.58	6.23	0.69	6.92
1982	0.24	0.62	1.54	0.99	0.65	4.05	0.44	4.49
1983	0.09	1.08	1.26	2.48	1.03	5.95	0.65	6.60
1984	2.06	0.58	2.87	1.33	0.66	7.50	0.83	8.33
1985	0.27	2.07	2.27	2.45	1.26	8.32	0.92	9.23
1986	0.42	0.93	2.44	2.21	0.94	6.95	0.76	7.71
1987	0.10	1.96	2.21	1.90	0.68	6.84	0.75	7.60
1988	1.40	0.47	0.92	1.63	0.59	5.01	0.55	5.56
1989	0.78	1.20	2.22	1.63	0.64	6.47	0.71	7.19
1990	0.82	3.25	1.06	2.21	0.89	8.23	0.91	9.14
1991	0.00	1.37	2.65	1.37	0.54	5.93	0.65	6.58
1992	0.19	1.04	1.60	2.94	0.95	6.71	0.74	7.45
1993	0.65	0.56	0.87	2.64	1.05	5.77	0.63	6.41
1994	1.40	2.14	1.76	1.33	0.73	7.37	0.81	8.18
1995	0.40	1.35	3.19	2.59	1.01	8.54	0.94	9.48
1996	1.61	1.40	2.16	1.05	0.45	6.67	0.73	7.40
1997	0.48	1.89	3.78	1.60	0.66	8.40	0.92	9.33
1998	0.35	1.14	1.58	1.70	0.73	5.50	0.60	6.10
1999	0.62	1.75	2.47	2.16	0.89	7.89	0.87	8.76
2000	0.21	0.80	1.10	1.45	0.64	4.19	0.46	4.65
2001	1.01	1.51	1.32	1.00	0.45	5.30	0.58	5.88
2002	1.09	0.26	2.05	1.27	0.71	5.38	0.59	5.97
2003	0.00	0.75	1.96	1.15	0.85	4.71	0.52	5.23
2004	0.00	0.66	2.54	1.14	0.65	4.99	0.55	5.54
2005	0.05	1.21	1.06	1.25	0.63	4.20	0.46	4.67
2006	0.30	1.22	1.33	1.63	0.61	5.10	0.56	5.66
2007	0.13	2.75	2.20	2.20	0.73	8.01	0.88	8.90
2008	1.38	2.68	1.67	1.28	0.49	7.49	0.82	8.32
2009	0.00	1.45	1.73	2.38	0.84	6.40	0.70	7.11
2010	0.08	0.40	0.61	1.48	0.59	3.15	0.35	3.50
2011	1.63	0.80	3.96	1.92	0.73	9.05	1.00	10.04
2012	0.43	2.23	2.34	2.72	0.84	8.56	0.94	9.50
Average	0.45	1.32	1.83	1.83	0.77	6.20	0.68	6.88

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Table 12.2.1-3 Annul Inflow

	Upper Dam (MCM)	Lower Dam (MCM)	in mm
Annual Inflow	4.51	6.880	544

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

2) Rainfall

The monthly rainfall data at Baghmundi Raingauge Station from 1958 to 2012 is used for the reservoir impounding schedule.

3) Evapotranspiration (ETA)

Evapotranspiration from the project area can be calculated as following. The same values of evapotranspiration are used for the upper and the lower reservoir areas.

E_{TA} = Rainfall – Inflow (before impounding)

Table 12.2.1-4 Evapotranspiration

(Unit: mm)

	June	July	Aug.	Sep.	Oct.	Monsoon Total	Non Monsoon Total	Annual
Rainfall	232	330	307	257	70	1,197	137	1,334
Inflow	35	104	145	145	62	490	54	544
E_{TA}	197	226	162	112	8	707	83	790

(note: the above figures are average from 1958 to 2012)

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

4) Evaporation from Reservoir

The evaporation from the upper and the lower reservoirs is as shown table below, which is introduced in hydrological study. The same values of evaporation are used for the upper and the lower reservoirs.

Table 12.2.1-5 Evaporation from Reservoir

(Unit: mm)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
70	80	140	180	210	170	110	120	100	90	70	50	1,390

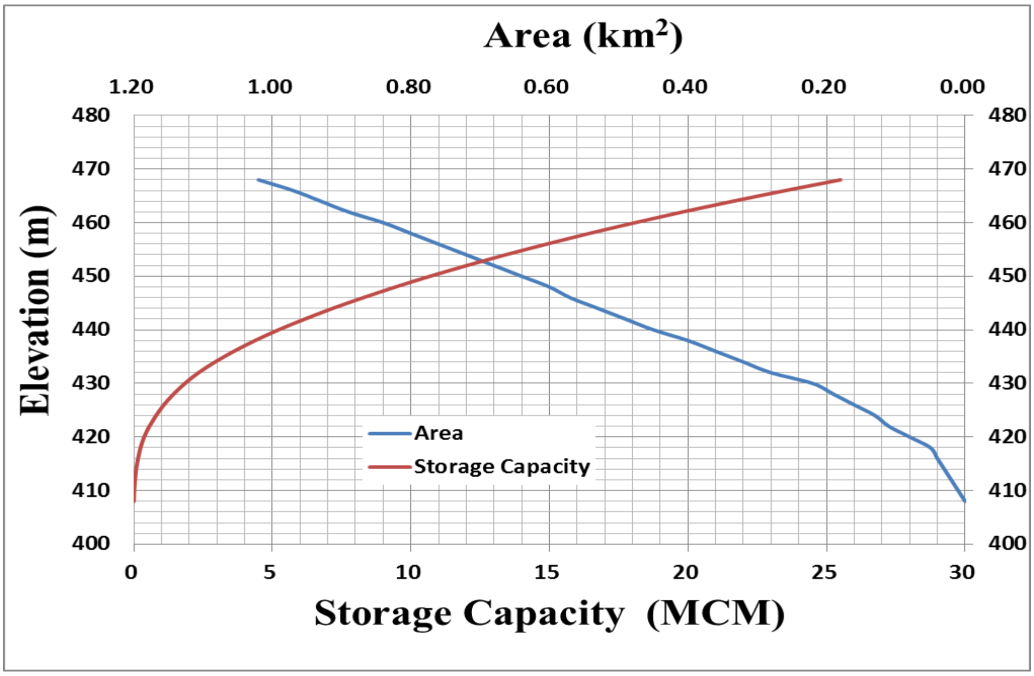
(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

The above figures are exactly same as those used for Purulia Pumped Storage Project (PPSP).

(3) Reservoir storage capacity/area curves

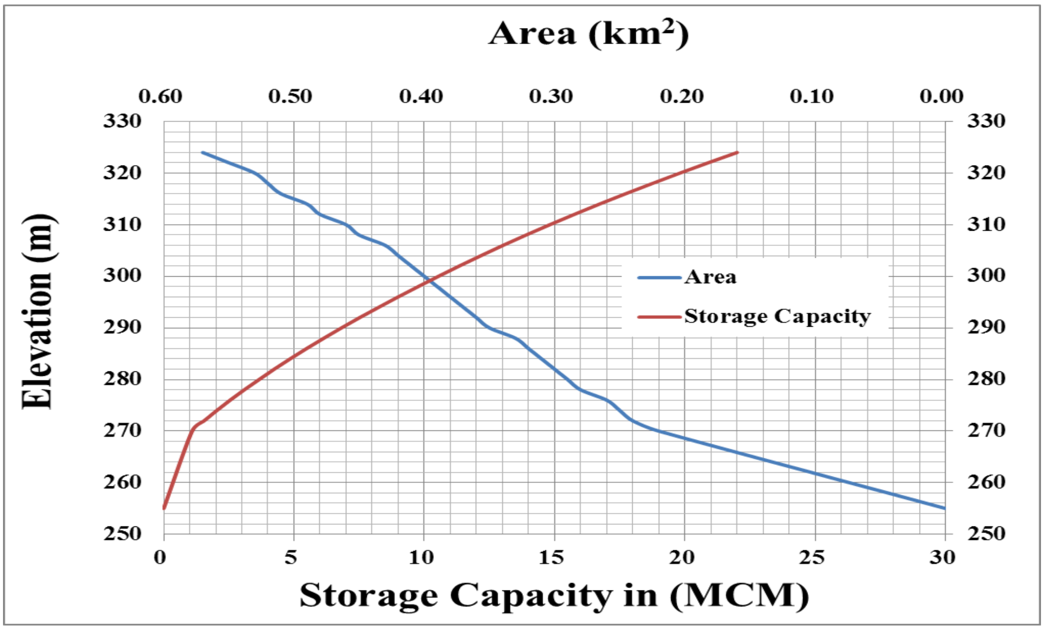
The reservoir storage capacity/area curves for impounding schedule are shown in Figure 12.2.1-1 and 12.2.1-2.

Evaporation volume from reservoir is assumed to be exactly proportional to submerged area, which of upper reservoir varies from 0.53 km^2 (at MDDL) to 0.93 km^2 (at FRL) and that of lower reservoir varies from 0.24 km^2 (at MDDL) to 0.50 km^2 (at FRL) approximately.



(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Figure 12.2.1-1 Upper ReservoirStorage Capacity / Area Curve



(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Figure 12.2.1-2 LowerReservoirStorage Capacity / Area Curve

(4) Inflow during impounding

Inflow to reservoir can be calculated as following. Since the volume of evaporation varies according to the area of reservoir, it is necessary to continue the calculation until obtaining convergent state.

$$Q_2 = Q_1 \times (CA - A_R) + [R - (E - E_{TA})] \times A_R$$

where.

Q_2 : Inflow during impounding (mm)

Q_1 : Inflow before impounding (natural inflow) (mm)

CA : Catchment area (km^2)

A_R : Reservoir area (km^2)

R : Rainfall (mm)

E : Evaporation from reservoir (mm)

E_{TA} : Evapotranspiration from river basin (catchment area) (mm)

(5) Impounding schedule without consideration of environmental flow

The required periods of reservoir impounding for commencement of the project are calculated under following conditions.

- Irrigation and other water demand required at the downstream of the lower reservoir would be supplied from other water resources during the reservoir impounding period.
- Irrigation and other water which must be kept at the upper reservoir would be stored after full (four (4) units) operation of the project

Following three (3) scenarios under difference hydrological conditions (average, wet and dry) are considered to estimate the required period for plant operation.

1) Average Year

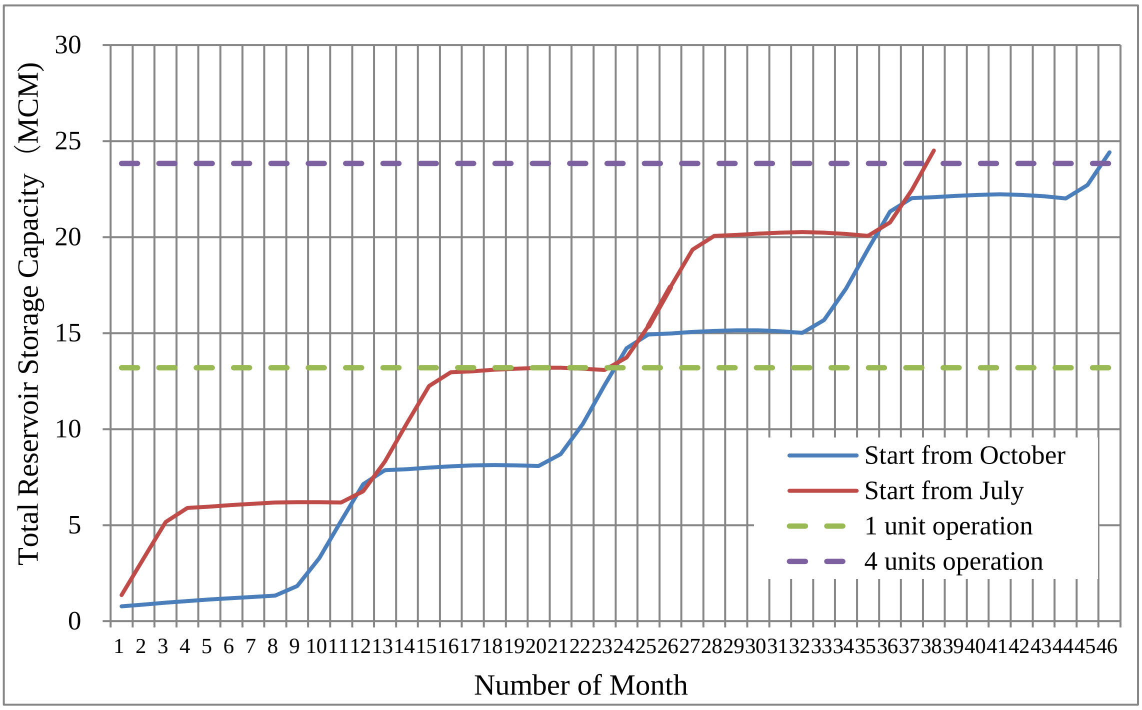
By using monthly average inflows to both reservoirs from 1958 to 2012, the required period of reservoir impounding for one (1) unit operation and four (4) units' operation are calculated.

The shortest period and the longest period for first unit's operation are to start impounding from the beginning of the monsoon season (June), which takes seventeen (17) months, and from July / August / September/ October, which takes twenty-four (24) months.

It can be said that two (2) monsoon seasons to two (2) years are necessary for one (1) unit's operation if the average inflow data is used.

The shortest period and the longest period for four (4) units' operation are to start impounding from July / August / September, which takes thirty-eight (38) months, and from October or November, which takes forty-six (46) months.

It can be said that three and half (3.5) monsoon seasons are necessary for four (4) units' operation if the average inflow data is used.



(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

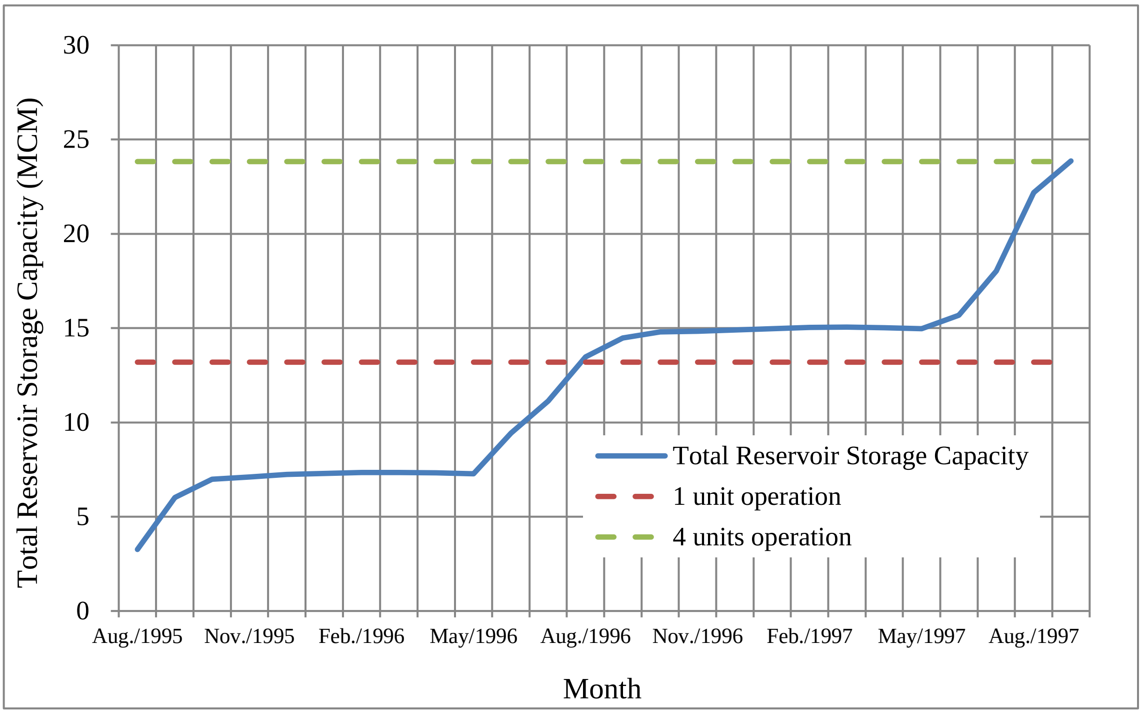
Figure 12.2.1-3 Impounding Schedule for Average Year

2) Wet Year

By using monthly sequential inflows to both reservoirs from 1958 to 2012, the shortest required period of reservoir impounding for one (1) unit`s operation and four (4) units' operation are calculated.

The shortest periods for first unit's operation and four (4) units' operation are to start impounding from August 1995 to August 1996, which takes thirteen (13) months, and from August 1995 to September 1997, which takes twenty-six (26) months.

It can be said that only one (1) year plus one (1) month are enough for one (1) unit's operation if the reservoir impounding fortunately starts in the wettest year (the heaviest rainy monsoon year), and two (2) monsoon seasons plus two (2) months are enough for four (4) units' operation if impounding fortunately starts at the beginning of successive three (3) wet years.



(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

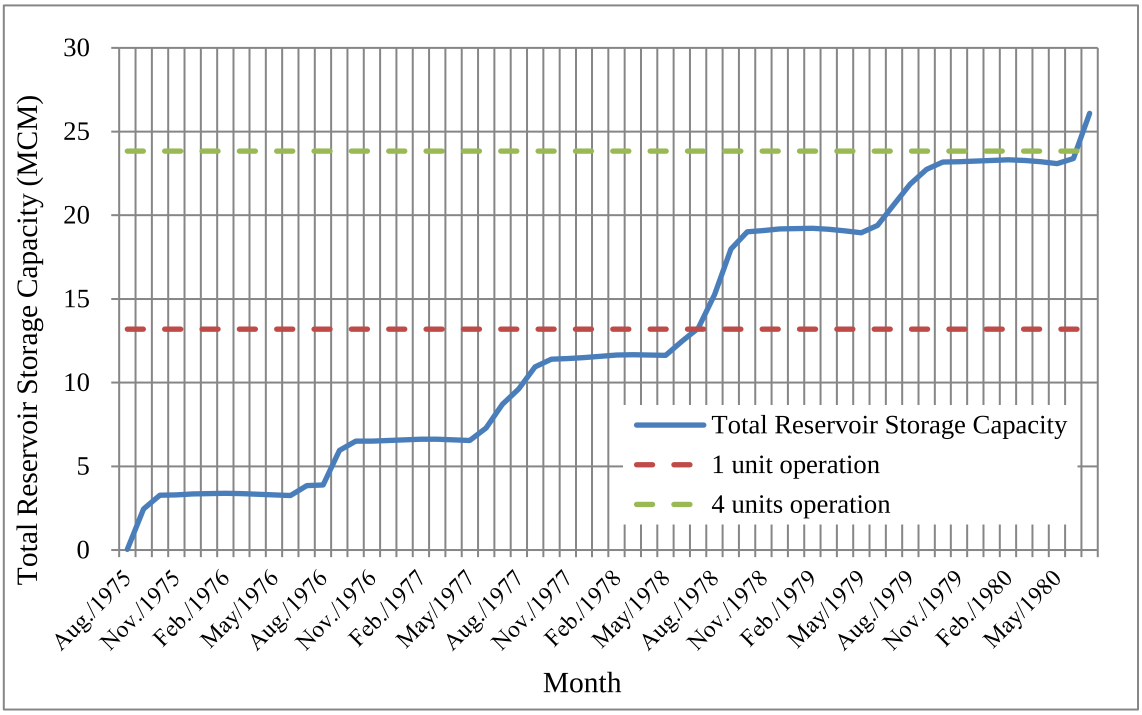
Figure 12.2.1-4 Impounding Schedule for Wet Years

3) Dry Year

By using monthly sequential inflows to both reservoirs from 1958 to 2012, the longest required periods of reservoir impounding for one (1) unit's operation and four (4) units' operation are calculated.

The longest period for first unit operation and four (4) units' operation are to start impounding from August 1975 to July 1978, which takes thirty-six (36) months, and from August 1975 to July 1980, which takes sixty (60) months.

It can be said that three (3) years are necessary for one (1) unit's operation and five (5) years are necessary for four (4) units' operation if impounding unfortunately starts at the beginning of successive dry years.



(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Figure 12.2.1-5 Impounding Schedule for Dry Years

(6) Consideration of Environmental Flow Release

In this study, the impounding schedule is estimated based on the condition that environmental flow can be supplied from other water resources and inflow to upper and low dams can be fully utilized for the pumped storage project.

Here, the worst case, that other water resources are not available at all, is examined by estimating how the impounding period becomes longer than the original.

1) Environmental Flow

Minimum environmental flow release would be 20% of average of four months of lean period and 25% of flow during non-lean non-monsoon period corresponding to 90% dependable year. The cumulative flow releases including spillage during monsoon period should be 30% of the cumulative inflows during the monsoon period corresponding to 90% dependable year.

Base on annual inflow data shown in Table 1 and 2, the year 1975 is found as 90% dependable year as shown in Table 12.2.1-6.

Since there is no lean period in this area, the environmental flows during monsoon period and non-monsoon period for the upper dam are 0.79 (2.63 × 30%) MCM and 0.07 (0.29 × 25%) MCM respectively, and those for the lower dam are 1.20 (4.01 × 30%) MCM and 0.11 (0.44 × 25%) MCM respectively.

Table 12.2.1-6 90% Dependable Year for Annul Inflow

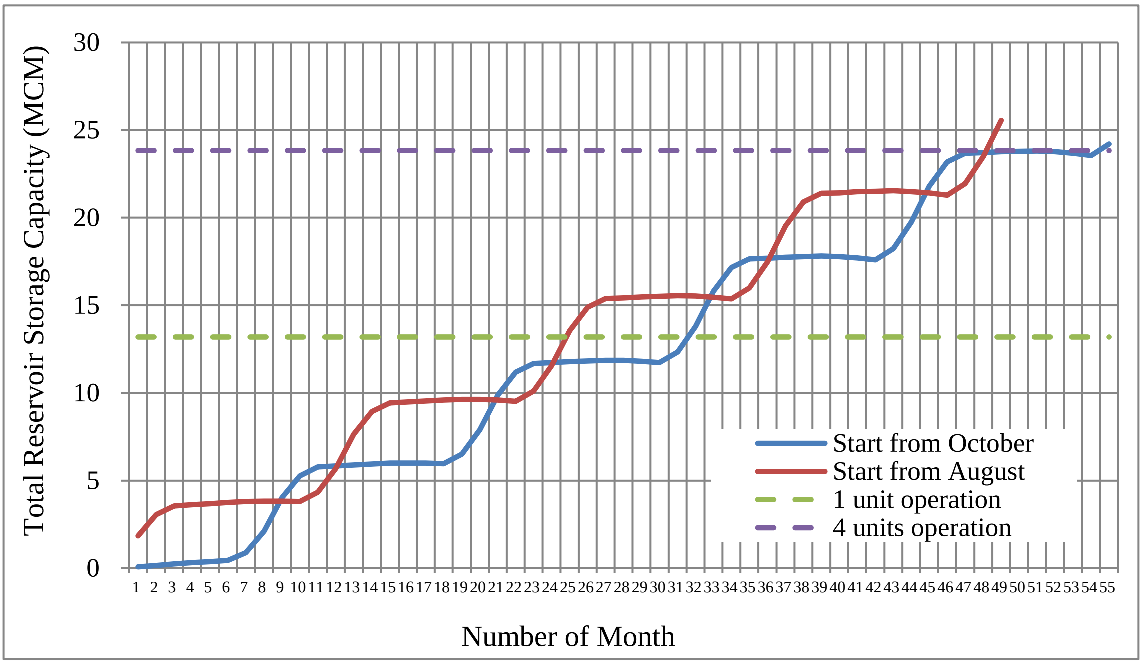
Year	Annual Inflow (MCM)		Exceedance Probability
	Upper Dam	Lower Dam	
2011	6.58	10.04	1.79%
1967	6.34	9.68	3.57%
2012	6.22	9.50	5.36%
1995	6.21	9.48	7.14%
1997	6.11	9.33	8.93%
1985	6.05	9.23	10.71%
1990	5.98	9.14	12.50%
2007	5.82	8.90	14.29%
1999	5.74	8.76	16.07%
1971	5.73	8.74	17.86%
1964	5.52	8.43	19.64%
1984	5.45	8.33	21.43%
2008	5.45	8.32	23.21%
1994	5.36	8.18	25.00%
1970	5.35	8.17	26.79%
1974	5.14	7.84	28.57%
1986	5.05	7.71	30.36%
1987	4.97	7.60	32.14%
1968	4.96	7.57	33.93%
1958	4.88	7.45	35.71%
1992	4.88	7.45	37.50%
1996	4.85	7.40	39.29%
1963	4.77	7.28	41.07%
1978	4.75	7.25	42.86%
1989	4.71	7.19	44.64%
2009	4.65	7.11	46.43%
1961	4.60	7.02	48.21%
1973	4.60	7.02	50.00%
1981	4.53	6.92	51.79%
1960	4.50	6.88	53.57%
1962	4.50	6.86	55.36%
1959	4.44	6.78	57.14%
1983	4.32	6.60	58.93%
1991	4.31	6.58	60.71%
1965	4.27	6.52	62.50%
1993	4.19	6.41	64.29%
1980	4.16	6.35	66.07%
1998	4.00	6.10	67.86%
2002	3.91	5.97	69.64%
2001	3.85	5.88	71.43%
2006	3.70	5.66	73.21%
1972	3.68	5.63	75.00%
1988	3.64	5.56	76.79%
2004	3.63	5.54	78.57%
2003	3.42	5.23	80.36%
1977	3.22	4.92	82.14%
2005	3.06	4.67	83.93%
2000	3.05	4.65	85.71%
1969	2.95	4.51	87.50%
1982	2.94	4.49	89.29%
1975	2.92	4.45	91.07%
1979	2.74	4.18	92.86%
1966	2.59	3.96	94.64%
1976	2.29	3.50	96.43%
2010	2.29	3.50	98.21%

(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

2) Impounding Schedule for Average Year (considering environmental flow)

By using monthly average inflows to both reservoirs from 1958 to 2012, the required period of reservoir impounding for one (1) unit operation and four (4) units operation are calculated.

The shortest and the longest periods for first unit operation are to start impounding from August, which takes twenty-five (25) months meaning eight (8) months longer that the original, and from October, which takes thirty-four (34) months meaning ten (10) months longer than the original.



(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

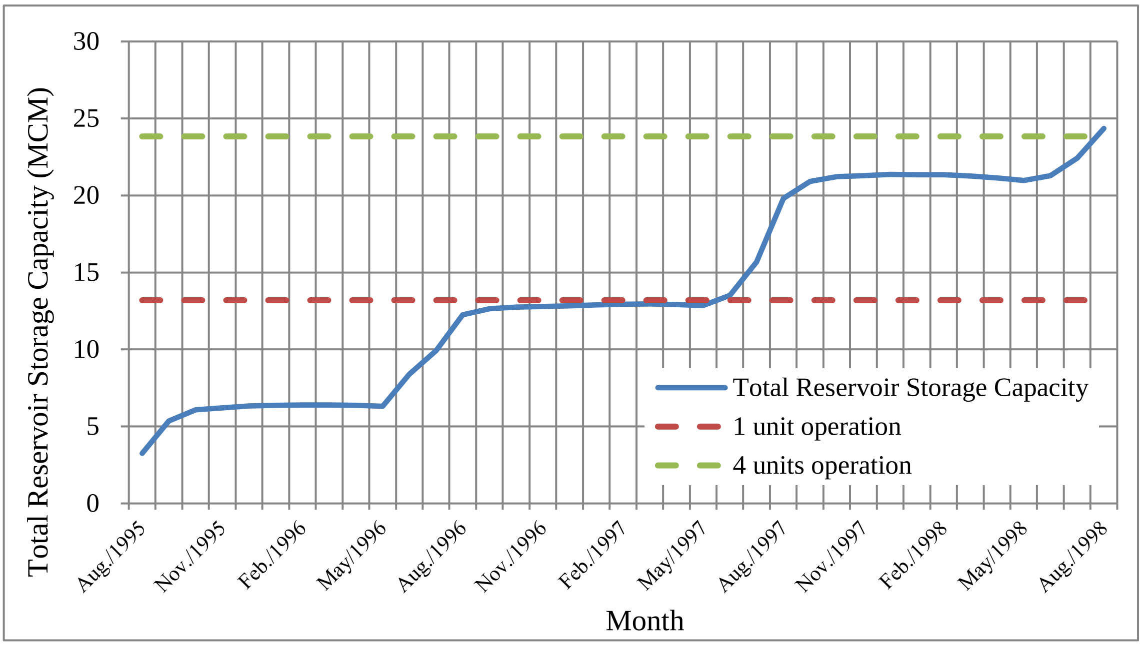
Figure 12.2.1-6 Impounding Schedule for Average Year (with envirometal flow)

The shortest period and the longest period for four (4) units operation are to start impounding from July or August or September or October, which takes forty-nine (49) months meaning eleven (11) months longer than the original, and from December, which takes fifty-five (55) months meaning nine (9) months longer than the original.

3) Impounding Schedule for Wet Year (considering environmental flow)

The required period of reservoir impounding for one (1) unit operation and four (4) units operation are calculated taking into account environmental flow release against the shortest periods of the original, which start from August 1995, without consideration of environmental flow release.

The start months for first unit operation and four (4) units operation change from thirteen (13) months later to twenty-three (23) months later, which means ten (10) months longer, and from twenty-six (26) months later to thirty-seven (37) months later, which means eleven (11) months longer.



(source: DPR of 1,000 MW Turga Pumped Storage Project, Purulia, West Bengal)

Figure 12.2.1-7 Impounding Schedule for Wet Years (with environmental flow)

(7) Recommendation for shortening impounding period

To shorten the reservoir impounding period for the plant operation, it is recommended to consider partial reservoir impounding during the construction works of the dams during the detailed study in DPR. As a matter of course, the related rules and regulations to partial impounding must be preserved.

It might be possible to start reservoir impounding during the construction works of embankment at the upper and lower dams under following conditions from technical aspect.

- Construction works of spillway portion of dam is completed
- Construction works of embankment portion reaches to a certain elevation, which can keep a certain overflow depth to discharge a flood
- Reservoir water elevation even during a certain flood would not be permitted to exceed the height of embankment at any time

12.2.2 Review of Reservoir Impounding Schedule in DPR

The review of reservoir impounding schedule in DPR is basically unnecessary.

In the DPR, the impounding schedule was estimated based on the condition that environmental flow can be supplied from other water resources and inflow to upper and low dams can be fully utilized for the pumped storage project.

But the worst case, that other water resources are not available at all, was examined by estimating how the impounding period becomes longer than the original for two difference hydrological conditions (average, wet) only as a precaution in the DPR. Therefore, the reservoir impounding schedule in consideration of environmental flow for dry year also is estimated additionally this time.

The period for first unit operation and four (4) units' operation for dry year in consideration of environmental flow take twelve (12) months more than those without consideration of environmental flow, forty-eight (48) months and seventy-two (72) months, respectively.

12.3 COST ESTIMATION

(Not be disclosed per cost related information)

12.4 PROCUREMENT METHOD

(Not be disclosed per bid related information)

12.5 ACTIVITIES OF THE DONORS

Government of India has not requested any financial and technical assistance for Turga PSP other than to Japan. Therefore, the project is to be implemented with financial assistance only from Japan.

Activities of donor countries and international financial institutions in electric power sector in India in recent years are summarized below.

12.5.1 Bilateral Assistance

(1) Japan

Japan has been constantly extending financial assistance to India. The assistance has been implemented in line with the "Country Assistance Policy for India" (March 2016). Priority areas in medium-term objectives include strengthening industrial competitiveness. Japan is committed to support key infrastructure development including power generation, transmission and distribution, energy efficiency, etc. in order to contribute to strengthening industrial competitiveness including manufacturing sector.

As to the power projects, ODA loan for eight projects have been extended since 2011 in the field of transmission and distribution lines as well as credit line for renewable energy. Recent loans to India by JICA are summarized in Table 12.5.1-1.

Table 12.5.1-1 Recent Projects financed by JICA

Date	State	Project	Agency / Amount

MAR 2016	Madhya Pradesh	Transmission System Strengthening Project	MPPTCL 15,457 Million Yen
MAY 2015	Odisha	Odisha Transmission System Improvement Project	OPTLC 21,787 Million Yen
SEP 2014	(all)	New and Renewable Energy Development Project (Phase 2)	IREDA 30,000 Million Yen
MAR 2014	Haryana	Haryana Distribution System Upgradation Project	UHBVML/DHBVML 26,800 Million Yen
SEP 2012	Tamil Nadu	Tamil Nadu Transmission System Improvement Project	TNTCL 60,740 Million Yen
JUN 2011	Andhra Pradesh	Andhra Pradesh Rural High Voltage Distribution System Project	CPDCL/SPDCL/NPDCL 18,590 Million Yen
JUN 2011	Madhya Pradesh	Madhya Pradesh Transmission System Modernization Project	MPPTCL 18,475 Million Yen
JUN 2011	(all)	New and Renewable Energy Development Project	IREDA 30,000 Million Yen

(source: Website of JICA, arranged by JICA study team)

(2) Germany

Germany has been cooperating with India putting priority on the following three areas:

- Energy
- Sustainable economic development
- Environmental protection and climate change mitigation

As to the power sector, the country has actively involved in cooperation for solar power projects including construction of the world largest solar power plant at Skari (125MW); Hydropower projects such as Shongtong-Karcham (450MW) and Thana-Plaun (191MW); Transmission line projects to convey energy generated by renewable energy, so called Green energy corridor. In addition, Germany is also supporting projects to improve energy efficiency and efficiency improvement of power plants as well as transmission lines. Recent loans to India by Germany (KfW) are summarized in Table 12.5.1-2.

Table 12.5.1-2 Recent Projects financed by KfW

Date	State	Project / Executing Agency	Amount
OCT 2015	Andhra Pradesh	Andhra Pradesh Green Energy Corridors' Projects / APTRANSCO	EUR57M
OCT 2015	Himachal Pradesh	Himachal Green Energy Corridors' Projects / HPPTCL	EUR68M
DEC 2014		Green corridor transmission line / POWERGRID	EUR 500M
DEC 2014	Rajasthan	Transmission line /TRANSCO	EUR125M

	Tamil Nadu		
OCT 2013	West Bengal	Kolaghat Thermal Power Plant rehabilitation and modernization Project / WBPDCL	(INR 1,100 Crore)
SEP 2013	Maharashtra	Mouda Super Thermal Power Project, Stage-II / NTPC	EUR55M

(source: Website of KfW, arranged by JICA study team)

(3) France

French Development Agency (AfD) has been operating in India since 2008, by developing cooperation actions for sustainable development and the fight against climate change. As to the power sector, AfD extended credie lines to Indian Renewable Energy Development Agency (IREDA) with a total amount of EUR 170 million to be used by private sector developers for development of small hydro, solar power, wind power, cogeneration, and biomass power.

In September 2014, AfD agreed to offer loan to Himalchal Pradesh Power Corporation Limited for construction of two run of river type hydropower stations: Chanju-III (48 MW) and Deothal Chanju (33 MW), as well as Berra Dol Solar Power Project (5MW). In January 2016, France expressed its intention to provide EUR 300 million through AfD over a five-year period as a Development of Solar Energy Project. Recent loans to India by France (AfD) are summarized in Table 12.5.1-3.

Table 12.5.1-3 Recent Projects financed by AfD

Date	State	Project	Agency/Amount
JAN 2016	(all)	Development of Solar Energy Project	EUR 300M
SEP 2014	Himachal Pradesh	Chanju-III and Deothal Chanju Hydropower Projects / Berra Dol Solar Power Project	HPPCL EUR80M
2008	(all)	Renewable Energy and Energy Efficiency projects	IREDA EUR170M

(source: Website of AfD, arranged by JICA study team)

12.5.2 Multilateral Assistance

(1) The World Bank

World Bank Group once extended a huge amount of money to the development of hydropower projects in the past. Recently their financial cooperation focuses on transmission and distribution, as well as solar power projects. As to the latter, they intend to supply finance of one billion dollar in the coming years. Recent loans to India by the World Bank are summarized in Table 12.5.2-1.

Table 12.5.2-1 Recent Projects financed by the World Bank

Date	State	Project	Amount
JUN 2016	Tripura, Nagaland, Mizoram, Meghalaya, Manipur, Assam	North Eastern Region Power System Improvement Project	US$ 470M
MAY 2016		Grid-Connected Rooftop Solar Program	US$ 500M

		Project	
MAR 2016	Rajasthan	First Programmatic Electricity Distribution Reform Development Policy Loan	US$ 250M
JUN 2015	Andhra Pradesh	Andhra Pradesh Disaster Recovery Project (including component of underground power distribution system)	US$ 250M (total)
JUN 2011	Uttarakhand	Vishnugad Pipalkoti Hydro Electric Project	US$ 648M

(source: Website of the WB, arranged by JICA study team)

(2) Asian Development Bank

A major part of the credit is given to the private sector as a Private Sector Loan in the field of Solar Power Projects. As to the assistance to the public power utilities, finance is mainly destined to the grid and hydropower projects. Recent loans to India by ADB are summarized in Table 12.5.2-2.

Table 12.5.2-2 Recent projects financed by ADB

Date	State	Project / Executing Agency	Amount
MAR 2017	Karnataka	Solar Transmission Sector Project / POWERGRID	US$225M
DEC 2016	Rajasthan	Rajasthan Renewable Energy Transmission Investment Program - Tranche 2 / RRVPNL	US$348M
DEC 2016	Andhra Pradesh, Gujarat, Jharkhand, Karnataka, Madhya Pradesh, Telangana	ReNew Clean Energy Project / Helios Inflatech Pvt. Ltd. and six other companies	US$195M
SEP 2016	Rajasthan, Maharashtra, Andhra Pradesh Goa, Karnataka, Uttar Pradesh	Demand - Side Energy Efficiency Sector Project / Energy Efficiency Services Ltd.	US$200M
MAR 2016	Rajasthan, Madhya Pradesh Andhra Pradesh Karnataka Telangana Punjab	Mytrah Wind and Solar Power Development Project Mytrah Energy (India) Ltd.	US$165 M
DEC 2015	Gujarat, Punjab, Rajasthan, Chhattisgarh, Tamil Nadu, Kerala	Green Energy Corridor and Grid Strengthening Project / PGCIL	US$500M
NOV 2015	Assam	Assam Power Sector Investment Program - Tranche 2 Assam Power Distribution Co.	US$48M
NOV 2014	Rajasthan	ACME-EDF Solar Power	US$100M
SEP 2014	Himachal Pradesh	Himachal Pradesh Clean Energy Transmission Investment Program – Tranche	US$100M

Date	State	Project / Executing Agency	Amount
		2 / HPPTCL	
DEC 2013		Solar and Wind Power Development Project Welspun Renewables Energy Limited	US$50M
DEC 2013	Delhi	Delhi Electricity Distribution System Improvement BSES Rajdhani Power Limited	US$80M
APR 2013	Himachal Pradesh Maharashtra	Hydro and Wind Power Development Project / NRPPL	US$30M
NOV 2012	Himachal Pradesh	Himachal Pradesh Clean Energy Development Investment Program - Tranche 4 / HPPCL	US$257M
SEP 2012	Gujarat	145 MW Grid-Connected Solar Project / vairous	US$100
MAR 2012	Rajasthan	Rajasthan Concentrating Solar Power / Rajasthan Sun Technique Energy Priv.	US$103
NOV 2011	Rajasthan	Dahanu Solar Power Project Reliance Power Limited	US$48M
NOV 2011	Chhattisgarh	National Grid Improvement Project / PGCIL	US$250M

(source: Website of ADB, arranged by JICA study team)

12.5.3 Lessons Learned in the Post-Evaluation

Lessons learned in the hydropower projects financed by ADB in recent years as mentioned in the Completion Report is mentioned below. In most evaluation, employment of competent consultant as well as the initiative taken by the executing agency is a key to a successful completion of the projects. As a whole no concrete description is made, therefore, it is difficult to grasp the detailed situation.

- "Appointment of an inexperienced project manager without relevant work experience in Viet Nam resulted in an avoidable delay in the commissioning of the hydropower plant. Appointing experienced project management experts is important."
  (Viet Nam: Song Bung 4 Hydropower Project, Completion Report,. August 2017)
- "Establishing a dedicated entity for the design, construction, and operation the ZHSHPP contributed to the smooth implementation of the project and its subsequent operation. The core staff of ZPSC has been involved in the project from its inception, so ZPSC has a strong sense of ownership and institutional memory.
  Competent implementation supervision consultants are important to ensure the quality of the technical design and the performance of contractors for complex infrastructure projects. ZPSC highly appreciated the contribution from implementation consultants for the smooth implementation construction of the project within the original schedule."
  (China: Hebei Zhanghewan Pumped Storage Project, Completion Report, August 2014)
- "Deviations between the final project costs and the appraisal estimates were small. The results were achieved through coordinated efforts made by all parties involved in project implementation. Advance actions were taken to expedite the procurement of civil works and critical equipment. Effective bidding processes were vital in obtaining advantageous bid offers. Proactive project management, both in equipment procurement and in construction, enabled capital cost savings and ensured the quality of construction and equipment supply. The selection and hiring of competent international and national consultants ensured that the quality standards required for the project were met."
  (China: Gansu Heihe Rural Hydropower Development Investment Program - Dagushan Hydropower Project, Completion Report, April 2013)
- "The successful construction of the project resulted from the strong government ownership and provides a valuable lesson on the importance of this factor in facilitating effective implementation and delivery of development results in ADB-financed projects. The EHC always took the initiative in solving problems, including in the provision of design documents, timely delivery of equipment, approach to dealing with issues, and other areas. The owner's initiative guaranteed appropriate procedures and timely action on key tasks and when problems arose."
  (China: Gansu Heihe Rural Hydropower Development Investment Program - Erlongshan Hydropower Project, Completion Report, December 2011)

12.6 RISK MANAGEMENT FRAMEWORK

Risk Management Framework was prepared to evaluate the various kinds of risks accompanied by the implementation of the Project, and the countermeasures have been proposed. In preparation of the Risk Management Framework, arrangement has been made from the viewpoint of: i) Stake holder risk; ii) Executing agency risk; and iii) Project risk.

Risk Management Framework is shown in Table 12.6-1.

Table 12.6-1 Risk Management Framework

Risk items	Viewpoint, Check items, Points to be confirmed	Countermeasures
1. Stakeholder risk		
- Low commitment by the government to the Project (political priority, commitment including financial support) - Sustainability of political priority after change of administration 【Priority of the Project in development policy】	<u>Viewpoint, check items</u> : ★Whether the project is identified as a priority project in the government; whether there is a commitment for development policy or reform policy at a high level. ★ Possibility of losing a commitment to the project due to change of political priority after administration change ★ Are there any factors which will lose or enforce the motivation of project implementation, influenced by the Project on the national or international image of the government? <u>Points to be confirmed</u> : ★Inclusion in power development plan ★Clearance of DPR by CEA ★Approval of the Project in State Assembly	The Turga Project was approved by CEA in 2016; the approval of the State Assembly was obtained in May 2017. At a union level, the project has been included in the rolling plan for Japanese ODA by the Ministry of Finance in 2017. Unless a special circumstance arises, it is expected that the possibility of cancelling the Project is low. ★To confirm the necessity of the Project and evaluate the effect by cancellation ★ To have regular opportunity to provide information on the Project and its progress to the mass media
- Compatibility with the needs of the citizens in general outside the government - Possibility of conflict with those with vested interests 【Positioning of the Project in the development policy】	<u>Viewpoint, check items</u> : ★Is there any possibility to cause strong object to the Project from the stakeholders including citizen's movement, mass media, adjacent foreign government ★ If the risk is high, are there any countermeasures to the risk including the proper public relations policy ★ Is there any possibility to cause political disturbance especially by infringing the invested interests of a specific group having political pressure Pu <u>Points to be confirmed</u> : ★Economic development, effect of employment creation ★Increase in electric power demand ★Stable electric power supply	The Project is to construct a power plant for the purpose of sustainable economic development as well as stable power supply. It is also expected to create employment. ★To maintain constant provision of information and explanation regarding the necessity and benefit of the Project ★To explain to the local inhabitants about the good effect to the local economy as well as employment creation
- In case of	<u>Viewpoint, check items</u> :	

Risk items	Viewpoint, Check items, Points to be confirmed	Countermeasures
introducing private fund to the Project, possibility of the capital contribution to the executing agency. 【Project cost and capital plan】	Not applicable Points to be confirmed :	
2. Executing agency risk		
2.1 Capacity risk		
- Transfer of appropriate resources and authority to the executing agency - 【Executing agency – financial ability】	Viewpoint, check items : ★ Does the executing agency have enough human and financial resources and authority to make various decision required to implement the Project? Points to be confirmed : ★Executing agency is WBSEDCL ★Budgeting by State Government ★Experience of Purulia PSP	WBSEDCL is a state distribution company, and the costs required for the services are basically recovered from the beneficiaries with the electricity tariff. Tariff level may be suppressed politically to avoid sharp increase and it takes time to recover full cost. WBSEDCL is an executing agency for Purulia PSP, therefore, the company grasps the required human and financial resources, based on the past experience. On the other hand, equity portion will be borne by the State Government and the corresponding particulars have already established for their budget in this fiscal year. ★Due attention shall be paid to book annual budget through discussion with the State Government. ★Clarification of procedure to be taken in case of budget excess.
- Reliability of the financial management and procurement process, and technical capability of administration department - Actual application of rules including freedom from political pressure 【Executing agency –technical ability】	Viewpoint, check items : ★ Various regulation/laws related to governmental procurement are adequately provided? Is concurrence process by JICA incorporated properly? ★ Is there any possibility to be obliged to re-tender due to the more excessive conditions than those stipulated in the JICA guidelines for procurement? Points to be confirmed : ★Experience in Purulia PSP ★To have more than three bidders	★ To prepare bidding documents properly incorporating the concurrence process by JICA ★To be prepared for the case pf less than three bidders, and prior examination shall be made for easing the bidding requirement. ★To plan a bidding schedule with margin ★To make publicity of bidding in advance in order to secure bidders ★To deploy preferentially capable personnel having experience in Purulia PSP ★To participate in such training as procurement and financial administration seminar sponsored by JICA
- Reliability of funding equity - Reliability of financial	Viewpoint, check items : ★Is it possible to properly collect equity fund and operation and maintenance costs? Or is it provided by the Government? In case of	As the equity portion is provided by the State government, it is necessary to include it in the State Budget. ★To keep informed about progress of the Turga

Risk items	Viewpoint, Check items, Points to be confirmed	Countermeasures
administration 【Executing agency －financial ability】	necessity, money can be borrowed promptly? ★(As a condition for assembly approval, etc.), full finance is required including the later tranche and this would cause delay in project approval in the Indian/WB Government? Points to be confirmed： ★Budgetary provision of the equity portion in the State budget	Project to the member of assembly as well as to the persons concerned in the State government ★To keep an eye on the preparation of State Budget so that the annual budget would be secured for the Project through close consultation with the State Government.
- Possibility of delay in payment to contractors 【Executing agency － financial ability, implementation structure】	Viewpoint, check items： ★Is the authority is transferred widely to the local office with regard to checking of payment procedure such as contents of the works, and appropriateness of request for payment Points to be confirmed： ★Experience in Purulia PSP ★Payment process and authority	★To deploy preferentially capable personnel having experience in Purulia PSP。 ★Awareness of cost increase in case of delay ★ Clarification, simplification and transfer of authority in payment process
- Possibility of a lack of financial or technical capability of the local government and community in the case of dispersed project; or of the mediation agency in the case of TSL, etc. 【Executing agency － Implementation structure, operation and maintenance structure】	Viewpoint, check items： Not applicable Points to be confirmed：	
2.2 Governance risk		
- Structure for cooperation among related departments; structure for complicated implementation 【Executing agency － Implementation structure, structure for O&M】	Viewpoint, check items： ★ Is there any responsibility sharing and cooperation structure among related organizations including upper ministries with respect to various decision making required for project implementation Points to be confirmed： ★ Relationship between WESEDCL and WBSETCL	Procedures for decision making in central government, state government and WBSEDCL are established. Construction work of transmission line will be in charge of WBSETCL, it is necessary to have a regular meeting regarding construction schedule to share the latest information of the entire works.
- Delay in assembly approval necessary for financing.	Viewpoint, check items： ★Is there any possibility to cause delay in approval by assembly of E/N and L/A due to lack	There is no election in 2018 at the national level or in West Bengal, however, election of panchayat is scheduled to be made in the State. This may affect the

Risk items	**Viewpoint, Check items, Points to be confirmed**	**Countermeasures**
【Implementation schedule】	of communication between government and assembly, requirement of Indian Government based on their rules (e.g. to secure funding including later tranche)	deliberations at the assembly. To continue lobbying to the major members of the assembly for the purpose of recognition of the necessity of the Project.
	Points to be confirmed： ★Past experience in India ★Share of political parties in Indian assembly	
2.3 Fraud & corruption risk		
- Appropriateness and effectiveness of financial and procurement management rules 【Method of procurement and execution】	Viewpoint, check items： ★ Is there a system necessary for smooth implementation of the Project including procurement, financial management, measures for fraud and corruption? Is there any system to secure proper accounting audit, disclosure of information? In case there is a high risk, is there any complementing measures including post audit? ★Are there any past experience of a large delay or problem during implementation stage in similar projects (including those financed by other donors)?	The government of India has been working on strengthening accounting audits and development of laws. ★To promote fair and clear procurement ★Clarification of procurement process. Especially to clarify who is a decision maker ★To prepare a manual for procurement management ★To appoint a personnel experienced in international procurement
	Points to be confirmed： ★ Actual situation and plan for system development ★Confirmation of the past experience ★Hearing from the related persons	
3. Project risk		
3.1 Design risk		
- Technical design of the Project - Adoption of too sophisticated technology 【Summary of the Project】【Executing agency ― technical ability】	Viewpoint, check items： ★Does the Project have designs too complicated technically? Does it include necessary components to attain the development effects? ★Does it lead to high electricity tariff or high O&M cost resulting from too sophisticated technology?	The Project introduces variable speed machine, however, this does not correspond to adoption of too sophisticated technology. On the other hand, WBSEDCL has no operational experience. The following measures shall be taken to have a full effect of the machine: ★To deploy operators experienced in operation of pumped storage plants ★Detailed planning of technical transfer through operation guidance by manufacturer ★To train operators of pumped storage plants in advance to secure personnel having basic knowledge
	Points to be confirmed： ★ Ability to operate properly ★ Ability to maintain properly	
- Appropriateness of the Project scope 【Project outline】	Viewpoint, check items： Are the components (including soft ones) necessary to attain the purpose of the Project included? Is there any possibility not to emerge development effect due to no implementation of the components which are out of scope for JICA assistance.	Construction of transmission line to be implemented by WBSETCL is not included in the scope of JICA finance. Without the transmission line, function of the Project will not be fulfilled. The following measures shall be taken: ★To have a coordination point between WBSETCL and WBSEDCL

Risk items	Viewpoint, Check items, Points to be confirmed	Countermeasures
	Points to be confirmed： ★Confirmation of certainty of construction of transmission line	★To have a regular meeting with WBSETCL regarding schedule coordination, etc. ★To share information regarding progress of construction work of the transmission line (including regular reporting to the Consultant)
- Reliability of monitoring of the Project 【Executing agency － Implementation structure】	Viewpoint, check items： ★Is there any possibility that status of implementation (budget/works) in a timely manner is not obtained correctly and occurrence of a problem is not noticed, which lead to leaving the problem unattained. ★Is there any possibility to occur unproper use of fund, etc. due to insufficient monitoring?	★To build a system to manage detailed payment status ★To share information with the Consultant regarding the progress status of the works
	Points to be confirmed： ★Confirmation of the similar experience of the responsible officer ★To review the current budget management system	
- Implementation structure in the case of a reginal dispersed projects 【Executing agency － Project implementation】	Viewpoint, check items： Not applicable	
	Points to be confirmed：	
- Inappropriateness of procurement package - Insufficient capability of contractors【Method of procurement / construction】	Viewpoint, check items： ★Are there too much number of procurement package? ★Is there procurement packages which require too expensive coordination cost among contractors, or too small for capable contractors to participate in bidding? ★Are local contractor and/or materials sufficient to procure for LCB portion?	It is possible to have the proper number of packages incorporating the comments from the Consultant upon research of the past experience. As to the capability of the contractor, evaluation is to be made on the description of the past experience in the PQ documents or technical proposal. Data base of capability of local contractors may be prepared based on past experience.
	Points to be confirmed： ★Experience in the past ★Hearing to WBSEDCL, local consultant and contractors	
- Vulnerability of inflation of projects costs due to external factors 【Project cost and financing plan】	Viewpoint, check items： ★Is there any possibility to lead to increase of the project cost resulting from the fluctuation of international market or foreign exchange?	In case of borrowing in Japanese Yen, evaluation of Japanese Yen lead to the hike of project cost. Thorough discussion shall be made on the foreign exchange risk in advance. In order to cope with the hike of construction cost, consideration shall be made in advance regarding additional cost burden (confirmation of procedure and decision maker).
	Points to be confirmed： ★Hearing to the contractors regarding the business perspective	

Risk items	Viewpoint, Check items, Points to be confirmed	Countermeasures
- Vulnerability to reduced demand caused by external factors 【Necessity of the Project】	Viewpoint, check items： ★Is there any possibility that the service of the Project is limited to the small object and the demand is reduced rapidly due to external economic factors, etc.? Points to be confirmed： ★Timely revision of power demand forecast ★Attention to the trend of renewable energy ★Attention to the economic activities in India and abroad	It is possible that the power demand stagnates with the slowdown of the economic activities in India and abroad. On the other hand, the function expected to this project is not only the power supply, but also to secure quality of the electricity. For this purpose, in order to fulfill the latter function, more detailed attention shall be made to the maintenance to the variable speed machine than to the conventional one.
3.2 Program/donor risk		
- Development of related projects 【Project outline】	Viewpoint, check items： Not applicable Points to be confirmed：	
- Policy and system reform necessary for manifesting the development effects 【Development policy and the positioning of the Project in it】	Viewpoint, check items： ★Is the necessity of policy or system reform necessary for manifesting the development effect such as tariff policy recognized fully? Has any assistance (including other donors) for the realization been obtained? Points to be confirmed： ★ Incorporation of ancillary service into electricity tariff	Ancillary service has been stipulated by CERC for the purpose of maintaining frequency at a expected level, however, the corresponding cost is not stipulated in its tariff system. In order to have full development effect of the Project, it is indispensable to set up a system to properly evaluate the value of the ancillary service.
- Cooperation with other related donors 【Measures by other aid agencies】 【Cooperation with other donors】	Viewpoint, check items： Not applicable Points to be confirmed：	
3.3 Delivery quality risk		
- Possibility of measuring development effects 【Project performance】	Viewpoint, check items： ★Is it possible to easily obtain data to measure operation and effect indicators? Has the channel of data acquisition been identified properly? Points to be confirmed： ★Status of data acquisition at PPSP	Operation and effect indicators are usual result of operation at power plants, and such data shall be recorded as a routine. It is important to set up a system by nominating a person in charge to arrange operation results for reliable acquisition, registration and back up.
- Insufficiency of monitoring after completion of the Project due to geographical dispersion of sub-projects 【System of	Viewpoint, check items： Not applicable Points to be confirmed：	

Risk items	Viewpoint, Check items, Points to be confirmed	Countermeasures
operation, maintenance and administration】		
- Sustainability of development effects 【System of operation, maintenance and administration】	Viewpoint, check items： ★ Is there clear stipulation regarding the responsibility of operation and maintenance? Has operation and maintenance plan been formulated properly (especially from a technical viewpoint) and given sufficient budget allocation? If there is a shortage of the fund, what is the background (e.g. low level of the tariff, etc.) Points to be confirmed： ★Past example at PPSP	Cost of the Project is officially recovered with the electricity tariff under the basis of cost-pus. On the other hand, in order to avoid sharp increase in electricity tariff, sometimes the tariff may be fixed politically at the lower level, and this causes delay in recovery of the justifiable costs. As to the O&M cost for hydropower plants, a normative cost by installed capacity (MW) is stipulated by WBERC. Except for unexpected failure in the plant, it is regarded that sufficient budget has been secured ★Confirmation of procedure to secure additional budget in case of failure ★Arrangement of system and plan of operation and maintenance
- Possibility of impact on Project implementation due to natural disasters, local security situation, etc. 【Necessity of the Project】【Others】	Viewpoint, check items： ★Is there any possibility for the Project to be interrupted or hampered resulting from natural disasters in the project area? ★Is there any possibility for smooth progress of the Project to be hampered by local demonstration or anti-governmental forces? Points to be confirmed： ★Amount of precipitation during monsoon season ★Flooding in the past	The project area enters into monsoon period in mid June and continues to October. Construction plan shall be formulated considering the period. No major opposition movement by the local inhabitants has been confirmed, however, public relations activities such as the contents and progress of the Project shall be made to major stake holders. A system for reliable implementation of environmental measures based on EIA and monitoring shall be established.
- Inappropriate or unlawful use of the Project 【Project effect】	Viewpoint, check items： Not applicable Points to be confirmed：	
- Increase in maintenance costs due to Improper use of the facilities 【System of operation, maintenance and administration】	Viewpoint, check items： Not applicable Points to be confirmed：	
- Possibility of imbalanced benefit for specific demographics - Restricted scope of benefit from the development effects 【Project effect】	Viewpoint, check items： Not applicable Points to be confirmed：	

(source: JICA study team preparation)

Annexure 12-1

The Cost Estimation of Electro Mechanical Equipment for Turga Project

(Not be disclosed per cost related information)

Annexure 12-2

Terms of Reference for Design and Supervision Consultant for the works under TURGA PUMPED STORAGE PROJECT

(Not be disclosed per bid related information)

CHAPTER 13

ECONOMIC AND FINANCIAL EVALUATION

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13.1 ECONOMIC EVALUATION

13.1.1 Methodology

(1) Methodology

Economic evaluation aims at measuring the “economic” impact brought about to a country by implementing a project from a viewpoint of national economy. For Don Duong Pumped Storage Hydropower Project, a comparison of costs and benefits expressed in terms of economic prices will be made by applying the Discount Cash Flow Method, which is widely adopted for such purposes.

The basic approach for this method is as follows: First, the cash outflow (costs) and inflow (benefits) are developed on an annual basis over the project life. Secondly the amount generated during different years will be discounted to the start year of the project and expressed as an accumulated present value at the same standard year. Then a comparison will be made between the costs and benefits.

Evaluation indices to be obtained will be the Net Present Value, the Benefit/Cost Ratio, and the Economic Internal Rate of Return (EIRR). The EIRR is a discount rate at which the present values of the two cash flows become equal. This rate shows the return to be expected from the project. EIRR is expressed in the following equation:

$$\sum_{t=0}^{n} C_t \ / \ (1+r)^t - \sum_{t=0}^{n} B_t \ / \ (1+r)^t = 0$$

Where,

C_t : Cost

B_t : Benefit

t : Year

n : Project life (year)

r : Discount rate (= EIRR)

(2) Basic Conditions

(Not be disclosed per cost related information)

13.1.2 Economic Costs of the Project

The economic costs of the Project are calculated based on the construction cost at market price as presented in Chapter 12. First, price escalation, interest during construction, front end fee and transfer items (VAT and import tax) are excluded from this construction cost. Next, a conversion factor is applied to the local currency portion to obtain the construction cost at economic prices.

Construction cost, O&M cost and pumping energy cost at economic prices are shown in Table 13.1.2-1.

Turga Project is expected to enter into commercial operation one unit after another from the 9th year, therefore, cost related to partial operation is estimated.

Table 13.1.2-1 Economic Cost of the Project

(Not be disclosed per cost related information)

(source: JICA study team preparation)

13.1.3 Economic Benefit of the Project

For the purpose of the study, construction cost and operation & maintenance cost of an alternative power plant, which can supply equivalent power and energy to the pumped storage plant are considered as economic benefit of the project. A combined cycle power plant fueled by gas is selected as the alternative power plant, which is affordable to supply peak power is selected.

(1) Adjustment Factor

In order to estimate the economic benefit in terms of alternative thermal power plant, firstly an adjustment factor to adjust the difference of loss rates between hydropower plant and thermal power plant is calculated. As a result, adjustment factor of 1.07394 for power (kW) and 1.00908 for energy (kWh) is obtained. Calculation of adjustment factors is shown in Table 13.1.3-1.

Table 13.1.3-1 Adjustment Factors for Power (kW) and Energy (kWh)

(Not be disclosed per cost related information)

(source: JICA study team preparation)

(2) Cost of Alternative Thermal Power Plant

Basis characteristics of alternative thermal power plant, which have been obtained with the adjustment factors, are shown in Table 13.1.3-2.

Table 13.1.3-2 Basic Features of Alternative Thermal Power Plant

	Unit	Turga	Adjustment factor	Alternative Thermal
Installed capacity	MW	1,000	1.07394	1,074
Energy generation	GWh	1,825	1.00908	1,842
Plant life	Year	--	--	25

(source: JICA study team preparation)

(3) Unit construction cost of alternative thermal power plant

Unit construction cost has been obtained referring to the amount cited in the recent tariff order of CERC. Table 13.1.3-3 shows the unit costs mentioned in tariff order for Palatana Project in 2017.

Table 13.1.3-3 Unit Cost of Alternative Thermal Power Plant

Project	COD	Hard Cost (Crore)	Capacity (MW)	Unit Cost (Crore/MW)
Pragati-III	2010-2014	4792.23	1371	3.50
Uno-Sugen CCPP	2013	1495.65	382.5	3.91
OPTC	2014	2560.10	726.6	3.52

(source: Order in Petition No.129-GT-2015, CERC, 2017)

3.50 Crore/MW has been adopted as a base unit construction cost as of 2014 from this table. Then, average CPI (4.9% for 2015, 4.5% for 2016 and 3.8% for 2017) is considered to obtain price of 2017: 3.98 Crore Rs/MW.

(4) Fuel cost

Development of natural gas has been made in India, however, the output is not expected to cover all the domestic demand, and the shortage in demand in the future has to be covered with the import. This means that from a viewpoint of demand and supply of natural gas as a county, additional amount of natural gas shall be supplied by increasing import. Therefore, in case relatively low priced domestic gas is available for this alternative project, economic cost of natural cost shall be expressed with the price of imported gas (CIF price). No details of import price by the gas importer is disclosed, but a recent newspaper article reveals example of price calculation model. The price calculation model is indicated in Table 13.1.3-4.

Table 13.1.3-4 Basic Feature of Alternative Thermal Power Plant

Importer	Petronet LNG	Petronet LNG	GAIL
Supplier	RasGas	Exxon Mobil	Cheniere Energy
Formula	12.67% of crude + US$0.6	13.9% of Brent Crude	115% of Henry Hub + US$3
Base Price	US$49.91	US$49.91	US$3.00
Import Price	US$ 6.92	US$ 6.94	US$6.45
Others		Including shipping costs	

(note: Base Price corresponds to referential case price for 2017 in Annual Energy Outlook 2017, published by U.S.EIA.)

(source: JICA study team preparation based on The Economic Times, Sept.13, 2017.)

A calculation model of Petronet LNG has been adopted for this study, because it is the price including transportation cost.

Price of petroleum and natural gas fluctuates largely due to the condition of demand and supply. Remarkably low level of price was dominant during 2016 and it was still lower in 2017 as compared to that of the previous years. Therefore, the following assumption was used to obtain the natural gas price:

- Base cost was calculated from the average price for 15 years from 2015 to 2029 estimated by U.S. Energy Information Administration: US$87.235.
- Fuel cost was derived from the equation of Petronet LNG: US$87.235×13.9% = 12.126US$/MMBtu.

(5) Operation & Maintenance cost

Annual O&M cost of 17.61 Lakh Rs/MW was adopted, as stipulated in Tariff Regulations 2014-19 by CERC.

Construction cost, annual O&M cost, and annual fuel cost are summarized in Table 13.1.3-5.

Table 13.1.3-5 Economic Benefit of the Project

	Unit	
1. Pumped Storage Power Plant		
Installed Capacity	MW	1,000
Annual Energy Generation	MWh	1,825,000
2. Alternative Thermal		
Adjustment Factor (kW)		1.07394
Installed Capacity	MW	1,074
Adjustment Factor (kWh)		1.00908
Annual Energy Generation	MWh	1,841,579
1) Construction cost		
Unit Construction Cost	Rs/kW	39,800.00
Construction cost	Crore Rs	4,274.52
First year (20%)	Crore Rs	854.90
Second year (30%)	Crore Rs	1,282.36
Third year (40%)	Crore Rs	1,709.81
Fourth year (10%)	Crore Rs	427.45
2) Fuel Cost		
Fuel Price	Rs/Gcal	3,099
Heat Rate	kcal/kWh	1,830
Unit Fuel Cost	Rs/kWh	5.670
Annual Fuel Cost	Crore Rs/year	1044.18
3) O&M cost		
O&M cost rate	Crore Rs/MW	0.1761
Annual O&M cost	Crore Rs/year	189.13

(source: JICA study team preparation)

This Project contemplates to start commercial operation unit by unit from the seventh year, therefore, O&M cost and fuel cost for partial commissioning is included.

13.1.4 Result of Economic Evaluation

Evaluation indices like the Net Present Value (B-C) and Benefit Cost Ratio (B/C), as well as EIRR are summarized in Table 13.1.4-1, and cash flow in Table 13.1.4-2.

Table 13.1.4-1 Result of Economic Evaluation

(Not be disclosed per cost related information)

(source: JICA study team preparation)

Table 13.1.4-2 Economic Evaluation

(Not be disclosed per cost related information)

(source: JICA study team preparation)

13.1.5 Sensitivity Analysis

(1) Conditions for Analysis

The sensitivity of economic evaluation indices was analyzed for cases with different basic conditions. A discount rate of 10% was used for this analysis. The following assumptions were made using alternative thermal cost as benefit:

Case 1	Change in discount rate to 10 % and 12 %
Case 2	Increase in construction cost by 10 % and 20 %
Case 3	Increase in pumping cost by 10 % and 20 %
Case 4	Decrease in fuel cost for alternative thermal plant by 10 % and 20 %

(2) Result of Sensitivity Analysis

The result of the sensitivity analysis is shown in Table 13.1.5-1.

Table 13.1.5-1 Result of Sensitivity Analysis

(Not be disclosed per cost related information)

(source: JICA study team preparation)

13.2 FINANCIAL EVALUATION

13.2.1 Methodology

(1) Evaluation Method

Financial analysis aims at measuring the expected return on investment from a viewpoint of an implementing agency. Here, the Discounted Cash Flow method was adopted. The basic approach for this method is as follows: First, the cash outflow (construction cost and O&M cost estimated at market price, i.e. financial costs) and inflow (benefits as electricity sale revenue) are developed on an annual basis over the project life. Secondly the amount generated each year will be discounted to the start year of the project and expressed it as an accumulated present value at the same standard year. Then a comparison will be made between the costs and benefits. The evaluation index to be obtained is the Financial Internal Rate of Return (FIRR) on investment. FIRR on investment is not affected by financing conditions; therefore, it is appropriate to evaluate the profitability of the project itself.

(2) Basic Conditions

According to the discussions with PECC2, as well as in line with the existing reports for other projects inIndia, the following basic conditions were adopted:

(Not be disclosed per cost related information)

13.2.2 Financial Cost and Benefit of the Project

(1) Financial Cost

Financial costs of the Project are shown in Table 13.2.2-1.

Table 13.2.2-1 Financial Cost of the Project

(Not be disclosed per cost related information)

(source: JICA team preparation)

(2) Financial Benefit

Table 13.2.2-2 Financial Benefit

(Not be disclosed per cost related information)

(source: JICA study team preparation)

13.2.3 Result of Financial Evaluation

The Financial Internal Rate of Return (FIRR) on investment was calculated based on the financial revenue. The result is shown in Table 13.2.3-1 and the cash flow is shown in Table 13.2.3-2.

Table 13.2.3-1 Result of Financial Evaluation

(Not be disclosed per cost related information)

(source: JICA study team preparation)

Table 13.2.3-2 Financial Evaluation

(Not be disclosed per cost related information)

(source: JICA study team preparation)

13.2.4 Sensitivity Analysis

(1) Conditions for Analysis

Sensitivity was analyzed for the cases with different basic conditions. The following cases were examined.

Case 1	Increase in construction cost by 10 % and 20 %
Case 2	Increase in pumping up energy cost by 10 % and 20 %
Case 3	Increase/decrease in energy tariff by 10 % and 20 %

(2) Result of Analysis

The result of sensitivity analysis is shown in Table 13.2.4-1.

Table 13.2.4-1 Result of Sensitivity Analysis

(Not be disclosed per cost related information)

(source: JICA study team preparation)

13.3 CALCULATION OF GENERATION COST AND TARIFF

13.3.1 Calculation of Financial Generation Cost

Result of calculation is shown in Table 13.3.1-1. Details of calculation for each case are shown in Table 13.3.1-2 to 13.3.1-4.

Table 13.3.1-1 Financial Generation Cost

(Not be disclosed per cost related information)

(source: JICA study team preparation)

Table 13.3.1-2 Financial Generation Cost (JICA finance)

(Not be disclosed per cost related information)

(source: JICA study team preparation)

Table 13.3.1-3 Financial Generation Cost (State finance)

(Not be disclosed per cost related information)

(source: JICA study team preparation)

Table 13.3.1-4 Financial Generation Cost (Private finance)

(Not be disclosed per cost related information)

(source: JICA study team preparation)

13.3.2 Levelised Cost and Tariff

Levelised generation cost and tariff were calculated. The former was obtained according to the methodology stipulated by CERC, while the latter according to that of WBERC. The result is shown below.

Calculation sheets are presented in Table 13.3.2-1 and 13.3.2-2.

Table 13.3.2-1 Levelised Generation Cost

(Not be disclosed per cost related information)

(source: JICA study team preparation)

Table 13.3.2-2 Levelised Tariff Rate

(Not be disclosed per cost related information)

(source: JICA study team preparation)

13.4 INDEX OF OPERATION EFFICIENCY

13.4.1 Index of Operation Efficiency

The Project aims at contributing to the improvement of the quality of electricity in West Bengal State and regional power system by dealing with the increasing demand at the peak time and by stabilizing the power system. Based on the purpose and characteristics of the Project, the following operation effect indicators have been set:

Table 13.4.1-1 Operation and Effect Indicators

Indicator	Target	Calculation method
(1) Operational indicators		
Forced outage - Failure of equipment - Personal mistake - Others	 168 hours / year 0 hours / year 90 hours / year	As shown by the name
Cycle efficiency	74 %	(Energy volume at transmission end) / (energy volume for pumping up)×100%
Operation hour - Pumping up - Generation	 2466 hours / year 1825 hours / year	As shown by the name
Scheduled outage	42 hours / year	As shown by the name
Change in output speed	100 % / 3 min	As shown by the name Registered by recorder
(2) Effect indicators		
Energy generation at transmission end	1803 GWh / year	Maximum output × (1- station use) × 8760h × availability factor
Maximum output	1000 MW	As shown by the name

(source: JICA study team preparation)

Data for operational/effect indicators are usually measured and registered during plant operation, there is no need to establish any special monitoring method nor planning.

13.4.2 Qualitative effect

What is expected by operation of a pumped storage power plant is the stabilization of power system / frequency as well as increase in power supply at the peak time. Based on these characteristics, qualitative effect will include economic development in the West Bengal State and improvement of living standard of the inhabitants. The following indicators are proposed for qualitative effect:

- Decrease of fluctuation of frequency in the power system
- Acceleration of investment by improvement of infrastructure through stable power supply in West Bengal State
- Economic development of West Bengal State through industrial productions
- Improvement of living environment by decrease of planned black outs

These effects, however, are not realized only by operation of the pumped storage power plant, but they are attained in close combination with other factors. Therefore, it is not easy to express the effect numerically, so no target value will be set.

CHAPTER 14

RECOMMENDATION

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CHAPTER 14 RECOMMENDATION

JICA study team conducted the Preparatory Study to verify the requirements necessary for the assessing the Project in the light of the Japanese ODA loan. As the result of the study, the validity of introducing the adjustable speed pumped storage project is confirmed for Turga Project.

In order to proceed the development of the Turga pumped storage power project, it is important and necessary to obtain all the required approvals from the government including the Environmental Clearance, public disclosures of the revised EIA, and to initiate the detailed design (DD) study at earliest to finalize the concrete detailed design and schedule. It has high priority and is recommended to implement DD study utilizing experienced foreign consultant.