

THE REPUBLIC OF THE UNION OF MYANMAR
YANGON CITY DEVELOPMENT COMMITTEE (YCDC)

**PREPARATORY SURVEY
FOR
GREATER YANGON
WATER SUPPLY IMPROVEMENT PROJECT
(PHASE II)**

SUMMARY

FEBRUARY 2017

JAPAN INTERNATIONAL COOPERATION AGENCY

**TEC INTERNATIONAL CO., LTD.
NIPPON KOEI CO., LTD.
NJS CONSULTANTS CO., LTD.**

1R
JR
17-027

**THE REPUBLIC OF THE UNION OF MYANMAR
YANGON CITY DEVELOPMENT COMMITTEE (YCDC)**

**PREPARATORY SURVEY
FOR
GREATER YANGON
WATER SUPPLY IMPROVEMENT PROJECT
(PHASE II)**

SUMMARY

FEBRUARY 2017

JAPAN INTERNATIONAL COOPERATION AGENCY

**TEC INTERNATIONAL CO., LTD.
NIPPON KOEI CO., LTD.
NJS CONSULTANTS CO., LTD.**

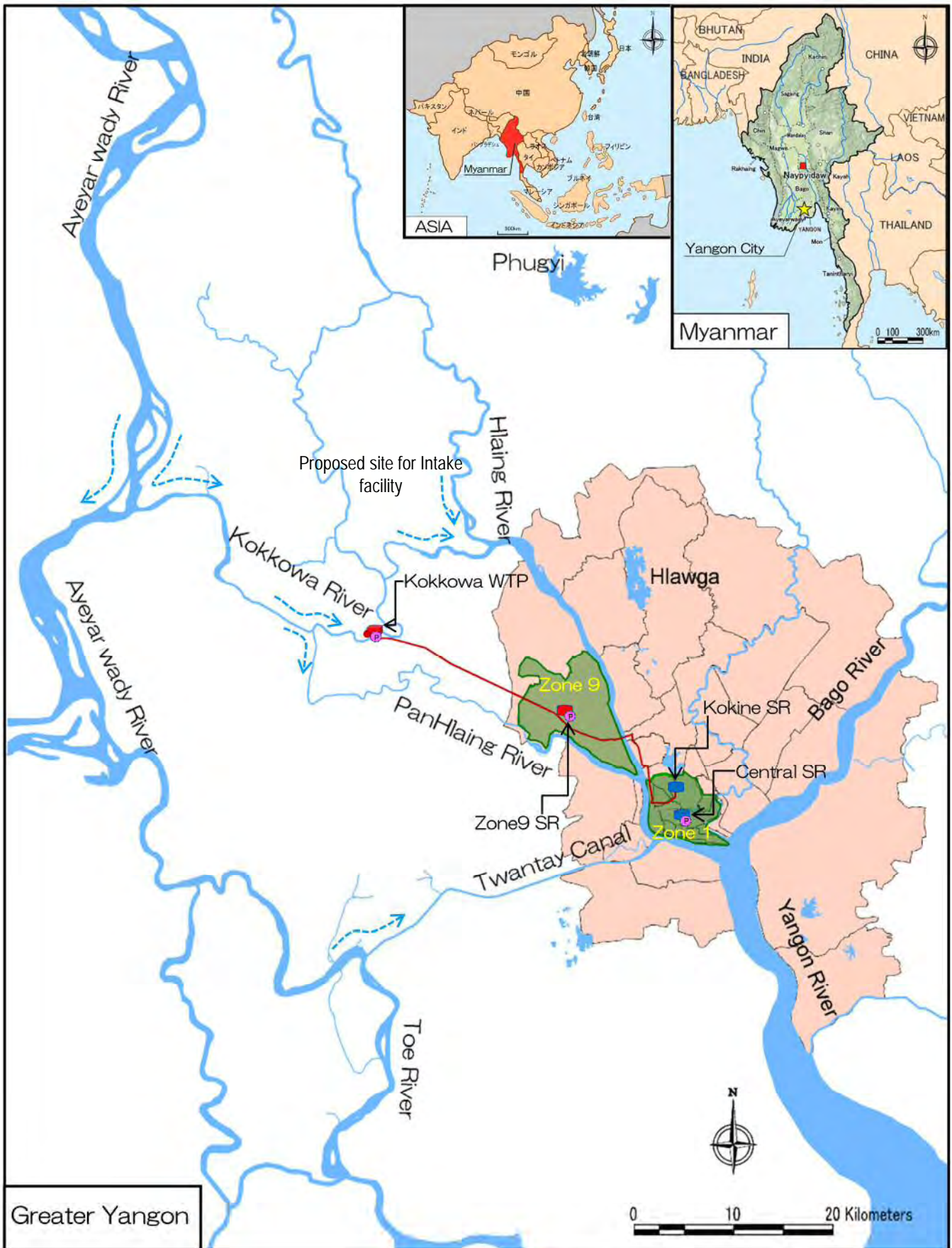
Foreign Exchange Rate

1 USD = 109.2 JPY

1 USD = 1183.0 Kyat

1 Kyat = 0.0923 JPY

(As of July 2016)



Location Map



Map of 33 townships in YCDC Area and 10 Water Supply Zones

**PREPARATORY SURVEY FOR GREATER YANGON WATER SUPPLY
IMPROVEMENT PROJECT (PHASE2)**

Location Map

Map of 33 townships in YCDC Area and 10 Water Supply Zones

Table of Contents

List of Tables/ Figures

List of Abbreviations

Abbreviation for The Relevant Studies

Unit

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION	1
1.1 Outline of Phase 2 Project.....	1
1.2 Outline of This Study.....	1
CHAPTER 2 CHARACTERISTICS OF YANGON CITY.....	3
CHAPTER 3 REVIEW OF MASTER PLAN	4
3.1 Review of Planning Framework	4
3.2 Revised Supply Capacity Development.....	5
3.3 Water Allocation to 10 Zones.....	6
3.4 Revised Main Water Supply Facilities	7
CHAPTER 4 WATER TREATMENT PLANT.....	10
4.1 Appropriateness of The Site Location	10
4.2 Water Quality and Treatment Process.....	10
4.3 Project Sites of WTP.....	12
4.4 Planning of Intake Facility.....	13
4.5 Planning of Kokkowa WTP.....	14
CHAPTER 5 TRANSMISSION FACILITY	22
5.2 Summary of Transmission Facilities for Zone 9.....	23
5.3 Summary of Transmission Facilities for Zone 1.....	23
CHAPTER 6 DISTRIBUTION FACILITIES OF ZONE 9.....	28
CHAPTER 7 DISTRIBUTION FACILITIES OF ZONE 1.....	31
CHAPTER 8 OPERATION, MANAGEMENT AND CAPACITY.....	35

8.1	Current Challenges to Existing Facilities	35
8.2	Organization Structure for Maintenance.....	35
8.3	Technical Assistance by the JICA Technical Assistance Project and by this Project.....	35
CHAPTER 9 IMPLEMENTATION SCHEME OF THE PROJECT.....		36
9.1	Scope of Works of Phase 2 Project	36
9.2	Preparation of Implementation Schedule.....	40
9.3	Organizational Structure for Implementing The Project.....	40
CHAPTER 10 FINANCIAL AND ECONOMIC ANALYSIS.....		43
CHAPTER 11 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS.....		44
11.1	Environmental and Social Condition	44
11.2	Land Acquisition and Resettlement Issue	44
11.3	Stakeholder Meetings for WTP Site	45
11.4	Social and Economic Interview Survey on the Proposed Alignment of Transmission Pipeline along the Route No. 5	45
CHAPTER 12 PROJECT EFFECTS.....		47
12.1	Quantitative Effects	47
12.2	Qualitative Effects	48
CHAPTER 13 RECOMMENDATIONS.....		50

LIST OF TABLES

Table 3-1	Revised Water Demand and Service Level Targets for Yangon City	4
Table 3-2	Water Demand for Yangon City as per 2014 JICA Water MP (reference).....	4
Table 3-3	Revised Water Source Development for Yangon City under This Study	5
Table 4-1	Target Water Quality after Treatment with Reference to Other Standards.....	10
Table 9-1	Detailed Project Scope of Phase 2 Project	37
Table 9-2	Roles and Responsibilities of Project Organizations	41
Table 12-1	Evaluation and Performance Indicators	47
Table 12-2	Monitoring of Operation and Effect Indicators.....	48

LIST OF FIGURES

Figure 3-1	Revised Water Source Development for Yangon City.....	6
Figure 3-2	Revised Water Supply System (2025) for This Project	8
Figure 3-3	Revised Water Supply System (2040) for This Project	9
Figure 4-1	Proposed Water Treatment Process	12
Figure 4-2	Land Acquisition Status of YCDC as of 31 July 2016	12
Figure 4-3	Setting of Intake Location under Consideration.....	13
Figure 4-4	Proposed Layout of WTP (for 140 MGD).....	15
Figure 4-5	Proposed Layout of WTP (1 st Stage of 60 MGD).....	15
Figure 4-6	Layout Plan (1/2).....	17
Figure 4-7	Layout Plan (2/2).....	18
Figure 4-8	Water Level Chart.....	19
Figure 4-9	Flow Sheet (Intake)	20
Figure 4-10	Flow Sheet (WTP).....	21
Figure 5-1	Stepwise Transmission Plan to Zone 9 SR/RPS.....	22
Figure 5-2	Layoutplan of Zone 9 SR and Relay Pump Station.....	24
Figure 5-3	Index MAP (Htantabin and Hlaing Tharyar TS)	25
Figure 5-4	Hlaing River Crossing Plan and Longitudinal Section.....	26
Figure 5-5	Index MAP (Yangon City).....	27
Figure 6-1	Distribution Main Pipe for Zone 9 in 2025	29
Figure 6-2	Distribution Pipe with DMA for Zone 9.....	30
Figure 7-1	Distribution Pipe with DMA for Zone 1.....	31
Figure 7-2	Distribution Main Pipes for Low Subzone by Gravity System from Kokine SR (upper figure) and for High subzone by Pump System from Central SR (lower figure).....	32
Figure 7-3	Layout Plan of Kokine SR.....	33
Figure 7-4	Layout Plan of Central SR.....	34
Figure 9-1	Scope of Works of Phase 2 Project.....	37
Figure 9-2	Proposed Organizational Arrangement for Project Implementation	41
Figure 10-1	Financing Structure of JICA ODA Loan	43
Figure 10-2	Case of Grant Subsidy from Union Government	43

LIST OF ABBREVIATIONS

ACH	Aluminum Chlorohydrate
CIP	Cast Iron Pipe
DCIP	Ductile Cast Iron Pipe
DMA	District Metered Area
EDWS	Engineering Department (Water & Sanitation)
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
FS	Feasibility Study
GIS	Geographical Information System
HDPE	High-Density Polyethylene
HHWL	Highest High Water Level
HIV	Human Immunodeficiency Virus
HWL	High Water Level
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
Kyat	Myanmar Kyat
L/A	Loan Agreement
LLWL	Lowest Low Water Level
LPCD (or lpcd)	Liters Per Capita per Day
LWL	Low Water Level
MG	Million Gallons
MGD	Million Gallons per Day
MoAI	Ministry of Agriculture, Livestock and Irrigation
MP	Master Plan
MS	Mild Steel Pipe
MVA	Megavolt-Ampere
N/A	Not Available
NRW	Non Revenue Water
NTU	Nephelometric Turbidity Unit
ODA	Official Development Assistance
O&M	Operation & Maintenance
PCP	Prestressed Concrete Pipe
PS	Pumping Station
RPS	Relay Pumping Station
SCADA	Supervisory Control And Data Acquisition
SHM	StakeHolder Meeting
SR	Service Reservoir
US\$, USD	United States Dollars
VFD	Variable Frequency Drive
WHO	World Health Organization
WTP	Water Treatment Plant
YCDC	Yangon City Development Committee
YRG	Yangon Region Government

ABBREVIATION FOR THE RELEVANT STUDIES

The Project for the Improvement of Water Supply, Sewerage and Drainage System in Yangon City (JICA)	2014 JICA Water MP or Phase 1 FS
Greater Yangon Water Supply Improvement Project (Phase 1)	Phase 1 Project
The Project for Urgent Improvement of Water Supply System in Yangon City	Japanese Grant Aid Project
Preparatory Survey for Greater Yangon Water Supply Improvement Project (Phase 2)	This Study
Greater Yangon Water Supply Improvement Project (Phase 2)	This Project

UNIT

Area

1 Acre = 4046.86 m² (square meter) = 0.404686 ha (hectare)

Length

1 ft (foot) = 0.3048 m (meter)

1 mi (mile) = 1.61 km (kilometer)

Volume

1 Gallon (imperial gallon) = 0.004546 m³ (cubic meter) = 4.546 l (liter)

1 MG (million imperial gallon) = 4546 m³ (cubic meter)

Pressure

1 MPa (Mega Pascal) = 10 bar \doteq 100 mAq as water head

CHAPTER 1 INTRODUCTION

1.1 Outline of Phase 2 Project

(1) Objectives

The project aims at improving water supply services to meet the increasing water demand by using raw water from the Kokkowa River and constructing a new WTP and construction and rehabilitation of associated transmission and distribution facilities, which in turn will contribute the improvement of living environment and economic development of Yangon City.

(2) Implementing Organization

Engineering Department (Water and Sanitation), Yangon City Development Committee (YCDC)

(3) Assistance Activities Related to The Japanese Project

- Japanese ODA Loans (Japanese ODA-loan) for “Greater Yangon Water Supply Improvement Project (Phase-1)”
- Japanese Technical Cooperation for “The Project for Improvement of Water Supply Management of YCDC”
- Advisor on Water Supply and Sanitation Improvement in Yangon City

1.2 Outline of This Study

(1) Study Objectives

JICA study team is to firstly study and analyze the background, objectives and scope of the Project to decide whether the Project is necessary or not. If the Project is confirmed necessary, JICA study team is to study on appraisal items required for implementing the Project under the ODA loan project, such as objectives, scope, cost, implementation schedule, implementation method (procurement and construction), implementing organization, operation and maintenance organization, environmental and social considerations, and so on. However, the Study itself does not mean that JICA promises ODA loan to Myanmar counterpart.

(2) Study Method and Schedule

“The project for the improvement of water supply, sewerage and drainage system in Yangon city” was conducted from 2012 to 2014 by JICA. It includes the preparation of water supply MP (2014 JICA Water MP) and feasibility study of Zone 1. In this study, JICA study team has reviewed the MP and updated in terms of future population, reflecting the 2014 census to confirm future water demand and water balance in Yangon. Based on the updated demand, facility plan of Zones 1 and 9 was formulated and compiled as Interim Report 1 (August 2015) and Interim Report 2 (February 2016). Considering the comments in the Interim Reports and outcome of financial analysis, Draft Final Report was

prepared and submitted (April 2016). Subsequently, the Final Report was prepared and submitted (February 2017) based on result of all the study outcomes and considering comments of counterpart on the Draft Final Report.

CHAPTER 2 CHARACTERISTICS OF YANGON CITY

(1) Topography

Yangon city is situated at 34 km inland from the mouth of the Yangon River which traverses parts of the Ayeyarwady delta. The relief of the city varies from flat plains to lowland hills in the central part. Flat plains are extensive and occur mostly in the eastern and western parts as wide flat bottoms along the rivers. These flat lands have elevation between about 3m (10ft) to 6m (20ft) above mean sea level.

Yangon city has, in the center, lowland hills commonly known as the faulty zone ponds with artificial dams namely Kandawgyi Lake, Inya Lake, Hlawga Reservoir, Gyobu Reservoir and Phugyi Reservoir which used to be or are main sources of water supply system for YCDC. There are three service reservoirs are located on the hills. A long and narrow spur of Pegu Yomas in the central area runs almost in N-S direction with an average height of 30 m (100 ft) and slopes gradually into flat plains towards east and west.

(2) Climate

Yangon has a tropical monsoon climate which consists of three seasons as listed below. It has an annual rainfall of 2,700 mm, annual evaporation of 1,347 mm, average temperature of 27.4 °C, maximum mean temperature of 33 °C, and minimum mean temperature of 21.8 °C.

- Summer season: March–mid May
- Rainy season: Mid May–October
- Dry season: October–February

(3) Rainfall

The annual mean rainfall is 2,700 mm. About 95% of the total annual rainfall occurs during the rainy season from May to October based on data of 2001 to 2008 in Yangon (Kaba Aye).

CHAPTER 3 REVIEW OF MASTER PLAN

3.1 Review of Planning Framework

The outline of the 2014 JICA Water MP was reviewed. The population data of 2011 used in the MP was estimated and not reliable. Now the reliable data of 2014 census data, is available and the study team compared the census data with the data used in the MP in order to confirm whether the planning framework is still valid or need to be modified. After the review, the study team has confirmed that the framework is still valid with some minor modifications.

After the confirmation, water allocation up to 2040 (target year of the MP) is revised. The revised water allocation is almost the same as in the MP with some numbers changed and the study team has confirmed on the necessity of the 60 MGD Kokkowa system till 2025, target year of this study.

Table 3-1 Revised Water Demand and Service Level Targets for Yangon City

Item	Unit/ Year	2014	2025	2040
Population	1,000 person	5,211	6,464	8,520
Served Population	1,000 person	<u>1,845</u>	<u>3,618</u>	<u>6,661</u>
Water Supply Coverage Ratio	%	<u>35</u>	<u>56</u>	<u>78</u>
Unit Consumption (Domestic) City/suburbs*	Lpcd	111/69	150/100	200/150
Unit Consumption (Non-domestic) City/suburbs *	Lpcd	74/46	100/67	133/100
Leakage Ratio	%	50	25	10
Daily Average Water Demand	1,000 m ³ /day	643	<u>1,072</u>	<u>2,174</u>
Daily Maximum Water Demand	1,000 m ³ /day	708	<u>1,179</u>	<u>2,391</u>
Daily Average Water Demand	MGD	142	<u>237</u>	<u>477</u>
Daily Maximum Water Demand	MGD	<u>156</u>	<u>258</u>	<u>525</u>
Water Pressure	MPa	0.075	More than 0.15Mpa	
Supply Duration (average)	Hour	8	24	
Water Quality	-	Not drinkable	Drinkable	

Note: * The numbers in the Right are applied to South of CBD and New Suburbs Zone, and in the Left are for other area.

Source: JICA Study Team

Table 3-2 Water Demand for Yangon City as per 2014 JICA Water MP (reference)

Item	Year	2011	2025	2040
Population	1,000 person	5,142	6,464	8,520
Served Population	1,000 person	1,934	3,764	6,810
Water Supply Coverage Ratio	%	38	58	80
Unit Consumption (Domestic) *	Lpcd	95	150/100	200/150
Unit Consumption (Non-domestic) City/suburbs *	Lpcd	63	100/67	133/100
Leakage Ratio	%	50	25	10
Daily Average Water Demand	1,000 m ³ /day	612	1,126	2,243
Daily Maximum Water Demand	1,000 m ³ /day	673	1,238	2,467
Daily Average Water Demand	MGD	135	248	493
Daily Maximum Water Demand	MGD	148	272	543

Item	Year	2011	2025	2040
Water Pressure	MPa	0.075	More than 0.15Mpa	
Supply Duration (average)	Hour	8	24	
Water Quality	-	Not drinkable	Drinkable	

Note: * The numbers in the Right are applied to South of CBD and New Suburbs Zone, and in the Left are for other area.

Source: 2014-JICA Water MP

3.2 Revised Supply Capacity Development

(1) Revised Water Source Development for Yangon City

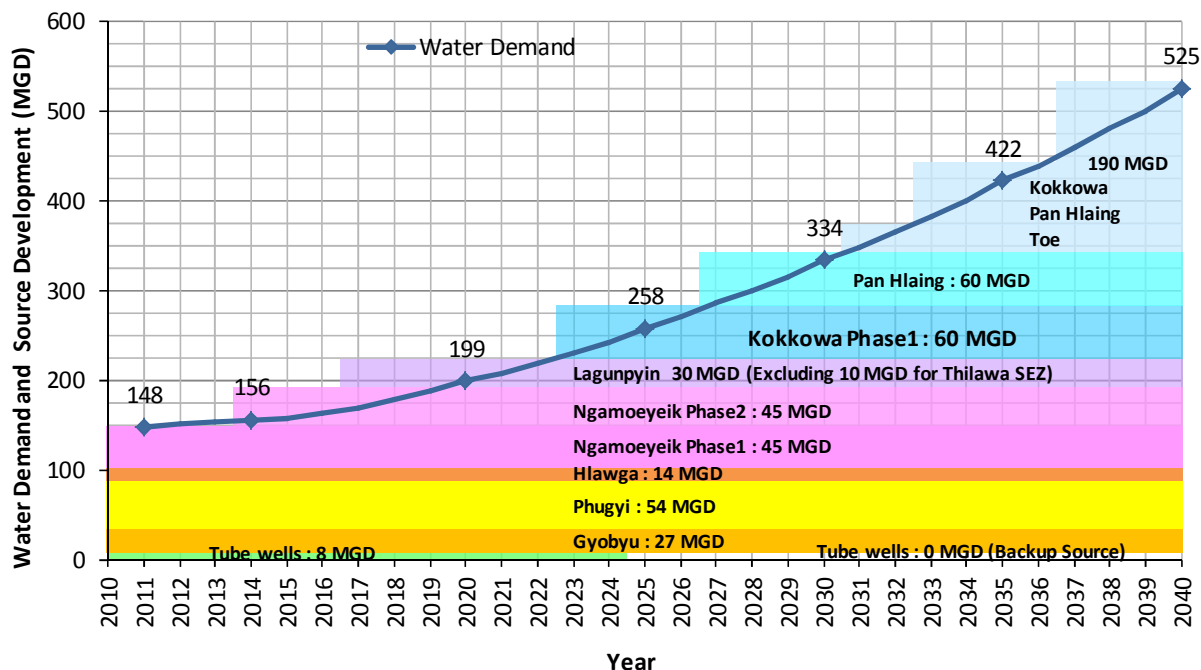
Although the Kokkowa River and the Toe River have been selected as additional water sources to meet the demand after 2025 in the 2014 JICA Water MP, YCDC has identified the Pan Hlaing River as another water source after the MP study. Considering the new water source of Pan Hlaing, water development scenario proposed in the MP is revised in this Study as below.

Table 3-3 Revised Water Source Development for Yangon City under This Study

Year	2014	2020	2025	2030	2035	2040
Daily Maximum Demand	156	199	258	334	422	525
Water Source						
(Reservoir (Dam) System)						
Gyobyu Reservoir	27	27	27	27	27	27
Phugyi Reservoir	54	54	54	54	54	54
Hlawga Reservoir	14	14	14	14	14	14
Ngamoeveik Reservoir	90	90	90	90	90	90
Wells	8	8	0	0	0	0
Lagunbyin Reservoir*	-	30	30	30	30	30
Sub-total (1)	193	223	215	215	215	215
(River System)						
Kokkowa Ph 1	-	-	60	60	60	60
Pan Hlaing Ph 1	-	-	-	60	60	60
Kokkowa Ph 2 or Pan Hlaing Ph 2 or Toe	-	-	-	-	100	190
Sub-total (2)	-	-	60	120	220	310
Water Source Total	193	223	275	335	435	525
Balance (Supply – Demand)	+37	+24	+17	+1	+13	0

Note: * Excluding 10 MGD capacity for Thilawa SEZ,

Source: JICA Study Team



Source: JICA Study Team

Figure 3-1 Revised Water Source Development for Yangon City

(2) Expansion Plan of Kokkowa WTP

The overall capacity in the plan of Kokkowa WTP will be set to be 140-180 MGD as it changes depending on the amount of water rights which can be obtained for Pan-Hlaing River. Based on a series of discussions with EDWS, the following expansion plan is tentatively formulated for this Study.

- **Kokkowa Stage 1:** 60 MGD (Total 60 MGD)
- Construction of Pan-Hlaing WTP: Total 60-100 MGD (Under negotiation with MoAI)
- **Kokkowa Stage 2:** +40 MGD (Total 100 MGD)
- **Kokkowa Stage 3:** +40 MGD (Total 140 MGD)
- **Kokkowa Stage 4:** +40 MGD (Total 180 MGD) Will be decided depending on the capacity of Pan-Hlaing WTP.

Although Stage 4 is indefinite, YCDC's current targets are 140 MGD until Stage 3. The target of this study is Stage 1 (60 MGD) from overall plan of Kokkowa WTP.

3.3 Water Allocation to 10 Zones

(1) Changed Points from the 2014 JICA Water MP

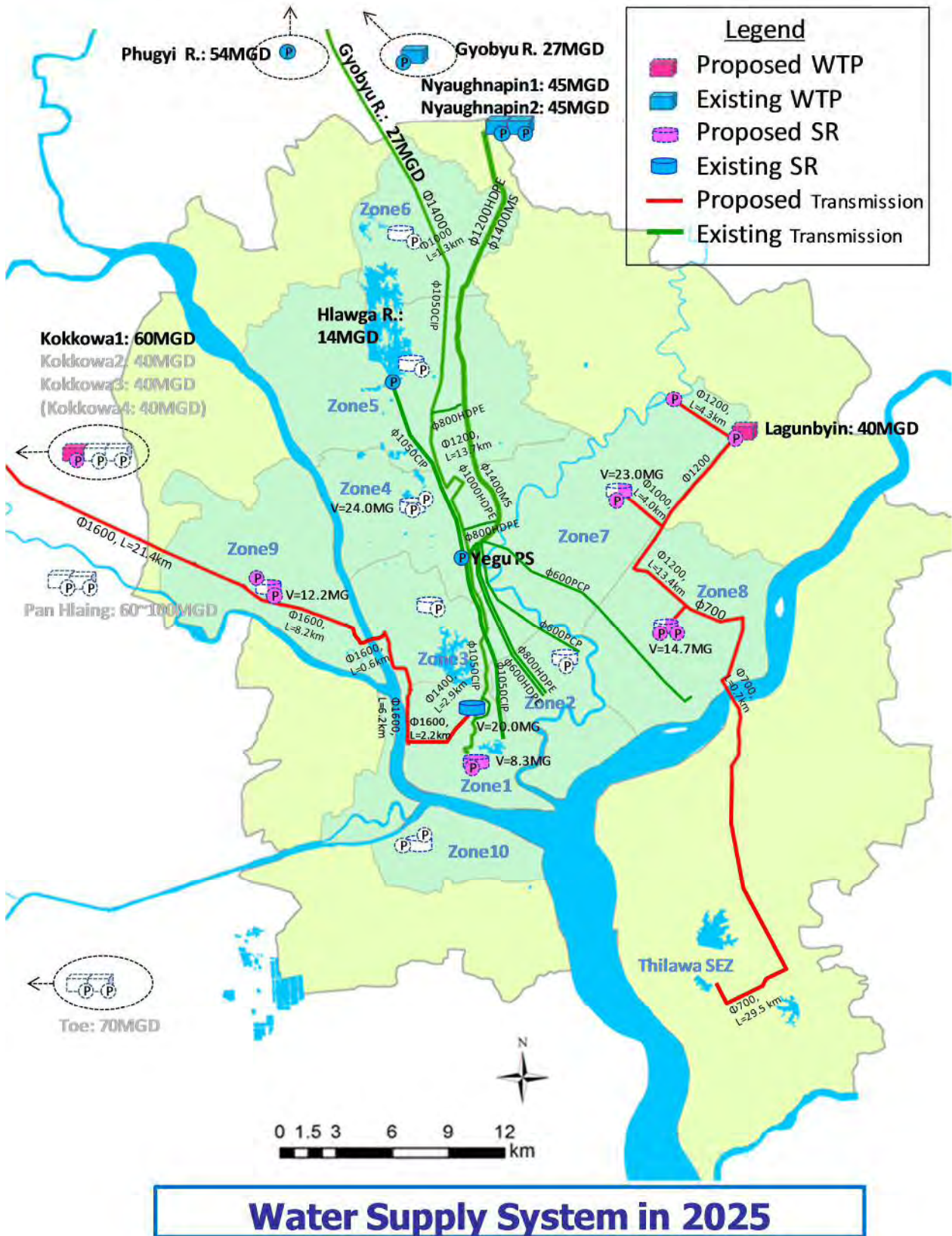
The areas in 10 zones proposed in the MP are not changed; however, locations of the two SRs for Zones 2 and 3 are changed by EDWS considering SRs' sites availability. Location of the Zone 2 SR is shifted from the western side to the eastern side of the zone with name change from Tamway to Thingangyun.

(2) Allocation to Zones 1 and 9 in 2025

Additional water source is required to meet water demand of Yangon city in 2025. According to the proposed water balance, water from the Kokkowa supply system (60MGD) will cover all demand of Zone 9 and partial demand of Zone 1 in 2025. Out of the 60 MGD treated water, 20 MGD water and 40 MGD water will be conveyed respectively to Zone 9 and Zone 1 separately. On the other hand, the remaining 20 MGD water for Zone 1 will continue to be supplied via Yegu pumping station of the existing reservoir system.

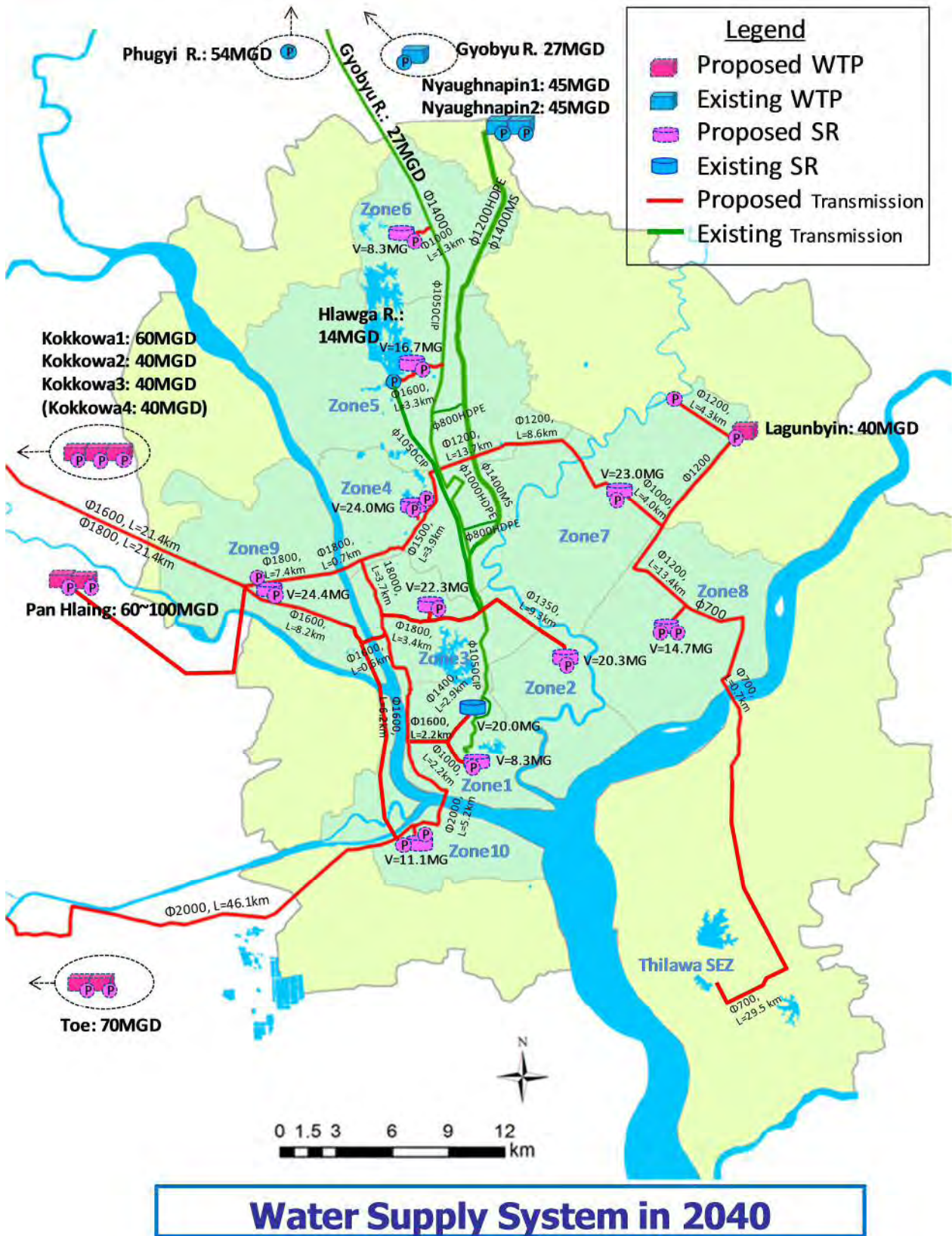
3.4 Revised Main Water Supply Facilities

The revised plans of facilities which will be built by 2025 and by 2040 are illustrated in Figures 3-2 and 3-3.



Source: JICA Study Team

Figure 3-2 Revised Water Supply System (2025) for This Project



Water Supply System in 2040

Source: JICA Study Team

Figure 3-3 Revised Water Supply System (2040) for This Project

CHAPTER 4 WATER TREATMENT PLANT

4.1 Appropriateness of The Site Location

The Kokkowa WTP site is selected based on following considerations.

- Since there is no appropriate place for development of dam as water source, River source needs to be developed newly for Yangon.
- High priority project within the proposed new resource developments
- The raw water quality near intake point must satisfy standards in terms of salt concentration.
- Stabilization of the River Course
- Downstream Water User
- Availability of large land area in the Yangon region.
- Location has good access using the Route No. 5.
- Flood Protection

The considered location is one of the best options, and is determined to be appropriate in consideration of the technical viewpoint and O&M. Consequently, it is judged that the selected site is the most appropriate one.

4.2 Water Quality and Treatment Process

(1) Drinking Water Quality Standard

The target treated water quality is set as the same as in the 2014 JICA Water MP, considering standards in Myanmar and WHO.

Table 4-1 Target Water Quality after Treatment with Reference to Other Standards

Parameters	Allowable Value	WHO standards	Myanmar standards
pH	6.5 – 8.5	N/A	6.5 – 8.5
Taste	Foul smell and taste are not detected	Acceptable	Acceptable
Odor	Foul smell and taste are not detected	Acceptable	Acceptable
Color	5 true color units	15 true color units	15 true color units
Turbidity	5 NTU (1 NTU for target turbidity of treated water in WTP)	1 NTU for target	5 NTU
Standard plate count	< 100CFU/mL	N/A	N/A
Fecal coliforms	Not to be detected	Not to be detected	0
Residual chlorine	To be detected (at service tap by direct supply and before storage tank of customer) The residual chlorine at the exit of WTP shall be set separately, considering the travel time to the end of the service area.	< 5.0 mg/L	N/A
Zinc (Zn)	< 1.0 mg/L	N/A	< 3.0 mg/L
Aluminum	< 0.2 mg/L	N/A	< 0.2 mg/L

Parameters	Allowable Value	WHO standards	Myanmar standards
(Al)			
Iron (Fe)	< 0.3 mg/L	N/A	< 1.0 mg/L
Copper (Cu)	< 1.0 mg/L	< 2.0 mg/L	< 2.0 mg/L
Manganese (Mn)	< 0.05 mg/L	< 0.4 mg/L	< 0.4 mg/L
Hardness	< 100 mg/L	N/A	< 500 mg/L
Chloride ion	< 200 mg/L	N/A	< 250 mg/L
Sulfide	< 200 mg/L	N/A	< 250 mg/L

Source: 2014 JICA Water MP, WHO Guidelines for drinking-water quality, fourth edition and National drinking water quality standards Myanmar (September 2014)

(2) Raw Water Quality

EDWS's laboratory has started water quality tests of the Kokkowa River since May 2015. Variation in average turbidity is 517 NTU in rainy season and 150 NTU in dry season based on combined results of these tests, Phase 1 study and other F/S(s). The following salient features are observed in terms of water quality of Kokkowa River.

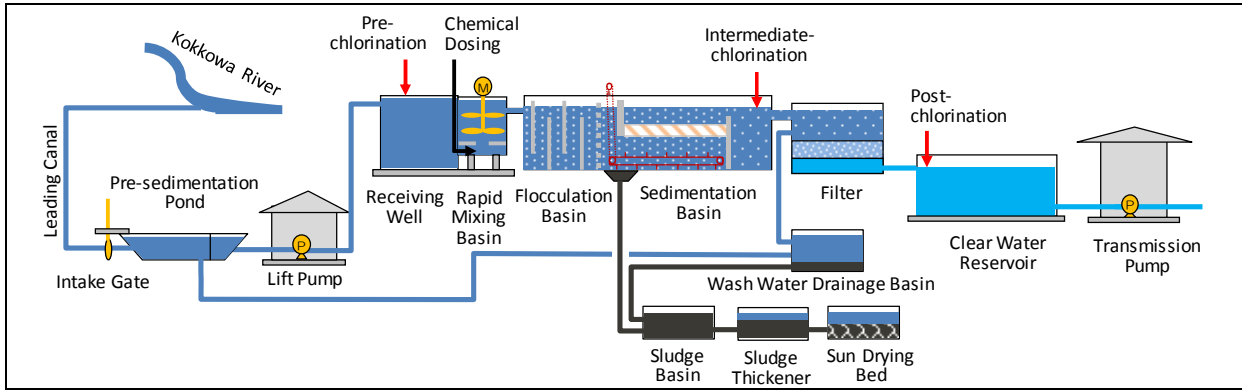
- In general, high level of Turbidity, Color and Iron are observed.
- These parameters generally increase during rainy seasons.

(3) Sedimentation Characteristics

The study team investigated sedimentation characteristic of Kokkowa River water. The water sample was filled in measuring cylinder, and turbidity of surface water was measured at specified intervals of settling in rainy season (May – October, 2015) and in dry season (November, 2015- April, 2016). Trend of turbidities indicates that average turbidity reaches a constant level after 12 hours of settling. On the other hand, the turbidity of river water exceeding 1,000 NTU was observed during about ten (10) days when the long duration rain continued during the end of July to early August 2015. In case of such high level of turbidity, just after settlement of 36 hours the turbidity reduces to less than 100 NTU, and it attains steady value of nearly 50 NTU after 48 hours of settlement. Therefore, the team proposes that size of pre-sedimentation pond should be equivalent to 48 hours of storage volume based on these results.

(4) Water Treatment Process

The main aim of water treatment is to reduce turbidity, color, iron and manganese to acceptable levels. High turbidity, color, iron and manganese concentration can be removed by process of coagulation-sedimentation and rapid sand filtration. Therefore, conventional treatment process is applicable considering raw water quality of Kokkowa River.



Source: JICA Study Team

Figure 4-1 Proposed Water Treatment Process

4.3 Project Sites of WTP

(1) Land Acquisition Status of YCDC

Existing situation of the land obtained by YCDC is as follows (as of July 2016). An illustration of the acquisition of the Project sites that would be required for Project facilities is shown in the following Figure. However, the acquired land is insufficient with 20 Acres for 60MGD of pre-sedimentation pond with 48 hours retention time.

- For Intake Facility : 16,187 m² (4 Acre)
- First obtained land for WTP : 137,593 m² (34 Acre)
- Additional obtained land for WTP : 31,379 m² (7.754 Acre)
- **Total of obtained land by YCDC : 185,159 m² (45.754 Acre)**



Source: YCDC and edited by JICA Study Team

Figure 4-2 Land Acquisition Status of YCDC as of 31 July 2016

(2) Additional Land for Pre-sedimentation Pond

60MGD of pre-sedimentation pond with 48 hours retention time requires large areas of lands; however that could be compensated by small amount of ACH dosing that has a high-cost. Therefore, the result, land acquisition cost could be recovered in a short period of time. The cost comparison of pre-sedimentation pond for 12 and 48 hours retention time is made. Pre-sedimentation pond with 48 hours can reduce the chemical cost of about 28.2 million USD in ten years. Therefore, the study team proposed and agreed that size of pre-sedimentation pond should be equivalent to 48 hours of storage volume based on the result of jar tests by YCDC (refer to Figure 4-5).

4.4 Planning of Intake Facility

(1) Intake Point/ Form of Leading Canal for WTP

The intake point is to be drawn directly from Kokkowa River based on discussion between MoAI, YCDC and Study Team. The form of leading canal for WTP will be finally decided according to the availability of land form which will be purchased under 2016/17 budget of YCDC.



Source: JICA Study Team

Figure 4-3 Setting of Intake Location under Consideration

(2) Proposed Capacities of Intake

There exists the MOAI's embankment along the Kokkowa River that is an important facility to protect against flood water. Therefore, repeated construction of the intake facilities should be avoided and one-time construction is proposed. Hence, intake facilities need to be constructed with 154 MGD (140 MGD x 110%) capacity which is the final capacity at this moment. It is considered that pre-sedimentation pond and lift pumps of 66 MGD (60 MGD x 110%) be the candidate under this plan.

(3) Planning Policy of Intake Facility

The location of intake point and WTP in this project is close to the Kokkowa River. Since fluctuation in water level of the river is large, fluctuation in pump head is also large. However, using the river water level effectively as natural power at the time of high-water level in river, the pump head becomes small and electric power cost can be reduced. Therefore, Kokkowa water is led to WTP by gravity, and lift pumps are installed at the starting point of treatment process. In addition, policy of intake planning is as follows.

- Effective use of natural power sources
- In order to avoid interruption in operation of WTP, intake gates are set below LLWL of the Kokkowa River.
- High turbidity in raw water is reduced using pre-sedimentation pond in order to reduce consumption of chemical.
- To use surface water with low turbidity (of pre-sedimentation pond) than using low layer water.

4.5 Planning of Kokkowa WTP

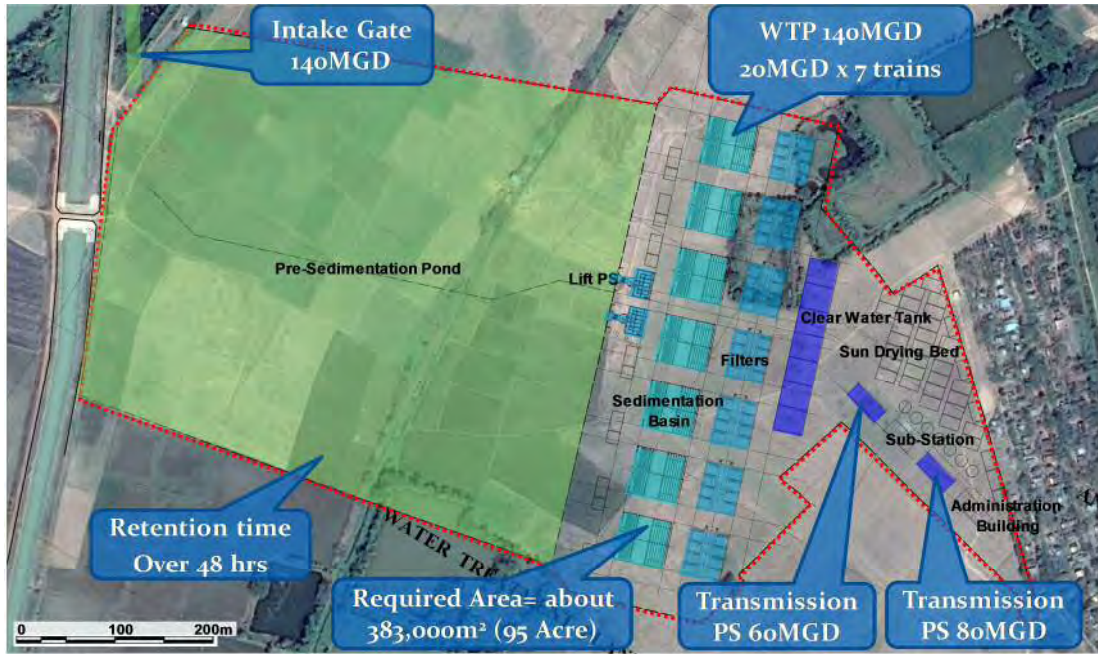
(1) Planning Policy of Kokkowa WTP

For planning of Kokkowa WTP, the following 5 targets are considered to be achieved and this WTP can provide as a model in Myanmar.

Target- 1: Scalable System
➤ A simple train system with easy extension: One train unit is planned from lift pump to clear water tank, one train has the capacity of 20 MGD, and then, 7 trains will be installed to achieve the planned capacity of 140 MGD finally.
Target- 2: Stable Supply
➤ Secure stabilized amount of water from the river
➤ Secure the process of sludge treatment to deal with large amount of mud
➤ Raising up of WTP's ground level as measure against flood and inundation
Target- 3: Water Quality Control
➤ Process that can treat raw water having high turbidity
➤ Water quality monitoring by introduction of automatic measuring equipment
➤ Avoiding dangerous chemicals by using sodium hypochlorite for disinfection
Target- 4: Operation and Maintenance
➤ Collection of data on flow rate in each treatment process by SCADA
➤ Adjustable equipment of chemical injection considering the fluctuation in raw water quality
Target- 5: Environmental Consideration
➤ Reduction of power consumption of pump by inverter control
➤ Introduction of back-washing method for filters to reduce consumption of unnecessary pump power

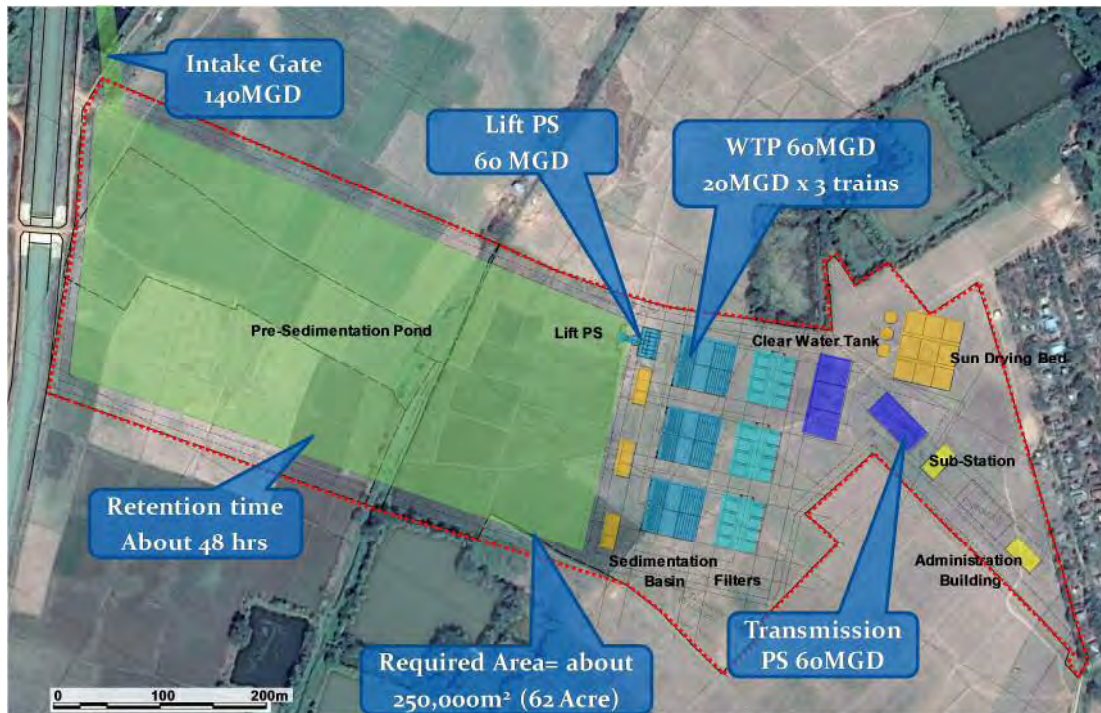
(2) Layout Plan of Kokkowa WTP

As is proposed in the preceding section and as YCDC has agreed to acquire additional land in the fiscal year 2016/17 to have 60 MGD of pre-sedimentation pond with 48 hours retention time, layout of the WTP is planned for 60 MGD capacity. Firstly, layout of the 140 MGD WTP is considered and then, layout of the 60 MGD WTP is proposed.



Source: JICA Study Team

Figure 4-4 Proposed Layout of WTP (for 140 MGD)

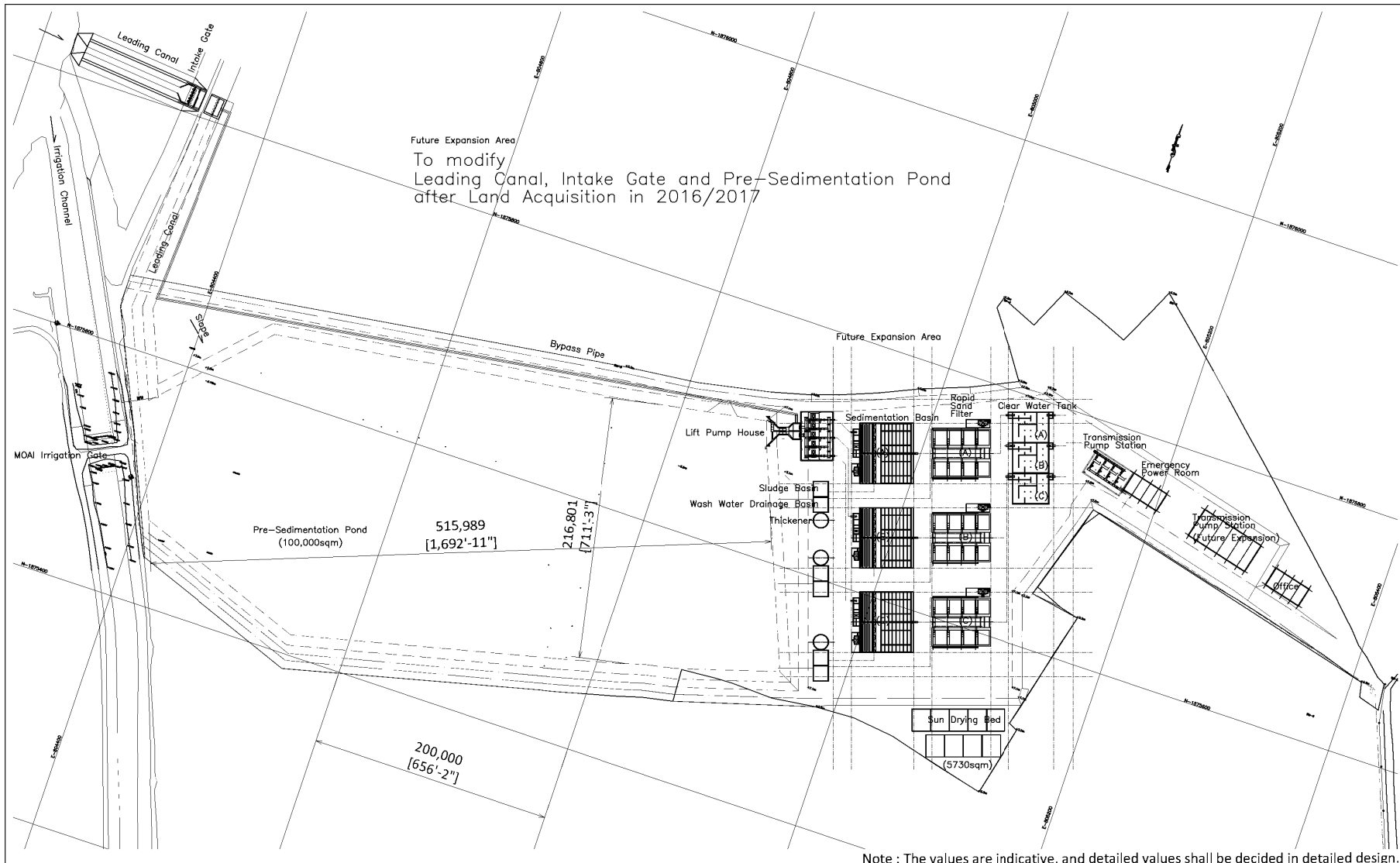


Source: JICA Study Team

Figure 4-5 Proposed Layout of WTP (1st Stage of 60 MGD)

(3) Proposed Facilities for WTP

The facilities of Intake/WTP are planned as listed in the Table 9-1.



Note : The values are indicative, and detailed values shall be decided in detailed design.

JAPAN INTERNATIONAL COOPERATION AGENCY YANGON CITY DEVELOPMENT COMMITTEE		JICA Study Team ENGINEERING DEPARTMENT (WATER & SANITATION)		PROJECT	Preparatory Survey for Greater Yangon Water Supply Improvement Project Phase II (Kokkowa River)	Scale	A3; S=1:3000
DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY	TITLE	Kokkowa Water Treatment Plant Layout Plan(1/2)	Drawing No.	WTP- 1
-	-	-	-			Date	30 June 2016

Figure 4-6 Layout Plan (1/2)

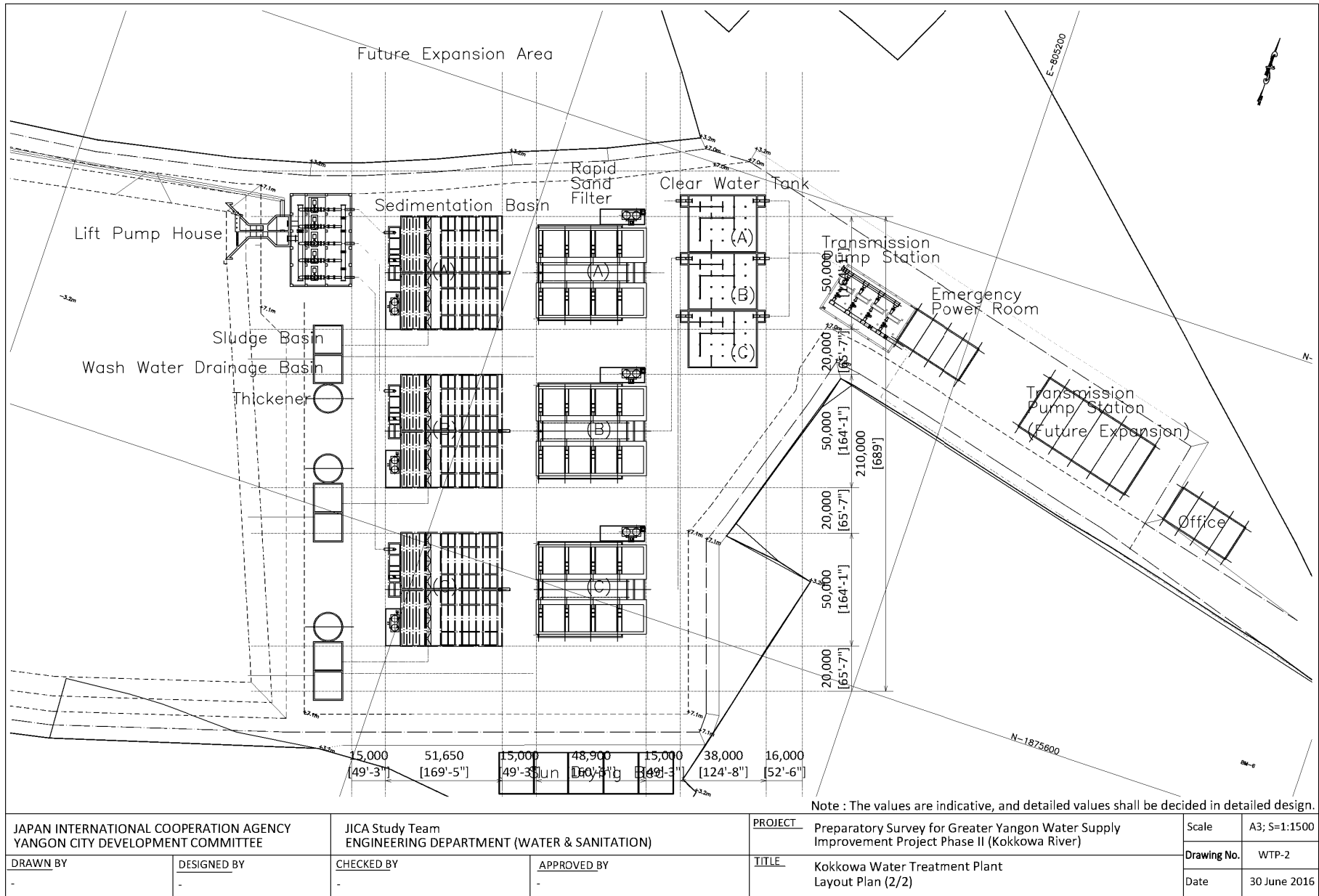


Figure 4-7 Layout Plan (2/2)

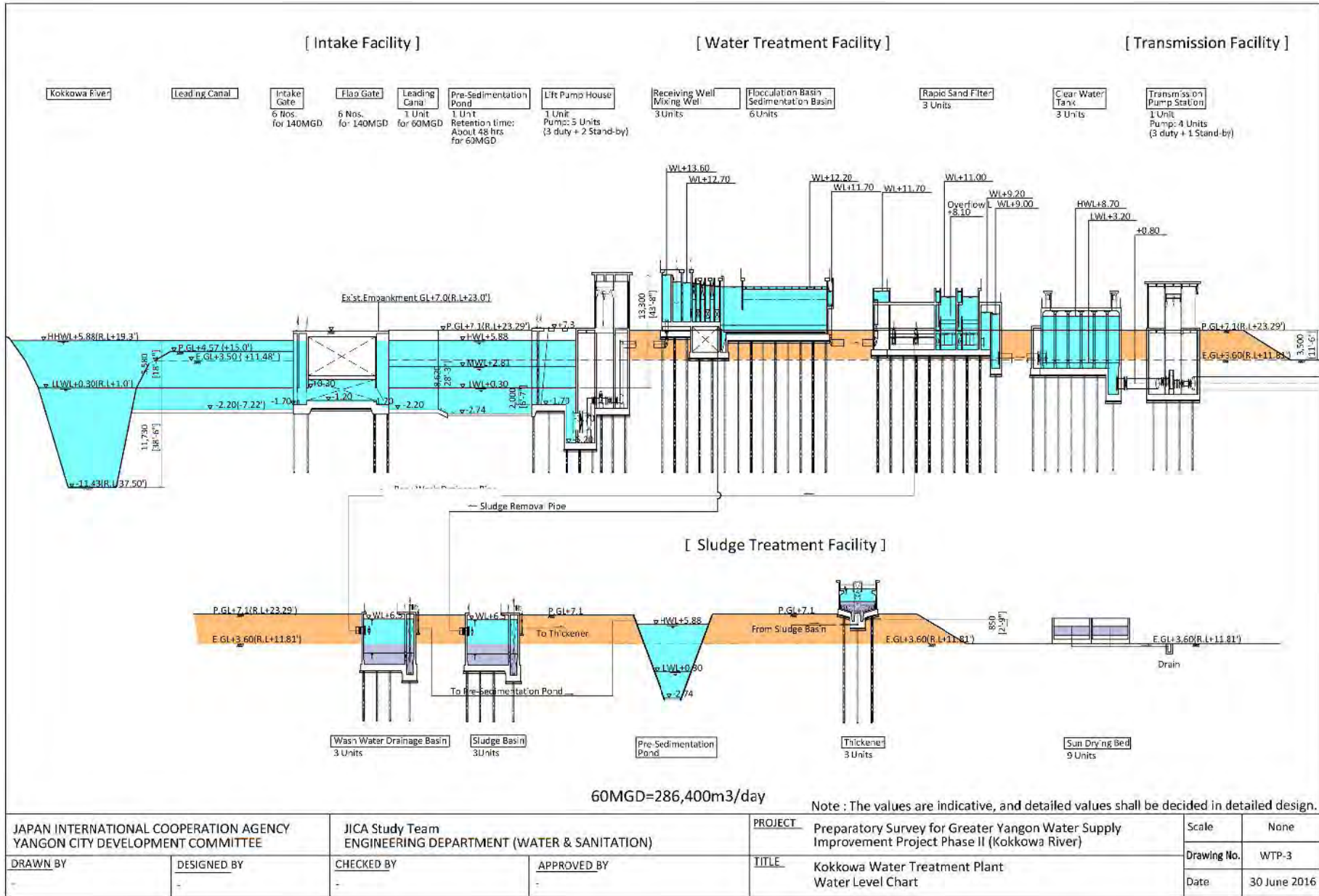


Figure 4-8 Water Level Chart

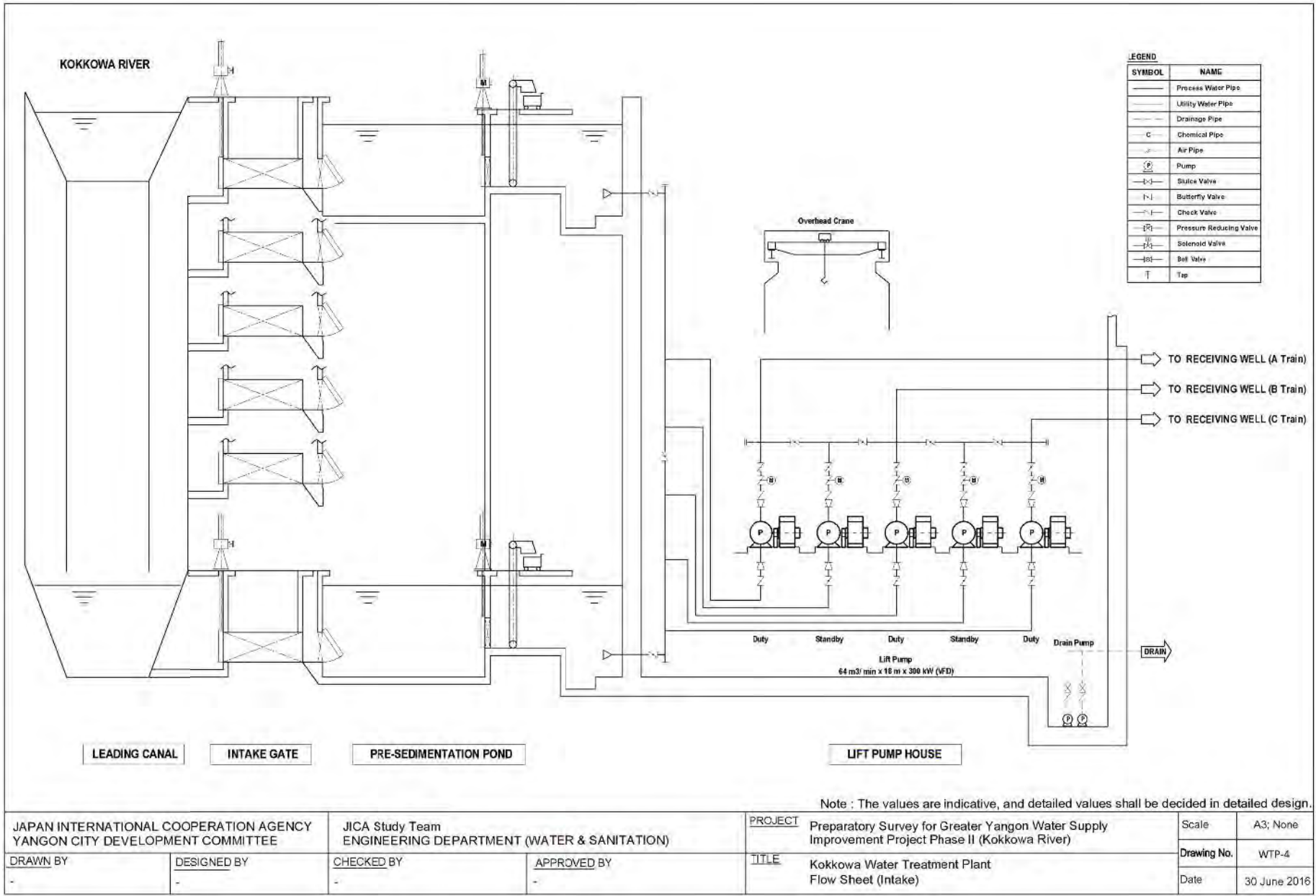


Figure 4-9 Flow Sheet (Intake)

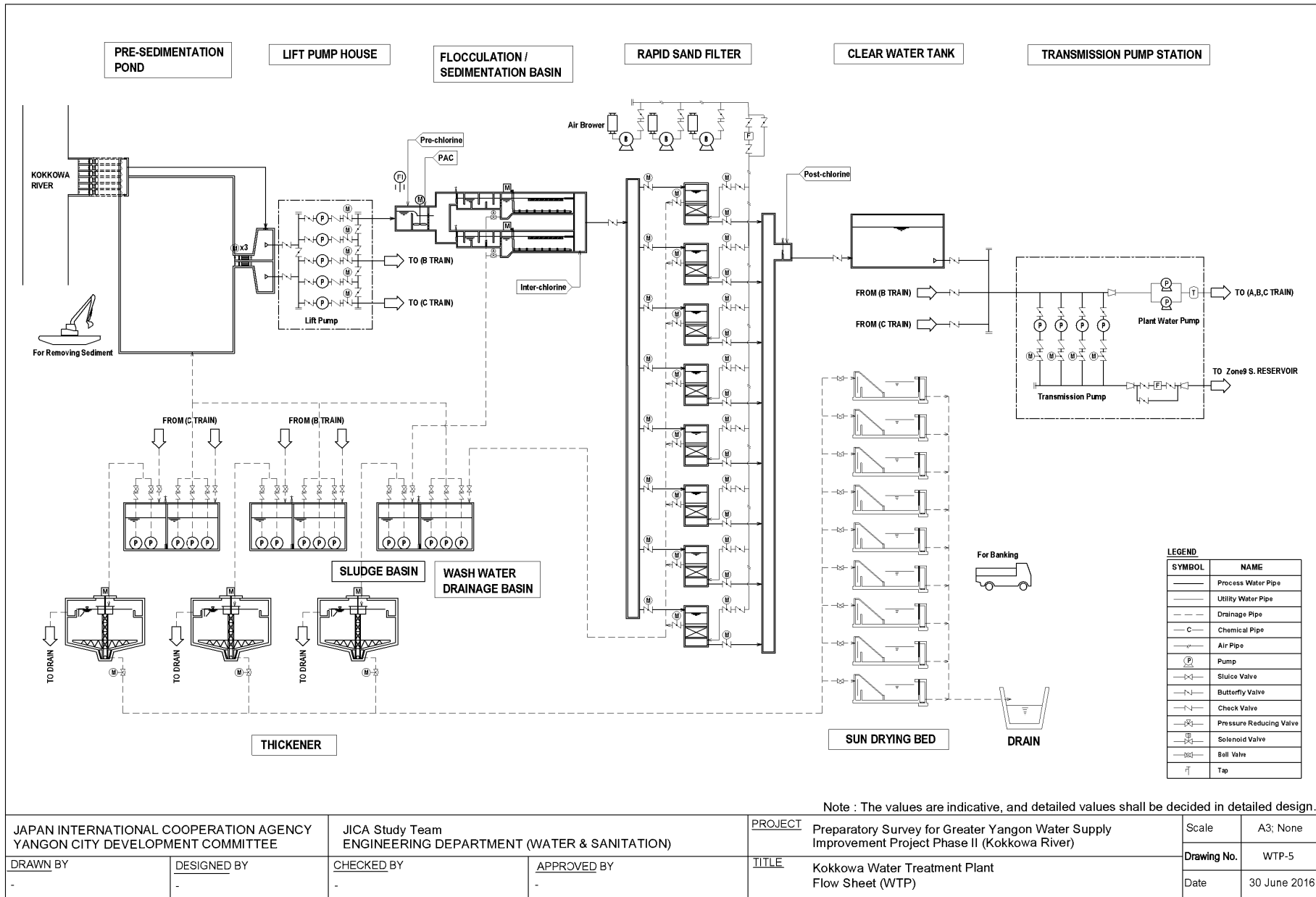
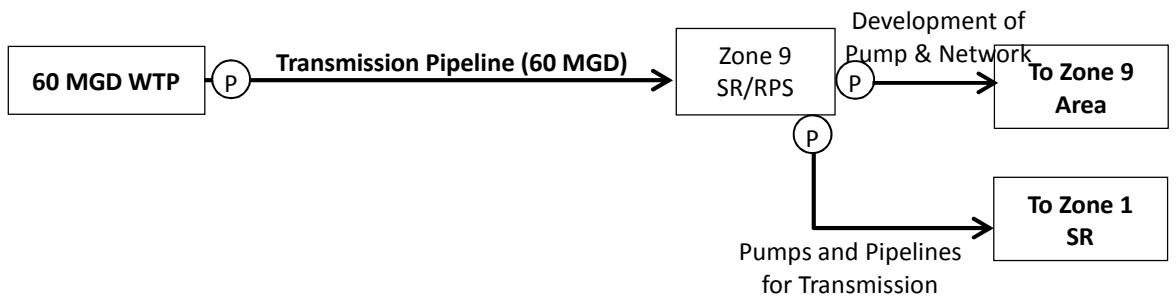


Figure 4-10 Flow Sheet (WTP)

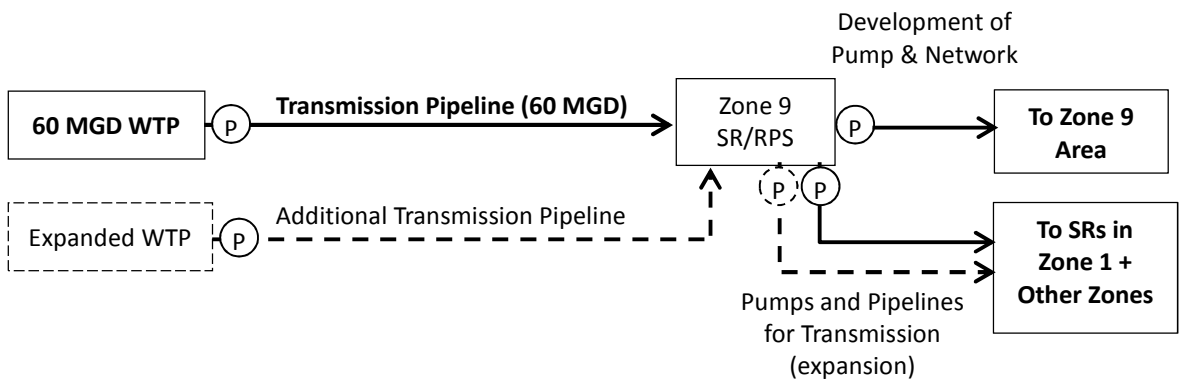
CHAPTER 5 TRANSMISSION FACILITY

(1) Outline of Planning

This facility is planned to convey treated water from Kokkowa WTP to Zone 9 SR. From the WTP, all treated water is planned to be conveyed to Zone 9 SR because of the geographical conditions; therefore water which is to be conveyed to the Zones on the eastern side of the river passes through Zone 9. The distance between WTP and Zones is far. As a result, Zone 9 SR is planned to perform both as a service reservoir for Zone 9 and as a Relay PS (hereinafter referred to as “RPS”) to convey water to other Zones.



(i) Planned Water Supply in 2025 (For This Project)



(ii) Planned Water Supply in the Future

Source: JICA Study Team

Figure 5-1 Stepwise Transmission Plan to Zone 9 SR/RPS

(2) Route and Laying Position of Transmission Pipeline

During the 60 MGD Kokkowa WTP development by 2025, following large diameter pipelines are planned to be laid along the Route No. 5;

- Transmission pipeline from the WTP to Zone 9 SR/RPS (This Project)
- Transmission pipeline from the Zone 9 SR/RPS to Zone 1 SRs (This Project)
- Distribution main from Zone 9 SR to Zone 9 area (YCDC Project)

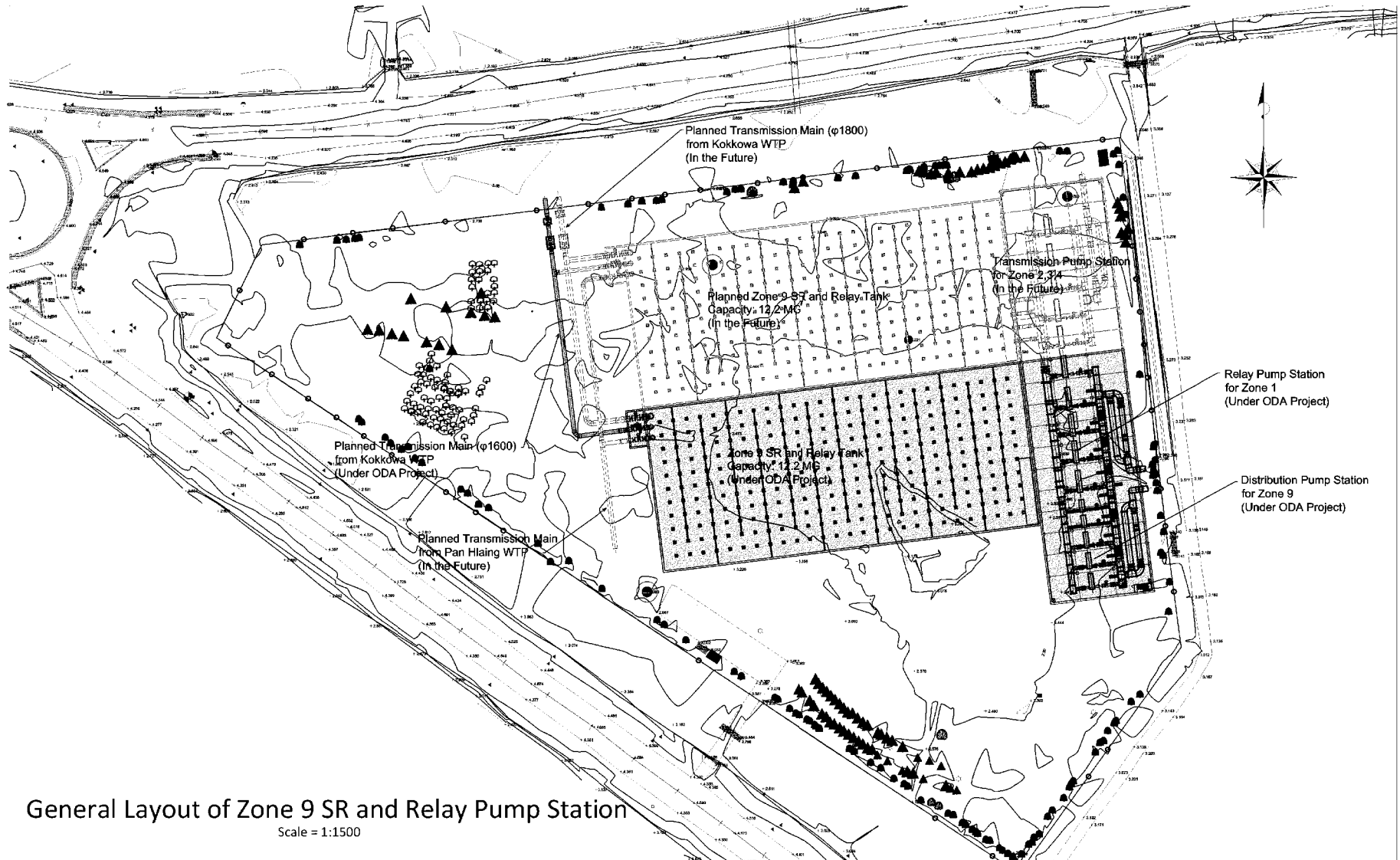
Since Route No. 5 is the only road connecting between the WTP and Zone 9 SR, pipelines mentioned above are planned to be laid along the Route No. 5. The transmission facilities are planned as listed in the Table 9-1. This facility is divided roughly into the following two based on functions.

5.2 Summary of Transmission Facilities for Zone 9

This facility transmits all 60 MGD treated water from Kokkowa WTP to RPS. RPS is combined with Zone 9 SR and constructed in the same site. The facilities are planned as listed in the Table 9-1.

5.3 Summary of Transmission Facilities for Zone 1

This facility transmits 40 MGD treated water from Relay Pump Station to existing Kokine SR for Low subzone in Zone 1 by gravity. On the other hand, reservoir water of 22.1 MGD is transmitted from existing Yegu Pump Station to Central SR reconstructed for High subzone in Zone1 by pumping. The facilities are planned as listed in the Table 9-1.

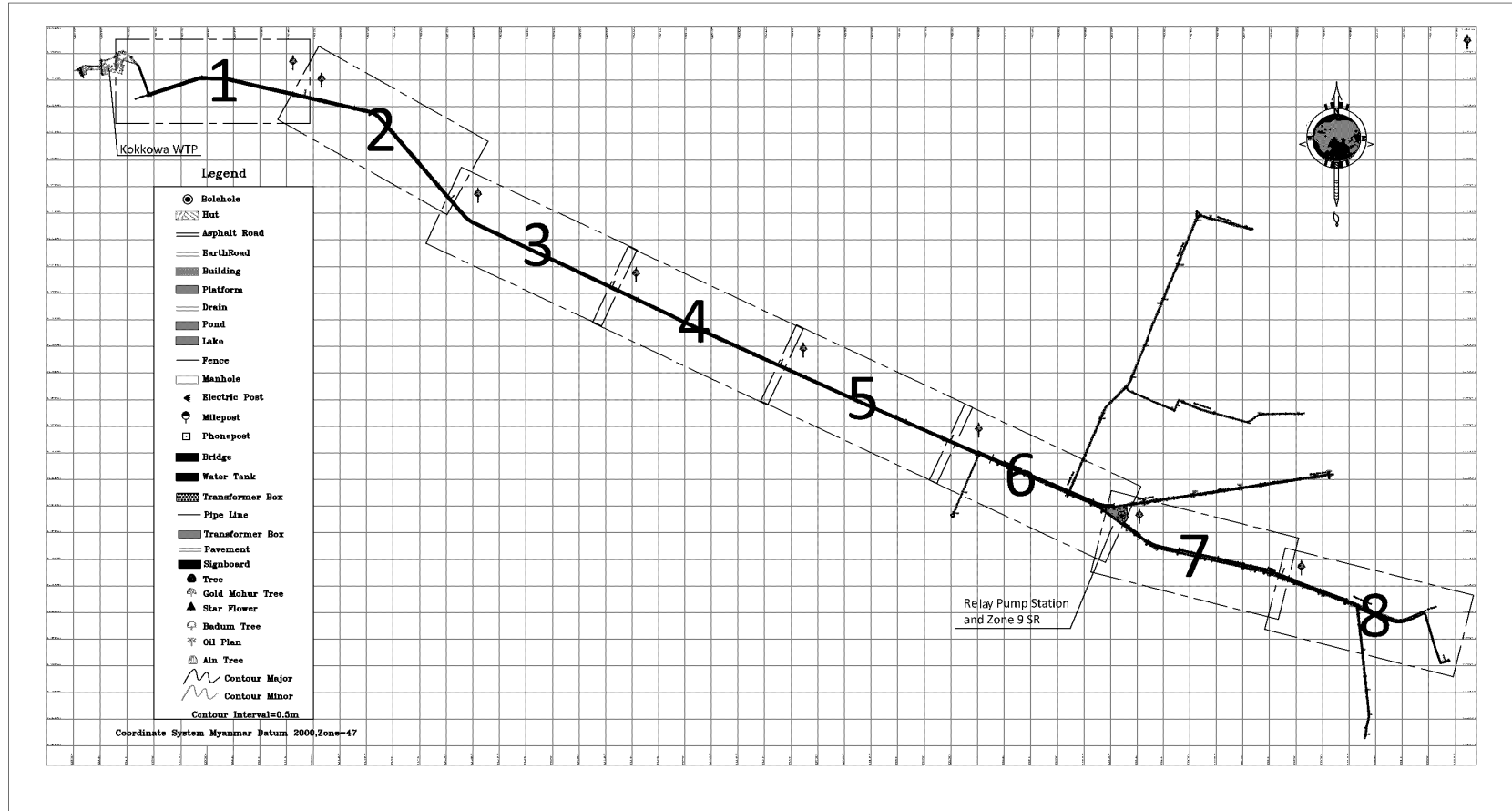


General Layout of Zone 9 SR and Relay Pump Station

Scale = 1:1500

JAPAN INTERNATIONAL COOPERATION AGENCY YANGON CITY DEVELOPMENT COMMITTEE		JICA Study Team ENGINEERING DEPARTMENT (WATER & SANITATION)		PROJECT	Preparatory Survey for Greater Yangon Water Supply Improvement Project Phase II (Kokkova River)	Scale	1:1500
DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY	TITLE	General Layout of Zone 9 SR and Relay Pump Station	Drawing No.	Z9SR-1
-	-	-	-			Date	June 2016

Figure 5-2 Layoutplan of Zone 9 SR and Relay Pump Station

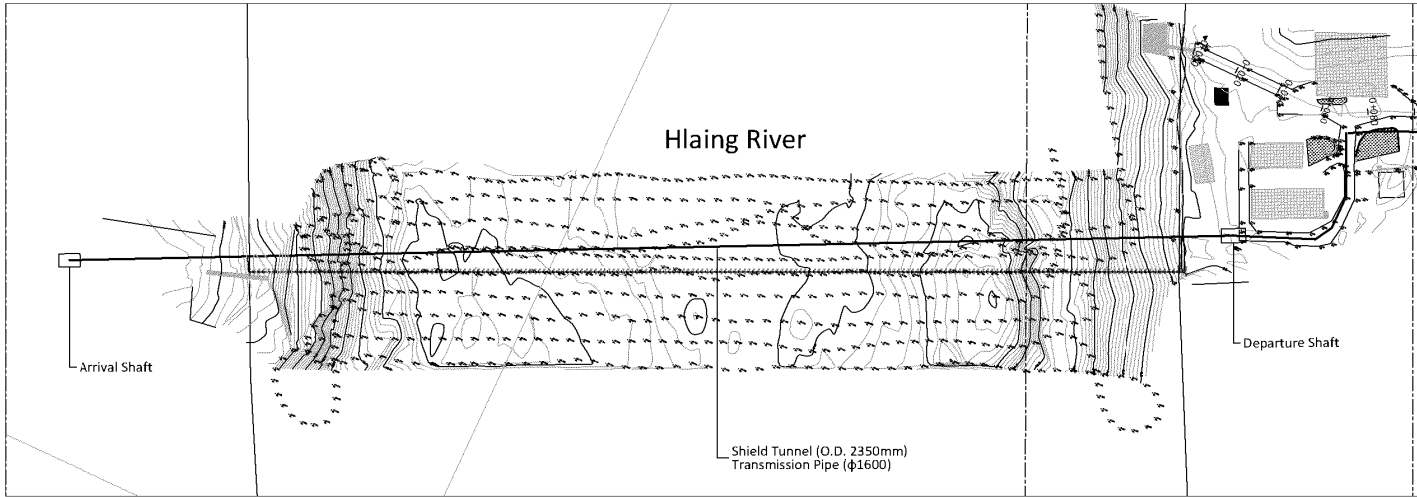


Index Map (1)

Scale = 1: 80000

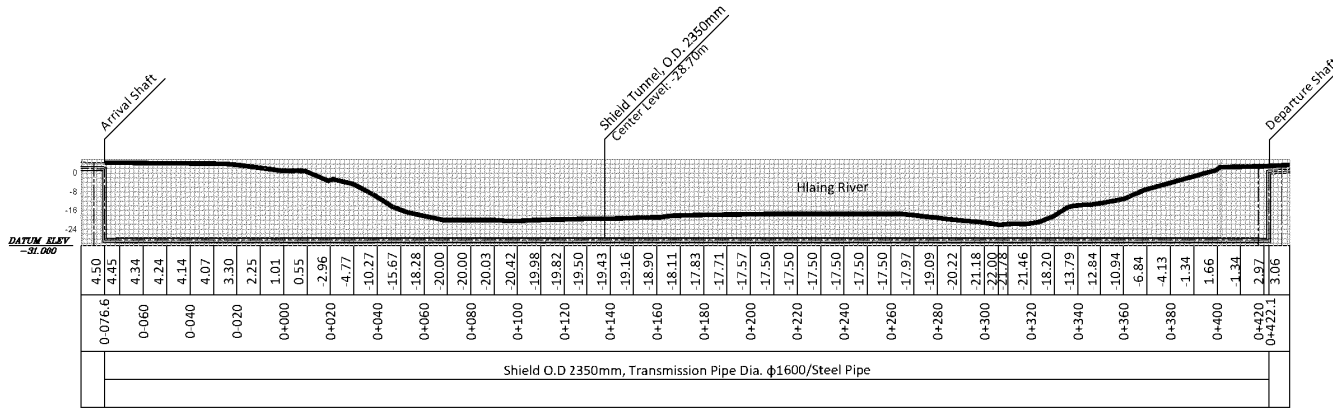
JAPAN INTERNATIONAL COOPERATION AGENCY YANGON CITY DEVELOPMENT COMMITTEE		JICA Study Team ENGINEERING DEPARTMENT (WATER & SANITATION)		PROJECT Preparatory Survey for Greater Yangon Water Supply Improvement Project Phase II (Kokkova River)	Scale 1:80000
DRAWN BY -	DESIGNED BY -	CHECKED BY -	APPROVED BY -	TITLE Transmission Pipe to Zone 9 Index Map (Hlaing Tharyar TS)	Drawing No. TRM-PL-001
					Date June 2016

Figure 5-3 Index MAP (Htantabin and Hlaing Tharyar TS)



Hlaing River Crossing Plan

Scale = 1:1000

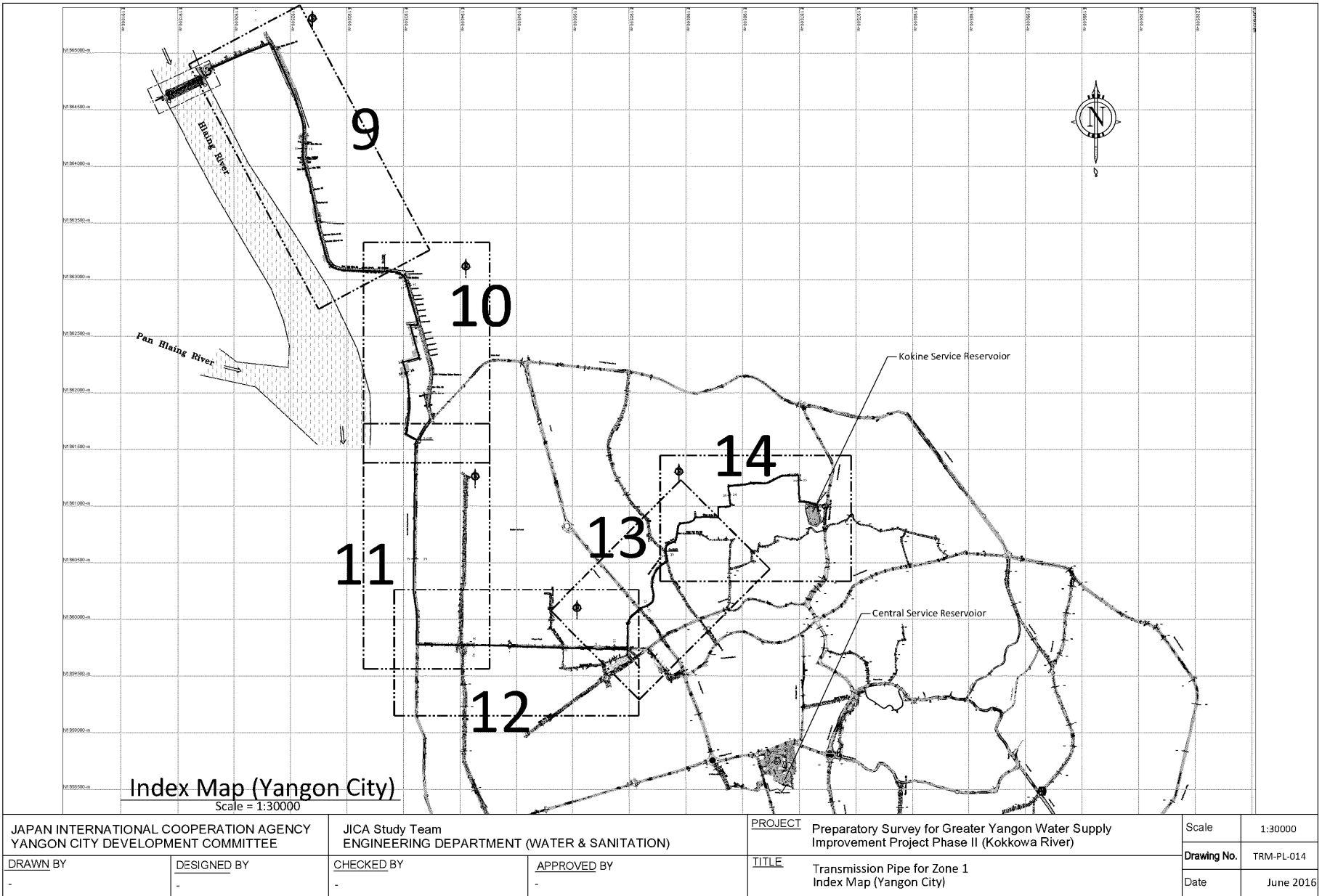


Hlaing River Crossing Longitudinal Section

Scale: H=V= 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY YANGON CITY DEVELOPMENT COMMITTEE		JICA Study Team ENGINEERING DEPARTMENT (WATER & SANITATION)		PROJECT	Preparatory Survey for Greater Yangon Water Supply Improvement Project Phase II (Kokkowa River)	Scale	1:1000
DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY	TITLE	Transmission Pipe for Zone 1 Hlaing River Crossing Plan and Longitudinal Section	Drawing No.	TRM-PL-013
-	-	-	-			Date	June 2016

Figure 5-4 Hlaing River Crossing Plan and Longitudinal Section

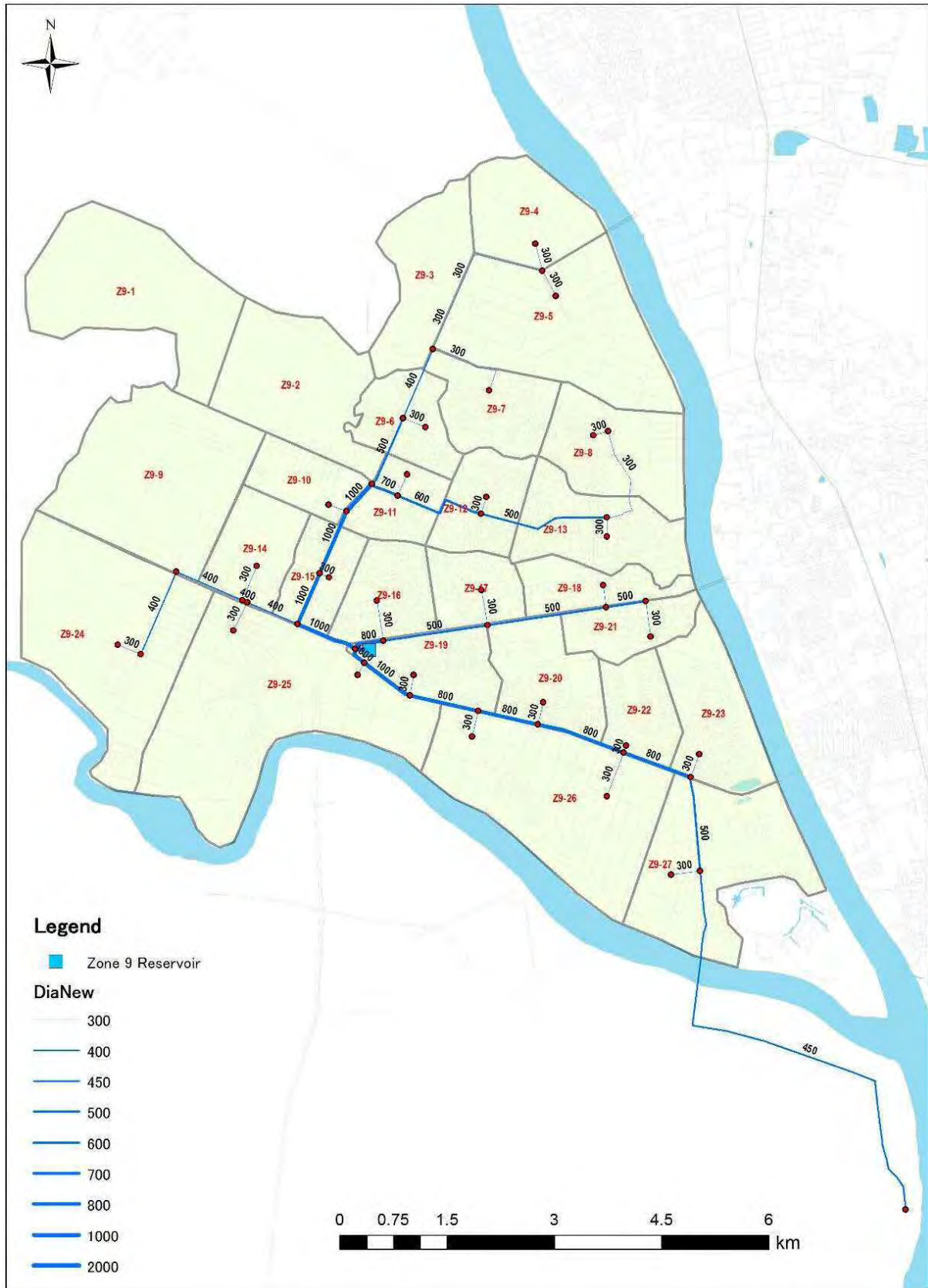


JAPAN INTERNATIONAL COOPERATION AGENCY YANGON CITY DEVELOPMENT COMMITTEE		JICA Study Team ENGINEERING DEPARTMENT (WATER & SANITATION)		PROJECT Preparatory Survey for Greater Yangon Water Supply Improvement Project Phase II (Kokkowa River)	Scale 1:30000
DRAWN BY -	DESIGNED BY -	CHECKED BY -	APPROVED BY -	TITLE Transmission Pipe for Zone 1 Index Map (Yangon City)	Drawing No. TRM-PL-014
					Date June 2016

Figure 5-5 Index MAP (Yangon City)

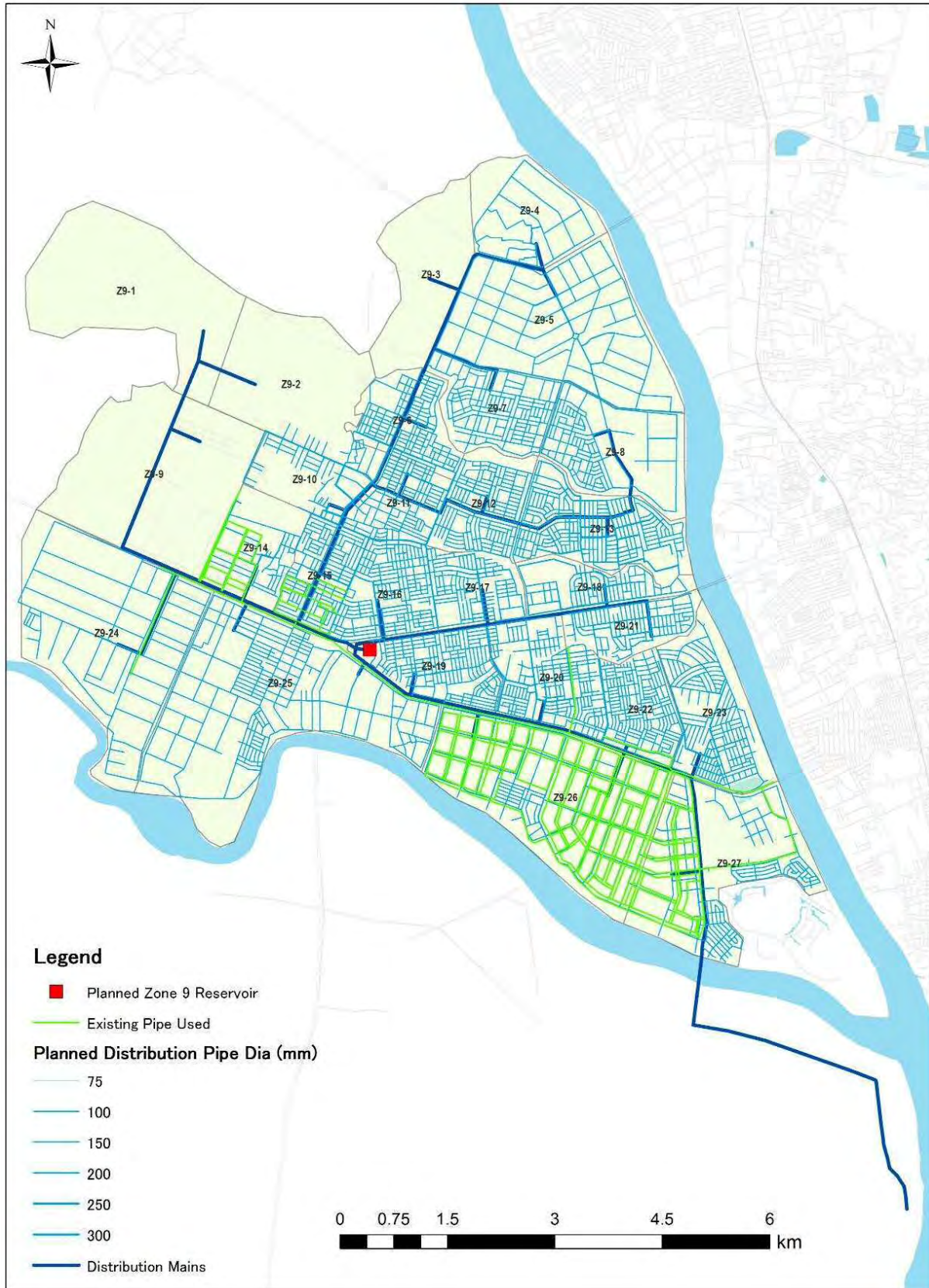
CHAPTER 6 DISTRIBUTION FACILITIES OF ZONE 9

The daily maximum demand of 1 MGD will increase to 19 MGD by 2025 and to 49 MGD by 2040. For equitable distribution of water, the entire area of Zone 9 is divided into 23 DMAs and 27 DMAs in 2025 and 2040 respectively. As a result of the hydraulic analysis, distribution main pipe network for the demands of 2025 have been decided as given in the Figure 6-1, 6-2 and Table 9-1.



Source: JICA Study Team

Figure 6-1 Distribution Main Pipe for Zone 9 in 2025

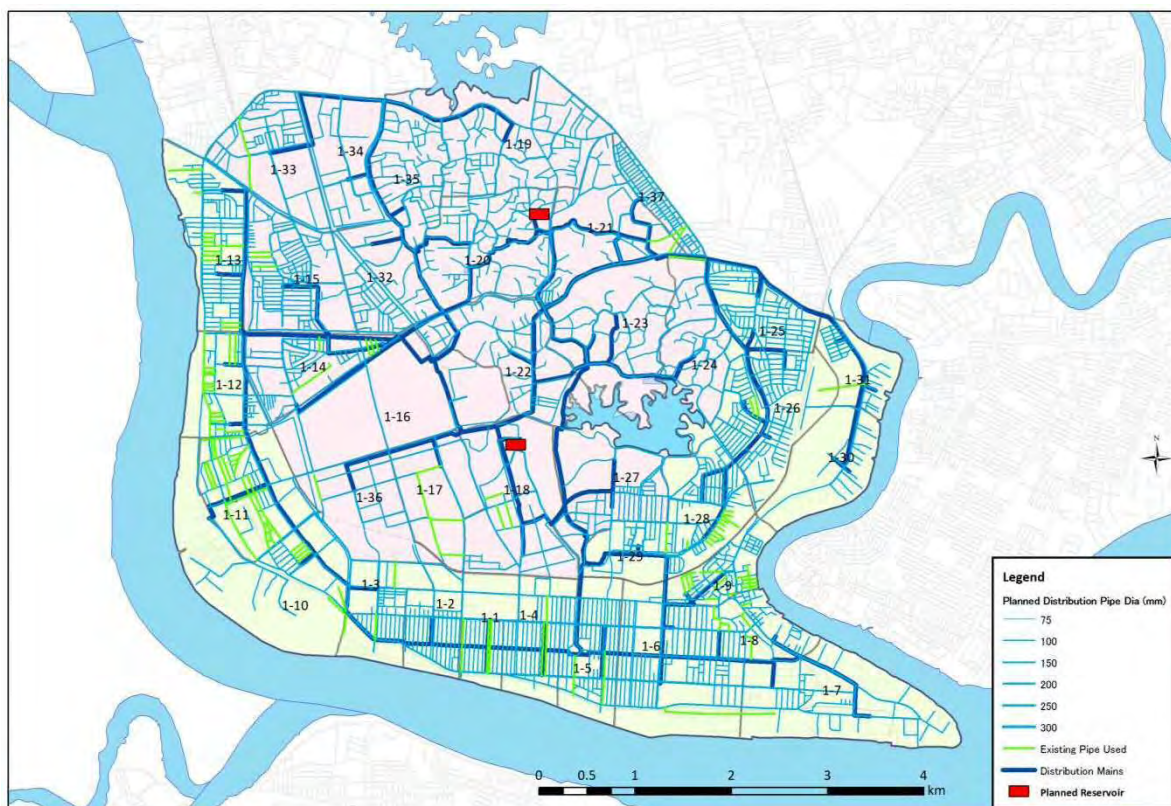


Source: JICA Study Team

Figure 6-2 Distribution Pipe with DMA for Zone 9

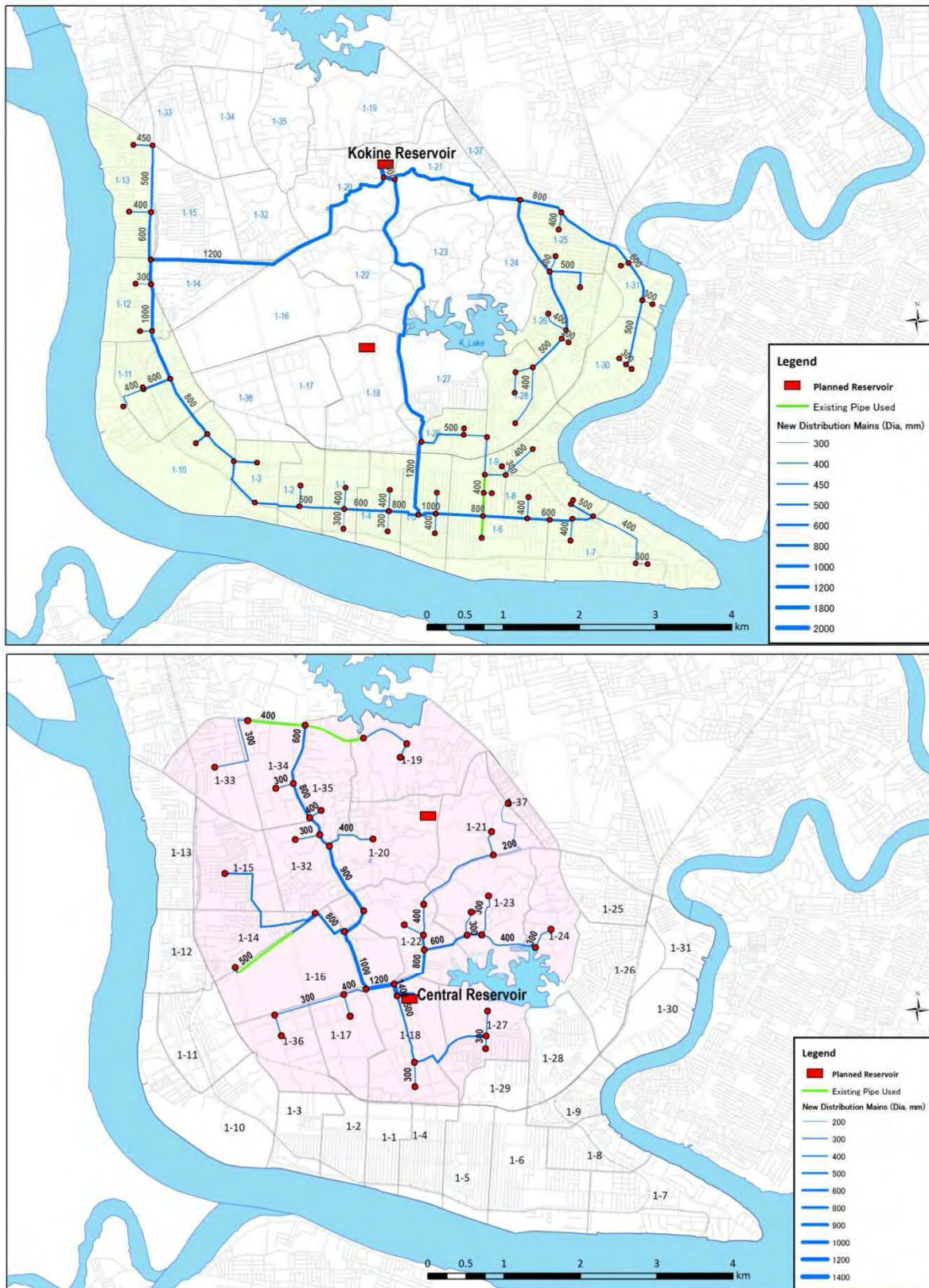
CHAPTER 7 DISTRIBUTION FACILITIES OF ZONE 1

The daily maximum demand of 44 MGD in the Zone1 will increase to 54 MGD by 2025 and to 71 MGD by 2040. Distribution main facilities are planned for the demand in 2040 considering that it is not easy to lay large diameter pipelines in densely populated city area with heavy traffic on roads. Two SRs are planned in Zone 1; From Kokkowa system, 40 MGD of water is planned to be delivered to existing Kokine SR to be distributed in Low subzone through gravity. On the other hand, water from existing Yegu system is planned to be conveyed to Central SR to be distributed in High subzone. Zone 1 (Figure 7-1) has been divided into 37 DMAs (19 DMAs in Low subzone and 18 DMAs in High subzone). The distribution facilities are planned as listed in the Table 9.1.



Source: JICA Study Team

Figure 7-1 Distribution Pipe with DMA for Zone 1



Source: JICA Study Team

Figure 7-2 Distribution Main Pipes for Low Subzone by Gravity System from Kokine SR (upper figure) and for High subzone by Pump System from Central SR (lower figure)

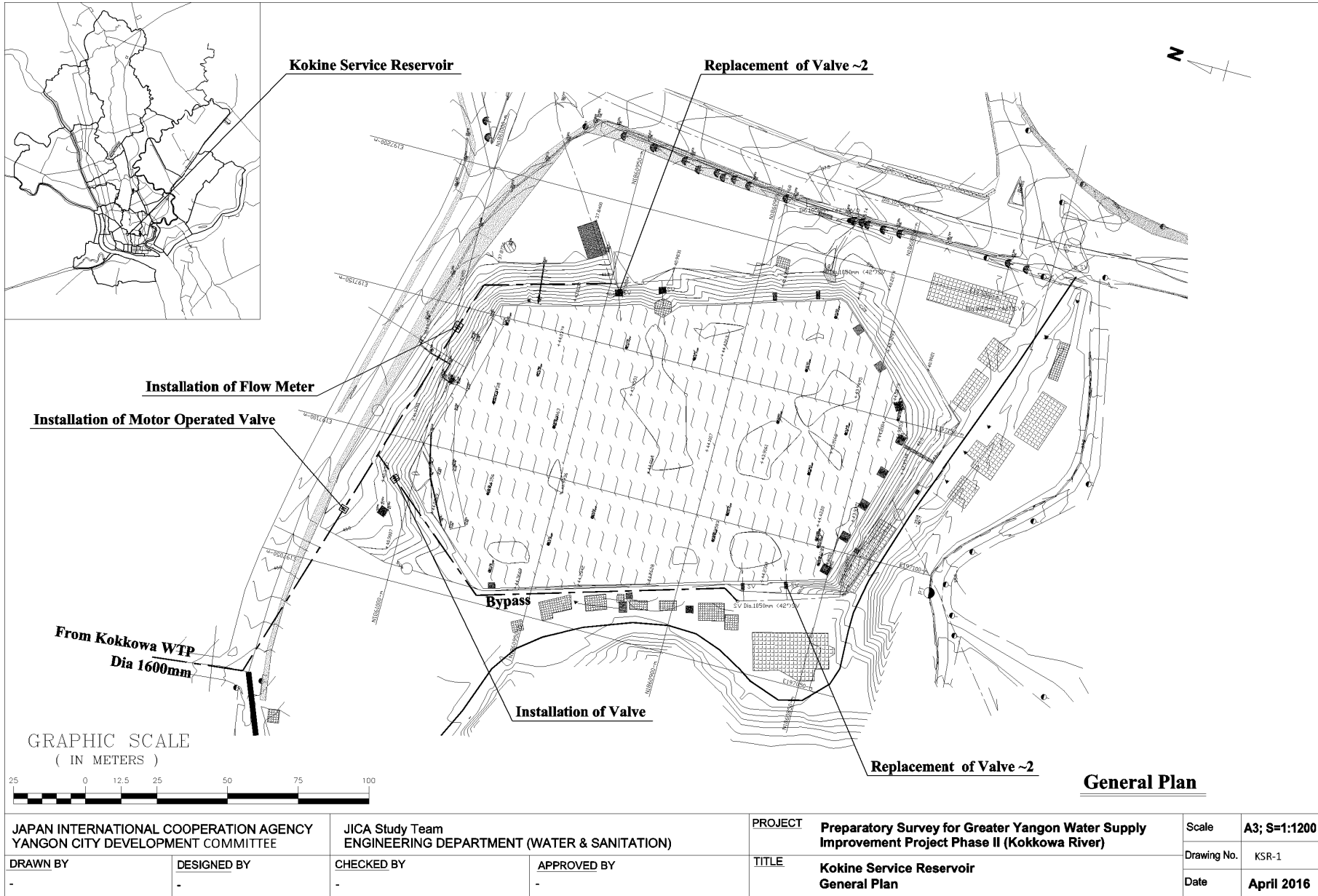


Figure 7-3 Layout Plan of Kokine SR

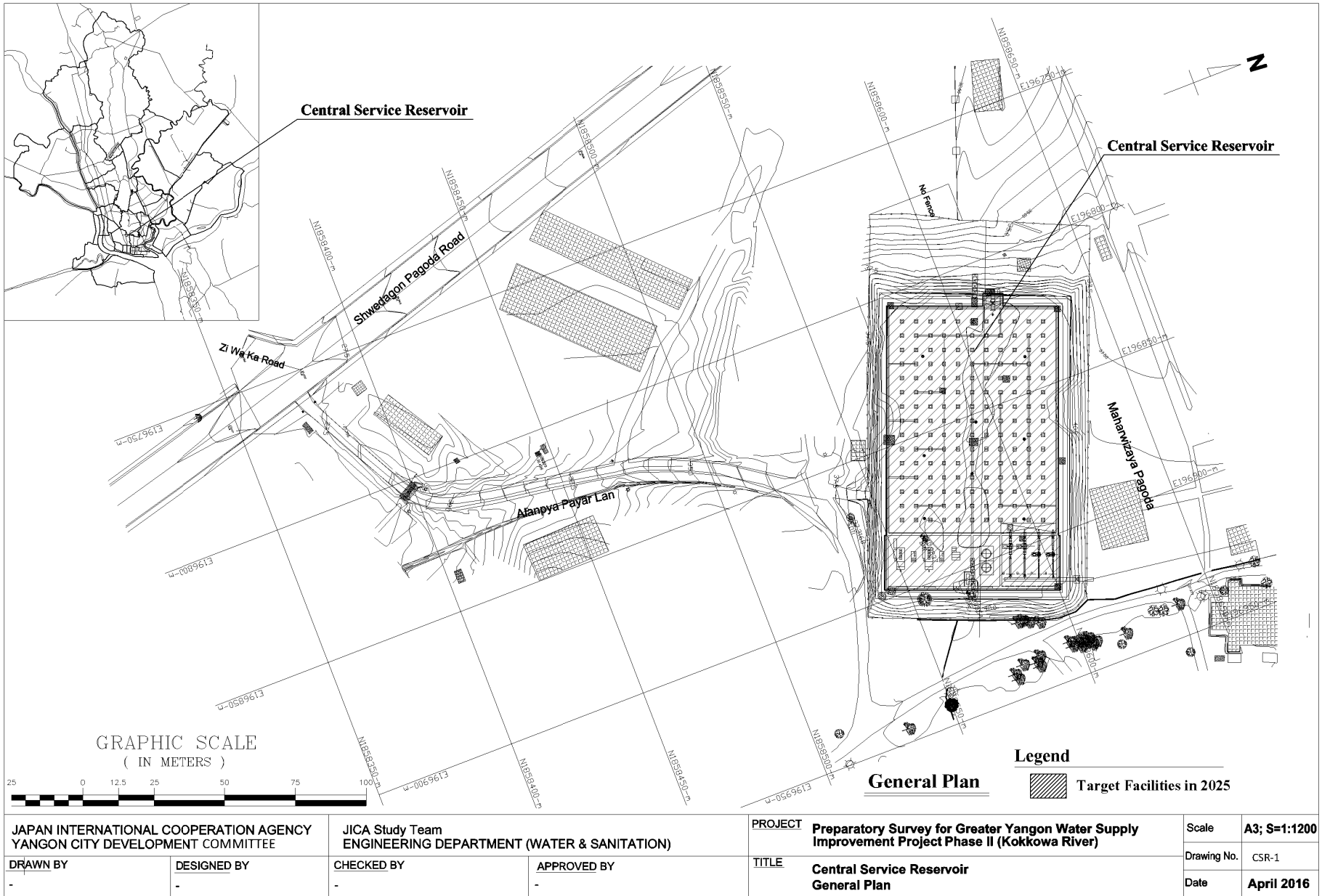


Figure 7-4 Layout Plan of Central SR

CHAPTER 8 OPERATION, MANAGEMENT AND CAPACITY

8.1 Current Challenges to Existing Facilities

There are some challenges in the fields of operation and maintenance, equipment, quality control and structure in the Nyaungnabin WTP, maintenance and standardization of specification, manuals and procedures on transmission and distribution pipes and water supply equipment, and customer management.

8.2 Organization Structure for Maintenance

It is necessary to practice operation and maintenance methods of existing facilities and equipment by their manuals and by suppliers' demonstration for prolonging their lives.

Operation and maintenance methods in the Kokkowa WTP should be considered in reference to ones in Japan because many kinds of mechanical and electrical equipment will be installed in the Kokkowa WTP that will treat river water for the first time in Yangon. Some operation and maintenance manuals are developed as reference for establishing the organization structure and preparing manuals for Kokkowa system and for developing capacities of YCDC engineers.

It is also necessary to improve on the maintenance of pipes, meter reading, billing and water charge collection. In addition, public relations and awareness activities should be implemented positively to execute projects in good relationships with customers.

8.3 Technical Assistance by the JICA Technical Assistance Project and by this Project

As of July 2016, the ongoing JICA technical assistance project includes capacity development of YCDC for improvement of water utility management, NRW reduction and water quality management.

In this project, it is proposed that experts will be dispatched to assist design of distribution facility with DMAs and procurement of SCADA in Zone 9 by YCDC own budget.

Moreover, Techniques of operation and maintenance such as information analysis and operation manual improvement will also be transferred to YCDC by dispatching experts and by sharing information about 60 MGD facilities on SCADA system with a Japanese local government and/or a Japanese maintenance company in Japan online.

CHAPTER 9 IMPLEMENTATION SCHEME OF THE PROJECT

9.1 Scope of Works of Phase 2 Project

The outline of the scope of works of Phase 2 project is summarized as below.

- Candidate scopes of work under Japanese ODA loan
 - Scope 1: Construction of Kokkowa WTP (60 MGD)
 - Scope 2: Construction of transmission facilities from Kokkowa WTP to Zone 9 SR/RPS (Zone 9 SR/RPS, transmission pipeline from WTP to Zone 9 SR/RPS)
 - Scope 3: Construction of transmission facilities from Zone 9 SR/RPS to Zone 1 (transmission pipeline from Zone 9 SR/RPS to Zone 1 and River crossing)
 - Scope 4: Modernization and restructuring of distribution facilities of Low subzone in Zone 1 (Repair of Kokine SR, distribution main pipes, distribution pipe network with 19 DMAs)
 - Scope 5: Modernization and restructuring of distribution facilities of High subzone in Zone 1 (Reconstruction of Central SR with PS, distribution main pipes, distribution pipe network with 18 DMAs)
 - Scope 6: Procurement of vehicles (for use during the detailed design and construction supervision; eight (8) four-wheel drive vehicle)

- Scopes of work under YCDC's own budget
 - Scope 7: Landfill for WTP
 - Scope 8: Distribution facilities of Zone 9

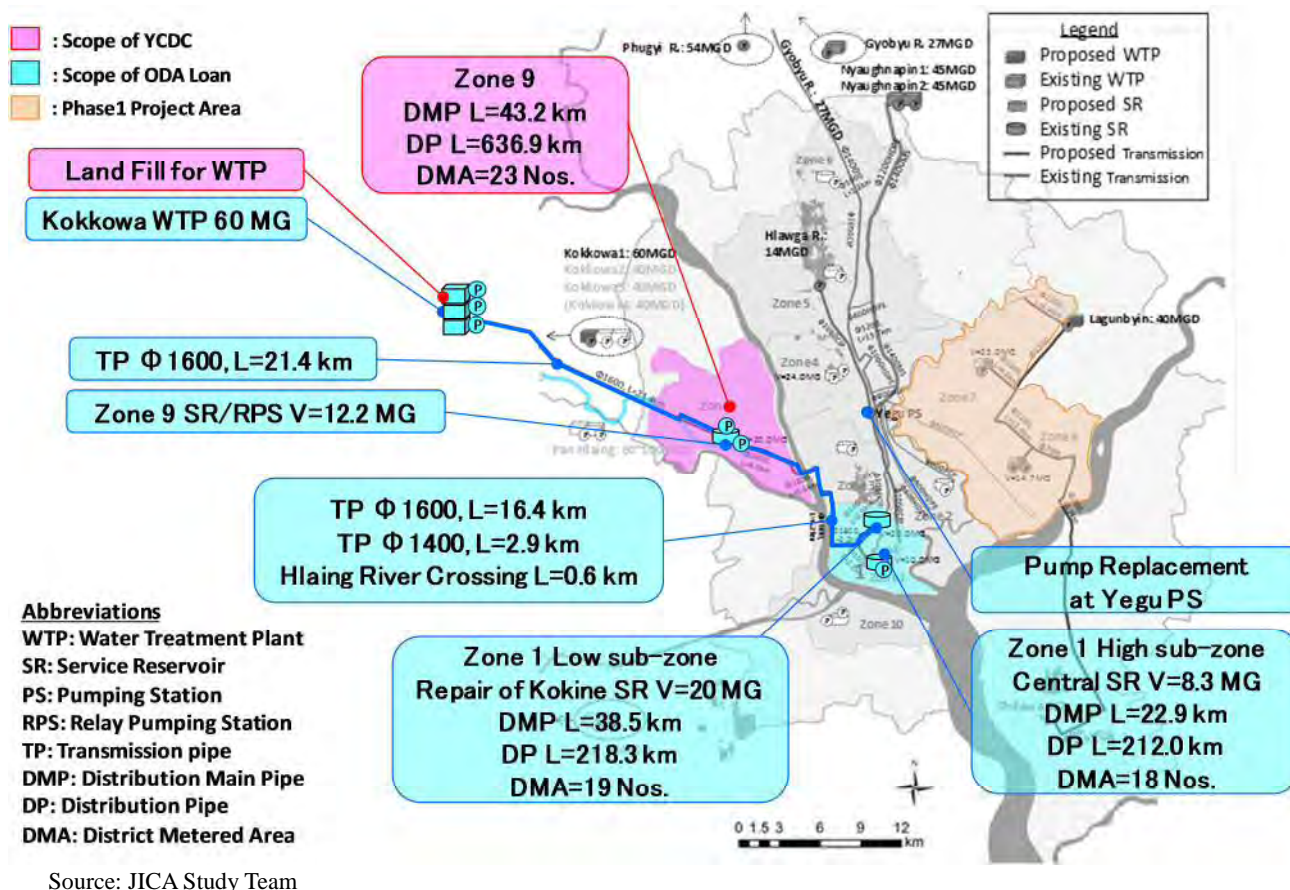


Figure 9-1 Scope of Works of Phase 2 Project

The detailed project scope to be considered under Phase 2 project is given in the Table below.

Table 9-1 Detailed Project Scope of Phase 2 Project

		Facility Name	Quantity	Capacity	Type Remarks
Eligible					
Scope 1: Construction of Kokkowa WTP					
A	1	Leading Canal with River Bank Protection, Intake Facilities	1 Unit	140 MGD	W 1500 mm x H 1500 mm of Square Gate with screen x 6 nos.
		Pre-Sedimentation pond	1 Unit	60 MGD	Surface Area: 100,000 m ² Storage volume =812,000 m ³
	2a	Lift Pump House (Civil work)	1 Unit	60 MGD	Auto Screen x 2 nos.
	2b	Lift Pump House (Mechanical and Electrical)	Pump Unit: 5 nos. (3 operation + 2 stand-by)	20 MGD x H 18m x Approx. 300 kW	Double suction volute pump by VFD control
	3	Receiving Well	1 Unit (3 Basins)	60 MGD	
	4	Rapid Mixing Basin	1 Unit (3 Basins)	60 MGD	Flash mixer, Overflow weir
		Flocculation Basin	1 Unit (3 Basins)	60 MGD	Horizontal and vertical zigzag flow
		Sedimentation Basin	1 Unit (6 Basins)	60 MGD	Upflow type with tube settler and Mechanical sludge collector
5	Rapid Sand Filter	1 Unit (24 Filters)	60 MGD	Self-backwashing type	
6	Clear Water Tank	1 Unit (3 Lots)	V=4125 m ³ x3		

		Facility Name	Quantity	Capacity	Type Remarks
				Lots	
	7	Chemical Dosing Facilities	1 Unit (3 Lots)	60 MGD	Liquid ACH, Liquid Hypochlorite
	8a	Transmission Pump Station (Civil work)	1 Unit	60 MGD	
	8b	Transmission Pump (Mechanical and Electrical)	Pump Unit: 4 nos. (3 operation + 1 stand-by)	20 MGD x H 38m x Approx. 720kW	Double suction volute pump with Flywheel by ON-OFF control
	9	Wash Water Drainage Basin	1 Unit (3 Basins)	60 MGD	Discharge Pump x 9 nos.
	10	Sludge Basin	1 Unit (3 Basins)	60 MGD	Sludge Withdrawal Pump x 6 nos.
	11	Thickener	1 Unit (3 Basins)	60 MGD	
	12	Drying Bed	1 Unit (9 Basins)	60 MGD	
	13	Administration Facility, Laboratory, Accomodation Building for WTP staff, etc	1 Unit	60 MGD	Central Administration Building, Laboratory, SCADA Room, Warehouse, Road, Lighting, Drainage, Fence, Landscaping etc.
	14	Sub Power Station Facilities, Generator System	1 Unit	60 MGD	Diesel engine generator 6MVA, built-in radiator
	15	SCADA System of WTP	1 Unit	60 MGD	
Scope 2: Construction of Transmission Facilities from Kokkowa WTP to Zone 9 SR/RPS					
B	1a	Transmission Pipe	Length: 21.4 km	Diameter: 1600 mm	Pipe Material: DCIP and/or MS
	a	Zone9 SR including Relay Tank (Civil work) including Administration Facility (Civil work)	1 Unit	12.2 MGD	
	C	Relay Pumps Station at Zone9 SR/RPS (Mechanical and Electrical) for Zone1	Pump Unit: 4 nos. (3 operation + 1 stand-by)	16.3 MGD x H 87 m x Approx. 1250 kW	Double suction volute pump with Flywheel by VFD control
	b	Sub Power Station Facilities, Generator System	1 Unit		Diesel engine generator 9 MVA, built-in radiator
		SCADA System of Transmission Flow	1 Unit		
	Z	Distribution Pumps Station for Zone 9 (Mechanical and Electrical)	Pump Unit: 2 nos. (1 operation + 1 stand-by)	Capacity: 76 m ³ /min x H 40 m x Approx. 720 kW	Double suction volute pump with Flywheel by VFD control
	1		Pump Unit: 2 nos. (1 operation + 1 stand-by)	Capacity: 32 m ³ /min x H 40 m x Approx. 375 kW	Double suction volute pump with Flywheel by VFD control
Scope 3: Construction of Transmission Facilities from Zone 9 SR/RPS to Zone 1					
	1b	Transmission Pipe	Length: 16.4 km	Dia. 1600 mm	Pipe Material : DCIP and/or MS
			Length: 2.9 km	Dia. 1400 mm	Pipe Material : DCIP and/or MS
B	2	Transmission Pipe Under Crossing Hlaing River by shield method	Length: 0.6 km	Shield Dia. 2400 mm Pipe Dia. 1600 mm	Pipe Material : DCIP and/or MS

			Facility Name	Quantity	Capacity	Type Remarks
		3	Tentative Connection pipe to Existing pipe by Non-stoppable Tapping method	4 locations	Dia. 1400 mm x 1000mm, Dia. 1050 mm x 1000mm, Dia. 750 mm x 700mm, and Dia. 700 mm Valve Insertion	
Scope 4: Modernization and Restructuring of Distribution Facilities of Zone 1 (Low subzone)						
D	1	Repair of Kokine SR including Installation Inflow and Outflow Valves	1 Unit	20 MGD		
	2	Distribution Main Pipe (including Pipe Jacking method)	Length: 38.5 km	Dia. 300 ~2000 mm	Pipe Material: DCIP and/or MS Pipe jacking method (Railway crossing): 2 nos. ; Dia. 600 mm and Dia. 1200 mm	
	3	Distribution Pipe with DMA	Length: 218.3 km	Dia. 100 ~250 mm	Pipe Material : HDPE and/or DCIP	
		Service Connection Replacement	103,200 nos.			
		Customer Meter Replacement & Installation	103,200 nos.			
4	SCADA System of DMA	19 nos.				
Scope 5: Modernization and Restructuring of Distribution Facilities of Zone 1 (High subzone)						
D	5a	Reconstruction of Central SR (Civil work)	1 Unit	8.3 MGD		
	5b	Distribution Pumps for Zone 1 (High) (Mechanical and Electrical)	Pump Unit: 2 nos. (1 operation + 1 stand-by)	Capacity: 67 m ³ /min x H 42 m x Approx. 660 kW	Type: Double suction volute pump with Flywheel by VFD control	
			Pump Unit: 2 nos. (1 operation + 1 stand-by)	Capacity: 32 m ³ /min x H 42 m x Approx. 375 kW	Type: Double suction volute pump with Flywheel by VFD control	
	6	Power Line and Sub Power Station Facilities, Generator	1 Unit		Diesel engine generator 4MVA, built-in radiator	
	7	Distribution Main Pipe	Length: 22.9 km	Dia. 200 ~1400 mm	Pipe Material : DCIP and/or MS	
	8	Distribution Pipe with DMA	Length: 212.0 km	Dia. 100 ~250 mm	Pipe Material : HDPE and/or DCIP	
		Service Connection Replacement	49,100 nos.			
		Customer Meter Replacement & Installation	49,100 nos.			
	9	SCADA System of DMA	18 nos.			
	10	Replacement of Pump Equipment and Related Electrical Facilities at Yegu Pump Station	Pump Unit: 3 nos. (2 operation + 1 stand-by)	Capacity: 11 MGD x H 53 m x Approx. 450 kW	Type: Double suction volute pump by ON-OFF control	
Scope 6: Procurement of vehicles						
		Purchasing 4WD Used				

			Facility Name	Quantity	Capacity	Type Remarks
			Car for Consulting Service			
Non Eligible						
Scope 7: Landfill for WTP						
	Y	1	Landfill (Civil work) for WTP	Amount of earth fill soil: about 210,000 m ³		
Scope 8: Distribution Facilities of Zone 9						
	Z	2	Distribution Main Pipe	Length: 43.2 km	Dia. 300 ~2000 mm	Pipe Material : HDPE, DCIP and/or MS
		3	Distribution Pipe with DMA	Length: 636.9 km	Dia. 100 ~300 mm	Pipe Material : HDPE
		4	SCADA System of DMA	23 nos.		

Source: JICA Study Team

9.2 Preparation of Implementation Schedule

If the Project is financed through Japanese ODA Loan, the Government of Myanmar must follow JICA procurement guidelines for the selection of the consultants and the contractors to implement the Project. Implementation of the project is estimated to require the duration of about 9.0 years in total from the signing of L/A to taking into account of all the necessary steps.

The construction schedule is prepared for pipe works mainly depending on the procedure, work volume and working party. Construction works might need to be suspended or cancelled/changed for safety reasons especially for drainage of rain water inside trench in rainy season during May to October. Construction works of 5 packages of construction are estimated to require about 5.3 years from start to finish

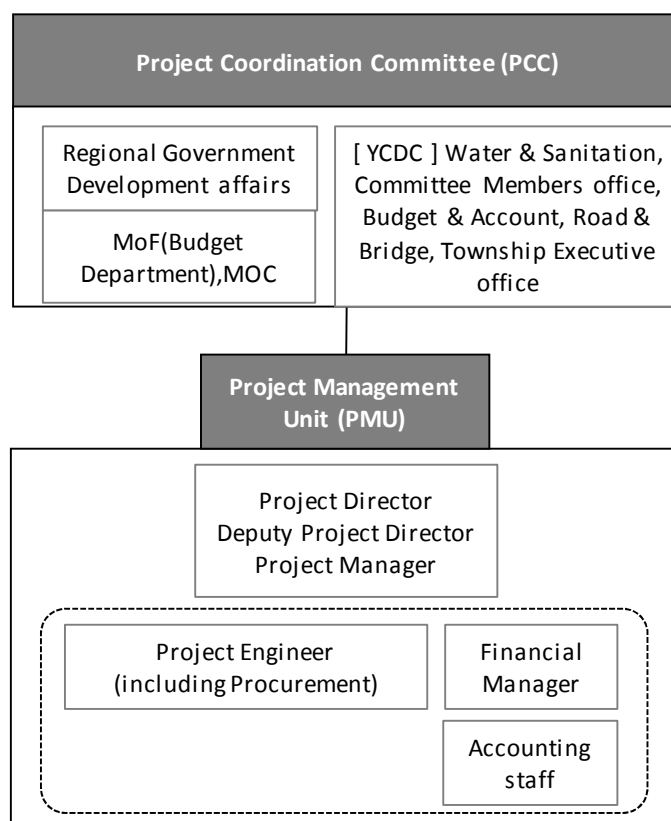
9.3 Organizational Structure for Implementing The Project

An organizational structure for the Project consists of Project Coordination Committee (PCC) and Project Management Unit (PMU).

Table 9-2 Roles and Responsibilities of Project Organizations

Project organization	Institutions responsible	Role and responsibility
Project Coordination Committee: PCC	Regional government, YCDC, Related ministries	<ul style="list-style-type: none"> • Project coordination for planning and implementation
Project Management Unit: PMU	EDWS	<ul style="list-style-type: none"> • Project management • Supervision • Monitoring and coordination • Allocation of budget

Source: JICA Study Team



Source: JICA Study Team

Figure 9-2 Proposed Organizational Arrangement for Project Implementation

(1) Project Coordination Committee (PCC)

PCC is a supreme organization related to project implementation. The committee meeting will be held regularly, for instance quarterly in addition to the beginning and completion of the project. PCC shall be co-chaired by YCDC. The main functions of PCC will be as follows:

- Approving work plans and budgets for the project
- Monitoring and reviewing progress of activities of various concerned agencies
- Opening of regular meetings for committee
- Coordinating stakeholders relevant to the project activities of other institutions, dispute settlement, enhancing smooth project implementation
- Monitoring and reviewing the activity progress by the relevant institutions
- Identifying problems and bottlenecks in course of implementing various activities by the

concerned agencies and suggest ways and means to solve the problems and bottlenecks

- Identifying issues which need to be considered, discussed, and coordinated
- Coordinating follow-up actions

(2) Project Management Unit (PMU)

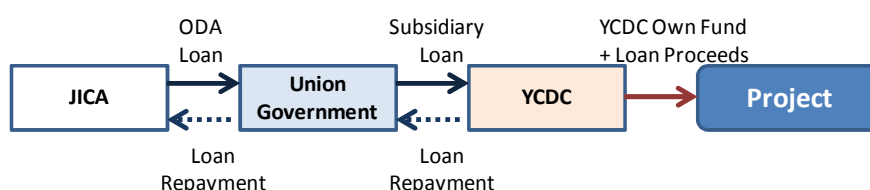
PMU shall be established within EDWS and ad-hoc entity to be established for the project implementation. PMU is aimed at enhancing management and monitoring of the project, and be an independent organization to implement the specified project during the limited period. PMU shall be tasked with managing and monitoring the day-to-day activities of the project at the field level. The Project Director has the responsibility and authority for overall activities including coordination between sections and with construction companies to ensure the progress of the project within the implementation period. The main functions are listed as follows.

- To be comprehensively responsible for project implementation in accordance with the loan contract
- To coordinate and manage the Project activities
- To establish a monitoring and evaluation system that would track the progress of the Project
- Supervising and monitoring the day-to-day project activities
- Preparing project implementation and work plan and reporting the progress of the project with the assistance of the consultant
- Arranging and supervising construction works
- Arranging procurement of goods, works and services for the project
- Receiving and distributing funds for project activities
- Maintaining accounts of the project and arrange audit

CHAPTER 10 FINANCIAL AND ECONOMIC ANALYSIS

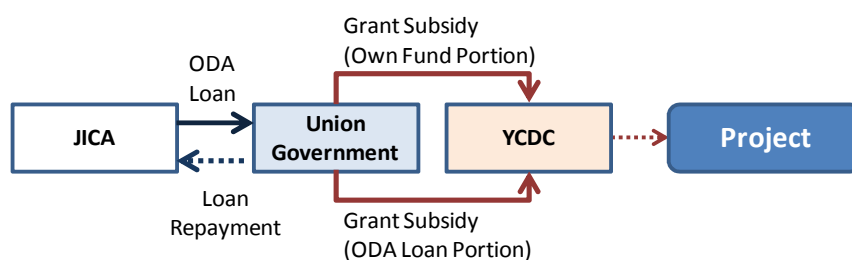
Since the actual water tariff level applied at the base case scenario of the financial analysis is set too low to even recover the recurrent O&M cost besides the massive initial investment, the projected financial cash flow is kept negative over almost the whole project lifetime. The financial internal rate of return (FIRR) is estimated at minus 18.7 % which indicates that the project is not financially viable. The economic internal rate of return (EIRR) is estimated at 14.3 % thus the project is deemed economically feasible.

The financial challenge faced by the project is that funding requirement is very large and the YCDC's water supply service is not profitable by nature. In order to ensure financial soundness of YCDC, it is required to increase water tariff to cover O&M cost, initial investment and financial cost that derives from the ODA loan on-lending through the central government. According to the financial projection results, water tariff increase should be over 50 % in 2019 and 2023 in 4 scenarios. In order to ease the drastic hike in water tariff, it is necessary that the central government provides grant subsidy to YCDC to cover a part of the own-fund portion of initial investment and repayment obligation of subsidiary loan originated from the JICA ODA loan proceeds (See figures below).



Source: JICA Study Team

Figure 10-1 Financing Structure of JICA ODA Loan



Source: JICA Study Team

Figure 10-2 Case of Grant Subsidy from Union Government

On the assumption of 3 to 4 % of household income affordability criteria, the increased water tariff level in all the four cases are lower than 3 %, indicating the required tariff increase is considered affordable by the domestic customers.

CHAPTER 11 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

11.1 Environmental and Social Condition

Environmental Conservation Law (2012) and Environmental Conservation Rules (2014) have been instituted in Myanmar and the EIA Procedure was published in January 2016. In the EIA Procedure, water supply project with surface water is not included in the list of project requiring IEE/EIA procedure.

During the construction and operation period, the appropriate management shall be executed for environmental conservation for air quality, water quality, waste disposal, and noise following WHO, EHS, and Myanmar guidelines. Also, the vulnerability to climate change caused by flood and drought is not expected by the considerable facility design. There is no cultural heritage building, endangered species, protected area, and traditional settlement of indigenous ethnic minority groups in the proposed construction site and project affected area. The project will contribute to the encouragement of gender equality and be managed with gender consideration and HIV prevention measures.

11.2 Land Acquisition and Resettlement Issue

Currently, there is no law in Myanmar, comprehensively stipulating on land acquisition and resettlement matters. The Land Acquisition Act, enacted in 1894, is still serves as the legal basis for land acquisition. Resettlement related issues are described in some existing laws and regulations. However, in most of cases, details such as procedures and conditions related to resettlement issues are yet to be determined. Therefore, the land acquisition and resettlement procedure in this project will be taken following JICA Guidelines and World Bank OP 4.12. Responsible organization will be EDWS chaired by the Chief Engineer and the resource of compensation, income restoration program and related operation will be included in the budget of Engineering Department.

- (1) The land acquisitions of 42.68 Acre of construction site for WTP were completed in 2015 for which involuntary resettlement were not required. In addition, land acquisition procedures of YCDC for the additional land of 20 Acre for the pre-sedimentation pond were initiated by organizing a procurement committee and a management committee in January of 2017. All 20 Acres are the paddy fields and settlement of households are not identified in. Therefore involuntary resettlement will be not be required by the acquisition.
- (2) Alternatives of transmission pipe laying location are studied and recommended from the technical, operational, environmental and social viewpoints in this Study. As of January 2017, 41 illegal occupancies were scattered along the proposed alignment of transmission pipeline. However, a relocation plan of illegal households along the Route No. 5 by the Yangon region government has not announced yet.

- (3) Departure shaft and working space for river crossing of transmission pipe will be conducted in MoAI's land, and YCDC is waiting for the permission letter for tentative occupation.
- (4) The construction sites for service reservoirs are located in YCDC properties. Therefore, land acquisition and involuntary resettlement will not be required.
- (5) The distribution pipes will be installed under the existing city roads owned by YCDC. Therefore, land acquisition and involuntary resettlement will not be required.

11.3 Stakeholder Meetings for WTP Site

(1) Explanatory Meeting held in April 2015

On 11th and 12th April 2015, an explanatory meeting of Kokkowa WTP construction was held in the adjacent Anyasu Village. The explanatory meeting was held based on the local traditional custom including some religious ceremony for praying the success of the Project by inviting local high monks as well as local people.

(2) Stakeholder Meeting for the Project held in January 2017

On 11th January 2017, a stakeholder meeting of the Project was held by YCDC for explaining the project components including possible environmental social impacts with proposed countermeasures, additional land acquisition of 20 Acres for the WTP, JICA policy of land acquisitions with entitlements, cut-off date and so on. In the meeting, negative opinions and complaints were not expressed by the participants.

11.4 Social and Economic Interview Survey on the Proposed Alignment of Transmission Pipeline along the Route No. 5

In 16th and 17th of January 2017, a social and economic interview survey for the illegal occupancies on the proposed alignment of transmission pipeline along the Route No. 5 was conducted as follows.

- ✓ As the results of the survey, a total of 41 illegal occupancies were identified around the proposed alignment of transmission pipeline along the Route No.5, and then six (6) illegal occupancies (houses/shops) and one (1) local religious facility were situated on the proposed alignment.
- ✓ At the opening of the social and economic interviews, the following seven (7) points were orally explained to the illegal occupants by interviewers of JICA Study Team.
 1. Explanation of the Project and construction of the transmission pipeline on Right of Way of the Route No. 5
 2. Necessity of involuntary resettlement for the Project and the legal status of the occupation
 3. Possible environment and social impacts by the project and mitigation measures
 4. Explanation on Project policy and the Entitlements of the involuntary resettlement for the

illegal occupation

5. Explanation on the setting up of cut-off date
 6. Possible resettlement schedule
 7. Contact persons of YCDC for the resettlement
- ✓ Basically all of the occupancies were willing to implement this Project.

CHAPTER 12 PROJECT EFFECTS

12.1 Quantitative Effects

The direct effects by implementation of Phase 2 project, same as Phase 1 project, are expected as listed below.

1. The service population with treated safe water will be increased.
2. The water consumption per capita will be increased.
3. The quality of supplied water will be improved.
4. The duration of water supply will be increased.

The following Table shows the proposed evaluation and performance indicators and their target values for the project.

Table 12-1 Evaluation and Performance Indicators

Indicator	Original (Yr 2015)	Target (Yr 2026)
Indicators for Zone 1 and Zone 9		
Operation Indicator		
Served Population (thousand)	546	1,040
- Zone 1 (Low subzone)	369	457
- Zone 1 (High subzone)	142	219
- Zone 9	36	364
Maximum Amount of Water Supply (MGD)	46	75
- Zone 1 (Low subzone)	32	37
- Zone 1 (High subzone)	12	18
- Zone 9	2	20
Rate of Facility Utilization (%) (Kokkowa WTP) ^{*1}	-	95
Water Pressure in Distribution Network (MPa) ^{*2*3}	0.075	0.15
Non-revenue Water Ratio (%) ^{*2*4}	66	20
Rate of Continuous Dosing of Disinfection Facility (%) ^{*3}	0	100
Minimum Amount of Residual Chlorine (mg/L) ^{*3}	0	0.1
Effect Indicator		
Served Coverage Rate (%)	36	63
Indicators for Yangon City (for reference)		
Served Population (thousand)	1,991	3,789
Maximum Amount of Water Supply (MGD)	162	274
Served Coverage Rate (%)	37	58

Notes:

*1: Rate of Facility Utilization = Max Amount of Water Supply in Zone 1 (Low) and Zone 9 / Capacity of Kokkowa WTP

*2: Base value is set from the average value of Yangon city in 2011

*3: Target value is set from the target service level of 2014 Water MP

*4: Target value is set same as the average value of other cities in the Southeast Asian countries.

Others: Values are set from the water demand of this Study (2016 Phase 2 FS)

2 years after the completion of the implementation works as Yr 2024

Source: JICA Study Team

Monitoring of projects effects are proposed to be implemented as per the following Table.

Table 12-2 Monitoring of Operation and Effect Indicators

Indicator for Zone 1 and Zone9	In charge of monitoring	Means of Verification	Monitoring Frequency
Served Population	YCDC	Calculation formula = number of water supply connections × average number members per household	Yearly
Maximum amount of water supply	YCDC	Amount of distributed water from each service reservoir (Zone 9, Kokine and Central SR)	Yearly
Rate of facility utilization of Kokkowa WTP	YCDC	Calculation formula = Volume of water produced annually at Kokkowa WTP / 365 days / WTP capacity	Yearly
Water pressure in distribution network	YCDC	Measurement at location where the pressure is expected to be the lowest among the distribution pipe network (the end of distribution pipe network or the location where the altitude is high)	Quarterly
NRW ratio	YCDC	Calculation formula = Amount of water consumed annually by users / Amount of water distributed annually (from Zone 9, Kokine and Central SR)	Yearly
Rate of continuous dosing of disinfection	YCDC	Measured at Kokkowa WTP	Quarterly
Free residual chlorine concentration	YCDC	Measured at the location where residual chlorine concentration is expected to be the lowest in distribution network (the end of distribution pipe network)	Quarterly
Served Coverage Rate	YCDC	Calculation formula = Number of water supply connection / (population ÷ average number of members per household)	Yearly

Source: JICA Study Team

12.2 Qualitative Effects

Qualitative effects envisaged by the project implementation are as follows:

- Improvement of the living environment of Greater Yangon residents
 - Improvement in water supply conditions mentioned above shall contribute to reduction in occurrence of water related diseases such as cholera, typhoid and diarrhea, and skin & eye diseases and is expected to improve health conditions of the people, which will contribute to reduction in medical expenditure of household.
 - The current cost for obtaining water will be reduced and the household expenditure on water will be reduced, which will indirectly contribute to improvement in the livelihood of the people.
 - Water use will be more convenient, i.e., whenever required, water will be supplied.
 - Water fetching time and efforts will be reduced and mitigated. As a result, working and education opportunity for women and children will be enhanced.
- Establishment of an environment for investment through water supply in Greater Yangon
 - Working opportunities will be created during construction and operation & maintenance of

water supply facilities

- It will contribute to the stabilization of people's livelihood in the area and political stability.
- The industry and business that are now affected by dirty water supply will be activated and contribute to the development of the country.
- Occurrence of land subsidence and salinization of ground water is expected to be reduced due to reduction in groundwater withdrawal.

CHAPTER 13 RECOMMENDATIONS

Major problems of water supply conditions are low service coverage, low water pressure and short duration of water supply and undrinkable water supply. Major problems related to water supply facilities are limited water production, old facilities, and absence of disinfection in water supply system. Major problems related to management of water works include high NRW ratio and inefficiency of business management basis for waterworks. To tackle these problems, the proposed priority projects for infrastructure development and capacity building shall be implemented as soon as possible as a first step.

In addition, the assistance to enhance the capacity of YCDC on waterworks management shall be obtained from the countries with high technology and management skills such as Japan for effective and quick transfer of technology and management skills. For this purpose, Phase 1 project, JICA technical cooperation project and other capacity enhancement projects are being carried out in parallel currently and are expected to be very beneficial for YCDC.

For long time, investment in infrastructure has been deferred and the service level of public water supply is at low level. Therefore, development of water supply facilities to improve water supply services requires input of a large amount of fund. To meet this requirement, the most favorable loan, soft loan of donor at low interest rate, shall be utilized to reduce financial burden of YCDC, or the country as a whole. However, due to the project's massive investment requirement and low profitability of water supply services sector, YCDC may need subsidy from Union Government as grant assistance. In such case, both ODA loan obligation and own-fund portion (or either one) should be borne by the Union Government.

In addition, to improve water supply services on sustainable basis through development of infrastructure, it is inevitable to raise water tariff level and optimize the system to carry out operation and maintenance without any subsidy. For this purpose, YCDC has to work with the public through public awareness activities and consider poor people in tariff setting.

