National Water Supply and Drainage Board
The Democratic Socialist Republic of Sri Lanka

THE PREPARATORY SURVEY ON WATER SECTOR DEVELOPMENT PROJECT III IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FINAL REPORT

VOLUME I

EXECUTIVE SUMMARY

May 2015

Japan International Cooperation Agency (JICA)

Nihon Suido Consultants Co., Ltd.

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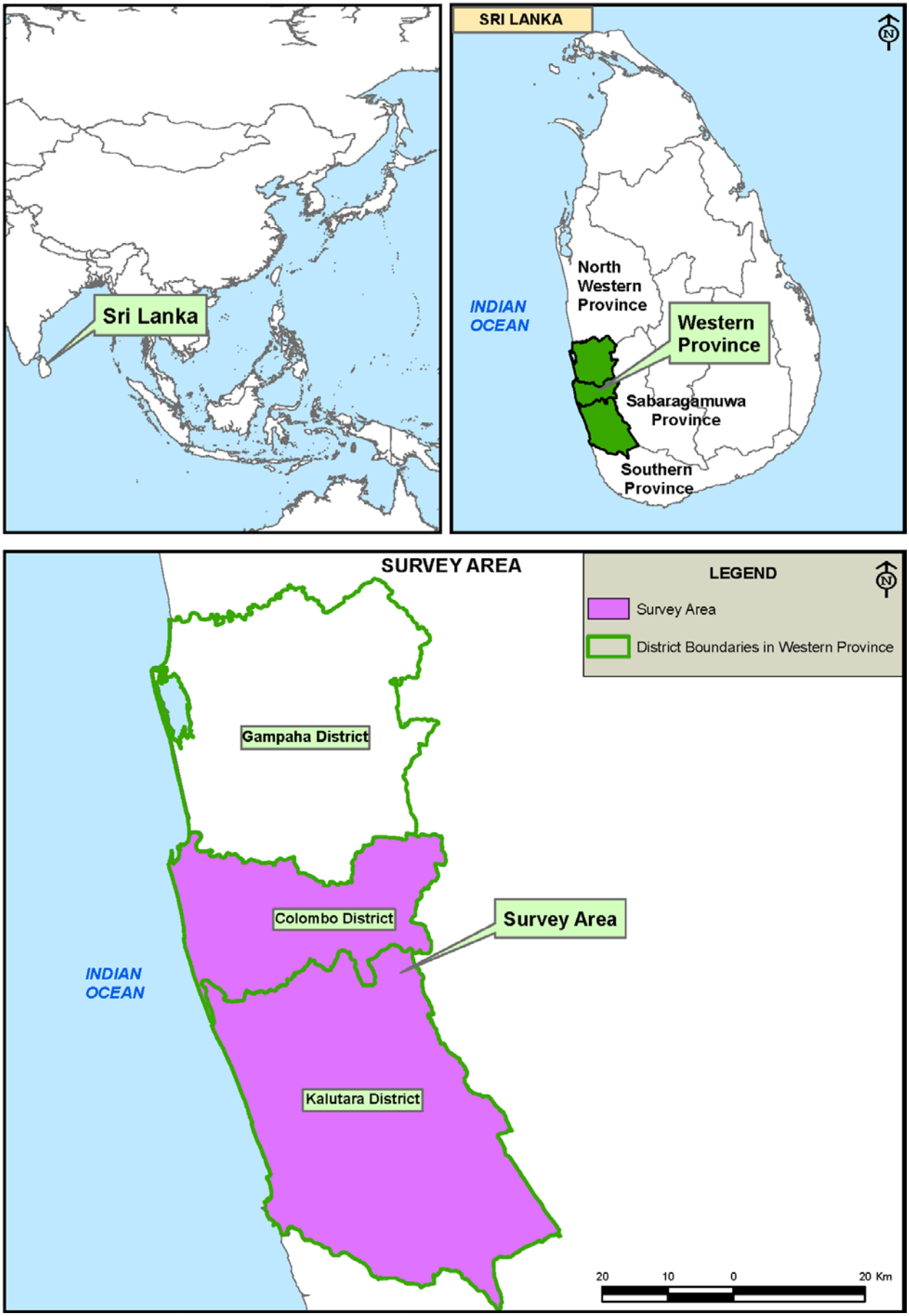
JR (先)
15-031

EXCHANGE RATE

Central Bank of Sri Lanka
(Data as of December 2014)

USD 1 = LKR 131.02
USD 1 = JPY 119.37
JPY 1 = LKR 1.0976

LOCATION MAP OF THE SURVEY AREA



~ OUTLINE ~

1. INTRODUCTION

The Government of Sri Lanka (GOSL) is planning to implement a project (Water Sector Development Project III, hereinafter referred to as the "Project") for the extension of the existing the Kalu Ganga Water Supply System in Colombo and Kalutara District where rapid urbanization is in progress, and for the rehabilitation of the transmission mains and distribution networks in Dehiwala and Moratuwa, where the ratio of NRW is particularly high, with an Official Development Assistance (ODA) loan from the Government of Japan (GOJ). GOSL requested the implementation of a Preparatory Survey on the Project (hereinafter referred to as the "Survey") to GOJ. The Survey is required to decide whether this Project, as requested, satisfies the evaluation criteria (on such issues as outline including the objectives, scope and cost of the Project, organizational structure for project implementation and environmental and social considerations) required for the disbursement of an ODA loan from GOJ. The Survey has been conducted between September 2014 and April 2015.

2. EXISTING WATER SUPPLY SYSTEM

Currently, service conditions of covered areas mainly supplied by the existing Kandana Water Treatment Plant and transmission and distribution system with a capacity of 60,000 m^3/day is generally good. However, service conditions in Dehiwala and Moratuwa areas are worse, and non-revenue ratio is higher than the other areas due to the aged transmission and distribution system.

Meanwhile, the capacity augmentation by 60,000 m^3/day for the existing Kandana Water Treatment Plant and transmission and distribution system, along with expansion of service area of Kalu Ganga Water Supply System are currently under construction under the Kalu Ganga Water Supply Project Phase I Stage 2. This project will be completed in 2015.

3. EXISTING PLANS AND STUDIES

Western Province Metropolitan Area Water Supply Master Plan (MPU/2013), which targets 2040 and covers Colombo, Kalutara and Gampaha Districts was prepared in 2013 by the National Water Supply and Drainage Board (NWSDB). And Kalu Ganga Water Supply Project Phase II Stage 1 and Non-Revenue Water (NRW) Reduction Projects in Dehiwala and Moratuwa were selected as the priority projects to be implemented as soon as possible.

After the MPU/2013, NWSDB carried out a feasibility study on the Kalu Ganga Water Supply System (KGFSII) in 2014 (latest report was prepared in July, 2014).

4. WATER DEMAND AND STAGED DEVELOPMENT PLAN

As the result of review of existing water demand projections conducted in MPU/2013 and the Fdasibility Study on the Kalu Ganga Water Supply System Phase II (KGFSII), 140,000 m^3/day of additional capacity of for the Phase II of Kalu Ganga Water Supply Project was estimated to be required by 2025.

Meanwhile, as mentioned in MPU/2013, the probability of water shortage of the Kalu River at Kandana existing intake location during dry season is confirmed for the implementation of Phase III of Kalu Ganga Water Supply Project. This survey has suggested NWSDB to carry out a water resource survey and consider preventative measures in the case of water shortages.

NWSDB should made effort to ensure the water right and sharing for KGWSS incorporate with relevant authorities as proposed in MPU/2013.

5. FACILITY PLAN

As the result of review of existing plans, studies, and their proposals, the following major project components to be implemented were the identified.

For Kalu Ganga Water Supply Project Phase II

- ✓ Expansion of existing Kandana Water Treatment Plant (WTP) (60,000 m^3 constructed under Phase I Stage 1) and expanded facilities under construction (60,000 m3) with a production capacity of 12,000 m^3/day by additional production capacity of 140,000 m^3/day. It is noted that the capacity of intake to be constructed in Phase II is proposed be 294,000 m^3/day including required capacity for the Phase II.
- ✓ Construction of new Kesbewa ground reservoir with a capacity of 18,500 m^3
- ✓ Construction of new Delkada ground reservoir with a capacity of 10,000 m^3
- ✓ Construction of new Bandaragama ground reservoir with a capacity of 20,000 m^3
- ✓ Construction of new Keselwatta ground reservoir with a capacity of 4,000 m^3 at existing Keselwatta Tower site
- ✓ Expansion of existing Moratuwa ground reservoir (4,600 m^3) by 20,000 m^3
- ✓ Installation of inlet flow and pressure chamber with SCADA instruments at existing Panadura G7 ground reservoir
- ✓ Construction of transmission pipe of DI 1200 mm from Kandana WTP to Horana with a length of approximately 6 km
- ✓ Construction of transmission pipe of DI 1200 mm from new Bandaragama ground reservoir to Horana with a length of approximately 19 km
- ✓ Construction of transmission pipe of DI 400 mm from Keselwatta to existing / new Moratuwa ground reservoirs with a length of approximately 3 km
- ✓ Construction of distribution feeder mains with a total length of approximately 135 km and creation of 60 district metered areas (11 district metered areas in Moratuwa are included in the project of NRW reduction in Dehiwala and Moratuwa)
- ✓ Construction of distribution system by installation of new pipes and re-arrangement of existing system with a total length of approximately 1,528 km (in 60 DMAs excluding Moratuwa Area)
- ✓ Construction of service pipes for the new connections with a total number of 78,000 connections (in 60 DMAs excluding Moratuwa Area)
- ✓ Installation of Transmission / Distribution Pumps at WTP and Reservoirs
- ✓ Emergency supply arrangement branching from existing DI800 transmission at Piliyandala junction to existing DI500 distribution main from Maharagama ground reservoir
- ✓ Procurement of equipment for O&M

For NRW Reduction in Dehiwala and Moratuwa

- ✓ Pipe rehabilitation works including replacement (205 km), re-lining (11 km), removal (2 km) and new installation (89 km) of pipes in Dehiwala and Moratuwa
- ✓ Creation of 19 districted metered areas in Dehiwala and Moratuwa
- ✓ Construction of service pipes for the connection transfer with a total number of 45,000 connections (in 19 DMAs of Dehiwala and Moratuwa)
- ✓ Construction of new Kohuwala ground reservoir with a capacity of 6,000 m^3
- ✓ Procurement of equipment for O&M

6. PROJECT COST AND IMPLEMENTATION SCHEDULE

Project may be needed to be separated into two since the cost too big to handle as one Japanese ODA project in Sri Lanka. The typical project period for this project is estimated about 81 months (including soft component for O&M of New WTP).

7. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

According to the environmental laws and regulations of Sri Lanka, Initial Environmental Examination and Environmental Impact Assessment (EIA) are not required for the project. Some land acquisitions are required for new reservoirs.

8. FINANCIAL AND ECONOMIC ANALYSIS

The project is deemed financially viable provided that the project may enjoy government grant subsidy. Alternative water source cost in the without-project case, and willingness to pay for the increased water supply, are recognized as economic benefits of the project. The analysis for economic internal rate of return (EIRR) demonstrates that the project deliver economic benefit.

9. CAPACITY OF EXECUTING AND IMPLEMENTING AGENCIES

NWSDB has the capacity to implement water works in general while it is considered that NWSDB needs continued support in some aspects including safety management, human resource development, operation and maintenance. In addition, in order to make the Project feasible financially, it is evaluated that a majority of cost needs to be covered by the government's grant subsidies and tariff increase is required..

10. POSSIBILITY OF PUBLIC PRIVATE PARTNERSHIP

The national economic policy framework supports Public Private Partnerships (PPP), and facilitating private sector investments are mentioned as a development policy in various sectors. However, no PPP projects have materialized in the water and sewerage sector. This is primarily because main PPP promoting factors such as policy, legal framework, PPP unit, industry regulatory agency, and financial support, are lacking or inadequate.

Developing the framework to promote PPP projects is needed in the medium or long run. Issues that should be tackled prioritarily include (i) PPP policy setting of NWSDB, (ii) development of laws and regulations, (iii) update of PPP procurement guideline, (iv) establishment of PPP unit, (v) standardization of F/S quality, (vi) legislation of regulatory agency, (vii) tariff setting and (viii) creation of Viability Gap Funding (VGF).

In the short run, by incorporating Japanese superior technologies into a PPP project, taking advantage of merits obtained through collaboration with local governments and using financial assistance available through JICA yen loan schemes, Japanese investors could formulate competitive PPP projects.

11. EVALUATION OF THE PROJECT

(1) Project Effects and Monitoring

Operation and effect indicators, or performance indicators, are selected to measure quantifiable performance of the project for the purposes of ex-ante and ex-post evaluation. Water supply amount (daily average, m^3/day), facility usage rate (daily average, %), served population (persons), service connections to customers (connections), and service time (daily average, hours/day) are selected as indicators for Kalu Ganga Water Supply Project Phase II Stage. NRW rates (%) and served population (persons) are selected for NRW Reduction in Dehiwala and Moratuwa.

(2) Overall Evaluation of Projects

An investment value of the Project was evaluated in terms of relevance, effectiveness, efficiency, impacts,

and sustainability. The implementation of projects and all proposals and recommendations in the Survey will be quite effective in addressing current issues, improving the water supply conditions, and developing the necessary water supply and management systems. The projects are positive achievement from social perspective, and have very low negative impact form environmental perspective and would benefit local residents directly through the improvement of living conditions.

12. RECOMMENDATIONS

In order to ensure implementing the Project smoothly and efficiently, and to maximize the effect to be brought by the Project, several recommendations were delivered in terms of various aspects including project implementation, staged development, water resources, social & environmental considerations, financial & economic issues, project management, safety & quality management, institutional development, human resource development, O&M, and utilization of PPP scheme. Followings are the major ones among them.

(1) Recommendations on Staged Development

- ✓ Water supply facilities are insufficient to satisfy water demand at present. The Project should be commenced and completed without delay in order to satisfy water demand and improve customer service.
- ✓ When operation of Kandana WTP / transmission systems is suspended due to several reasons, water supply area will be very limited due to poor backup system. Construction of backup system of Kalu Ganga Water Supply System, such as Backup form Ambatale, Kalatuwawa, Kethhena, Weliwita and Ingiriya systems, should be considered in an early stage.

(2) Recommendations on Water Resources

- ✓ Water flow measurement at Kandana (especially for minimum flow) and estimation of required maintenance flow at Kandana
- ✓ Ensure water right and sharing for KGWSS incorporate among NWSDB and relevant authorities as recommended in MPU/2013

(3) Recommendations on Project Implementation

- ✓ Review of design of facilities of WTP for reducing sizes to save space and make the operations efficiently handled by the plant operators.
- ✓ Limitation/ avoidance of polymer for water treatment
- ✓ Future plan of disposal of dried sludge (while dried sludge can be stored on the premises for the time being)
- ✓ Land acquisition for the proposed Kesbewa, Delkada, Bandaragama and Keselwatta ground reservoir sites and a site along distribution pipeline
- ✓ Collecting existing underground utilities such as water supply, sewerage, drainage, power and communication utilities
- ✓ Carrying out surge analysis and providing necessary measures for all pumping pipelines
- ✓ Review of transmission pumping arrangement in multi destinations system to avoid operational problems
- ✓ Review and study the suitability of restraining methods of existing gravity pipelines which will be utilize as pumping pipelines
- ✓ Discuss with M&E sections of NWSDB on energy saving measures and the revised plan
- ✓ Technical assistance program (e.g., dispatch of individual experts, and implementation of capacity development project) for O&M of DMA, including further reduction activity of NRW, should be conducted, coordinating the schedule of the physical works to be done under the Project
- ✓ Before or during the initial phase of D/D phase, some samples should be taken from the old CI pipes that are currently considered for re-lining to verify the actual condition of inner layer and outer body of the pipe

(4) Recommendations on Environmental and Social Aspects

- ✓ Land acquisition for the proposed Kesbewa, Delkada, Bandaragama and Keselwatta ground reservoir sites based on full replacement cost.
- ✓ Promote and facilitate the equal participation of men and women as stakeholders and beneficiaries of the project in accordance with the Gender Action Plan (GAP)

(5) Recommendations on Financial and Economic Aspects

- ✓ GOSL should constantly increase the water tariff level as indicated in the financial analysis results
- ✓ GOSL should provide necessary grant subsidy for the initial investment, following the financing structure of existing ODA loan projects
- ✓ GOSL should establish a regulatory framework for more accountable water tariff adjustment mechanism applicable to NWSDB customers
- ✓ GOSL and NWSDB should elaborate a long-term road map for financial restructuring of NWSDB towards its less dependence on the government financial support

(6) Recommendations on Project Management

- ✓ Establishment of the organization for safety management
- ✓ Publication of safety manual
- ✓ Sharing of accident information
- ✓ Analysis of the cause of accident
- ✓ Implementation of field patrol
- ✓ Implementation of Training of Safety management

(7) Recommendations on Institutional Improvement

- ✓ The collection and analysis of pressure and flow data throughout each WSS, enabling water balances to be carried out throughout the WSSs
- ✓ Recording of all leaks reported and repaired in the GIS database
- ✓ Prioritizing of ALC sweeps and other water loss management activities in each area
- ✓ Co-ordination between the differing sections, which directly affect the NRW in the WSSs

(8) Recommendations on Human Resources Development

- ✓ The new training center, which will be have hands-on training facilities and accommodation facilities, is under construction through an ADB loan
- ✓ To complete programs of trainings and to implement them in this center, Japanese technical cooperation, including by Japanese local governments, can be considered
- ✓ Training for active leakage control methodologies
- ✓ Training for equipment of NRW measurements, such as water leakage detectors and flowmeters
- ✓ Training by example network, enabling differing types of leaks to be simulated in the field
- ✓ Training for introduction of DMA system
- ✓ Promotion of Preventive Management Program (PMP)
- ✓ Training of O&M method of important facilities using PM manuals
- ✓ Training for SCADA (Supervisory Control and Data Acquisition) systems will be recommended

(9) Public-private Partnership (Chapter 11)

- ✓ No PPP arrangement for this Project as yen loan financing will be provided in principle
- ✓ Development of PPP promoting framework in the medium or long term
- ✓ Formulation of competitive PPP projects using Japanese superior technologies

THE PREPARATORY SURVEY
ON
WATER SECTOR DEVELOPMENT PROJECT III
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FINAL REPORT

EXECTIVE SUMMARY

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Volume I : Executive Summary
Volume II : Main Report

Volume I : EXECUTIVE SUMMARY

LIST OF ABBREVIATIONS

Abbreviation	Definition
ABC	Allowable Bearing Capacity
AC	Asbestos-cement
ACP	Asbestos-cement Pipe
ADB	Asian Development Bank
AE	Area Engineer
AIDS	Acquired Immune Deficiency Syndrome
AP	Affected People
ARI	Average Recurrence Interval
BIQ	Basic Information Questionnaire
BOD	Biological Oxygen Demand
BOI	Board of Investment
BOO	Build-Own-Operate
BOOT	Build-Own-Operate-Transfer
BPO	Business Process Outsourcing
C/P	Counterpart
CBO	Community Based Organization
CE	Chief Engineer
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
CI	Cast Iron
CMC	Colombo Municipal Council
CO	Commercial Officer
COD	Chemical Oxygen Demand
CT	Contact Time
CWR	Clear Water Reservoir
CWT	Clear Water Tank
D/D	Detailed Design
DANIDA	Danish International Development Agency
DB	Design and Build
DBFO	Design–Build–Finance–Operate
DCIP	Ductile Cast Iron Pipe
DF/R	Draft Final Report
DGM	Deputy General Manager
DI	Ductile Iron
DIP	Ductile Iron Pipe
DLMC	Dehiwala/Mount Lavinia Municipal Council
DMA	District Metering Area
DMC	Dehiwala -Mt Lavinia MC
DNI	Distribution Network Improvement
DO	Dissolved Oxygen
DOCS	Department of Census and Statistics
DPF	Department of Public Finance, Ministry of Finance and Planning
DS	Divisional Secretariat
DSCR	Debt Service Coverage Ratio
DSD	Divisional Secretariat Division
E&M	Electrical and Mechanical
EDCF	Economic Development Cooperation Fund, Korea
EIA	Environmental Impact Assessment
EII	Environmental Impact Identification
EIRR	Economic Internal Rate of Return
EOI	Expression of Interest
EPL	Environmental Protection License
EPZ	Economic Processing Zone
ERD	Department of External Resurces, Ministry of Finance and Planning
ET	Elevated Tank
EUR	Euro
F/R	Final Report
F/S	Feasibility Study
FBC	Full Business Case
FC	Foreign Currency
FDI	Foreign Direct Investment
FIRR	Financial Internal Rate of Return

Abbreviation	Definition
FIT	Feed in Tariff
GCWWMIIP	Greater Colombo Water and Wastewater Management Improvement Investment Program
GDP	Gross Domestic Product
GGWSP	Greater Galle Water Supply Project
GHS	Greenhouse Gas
GL	Guideline
GN	Grama Niladhari
GND	Grama Niladhari Division
GOJ	Government of Japan
GOSL	Government of Sri Lanka
GR	Ground Reservoir
HDPE	High Density Polyethylene Pipe
HV	High Voltage
IC/R	Inception Report
ICA	Instrumentation Control & Automation
ICB	International Competitive Bidding
ICTAD	Institute for Construction, Training and Development
IDB	Industrial Development Board
IEE	Initial Environmental Examination
IPP	Independent Power Producer
IT	Information Technology
IT/BPO	Information Technology and Business Process Outsourcing
IT/R	Interim Report
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JICA Climate-FIT	JICA Climate Finance Impact Tool
JPY	Japanese Yen
JST	JICA Survey Team
KfW Bank	Kreditanstalt für Wiederaufbau Bankengruppe
KGFSII	Feasibility Study on Kalu Ganga Water Supply System Phase II
KGWSP	Kalu Ganga Water Supply Project
KGWSS	Kalu Ganga Water Supply System
KRB	Kelani Right Bank
LA	Local Authority
LAA	Land Acquisition Act
LC	Local Currency
LCB	Local Competitive Bidding
LDO	Lease-Develop-Build
LKR	Sri Lankan Rupee
LKR	Sri Lankan Rupee
LPCD	Litter Per Capita per Day
M/M	Minutes of Meetings
MASC	Mobilization of Loan Consultants
MC	Municipal Council
MCC	Main Control Center
MCC	Motor Control Center
MCM	Million Cubic Meters
MDB	Main Distribution Board
MDG	Millennium Development Goals
MGD	Million Gallons Per Day
MLKR	Million Sri Lankan Rupee
MM	Man-Months
MOFP	Ministry of Finance and Planning
MOU	Memorandum of Understanding
MPU/2013	Western Province Metropolitan Area Water Supply Master Plan
MSL	Mean Seawater Level
MSW	Municipal Solid Wastes
MWSD	Ministry of Water Supply and Drainage / Ministry of Urban Development, Water Supply and Drainage
NEA	National Environmental Act
NGO	Non- Governmental Organization
NHDA	National Housing Development Authority
NIRP	National Policy on Involuntary Resettlement
NPA	National Procurement Agency

Abbreviation	Definition
NPD	Department of National Planning, Ministry of Finance and Planning
NPD/2030	Project Proposals for 2030
NPV	Net Present Value
NRW	Non- Revenue Water
NSC	Nihon Suido Consultants Co Ltd
NWSDB	National Water Supply & Drainage Board
O&M	Operation and Maintenance
OBC	Outline Business Case
ODA	Official Development Assistance
OIC	Officer in charge
P&C	Procurement and Construction
P&D	Planning and Design
P1S1	Phase I Stage 1
P1S2	Phase I Stage 2
P2	Phase II
P3	Phase III
PAA	Project Approving Authority
PAC	Public Accounts Committee
PAH	Project Affected Household
PAU	Project Affected Unit
PBC	Performance-based Contracts
PC	Pre-stressed Concrete
PE	Polyethylene
PGR	Population Growth Rate
PI	Performance Indicators
PLC	Programmable Logic Controller
PLC	Programmable Logic Controller
PMU	Project Management Unit
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PQ	Prequalification
Pre-F/S	Pre-feasibility Study on Replacing Old Asbestos Cement and Cast Iron Pipes in Manager Dehiwala Area to Provide a Satisfactory Water Supply to Consumers
PS	Pradeshiya Sabha
PS	Pump Station
PSC	Project Steering Committee
PSP	Private Sector Participation
PUC	Public Utilities Committee
PUCSL	Public Utilities Commission of Sri Lanka
PVC	Polyvinyl chloride
R&D	Research and Development
RAMP	Remote Actuation & Monitoring Panels
RAP	Resettlement Action Plan
RDA	Road Development Authority
RFP	Request for Proposal
RO	Reverse Osmosis
RP	Resettlement Plan
RSC	Regional Support Centre
RWS	Rural Water Supply
SAPROF	Special Assistance for Project Formation
SC	Statutory Compensation
SCADA	Supervisory Control and Data Acquisition
SCAPC	Standing Cabinet Appointed Procurement Committee
SCARC	Standing Cabinet Appointed Review Committee
SCR	Debt Service Coverage Ratio
SEBS	Socio Economic Baseline Survey
SIV	System Input Volume
SLPA	Sri Lanka Ports Authority
SLS	Sri Lankan Standards
SME	Small and Medium Enterprise
SOBE	State Owned Business Enterprise
SOE	State Owned Entity
SOP	Stand Operation Procedures
SP	Steel Pipe

Abbreviation	Definition
SPC	Special Purpose Company
SPP	Small Power Producer
SS	Suspended Solids
ST	Steel
STEP	Special Terms for Economic Partnership
SV	Supervision
T/A	Tender Assistance
TA	Technical Assistance
TEC	Technical Evaluation Committee
TNC	Towns North of Colombo
TOR	Terms of References
TSC	Towns South of Colombo
TSS	Total Suspended Solids
UC	Urban Council
UCW	Unit Cost for Water
UDA	Urban Development Authority
UFW	Unaccounted for Water
UPS	Urgent Power Supply
uPVC	Un-plasticized Polyvinyl Chloride
USA	United States of America
USD	United States Dollar
VFD	Variable-Frequency Drive
VGF	Viability Gap Funding
VSD	Variable Speed Drive
WACC	Weighted Average Cost of Capital
WB	World Bank
WC	Western Central
WHO	World Health Organization
WQM	Water Quality Management
WS	Western South
WSS	Water Supply System
WTP	Water Treatment Plant
WWTP`	Wastewater Treatment Plant

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The Kalu Ganga Water Supply System in Colombo District and the neighbouring Kalutara District, both in the Western Province of the Democratic Socialist Republic of Sri Lanka (hereinafter "Sri Lanka"), has been improved in phases with assistance from the Japan International Cooperation Agency (JICA). However, the increase in water demand caused by rapid population growth is outpacing the development of water supply facilities. It is estimated that the gap between water demand and water supply will increase to at least 100,000 m^3/day in the area served by the Kalu Ganga Water Supply System (KGWSS) by 2020. Many of the existing transmission mains and distribution networks were installed 50 to 100 years ago. Partly because of water leakage from these old, deteriorated pipelines, the percentage of non-revenue water (NRW) at around 40 % exceeds the national average of 31 %.

In order to meet the increasing water demand in the area concerned, following tasks are regarded as urgent issues.

i. Augmentation of the capacity of Kalu Ganga Water Supply System water supply facilities
ii. Improvement of water supply efficiency by replacement and repair of the old existing transmission mains and distribution pipes

Against this background, the Government of Sri Lanka (GOSL) is planning to implement a project (Water Sector Development Project III, hereinafter referred to as the "Project") for the extension of the existing the Kalu Ganga Water Supply System in Colombo and Kalutara District where rapid urbanization is in progress, and for the rehabilitation of the transmission mains and distribution networks in Dehiwala and Moratuwa, where the ratio of NRW is particularly high, through an Official Development Assistance (ODA) loan from the Government of Japan (GOJ).

GOSL requested the implementation of a Preparatory Survey on the Project (hereinafter referred to as the "Survey") to GOJ. The Survey is required to decide whether this Project, as requested, satisfies the evaluation criteria (on such issues as outline including the objectives, scope and cost of the Project, organizational structure for project implementation and environmental and social considerations) required for the disbursement of an ODA loan from GOJ. **Table 1.1.1** shows the outline of the Project as requested.

Table 1.1.1: Outline of the Project

Project Title	The Preparatory Survey on Water Sector Development Project III
Purpose	To provide safe drinking water and increase water supply coverage, improving conditions of existing water supply system by implementing Kalu Ganga water supply improvement in Colombo and Kalutara, where increasing population has been causing significant water shortage. The Project comprises the following: 1) Kandana System Augmentation 2) NRW reduction in Dehiwala and Moratuwa by replacement of old pipes
Outline	1) Water treatment plant (Intake structure, water treatment plant, water towers, ground storage tank, mechanical & electrical equipment, transmission mains & Distribution networks) 2) Replacement/rehabilitation of existing transmission and distribution pipes for reduction of NRW 3) Consulting Services (Detailed design, Tender assistance, Construction supervision etc.)
Agencies	1) Ministry of Finance and Planning 2) Ministry of Water Supply and Drainage (MWSD) 3) National Water Supply and Drainage Board (NWSDB)

Source: JICA Survey Team

1.2 Objectives of the Survey and Survey Area

1.2.1 Objectives of the Survey

This Survey is a preparatory survey to be implemented with the purposes and scope mentioned in **Table 1.2.1** as described in the minutes of meetings (M/M) between GOSL and JICA approved by both parties with the signatures of their respective representatives on August 16, 2013.

Table 1.2.1: Purposes and Scope of the Survey

Purposes	・To examine the background, objectives and contents of the Project in detail and to evaluate the necessity for its implementation ・To conduct a study on such subjects as the objectives, outline, cost, implementation schedule and method (for procurement and construction work), project implementation structure, operation and maintenance (O&M) structure and environmental and social considerations of the Project, required for evaluation of the Project for implementation with an ODA loan from GOJ, once the necessity has been established
Scope	・The Survey shall be implemented as stipulated in M/M agreed upon by GOSL and JICA in August 2013 ・The "Survey" shall be conducted in order to achieve the "purposes" mentioned above taking into consideration "the implementation policy and notes" described in the JICA terms of reference (TOR), and reports shall be prepared and submitted at appropriate stages of the Survey as stipulated in "V. REPORTS" in the M/M

Source: JICA Survey Team

1.2.2 Survey Area

This Survey shall be conducted in the area currently served by Kalu Ganga Water Supply System and the area in Colombo and Kalutara Districts, Western Province, to which the service is to be extended in future, as shown in **Figure 1.2.1**.

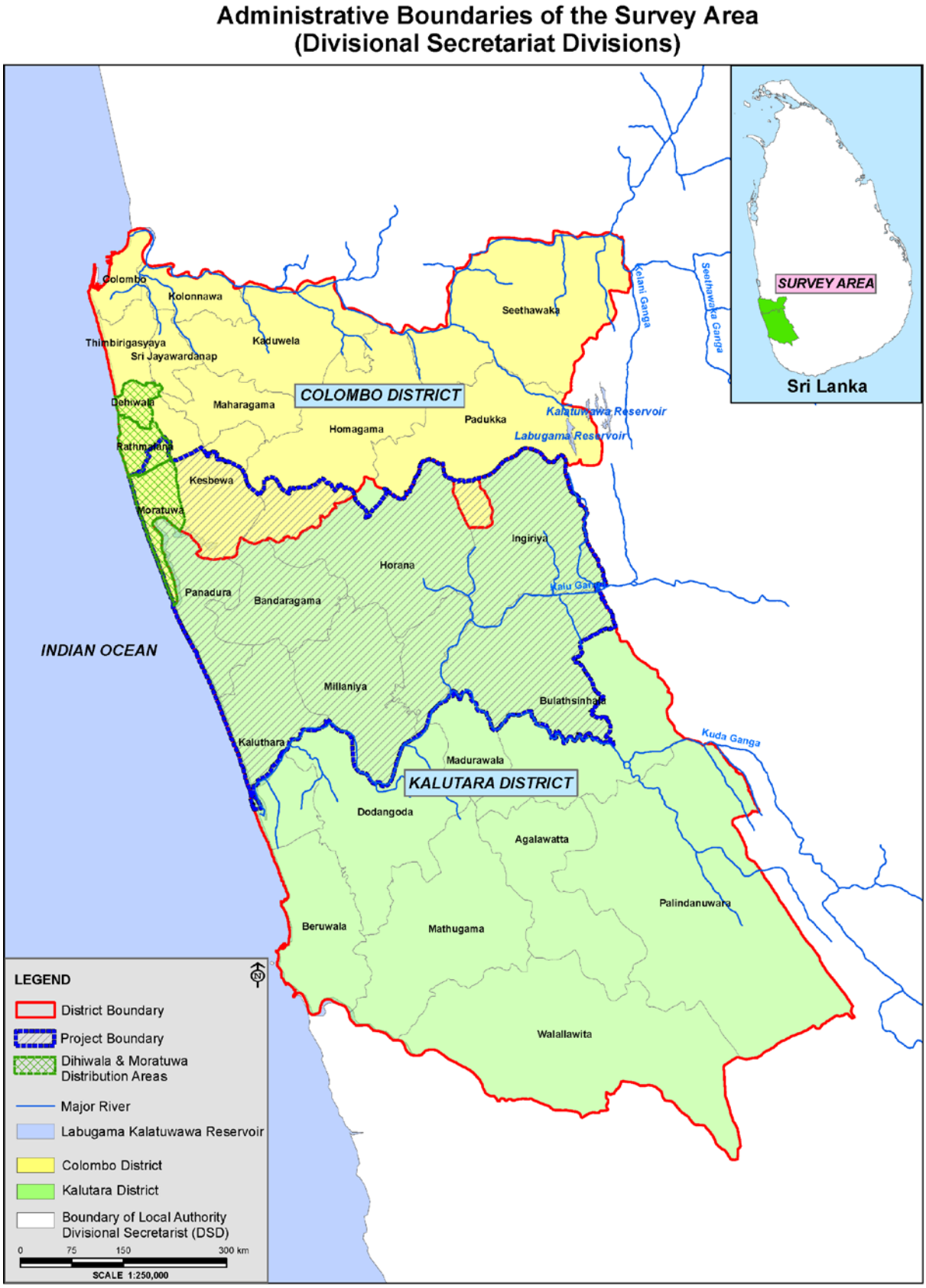


Figure 1.2.1: Divisional Secretariats in the Survey Area
Source: JICA Survey Team

1.3 Scope of the Works and Survey Schedule

1.3.1 Scope of the Works

Scope of the works required is described as follows:

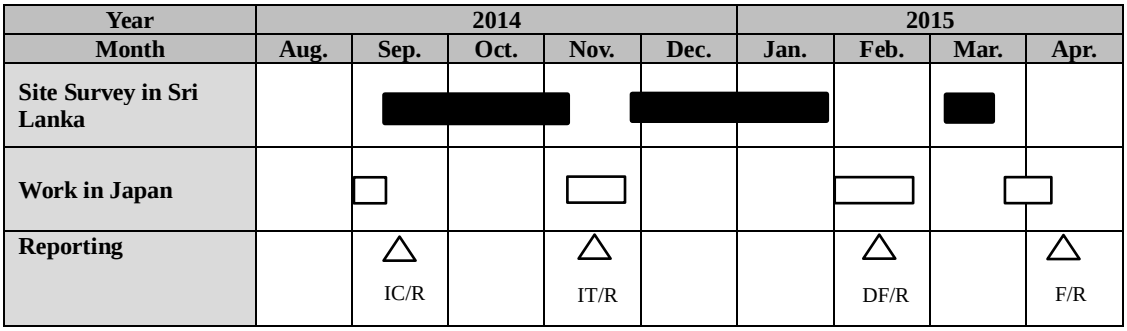
(1) Reconnaissance Survey through Review of Existing Available Data
(2) Preparation of Inception Report (IC/R)
(3) Discussion of IC/R
(4) Collection of Information on Past Water Supply Projects in Sri Lanka
(4-1) Verification of Background and Necessity of Implementation of Project
(4-2) Confirmation of State of Assistance by Other Donors
(4-3) Survey of Social Conditions
(5) Confirmation of Framework of the Project
(5-1) Water Demand Projection in Survey Area
(5-2) Confirmation of Planned Water Supply Areas
(5-3) Confirmation of Water Intake and Conveyance Plan
(5-4) Confirmation of Development Plan for Development of Kalu Ganga Water Supply System and Scope of Work of Project
(5-5) Confirmation of Scope of Work for Replacement and Repair of Transmission Mains and Distribution Pipes in Dehiwala and Moratuwa Areas
(6) Confirmation and Preparation of Facility Planning
(6-1) Confirmation and Preparation of Facility Development Plan for Development of Kalu Ganga Water Supply System
(6-2) Confirmation and Preparation of Facility Development Plan for Replacement and Repair of Transmission Mains and Distribution Pipes in Dehiwala and Moratuwa Areas
(6-4) Confirmation of Outline Design
(6-5) Preparation of Execution Plan
(7) Proposal of Possible Supplemental Technical Assistance
(8) Preliminary Cost Estimation of the Project
(8-1) Project Cost Items
(8-2) Methodology for Project Cost Estimation
(8-3) Guidelines to be Followed
(8-4) Consideration of Measures to Reduce Estimated Project Cost
(9) Preparation of Implementation Schedule of the Project
(9-1) Preparation of Bar Chart
(9-2) Preparation of Action Plan
(10) Preparation of Disbursement Schedule of the Project
(11) Proposal of Procurement Method
(12) Confirmation of Project Implementation Structure
(12-1) Inspection of Project Implementation Capacity of Project Executing Agencies
(12-2) Confirmation of Project Implementation Structure (including Organizational Structure of the Project Management Unit (PMU))
(13) Confirmation of System for Safety and Quality Control of the Project
(14) Confirmation of O&M Structure
(15) Social and Environmental Considerations of the Project
(15-1) Environmental and Social Considerations
(15-2) Confirmation of Requirement for/Exemption from Preparation of Initial Environmental Evaluation (IEE) and Environmental Impact Assessment (EIA) Reports, and Assistance in Preparation of said Reports
(15-3) Assistance in Preparation of Simple Relocation Plan
(15-4) Investigation into Strategies for Consideration of Poor Households
(15-5) Investigation into Promotion of Social Development
(16) Analysis of Project Effects
(17) Identification of Possible Mitigation/Adaptation measures for Climate Change
(18) Confirmation of Activities by Other International Donors and Seeking Possibilities of

Collaboration

(19) Analysis of Points to be Concerned for Implementation and Supervision of the Project
(20) Confirmation of Priority Order of Projects in Water Supply and Sewerage Sector to be Implemented in Future
(21) Analysis of Feasibility of Introduction of PPP Scheme
(22) Preparation and Discussion of Interim Report (IT/R)
(23) Preparation and Discussion of Draft Final Report (DF/R)
(24) Submission of Final Report (F/R)

1.3.2 Survey Schedule

The Survey will be implemented in Site Surveys in Sri Lanka and Work in Japan as shown in **Figure 1.3.1**.



IC/R: Inception Report, IT/R: Interim Report, DF/R: Draft Final Report, F/R: Final Report

Figure 1.3.1: Survey Schedule

Source: JICA Survey Team

1.4 Discussion on Inception, Interim and Draft Final Reports

1.4.1 Discussion on Inception Report

IC/R was prepared and submitted to the Ministry of Finance and Planning, MWSD and NWSDB. JICA Survey Team (JST) explained the basic policies, work schedule and implementation structure of the Survey in the inception meeting held on 11 September, 2014. The details of the services to be provided and Counterpart (C/P) personnel to be assigned by NWSDB were discussed.

JICA Survey Team has emphasized that the survey results are to be used as reference material for the Project and that the results of the Survey are not necessarily approved fully as the design of the Project.

Major comments given by Sri Lanka side and the relevant discussion are summarized below:

- NWSDB requested to consider inclusion of salinity barrier to the scope of the Project. The salinity barrier is required for Kethhena Water Treatment Plant but not Kandana Water Treatment Plant to be constructed in the Project. However there is a study that the minimum maintenance flow at Kandana will be reduced and available intake volume will be increased after construction of the salinity barrier. A study on the salinity barrier construction was given to the survey team just before completion of 1st survey in Sri Lanka for consideration.
- NWSDB commented that large water consumption by the private sector such as tall buildings should be considered for the plan. The JICA Survey Team replied that total increase of water demand has been already taken into account in the MPU/2013 and detailed allocation of water demand shall be reviewed when details of development plans are available, probably at the detailed design stage of the Project.
- NWSDB raised the importance of introduction of ring transmission main, for the Greater Colombo Transmission System which will allow emergency water supply from different direction to prevent

possible supply failure. NWSDB understood this will not be included in the Water Sector Development Project III and requested JICA to consider as a future project.

1.4.2 Discussion on Interim Report

Meeting on IT/R was held on 11 November 2014 among NWSDB, JICA, Nagoya mission and JST. All parties discussed and basically agreed on the results of the 1st Survey in Sri Lanka described in IT/R, such as water demand forecast and plan of water treatment plant. In addition, the attendants discussed Involvement of Japanese technology and comments so far given by NWSDB and JICA.

Advantages and disadvantage of Special Terms for Economic Partnerships (STEP) were discussed, and it was agreed to use Japanese technology when there is comprehensive advantage, even if STEP is not applied.

In the meeting, NWSDB requested inclusion of study of water resources, salinity barrier, and alternative transmission arrangement to Maharagama and Dehiwala reservoir into the Project. NWSDB also requested consideration of "construction of Weliwita Water Treatment", "ring transmission mains for Greater Colombo transmission system" and "re-use and recycle of sludge waste" as future projects.

NWSDB considers the components of Water Supply Development Project III as top priority Projects.

1.4.3 Discussion on Draft Final Report

Meeting on DF/R, which described the survey results during the 1st and 2nd Survey in Sri Lanka, was held on 12 March 2015 among NWSDB, JICA and JST. The main points for discussion are summarized below.

- ***Necessity of flow measurement at dry period:*** NWSDB commented that it will consult with JICA Sri Lanka Office to seek the possibility to use available saving of SLP-93 for subletting the flow measurement survey at the earliest opportunity.
- ***Salinity barrier and its EIA study:*** Following to the JICA's negative concern over inclusion of salinity barrier into the project and its advice that at least discussion with river management authorities of Kalu Ganga should be held, NWSDB commented that it will consult to JICA Sri Lankan Office to seek the possibility to use available saving of SLP-93 for conducting EIA study at the earliest opportunity.
- ***Cut-off date setting for land acquisition:*** Following to the JICA's comment on cut-off date setting for land acquisition, NWSDB commented that the cut-off date may be defined only after the timing of negotiation with the land owners.
- ***STEP loan scheme:*** NWSDB commented that an internal committee has been appointed to discuss whether to go for the STEP scheme or untied scheme and will inform NWSDB's intention to JICA Mission later. JICA commented that the results should be discussed with ERD since ERD had originally proposed STEP for the Project.
- ***Comments on the DF/R:*** NWSDB replied that it understood the comments for DF/R should be delivered by the end of March 2015.

1.5 Use of Japanese Technologies

After discussion of the advantages and disadvantages of STEP loan compared to general condition, NWSDB expressed its preference not to apply STEP loan scheme for the Project. However NWSDB appointed internal committee who will conclude the intension and will discuss with ERD. Advantage and Disadvantage of STEP is summarized in **Table 1.5.2**.

Table 1.5.1: Advantage and Disadvantage of STEP

Item	General Condition	STEP
Condition of Procurement	**Untied**	Tied
Construction Cost	**Lower**	Higher
Construction Period	Lower Reliability	**High Reliability**
Quality of Facilities	Moderate	**High Reliability**
Interest Rate	1.4%	**0.1%**
Repayment Period	25 yeas	**40 years**
Grace Period	7 years	**10 years**
Total Repaid Cost (and NPV)	Higher	**Lower**

Note: Colored column has higher advantage

Even when STEP is not applied, usage of Japanese technology shall be considered. The noteworthy Japanese technologies considerable for application in the Project are summarized in **Table 1.5.2**.

Table 1.5.2: Summarized Japanese Technologies considerable for application in the Project

Name of Technology	Summary of Technology	Advantage in General	Advantage in Japanese Technology	Applicability
PC tank	1) Construction of top slab by dorm method 2) Wall fixing method with bottom slab	1) Waterproofing is reliable and re-paint or re-covering is unnecessary 2) Leakage will be prevented at connection point of wall and bottom	1) High reliability due to abundant experience 2) Less delay of construction by careful schedule management 3) Meticulous safety management 4) Reliable quality management	High possibility at suitable locations/ conditions
Trenchless technology	Pipe jacking	1) Avoiding open cut at congested locations or special crossings	1) High reliability due to abundant experience 2) Less delay of construction by careful schedule management 3) Meticulous safety management 4) Reliable quality management	Good at highway crossing but not required in the Project. (Site condition was checked)
Methods of pipe branch / connection without suspension of water supply	Non-suspension water method	1) Suspension of water supply is not necessary during the pipe branching works	1) High reliability due to abundant experience for large diameter pipes 2) Less delay of construction by careful schedule management 3) Meticulous safety management 4) Reliable quality management	Useful if cost is not high. There is room to consider/there is room for consideration
Pipe rehabilitation methods	1) Pipe relining method 2) Pipe scraping method 3) Pipe in pipe method	Existing pipe can be used without replacement	1) High reliability due to abundant experience 2) Less delay of construction by careful schedule management 3) Meticulous safety management 4) Reliable quality management	Reliable methods but cost is too high

Sludge dewatering equipment	Filter press method – long-time type	1) Minimizing risk of cancer due to no use of polymer 2) Reducing sludge treatment cost by high efficiency in sludge dewatering	1) Wide selection in many manufacturers 2) High efficacy equipment are available 3) Reliability in abundant experience 4) Less delay of construction by careful schedule management 5) Meticulous safety management 6) Reliable quality management and after-services	Japanese product may have advantage in lower maintenance (energy and chemical) cost
Automatic metering system	Automatic metering and recording system	Minimize meter reading errors	1) High reliability due to abundant experience 2) Less delay in supply 3) Reliable quality management	Might be applied in pilot areas
SCADA system	1) Monitoring and control system of process facilities 2) Monitoring and control system of comprehensive water transmission system 3) Monitoring and control system of distribution system	Automatic / manual monitoring and control are possible	1) Preventing accidents or issues in the process / transmission / distribution by prediction of future event by effective utilization of big data 2) Reliability in abundant experience for large diameter pipes (in the future) 3) Less delay of construction by careful schedule management 4) Meticulous safety management 5) Reliable quality management	High reliability but cost should be competitive with existing SCADA.

Source: JICA Survey Team

Japanese technology may have advantage in some fields such as PC tanks, pipe driving methods, pipe branching without suspension of water supply, pipe rehabilitation methods, sludge dehydrators, automatic metering systems, technology of NRW reduction to be applied in TESCO project, and SCADA systems. PC tanks are planned to be used as ground reservoirs at Moratuwa, Kesbewa, Delkada and Kohuwala. However, usage of Japanese technology has not been decided yet. It is worth discussion during detailed design stage to arrange technical specifications for usage of Japanese technologies and products, which have comprehensive advantage, such as pumps.

It is difficult to show the advantages of pumps provided by Japanese manufacturers quantitatively in the table above. However, advantages, such as long service life, high efficiency, high reliability, and good maintenance services, can be anticipated from Japanese manufactures. NWSDB recognizes these advantages and evaluates Japanese products highly.

1.6 Use of Knowledge of Japanese Local Governments

Nagoya City Waterworks & Sewerage Bureau, a Local government in Japan, has dispatched two officers to seek the possibility of providing assistance to the Project or NWSDB by using their knowledge. They stayed for 10 days in the period from 8th December to 17th December 2014. Major requests from NWSDB are as follows:

1) New Training Center to be constructed by ADB project

Procurement of equipment and facilities, advice on the design especially for leak training yard, preparation of curriculum and training to the trainers, and assistance on introduce license system to the authorized plumbers are requested.

2) Assistance to NRW reduction in Dehiwala and Moratuwa

Technical assistance in Dehiwala and Moratuwa will be an ideal model for NRW reduction after the Project. The assistance will include further reduction of NRW after replacement of old pipes, finding of priority activities, improvement of pipe drawing and customer data, and PR activities.

CHAPTER 2 EXISTING WATER SUPPLY SYSTEM

2.1 Summary of Existing Water Supply System in Colombo and Kalutara Districts

2.1.1 Existing Water Treatment Plants

There are many treatment plant operating in the Colombo and Kalutara Districts as shown in **Table 2.1.1** and general information on existing WTP is briefly described in **Table 2.1.2** and **Figure 2.1.1**. The Kandana WTP is the scope of this Survey and existing capacity is 60,000 m^3/day. In addition, the project of Kalu Ganga Water Supply Phase I Stage 2 is on-going, and additional facilities with a capacity of 60,000 m^3/day to be constructed within the area of existing Kandana WTP are under construction. The construction of the expanded facilities (60,000 m^3/day) is planned to be completed within 2015.

Table 2.1.1: Summary of Existing Water Treatment Plants Managed by NWSDB in 2012

Regional Support Centre	Name of WTP		Construction Year	Design Capacity (m^3/day)	Estimated Average Daily Production in 2011 (m^3/day)
Western Central	Labugama		1882	59,100	44,340
	Kalatuwawa		1953	91,000	83,040
	Ambatale	(Stage I)	1966	91,000	N/A
		(Stage II)	1978	60,000	N/A
		(Stage III)	1986	122,000	N/A
		(Stage IV)	1994	182,000	N/A
		(Stage V)	2009	45,000	N/A
				Total 500,000	Total 547,700
	Chiko	(Rehabilitation)	1962 (2012)	13,500	0
	Kosgama		2005	2,750	2,200
	Penrithwatta		2000	3,000	2,550
	Kotabodawatta (Disinfection Only)		1998	3,800	1,250
			Sub-Total	***673,150***	***681,080***
Western South	Kethhena	(Stage I)	1986	26,300	N/A
		(Stage II)	2000	30,500	N/A
				Total 56,800	Total 32,880
	Kandana	(Phase I - Stage I)	2006	60,000	58,740
	Ingiriya (Disinfection Only)		1994	675	650
	Mathugama (Wettewa)*			200	120
			Sub-Total	***117,675***	***92,390***
			Total	**790,825**	**77,3470**

Source: MPU/2013

Table 2.1.2: Existing WTP Systems

No.	WTP System	Summary of Water Supply System
1	Labugama	The Labugama WTP and its supply system are the oldest system in the country which was established about 125 years ago. It has a production capacity of 59,000 m^3/day and supplies mainly Colombo city through a 45 km long transmission system by gravity. Currently the treatment plant is producing approximately 44,300 m^3/day and supplies water to parts of CMC, parts of Battaramulla, Kaduwela and Jaltara WSSs and many small scale distribution systems especially along the Low level Road through direct connections to the gravity transmission mains. The supply from Labugama WTP is mixed with the supply from Kalatuwawa because of the interconnection between transmission mains therefore there is no exact record of how much water is supplied to each distribution area.
2	Kalatuwawa	The Kalatuwawa WTP and its supply system are the second oldest system. It was constructed in line with the Labugama system having a design capacity of 91,000 m^3/day mainly to supplement the Labugama supply to cater to the incremental demand in Colombo city. Currently the Kalatuwawa system is producing approximately 83,000 m^3/day and supplies water to Part of CMC and the eastern part of Colombo along the high level road such as Maharagama and Dehiwala, Pelenwatta, Mattegoda, Homagama, Godagama, Habarakada, Templeburg and Pannipitiya WSS. There is a set of bulk meters available in the supply system but there is no exact record of how much water from Kalatuwawa WTP is supplied to each distribution area.
3	Ambatale	The Ambatale WTP Is the largest water treatment plant in the country. It was constructed in the early 1960s by focusing on the Kelani river as the main source. The plant capacity and transmission system capacity have been improved to cater to the increasing water demand. The plant currently supplies water to Colombo and the suburb areas of CMC, Kotte, area large part of Kolonnawa, part of Battaramulla, Dehiwala, Maharagama, Piliyandala, Soysapura and part of Moratuwa. The total design capacity is 500,000 m^3/day. It is very difficult to obtain the exact record of the supply to each distribution areas because the transmission system is very complicated with many interconnections. Average production in 2011 was 547,000 m^3/day, the existing production record gives that recent operation has been overloaded. The intake for the WTP in Kelani Ganga at Ambatale.
4	Kosgama	Kosgama WTP has a design capacity of 2,750 m^3/day and currently supplies 1,100 m^3/day to Kosgama WSS. The intake is located in Kelani Ganga at Kosgama.
5	Penrithwatta	Penrithwatta WTP has a design capacity of 3,000 m^3/day and currently supplies 1,000 m^3/day to major part of Avissawella WSS. The intake is located in Kelani Ganga at Avissawella.
6	Kotabodawatta Sump	Kotabodawatta system is providing chlorination only. It has a capacity of 3800m3/day and is currently supplying part of Avissawella WSS. The intake is located in Kelani Ganga at Avissawella.
7	Kethhena	Kethhena WTP was constructed in the 1980s with design capacity of 26,000 m^3/day. It was subsequently augmented to 56,800 m^3/day. Currently the system is supplying water to towns south of Colombo: Wadduwa, part of Mathugama, Kalutara, Bombuwala, Pilaminawatta, Payagala, Beruwala and Aluthgama WSSs. The Intake of supply is Kalu Ganga at Kethhena.
8	Kandana	Kandana WTP was constructed in 2006. The production capacity is 60,000 m^3/day for the Phase I Stage 1 and it supplies part of Moratuwa, Keselwatta, Panadura, Panadura East, Bandaragama, Horana, and Wadduwa WSSs. Additional capacity of 60,000 m^3/day for Phase I Stage 2 is under construction and will be commenced operation in 2015. The intake facility has already been constructed for the ultimate capacity of Phase I. The intake is at Kandana extracted from Kalu Ganga in Kandana WTP. This WTP system is vital role in water supply for the Colombo South and Kalutara North.
9	Ingiriya	The Ingiriya system is providing chlorination only. It has a capacity of 450 m^3/day and is currently supplying the Ingiriya WSS. Water is taken from the Nambapana Ela, disinfected and stored in a sump.
10	Mathugama	The Mathugama system is providing chlorination only. It has a capacity of 200 m^3/day and currently supplies the Mathugama WSS. Water is taken from Ella Kanda, disinfected and stored in a tank at Wettewa.

Source: MPU/2013

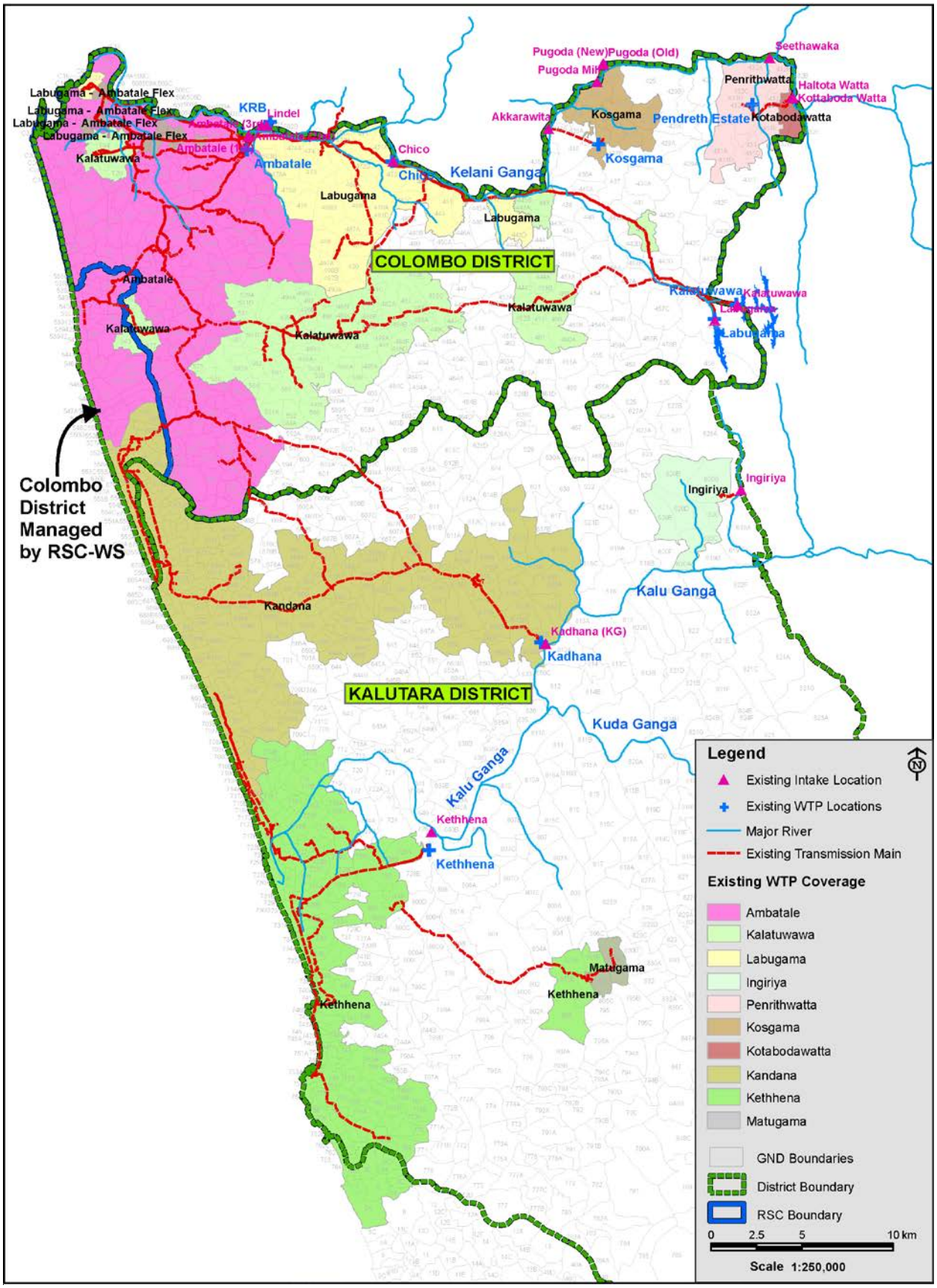


Figure 2.1.1: Existing WTP Coverage
Source: MPU/2013

2.2 Kalu Ganga Water Supply System

(1) Service Area and Schemes

Existing Kalu Ganga Water Supply System is managed by Regional Support Centre Western South (RSC-WS) under the National Water Supply and Drainage Board (NWSDB). The existing supply area and schemes covered by the system is shown in the **Table 2.2.1** and **Figure 2.2.1**.

Table 2.2.1: Existing Service Area of Kalu Ganga Water Supply System

Regional Service Centre	Chief Engineer / Manager	Area Engineer (AE)	Officer In Charge (OIC)	Scheme
Western South	Towns South of Colombo (TSC)	Moratuwa	Moratuwa	Moratuwa
	Panadura / Horana	Panadura	Panadura	Panadura
				Panadura East
				Keselwatta
		Bandaragama	Bandaragama	Bandaragama
			Horana	Horana
	Kalutara	Kalutara	Wadduwa / Waskaduwa	Wadduwa

Source: Feasibility Study Report on Kalu Ganga Water Supply Project - Phase II (July-2014, P&D Section, NWSDB)

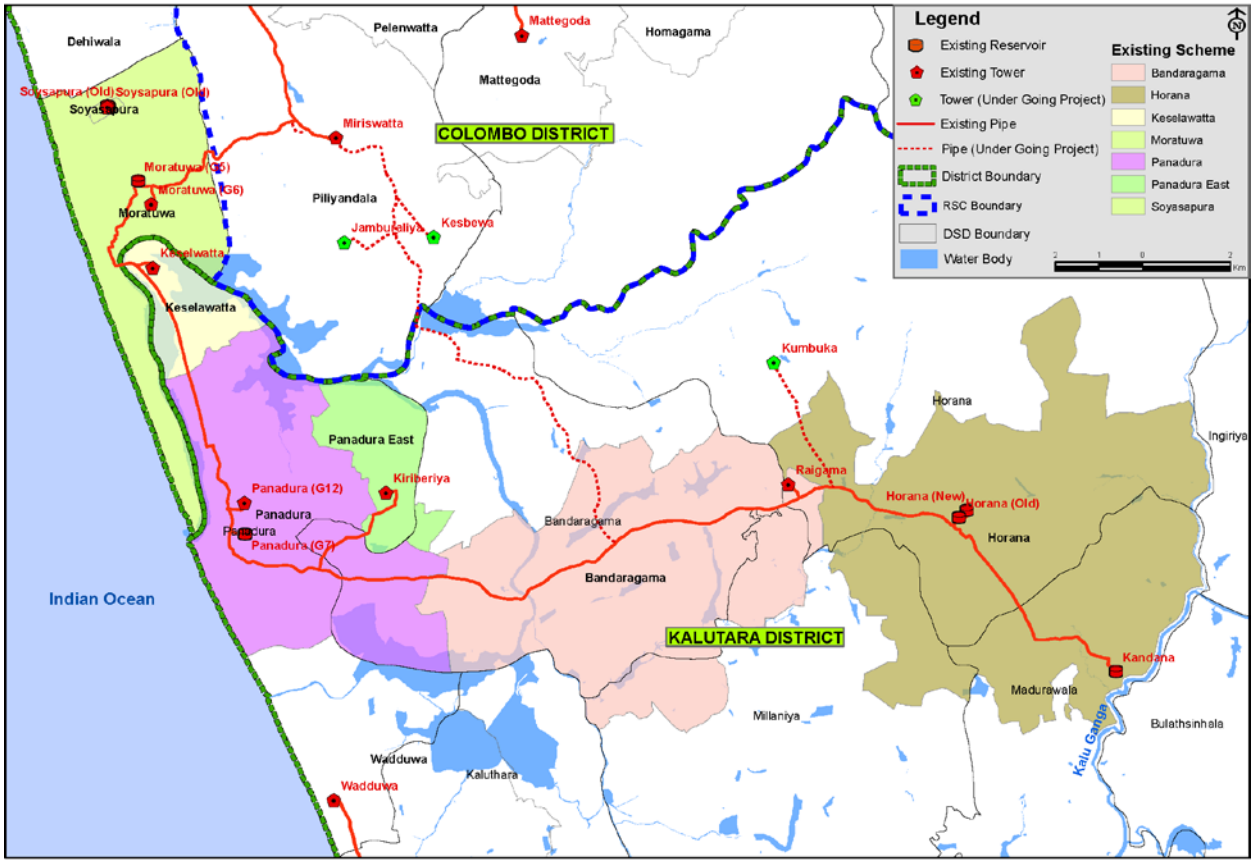


Figure 2.2.1: Existing Service Area of Kalu Ganga Water Supply System

Source: JICA Survey Team based on MPU/2013

(2) Water Supply System

1) Kalu Ganga Water Supply Project Phase I Stage 1

The Kalu Ganga Water Supply Project Phase I Stage 1 (KGWSP-P1S1) project consists of intakes, raw water transmission system, water treatment plant with a production capacity of 60,000 m^3/day, and transmission mains. Raw water is extracted from Kalu Ganga at Kandana. This system covers part of Moratuwa, Panadura, Keselwatta, Bandaragama and Horana. Implementation of the project was commenced in 1997 and was completed in year 2006 under the JICA (former JBIC) funding. Major component of the project are listed in followings.

- Intake Structure: 126,000 m^3/day capacity
- Water Treatment Plant: 60,000 m^3/day capacity
- High Level Reservoir (15,000 m^3) at Horana
- Transmission Mains:
  - Horana to Bandaragama (DI 1200 mm, 9,020 m)
  - Bandaragama to Panadura (DI 800 mm, 10,200 m)
  - Panadura to Keselwatta (DI 800 mm, 6,090 m)
- Towers at Raigama (1,000 m^3) and Panadura East (409 m^3)
- Distribution system in Panadura, Moratuwa, Bandaragama, Raigama and Horana.

2) Kalu Ganga Water Supply Project Phase I Stage 2

The general plan of the existing Kalu Ganga Water Supply System Phase I Stage 1 and on-going Kalu Ganga Water Supply System Phase I Stage 2 are shown in **Figure 2.2.2**.

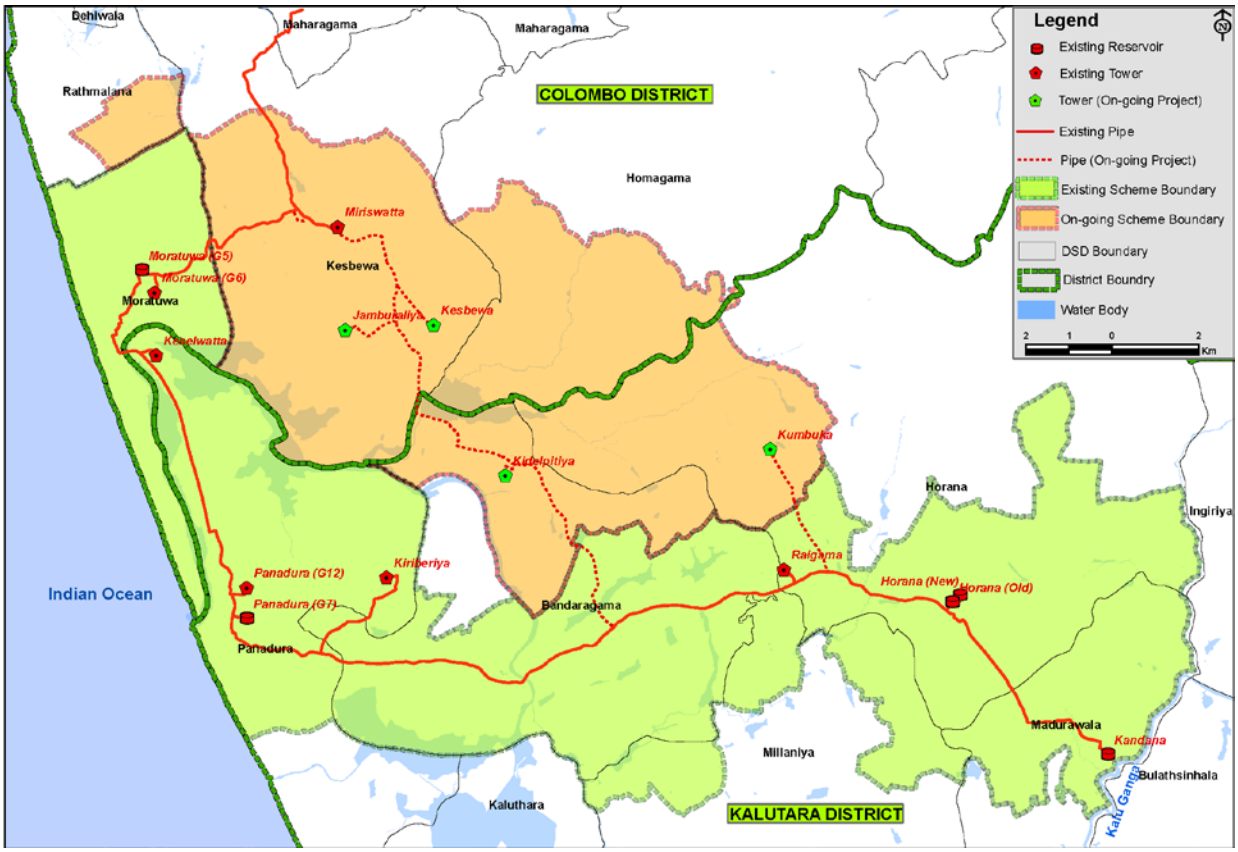


Figure 2.2.2: General Plan of Existing KGWSSP1S1 and On-going KGWSSP1S2
Source: JICA Survey Team based on KGFSII

Below shows the present water supply level in the existing service area of KGWSS.

Service Hours: Basically 24 hours
Water Quality: No complaint
Water Pressure: Generally Sufficient
Water Loss Ratio: Approximately 20%

2.3 NRW in Dehiwala and Moratuwa

2.3.1 Outline of Dehiwala and Moratuwa Area

The target areas of the NRW reduction component under the Project are Dehiwala and Moratuwa. The following **Figure 2.3.1** specifies the location of Dehiwala and Moratuwa with the target area for KGWSS II.

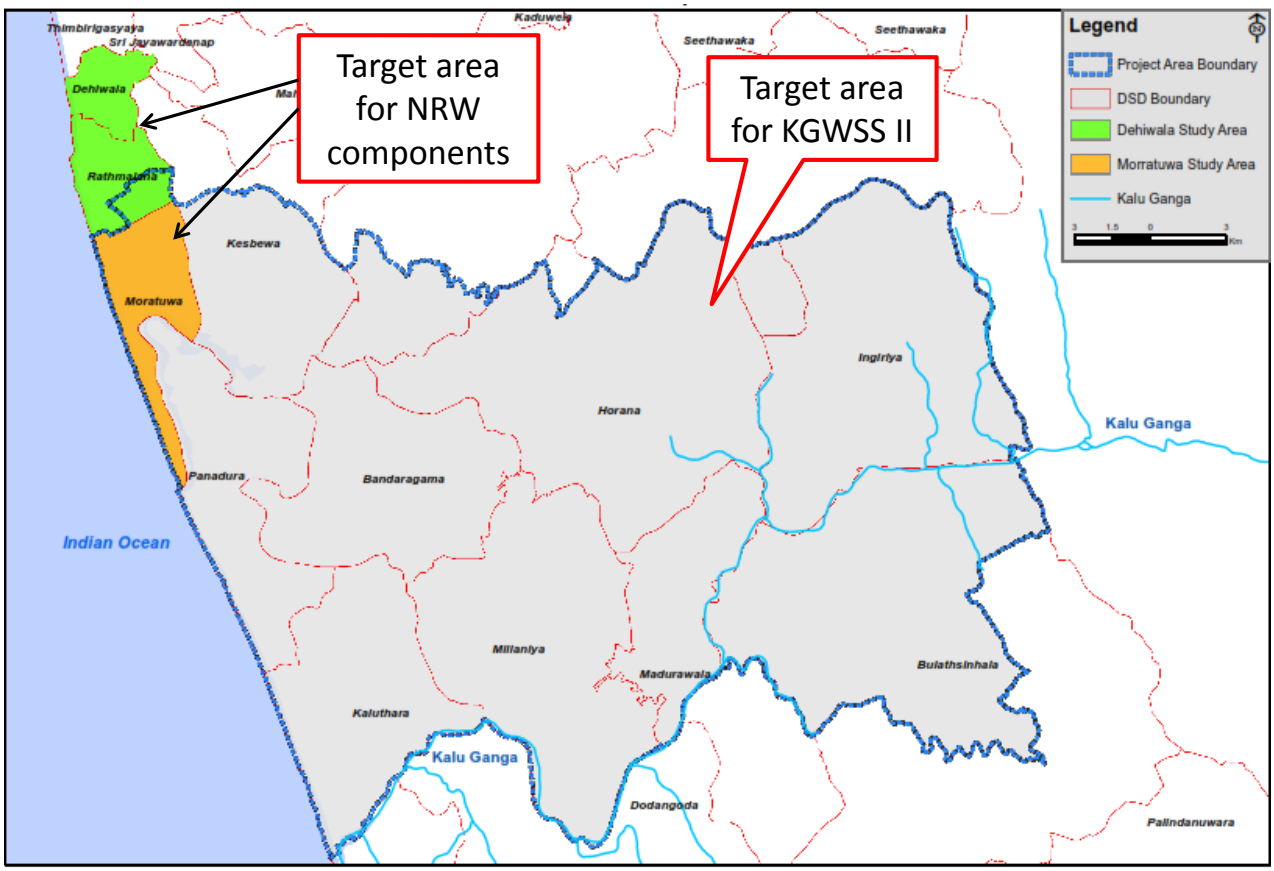


Figure 2.3.1: Geographical Relation between Dehiwala & Moratuwa Area and KGWSS II Area
Source: JICA Survey Team

Dehiwala

The town of Dehiwala is the closest town to the Colombo Municipal Council area and is part of the Greater Colombo Metropolitan area. It also encompasses the Mount Lavinia beach area. It has around 55,000 residential properties. The area is administered by the Dehiwala/Mount Lavinia Municipal Council (DLMC) and covers the Dehiwala and Ratmalana Divisional Secretariat Divisions (DSDs). These two DSDs incorporate 28 Grama Niladari (GN) Divisions. The area covers 18 km^2.

Moratuwa

The town of Moratuwa has a boundary to Bolgoda Lake on the East and South and Dehiwala/Mount Lavinia in the North. It has around 55,000 residential properties. It is also part of the Greater Colombo Metropolitan Area and is administered by the Moratuwa Urban Council (UC) and the Moratuwa DSD. The Moratuwa DSD also covers 42 GN Divisions and covers an area of 22 km^2.

2.3.2 Existing Water Supply System

The intended areas for NRW reduction under the Project are AE Area (Dehiwala) and AE Area (Moratuwa).

Following **Table 2.3.1** outlines general feature of the both AE areas.

Table 2.3.1: Key Information of AE areas for Dehiwala and Moratuwa

Condition		AE Area (Dehiwala)	AE Area (Moratuwa)	Dehiwala & Moratuwa	Entire RSC (WS)	Remarks
Population served		208,000	180,000	388,000	N/A	As of Jan/2013, Pre-F/S
No. of connection		54,826	44,088	98,914	203,452	As of Aug/2014, NRW Monitoring Report (RSC-WS, Aug/2014)
Total distributed amount (m^3/month)		N/A	N/A	3,215,400	5,463,600	
Total consumption (m^3/month)	Non-priority	1.14 million	0.77 million	2,193,000	3,957,923	
	Priority	0.19 million	0.10 million			
NRW (m^3/month)		N/A	N/A	1,022,400	1,505,677	
NRW (%)		N/A	N/A	31.80%	27.56%	

Source: NWSDB

CHAPTER 3 EXISTING PLANS AND STUDIES

3.1 Western Province Metropolitan Area Water Supply Master Plan (2013)

The developments and improvement for Phase II of the Kalu Ganga Water Supply System proposed in MPU/2013 are summarized as follows.

(1) Headworks

The proposed development of the headworks for the Kalu Ganga Water Supply System Phase II in the MPU/2013 is shown in **Table 3.1.1**.

Table 3.1.1: Staged Development for the Kandana WTP Proposed in MPU/2013

Facility	Phase I		Phase II		Phase III	
	Stage 1	Stage 2	Stage 1	Stage 2	Stage 1	Stage 2
	Existing	2020	2025	2030	2035	2040
Intake and Raw Water Transmission System	126,000	-	126,000	-	84,000	-
Water Treatment Plant	60,000	60,000	120,000	40,000	40,000	40,000
Total Capacity of Intake and RWTS	126,000	126,000	252,000	252,000	378,000	378,000
Total Capacity of WTP	60,000	120,000	240,000	280,000	320,000	360,000

Source: MPU/2013

(2) Transmission System

The transmission pipes and pumps to be installed for the KGWSSII proposed in MPU/2013 are listed in **Table 3.1.2** and **Table 3.1.3** respectively.

Table 3.1.2: Transmission Pipes to be installed for the KGWSSII Proposed in MPU/2013

Phase II		Pipeline	Material	Diameter (mm)	Length (m)
Stage 1	1.	New Kandana P2 WTP to Ex. Horana High-level GR	DI	900	5,450
	2.	New Kesbewa GR to Ex. Jamburaliya Tower	DI	500	2,450
	3.	New Kesbewa GR to Ex. 450 mm DI Transmission main to Ex. Kesbewa Tower	DI	400	600
	4.	New Kesbewa GR to Ex. Miriswatta Tower	DI	700	1,400
	5.	New Kandana P2 WTP to New Bamunumulla GR	DI	1,200	13,500
	6.	New Bamunumulla GR to Bandaragama junction and connected to the Ex. 800 mm DI Transmission main	DI	1,000	4,800
	7.	New Keselwatta GR from the Ex. 800 mm DI Transmission main	HDPE	400	500
	8.	New Moratuwa GR to Ex. 800 mm DI Transmission Main at Keselwatta (operated in parallel with the Ex. 450 mm DI line)	DI	600	3,000
				Total Length	**31,700**

Sauce: MPU/2013

Table 3.1.3: Transmission Pumps to be installed for the KGWSSII Proposed in MPU/2013

Phase II		Pumping Station	Destination	Capacity (m^3/hour)	Head (m)
Stage 1	1.	New Kandana P2 WTP	New Bamunumulla GR	6,080	70
	2.	New Kandana P2 WTP	New Bandaragama South Optional Reservoir (Alt)	765	52
	3.	New Kandana P2 WTP	Horana New GR	1,576	62
	4.	Ex. Kandana P1 WTP	New Kesbewa GR	3,447	44
	5.	New Kesbewa GR	Moratuwa GR	1,835	14
	6.	New Kesbewa GR	Kesbewa Tower	353	23
	7.	New Kesbewa GR	Jamburaliya Tower	526	31
	8.	New Kesbewa GR	Miriswatta Tower	1,364	41
	9.	Moratuwa GR	Moratuwa Tower	784	45
	10.	New Keselwatta GR	Keselwatta Tower	682	35

Source: MPU/2013

(3) Storage and Distribution System

The storage facilities to be constructed and distribution pipes and pumps to be installed for the KGWSSII proposed in MPU/2013 are listed in **Table 3.1.4**, **Table 3.1.5** and **Table 3.1.6** respectively.

Table 3.1.4: Storage Facilities to be constructed for the KGWSSII Proposed in MPU/2013

Phase II	Storage		Type	Capacity (m^3)
Stage 1	1.	Moratuwa	Ground Reservoir	10,000
	2.	Kesbewa	Ground Reservoir	10,000
	3.	Bamunumulla	Ground Reservoir	15,000
	4.	Keselwatta	Ground Reservoir	2,500
			Total	**37,500**

Source: MPU/2013

Table 3.1.5: Distribution Feeder Mains to be installed for the KGWSSII Proposed in MPU/2013

Feeder Main		Length (m)	
Material	**Diameter (mm)**	**Stage 1**	**Stage 2**
DI	400	22,688	84
	500	11,510	1,443
	600	11,478	1,862
	700	4,941	
	800	5,765	
	900	4,210	
	1000	4,623	
	Sub Total	**65,215**	**3,389**
PE	160	3,562	2,612
	225	21,677	
	280	817	
	315	11,691	
	400	13,577	
	Sub Total	**51,324**	**2,612**
Total		**116,539**	**6,001**
➢ New Secondary, Tertiary and Service Pipes (LS)			
➢ Replacement of Existing Pipes (LS)			

Source: MPU/2013

Table 3.1.6: Distribution Pumps to be installed for the KGWSSII Proposed in MPU/2013

Phase II	Pumping Station		Supply Area	Capacity (m^3/hour)	Head (m)
Stage 1	1.	Kandana P2 GR	Horana South Distribution	637	46
	2.	Kandana P2 GR	Bandaragama South (Alt)	1,124	43

Source: MPU/2013

3.2 Feasibility Study on Kalu Ganga Water Supply System Phase II (2014)

The components proposed in the KGFSII are summarized as follows.

(1) Headworks

The proposed development of the headworks for the Kalu Ganga Water Supply System Phase II in the KGFSII is shown in **Table 3.2.1**.

Table 3.2.1: Staged Development for the Headworks Proposed in KGFSII

Facility	Phase I		Phase II	Phase III
	Stage 1	Stage 2		
	Existing	2015	2020	2030
Intake and Raw Water Transmission System	126,000	-	105,250	105,250
Water Treatment Plant	60,000	60,000	100,000	100,000
Total Capacity of Intake and RWTS	**126,000**	**126,000**	**231,250**	**336,500**
Total Capacity of WTP	**60,000**	**120,000**	**220,000**	**320,000**

Source: KGFSII

(2) Transmission System

The transmission pipes and pumps to be installed for the KGWSSII proposed in KGFSII are listed in **Table 3.2.2** and **Table 3.2.3**, respectively.

Table 3.2.2: Transmission Pipes to be installed for the Phase II of Kalu Ganga Water Supply System Proposed in KGFSII

Pipeline		Material	Diameter (mm)	Length (m)
1.	Kandana WTP – Delkada GR	DI	1,200	14,000
2.	Delkada GR – Existing Bandaragama Transmission Pipeline	DI	1,000	5,000
3.	Delkada GR – Wadduwa Tower	DI	700	10,500
4.	Battagoda Transmission Pipeline – Battagoda Tower	DI	400	3,000
			Total	**32,500**

Source: KGFSII

Table 3.2.3: Transmission Pumps to be installed for the Phase II of Kalu Ganga Water Supply System Proposed in KGFSII

Pumping Station		Location	Destination	Capacity (m^3/min)	Head (m)
1.	Kandana	Kandana WTP	Delkada GR	N/A	N/A
2.	Delkada	Delkada GR	Waskaduwa Tower	N/A	N/A

Source: KGFSII

(3) Storage and Distribution System

The storage facilities to be constructed and distribution pipes to be installed for the KGWSSII proposed in KGFSII are listed in **Table 3.2.4** and **Table 3.2.5** respectively.

Table 3.2.4: Storages facilities to be constructed for the Phase II of Kalu Ganga Water Supply System Proposed in KGFSII

Storage		Type	Capacity (m^3)
1.	Delkada	Ground Reservoir	25,000
2.	Battagoda	Tower	1,500
		Total	**26,500**

Source: KGFSII

Table 3.2.5: Distribution Pipes to be installed for the Phase II of Kalu Ganga Water Supply System Proposed in KGFSII

Pipeline		Material	Diameter (mm)	Length (m)
1.	Distribution Improvement / Reinforcement	-	-	4,00,000

Source: KGFSII

CHAPTER 4 WATER DEMAND AND STAGED DEVELOPMENT PLAN

4.1 Service Area Adjusted

4.1.1 Kalu Ganga Water Supply System

Service area to be covered by KGWSS Phase II project is revised based on previous studies considering current conditions such as water balance in Colombo and Kalutara Districts, required energy for water supply system and topographic conditions through several discussions with NWSDB.

MPU/2013 and KGFSII planned to cover almost same areas under the KGWSSII, while there are difference in several GNs in Millaniya DS Division in Kalutara District and 3 GNs in Padukka DS Division in Colombo District. However, the largest difference is that KGFSII proposed for Kandana WTP to provide treated water to Ingiriya-Handapangoda Water Supply Project in addition to the Kalu Ganga Water Supply Project area.

Some parts of Padukka DS Division in Colombo District are reviewed to be covered under KGWSSII instead of the existing Kalatuwawa and Ambatale systems, considering advantage in operation and maintenance, water supply capacity and current activities. However, the areas will be supplied from Ambatale system in emergent cases. Some areas of Horana DS Divisions in Kalutara District are also revised from planned Weliwita system, considering access from the system (existing roads, terrain and elevation). Based on the results of review and discussion with NWSDB, the service area to be covered by the KGWSSII is proposed as illustrated in **Figure 4.1.1**.

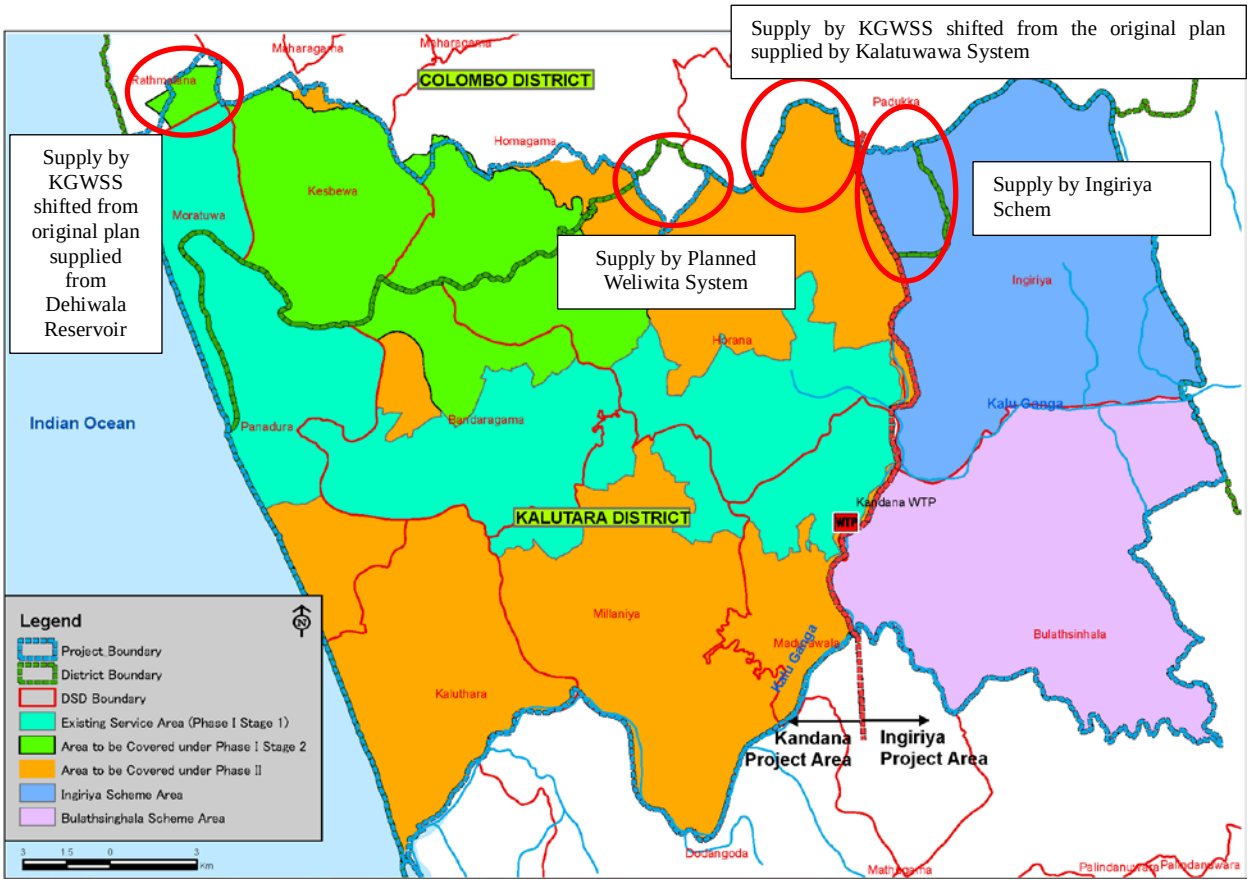


Figure 4.1.1: Proposed Service Area in the Survey
Source: JICA Survey Team

4.1.2 Dehiwala and Moratuwa Areas

The survey area consisted of Dehiwala and Ratmalana DS Divisions and Moratuwa DS Division as shown in **Figure 4.1.2**.

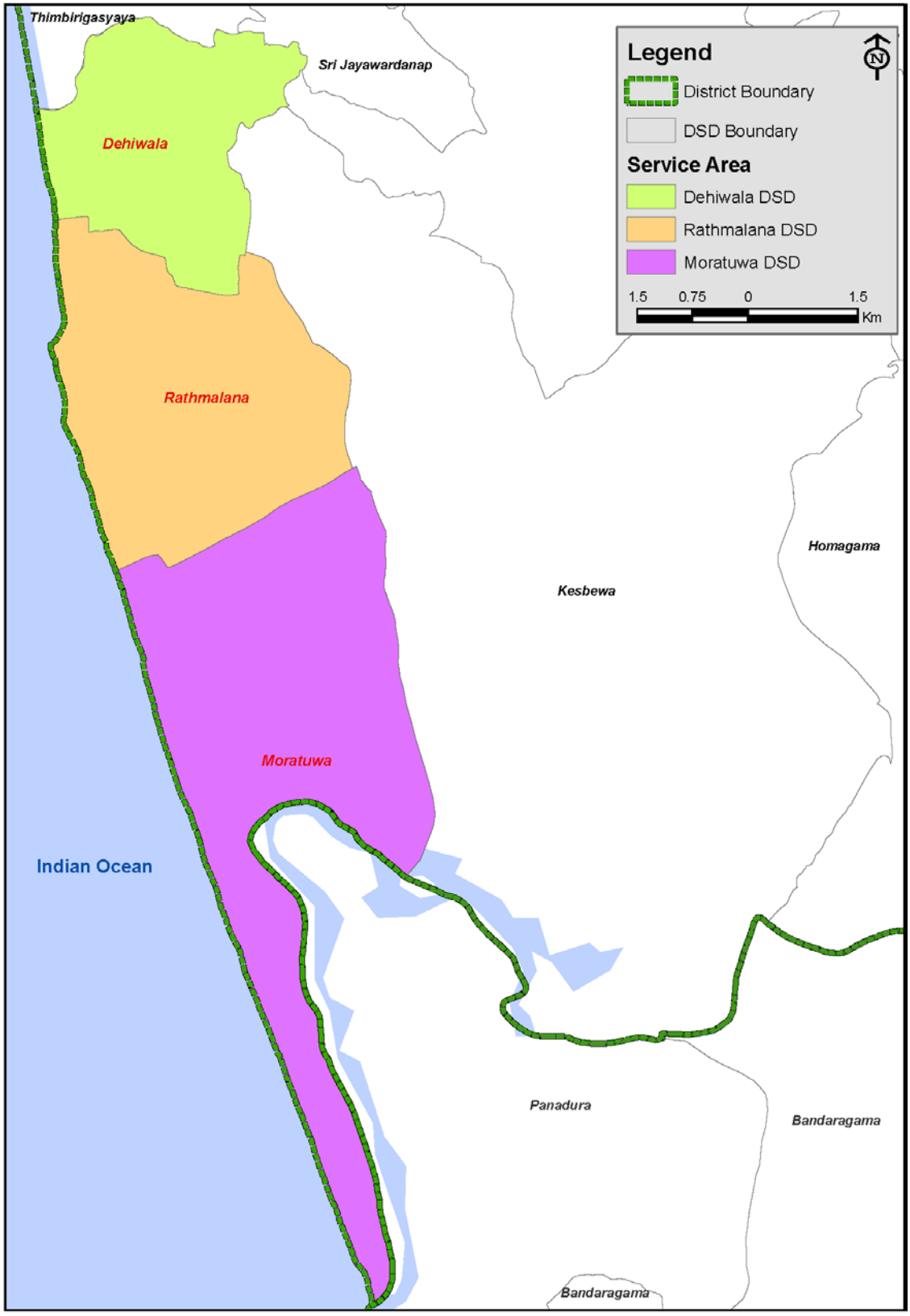


Figure 4.1.2: Proposed Service Area in the Survey
Source: JICA Survey Team

4.2 Revision of Water Demand Projection for Kalu Ganga Water Supply System

Water Demand was reviewed based on MPU/2013 and KGFSII with consideration of current conditions and newly available data since MPU/2013 was prepared after long discussion with NWSDB and agreed. KGFSII was prepared based on the concept of MPU/2013. The largest difference is that KGFSII proposed for Kandana WTP to provide treated water to Ingiriya-Handapangoda Water Supply Project. NWSDB and Ministry of Water and Drainage strongly request/insist this additional treatment capacity.

4.2.1 Population and Service Level

Service population is revised from previous studies due to modification of service area as described in the previous section. In addition, population data, population growth rate, and service coverage are reviewed.

(1) Basis of Population Projection

While population indicated in draft Census 2012 was used for future projection in MPU/2013, final population in official Census 2012 is applied in KGFSII.

The differences of population between Draft Census 2012 applied in MPU/2013 and Final Census 2012 applied for KGFSII are shown in **Table 4.2.1**.

Table 4.2.1: Population (Person) applied in MPU/2013 and KGFSII

District	DS Division	Census 2012 (KGFSII)	Draft Census 2012 (MPU/2013)	Balance
Colombo	Homagama	236,179	236,201	-22
	Padukka	65,167	65,135	32
	Kesbewa	244,067	243,842	225
	Dehiwala	87,736	87,834	-98
	Moratuwa	167,160	167,255	-95
	Ratmalana	95,011	95,162	-151
	Total	**895,320**	**895,429**	**-109**
Kalutara	Bandaragama	108,889	108,889	0
	Bulathsinhala	64,635	64,309	326
	Horana	112,441	112,815	-374
	Ingiriya	53,645	53,645	0
	Kalutara	159,225	159,225	0
	Madurawala	34,245	34,245	0
	Millaniya	52,078	52,078	0
	Panadura	181,724	181,730	-6
	Total	**766,882**	**766,936**	**-54**

Source: MPU/2013 and KGFSII

Population given in Census 2012 is applied for the basis of the population projection in the Survey, while differences between MPU/2013 and KGFSII are not significant.

The population growth rate was projected in MPU/2013 considering following:

1. Population growth rate proposed in Census 2001
2. Population growth rate 2001 - 2009 of estimated population in each DS Divisions using data of Census 2001
3. District level long term population growth rate 1981 – 2012
4. District level population growth rate 1981 – 2001
5. District level population growth rate 2001 – 2012
6. Projected migration factor

After several discussions between NWSDB and JST, it was concluded that the population growth rate predicted in MPU/2013 is to be applied considering that the projection in MPU/2013 is based on the actual detailed data. Population growth rate applied for the survey is shown in **Table 4.2.2**.

Table 4.2.2: Population Growth Rate for the Survey

District	Council & Pradeshiya Sabhas		Projected Population Growth Rate (%)					
			2012 - 2015	2015 - 2020	2020 - 2025	2025 - 2030	2030 - 2035	2035 - 2040
Colombo	Municipal Councils	Dehiwala - Mt. Lavinia	1.28%	1.28%	1.12%	1.12%	0.98%	0.98%
		Moratuwa	1.20%	1.20%	1.04%	1.04%	0.91%	0.91%
	Urban Councils	Maharagama	1.63%	1.63%	1.42%	1.42%	1.24%	1.24%
		Kesbewa	1.63%	1.63%	1.42%	1.42%	1.24%	1.24%
	Pradeshiya Sabha	Seethawaka	1.85%	1.85%	1.85%	1.85%	1.85%	1.85%
		Homagama	2.43%	2.43%	2.10%	2.10%	1.81%	1.81%
Kalutara	Urban Councils	Kalutara	1.27%	1.27%	1.16%	1.16%	1.06%	1.06%
		Panadura	2.23%	2.23%	2.02%	2.02%	1.83%	1.83%
		Horana	1.63%	1.63%	1.48%	1.48%	1.34%	1.34%
	Pradeshiya Sabha	Kalutara	1.23%	1.23%	1.12%	1.12%	1.02%	1.02%
		Panadura	2.23%	2.23%	2.02%	2.02%	1.83%	1.83%
		Bandaragama	2.17%	2.17%	1.97%	1.97%	1.79%	1.79%
		Horana	1.63%	1.63%	1.48%	1.48%	1.34%	1.34%
		Bulathsinhala	1.38%	1.38%	1.25%	1.25%	1.14%	1.14%
		Maduruwela	1.43%	1.43%	1.30%	1.30%	1.18%	1.18%

Source: MPU/2013

(2) Service Coverage

MPU/2013 proposed target service coverage for the Colombo District and Kalutara District are shown in **Table 4.2.3**.

Table 4.2.3: Target Service Coverage (%) Proposed in MPU/2013

RSC	Service Provider	Year						
		2012	2015	2020	2025	2030	2035	2040
Western Central	NWSDB	74	81	92	94	96	99	100
	CBOs	4	2	0	0	0	0	0
	Total	**78**	**83**	**92**	**94**	**96**	**99**	**100**
Western South	NWSDB	26	36	51	67	78	90	94
	CBOs	4	3	3	2	2	2	2
	Total	**30**	**39**	**54**	**69**	**70**	**92**	**96**

*CBO: Community Based Organizations
Source: MPU/2013

KGFSII proposed coverage of 100% in existing service area and coverage of 80-90% for all areas managed by RSC Western South in 2030. Target supply hours were not given in KGFSII.

As a result of review and consideration of the detailed data used in MPU/2013, it was concluded that target service coverage shown in MPU/2013 should be applied.

(3) Projected Population and Service Population

Service population is revised using the population in Census 2012, population growth rate and service coverage as explained in previous sections. The projected population and served population for the KGWSS in this Survey are shown in **Table 4.2.4**, and the projected population and served population in the Dehiwala and Moratuwa area for the project of NRW reduction are shown in **Table 4.2.5**.

Table 4.2.4: Projected Population and Proposed Served Population for KGWSS

District	DS Division	Projected Population (Person)							Projected Served Population (Person)							Coverage (%)						
		2012	2015	2020	2025	2030	2035	2040	2012	2015	2020	2025	2030	2035	2040	2012	2015	2020	2025	2030	2035	2040
Colombo	Homagama	44,728	48,066	54,198	60,134	66,714	72,976	79,817	3,109	11,823	36,233	45,940	56,709	72,976	79,817	7.0%	24.6%	66.9%	76.4%	85.0%	100.0%	100.0%
	Padukka	3,444	3,639	3,988	4,370	4,790	5,250	5,753	0	0	1,596	2,186	3,352	4,725	5,753	0.0%	0.0%	40.0%	50.0%	70.0%	90.0%	100.0%
	Kesbewa	141,316	148,340	160,832	172,581	185,189	196,960	209,483	71,293	95,221	160,832	172,581	185,189	196,960	209,483	50.4%	64.2%	100.0%	100.0%	100.0%	100.0%	100.0%
	Moratuwa	167,255	173,347	184,001	193,772	204,059	213,514	223,406	155,547	164,680	184,001	193,772	204,059	213,514	223,406	93.0%	95.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Ratmalana	9,518	9,888	10,537	11,140	11,778	12,367	12,985	9,042	9,690	10,537	11,140	11,778	12,367	12,985	95.0%	98.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Sub-Total	***356,743***	***373,392***	***403,019***	***430,857***	***460,752***	***488,700***	***518,459***	***229,949***	***271,724***	***382,662***	***414,479***	***449,309***	***488,175***	***518,459***	***64.5%***	***72.8%***	***94.9%***	***96.2%***	***97.5%***	***99.9%***	***100.0%***
Kalutara	Horana	108,900	114,317	123,941	133,392	143,564	153,451	164,011	11,201	44,946	80,561	103,093	122,033	145,779	164,011	10.3%	39.3%	65.0%	77.3%	85.0%	95.0%	100.0%
	Ingiriya	53,645	56,316	61,056	65,710	70,725	75,593	80,793	6,665	10,368	16,570	20,627	38,649	61,118	71,522	12.4%	18.4%	27.1%	31.4%	54.6%	80.9%	88.5%
	Madurawala	23,988	25,033	26,873	28,667	30,580	32,424	34,383	3,329	4,040	8,063	17,197	21,405	25,937	29,226	13.9%	16.1%	30.0%	60.0%	70.0%	80.0%	85.0%
	Millaniya	52,078	55,546	61,841	68,180	75,170	82,151	89,770	2,675	4,784	9,282	26,992	48,859	65,720	76,304	5.1%	8.6%	15.0%	39.6%	65.0%	80.0%	85.0%
	Bandaragama	108,889	116,134	129,297	142,543	157,147	171,735	187,667	29,694	56,652	100,551	121,162	141,437	163,145	187,667	27.3%	48.8%	77.8%	85.0%	90.0%	95.0%	100.0%
	Panadura	181,730	194,159	216,803	239,601	264,795	289,925	317,440	91,605	116,228	170,814	203,661	238,318	275,429	317,440	50.4%	59.9%	78.8%	85.0%	90.0%	95.0%	100.0%
	Kalutara	90,123	93,496	99,412	105,127	111,171	116,988	123,109	39,221	50,610	67,454	91,233	101,436	112,010	123,109	43.5%	54.1%	67.9%	86.8%	91.2%	95.7%	100.0%
	Bulathsinghala	36,170	37,687	40,360	42,946	45,703	48,367	51,188	0	0	8,073	12,886	22,858	38,693	43,509	0.0%	0.0%	20.0%	30.0%	50.0%	80.0%	85.0%
	Sub-Total	***655,523***	***692,688***	***759,583***	***826,166***	***898,855***	***970,634***	***1,048,361***	***184,390***	***287,628***	***461,368***	***596,851***	***734,995***	***887,831***	***1,012,788***	***28.1%***	***41.5%***	***60.7%***	***72.2%***	***81.8%***	***91.5%***	***96.6%***
Total		**1,012,266**	**1,066,080**	**1,162,602**	**1,257,023**	**1,359,607**	**1,459,334**	**1,566,820**	**414,339**	**559,352**	**844,030**	**1,011,330**	**1,184,304**	**1,376,006**	**1,531,247**	**40.9%**	**52.5%**	**72.6%**	**80.5%**	**87.1%**	**94.3%**	**97.7%**

Note: Population and served population in the table are only in the area to be covered by KGWSS and served population in 2012 and 2015 include population currently supplied by other schemes
Source: JICA Survey Team

Table 4.2.5: Projected Population and Proposed Served Population in Dehiwala and Moratuwa Areas for the Project of NRW Reduction

District	DS Division	Projected Population (Person)							Projected Served Population (Person)							Coverage (%)						
		2012	2015	2020	2025	2030	2035	2040	2012	2015	2020	2025	2030	2035	2040	2012	2015	2020	2025	2030	2035	2040
Colombo	Dehiwala	87,736	91,147	97,133	102,697	108,578	114,004	119,702	83,348	89,324	97,133	102,697	108,578	114,004	119,702	95.0%	98.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Ratmalana	95,011	98,706	105,186	111,209	117,577	123,451	129,621	90,259	96,733	105,186	111,209	117,577	123,451	129,621	95.0%	98.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Moratuwa	167,255	173,347	184,001	193,772	204,059	213,514	223,406	155,547	164,680	184,001	193,772	204,059	213,514	223,406	93.0%	95.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Sub-Total		**350,002**	**363,200**	**386,320**	**407,678**	**430,214**	**450,969**	**472,729**	**329,154**	**350,737**	**386,320**	**407,678**	**430,214**	**450,969**	**472,729**	**94.0%**	**96.6%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: JICA Survey Team

4.2.2 Per-Capita Domestic Water Demand

The per-capita domestic water demand projected in MPU/2013 was estimated based on following points of view.

1. Existing record of domestic water user in past 4 years (2009-2012)
2. Condition in other cities in South East Asia
3. Classification by Population Density Estimated for 2040
4. Predicted view of future domestic water use

New data/ information of domestic per-capita consumption are not available after both studies.
Per-capita domestic consumption for each area in MPU/2013 is reviewed considering the amendment of KGFSII and summarized in **Table 4.2.6**.

Table 4.2.6: Proposed Per-capita Domestic Water Demand

District	Council & Pradeshiya Sabhas		Per-capita Domestic Water Demand (lpcd)						
			2012	2015	2020	2025	2030	2035	2040
Colombo	Municipal Councils	Dehiwala-Mt.Lavinia	180	182	184	188	192	196	200
		Moratuwa	160	162	164	168	172	176	180
	Urban Councils	Maharagama	160	162	164	168	172	176	180
		Boralesgamuwa	140	142	144	148	152	156	160
		Kesbewa	140	142	144	148	152	156	160
	Pradeshiya Sabha	Homagama	140	142	144	148	152	156	160
		Seethawaka	120	122	124	128	132	136	140
Kalutara	Urban Councils	Kalutara	160	162	164	168	172	176	180
		Panadura	160	162	164	168	172	176	180
		Horana	140	142	144	148	152	156	160
	Pradeshiya Sabha	Walallawita	120	122	124	128	132	136	140
		Palindanuwara	120	122	124	128	132	136	140
		Dodangoda	120	122	124	128	132	136	140
	Pradeshiya Sabha	Kalutara	140	142	144	148	152	156	160
		Panadura	140	142	144	148	152	156	160
		Bandaragama	140	142	144	148	152	156	160
		Horana	120	122	124	128	132	136	140
		Madurawela	120	122	124	128	132	136	140
		Bulathsinhala	120	122	124	128	132	136	140

Source: MPU/2013

4.2.3 Non-Domestic Water Use

Based on survey results of current domestic use ratio in each area (GN) the future ratio was projected in MPU/2013.

On the other hand, 15% was applied to the entire area in KGFSII, considering that majority of water use is for domestic purpose in new development areas.

After several discussions between NWSDB and JST, it was concluded that the figure given in MPU/2013 should be used for the exiting areas (GNs) and 15% should be applied in new service areas (GNs), considering that the new areas are in rural areas and should have different tendencies from the exiting developed areas in each GNs.

Revised ratio for non-domestic water use in each area is summarized in **Table 4.2.7**.

Table 4.2.7: Non-Domestic Water Use Proposed in MPU/2013

Regional Service Center	Area Engineer	Officer In Charge	Existing Scheme	Future Scheme	Projected Water Use								
					Domestic			Non-Domestic					
					Direct	Stand Post	Yard Tap	Commercial	Industrial	Educational	Governmental	Religious	Others
					2012 - 2040	2012 - 2040	2012 - 2040	2012 - 2040	2012 - 2040	2012 - 2040	2012 - 2040	2012 - 2040	2012 - 2040
Western Central	Maharagama	Homagama	Homagama	Homagama	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
			Godagama	Godagama	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
			Templeburg	Jaltara	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
			Galagedara	Padukka	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
			Padukka	Padukka	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
			Hanwella	Hanwella	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
			Kahahena	Kahahena	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
			Kaluaggala	Kaluaggala	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
			Jaltara	Jaltara	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
			Habarakada	Jaltara	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
			Jayaweeragoda	Jayaweeragoda	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
			-	Diyagama	77.5%	0.0%	0.0%	16.5%	0.5%	1.5%	3.0%	1.0%	0.0%
	Kesbewa	Pelenwatta	Pelenwatta	Pelenwatta	94.5%	0.0%	0.0%	3.0%	0.5%	0.5%	0.5%	1.0%	0.0%
			Mattegoda	Mattegoda	94.5%	0.0%	0.0%	3.0%	0.5%	0.5%	0.5%	1.0%	0.0%
		Piliyandala	Piliyandala	Piliyandala	90.0%	0.0%	0.0%	6.5%	0.5%	1.0%	1.0%	1.0%	0.0%
Western South	Dehiwala	Dehiwala	Dehiwala	Dehiwala	86.1%	1.8%	0.1%	9.0%	0.5%	0.5%	1.0%	1.0%	0.0%
		Mt. Lavinia	Dehiwala	Dehiwala	86.1%	1.8%	0.1%	9.0%	0.5%	0.5%	1.0%	1.0%	0.0%
	Moratuwa	Moratuwa	Moratuwa	Moratuwa	86.7%	4.8%	0.0%	5.0%	0.5%	1.0%	1.0%	1.0%	0.0%
		Soysapura	Moratuwa	Moratuwa	86.7%	4.8%	0.0%	5.0%	0.5%	1.0%	1.0%	1.0%	0.0%
	Panadura	Panadura	Panadura	Panadura	83.4%	0.6%	0.0%	10.0%	0.5%	2.0%	2.5%	1.0%	0.0%
			Panadura East	Panadura East	39.0%	0.0%	0.0%	1.5%	57.5%	0.5%	0.5%	1.0%	0.0%
			Keselawatta	Keselawatta	92.0%	0.0%	0.0%	3.5%	0.5%	1.5%	0.5%	2.0%	0.0%
	Bandaragama	Bandaragama	Bandaragama	Bandaragama	90.5%	0.0%	0.0%	5.0%	0.0%	0.5%	2.0%	2.0%	0.0%
		Horana	Horana	Horana	62.2%	1.3%	0.0%	12.0%	1.0%	6.0%	15.0%	2.5%	0.0%
		Ingiriya	Ingiriya	Ingiriya	79.0%	0.0%	0.0%	10.0%	0.0%	4.5%	5.0%	1.5%	0.0%
	Kalutara	Kalutara	Kalutara	Kalutara	65.5%	0.0%	0.0%	5.0%	0.0%	2.5%	25.0%	2.0%	0.0%
		Wadduwa / Waskaduwa	Wadduwa	Wadduwa	92.9%	0.1%	0.0%	4.0%	0.0%	0.5%	1.5%	1.0%	0.0%
			-	SSI-RWS Bulathsinhala North	95.0%	0.0%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			-	SSI-RWS Bulathsinhala Central	95.0%	0.0%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			-	SSI-RWS Bulathsinhala South	95.0%	0.0%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: MPU/2013

4.2.4 Special Water Demand

Special water demand is composed of water demand for large scale housing, and commercial and industrial areas, including ports and airports, which are considered priority users. Current special water demand and existing plan were surveyed and analyzed in MPU/2013. However, special water demand was not included in KGFSII. After discussion and confirmation with NWSDB, it was concluded to use the figure given in MPU/2013 considering that new information to revise the figure is not available in KGFSII and in this survey. Special water demand is summarized in **Table 4.2.8**.

Table 4.2.8: Special Water Demand (m^3/day) Projected in MPU/2013

Local Authority	2012	2015	2020	2025	2030	2035	2040
Dehiwala MC							14,884
Kaduwela MC	2,269	4,168	4,626	4,838	5,059	5,279	5,501
Bandaragama PS	9	14	16	17	38	41	43
Boralesgamuwa UC	1,099	1,099	1,155	1,212	1,264	1,320	1,377
Horana UC	960	960	1008	1056	1104	1152	1200
Maharagama UC	2,421	2,421	2,540	2,665	2,783	2,904	3,023
Panadura UC	320	320	336	352	368	384	400
Kalutara PS			3,780	3,960	4,140	4,320	4,500
Homagama PS	3,600	3,600	3,780	3,960	4,140	4,320	4,500
Madurawala PS			546	572	552	576	600
Panadura PS	84	84	87	92	96	98	102
Seethawaka PS	381	381	1,458	1,531	1,596	1,664	1,737
Bulathsinhala					1,104	1,152	1,200

Source: MPU/2013

4.2.5 Water Loss in the Distribution System

Table 4.2.9 introduces predicted water loss ratio in the distribution system in MPU/2013.

Table 4.2.9: Water Loss Ratio (%) Predicted in MPU/2013

Regional Support Centre / Area	Year						
	2012	2015	2020	2025	2030	2035	2040
CMC Area	39.0	36.0	20.0	18.5	17.0	16.0	15.0
Western Central (Excluding CMC)	32.0	30.0	20.0	18.5	17.0	16.0	15.0
Western South	33.0	32.0	20.0	18.5	17.0	16.0	15.0
Year After Commencement	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35
New Service Area	12.0	12.5	13.0	13.5	14.0	14.5	15.0

Source: MPU/2013

After discussions with NWSDB, it was concluded that water loss ratio given in MPU/2013 is to be applied since water loss ratio is some kind of policy of NWSDB, and the figure in MPU/2013 was decided after series of discussions among NWSDB management level.

4.2.6 Seasonal Peak Factor

Seasonal peak factor of 1.10 was applied in MPU/2013 considering previous water usage data and experience of NWSDB. KGFSII used the same figure.

It is concluded to use the same figure considering that no reason/data is available to change or modify the figure.

4.2.7 Projected Water Demand

Water demand is calculated using the figure described above. The results of water demand forecast in the project area is shown in **Table 4.2.10** and **Table 4.2.13**.

Table 4.2.10: Projected Water Demand Reviewed for the KGWSS

No.	Description	Year						
		2012	2015	2020	2025	2030	2035	2040
1	**Total Population (Person)**							
	In Kandana Project Area	483,420	825,072	1,019,309	1,155,137	1,250,167	1,342,491	1,442,071
	In Ingiriya Project Area	16,270	17,081	68,415	73,218	121,218	129,210	137,734
	Total	**499,690**	**842,153**	**1,087,724**	**1,228,355**	**1,371,385**	**1,471,701**	**1,579,805**
2	**Served Population (Person)**							
	In Kandana Project Area	259,956	519,466	828,328	986,771	1,131,223	1,283,837	1,423,448
	In Ingiriya Project Area	6,665	8,064	26,239	35,699	64,859	104,536	120,784
	Total	**266,621**	**527,530**	**854,567**	**1,022,470**	**1,196,082**	**1,388,373**	**1,544,232**
3	**Water Demand (m^3/day)**							
	Domestic Demand							
	In Kandana Project Area	38,582	76,566	122,566	149,035	174,884	203,053	230,510
	In Ingiriya Project Area	800	984	3,254	4,569	8,561	14,217	16,910
	Total	**39,381**	**77,550**	**125,819**	**153,605**	**183,446**	**217,270**	**247,420**
	Non-Domestic Demand							
	In Kandana Project Area	6,042	13,694	23,436	28,845	34,510	40,861	46,940
	In Ingiriya Project Area	213	262	758	1,042	1,803	2,871	3,382
	Total	**6,255**	**13,955**	**24,194**	**29,887**	**36,313**	**43,732**	**50,323**
	Special Demand							
	In Kandana Project Area	1,373	1,685	9,563	9,936	10,068	10,305	10,548
	In Ingiriya Project Area	-	-	-	-	1,104	1,152	1,200
	Total	**1,373**	**1,685**	**9,563**	**9,936**	**11,172**	**11,457**	**11,748**
4	**Non Revenue Water (m^3/day)**							
	In Kandana Project Area	24,028	42,688	40,515	44,759	48,078	52,845	56,964
	In Ingiriya Project Area	529	623	878	1,159	2,166	3,415	4,068
	Total	**24,557**	**43,310**	**41,393**	**45,919**	**50,244**	**56,260**	**61,032**
5	**Average Day Water Supply (m^3/day)**							
	In Kandana Project Area	70,025	134,633	196,080	232,575	267,541	307,064	344,962
	In Ingiriya Project Area	1,541	1,868	4,889	6,771	13,634	21,655	25,560
	Total	**71,566**	**136,501**	**200,970**	**239,346**	**281,175**	**328,719**	**370,523**
6	**Maximum Day Water Supply (m^3/day)**							
	In Kandana Project Area	77,027	148,096	215,688	255,833	294,295	337,771	379,458
	In Ingiriya Project Area	1,695	2,055	5,378	7,448	14,998	23,820	28,116
	Total	**78,723**	**150,151**	**221,067**	**263,281**	**309,292**	**361,591**	**407,575**

Note: Per capita shown in **Table 4.2.6** was applied
Source: JICA Survey Team

Table 4.2.11: Projected Water Demand Reviewed for the Project of NRW Reduction in Dehiwala and Moratuwa Areas

DSD	Estimated Maximum Day Water Demand (m^3/day)						
	2012	2015	2020	2025	2030	2035	2040
Dehiwala	32,436	34,590	32,442	34,439	36,172	37,849	39,586
Rathmalana	39,517	49,062	45,178	47,520	49,207	51,074	53,012
Moratuwa	44,656	47,165	45,347	48,019	50,837	53,781	56,875
Total	**116,609**	**130,817**	**122,967**	**129,978**	**136,216**	**142,704**	**149,473**

Note: per capita shown in **Table 4.2.6** was applied
Source: JICA Survey Team

There is difference in the results of water demand for the KGWSS between MPU/2013 and the JICA Survey. The big difference of 40,000 m^3/day in 2040 is created mainly due to the following two reasons.

1. Inclusion of water supplied to Ingiriya project area in Kandana Phase 2 WTP

It has been recommended in MPU/2013 that Ingiriya and Bulathsinhala areas be supplied with two independent water supply schemes, but not from Kandana WTP. (It has been proposed to construct an impounding reservoir across Nambapana Ela and to construct a WTP at Ingiriya.) However, KGFSII has recommended that water shall be provided form Kandana WTP to Ingiriya DSD as well as some parts of

Bulathsinhala DSD while distribution system will be constructed in another project. For the JICA survey, water demand provisions for Ingiriya and Bulathsinhala areas have been included considering the strong requests made by NWSDB and considering the criteria mentioned in KGFSII. The additional water demands included for the Kandana WTP due to the inclusion of above mentioned areas are summarized in following **Table 4.2.12**.

Table 4.2.12: Estimated Max. Day Water Demands in Ingiriya Project Area

Year	2012	2015	2020	2025	2030	2035	2040
Max. Day Water Demand (m^3/day)	1,695	2,055	5,378	7,448	14,998	23,820	28,116

Source: JICA Survey Team

2. Review of Service Area - Inclusion of Kandawala (543 A) GND from Ratmalana DSD

In MPU/2013, Kandawala (543 A) GND of Ratmalana DSD has been considered to be included in Ambatale supply area. However, it was decided to include this GND under the Kandana supply area in the JICA survey and this GND will be supplied from Ambatale in emergency cases. It should be noted that there is a substantial special water demand in this GND from the domestic airport and some other institutions. The demand of Kandawala (543 A) GND is summarized in the below **Table 4.2.13**.

Table 4.2.13: Demand of Kandawala (543 A) GND of Ratmalana DSD

Year	2012	2015	2020	2025	2030	2035	2040
Estimated Max. Day Water Demand (m^3/day)	7,451	15,022	13,230	13,588	13,599	13,857	14,126

Source: JICA Survey Team

4.3 Staged Development Plan

The summary of staged development for the system capacity and water balance up to 2040 discussed in MPU/2013 are shown in **Table 4.3.1** and **Figure 4.3.1**.

Table 4.3.1: Staged Development for the System Capacity and Water Balance Proposed in MPU/2013

Amount (m^3/day)	Year						
	2012	2015	2020	2025	2030	2032	2040
Total Water Demand	76,057	146,279	198,116	236,626	273,404	314,428	353,277
Total Production Capacity	60,000	120,000	240,000	280,000	320,000	360,000	360,000
Total Extraction Amount	81,457	156,665	212,182	253,426	292,816	336,752	378,360
Water Resource Capacity	545,000	545,000	491,800	491,800	480,800	480,800	480,800

Source: JICA Survey Team based on latest proposal of MPU/2013

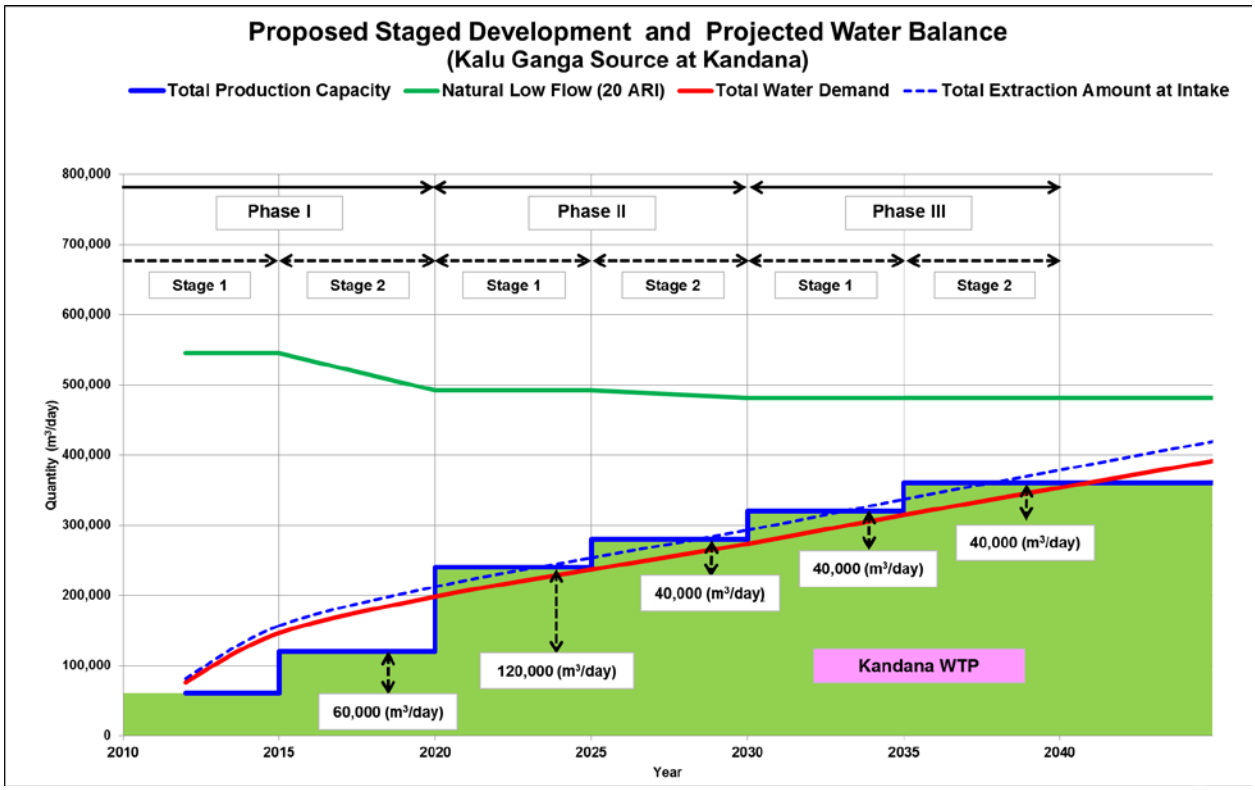


Figure 4.3.1: Staged Development and Water Balance Discussed in MPU/2013
Source: JICA Survey Team based on latest proposal of MPU/2013

Based on the updated water demand and discussion with NWSDB, the staged development plan was proposed as shown in **Table 4.3.2** and **Figure 4.3.2**.

In MPU/2013, WTP capacity was planned to be expanded by 120,000 m^3/day and 40,000 m^3/day in Stage I and Stage 2 of Phase II, respectively. However, it is proposed to expand capacity by 140,000 m^3/day by 2020 as Phase II. Another expansion of 140,000 m^3/day (expansion of 70,000 m^3/day two times) will be done as Phase III project. Therefore, the target year of phase II is set at year 2025. The arrangement of the phase is reviewed considering ease of construction and investment.

Table 4.3.2: Proposed Staged Development Reviewed in this Survey

Amount (m^3/day)	Year						
	2012	2015	2020	2025	2030	2032	2040
Total Water Demand	77,027	148,096	221,067	263,281	309,292	329,336	407,575
Total Production Capacity	60,000	120,000	260,000	330,000	330,000	400,000	400,000
Water Resource Capacity	382,500	382,500	324,400	324,400	313,400	313,400	313,400

Source: JICA Survey Team

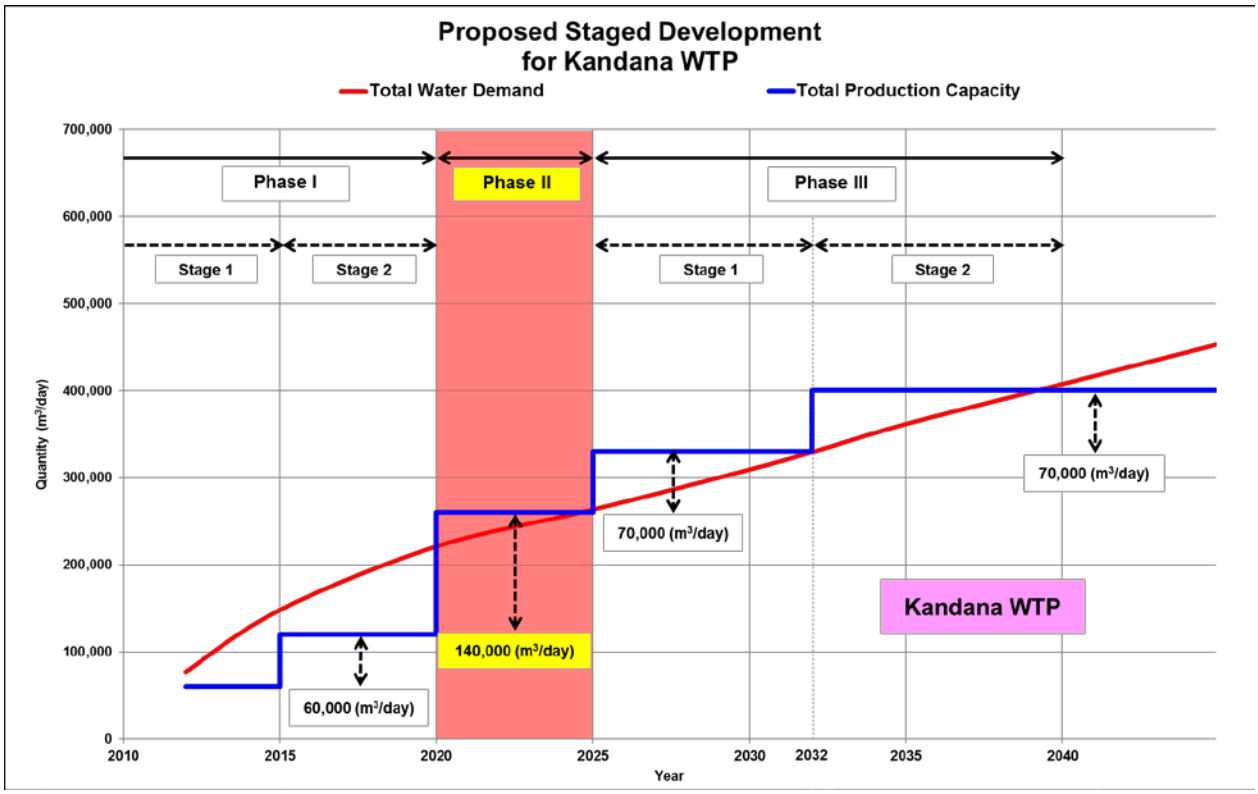


Figure 4.3.2: Staged Development of WTP Revised in this Survey

Source: JICA Survey Team

4.4 Water Resource

MPU/2013 estimated demand gap of Kalu River at confluence of Kalu and Kuda Rivers (approx. 5 km downstream of Kandana).

In the MPU/2013, confluence point of Kalu and Kuda Rivers was considered as the one of the alternative intake location of the Kandana WTP in case low flow at Kandana. However, in the end, the location of intake for regular operation was proposed at Kandana.

The maintenance flow at Kandana is not clearly defined but maintenance flow of 11 m^3/sec at Kethhena is mentioned in MPU/2013. Therefore maintenance flow of Kalu River at Kandana is assumed to be 3.92 m^3/day, as calculated below:

11 m^3/day x 8.35 (minimum natural flow at Kandana) / 23.42 (minimum natural flow at Kethhena)

Estimated water balance and demand gap at Kandana in Kalu River is shown in **Table 4.4.1**, while **Figure 4.4.2** shows the water balance at Kandana between water demand and available water source capacity (10 ARI). Natural low flow (10 ARI) is decreased since water intake volume at upstream will be increased. Water demand at upstream is surveyed at industrial estates at upstream and NWSDB. However data/ information to revise the figures in MPU/2013 are not available so far.

These table and figure shows that water source will be deficient after Phase III when river water flow rate

is lowest in 10 years (10 ARI).

Considering that the maintenance flow is an assumption and the raw water is just enough for Phase II, it is strongly recommended to carry out water sources survey, such as natural low flow and maintenance at Kandana and possibility of water source development.

General Map of location discussed above is shown in **Figure 4.4.1**.

There will be several options for the further development of the Phase III and after 2040. Some of them are summarized below:

i. Construction of intake at the downstream of confluent point of Kalu and Kuda rivers and upstream of salinity intrusion limit. The intake will be used only when raw water is in short at Kandana.

Advantage: No issues for the water resource in future

Dis-advantage:
1) Detailed water resource survey and selection of intake location is necessary
2) Construction of new intake and raw water transmission system costs and takes time
3) Additional O&M cost is necessary

ii. Development of Ingiriya Reservoir for supplement to Kalu River

Advantage: Great potential for provision for future water supply not only for KGWSS but Kalatuwawa and Weliwita systems

Dis-advantage:
1) Detailed water resource survey is necessary
2) Construction of new water supply system such as dam, intake, raw water transmission system, WTP, transmission system and distribution system costs and takes time.

iii. Construction of salinity barrier at downstream of existing intake of Kethhena WTP for solving issues on extraction of raw water for existing Kethhena WTP and reducing required maintenance flow of Kalu River.

Advantage:
1) Possibility of unnecessary of construction of optional intake at Kaduyala as proposed in above option i.
2) Existing issue on extraction of water for Kethhena WTP will also be solved

Dis-advantage: 1) Detailed water resource survey is necessary

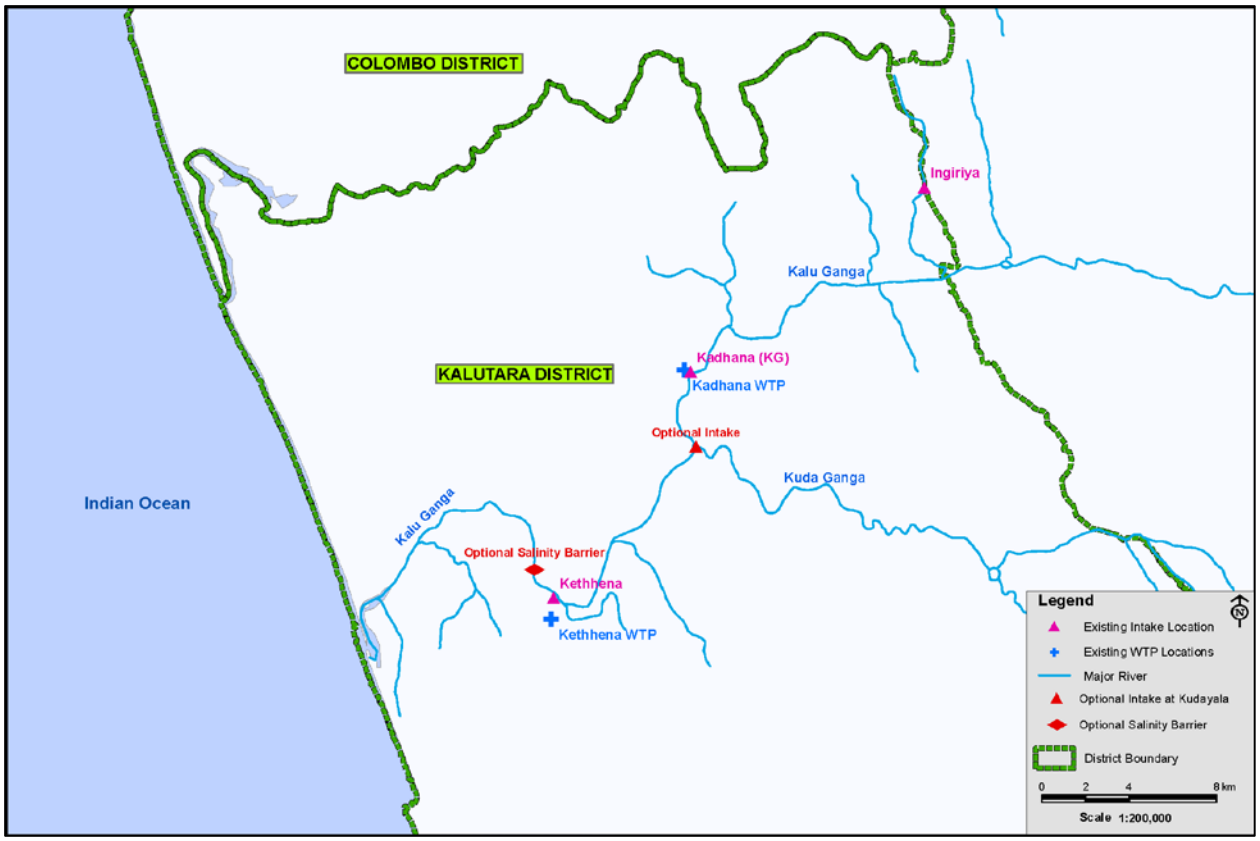


Figure 4.4.1: Kalu and Kuda Rivers, Existing and Alternative Locations of Intakes and Planned Salinity Barrier

Source: JICA Survey Team

Table 4.4.1: Estimated Demand Gap in Kalu River at Kandana

Item	Description			Year						
				2012	2015	2020	2025	2030	2035	2040
DEMAND										
1 (a)	Demand for Kandana WTP at Kandana		MLD	77	148	237	282	331	353	437
1 (b)			m^3/s	0.89	1.71	2.74	3.26	3.83	4.09	5.06
2	Demand for environmental flow at Kandana (11*8.35/23.42)		m^3/s	3.92	3.92	3.92	3.92	3.92	3.92	3.92
3	**TOTAL DEMAND**		m^3/s	**4.81**	**5.63**	**6.66**	**7.18**	**7.75**	**8.01**	**8.98**
LOW FLOWS WITHOUT EXTRACTIONS										
4 (a)	Estimated Natural Low Flow at Kandana (Daily Minimum)	2ARI	m^3/s	17.38	17.38	16.71	16.71	16.58	16.58	16.58
4 (b)		5ARI	m^3/s	11.18	11.18	10.51	10.51	10.38	10.38	10.38
4 (c)		10ARI	m^3/s	8.35	8.35	7.68	7.68	7.55	7.55	7.55
4 (d)		20ARI	m^3/s	6.31	6.31	5.64	5.64	5.51	5.51	5.51
4 (e)		30ARI	m^3/s	5.37	5.37	4.70	4.70	4.57	4.57	4.57
4 (f)		50ARI	m^3/s	4.39	4.39	3.72	3.72	3.59	3.59	3.59
DEMAND GAP (FLOW DEFICITS)										
5 (a)	Demand Gap or Flow Deficit (for low flows with various return periods)	2ARI	m^3/s	**12.57**	**11.75**	**10.04**	**9.52**	**8.83**	**8.57**	**7.60**
5 (b)		5ARI	m^3/s	**6.37**	**5.55**	**3.84**	**3.32**	**2.63**	**2.37**	**1.40**
5 (c)		10ARI	m^3/s	**3.54**	**2.72**	**1.01**	**0.49**	**-0.20**	**-0.46**	**-1.43**
5 (d)		20ARI	m^3/s	**1.50**	**0.68**	**-1.03**	**-1.55**	**-2.24**	**-2.50**	**-3.47**
5 (e)		30ARI	m^3/s	**0.56**	**-0.26**	**-1.97**	**-2.49**	**-3.18**	**-3.44**	**-4.41**
5 (f)		50ARI	m^3/s	**-0.42**	**-1.24**	**-2.95**	**-3.47**	**-4.16**	**-4.42**	**-5.39**

Note: ARI – Average Recurrence Interval
Source: JICA Survey Team

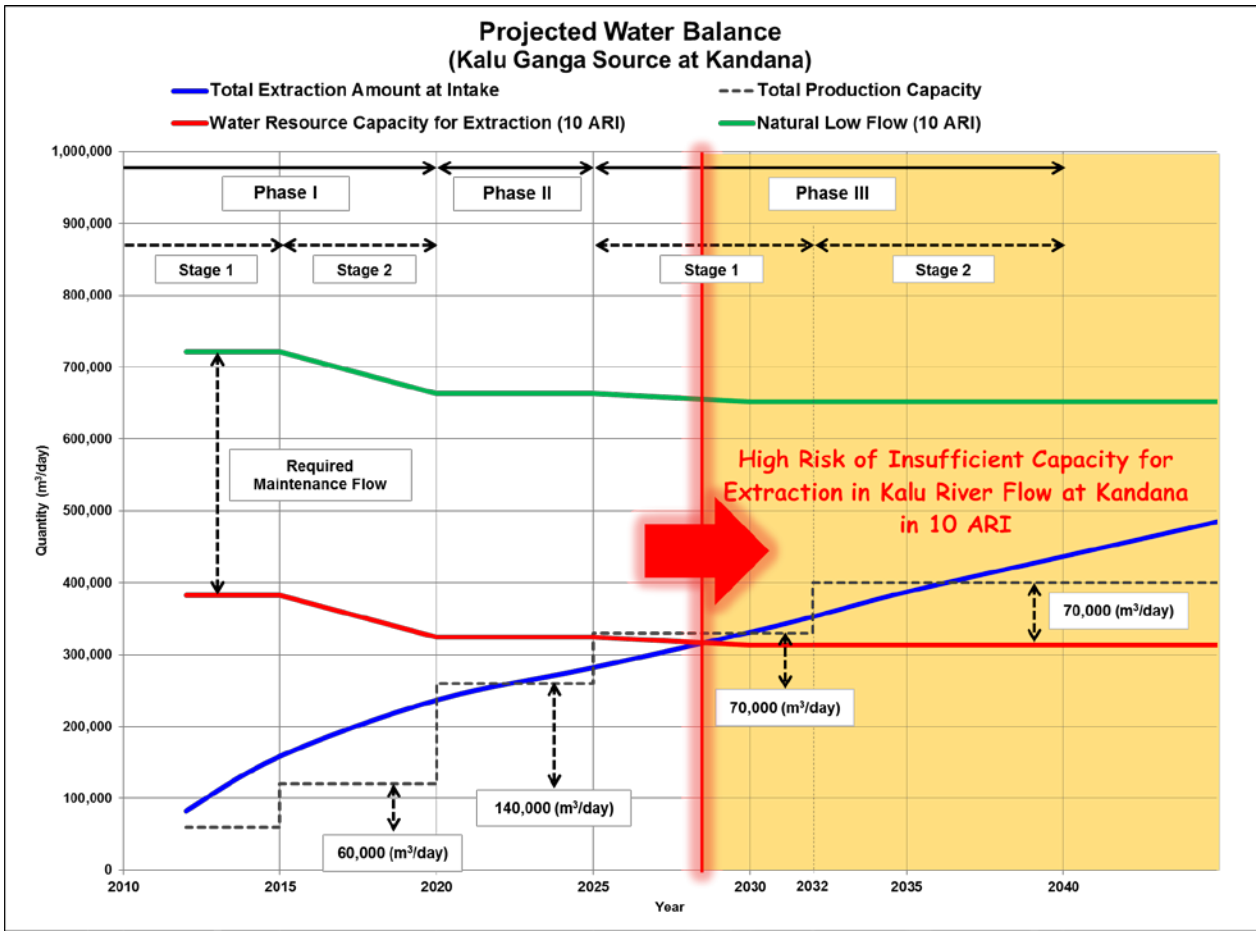


Figure 4.4.2: Water Balance Reviewed in this Survey
Source: JICA Survey Team

CHAPTER 5 FACILITY PLAN

5.1 Kalu Ganga Water Supply System Phase II

5.1.1 Summary of the Proposed Project Component

The summary of project components and facilities for the Kalu Ganga Water Supply System Phase II are shown in **Figure 5.1.1**.

- ✓ Expansion of existing Kandana WTP (60,000 m^3 constructed under Phase I Stage 1) and expanded facilities under construction (60,000 m^3) with a production capacity of 12,000 m^3/day by additional production capacity of 140,000 m^3/day. It is noted that the capacity of intake to be constructed in Phase II is proposed to be 294,000 m^3/day, including required capacity for the Phase II.(Lot-1)
- ✓ Construction of new Kesbewa ground reservoir with a capacity of 18,500 m^3 (Lot-3)
- ✓ Construction of new Delkada ground reservoir with a capacity of 10,000 m^3 (Lot-3)
- ✓ Construction of new Bandaragama ground reservoir with a capacity of 20,000 m^3 (Lot-3)
- ✓ Construction of new Keselwatta ground reservoir with a capacity of 4,000 m^3 at existing Keselwatta Tower site (Lot-3)
- ✓ Expansion of existing Moratuwa ground reservoir (4,600 m^3) by 20,000 m^3 (Lot-3)
- ✓ Installation of inlet flow and pressure chamber with SCADA instruments at existing Panadura (G7) ground reservoir (Lot-3)
- ✓ Construction of transmission pipe of DI 1200 mm from Kandana WTP to Horana with a length of approximately 6 km (Lot-2)
- ✓ Construction of transmission pipe of DI 1200 mm from Kandana WTP to new Bandaragama Ground Reservoir with a length of approximately 19 km (Lot-2)
- ✓ Construction of transmission pipe of DI 400 mm from Keselwatta to existing / new Moratuwa ground reservoirs with a length of approximately 3 km (Lot-2)
- ✓ Construction of distribution feeder mains with a total length of approximately 135 km and creation of 60 district metered areas (11 district metered areas in Moratuwa are included in the project of NRW reduction in Dehiwala and Moratuwa) (Lot-5 and 8)
- ✓ Construction of distribution system by installation of new pipes and re-arrangement of existing system with a total length of approximately 1,528 km (in 60 DMAs excluding Moratuwa Area) (Lot-6 and 7)
- ✓ Construction of service pipes for the new connections with a total number of 78,000 connections (in 60 DMAs excluding Moratuwa Area) (Lot-9)
- ✓ Installation of Transmission / Distribution Pumps at WTP and Reservoirs (Lot-4)
- ✓ Emergency supply arrangement branching from existing DI800 transmission at Piliyandala junction to existing DI500 distribution main from Maharagama ground reservoir (Lot-2)
- ✓ Procurement of equipment for O&M (Lot-10)

The definitions of the pipes are described below.

- Distribution feeder main is the pipe to metered point of each DMA from WTP / Ground Reservoirs (Dia. 225 – 1200 mm)
- Secondary main is the pipe for the distribution to the demand centers from metered point from each DMA (Dia.110 – 500 mm)
- Tertiary main is the pipe (HDPE 63 mm) along the road / array / pass in front of customer properties

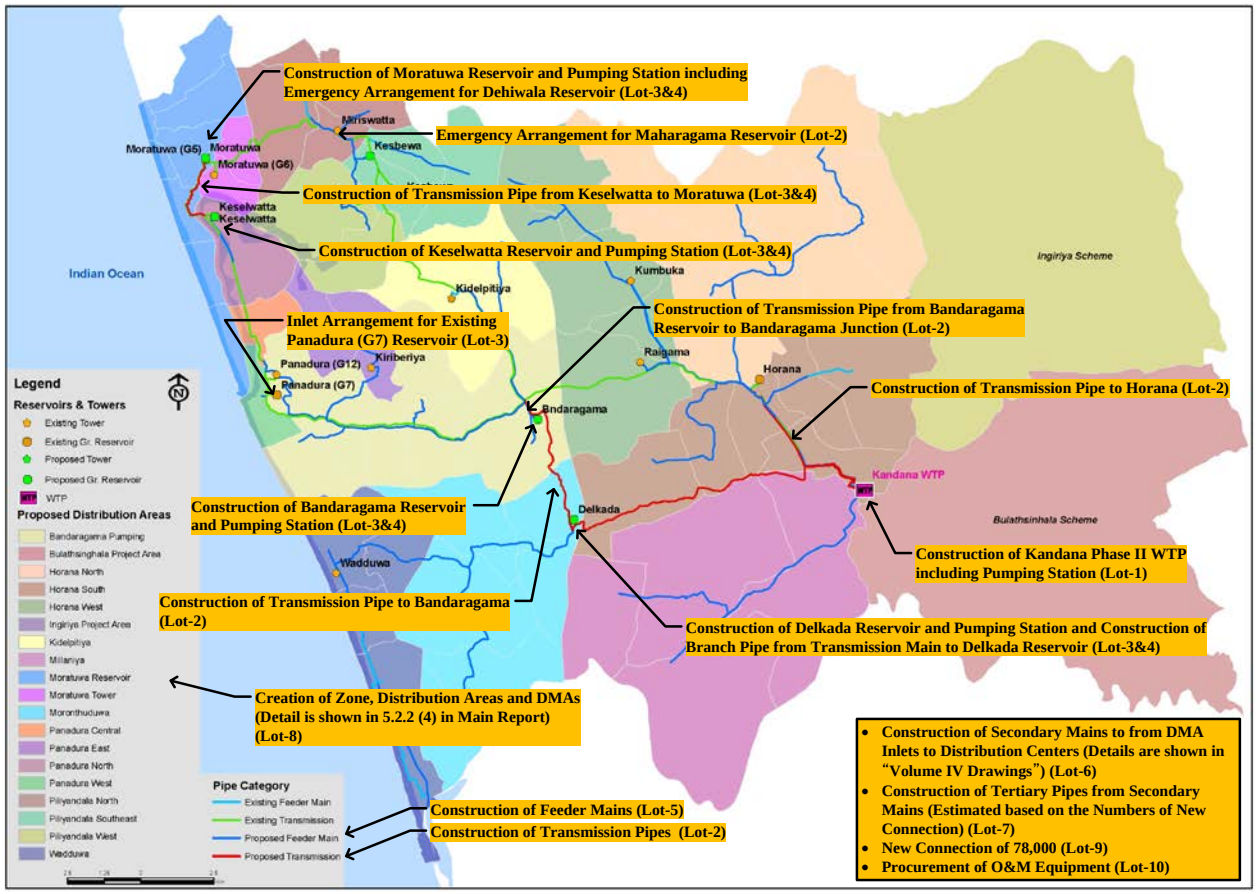


Figure 5.1.1: Summary of Project Component of the Project of KGWSSII
Source: JICA Survey Team

5.1.2 Headworks

(1) General

Proposed expansion of Kandana WTP is summarized as shown in **Table 5.1.1**.

Table 5.1.1: Proposed Staged Development of the Intake and WTP

Facility	Phase I		Phase II	Phase III	
	Stage 1	Stage 2		Stage 1	Stage 2
	Existing	2020	2025	2032	2040
Intake and Raw Water Transmission System	126,000	-	**294,000**	-	-
Water Treatment Plant	60,000	60,000	**140,000**	70,000	70,000
Total Capacity of Intake and RWTS	126,000	126,000	**420,000**	420,000	420,000
Total Capacity of WTP	60,000	120,000	**260,,000**	330,000	400,000

Source: KGFSII

The ground level of the land for the new WTP for Phase II and III proposed in MPU/2013 is lower than flooding level. In addition many resettlements will be required. After site visit and discussion with NWSDB, the proposed land for the expansion of WTP for the Phase II and Phase III (6.15 ha) is changed to the empty space of the existing Kandana WTP and the adjacent land which is required to be acquired (maximum required area to be acquired is approximately 1.30 ha).

The location and boundary of the land provided in the existing Kandana WTP are shown in **Figure 5.1.2**.

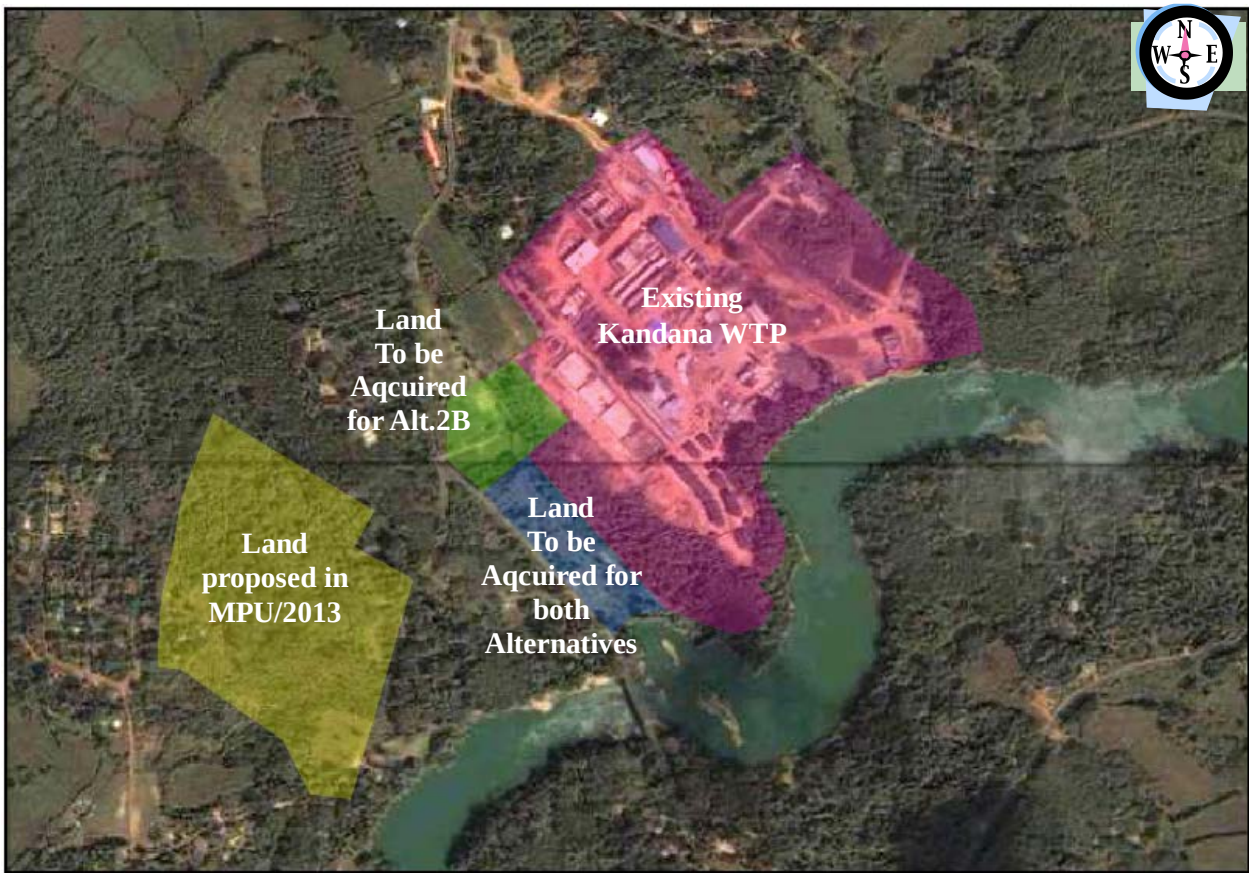


Figure 5.1.2: Location and Boundary of Proposed Kandana Phase II WTP
Source: JICA Survey Team

(2) Intake and Raw Water Transmission System

Existing intake facility and raw water conveyance pipe are located in the existing Kandana WTP.

NWSDB has proposed to construct intake with a capacity of 294,000 m^3/day for both Phase II and III at once considering the difficulty in construction at river and environmental impact to the Kalu River. When two intakes are constructed, difficulty and negative environmental impact will become almost double. The raw water shall convey to the proposed receiving well / distribution chamber by pumping through two raw water transmission pipes.

(3) Selection of Treatment Method

The treatment method shown in **Figure 5.1.3** is proposed be employed. This treatment method is basically the same treatment method employed in existing Phase I facilities which have not been in water quality and O&M, and it is a very common treatment method for the surface water treatment in Sri Lanka.

The summary of proposed method is shown in **Figure 5.1.3**.

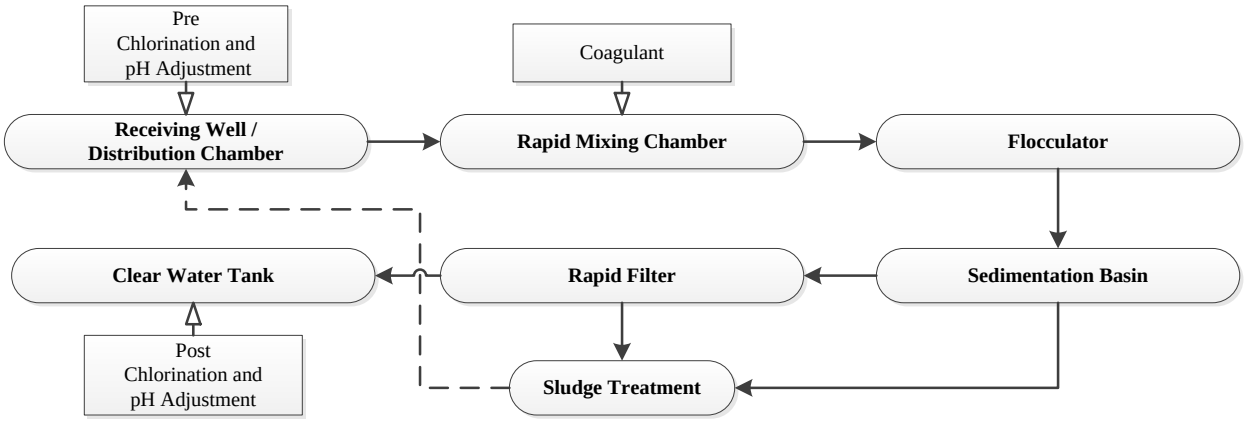


Figure 5.1.3: Proposed Treatment Method
Source: JICA Survey Team

(4) Proposed Process WTP Facilities and Equipment

Major process facilities are set out next to on-going major process facilities as shown in **Figure 5.1.4**. And the sizes of major process facilities are shown in **Table 5.1.2**.

Table 5.1.2: Comparison of Process Facilities

Facility	Existing / On-going Phase I	Proposed Phase II
	120,000 m^3/day – 2 Streams	**140,000 m^3/day – 2 Streams**
Receiving Well	5.0^W x 6.4^L x 4.5^H x 1	**3.0^W x 6.4^L x 4.5^H x 2**
Rapid Mixing Well	Hydraulic Mixing 2.0^W x 2.5^L x 3.86^H x 6	**Hydraulic Mixing** **2.0^W x 2.5^L x 3.86^H x 6**
Flocculator	Vertical Baffled Channel (3 unit per stream) 1.1^W x 10.0^L x 3.60^H x 2 1.5^W x 10.0^L x 3.65^H x 2 1.9^W x 10.0^L x 3.70^H x 2 Spacing of Baffle Wall: 1.34m	**Vertical Baffled Channel** **(3 unit per stream)** **1.1^W x 12.0^L x 3.60^H x 2** **1.4^W x 12.0^L x 3.65^H x 2** **1.8^W x 12.0^L x 3.70^H x 2** **Spacing of Baffle Walls:** **1.00m**
Sedimentation Basin	10.0^W x 50.0^L x 4.0^H x 6	**12.0^W x 45.0^L x 4.0^H x 6**
Filter	3.6^W x 10.8^L x 16	**4.6^W x 10.0^L x 16**
Backwash Water Recovery Tank	5.0^W x 10.0^L x 2.0^H x 2	**7.0^W x 16.5^L x 2.0^H x 2**
Clear Water Res.	16.0^W x 20.0^L x 5.0^H x 4	**22.0^W x 29.0^L x 5.0^H x 4 (with Distribution Capacity)**
Sludge Treatment	Design Turbidity: 20 NTU Sludge Thickener: φ15.0 x 2.5^H x 2 Mechanical Dewatering x 1 (Plan) Sludge Lagoon: 25.0^W x 30.0^L x 3.0^H x 4	**Design Turbidity: 40 NTU** **Sludge Balancing Tank: φ12.5 x 4.0^H x 2** **Sludge Thickener: φ20.0 x 3.5^H x 2** **Mechanical Dewatering x 2** **Drying Bed: 25.0^W x 30.5^L x 1.0^H x 24**

Source: JICA Survey Team

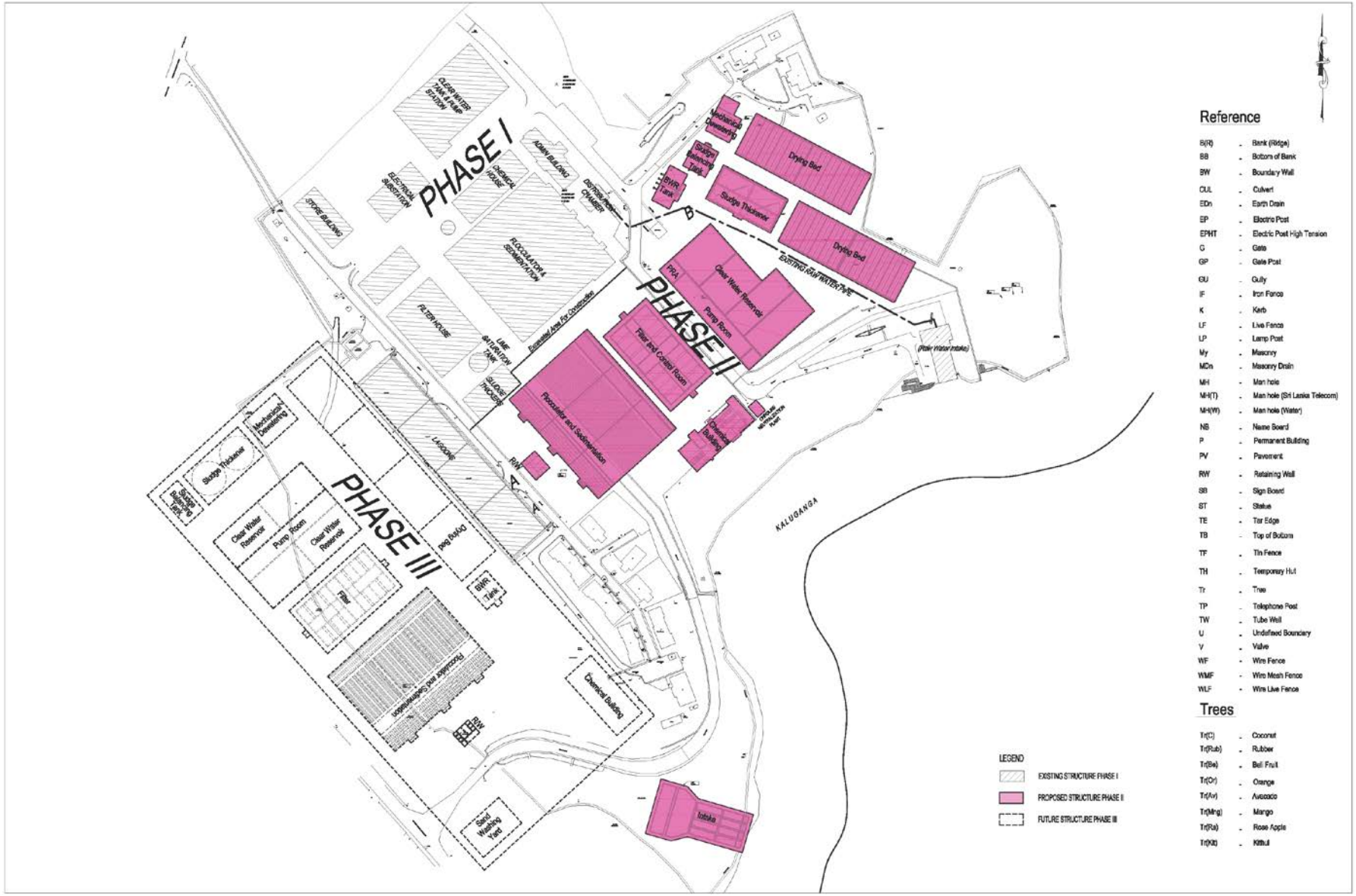


Figure 5.1.4: Proposed Layout of Process Facilities
Source: JICA Survey Team

5.1.3 Transmission and Distribution System

The proposed transmission system is in **Figure 5.1.5** and **Figure 5.1.6**.

(1) Storages

The proposed storage capacities are shown in **Table 5.1.3**. Six ground reservoirs are required to be constructed in Phase II and land acquisitions are necessary for four reservoirs, other than the existing Moratuwa ground reservoir and clear water reservoir of Kandana Phase II WTP. The proposed transmission pipes are shown in **Table 5.1.4**. The proposed distribution feeder mains for the creation of 60 DMAs are shown in **Table 5.1.5**.

Table 5.1.3: Proposed Storage Capacity

Storage		Capacity (m^3)			
		Existing	Phase II for 2025	Phase III for 2040	Total
Kandana Phase II CWR	New	-	12,000	16,000	28,000
Delkada GR	New	-	10,000	5,000	15,000
Bandaragama GR	New	-	20,000	13,000	33,000
Keselwatta GR	New	-	4,000	0	4,000
Kesbewa GR	New	-	18,500	0	18,500
Moratuwa GR	Expansion	4,600	20,000	0	24,600
Total		**4,600**	**84,500**	**34,000**	**123,100**

Source: JICA Survey Team

The PC tanks are recommended for the proposed new Kesbewa and Moratuwa reservoirs because of limitation of the lands. And PC tanks are proposed for the proposed Delkada reservoir to utilize residual head in the transmission system for the energy saving in the distribution.

The types of pumps are selected by the purpose of pumping to try to minimize energy in operation. The proposed transmission and distribution pumps are shown in **Table 5.1.6**.

Table 5.1.4: Proposed Transmission Mains

Project Phase	Pipe Material	Nominal Pipe Diameter (mm)	Pipe Length (m)
Existing	CI	600	1,020
	DI	400	3,690
		800	25,220
		1000	17,300
		1200	8,340
	Sub-Total		**55,570**
Phase II for 2025	DI	400	3,050
		800	970
		1,200	23,520
	Sub-Total		**27,540**
Phase III for 2040	DI	1,000	11,440
	Sub-Total		**11,440**
Total			**94,550**

Source: JICA Survey Team

Table 5.1.5: Proposed Distribution Feeder Mains

Pipe Material	Nominal Pipe Diameter (mm)	Pipe Length (m)	Pipe Material	Nominal Pipe Diameter (mm)	Pipe Length (m)	Pipe Material	Nominal Pipe Diameter (mm)	Pipe Length (m)
DI	400	24,166	DI	800	12,320	HDPE	280	7,340
DI	500	33,930	DI	900	545	HDPE	315	4,464
DI	600	15,087	DI	1000	2,683	HDPE	400	19,271
DI	700	11,146	DI	1200	3,327			
							Total	**134,279**

Source: JICA Survey Team

In addition, total of approximately 1,528 km of distribution systems in DMA and service pipes for approximately 78,000 connections were estimated (for 60 DMA excluding Moratuwa Area, which is proposed to be implemented under the project of "NRW Reduction in Dehiwala and Moratuwa")

Table 5.1.6: Proposed Transmission and Distribution Pumps

Location	Pump Outline	Number of Unit (Stand-by)	Type of Pump
Proposed Kandana Phase II WTP	1) Transmission Pump to New Kesbewa Gr. Res. Horizontal, centrifugal volute 32.4 m^3/min x 51 m x 375 kW	3 (1)	Variable speed
	2) Transmission Pump to New Delkada Gr. Res. and New Bandaragama Gr. Res. Horizontal centrifugal volute 40.4 m^3/min x 33 m x 300 kW	3 (1)	Variable speed
	3) Distribution Pump to Horana South Area Horizontal, centrifugal volute 12.7 m^3/min x 39 m x 120 kW	2 (1)	Variable speed
	4) Distribution Pump to Millaniya Area Horizontal, centrifugal volute 6.2 m^3/min x 38 m x 60 kW	2 (1)	Variable speed
Proposed Bandaragama Gr. Res.	1) Transmission Pump from New Bandaragama Gr. Res. to Ex. Panadura (G7) Gr. Res. and New Keselwatta Gr. Res. and New. Moratuwa Gr. Res. Horizontal, centrifugal volute 11 m^3/min x 35 m x 90 kW	3 (1)	Fixed speed
	2) Distribution Pump from New Bandaragama Gr. Res. to Panadura East, Panadura Central, Bandaragama and Kidelpitiya Areas Horizontal, centrifugal volute 28.3 m^3/min x 34 m x 220 kW	3 (1)	Variable speed
Proposed Keselwatta Gr. Res.	1) Transmission Pump from New Keselwatta Gr. Res. to Ex. Keselwatta Tower Horizontal, centrifugal volute 16.4 m^3/min x 38 m x 150 kW	2 (1)	Fixed speed
Ex. Moratuwa Gr. Res. Site	1) Transmission Pump from Ex. Moratuwa Gr. Res. to Ex. Moratuwa Tower Horizontal, centrifugal volute 12.3 m^3/min x 45 m x 130 kW	2 (1)	Fixed speed
	2) Distribution Pump from New Moratuwa Gr. Res. to Moratuwa Distribution Horizontal, centrifugal volute 26.1 m^3/min x 19 m x 115 kW	3 (1)	Variable speed
	3) Emergency Pump from New Moratuwa Gr. Res. to Ex. Dehiwala Gr. Res. with Distribution Horizontal, centrifugal volute 28.5 m^3/min x 45 m x 290 kW	2	Fixed speed
Proposed Kesbewa Gr. Res	1) Transmission Pump from Kesbewa Gr. Res. to Moratuwa Gr. Res. Horizontal, centrifugal volute 17.4 m^3/min x 23 m x 95 kW	3 (1)	Fixed speed
	2) Distribution Pump from New Kesbewa Gr. Res. to Piliyandala North Area Horizontal, centrifugal volute 17.2 m^3/min x 33 m x 135 kW	3 (1)	Variable speed
	3) Distribution Pump from New Kesbewa Gr. Res. to Piliyandala Southeast Area Horizontal, centrifugal volute 10.5 m^3/min x 33 m x 85 kW	2 (1)	Variable speed
Proposed Delkada Gr. Res.	1) Distribution Pump from New Delkada Gr. Res. to Moronthuduwa Distribution Area Horizontal, centrifugal volute 12.9 m^3/min x 48 m x 145 kW	2 (1)	Variable speed
	2) Distribution Pump from New Delkada Gr. Res. to Wadduwa distribution Area Horizontal, centrifugal volute 18.5 m^3/min x 31 m x 135 kW	2 (1)	Variable speed

Source: JICA Survey Team

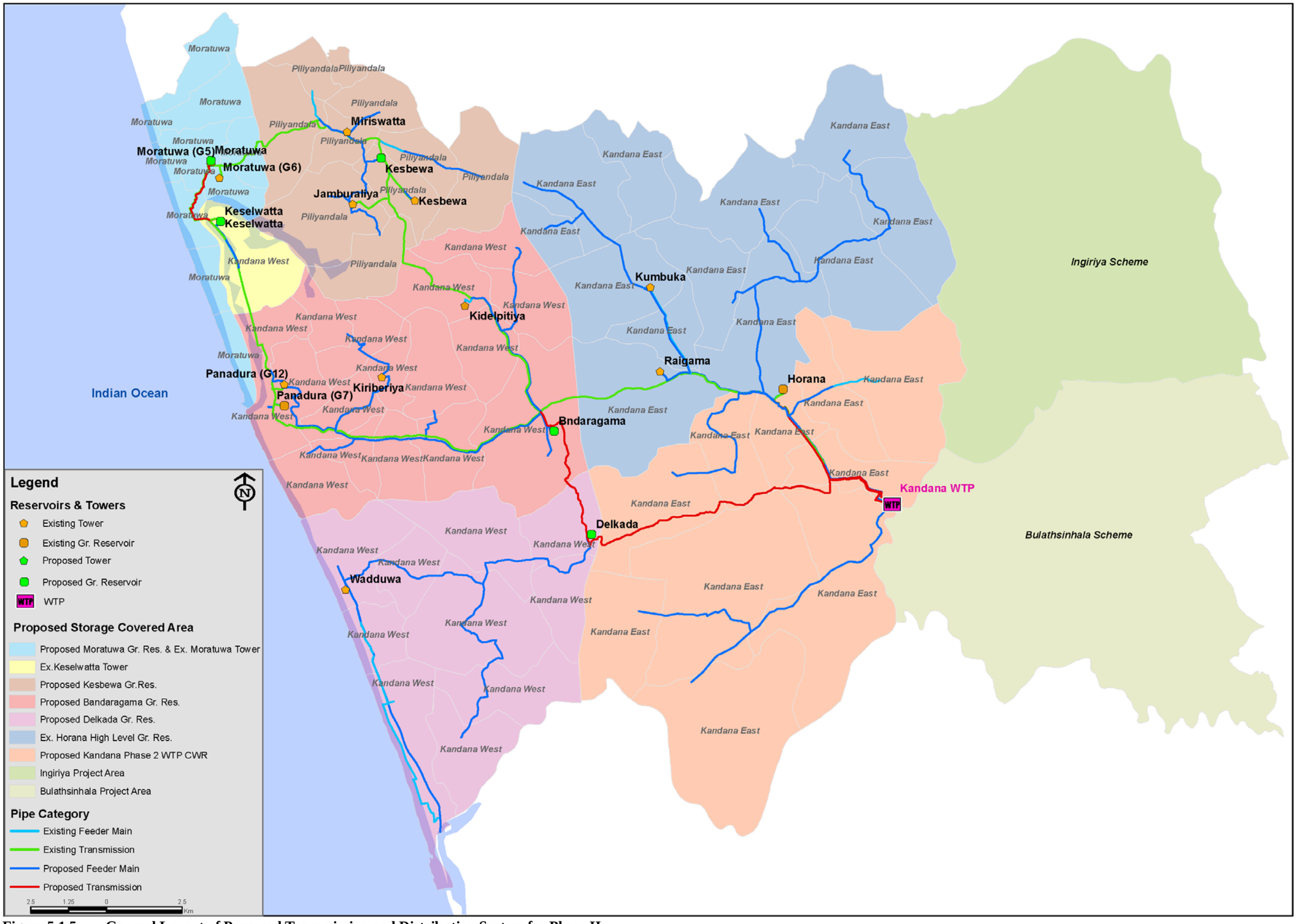


Figure 5.1.5: General Layout of Proposed Transmission and Distribution System for Phase II
Source: JICA Survey Team

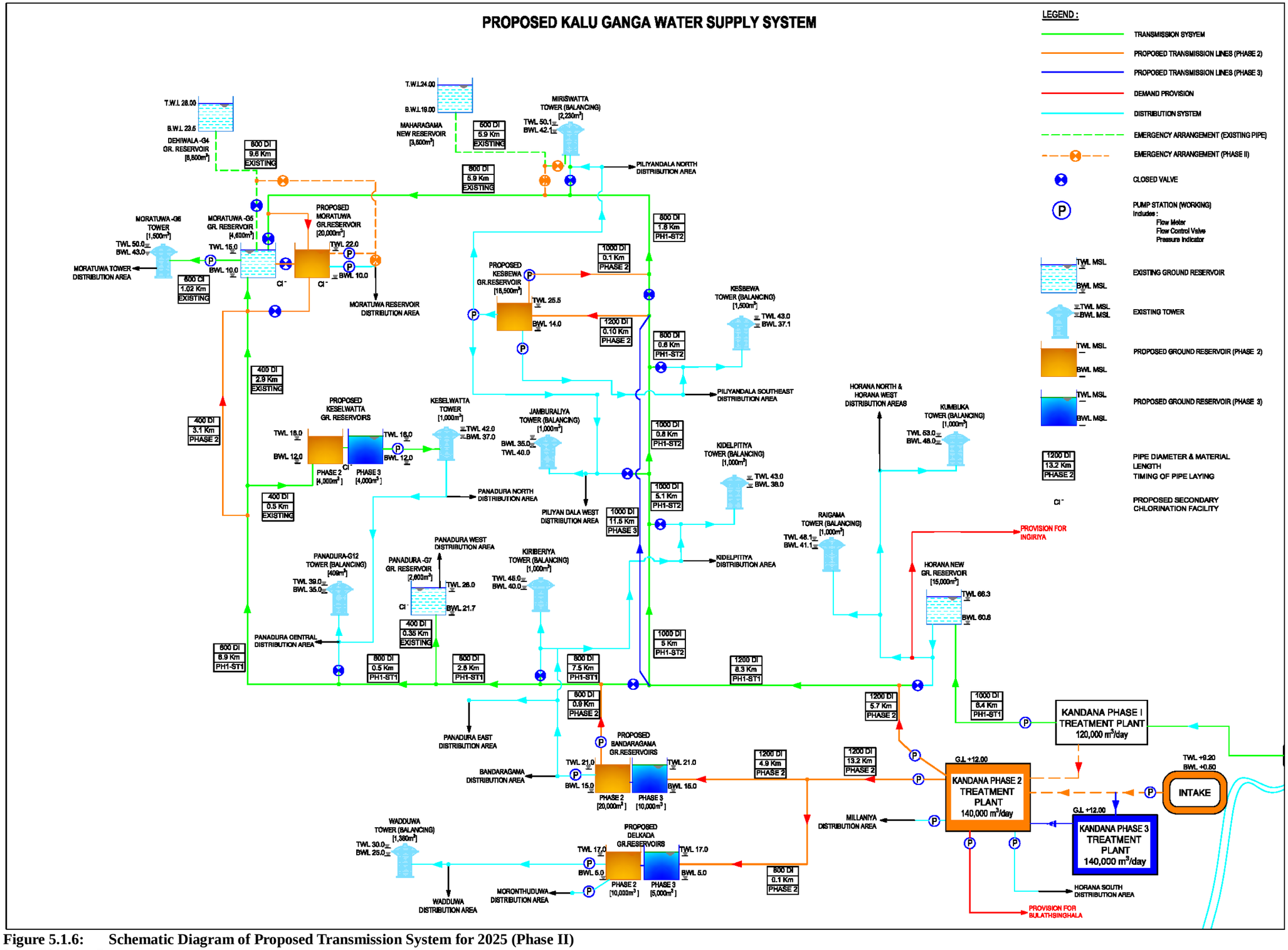


Figure 5.1.6: Schematic Diagram of Proposed Transmission System for 2025 (Phase II)
Source: JICA Survey Team

5.2 NRW Activities in Dehiwala and Moratuwa

5.2.1 On-going Projects by ADB

(1) Information Obtained by ADB Project in/around Colombo

Currently, NWSDB is conducting several projects under the assistance of ADB in/around Colombo area, including "Capacity Development for Non-Revenue Water Reduction" and "Greater Colombo Water and Wastewater Management Improvement Investment Program (GCWWMIIP)". The GCWWMIIP is divided into two projects, namely the "Tranche 1" and the "Tranche 2". The Tranche 1 covers northern part and the Tranche 2 covers southern part of Colombo city. In addition, ADB has released its announcement on "Institutional Development of National Water Supply and Drainage Board", which is a technical assistance (TA) project including activities regarding reinforcement of institutional structure and implementation of trainings in December 2014.

(2) Confirmation of Overlapping between the Project and ADB's Assistance

According to the NWSDB's project director (PD) of the GCWWMIIP, there are some transmission lines, which are supplying Dehiwala area and covered by the GCWWMIIP. However, the ADB's projects does not cover the distribution lines therefore there is no overlapping between the ADB projects in/around Colombo city and the Project, in principle.

5.2.2 Possibility of Providing Assistance in Operational Aspects

(1) Current Activities for NRW Reduction by RSC (WC) and RSC (WS)

According to the interview with RSC (WC) and RSC (WS), current activities for NRW reduction are summarized as follows:

- Leak repair: to be attended on reported or detected cases.
  - Nighttime leakage survey to identify visible leakage while system pressure increases:
  - Conducted under planned program.
  - Conducted by working teams called "gangs" that are in charge of field works including patrol survey, leak repair and plumbing work. All members are permanent NWSDB staff.
  - For example, there are 9 gangs in Dehiwala (approximately 20 km^2). Patrol plan is so programed as to be completed entire Dehiwala area in one month.
- Only one set of leak detection equipment (including listening stick and electronic leak detector) for underground leakage survey are available in RSC (WS)
- Involvement/assistance by NRW Section of RSC (WC):
  - Mounting ultrasonic flow meter and monitor flow rate
  - Identifying unknown pipes or valves
  - Any leak detection or repair works, which cannot be addressed by RSC (WS)

As mentioned above, RSC (WS) is now actively addressing to the leak detection and repair works. However, due to lack of leak detection equipment, majority of leak detection work is for visible leakage and underground leakage detection work is limited. With the assistance of leak detection equipment and advisory by experts, capacity development program regarding NRW reduction that focuses on O&M of DMA and NRW reduction activities including leak detection and repair, it is expected that considerable volume of NRW may be reduced.

(2) Possible Assistance in Operational Aspects other than Physical Works

General

In order to facilitate and maximize the Project's effect, technical assistance program for O&M can be an option. This type of program may be conducted either as a part of construction supervision (e.g., so-called

"soft component" program under the possible loan project during implementation stage) or independent program (e.g., dispatch of individual experts, and/or capacity development project with inputting experts, necessary equipment and overseas/regional training tour).

Soft Component Program

Regarding the "soft component" program during the design stage, NWSDB expects technical transfer on hydraulic analysis using GIS database and feeding back result of hydraulic analysis to the design. These issues may be done through joint work between consultant engineers and relevant C/P staff of NWSDB in the course of design work. Therefore, it may not be necessary to input particular person-month for these items.

Dispatch of Individual Experts

As discussed in the "Chapter 8 Project Cost and Implementation Schedule", physical works for NRW reduction for 2 DMAs out of total 19 DMAs in Dehiwala and Moratuwa may be implemented under the "Term 1", and the physical works for remaining 17 DMAs may be implemented under "Term 2". In addition, NWSDB's new training center is planned under the Tranche 2 of GCWWMIIP. In order to maximize the effects of the above-mentioned works and assistances, dispatch of individual experts may be a good option to follow-up especially for following issues:

- NRW monitoring and evaluation (one expert):
  - Duty: assistance for NRW monitoring before & after construction in 2 DMAs that are to be implemented under the Term 1 of the Project
  - Possible resource: Consulting engineer
  - Assignment: 1.5 to 2.0 month x 2 times per year, from the middle of 2018 (before commencement of Term 1) up to the middle of 2021 (after completion of Term 1).
- Asset management (one expert):
  - Duty: Assistance for GIS database update including:
    - ✓ collection, organizing and effective use of the existing data obtained through the above-mentioned activities in Term 1, and
    - ✓ feedback the experiences & lessons to the design works & tender documents for Term 2 Project
  - Possible resource: Japanese public water supply utility officer
  - Assignment: 0.5 to 0.8 month x 2 times per year, from the middle of 2018 (before commencement of Term 1) up to the middle of 2021 (after completion of Term 1)
- Training programs (one to two experts):
  - Duty: Assistance for preparation and implementation of training program and trainer's training
  - Possible resource: Japanese public water supply utility officer
  - Assignment: 0.5 to 0.8 month x 2 times per year, from the first quarter of 2017 up to the middle of 2021 (after completion of Term 1).

Capacity Development Project

Regarding technical assistance through capacity development project, JST and the relevant staff of NWSDB made a series of discussions to draft up a framework of possible technical cooperation project, in consideration of various issues and aspects including current and future proposed organization setup, O&M activities being done at present, difficulties they are facing to currently, how the Japanese technologies and/or Japanese public water provider's know-how can be applied to, and others. Following are the outline of the proposed capacity development project.

- Purpose: Further improvement of NRW reduction through capacity development project on O&M, in order to maximize the physical work to be done by the Project.
- Required time frame: 3.5 year
- Target Group: RSC (WS)

Following **Table 5.2.1** shows activities to be done under the proposed capacity development, contents of each activity, and relevant key staffs of NWSDB who take major role in each activity.

Table 5.2.1: Proposed Framework of Possible Capacity Development Program

Activity	Description of activities	Key staff in RSC (WS)
Database creation	• Database creation for facility (pipelines, valves, etc.). • Database creation for customer data in a designated DMA. • Database creation for NRW-related data (detected/attended leakages, illegal connections, free-water use). • Feedback created database to the relevant staff through Engineer (NRW).	• CE (P&D) • Engineer NRW • System Administrator
Monitoring & evaluation of DMA activities	• Monitoring of System input volume & NRW values in each DMA. • Trial monitoring by SCADA that is to be installed under the Project in some DMAs in Dehiwala and Moratuwa Area. • Identifying prioritized DMA to be attended urgently based on magnitude of NRW. • Summarizing result of monitored data, presenting result of evaluation and proposing improvement plan to concerned staff in NWSDB. • Motivation improvement plan for OICs/ZOs	• Engineer (NRW) under Manager (Dehiwala & Moratuwa):
DMA activities against leakages and illegal connections	• Preparation of field work (including valve condition survey, customer survey, identification of free-water use and meter condition survey) for NRW reduction activities in DMA. • Conducting necessary site work (including valve condition survey, flow measurement, leak detection and detection of illegal connection) • Quick attendance for detected/reported leakages and illegal connections. • Improvement of construction supervision (including leak repair work)	• AEs in Dehiwala & Moratuwa • OICs in Dehiwala & Moratuwa • Related ZOs
DMA activities against meter-related loss and free-water use	• Conducting necessary site work (including measurement of free-water use, customer survey, and meter condition survey) • Activities on meter accuracy improvement (including on-site accuracy test) • Planning of meter replacement work	• AEs in Dehiwala & Moratuwa • OICs in Dehiwala & Moratuwa • Related ZOs
	• Promotion of discipline of meter readers. • Review and improvement of meter reader's role (including how to report leakages and/or illegal cases) • Motivation improvement plan for meter readers. • Pilot project for meter reading improvement with remote handheld reading device.	• AEs in Dehiwala & Moratuwa • Related Meter Readers • COs
Common activities	• Procurement of necessary equipment to be used under the Project • Preparation of program for DMA activities • Overseas training for management level, engineers, ZO, OICs, and skilled assistance. • Proposing appropriate DMA setup and management, including effective utilization of SCADA. • Proposing regular meter replacement plan • Review and recommendation for organization structure. • Internal PR activities within NWSDB • PR activities to water users	• Additional GM (Western) • DGM (WS) • AGM (WS) • Manager (Dehiwala & Moratuwa)

Source: JICA Survey Team

Human resources or facilities available in public water supply utilities in Japan may be considered in order to make full use of their experiences and know-how to the possible capacity development program, especially on the following issues which the Japanese public water utilities are generally doing as their daily routine O&M works:

- Improvement of construction supervision (including leak repair work)
- Database creation and feedback of created database to the relevant staff
- PR activities to the water users
- Program design and hosting NWSDB trainees for training tour in Japan

Regarding technical cooperation, JICA has already conducted "the Capacity Development Project for Non-Revenue Water (NRW) Reduction in Colombo City" from 2009 to 2012. The outline of this technical cooperation project is as follows:

- Target group: NRW Section of RSC (WC)
- Purpose of the project
  - Conduct NRW reduction pilot activities
  - Disseminate the methodologies, outcome, experiences and lessons learned though the NRW reduction pilot activities to the entire area of Colombo City.

On the contrary, the outline of the technical cooperation project that is planned in this Survey is as follows:

- Target group: RSC (WS)
- Purpose of the project: Conduct further NRW reduction through appropriate O&M of DMA and utilization of SCADA, which will be constructed by the Project, based on the experience obtained from the previous technical cooperation project.

The previous technical cooperation was focusing rather on NRW reduction itself. On the contrary, the proposed technical cooperation is focusing rather on general O&M of DMA to maintain lowered NRW by the pipe replacement works, and to seek further reduction of NRW through O&M of DMA and SCADA.

In addition, "Institutional Development of National Water Supply and Drainage Board" that is to be conducted from 2015 to 2018 with the assistance of ADB includes activities for capacity development for strengthening institutional structure and trainings including NRW management, design manual update and trainings for GIS. Accordingly, the proposed capacity development project may incorporate results, experiences and/or lessons delivered by the ADB's TA Project (e.g., GIS database creation and trainings, and design manual for DMA creation, instruction manual for DMA).

Proposed Schedule of the Possible Technical Assistance

Based on the above idea, possible time schedule for dispatch of individual experts and capacity development project is proposed as shown in **Figure 5.2.1**. The proposed schedule is so planned as to ensure close coordination with the physical works of the NRW component (Lot 11). In addition, this schedule is based on the assumption that the Lot 11 would be so implemented as to be divided into two terms (Term 1 and Term 2).

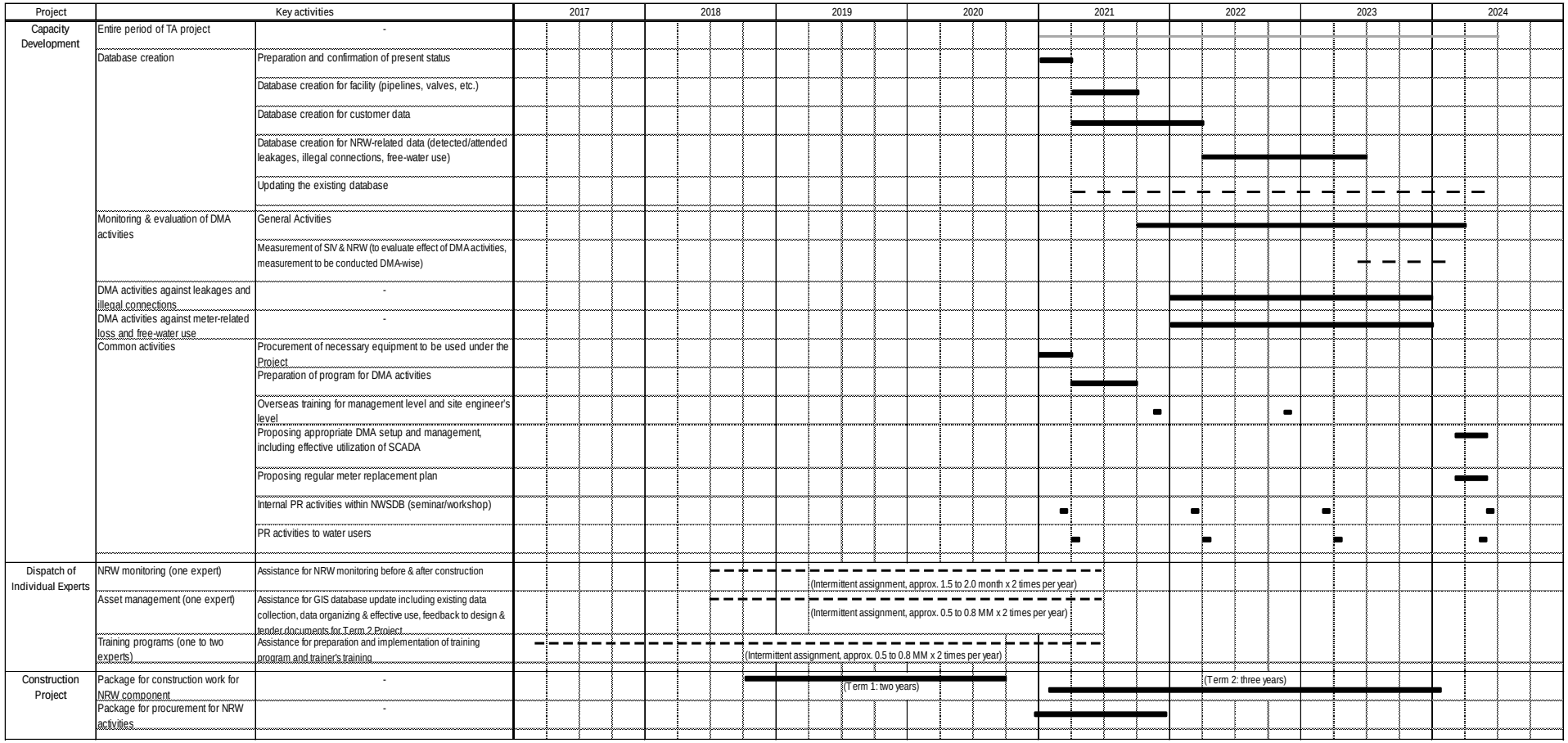


Figure 5.2.1: Proposed Schedule of Possible Capacity Development Program

Source: JICA Survey Team

5.2.3 Necessity of NRW Reduction and Relevant Preceding Studies in Dehiwala and Moratuwa

The Dehiwala and Moratuwa systems are the second and third oldest systems in Sri Lanka. Likewise CMC area, these two systems have been suffering from prolonged high NRW ratio due to such as old deteriorating pipes, lack of valves and lack of proper zoning. NWSDB management level has deemed the reduction of Non-Revenue Water (NRW) in water supply systems, especially in CMC and its surrounding areas including Dehiwala and Moratuwa, a priority due to the operational and financial restraints it places upon the organization. Under this circumstance, "Feasibility Study on Distribution Network Improvement and Water Loss Reduction for Dehiwala and Moratuwa Areas" has been prepared as a part of MPU/2013. At the same time, RSC (WS) prepared "Pre-Feasibility Report on Replacing Old Asbestos Cement and Cast Iron Pipes in Manager (Dehiwala) Area to Provide a Satisfactory Water Supply to Consumers" in August 2013 (hereinafter referred to as "Pre-F/S"). Dehiwala area gets its water from Ambatale system, on the contrary, Moratuwa area is supplied from Kandana system. However both areas are regarded as one project especially for NRW reduction due to its magnitude of the importance in NWSDB's business operation.

5.2.4 Contents of the Proposed Project for NRW Reduction in Dehiwala and Moratuwa

The Project will include replacement and repair of the existing transmission mains and distribution pipes in Dehiwala and Moratuwa areas because of the high priority recognized in the analysis conducted in the MPU/2013 and as planned in the studies including Pre-F/S.

Future transmission and distribution arrangement related to the areas of Dehiwala and Moratuwa is based on the MPU/2013, incorporating several updating done through this Survey including,

- Introduction of Bandaragama and Delkada GRs instead of Bamunumulla and Panadura Hub Reservoirs,
- Introduction of direct pumping distribution zones from Kesbewa GR to Piliyandala Distribution Zone,
- Emergency supply arrangement from Moratuwa GR to existing Dehiwala GR.
- Necessary arrangement to allow emergency supply to one GN that was added into Ratmalana DSD (supplied by KGWSS under normal operation and emergency supply arrangement will be added so that it can get water from Ambatale system as well)

Figure 5.2.2 shows the future transmission and distribution arrangement for the Dehiwala area. Future Transmission and distribution arrangement for the Moratuwa area is available in "**5.1 Kalu Ganga Water Supply System Phase II**".

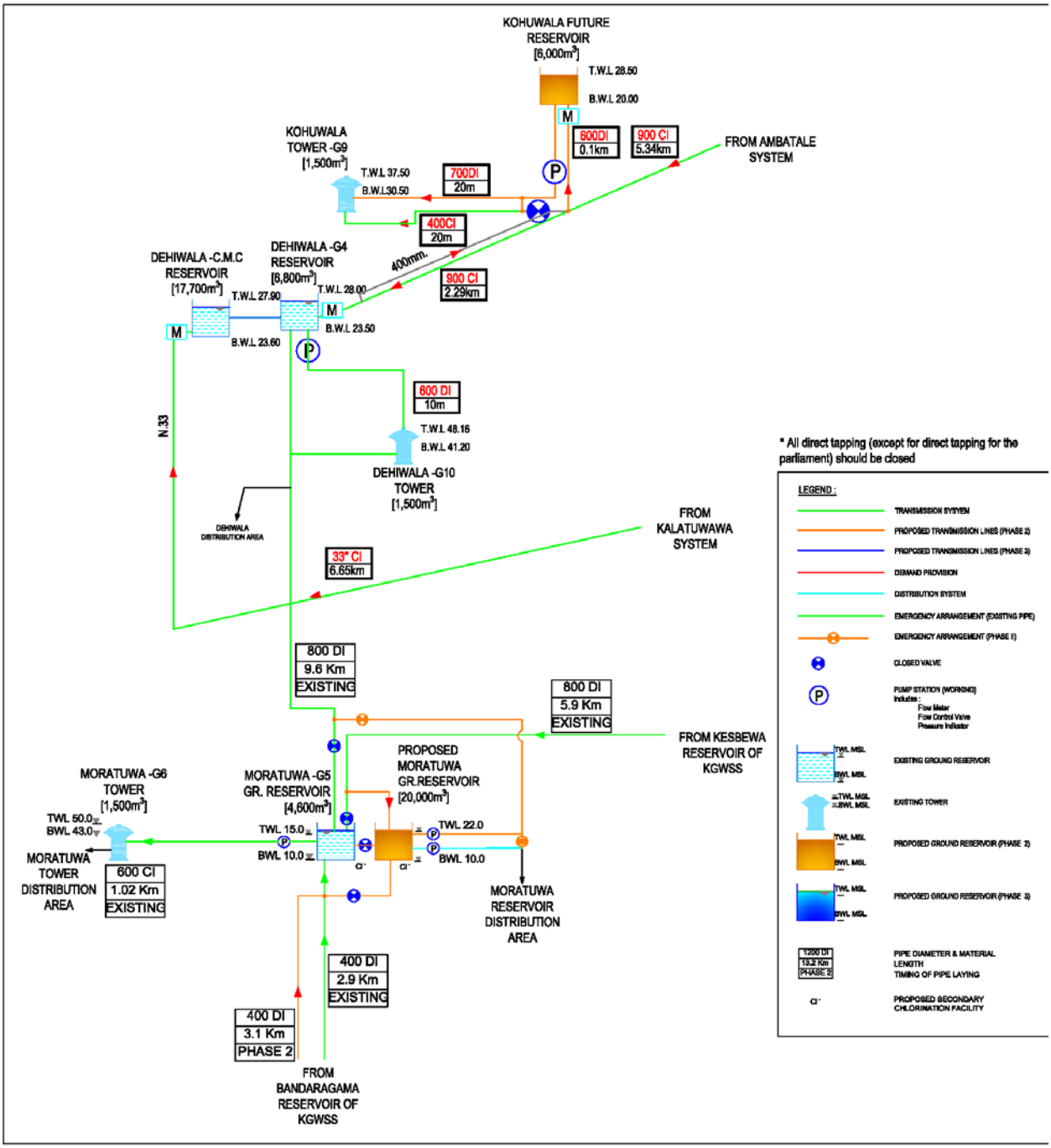


Figure 5.2.2: Future Transmission & Distribution Arrangement for Dehiwala and Moratuwa
Source: JICA Survey Team

The possible component of the NRW reduction in the areas of Dehiwala and Moratuwa proposed in **Table 5.2.2** are considered basically with reference to the those preceding studies, reflecting some additions (e.g., additional requests by NWSDB), omissions (e.g., replacement works that has been done after formulation of MPU/2013), and the above-mentioned updating for the transmission and distribution system.

Table 5.2.2: Summary of the Proposed Project Component

Work item	Contents
Pipe rehabilitation (including valves and fittings)	• Rehabilitation works are summarized as follows: - Replacement: 204.5 km (111.5 km for Dehiwala and 93.0 km for Moratuwa) - Re-lining: 10.9 km (5.6 km for Dehiwala and 5.3 km for Moratuwa) - Removal: 1.8 km (0.3 km for Dehiwala and 1.5 km for Moratuwa) - New installation: 88.8 km (49.7 km for Dehiwala and 39.1 km for Moratuwa) • Cost including fittings and specials, valves, culvert crossings, bridge crossings, valve chambers for replaced/newly installed pipes may be referred the NWSDB's "Rate Book 2014" as this considers those items. • In addition to the above, additional valves and chambers (including necessary fittings) are requested to be included into the cost estimate, namely,: - Section valve: 113 nos. (80 to 600 mm dia.) - Air valve: 25 nos. (25 mm dia.) - Washout valve: 25 nos. (80 mm dia.) - Fire hydrant: 20 nos. (80 mm dia.)
Bulk meter and interconnection valve for DMA creation	• Flexibility/Emergency interconnection valve: 9 nos. (200 to 800 mm) • Bulk meter for DMA boundary: 16 nos. (200 to 800 mm) • Bulk meter for reservoir inlet/outlet 16 nos. (400 to 1,000 mm)
House connection	• House connection transferring due to replacement of pipes: 45,000 connection (25,000 for Dehiwala and 20,000 for Moratuwa)
Reservoir	• Construction of Kohuwala Reservoir: 6,000 m^3, PC circular tank
Institutional development	• Equipment for O&M including leak repair: - Mini Generator - Night light Set - Sludge Pumps - Compactor - Drilling Machine - PE Welding Machine - Tool Kit - Asphalt cutter - Road breaker - Laboratory equipment • Office buildings: - OIC (Dehiwala) Office - fully furnished - Regional Stores (Dehiwala), OIC stores (Dehiwala), workshop (Dehiwala) - OIC (Horana) Office - OIC (Panadura) Office • Vehicles for O&M: - Boom truck - Mini Excavator - Tipper - Fully equipped vehicle (with mini excavator) - Cabs - Crew Cabs • Other equipment for O&M including leak detection: - Leak detector - Metal detector - Telephone System for Dehiwala Office - Fire Hydrant System - CCTV Camera System - Dehiwala Office Generators - Public address system

For scraping & re-lining:

Quantities for scraping and re-lining are estimated with the following manner.

- N NWSDB and JST confirmed that the contents and quantities for re-lining be updated from the ones in MPU/2013.
- NWSDB commented that the large diameter of CI should be left as it is because inner surface of large diameter CI pipes is generally in good condition, and the similar condition prevails for the dia. 400 mm and above according to O&M section, as shown in the following **Photo 5.3.1**.

Photo 5.2.1: Photos for Cut Piece of 800 mm Diameter of Old CI Pipe

- However, opposition/question was raised by JICA official side to include re-lining of old CI pipes into the recipients list of the Yen loan due to the concerns over the several issues (e.g., whether durability can be maintained after scraping such an aged CI pipes, whether the work volume and cost for scraping and re-lining work can be more beneficial than replacing work). Therefore, this issue was further discussed between NWSDB and JST.
- As a result of discussion, it was concluded that scraping and re-lining should be kept as a necessary work item to be done under the Project.
- Therefore, it was agreed, for the estimation purpose, that 400 mm and above diameters shall be counted either of the following categories as specified below.
  - 10% - To be replaced
  - 40% - To be scraped and re-lined
  - 50% - To be left as it
- However, before or initial phase of D/D phase, some samples should be taken from the old CI pipes that are currently considered for re-lining to verify actual condition of inner layer and outer body of the pipe.

Institutional Development

NWSDB requested that equipment for O&M including leak repair, office buildings, vehicles and other equipment for O&M including leak detection be covered by the Project as necessary items for reinforcing NWSDB's O&M after the physical works to be done under the Project. The detail of items and their estimated cost are presented in "**Chapter 10 Capacity of Executing and Implementing Agencies**" of the Main Report.

CHAPTER 6 SOCIAL CONDITION SUIRVEY

6.1 Outlines of the Survey

6.1.1 Survey Area

This survey targeted total 462 GN Divisions from 2 districts, 103 GN Divisions under 5 DS Divisions in Colombo District and 359 GN Divisions under 8 DS Divisions in Kalutara District, which are the same targeted area as the project. 12 GN Divisions were selected as sampling area and the interview survey was conducted.

6.1.2 Survey Items

The questionnaire used in this survey was developed by reviewing other social condition surveys conducted in the Master Plan and other related surveys in the water sector. The structure of the questionnaire consisted of 6 parts as follows;

- Part A; General Information of the respondent
- Part B; General Information of the household
- Part C; Situations of water usage
- Part D; Situation and Evaluation of existing water supply service by users
- Part E; Evaluation of water supply service by non-users
- Part F; Observation of the household by data collector

6.1.3 Survey Results

A total of 507 general households were visited and persons above 18 years old were interviewed to ensure accuracy and quality of data. Some of the results are described below.

(1) Information of Respondents

The average age of the respondents was 46.77 years old. More than two thirds of respondents (67.3%) were female while 32.7 were male (**Figure 6.1.1**).

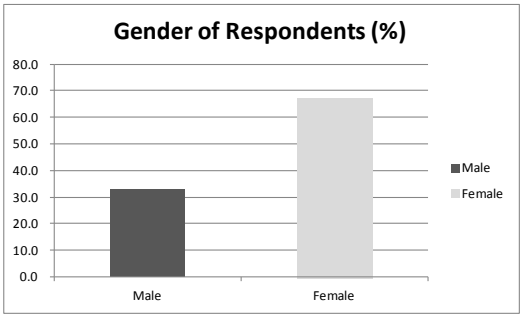


Figure 6.1.1: Gender of Respondents
Source: JICA Survey Team

(2) Information of Households

Table 6.1.1 shows family size of households by districts. Total average of family size of the survey area is 4.39.

Table 6.1.1: Family size by districts

District	Number of HHs	Total Number of Family Members	Average of Family Size
Colombo	53	230	4.34
Kalutara	454	1998	4.40
Total	**507**	**2228**	**4.39**

Source: JICA Survey Team

The average of monthly income by all family members is LKR 33,046.

All households spend the most for meal expenses. The results indicate around half of their expenses (50%) are on their meals. The ratio of expenses on water is very small, around 1 to 2 percentage of all expenses.

(3) Situation of Water Use

Table 6.1.2 shows that private well water is used for domestic purpose at more than 80 % of households, and around 28% of households uses pipe borne water for domestic purpose. In the surveyed area, few households use bottle water, rain water and river/stream/lakes water for drinking.

Table 6.1.2: Water Use for Domestic Purpose (%) (N=507)

Condition	Drinking	Cooking	Bathing	Personal Hygiene & Sanitation	Washing Clothes
Pipe borne water	28.21	28.40	28.21	28.21	28.60
Bottle water	0.20	0.00	0.00	0.00	0.00
Private Well water	80.08	80.28	81.66	81.26	81.85
Rain water	0.20	0.00	0.00	0.00	0.59
River/Stream/Lakes	0.20	0.20	1.97	0.79	1.58
Other	0.79	0.79	0.79	0.79	0.79

Source: JICA Survey Team

Table 6.1.3 shows that few households use water for agriculture and business. About half of the total households use private well water for their home gardening.

Table 6.1.3: Water use for other purpose (%) (N=507)

Condition	Agriculture	Gardening	Business	Washing Vehicles
Pipe borne water	1.18	15.98	0.79	7.89
Bottle water	0.00	0.20	0.00	0.00
Private Well water	6.71	50.49	1.78	25.64
Rain water	4.14	12.03	0.20	0.20
River/Stream/Lakes	0.59	0.79	0.00	0.00
Other	0.00	0.20	0.00	0.00

Source: JICA Survey Team

(4) NWSDBs Water Users

The survey revealed that 152 out of 507 households (30%) use NWSDBs water. An average of monthly water consumption of the 152 households is 15,119 liters.

All houses have domestic meter and only one household answered the meter does not function. The average water bill of the previous month was LKR 447, and of the three months was LKR 429 as shown in **Table 6.1.4.**

Table 6.1.4: Situation of NWSDBs water use (n=152)

Monthly Water Consumption	Number of HHs having Function Meter	Only Previous Month Water Bill	Average of Previous 3 Months Water Bill
15,119 Liters	151 HHs	LKR 429	LKR 447

Source: JICA Survey Team

(5) Evaluation of NWSDBs Water by Its Users

Table 6.1.5 indicates that 70.4% of NWSDBs water users have disclosed that the taste of water is satisfactory. In terms of smell of water, 92.8% confirmed satisfactory. 86.2% of households who use NWSDBs water service have disclosed that they are satisfied with the cleanness of water. 69.7% of households are satisfied with the supply time of water. With regard to the quantity of water supplied by the system, 78.9% householders are satisfied. Average percentage of 75.7 of households disclosed that they are satisfied with the water pressure of the system. Average percentage of 75.0 of households is satisfied with the prevailing tariff

Table 6.1.5: Satisfaction for NWSDBs Water (%) (n=152)

Condition	Satisfactory	Unsatisfactory
Taste	70.4	29.6
Smell	92.8	7.2
Cleanness	86.2	13.8
Supply Time	69.7	30.3
Quantity	78.9	21.1
Water Pressure	75.7	24.3
Tariff	75.0	25.0

Source: JICA Survey Team

The survey also revealed how much the users can afford for the service improvement. More than half of users answered they can afford to pay the current bill plus more than LKR 151 per month. However, about 20% cannot afford to pay, even though the water system is improved (**Table 6.1.6**).

Table 6.1.6: Affordability for improved water system (%) (n=152)

Not Affordable	Current Bill Plus					
	LKR 1-50	LKR51-100	LKR101-150	LKR151-200	LKR201-250	LKR 251 and more
19.7	7.2	7.2	6.6	10.5	19.7	28.9

Source: JICA Survey Team

(6) Well Water Use

The survey found that 83.6% of 507 households use private well water. Some households who use both NWSDBs water and well water are included. An average of monthly water consumption of those households is 17,797 liters, which is larger than average amount of NWSDBs water monthly consumption (**Table 6.1.7**).

Table 6.1.7: Situation of private well water use

Monthly Water Consumption (n=424)	Average of the Capital Costs (n=408*)	Average of the Recurrent Costs (n=411*)
17,797 Litters	LKR 40,098	LKR 304

*: Some cases did not remember those costs.
Source: JICA Survey Team

(7) Rain Water Use

Rain water collection was used at 39 households, and the average approximate amount of monthly rain water use is 652.6 liters. The rain water is mainly used for home gardening.

(8) River / Stream / Lake Water Use

The survey found the average approximate consumption of river/stream/lake water by 10 households is 2,210 liters per month. 8 households answered that the time for drawing water from river/stream/lake and the average is 0.63 hours per day.

(9) Evaluation of NWSDBs water By Non-users

Table 6.1.8 shows percentage of intention to connect NWSDBs water service. Total 84.5 % of current non-users answered that they have intention to connect. On the other hand, 15.5% of nonusers answered that they did not intend to connect the service. The survey did not reveal the actual reasons of not intending to connect NWSDBs water service, but some may not feel the necessity of the service since their needs are satisfied by wells and/or other sources.

Table 6.1.8: Intention to connect NWSDBs water service (n=355)

Condition	%
Not intend to connect NWSDBs water for now	15.5
Intend to connect NWSDBs water soon	80.6
Intend to connect NWSDBs water when satisfying its service	3.9

Source: JICA Survey Team

Table 6.1.9 shows willingness to pay when connected to NWSDB's water service answered by non-users. 16 1% of households are not willing to pay. It also shows 38.9% of households are willing to pay more than LKR250.00, 18.6% is up to LKR 250.00, 12.7% is up to LKR200.00, 7.6% is up to LKR150.00, 4.8% is up to LKR 100.00 and 1.4% is up to LKR50.00.

Table 6.1.9: Willingness to pay if connected to NWSDBs water service (n=355)

Not Willingness	Willingness					
	LKR 1-50	LKR51-100	LKR101-150	LKR151-200	LKR201-250	LKR 251 and more
16.1	1.4	4.8	7.6	12.7	18.6	38.9

Source: JICA Survey Team

6.2 Comparison with the Social Economic Baseline Survey in the Master Plan

The Socio Economic Baseline Survey (hereafter SEBS), the concept of which was similar to the Social Condition Survey, was conducted in the Master Plan. It also targeted the Western Province, including Gampaha District.

The sample size and methodology of the Social Condition Survey are also different from the SEBS. However, the results and recommendations of SEBS will be useful for this survey.

Some comparable items of both survey results are listed below, but statistical analysis was not applied here.

The SEBS in the Master Plan targeted Tenement Gardens, a low income community, but the project does not target the area, so the statement of the Tenement Gardens is omitted here.

6.2.1 General Household information

(1) General Information of Households

There are no remarkable differences on average family size, composition of male and female, and average monthly income. However, percentage of NWSDB water connection revealed by Social condition Survey was 30.0 against 58.8% by the SEBS (**Table 6.2.1**).

Table 6.2.1: Comparison of General Information of Households

Condition	Social Condition Survey	SEBS in the Master Plan
Average family size (person)	4.39	4.4
Male (%) / Female (%)	47.4/52.6	47.6 / 52.4
Average monthly income (LKR)	33,046	36,193
NWSDB water connection (%)	30.0	58.8

Source: MPU/2013

(2) Situation and Evaluation of NWSDBs Water by Service Users

Table 6.2.2 shows the comparison of situation and evaluation of NWSDBs water service by users between the Social Condition Survey and the SEBS. In terms of purpose of using the water, more than 28% of users in the survey answered they use the water for drinking and cooking. Less percentage of household answered they use the water for drinking and cooking.

On the other hand, in terms of satisfaction with the tariff, it is lower percentage of household in the Social Condition Survey (75.0%) than the household in the SEBS (82.9%) as shown in **Table 6.2.2**.

Table 6.2.2: Comparison of Situation and Evaluation of NWSDBs Water Service

Condition	Social Condition Survey	SEBS in the Master Plan
Use Domestic meter (%)	100	99.1
Functioning meters (%)	99.3	98.4
Use for drinking (%)	28.21	20.4
Use for cooking (%)	28.40	17.7
Water consumption (Units)	15.1	16.5
Satisfaction with water pressure (%)	75.7	77.5
Satisfaction with the tariff (%)	75.0	82.9

Source: MPU/2013

(3) Evaluation of Water Supply by Non-service users

The Social Condition Survey found that 84.5% of the households intend to use NWSDBs water services, and 76.6% of households interviewed in the Socio Economic Survey answered they were willing to obtain water supply service (**Table 6.2.3**).

Table 6.2.3: Comparison of Evaluation of Water Supply

Condition	Social Condition Survey	SEBS in the Master Plan*
Willingness/Intention to obtain NWSDBs water service (%)	84.5	76.6

Source: MPU/2013

(4) Other remarkable result from the Socio Economic Baseline Survey

The SEBS found that 30.4% of households propose for revising water tariff annually, but about half of the households (49.4%) propose for revising every five years.

6.2.2 Condominiums/ Commercial Units/ Institutions

(1) Sample Size

The Social Condition Survey targeted only general households, but the SEBS targeted other categories such as condominiums, commercial units, institutions etc. The following numbers in **Table 6.2.4** was those sample size in the SEBS.

Table 6.2.4: Number of Samples of Each Household

Households	No. of Samples
Hospitals	10
Education Institutions	10
Religious Places	10
Institutions (training centers, etc)	10
Hotels	10
Industries	10
Condominiums	400
Commercial Units	200
Total	660

Source: MPU/2013

(2) Major Findings of Water Supply Services

Table 6.2.5 shows the some of the major findings of water supply services from the result of the Master Plan. The percentage of connection to NWSDBs water service at all types of households is mostly high. Almost 100% of Condominiums are connected to NWSDBs water supply service.

Consumption by other institutions is much higher than other types of households since those include hospitals and education institute which regularly consume plenty of water. Water consumptions by Condominiums and Commercial Units do not differ greatly from General Households, which was 16.5 unit and 17.8 unit that was found by the Social Condition Survey (**Table 6.2.2**).

All types of households answered they are satisfied with the water tariff. However, the survey result showed that more than 10 % of users were unsatisfied the current tariff. The percentage of the satisfaction is also not different from that by General Households (**Table 6.2.2**).

Table 6.2.5: Situation of Water Supply Services

Households	% of Connection to Water Supply Services	Water Consumption 1 unit(1,000 litter)/Month	% of Satisfaction for Water Tariff
Condominiums	99.8	18.9	87.8
Commercial Units	83.5	27.0	86.8
Other institutions	96.6	1440	77.2

Source: MPU/2013

CHAPTER 7 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

7.1 Necessity of IEE/EIA

According to the environmental laws and regulations of Sri Lanka (Gazette Extra Ordinary No. 722/22 of 1993 and No. 1104/22 of 1999), IEE and EIA are not required for the project because the capacity of proposed Kandana WTP (140,000 m^3/d) is less than 500,000 m^3/d and the project sites are not located in protected areas or environmentally sensitive areas. NWSDB has received an office letter from CEA to declare that IEE/EIA is not necessary.

7.2 Initial Environmental Examination (IEE) Level Study

As per JICA Guidelines for Environmental and Social Considerations (April, 2010), the project is tentatively classified as environmental Category B. Thus, an Initial Environmental Examination (IEE) level study is prepared based on JICA's guidelines. Firstly, scoping of the IEE level study is carried out in collaboration with NWSDB, based on collected information and preliminary field surveys. Then, anticipated environmental and social impacts of the project are examined, and alternatives examinations are also conducted. Finally, mitigation measures for the negative impacts and monitoring plan are proposed. In addition, an environmental checklist for the project is prepared as required by the JICA Guidelines.

As a conclusion, the implementation of the proposed water supply project will have positive impacts on public health, local economy, gender, and greenhouse gas (GHS) reduction etc.. The negative impacts on the environment and society will be minor and mitigable.

7.3 Stakeholder Consultation

In order to explain and discuss the Preparatory Survey and the IEE level study results, stakeholder consultation meeting was held. The outline of the stakeholder consultation meeting is summarized in **Table 7.3.1**.

Table 7.3.1: Summary of the Stakeholder Consultation Meeting

Item		Action
1	Date	09:00 – 13:30, January 13, 2015
2	Place	Meeting room of Berjaya Hotel, Mount Lavinia, Colombo
3	Target areas	Dehiwala, Moratuwa, Kesbewa, Bandaragama, Horana, Millaniya, Madurawela etc.
4	Consultation contents	1) Outline of the Preparatory Survey 2) The results of IEE level study 3) Water demand and capacity of the WTP, sludge disposal and reuse, gender and children considerations etc.
5	Participants	47 persons from NWSD, NWSDB, CEA, RDA, NGOs, residents, JICA Sri Lanka Office etc.

Source: JICA Survey Team.

7.4 Abbreviated Resettlement Action Plan (RAP)

In order to avoid or minimize involuntary resettlement, various alternatives have been examined by the JICA Survey Team. As a result, no resettlement for Kandana WTP, distribution reservoirs and pipelines would be acquired. However, land acquisition (approx. 3.8ha) from six (6) land owners will be needed for construction of four (4) reservoirs as shown in **Table 7.4.1**.

Regarding land acquisition, a comparison of JICA and Sri Lankan policies on involuntary resettlement including land acquisition is made during the survey. No key gaps between JICA policies and Sri Lanka policies are identified. Considering the fact that no involuntary resettlement will be required, an

abbreviated Resettlement Action Plan (RAP) is prepared by following JICA guidelines and World Bank OP4.12.

Table 7.4.1: Land Acquisition and Resettlement for the Project

Name	Capacity	Land Area Needed	Land Acquisition Necessity	Current Land Use	Resettlement Household	Remarks
Kandana WTP						
Kandana	140,000 m^3/d	3.5 ha	No	Existing Kandana WTP	0	Within the existing Kandana WTP
Reservoirs						
New Delkada	10,000 m^3	1.0 ha	Necessary (1.0 ha)	Private (coconut land)	0	Based on alternative study results (1 owner)
New Bandaragama	20,000 m^3	2.0 ha	Necessary (2.0 ha)	Private (bare land + plant nursery)	0	Based on alternative study results (1 owner)
New Keselwatta	4,000 m^3	0.1 ha	Necessary (0.025 ha)	NWSDB + Private (vacancy)	0	Existing elevated tank (1 owner)
New Moratuwa	20,000 m^3	0.7 ha	No	NWSDB (21 quarters)	0	Japanese technology will be applied.
New Kesbewa	18,500 m^3	0.74 ha	Necessary (0.74 ha)	Private (Vehicle repair site)	0	3 owners
Total	**-**	**8.17 ha**	**3.8 ha**	**--**	**0**	**Finally resettlement is avoided.**

Source: JICA Survey Team.

The abbreviated RAP includes following items:

(a) Census survey results of displaced persons and valuation of assets;
(b) Compensation methods;
(c) Grievance procedures;
(d) Implementation system (organizations and their responsibilities);
(e) Costs and budget sources of land acquisition; and
(f) Implementation schedule and monitoring.

As conclusion, compensation on land acquisition will be based on the full replacement cost by following JICA and Sri Lankan policies.

7.5 Considerations for Low Income Households

Low income households (LKR 4,500 per month) can obtain the water connection for a special concessional rate of LKR 4,000 which is only 23% of regular connection fee. In addition, low income households are charged with 25% to 58% discounted usage charges comparing to the regular domestic water tariff.

7.6 Improvement of Social Development (Gender etc.)

According to the social survey, 8 households out of 365 households who are without pipe born water supply, had to spend the average 0.63 hours/day to collect water from river/streams/lake, etc.. Therefore, implementation of the project will not only provide good water quality to improve public health, but also benefits women and children in reducing their workload for collecting water.

In addition, during the preparatory survey, Gender Action Plan (GAP) is prepared to promote and facilitate the equal participation of men and women as stakeholders and beneficiaries of the project.

7.7 Identification of Possible Mitigation / Adaptation measures for Climate Change

By using JICA Climate Finance Impact Tool for Mitigation (Energy Conservation (Industry), the Survey Team has made an examination on greenhouse gas (GHS) emission reduction through energy conservation, which is contributed to by the implementation of the replacement and repair of the transmission mains and distribution networks for NRW reduction in Dehiwala and Moratuwa areas. The annual GHS emission reduction in year 2025 is estimated to be approximately 1,012 t-CO_2. According to existing information, there is no clear evidence to show long-term changes in rainfall amounts and patterns in the Kalu River basin due to climate changes. Therefore, it is considered that the project is not suitable for Adaptation Project.

CHAPTER 8 PROJECT COST AND IMPLEMENTATION SCHEDULE

8.1 Implementation Schedule

The implementation schedule from the loan agreement (in November 2015) is based on the following timeframes for completion in Sri Lanka:

(1) Selection of consultants : 12.0 Months
(2) Detailed Design including surveys : 12.0 Months
(3) Tender Assistance for International Competitive Bidding (ICB) : 25.0 Months[1]
(4) Tender Assistance for Local Competitive Bidding (LCB) : 18.0 Months
(5) Construction Work (for Main Component: ex. WTP) : 36.0 Months
(6) Technical Assistant for New Treatment System : 6.0 Months

The typical implementation schedule for this project is shown in **Figure 8.1.1**. The construction will be completed on January in 2022 at the earliest (if the loan will be agreed on November in 2015).

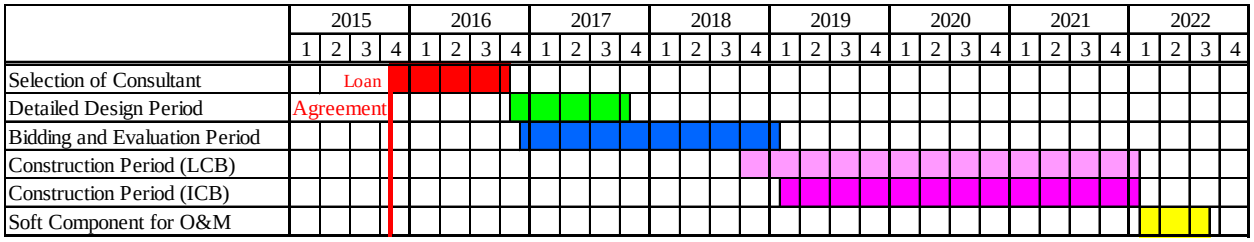


Figure 8.1.1: Typical Implementation Schedule for the Project
Source: The Survey Team

NWSDB requests to start the water supply services by this project as soon as possible. However the advanced schedule is not mentioned in this report because it should be discussed with JICA in the fact finding mission or appraisal mission.

8.2 Project Cost

The project cost is not mentioned in this report. However the basic conditions are explained as follows.

Project cost was estimated using JICA cost estimation tool. The rates given in "Rates 2014" provided by NWSDB were applied for the unit cost for the general construction works and items, and quotes collected were applied for the special items not given in the "Rate 2014". The exchange rate applied is the rate made public as the monthly average exchange rate on December 2014 by the Central Bank of Sri Lanka.

USD 1 = LKR 131.0216 ≒ LKR 131.02
USD 1 = JPY 119.37 ≒ JPY 119.37
JPY 1 = LKR 1.0976 ≒ LKR 1.0976

The index for the construction works was indicated in ICTAD Bulletin of Construction Statistics, Publication No: ID/05, Volume 24 No.09, on September 2014. The average growth rate of all construction in 2014 is about 3.2%. This value is similar to the average growth rate of Colombo Customer Price Index in 2014 (3.3%). Therefore the value of price escalation rate of 3.2% local currency (LC) is used as the average of all construction. The price escalation rate of 2.0% foreign currency (FC) is applied in accordance with ODA loan in 2014 for other countries. The other assumptions are shown as in **Table 8.2.1**.

[1] The processes for 10.0 months can be conducted in Detailed Design Stage.

Table 8.2.1: Assumptions for Cost Estimation

Item		Rate
Physical Contingency	Construction Works	5.0%
	Engineering Services	5.0%
Administration Cost for NWSDB		3.0%
Interest during Construction (Middle-Income Countries)	Construction Works	1.4%
	Engineering Services	0.1%
Value Added Tax (VAT)		11.0%
Nation Building Tax (NBT)		2.0%
Import Tax (Average Rate for Foreign Currency)		15.0%
Front End Fee		0.2%

Source: JICA Survey Team

This project is categorized into the following two main contents.

(a) Construction and Procurement of Equipment for Kalu Ganga Water Supply System Expansion
(b) Construction and Equipment Purchase for NRW Reduction in Dehiwala and Moratuwa Area

In this report, smaller scale package groups are recommended for easy arrangement of the project because the total project amount is too large. The contents of 13 package groups are shown in **Table 8.2.2**.

Table 8.2.2: Proposed Package Groups

Number	Contents	Bidding Method
Lot 1	Headworks for Kalu Ganga Water Supply System Expansion	ICB
Lot.2	Transmission Pipes for Kalu Ganga Water Supply System Expansion	ICB
Lot.3	Reservoirs for Kalu Ganga Water Supply System Expansion	ICB
Lot.4	Pump Stations for Kalu Ganga Water Supply System Expansion	ICB
Lot.5	Distribution Feeder Mains for Kalu Ganga Water Supply System Expansion	ICB
Lot.6	Distribution Secondary Pipes for Kalu Ganga Water Supply System Expansion	ICB
Lot.7	Distribution Tertiary Pipes for Kalu Ganga Water Supply System Expansion	LCB
Lot.8	DMA for Kalu Ganga Water Supply System Expansion	ICB
Lot.9	House Connection for Kalu Ganga Water Supply System Expansion	LCB
Lot.10	Procurement of OO&M Equipment for Kalu Ganga Water Supply System Expansion	LCB
Lot.11	Improvement Works for NRW Reduction Activities	ICB or LCB
Lot.12	Procurement of O&M Equipment for NRW Reduction Activities	LCB
Lot.13	Salinity Barrier at Kethhena	ICB

*ICB: International Competitive Bidding, LCB: Local Competitive Bidding
Source: JICA Survey Team

CHAPTER 9 FINANCIAL AND ECONOMIC ANALYSIS

9.1 Financial Analysis

Financial analysis has been carried out based on the cost estimates of the previous chapter for initial investment, reinvestment and O&M costs. NWSDB's water tariff revenue increased by each project component is recognized as its financial benefit.

The financial analysis has been carried out about three cases as for Kalu Ganga Water Supply System Expansion, NRW Reduction in Dehiwala and Moratuwa Areas and entire project.

The value and detail of financial analysis are not mentioned in this report. However the above all there cases are deemed financially viable.

9.2 Economic Analysis

Economic analysis has been carried out based on the cost estimates of the previous chapter for initial investment, reinvestment and O&M costs. Alternative water source cost in the without-project case and willingness to pay for the increased water supply is recognized as economic benefit of the project.

The value and detail of economic analysis are not mentioned in this report. However the economic analysis demonstrates that the project deliver economic benefit.

9.3 Financial and Economic Analysis of Divided Terms

The analysis for FIRR and EIRR are conducted for the case that the entire project be divided into two terms. This analysis also demonstrated that financial viability and economic benefit.

CHAPTER 10 CAPACITY OF EXECUTING AND IMPLEMENTING AGENCIES

10.1 Capacity of Executing/Implementing Agency

10.1.1 Capacity of Executing Agency

The central government is responsible for sector policy, regulation, and development in the water sector under the Ministry of Water Supply and Drainage (MWSD) and the Ministry of Urban Development and Sacred Areas (MUDSA). The existing NWSDB organizational structure is shown in **Figure 10.1.1**. MWSD has been playing the role of the Executing Agency of a lot of projects financed by Yen Loan and ADB loan and has sufficient capacity for the Executing Agency for this project.

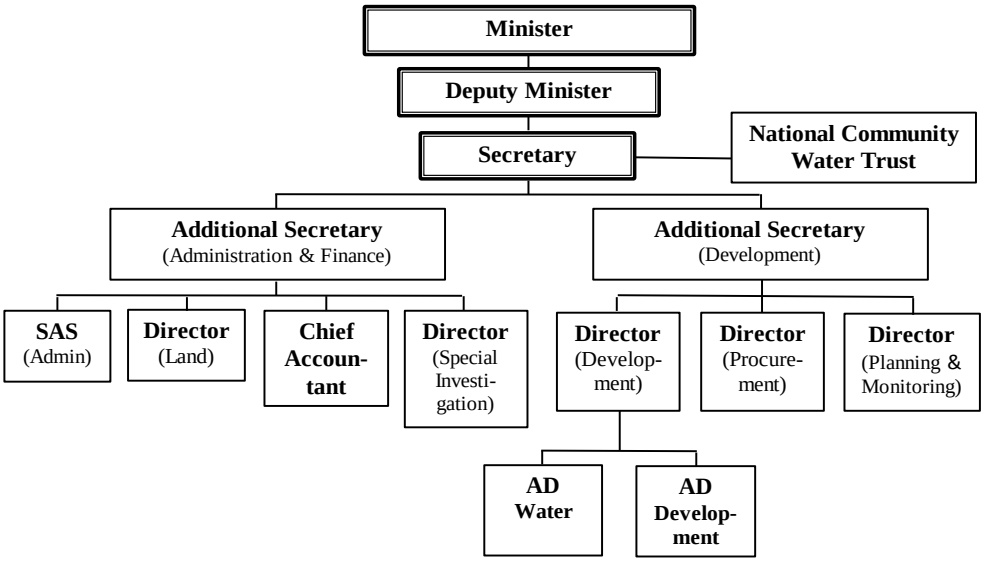


Figure 10.1.1: Organization Structure of MWSD
Source: MWSD

10.1.2 Capacity of Implementing Agency

The National Water Supply and Drainage Board (NWSDB) is the foremost public water supply management organization in Sri Lanka. The existing NWSDB organizational structure is shown in foregoing **Figure 10.1.2**.

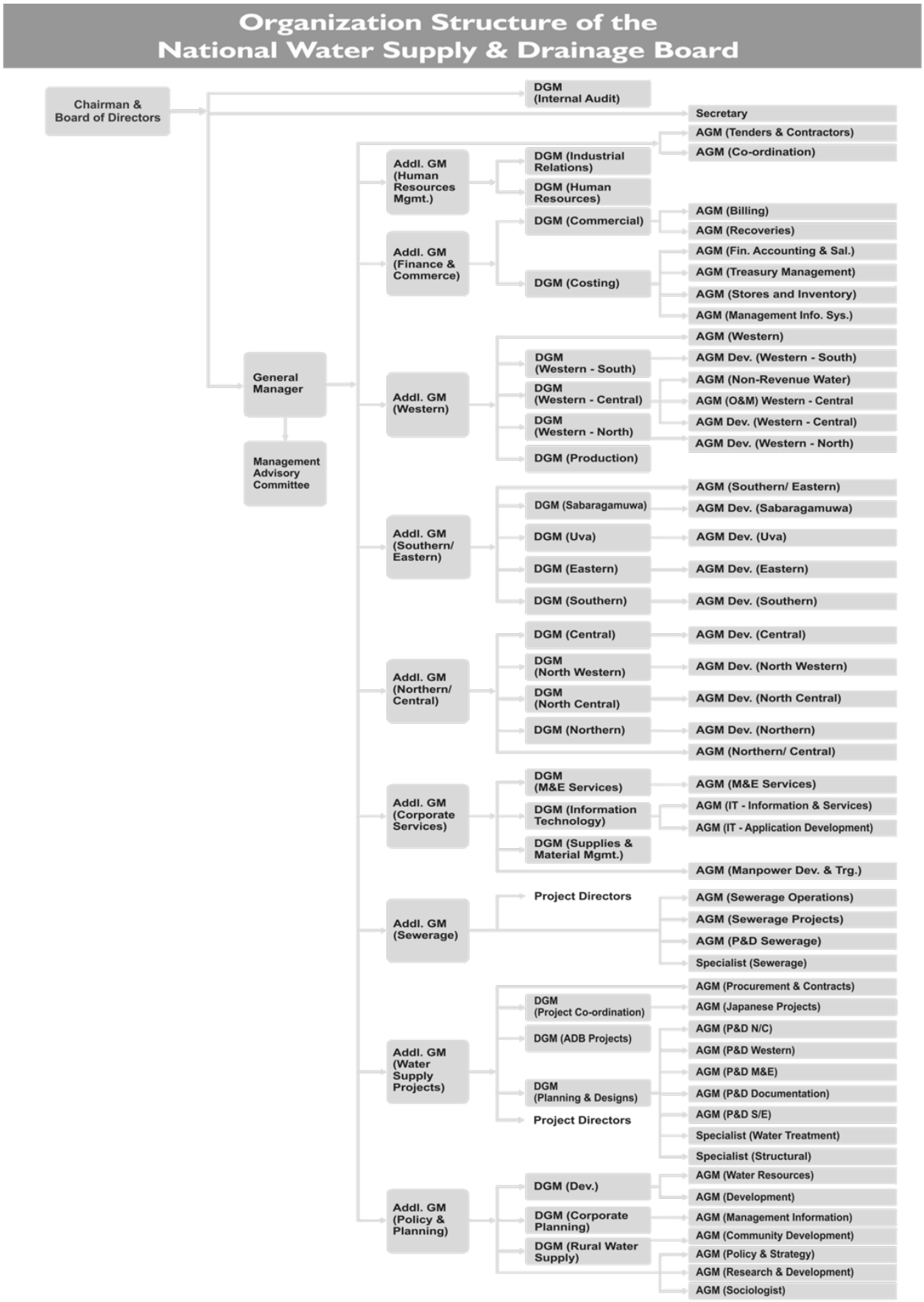


Figure 10.1.2: Existing NWSDB Organization Structure
Source: NWSDB

The percentage of the number of engineers is 6%, and that of skilled employees is higher than that of un-skilled employees. A certain level of the number of professional personnel is ensured, so that NWSDB has the ability to manage the waterworks system. In the future, professional personnel should be increased in keeping with the construction of new and more sophisticated facilities, and targeting better service.

NWSDB is set "Promote Human Resource Development" as a priority issue according to the Goal 6 of the Cooperate Plan 2012 – 2016. The Manpower Development and Training Division (MD&T Division) of NWSDB prepares an Annual Training Plan consisting of In-house Training, In-country External Training and Overseas Training programs.

ADB implemented the Technical Assistance project of "Institutional Strengthening for Decentralized Service Delivery in the Water Sector (April2009 - June2010)". The proposed framework has been executed by each phase and accordingly the institutional capacity of NWSDB has been strengthening.

ADB is also going to start the Technical Assistance project of "Institutional Development for National Water Supply and Drainage Board (NWSDB)" that aims to develop the capacity of staff employed in all relevant divisions of the NWSDB to implement and manage foreign funded projects.

10.2 Organization for Implementation of Project

Executing Agency of this project is MWSD and Project Implementation Agency would be NWSDB. Organization for project implementation is shown in
Figure 10.2.1. NWSDB is making study on the draft organization chart for Project Management & Coordination Unit shown in **Figure 10.1.2**, and could prepare an inspector for construction works in this unit.

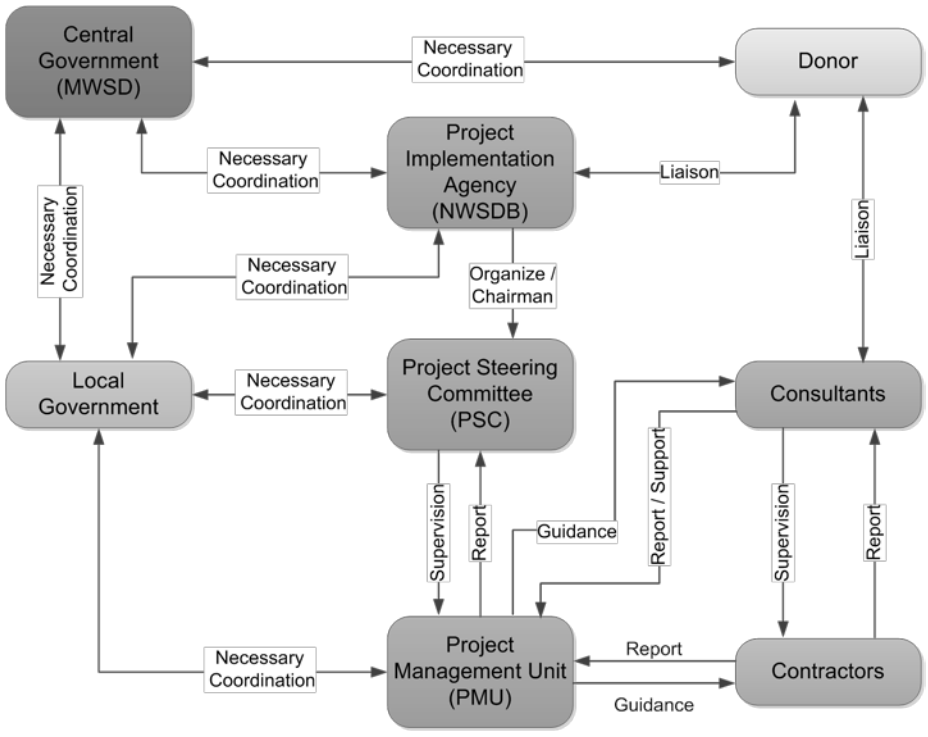


Figure 10.2.1: Organization for Project Implementation
Source: MPU/2013

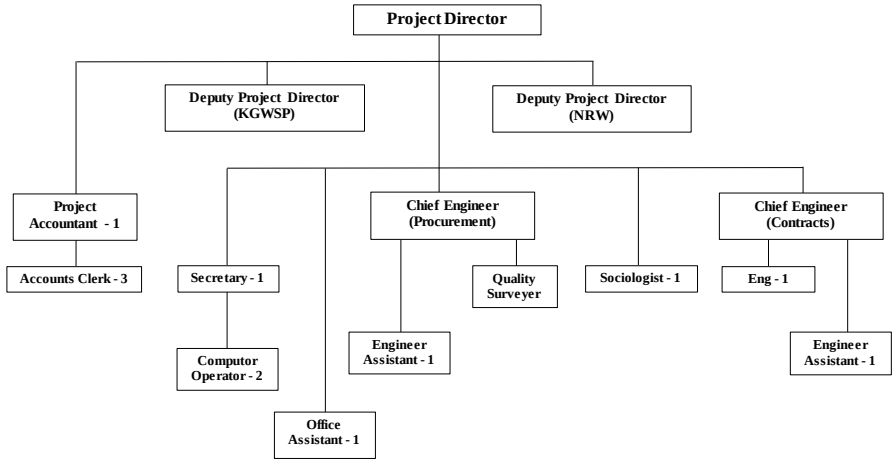


Figure 10.2.2: Organization Chart for Project Management & Coordination Unit (Draft)
Source: NWSDB

10.3 Project Management Capacity

10.3.1 Safety Management

(1) Actual Condition of Safety Management in NWSDB

It cannot be said that the safety management program of NRSDB is a comprehensive one. In performing day to day operation & maintenance duties, important safety measures, are implemented by habit or unwritten rules. In the construction works, the safety management programs are established by the contractors and managed by them.
Document Section under P&G of Head Office has been establishing a Safety manual based on what NWSDB has conducted until now and international standards, and will be published by the first half of 2015.

To establish the safety management system and to ensure the safety of works both in O&M and construction works, implementation of establishment of the organization for safety management, periodical revision of Safety Manual, sharing of accident information, analysis of the cause of accident, field patrol, training of safety management are proposed.

10.3.2 Quality Management

To ensure the quality management in construction works, NWSDB uses the national specifications and standards established by ICTAD (Institute for Construction Training and Development) in nationwide common. It is desirable that a person from an independent inspection team inspects for an accurate and fair inspection. Step-by-step inspection using photographs and by visual inspection are required. The accreditation of ISO 9001 and its implementation in Kandana WTP are recommended.

10.4 Actual condition for Organization and Operation and Maintenance

10.4.1 Actual Condition of Operation and Maintenance

In the Performance Indicators (PI) of the area of RSC – Western South area, water availability attains 24 hours, compliance of the water quality attains 100%, response to requests for new service connections attains 95%, and customer complaints resolution attains 100%. These outputs of PIs suggest that adequate water works services are implemented by this RSC.

10.4.2 Administrative Structure of RSC-Western South and West-Production

NWSDB has eleven (11) Regional Support Centers (RSCs) of which RSCs – Western South and Western Production are in charge of this project area. RSC - Western South is in charge of the transmission and distribution facilities, and Western Production is in charge of the intake and treatment facilities. The total number of NWSDB employees was 10,209 in 2014 of which 736 persons belonged to RSC – Western South and 324 persons to Western – Production. These include 722 of non-regular and other employees,

10.4.3 Current Administrative Structure of Dehiwala and Moratuwa

Existing administrative structure of RSC – WS is shown in **Figure 10.4.1**.

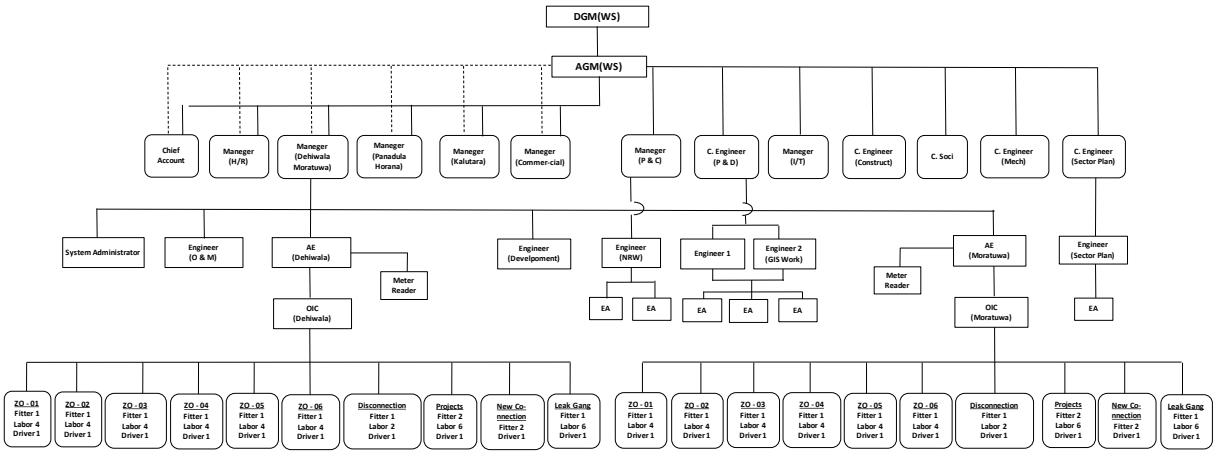


Figure 10.4.1: Administrative structure of RSC - WS
Source: NWSDB

Under the P&C manager, 1 CE and 2 EAs in charge of NRW Reduction are appointed andperform their duties covering the entire area of RSC – WS. The NRW Reduction duties include analysis of water balance by measuring flow volume from WTP to each distribution district, measures based on reports from citizens, nighttime investigations, and discovery by investigations. The NRW section for the grater Colombo area gives assistance to both Dehiwala and Moratuwa, when on such things as pressure and flow monitoring, when required.

10.4.4 Administrative Structure of Kandana WTP

(1) Administrative Structure of Western Production Division

DGM (Western Production) has the overall responsibility of planning, scheduling and implementing PM (Preventive Management) for the plant and the equipment. Under DGM, there are managers of operations, maintenance, Kandana WTP, and chief chemist. Under the managers, (O&M) Kandana M&E Engineer (Operations) is appointed. (**Figure 10.4.2**)

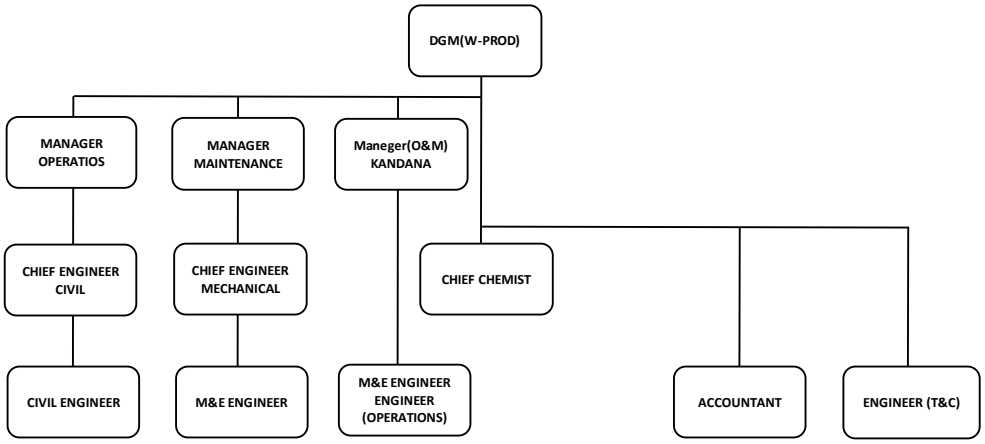


Figure 10.4.2: Organization Chart of Western Production Division
Source: NWSDB

(2) Administrative Structure of Kandana WTP

The Kandana WTP was inaugurated in 2006. Currently, it employees 23 stuff members including a manager and 6 shift working crews. This plant utilizes a SCADA system, which monitors the performance of water treatment processes, so the number of the operational stuff is comparatively less.

10.5 Proposal for Organization and Operation and Maintenance

10.5.1 Proposal for Organization

(1) Distribution System and Measures for NRW

Increase of the number of OICs (from 2 to 4) and ZOs (from 12 to 20) is proposed due to the increase in NRW staff, and OICs and ZOs in Dehiwala and Moratuwa are responsible for far more house connections than in Colombo district. ZOs will be in charge of newly employed DMA system. The organizational structure of RSC-WS is suggested in **Figure 10.5.1.**

Furthermore, 6 reservoirs will be enlarged or newly constructed in this project. In order to effectively manage the increased capacity, necessary operational stuff (18 pump operators, 18 O/M stuff and 22 security guards) should be assigned for operation.

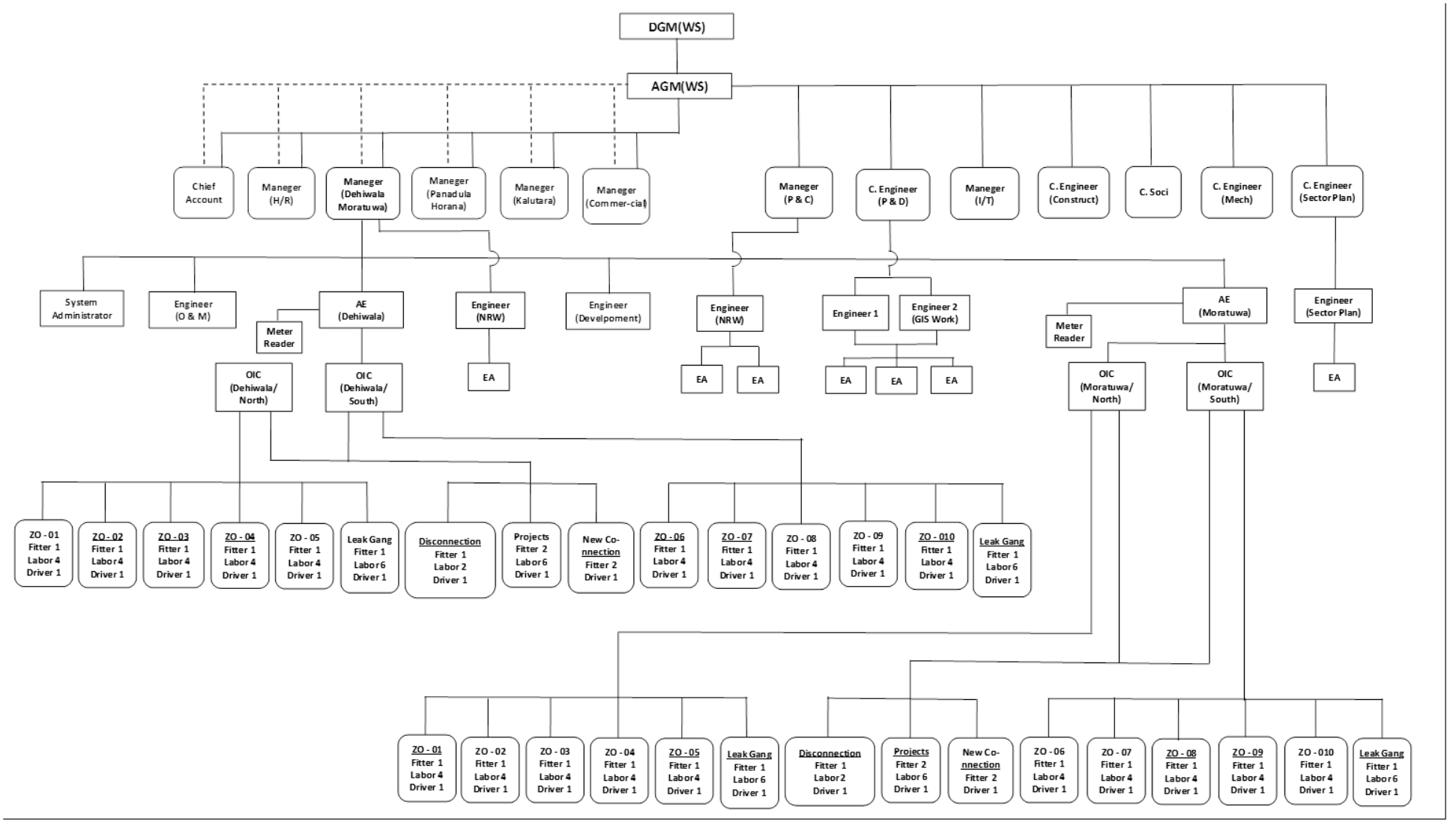


Figure 10.5.1: Proposed administrative structure of RSC – WS

Source JICA Survey Team

(2) Operation and Maintenance of WTP

As for shift working personnel for operation of the facilities, 1 team consists of 6 persons (3 groups of 2 persons) will be additionally designated because it is difficult for the personnel of existing facilities to be in charge of the operation of new facilities. For a new water transmission pump system, an additional 12 operators will be proposed. In case of the administrative personnel, including chemist for water quality examination, the existing personnel will be able to work for new facilities. Proposed personnel in Kandana WTP are as follows;

＜Regular Working – Water Treatment＞

・	Manager	01	Chemist		01
・	Mechanical/Electrical Engineer	01	Lab. Ass.		01
・	Operation in Charge	01	Labor		01
・	Eng. Assistants (Mech.)	01		Total	03
・	Eng. Assistants (Elect.)	02			
・	Mechanics	01			
・	Electricians	01			
・	TA (Inst.)	01			
・	Electronic Technicians	01			
・	Store keepers	01			
・	Fitters	02			
・	Drivers	03			
・	Labors	04			
	Total	20			

＜Regular Working – Transmission System＞

・	Operation in Charge	01		
・	Eng. Assistants (Mech.)	01		
・	Fitters	05		
・	Labors	05		
	Total	12 (+12)		

＜Shift Working＞

・	Plant Technician	06		
・	Helper	06		
	Total	12 (+6)	Grand total	47 (+18)

10.5.2 Proposal for Human Resource Development

The new training center, which is under construction through an ADB loan, will be used to the fullest. To complete training programs, and to implement them in this center, Japanese technical cooperation, including by Japanese local governments, can be considered.

For the human resource development, following items should be considered;

- Concerning measures, training for ALM (active leakage control methodologies) should be implemented. And as for training of DMA system, technological assistance such as technical projects of Japan, including by a local government, will be recommended.
- In O&M of WTP, promotion of Preventive Management Program (PMP) including operation manuals of important facilities and SCADA system in new facilities should be considered.

10.5.3 Proposal for Efficiency of O&M

- Concerning NRW: measures, practices and procedures of ACL and operation of DMA systems that support ALC are recommended.
- Concerning O&M of WTP: O&M based on operation manuals of each stage of intake, water treatment and transmission, and each unit processes is recommended. Each manual should be checked and revised periodically.
- Concerning maintenance of WTP: implementation of proper inspections and diagnosis based on the results of them will be proposed based on inspection manuals.
- Concerning maintenance of electronic facilities and instrumentation (SCADA system): it is needed to obtain sufficient technical supports in life time.
- Concerning energy saving by the reduction of electric consumption: it is proposed to adopt high efficiency motors and VF motors due to the high energy consumption of other motors. In order to take advantage of the lower nighttime electricity tariffs, NWSDB has been making efforts to use margin space of reservoirs to the fullest. It is recommended that energy conservation aspect should be noted at the detailed design stage.
- Concerning the procurement of materials and chemicals: NWSDB has been making effort to reduce cost by bulk purchase and so there will be little space to improve it.
- Concerning As for water quality management in WTP: a water quality examination plan should be established annually.
- Concerning implementation of asset management in the future: development of a ledger of equipment and data base of the history of repairs etc. are recommended. It is possible to carry out the study of Japanese technical cooperation, including municipalities with experience in this field.

10.5.4 Necessary Items and Cost for Institutional Development

As mentioned in "**Chapter 5 Facility Plan**" of this Report, NWSDB requested that equipment for O&M including leak repair, office buildings, vehicles and other equipment for O&M, including leak detection equipment, be covered by the Project as necessary items for reinforcing NWSDB's O&M after the physical works are completed under the Project.

10.6 Financial Capacity

The financial capacity of NWSDB is not mentioned in this report.

CHAPTER 11 POSSIBILITY OF PUBLIC PRIVATE PARTNERSHIP

11.1 National Development Plan

The economic policy framework of the government of Sri Lanka has been developed in line with the major principles set out in "Mahinda Chintana". Mahinda Chintana issued in 2010 outlined the six year development framework of 2011–2016. One of main targets was to lift the per capita income from US$2,400 in 2010 to US$4,470 in 2016, in order to position Sri Lanka as a strong middle income country. Pursuing this target, and taking account of the time horizon of 2020, Mahinda Chintana issued in 2013 featured 15 public investment strategies for the 2014 – 2016 period, of which ones strongly related to PPP and infrastructure investment (including water supply and sewerage) were as follows.

- Achieving the annual investment of 6 to 7% of GDP from the government sector and 27 to 29% from the private sector in 2016
- Integration to the global economy through five hub sectors (naval, aviation, commercial, energy and knowledge)
- Empowering the rural economy
- Strategic reorientation of state owned business enterprises
- Integrated water management
- Environmentally friendly urban development

11.1.1 Development Plan of Water Supply Sector

The entire target of water supply sector is to ensure that 95% of households have access to safe water in 2016. As far as the access to pipe borne water goes, this target becomes 51%.

The pipe borne water supply development strategy is divided into four segments, (i) upstream development and water sources stabilization, (ii) downstream development, (iii) operational efficiency of water service providers and (iv) financial approaches.

In the new strategic concept introduced in Mahinda Chintana, urban areas are classified into three types, (i) main, (ii) strategic and (iii) emerging. The main cities include Colombo, Hambantota, Trincomalee and Jaffna. The strategic cities include Kandy, Galle, Anuradhapura, Polannaruwa, Dambulla, Kurunagala, Ratnapura, Nuwara Ealiya, and Batticaloa.

Water supply service levels in all main, strategic and emerging cities will be strengthened to reflect reliable service levels. Water supply services in small townships that are not included in the city classification will also be upgraded and augmented to a level that can be managed locally.

A total of 85 major development projects for urban water supply are identified in Mahinda Chintana as being implemented approximately during the 2013-2019 period. The total estimated cost of these projects is LKR 531 billion. Rural water supply service is planned to be implemented from 2014 to 2017, providing water to five regions and 50,000 households at a total cost of LKR 5,000 million.

11.1.2 Development Plan of Sewerage Sector

Targets of pipe born sewerage coverage are set as 3% in 2015 and 7% in 2020. Installation of standard on-site sanitation shall be facilitated to all those not connected to sewer system. Highly populated and industrialized towns and areas are given priority in facilitating through centralized sewerage system. Such areas include Galle, Hambantota, Trincomalee, Jaffna, Kandy, Negombo, Kurunagala, Sri Jayewardenepura, Kataragama, Kaththankuddy, Ekala, Ja-Ela and Ratmalana. A total of 17 major sewerage projects to be completed by 2019 are identified. The total estimated cost of these projects amounts to LKR 184 billion.

11.2 NWSDB Investment Program

In 2011, NWSDB prepared "Corporate Plan 2012-2016" in line with "Mahinda Chintana". Currently the corporate plan is under revision to reflect the latest economic environment and new financing principles. It is expected to be issued as the "Corporate Plan 2015-2019". At time of this report (January 2015), the new corporate plan is not completed.

11.2.1 Water Supply Projects

NWSDB Corporate Plan 2012-2016 sets the target of safe water supply as 40.4% coverage by piped system in 2016. Water supply by protected dug wells, tube wells/hand pumps and rain water harvesting are respectively set at 29%, 7% and 1% by 2016. The capital investment programs for 2014, 2015 and 2016 are LKR 82.2 billion, LKR 63.4 billion and LKR 35.4 billion respectively. NRW reduction targets are also set region by region. For example Colombo city's NRW is targeted to decrease to 38% in 2016 from 47.4% in 2012.

11.2.2 Sewerage Projects

The sewerage coverage target is set in the NWSDB corporate plan as 2.8% of the total population by 2016. The capital investment programs to realize the targets amount to LKR 19.8 billion, LKR 10.8 billion and LKR 7.9 billion for 2014, 2015 and 2016 respectively.

11.3 CMC Sewerage Investment Program

The sewerage system in the area of Colombo Municipal Council (CMC) and two other adjacent local authorities are maintained by the CMC. A total of seven CMC sewerage projects amounting to Rs. 104 billion, are planned to be completed by 2019.

11.4 Infrastructure Development by PPP

11.4.1 Definition of PPP

"Public-private partnership" or PPP has various forms such as performance-based contracts (PBC) including management and service contract, build–own–operate–transfer (BOOT), build-own-operate (BOO), design–build–finance–operate (DBFO), lease-develop-build (LDB), other variants, and concessions. At GOSL and NWSDB, the term "private sector participation" (PSP) is also interchangeably used to indicate PPP. The term "privatization" has a clearly different meaning from PPP. Privatization is used to refer to any action which removes a function from the control of the public sector.

11.4.2 National Policy for PPP

GOSL's intention to involve the private sector in the infrastructure development is set out in "Mahinda Chintana". The target annual investment of the private sector by 2016 is considered as 27% to 29% of GDP. This means that the private investment should reach US$33 to US$35 billion in 2016. PPP projects are expected to account for a sizable part of the private investment. Therefore strengthening PPP and facilitating private sector investments are mentioned as a development policy in various sectors such as power, port, telecommunication, road, public transport, water supply, sewerage, solid waste management, irrigation, education, R&D, property development, tourism, agriculture, IT and BPO.

11.4.3 PPP Projects in Sri Lanka

Sri Lanka has been harnessing PPP for creation of new infrastructure and improvement of services. As a result, the number of the PPP projects in four primary sectors (water & sewerage, energy, telecom and transport) which reached the financial close during the 1990 – 2012 period, was 73. The investment

amount totaled US$5,182 million. It should be noted however, that no PPP projects were recorded in the water and sewerage sector. The highest annual amount of PPP projects that reached the implementation stage was US$878 million in 2010. But this decreased to US$181 million in 2012, partly due to weakened political commitment to support PPP.

Successful PPP can be found in the port sector and energy sector. In 2013 the power generation sector has a state power company and 155 independent power producers (IPPs). The power generated by the IPPs accounted for 26% of the national total.

The Public Utilities Commission of Sri Lanka (PUCSL) functions as a regulatory agency in the power sector. The tariffs paid to IPPs are set on the basis of the capacity and availability of power generation. The tariffs paid to SPPs are set as feed in tariff (FIT). Currently the water and sewerage sector is not regulated by PUCSL. The NWSDB act needs to be amended for PUCSL to be able to regulate NWSDB. The amendment process has been stalled since 2008 due to political interference. However, after the state president was newly elected in January 2015, PUCSL intends to resume the amendment process shortly.

Sri Lanka is placed behind its neighbor countries like India, Pakistan and Bangladesh in terms of investment amount and behind India and Pakistan in terms of number of projects implemented. Considering the economic size measured by GDP, this order is not surprising. But having the highest per capita GDP among the four countries, means that Sri Lanka is economically most developed. In this regard, PPP projects in Sri Lanka should have been more flourished.

11.4.4 Unrealized PPP Projects in Water Supply and Sewerage Sector

Several projects were proposed in the past under PPP arrangements such as BOO and BOOT, but they did not materialize due to political, financial and/or technical reasons. In addition, more than 30 unsolicited project proposals have been submitted to NWSDB. Some of those unsolicited projects were packaged as design and build (DB) and proposed together with a possible financing source such as export credit from foreign contractor's country. Those DB projects with export credit financing cannot be necessarily considered as PPP since the debtor is still GOSL and the Sri Lankan public sector does not actually reduce the debt for capital investment.

11.4.5 Legal and Regulatory Framework of PPP

Sri Lanka has no laws that are specifically tailored to regulate PPP projects. There is one guideline however, to regulate government and SOE's procurement procedures under PPP schemes. According to a supplement to this guideline, unsolicited project proposals which are of a strategic nature have to be submitted to a Standing Cabinet Appointed Review Committee (SCARC) appointed by the cabinet. Furthermore a special committee under the Prime Minister's Office may scrutinize unsolicited proposals. As there exists no specific PPP law other than the above mentioned guideline, contracts themselves are used as the main regulation instrument. Rules that govern the roles and responsibilities of the parties concerned as well as any performance expectations are supposed to be defined in the contracts.

The first government PPP unit was set up in 1996 under the Board of Investment (BOI). However this PPP unit of BOI was disbanded in 2012 due to political considerations. Since then there has been no PPP unit that is created under any ministry. ADB is currently providing a capacity development support to the Department of National Planning (NPD). Selected members of NPD staff are learning PPP knowledge and skills through a series of trainings.

11.5 PPP Feasibility in Water Supply and Sewerage Sector

Neither GOSL nor NWSDB releases a list of PPP projects to the public, as there are no such water supply or sewerage projects that are clearly designated as PPP. NWSDB shows lists of projects in pipeline at its website. Most of those projects in the lists have already started the procurement process as traditional government project. However this does not mean that there is no PPP possibility.

NWSDB has been receiving various unsolicited project proposals with its financing sources also proposed by the proponents. Those unsolicited projects have to obtain SCARC approval before going to the procurement stage. Even after the SCARC approval is obtained, the project proposals may be rejected at the procurement stage. In terms of PPP potentiality, all those unsolicited projects could be formulated by PPP schemes. Such potential PPP project candidates are selected from existing project lists. Criteria used in selection are (i) WTP or WWTP component is included, (ii) financing is not secured, and (iii) consultant and contractor have not been awarded.

The Greater Colombo Water and Wastewater Management Improvement Investment Program (GCWWMIIP) is an ADB-funded investment program. The direction of pursuing a PPP approach such as DBO and BOT, for materializing the WWTPs was agreed between ADB and CMC. An ADB TA will be provided to support this PPP approach, assisting CMC to go through necessary process to complete the PPP procurement.

The Greater Galle Water Supply Project (GGWSP) also contains a potential PPP component for a WTP operation. GGWSP has so far completed two stages financed mostly by the Economic Development Cooperation Fund (EDCF) of Korea. EDCF recommended to use PPP method for expansion of project volume and improvement of project effectiveness.

11.5.1 Issues in PPP Promotion

Issues related to PPP project promotion in water supply and sewerage sector and improvement possible measures are summarized in **Table 11.5.1**. Obviously almost all of these PPP promoting factors are lacking or need to be improved.

Table 11.5.1: PPP Issues and Improvement Measures

	Issue	Improvement measure
Policy and legal framework	1. National policy Existing policy is general and indirect.	- Consider refinement of PPP policy with clear commitment.
	2. MWSD policy No PPP policy has been prepared.	- Formulate the ministry policy to ensure alignment with the national policy and NWSDB policy.
	3. NWSDB policy No PPP policy has been prepared.	- Prepare clear statement of PPP policy in Corporate Plan
	4. Laws and regulations No comprehensive PPP law that overarches primary sectors.	- Prepare, revise and streamline necessary laws and regulation to establish PPP framework and other related frameworks such as land acquisition, labor, tax, dispute resolution and contract management.
	5. PPP procurement guideline Existing procurement guideline contains ambiguity and lacks incentives for unsolicited proposals	- Revise the guideline and increase transparency - Incorporate incentive system for unsolicited projects to lower the risk of cost increase and corruption.
	6. Document standardization Standardized forms are not presented in guideline. Thus efficient project formulation and evaluation is hampered.	- Revise the guideline and include standardized methodologies and forms.
Project formulation	7. PPP unit No PPP unit that oversees multiple sectors exists.	- Set up a PPP Unit in MOFP or elsewhere with a clearly defined role and responsibilities, and adequately staffed with skilled staff who can provide specialized expertise, guidance and oversight.
	8. Use of brown field assets Brown field assets are not yet utilized for PPP purposes	- Establish the national policy to allow concession - Develop technical guidance to utilize existing infrastructure assets - Examine appropriate bundling for concession
	9. Risk allocation Reasonable risk allocation rules among the public sector, private investors and lenders are yet to be established.	- Develop risk allocation guideline, hopefully sector by sector. - Establish risk allocation rule between GOSL and NWSDB and make sure both parties assume risks controllable by themselves.

	Issue	Improvement measure
	10. F/S quality The quality of F/S is unstandardized and unsatisfactory. Efficient project formulation and evaluation is hampered.	- Develop guidelines of Pre F/S, F/S, outline business case (OBC) and full business case (FBC)
	11. Japanese technology Employing Japanese technology in PPP projects is difficult.	- Highlight breakthrough technologies that can demand higher price. - Find combinations of several technologies
Water and sewerage sector	12. Regulatory agency PUCSL regulates only the electricity sector. PUCSL cannot regulate the water and sewerage sector until the NWSDB act is amended accordingly.	- Revise NWSDB act so that PUCSL can regulate the water and sewerage sector. - Align the legal framework to regulate the CMC sewerage operation.
	13. Tariff setting Water and sewerage tariff cannot be reasonably set in accordance with NWSDB cost structure. Political intervention sometimes affects the tariff setting.	- Discuss with MOFP and MWSD on application of tariff setting formula.
	14. Anti-PPP atmosphere NWSDB, both management and unions traditionally tends to be reluctant to privatization and competition. This often works against PPP.	- Establish a corporate policy as pro-competitive commercial entity - Formulate PPP projects firstly in green fields.
	15. Land acquisition Land acquisition section is newly created at NWSDB, but it is yet to function to acquire land needed for a specific project.	- Develop a technical guidance which reflects actual problems and solutions - Improve the capacity of Land acquisition section
	16. Capacity of O&M Except small scaled rural water supply systems, all the water supply schemes are operated and maintained by NWSDB. There are no local private companies capable of handling O&M of water supply and sewerage.	- Use O&M staff of international reputable operators - Recruit local technicians/engineers capable of O&M - Develop O&M capacity of currently available staff - Increase automation and mechanization parts in facilities so that manual O&M can be reduced.
Finance	17. Financing arrangement Private investors cannot arrange attractive financing method. Financing pre-arrangement hardly leads to financial close.	- Find financing sources that provide reasonably long tenors and low interest rate. - Find project finance as well as traditional corporate finance. - Establish PPP funds to finance both preparation and implementation of PPP projects
	18. VGF Capital investment subsidy is not provided.	- Develop risk mitigation products such as VGF and guarantees. - Train staff of NWSDB and MWSD so that applications of VGF and other subsidies can be submitted easily and go through within a short period.
	19. Other funding like equity, mezzanine, etc. Other than senior loans, banks do not show much appetite for funding PPP projects.	- Explore various risk taking levels of banks and prepare funding source variations according to the level.

Note: Marked are issues that should be tackled prioritarily, taking into consideration the degree of current unpreparedness and expected effect after rectification.
Source: JICA Survey Team

11.5.2 Possibility of Japanese Investment by PPP

Two projects under JICA partnership program have started in 2015 for a two-year period. The two Japanese technologies to be promoted are (i) pre-stressed concrete (PC) tanks for water supply and sewage treatment systems and (ii) NRW reduction technology.

Regarding the PC tank, after its technical superiority may be proven, the Japanese exporter of PC tank technology will first intend to sell the product as a supplier rather than formulate a PPP project featuring the PC tank installment and its O&M.

Regarding the NRW reduction, after the pilot project turns out to be successful, the private investor will aim at expanding the same scheme in other NWSDB service areas. As a plausible business path, they will enter into an outsourcing contract with NWSDB. When the size and scope of outsourcing grow, it may evolve into concession, which is considered as one of PPP modalities.

11.6 Conclusions and Recommendations

11.6.1 Conclusions

No PPP projects have materialized in the water and sewerage sector of Sri Lanka. This was primarily because main PPP promoting factors such as policy, legal framework, PPP unit, industry regulatory agency, and financial support, were lacking or inadequate. With the inauguration of the new state president in January 2015, the economic policy of Sri Lanka will be probably modified, meaning that the PPP environment is expected to be improved.

In order to promote water supply or sewerage PPP projects with Japanese companies' participation, both Sri Lankan and Japanese sides should develop the framework to foster PPP projects in the medium and long term. In the short term, Japanese companies should formulate and propose competitive PPP projects with Japanese superior technologies, taking advantage of collaboration merits with Japanese local governments and financial assistance schemes available through Japanese yen loans.

11.6.2 Recommendations

Developing the framework to promote PPP projects is generally a medium or long term objective. To do so, issues identified in **Table 11.5.1** should be tackled by the Sri Lankan side. The Japanese side could provide technical assistance to solve the issues. Taking account of the degree of current unpreparedness and expected effect after rectification, some issues should be dealt with prioritarily. Those will include (i) PPP policy setting of NWSDB, (ii) development of laws and regulation, (iii) update of PPP procurement guideline, (iv) establishment of PPP unit, (v) standardization of F/S quality, (vi) legislation of regulatory agency, (vii) tariff setting and (viii) creation of VGF.

In parallel with the development of PPP promoting framework, Japanese investors should propose PPP projects which contain Japanese superior technologies. Such superior technologies distinctive in the water and sewerage sector include pipe jacking method, pipeline rehabilitation, SCADA, sludge dehydration, mechanical meter reading and PC tank. Also in case of seawater desalination, RO membrane, high pressure pump and plant construction technology have the competitive edge. Incorporating such technologies and also taking advantage of merits obtained through collaboration with local governments and financial assistance available through JICA yen loan schemes, highly competitive PPP projects could be formulated.

To advance faster a PPP project by obtaining its financing more easily, the project could be formulated in a relatively small scale. After unbundling the process of water production or wastewater treatment, a component that will provide higher cost effectiveness can be extracted. Designing, building and O&M of the component can be formulated as a PPP project. Experiences suggest that pipe installation is usually costly therefore its responsibility can stay at the public side. The private can assume the treatment plant. For example, it is possible to formulate PPP projects by extracting treatment plant components out of the potential PPP project candidates.

CHAPTER 12 EVALUATION OF PROJECTS AND RECOMMENDATIONS

12.1 Project Effects and Monitoring

Operation and effect indicators, or performance indicators, are selected to measure quantifiable performance of the project for the purposes of ex-ante and ex-post evaluation (See **Table 12.1.1**) The target year for the ex-ante evaluation (two years after the completion) is set in 2023 in accordance with the implementation program that schedules the project completion in April 2021 (See "**Chapter 8 Project Cost and Implementation Schedule**").

Table 12.1.1: Baseline Data and Targets of Operation and Effect Indicators

Project Component and Indicator		Baseline (2012)	Target (2025) 2 yrs after completion
1. Kalu Ganga Water Supply Project Phase II Stage 1			
1.1 Kandana WTP Expansion			
(1) Water Supply Amount	m^3/day	**N/A**	**140,000 (Max.)**
(2) Facility Usage Rate		**N/A**	**100% (Max.)**
1.2 Transmission and Distribution Network Development			
(3) Served Population	persons	**262,358**	**903,758**
Colombo District	persons	103,661	391,996
Homagama DSD		0	30,560
Kesbawa DSD		0	160,669
Moratuwa DSD		103,661	189,867
Rathmalana DSD		0	10,899
Kaluthara District	persons	158,697	511,763
Horana DSD		11,201	92,600
Madurawala DSD		3,329	13,095
Millaniya DSD		2,675	19,905
Bandaragama DSD		29,694	113,922
Panadura DSD		91,605	190,514
Kalutara DSD		20,193	81,726
(4) Service Connections	connection	**64,957**	**223,549**
Colombo District	connection	25,283	95,609
Homagama DSD		0	7,454
Kesbawa DSD		0	39,188
Moratuwa DSD		25,283	46,309
Rathmalana DSD		0	2,658
Kaluthara District	connection	39,674	127,941
Horana DSD		2,800	23,150
Madurawala DSD		832	3,274
Millaniya DSD		669	4,976
Bandaragama DSD		7,424	28,481
Panadura DSD		22,901	47,629
Kalutara DSD		5,048	20,432

Project Component and Indicator		Baseline (2012)	Target (2025) 2 yrs after completion
1. Kalu Ganga Water Supply Project Phase II Stage 1 (Cont.)			
1.2 Transmission and Distribution Network Development (Cont.)			
(5) Supply Hours		-	-
Colombo District	hours/day	-	-
Homagama DSD		20 - 24	24
Kesbawa DSD		20 - 24	24
Moratuwa DSD		20 - 24	24
Rathmalana DSD		20 - 24	24
Kaluthara District	hours/day	-	-
Bandaragama DSD		20 - 24	24
Horana DSD		20 - 24	24
Kaluthara DSD		20 - 24	24
Madurawala DSD		20 - 24	24
Millaniya DSD		20 - 24	24
Panadura DSD		20 - 24	24
2. NRW Reduction in Dehiwala and Moratuwa Areas			
(6) NRW Rate		**33.0%**	**19.1%**
(7) Served Population	persons	**329,154**	**399,139**
Dehiwala DSD		83,348	100,471
Ratmalana DSD		90,259	108,800
Moratuwa DSD		155,547	189,867

Note:

(1), (2) Water Supply Amount and Facility Usage Rate

The treatment capacity of 140,000 m^3/day is designed at maximum day demand in 2025.

(3), (7) Served Population

The baseline data are estimated from the 2012 census data (See **Chapter 4**).

(4) Service Connections

The baseline data are estimated from the population estimates assuming a family size of 4.1 persons per household for Colombo District and 4.0 for Kaluthara District.
The data will be revised in further study on the detailed design stage by adopting actual connection data of NWSDB and other available data.

Source: JICA Survey Team

12.2 Overall Evaluation of Projects

The implementation of the Kalu Ganga Water Supply Project Phase II and NRW Reduction in Dehiwala and Moratuwa are necessary to raise the overall bottom level (e.g. living environment, hygienic environment, economic level, and etc.) in the Survey Area. The Survey Area, in the Colombo and Kalutara Districts, has a total population of approximately 1.7 million at present and continues to be being developed. The projects are considered highly cost-effective investments that would conserve energy and cost for operations through the improvement of water supply conditions, increase in overall efficiency of the systems, and reduction of water losses.

The implementation of projects and all proposals and recommendations in the Survey will be quite effective in addressing current issues, improving the water supply conditions, developing the necessary water supply and management systems.

The projects are also positive achievements from a social perspective as they have very low negative impacts on the environment, and would benefit local residents directly through the improvement of living conditions.

In conclusion, the overall evaluation can be summarized in **Table 12.2.1**.

Table 12.2.1: Summary of the Overall Evaluation of the Projects

No.	Criteria	Evaluation
1	Relevance	The implementation of the projects proposed in the Survey, which will raise the level of water supply condition, are recognized as relevant because the projects will increase service ratio, quantity and service hours, and it conforms to the National Policies, Millennium Development Goals, and NWSDB visions.
2	Effectiveness	The implementations of the projects are assessed as effective because they will increase the number of beneficiaries and satisfaction of water demand.
3	Efficiency	The implementation of the projects are efficient because they targets one of the economic, trade and commercial centers of Western Province, and will secure the stability of water supply and reduce water losses.
4	Impacts	It is expected that the implementation of the projects will cause positive impacts such as: 1) the improvement of water supply services; and 2) reduction of energy for operation and maintenance.
5	Sustainability	The knowledge and skills for water supply management are sufficient in the Survey Area because NWSDB has enough experiences in operation and maintenance. In order to ensure technical sustainability however, experienced and skilled personnel are required to educate new staff. As for financial sustainability, adequate water loss reduction should be achieved and adequate water tariff should be set for sustainable operation and maintenance of the facilities to be constructed by the priority projects. As for institutional sustainability, the NWSDB should keep good coordination with relevant authorities.

Source: JICA Survey Team

12.3 Recommendations

The major recommendations for the implementation of the projects are summarized as follows.

(1) Staged Development (Section 4.3)

Water supply facilities are insufficient to satisfy water demand at present. The Project should be commenced and completed without delay in order to satisfy water demand and improve customer service.

When operation of Kandana WTP / transmission systems is suspended due to several reasons, water supply area will be very limited due to poor backup system. Construction of backup system of Kalu Ganga Water Supply System, such as Backup form Ambatale, Kalatuwawa, Kethhena, Weliwita and Ingiriya systems, should be considered in an early stage.

(2) Water Resources (Section 4.4)

The following survey to be carried out for further development.

- ✓ Water flow measurement at Kandana
- ✓ Estimation of required maintenance flow at Kandana

(3) Water Right and Sharing (Section 4.5)

Recommendations proposed in MPU/2013 should be pushed on.

- ✓ Ensure water right and sharing for KGWSS incorporate among NWSDB and relevant authorities

(4) Kalu Ganga Water Supply System (Section 5.2)

To implement the project of KGWSPII, the following critical issues are required be settled before commencement of the construction works.

- ✓ Review of planning and design in detailed design stage
- ✓ Providing sufficient power supply for the Kandana WTP, reservoirs and pumping stations, and other field equipment
- ✓ Review of design of facilities of WTP for reducing sizes to save space and make the operations efficiently handled by the plant operators.
- ✓ Limitation/ avoidance of polymer for water treatment
- ✓ Future plan of disposal of dried sludge (while dried sludge can be stored on the premises for the time being)
- ✓ Land acquisition for the proposed Kesbewa, Delkada, Bandaragama and Keselwatta ground reservoir sites and a site along distribution pipeline
- ✓ Collecting existing underground utilities such as water supply, sewerage, drainage, power and communication utilities
- ✓ Carrying out surge analysis and providing necessary measures for all pumping pipelines
- ✓ Review of transmission pumping arrangement in multi destinations system to avoid operational problems
- ✓ Review and study the suitability of restraining methods of existing gravity pipelines which will be utilize as pumping pipelines
- ✓ Discuss with M&E sections of NWSDB on energy saving measures and the revised plan
- ✓ Review of DMA boundaries based on topographic mapping and cadastral survey
- ✓ Review of distribution feeder mains based on the result of above revision of DMA boundaries
- ✓ Review of distribution secondary and tertiary mains to utilize existing distribution pipes efficiently
- ✓ Identification and development of new connections to be supplied
- ✓ Cooperation with relevant authorities for the implementation of the project

(5) NRW Reduction in Dehiwala and Moratuwa (Section 5.3)

In order to maximize the potential effect of the proposed project for NRW in Dehiwala and Moratuwa, JST supports the following recommendations:

- ✓ Technical assistance program (e.g., dispatch of individual experts, and implementation of capacity development project) for O&M of DMA, including further reduction activity of NRW, should be conducted, coordinating the schedule of the physical works to be done under the Project
- ✓ Before or during the initial phase of D/D phase, some samples should be taken from the old CI pipes that are currently considered for re-lining to verify the actual condition of inner layer and outer body of the pipe
- ✓ In order to ensure that water reaches Kohuwala GR, all direct distribution on the transmission line to the Kohuwala GR (except for the distribution line to the parliament) should be stopped

(6) Environmental and Social Aspects (Chapter 7)

The followings are recommended:

- ✓ Land acquisition for the proposed Kesbewa, Delkada, Bandaragama and Keselwatta ground reservoir sites and a site along distribution pipeline
- ✓ Appropriate level of water tariff for low income households should be taken
- ✓ Promote and facilitate the equal participation of men and women as stakeholders and beneficiaries of the project

(7) Proposed TOR for Engineering Service (Chapter 8)

Relevant laws and regulations should be reviewed and revised as necessary with reference to the latest ones.

(8) Financial and Economic Aspects (Section 9.1 and Section 10.6)

In order to achieve financial viability, following must be ensured for the project:

- ✓ GOSL should constantly increase the water tariff level as indicated in the financial analysis results (See **Section 9.1**)
- ✓ GOSL should provide necessary grant subsidy for the initial investment, following the financing structure of existing ODA loan projects

Other financing options that do not take government grants, such as the direct borrowing of ODA loan by NWSDB, are deemed not financially viable unless unrealistically drastic water tariff increase may take place for end customers. Also, NWSDB is not capable of such financial arrangements and relevant costs in those cases.

For long-term financial soundness and sustainability of the public water services, it is recommended that:

- ✓ GOSL should establish a regulatory framework for more accountable water tariff adjustment mechanism applicable to NWSDB customers
- ✓ GOSL and NWSDB should elaborate a long-term road map for financial restructuring of NWSDB towards its less dependence on the government financial support

(9) Project Management (Section 10.3)

To establish the safety management system and to ensure the safety of works both in O&M and construction works, implementation of following items will be recommended.

- ✓ Establishment of the organization for safety management
  - Personnel in charge of safety management will be decided in Head Office and Regional Offices
  - Periodical conference will be held and information will be shared
- ✓ Publication of Safety Manual
  - Safety Manual will be revised periodically using PDCA cycle
  - Safety Manual should be easy to use for personnel in charge of O&M and construction
- ✓ Sharing of accident information
  - Information of accidents should be aggregated to database which all personnel can access, and should be used to prevent similar accidents in the future
- ✓ Analysis of the cause of accident
  - Each accident should be analysed to find the contributing factors
  - Measures to prevent similar accidents should be implemented
- ✓ Implementation of field patrol
  - Perform field patrol to inspect and verify implementation of the safety manual
  - It is desirable to make an inspection manual
- ✓ Implementation of Training of Safety management
  - Training of safety Management regarding safety manual and above mentioned items should be implemented
  - Text for this training materials prepared by JICA will be available

(10) Institutional Improvement (Section 10.5.1)

In this project for NRW measures these engineers and teams will work to the fullest and look after the followings;

- ✓ The collection and analysis of pressure and flow data throughout each WSS, enabling water balances to be carried out throughout the WSSs
- ✓ Recording of all leaks reported and repaired in the GIS database
- ✓ Prioritizing of ALC sweeps and other water loss management activities in each area
- ✓ Co-ordination between the differing sections, which directly affect the NRW in the WSSs

(11) Human Resources Development (Section 10.5.2)

1) Utilization of New Training Center

- ✓ The new training center, which will be have hands-on training facilities and accommodation facilities, is under construction through an ADB loan
- ✓ For human resource development, this center must be used to the fullest
- ✓ To complete programs of trainings and to implement them in this center, Japanese technical cooperation, including by Japanese local governments, can be considered

2) NRW Measures

For the human resource development in NRW measures, the following items should be considered;

- ✓ Training for active leakage control methodologies
- ✓ Training for equipment of NRW measurements, such as water leakage detectors and flowmeters
- ✓ Training by example network, enabling differing types of leaks to be simulated in the field
- ✓ Training for DMA system

3) O&M of WTP

For the human resource development in O&M of WTP, the following items should be considered;

- ✓ Promotion of Preventive Management Program (PMP)
- ✓ Training of O&M method of important facilities using PM manuals
- ✓ Training for SCADA (Supervisory Control and Data Acquisition) systems will be recommended

(12) Operation and Maintenance (Section 10.5.3)

1) Water Distribution and NRW Measures

- ✓ Organizational restructuring and securing of a needed budget

2) O&M of WTP

a. Operation Management

- ✓ Preparation of an operation manual to identify operating parameters
- ✓ To set up more concrete operation management targets and move forward systematically by the use of specific energy consumption, performance indicator, and others to make the operations more efficient

b. Maintenance

- ✓ Preparation and Observance of Manuals
- ✓ Diagnosis and Evaluation of Function Deterioration
- ✓ Acquisition of the Expertise, and Improvement of the Skill
- ✓ Proper Maintenance
- ✓ Collection, Preservation, and Utilization of Maintenance Data

3) Maintenance of Electrical Instrumentation

It is important to avoid the poor maintenance as indicated below;

- ✓ Poor design without considering maintenance requirements
- ✓ Inadequate training of the staff
- ✓ Non availability of spare parts
- ✓ Non availability of technical support from equipment manufacturers
- ✓ Non availability of technical information / manuals
- ✓ Asset management
- ✓ Inventory management
- ✓ Preventive maintenance
- ✓ Work order management

4) Energy Conservation

- ✓ Installation of power-factor correction capacitors for the large motors
- ✓ Use of Variable frequency drive motors
- ✓ Use of high-efficiency motors

5) Procurement of Materials

- ✓ The head office buys them in bulk based on the total demand from all of the local offices. As such, there is little space for improvement concerning procurement of materials.

6) Water Quality Management

- ✓ It is important that the prepared plan be disclosed to the customers to make the water quality examination proper and transparent

7) Asset Management

Implementation of asset management will be considered preparing procedures as follows;

- ✓ Determination of asset management policy
- ✓ Definition of asset categorization and life time
- ✓ Establishment of asset database
- ✓ Asset condition survey
- ✓ Asset valuation
- ✓ Cost estimate for rehabilitation or replacement
- ✓ Financing and budgeting

(13) Financing for Projects Implementation (Section 10.6)

- ✓ Preparation of the reliable Financing (Government grant for the own fund portion)

(14) Public-private Partnership (Chapter 11)

- ✓ No PPP arrangement for this Project as yen loan financing will be provided in principle
- ✓ Development of PPP promoting framework in the medium or long term
- ✓ Formulation of competitive PPP projects using Japanese superior technologies