THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
DEPARTMENT OF HOUSING AND URBAN PLANNING (DHUP)
OF MINISTRY OF PUBLIC WORKS AND TRANSPORT,
DEPARTMENT OF PUBLIC WORKS AND TRANSPORT (DPWT)
OF VIENTIANE CAPITAL,
VIENTIANE CAPITAL WATER SUPPLY STATE ENTERPRISE (NPNL)

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

THE PREPARATORY SURVEY ON VIENTIANE CAPITAL WATER SUPPLY EXPANSION PROJECT

FINAL REPORT SUMMARY

JUNE 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIHON SUIDO CONSULTANTS CO., LTD.

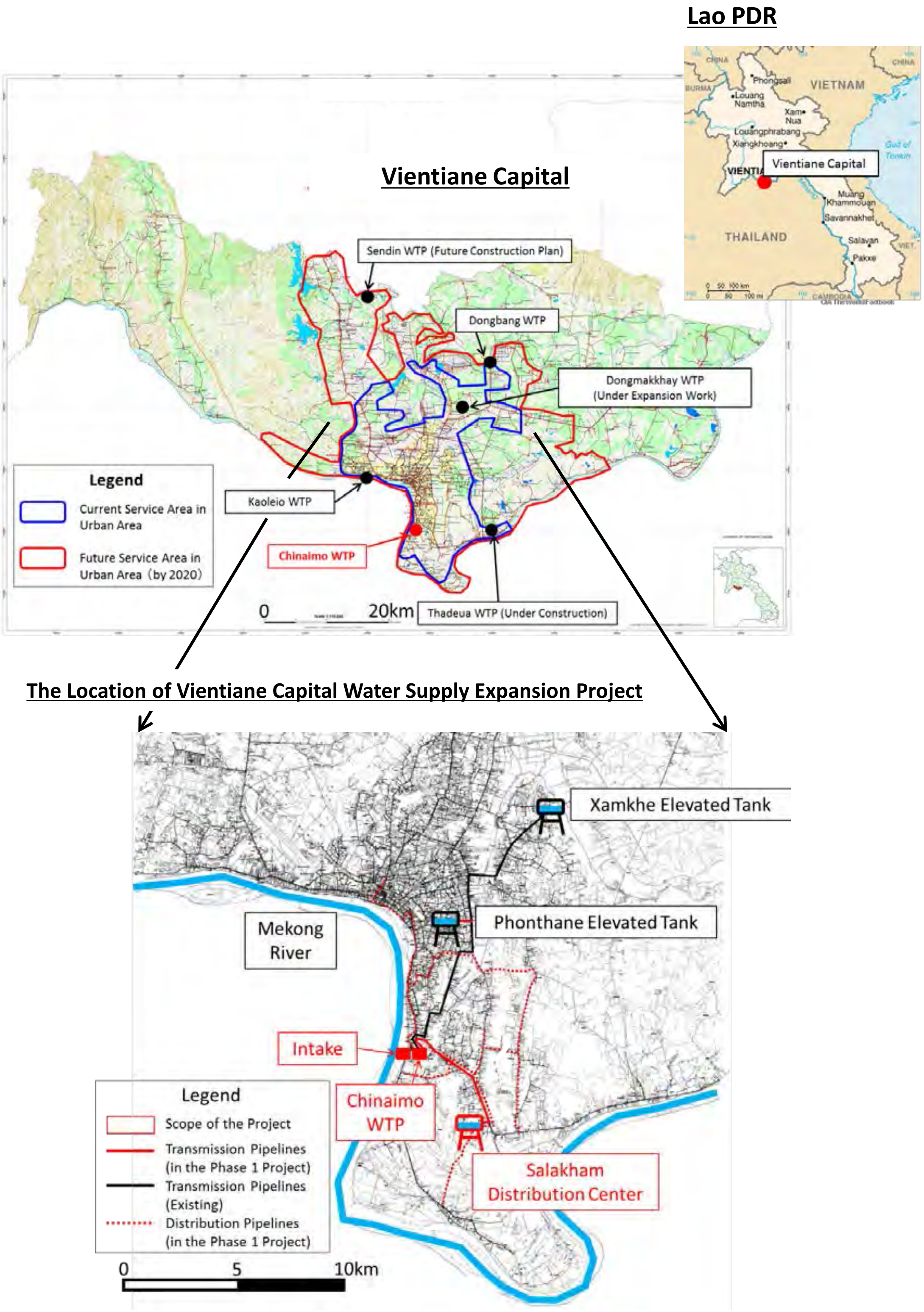
1R
CR (5)
15-025

EXCHANGE RATE

(effective for Fact Finding Mission for FY 2014)

1USD = 120.4 JPY
1USD = 8,094.60 LAK
1LAK = 0.0149 JPY

STUDY AREA LOCATION MAP



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ABBREVIATIONS

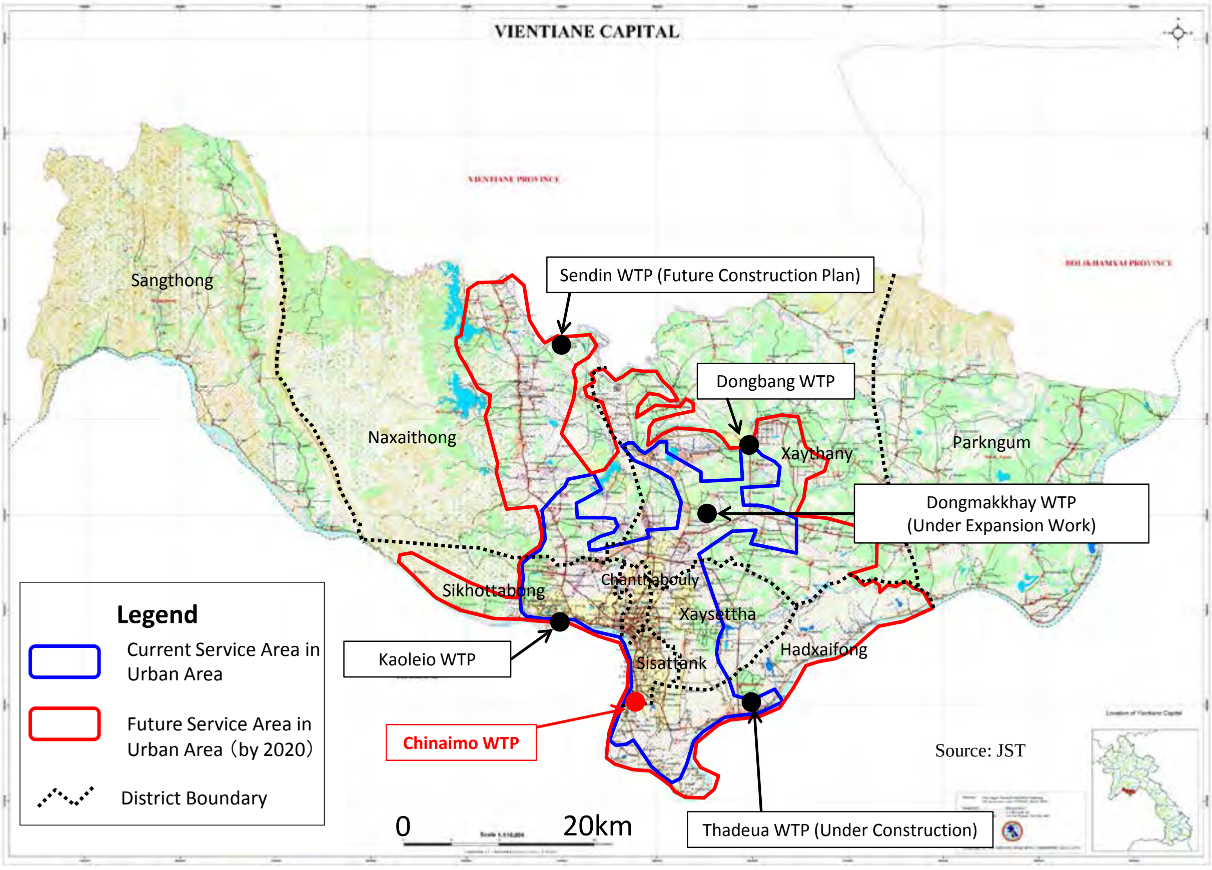
ADB	Asian Development Bank
AfD	French Development Agency
DBB	Design Bid Build
DEWATS	Decentralized Wastewater Treatment System
DF/R	Draft Final Report
DHUP	Department of Housing and Urban Planning
DIP	Ductile Iron Pipe
DONRE	Department of Natural Resources and Environment
DPWT	Department of Public Works and Transport
EA	Executing Agency
ECC	Environmental Compliance Certificate
EDL	Electricite du Laos
EIRR	Economic Internal Rate of Return
EIA	Environment Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
ESS	Environmental and Social Staff
ET	Elevated Tank
FIRR	Financial Internal Rate of Return
F/R	Final Report
F/S	Feasibility Study
GOJ	Government of Japan
GOL	Government of the Lao PDR
GSCP	Grass Fiber Coated Pipe
GSP	Galvanized Steel Pipe
HDPE	High Density Polyethylene Pipe
ICB	International Competitive Bidding
IC/R	Inception Report
IEE	Initial Environmental Examination
IT/R	Interim Report
JICA	Japan International Cooperation Agency
JST	JICA Study Team
Lao PDR	Lao People’s Democratic Republic
LCB	Local Competitive Bidding
LCC	Life Cycle Cost
MAWASU	Management Ability of Water Supply Authority
M/D	Minutes of Discussion
MOD	Ministry of Defense
MOH	Ministry of Health
MONRE	Ministry of Natural Resources and Environment
M/P	Master Plan
MPWT	Ministry of Public Works and Transport
NGPES	National Growth and Poverty Eradication Strategy
NPNL	Vientiane Capital Water Supply State Enterprise
NRW	Non-Revenue Water
NTU	Nephelometric Turbidity Unit
ODA	Official Development Assistance
O&M	Operation and Maintenance
PNP	Water Supply State Enterprises (i.e. Provincial Nam Papa)

PNP-LP	Luang Prabang Provincial Water Supply State Enterprise
PNP-KM	Khammouane Provincial Water Supply State Enterprise
PMU	Project Management Unit
PVC	Polyvinyl Chloride
RPM	Rotation per Minute
SP	Steel Pipe
UDM/P 2011	The Project for Urban Development Master Plan in Vientiane Capital in 2011 (a urban development master plan in Vientiane Capital prepared in 2011 with support by JICA)
uPVC	Un-plasticized Polyvinyl Chloride
VC	Vientiane Capital
WACC	Weighted Average Cost of Capital
WaSRO	Water Supply Regulatory Office
WB	World Bank
WSM/P 2004	The Study on Vientiane Water Supply Development Project in 2004 (a water supply master plan in Vientiane Capital prepared in 2004 with support by JICA)
WSM/P 2014	NPNL Water Supply Assets Master Plan in 2014 (a water supply master plan in Vientiane Capital prepared in 2014 with support by AfD)
WTP	Water Treatment Plant

EXECUTIVE SUMMARY

There are nine (9) districts in Vientiane Capital. Among them, design service area by piped water is mainly urban area of seven (7) districts (i.e. four (4) districts and partly three (3) districts). In the area, four (4) main water treatment plants, WTPs (i.e. Chinaimo WTP, Kaoleio WTP, Dongmakkhay WTP, and Dongban WTP), exist with a total design capacity of 180,000m^3/day, and the water supply coverage ratio was 72% in 2013. However, recent data records show they have produced, on average, over 199,000 m^3/day in 2013. This implies some plants were forced into over load operation recently. Also, the latest water demand projection shows the need for water production of over 400,000 m^3/day in 2030 due to rapid population and industry growth. Under such circumstances, improvement of water supply volume is urgently required for better living conditions in Vientiane Capital.

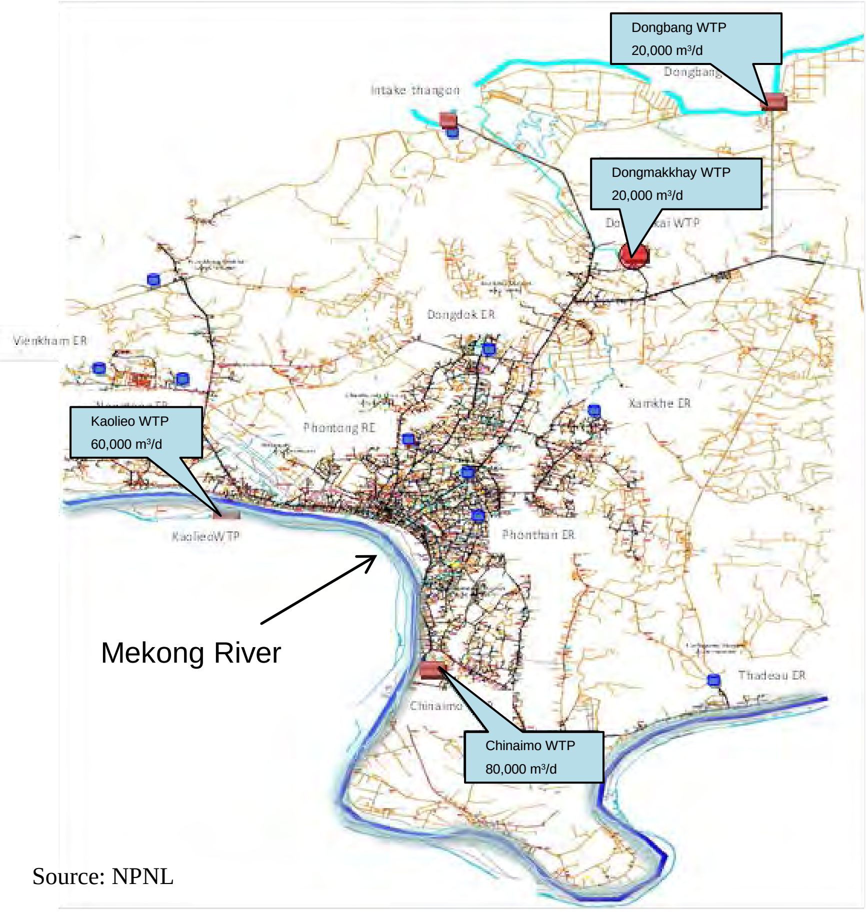
To improve this situation, this preparatory survey was formulated to carry out a feasibility study (F/S) for "Vientiane Capital Water Supply Expansion Project", based on the agreement between the Lao side and JICA, as stated in the M/M on 21st February, 2014. This survey covered in the current water supply service areas and future service areas to be expanded by 2020 in urban area of Vientiane Capital, and selected a priority project, Chinaimo Water Treatment Plant (WTP) Expansion Project. These areas of the survey and location of Chinaimo WTP are shown blow.



Source: JST

Areas of the Survey and Lactation of Chinaimo WTP

Water supply in Vientiane Capital is currently dependent on two (2) raw water sources, namely the Mekong River and the Nam Ngum River, and there are four (4) water treatment plants taking water from these rivers. The locations of the water treatment plants are shown below.



Source: NPNL

Locations of Existing Four Water Treatment Plants

The total design production capacity of these four (4) water treatment plants is 180,000 m^3/day. The actual daily production recorded in the year 2013 was, however, exceeding the nominal design capacity, as tabulated below.

Design Capacities and Actual Production of Existing Water Treatment Plants

Name of WTP	Design Capacity (m^3/d)	Actual Daily Average Production in 2013 (m^3/d)	Rate of Facility Utilization (%)
Chinaimo WTP	80,000	93,272	116.6%
Kaoleio WTP	60,000	68,084	113.5%
Dongmakkhay WTP	20,000	22,992	115.0%
Dongbang WTP	20,000	15,271	76.0%
Total	180,000	199,619	110.9%

Source: JST

Among the four water treatment plants, Chinaimo WTP and Kaoleio WTP are being overloaded by 16.6% and 13.5% on annual average, respectively. Dongmakkhay WTP is also overloaded by 15%, while Dongbang WTP is operated at 76 % of its design capacity due to the decreased production during high raw water turbidity seasons and frequent operation halts caused by leak repair of the transmission pipelines.

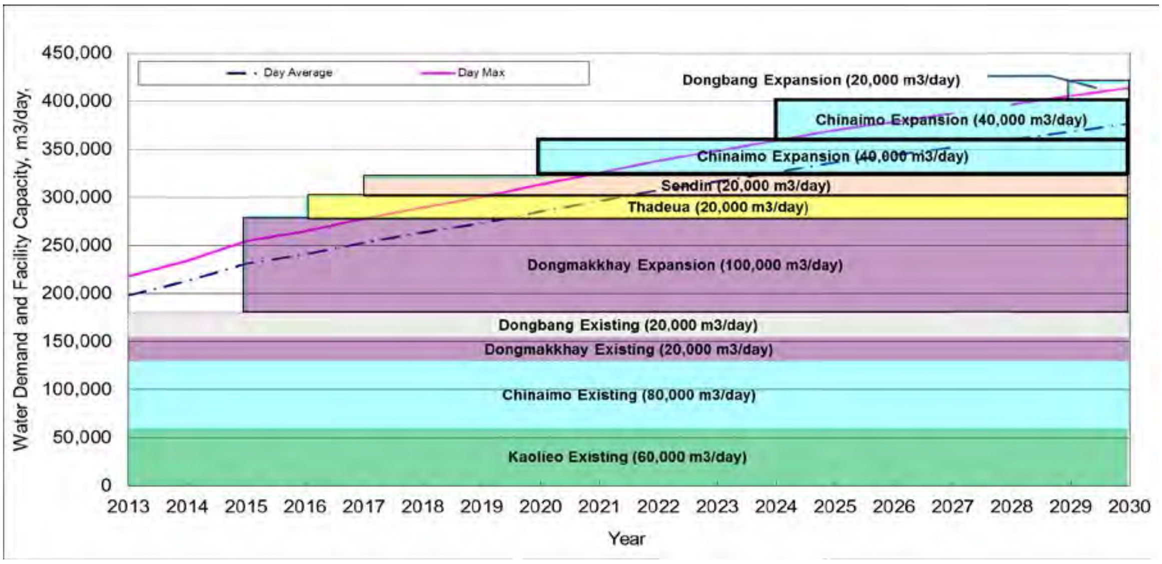
Setting served population, the per capita consumption, percentage of non-domestic water demand, NRW ratio, and peak daily factor, the table below shows the summary of projected water demand up to 2030.

Summary of Water Demand Projection

	Unit	2013	2015	2020	2025	2030
Population	person	854,069	906,082	1050,397	1,217,698	1,411,648
Population in Urban Area	person	675,751	700,498	766,891	840,368	921,787
Served Population	person	489,175	557,287	689,167	804,207	921,787
Service Ratio	%	72%	80%	90%	96%	100%
Per Capita Consumption	lpcd	245	245	245	245	245
Total Domestic Water Demand	m^3/day	119,848	136,535	168,846	197,031	225,838
Non-Domestic Water Demand	%	24%	27%	35%	45%	50%
	m^3/day	28,764	36,864	59,096	88,664	112,919
Total Water Demand	m^3/day	148,612	173,399	227,942	285,695	338,757
Non-Revenue Water (NRW)	%	25%	25%	20%	15%	10%
	m^3/day	49,537	57,800	56,986	50,417	37,640
Day Average Water Demand	m^3/day	199,619	231,199	284,928	336,112	376,397
Peak Daily Factor		1.1	1.1	1.1	1.1	1.1
Day Maximum Water Demand	m^3/day	219,600	254,300	313,400	369,700	414,000

Source: JST

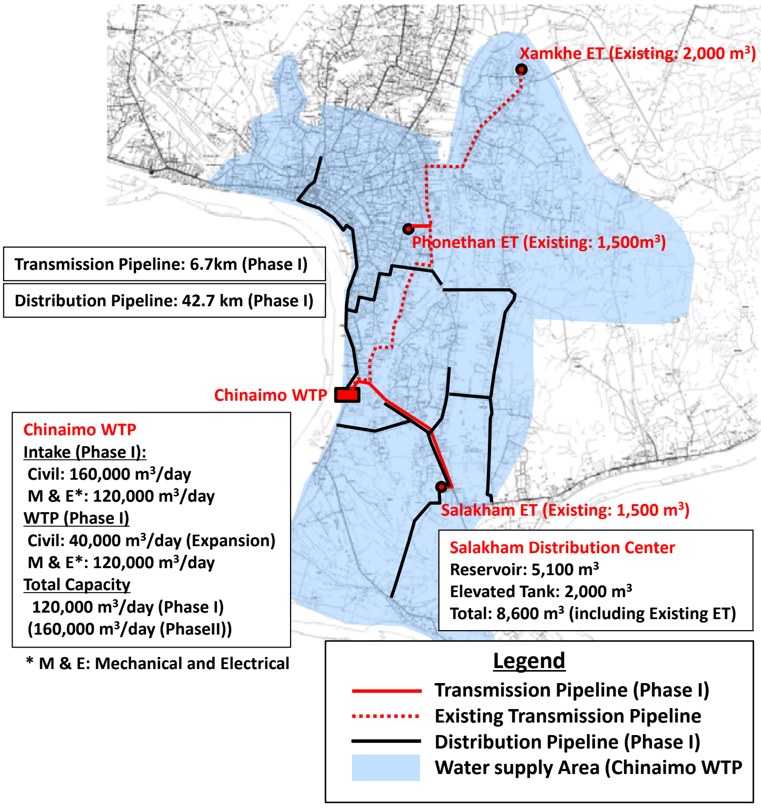
The total of the existing WTP capacities is 180,000m^3/day. Dongmakkhay WTP expansion project, with a capacity of 100,000 m^3/day, is expected to be complete in 2015. Also, Thadeua WTP (design capacity of 20,000 m^3/day by BOT) and Sendin WTP (design capacity of 20,000 m^3/day by BOT) are expected to complete construction and start their operations from 2016 and 2017, respectively. Considering these new WTPs, Chinaimo WTP Expansion Project (capacity of 80,000 m^3/day) with stepwise facility plan (i.e. 40,000 m^3/day in Phase 1 and another 40,000 m^3/day more in Phase 2) was proposed as below, and mutual consent was reached among the Government of Lao PDR (GOL).



Source: JST

Facility Plan (Chinaimo WTP Stepwise Expansion 80,000 m^3/day)

The following figure illustrates the phasing plan for the Chinaimo Expansion Project.



Source: prepared by JST

Chinaimo WTP Expansion and Related Facilities in Phase 1 and 2

Preliminary cost estimation based on project components in Phase 1 is shown in the table below.

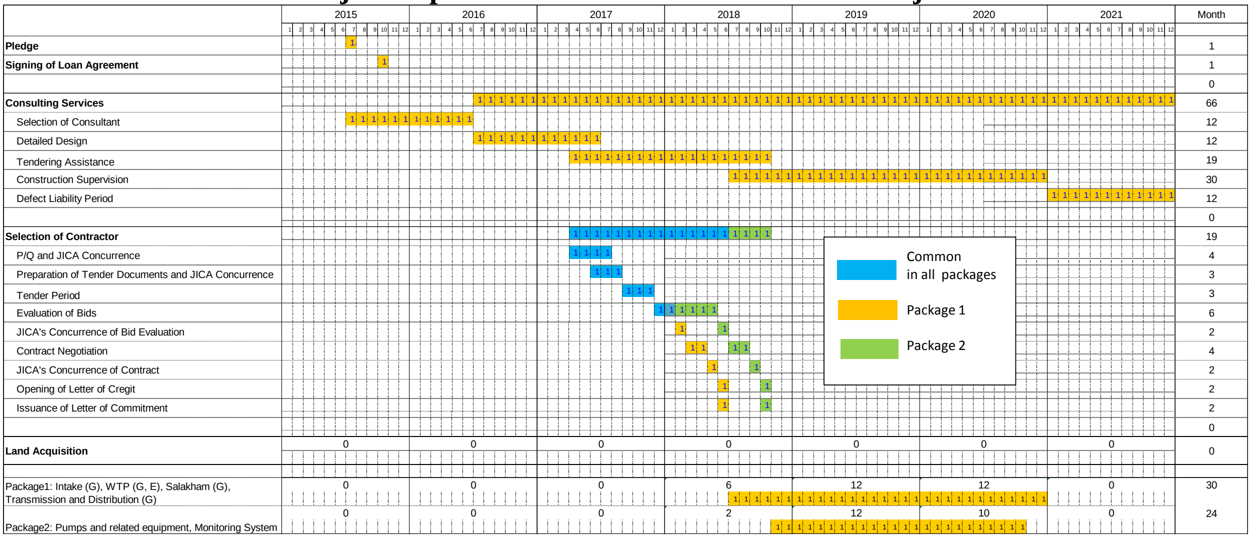
Preliminary Cost Estimation for the Project in Phase 1

Discription			Total				Percentage
			FC Million JPY	LC Million LAK	Total Million JPY	Total Million USD	
A. ELIGIBLE PORTION			7,266	179,097	9,934	82.5	92%
	I)	Procurement / Construction	6,472	149,750	8,703	72.3	-
		Base Cost	5,432	100,213	6,925	57.5	-
		Package 1	3,454	96,582	4,893	40.6	-
		Package 2	1,978	3,630	2,032	16.9	-
		Price escalation	452	35,924	987	8.2	-
		Physical contingency	588	13,614	791	6.6	-
	Ⅱ)	Consulting services	794	29,347	1,231	10.2	-
		Base cost	710	21,688	1,033	8.6	-
		Price escalation	45	6,261	139	1.2	-
		Physical contingency	38	1,397	59	0.5	-
B. NON ELIGIBLE PORTION			0	52,593	784	6.5	7%
	a	Procurement / Construction	0	0	0	0.0	-
	b	Land Acquisition	0	0	0	0.0	-
	c	Administration cost	0	33,336	497	4.1	-
	d	VAT	0	17,910	267	2.2	-
	e	Import Tax	0	0	0	0.0	-
	f	Front End Fee	0	1,347	20	0.2	-
C. Interest during Construction			103.1	0.0	103.1	1.1	1%
	i	Interest during Construction(Const.)	102.8	0.0	102.8	0.9	-
	ii	Interest during Construction (Consul.)	0.3	0.0	0.3	0.3	-
GRAND TOTAL (A+B+C)			7,369	231,690	10,821	90.1	100%
D. JICA finance portion incl. IDC (A + C)			7,369	179,097	10,037	83.6	93%

Source: JST

Implementation schedule for the Project in Phase 1 is shown in table below.

Project Implementation Schedule for Phase 1 Project



	2015	2016	2017	2018	2019	2020	2021	Month
Pledge								1
Signing of Loan Agreement								1
								0
Consulting Services								66
Selection of Consultant								12
Detailed Design								12
Tendering Assistance								19
Construction Supervision								30
Defect Liability Period								12
								0
Selection of Contractor								19
P/Q and JICA Concurrence								4
Preparation of Tender Documents and JICA Concurrence								3
Tender Period								3
Evaluation of Bids								6
JICA's Concurrence of Bid Evaluation								2
Contract Negotiation								4
JICA's Concurrence of Contract								2
Opening of Letter of Cregit								2
Issuance of Letter of Commitment								2
								0
Land Acquisition	0	0	0	0	0	0	0	0
Package1: Intake (G), WTP (G, E), Salakham (G), Transmission and Distribution (G)	0	0	0	6	12	12	0	30
Package2: Pumps and related equipment, Monitoring System	0	0	0	2	12	10	0	24

🟦	Common in all packages
🟨	Package 1
🟩	Package 2

Source: prepared by JST

The proposed priority projects in Phase 1 can be assessed as feasible resulting from the following views.

The priority projects, Chinaimo WTP expansion with a capacity of 40,000m^3/day in Phase 1, will increase the supply capacity of the NPNL's water supply system from the present 180,000 m^3/day to 360,000 m^3/day including three (3) other undergoing projects which are: Dongmakkhay WTP expansion with a capacity of 100,000m^3/day, Thadeua WTP BOT Project with a capacity of 20,000m^3/day, and Sendin WTP BOT Project with a capacity of 20,000m^3/day. This drastic increase in supply capacity is expected to solve or alleviate the chronic water shortage situation in Vientiane Capital.

The results of the analysis for Economic Internal Rate of Return (EIRR) and Financial Internal Rate of Return (FIRR)", as shown in table below, are to show financial feasibility and economic viability of the project without any tariff increases in addition to those scheduled by NPNL up to 2018.

Results of Financial and Economic Analysis of the Project

Types of Analysis	Value of Indicator	Evaluation of the Value	Results
Financial Analysis	FIRR: 9.29%	More than discount rate: 4%	The Project is financially feasible
Economic Analysis	EIRR: 27.30%	More than discount rate: 12%	The Project is economically viable

Source: JST

In the water tariff rate analysis, average monthly income of low income households is estimated at 1,853,920 LAK/month. Affordability to pay for water supply was set by international organizations (IBRD, and Pan American Health Organization) at 3.5% or 4% of household income, and it was considered that planned tariff raise (3.5% in every 5 years after 2020) is payable or under the ceiling of affordable water bill amount even for low income households with the future modest income growth.

In environmental and social consideration, after submitting the IEE report to Department of Natural Resources and Environment (DONRE), it was reviewed with two stakeholder meetings (village/district level and district /Vientiane Capital level). Then, the ECC was issued on 17 February, 2015 by DONRE.

Chapter 1 INTRODUCTION

1.1 Background of the Survey

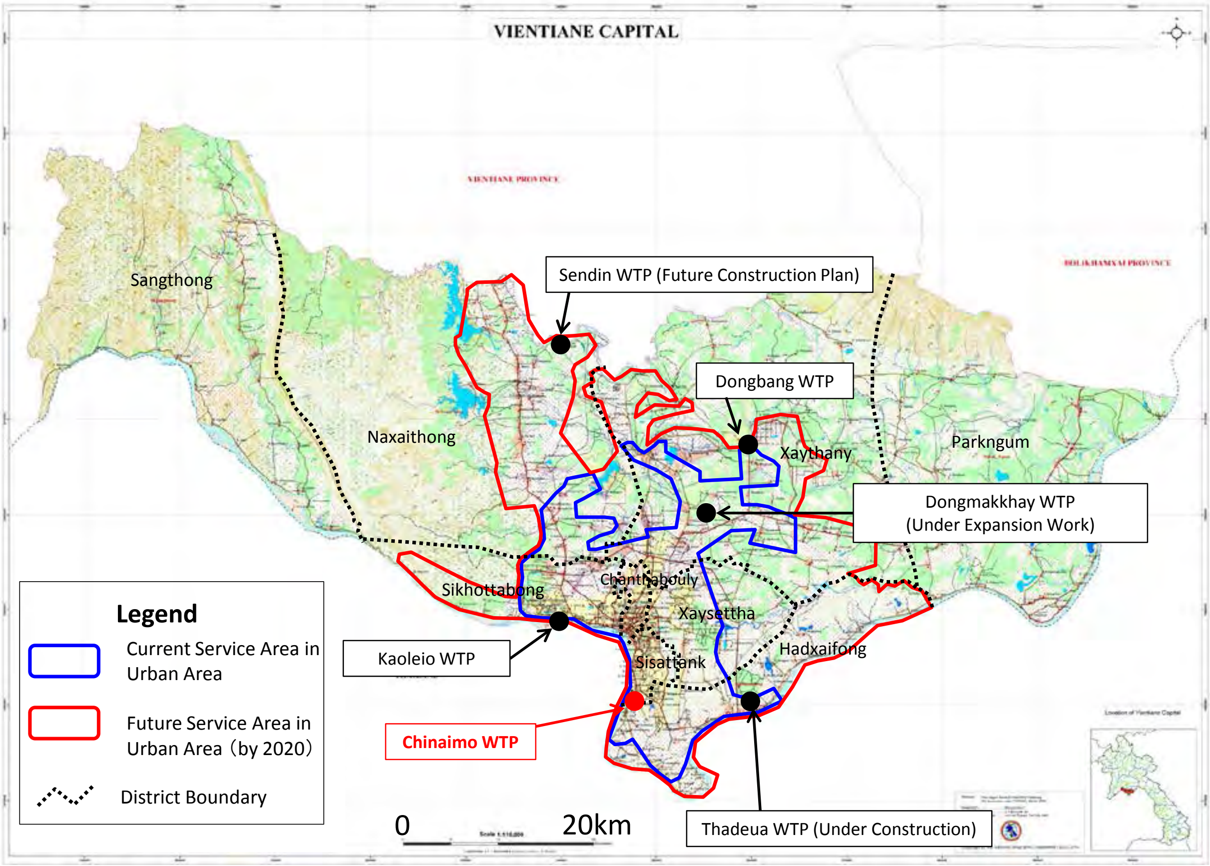
In Vientiane Capital, the capital of the Lao People’s Democratic Republic (hereafter referred to as the Lao PDR), the population and industry of the urban area are steadily growing in line with economic growth. The development of social infrastructure is not catching up with the growth, and in particular, maintenance and expansion of water utilities is an urgent task. The population in 2013 was approximately 854,000 and it is expected to reach one million in 2020.

There are nine (9) districts in Vientiane Capital. Among them, design service area by piped water is mainly urban area of seven (7) districts (i.e. the entire area of four (4) districts and part of three (3) districts). In the area, four (4) main water treatment plants, WTPs (i.e. Chinaimo WTP, Kaoleio WTP, Dongmakkhay WTP, and Dongban WTP), exist with a total design capacity of 180,000m^3/day, and the water supply coverage ratio was 72% in 2013. However, recent data records show they have produced, on average, over 199,000 m^3/day in 2013. This implies some plants were forced into over load operation recently. Also, the latest water demand projection shows the need for water production of over 400,000 m^3/day in 2030 due to rapid population and industry growth. Under such circumstances, improvement of water supply volume is urgently required for better living conditions in Vientiane Capital.

Under these situations, the Government of Lao (GOL) and the Japan International Cooperation Agency (JICA) reached a consensus for conducting a feasibility study (F/S) for the expansion of Chinaimo Water Treatment Plant (WTP) as a candidate for a Japanese loan project.

1.2 Objective of the Survey and Survey Area

The objective of this survey is to conduct an F/S for Vientiane Capital water supply system expansion including Chinaimo WTP expansion in order to carry out safe and stable water supply service to the residents of Vientiane Capital. This survey covered Vientiane Capital, and especially aimed at in the current water supply service areas and future service areas to be expanded by 2020 in urban area of Vientiane Capital, which are shown in Figure 1.1.



Source: JST

Figure 1.1 Areas of the Survey

1.3 Survey Schedule

The survey will be implemented by Site Surveys in Vientiane Capital and Works in Japan as shown in Figure 1.2

Year	2014						2015					
Month	7	8	9	10	11	12	1	2	3	4	5	6
Site Survey in Vientiane Capital		■	■ 1st Site Survey	■	■ 2nd Site Survey	■	■ 3rd Site Survey	■	■ 4th Site Survey			
Work in Japan		□ Preparation		□ 1st Work			□ 2nd Work	□ 3rd Work	□			
Reporting		△ IC/R			△ IT/R		DF/R	△				△ F/R

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

Figure 1.2 Survey Schedule

Chapter 2 PRESENT CONDITIONS OF THE SURVEY AREA

2.1 Natural Conditions

2.1.1 Meteorology

The climate in the Vientiane Capital is categorized as Southeast Asia tropical monsoon climate. It has into two distinct seasons, monsoon (rainy) season and dry season. The monsoon season is from May to October and the dry season is from November to April. The average monthly maximum temperature ranges from 28.47^{o}C in December to 35.06 ^{o}C in April. The average monthly minimum temperature ranges from 18.23 ^{o}C in December to 25.61 ^{o}C in June. The average monthly precipitation ranges from 7.5 mm in February to 435.2 mm in August, and 1600mm to 1750mm in annual basis. Approximately 87 % of rainfall occurs between May and September.

2.1.2 Topography

Vientiane Capital is situated on an alluvial plain extending along the left bank of the Mekong River east to west. The administrative area of Vientiane Capital is about 3,920 km^2 and ground elevation, except for west part of city, ranges from 160 m to 180 m above sea level. The west part has elevation over 180 m to 650m above sea level.

2.1.3 Hydrology

There are two main rivers in Vientiane Capital, which are: the Mekong River and the Nam Ngum River. The Nam Ngum River joins the Mekong River in the east side of Vientiane Capital. The average flow rate of the Mekong River shows that there is significant difference between rainy season and dry season. In 2010, the minimum water discharge of low years, only 912.24 m^3/s or 78,817,589.33 m^3/day, was recorded in March, and the maximum water discharge in the same year was 8908.79 m^3/s or 769,715,950.80 m^3/day in September. In the Mekong River, water depth has also significant fluctuations of over 10 meters between dry season and rainy season. As for water quality in the Mekong River, turbidity is generally high, especially in rainy season. The highest turbidity recorded in the past was over 3,000 NTU.

2.1.4 Hydro-geology

The Vientiane Basin is located at the northern part of the Sakhon Nakhon Basin in the Khorat Plateau. Seawater flowed in the Khorat Plateau since seawater level was high during the Cretaceous period. In Vientiane Capital, there are deep wells which produce salty groundwater. In some deep wells the chloride concentration is the same as seawater and the water tastes quite salty. Hence, it is considered that the groundwater in Vientiane Capital is not suitable for the city water supply.

2.2 Social and Environmental Conditions

2.2.1 Population and Administration

The recent statistics information shows that the current population in Vientiane Capital became 854,069 in 2013. The number of households in Vientiane Capital was 145,558 in the same year, and the average family size was calculated at 5.5 persons per household, as shown in Table 2.1.

Table 2.1 Population and Family Size in Vientiane Capital (2012-2013)

No.	District Name	Population	Number of Household	Family Size
1.	Chanthabuly	71,878	12,254	5.9
2.	Sikhottabong	109,096	20,638	5.3
3.	Xaysetha	108,889	21,517	5.1
4.	Sisattanak	78,088	11,196	7.0
5.	Naxaithong	71,795	13,168	5.5
6.	Xaytany	183,838	32,771	5.6
7.	Hadxaifong	90,662	18,217	5.0
8.	Sangthong	30,985	6,137	5.0
9.	Parkngum	55,992	9,660	5.8
	Others	52,846	-	-
Vientiane Capital		854,069	145,558	5.5

Source: Statictics Information and Poverty of Vientiane Capital, DPI

In Vientiane Capital, the area served by Water Supply State Enterprise (NPNL) currently covers 263 villages out of the 483 villages in the whole nine (9) districts. NPNL plans to expand the served area to another 124 villages by 2020. It should be noted that villages are classified into categories: urban and remote. In Table 2.2, villages counted as “Current Service Area” and “Future Expansion Area (2020)” villages and also “Urban Area” and “Remote Area” villages.

Table 2.2 Summary of Villages to be Served Water by NPNL

No.	District Name	Number of Villages			
		Existing	Current Service Area	Future Expansion Area (2020)	Outer Service Area
1.	Chanthabuly	30	30	0	0
2.	Sikhottabong	60	57	3	0
3.	Xaysetha	48	44	4	0
4.	Sisattanak	37	37	0	0
5.	Naxaithong	54	13	41	0
6.	Xaytany	104	33	40	31
7.	Hadxaifong	60	44	16	0
8.	Sangthong	37	3	8	26
9.	Parkngum	53	2	12	39
	Total	483	263	124	96

🟦 : Villages in Urban Area (Current Service Area)

□ : Villages in Urban Area (Future Expansion Area)

🟧 : Villages in Remote Area (Current Service Area)

□ : Villages in Remote Area (Future Expansion Area)

Source: Planning and Investment Department, NPNL
Note: The numbers are as of the year 2013.

2.2.2 Land Use

In Sisatthanak District and Chanthabouly District, most of the land is used for residential area. In Xaysetha District and Sikhottabong District, about 30-50 % of the land is used for residential area and the rest of the land is a combination of paddy fields and forest areas. In the other districts, most of the area is used for paddy fields. It is noteworthy to point out that the GOL has promoted dis-concentrating certain urban functions from the Vientiane Capital center towards the District centers, and industrial development in the suburbs of Vientiane Capital. The GOL has also pushed forward the future development of new towns, and specific economic zones (SEZ)[1].

2.2.3 Social Economic Conditions

The Lao PDR had continued steady economic growth. The Asian economic crisis in 1997 badly influenced the economy of the country as its GDP growth rate declined in 1998. Nevertheless, it has recovered since 1999 with average 5 to 6% annual GDP growth rate, and even higher economic growth rates of 7 to 8% in recent years.

The Government of the Lao PDR (GOL) started planning the establishment of the special economic zones in 2008. In the Lao PDR, there were 10 SEZ as of September 2014. SEZs are composed of 2 types of economic zones, namely; Special Economic Zone and Specific Economic Zone. Five of them were located in Vientiane Capital. They are expected to attract the domestic and foreign investment and to be the driving force of the economic expansion. Furthermore, they will be large users of public water if the public water supply capacity is developed enough for them and in time for each SEZ's completion.

Total number of tourists to Vientiane Capital exceeded 1 million in 2010, and the number has been increasing afterward. Caused by the steady increase of tourist arrival, tourism revenue and related industries are also expanding continuously. Tourism industry is one of the most important industries in Vientiane Capital, in the aspects of not only foreign currency acquisition and economic expansion, but also for job creation.

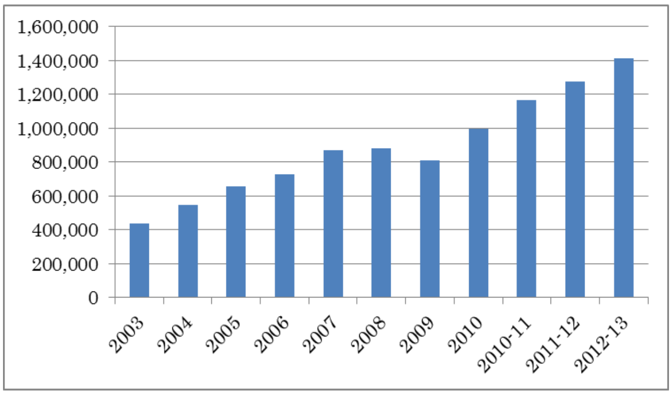


Figure 2.1 Tourist Arrival at Vientiane Capital

Source: 2010 Statistical report on tourism in Laos (2003 to 2010), and Socio-Economic Data Vientiane Capital (2010-11 to 2012-13)

2.2.4 Social Environment Conditions

In Vientiane Capital, most common ethnicity is the major ethnic group, Lao. Thus, special consideration for minor ethnic groups is not necessary. However, attention should be paid when ethnic minority groups are be found among the project's affected households.

Electrification rate is 100 % in all surveyed districts. Bottled water from factories is the drinking water source in all surveyed districts. However, ground water accounts for 5% of drinking water source in Xaysetha District. The coverage of piped water supply by Vientiane Capital Water Supply Enterprise (NPNL) ranges from 100 % in Sisatthanak District to 70 % in Hadxaifong District. No cultural heritage or archeological sites are found in the proposed project sites.

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[1] SEZ are composed of 2 types of economic zones, such as; Special Economic Zone and Specific Economic Zone. Special Economic Zone is a modern town, in order to attract domestic and foreign investment, having more than 1,000 ha area, whereas Specific Economic Zone is the specific purpose zone such as industry, production, tourism, duty free, IT, border trade, and so on.

Chapter 3 ANALYSIS OF CURRENT WATER SUPPLY SECTOR

3.1 Current Situation and Problem of the Water Supply Sector

The GOL gives high priority to improving water supply and sanitation throughout the country, setting an overall goal of 80% coverage of piped water supply for urban communities by 2020. Also, Vientiane Capital has their policy that the coverage of supply water in urban area should be reached 90-95 % by 2020[2]. For the achievement of this goals and sustainable water supply works, the following issues and problems should be addressed in the Vientiane Capital water supply sector.

- Service coverage in the urban area is still 72% as of 2013.
- Expansion of service area by 2020 is planned, but not enough production capacity.
- Existing WTPs have been over loaded 13-16% of their production capacity.
- 17% of connections suffer from water shortage at least one time a day.
- Existing elevated tanks have not been used for a longtime.
- Some areas are subject to low water pressures.
- Existing network hydraulic arrangement and pipe size are not sufficient.
- High leakage due to the material problems (e.g. old pipes, nondurable materials).
- There are many kinds of pipe material (difficulty of maintenance).
- Upskilling for plumbers is required with adequate training.
- Manual management for pipeline network has been continued.
- No strict of water supply regulation exists.

3.2 Laws, Policies and Plans of the Water Supply Sector

3.2.1 Legal Framework and Laws in Water Supply Sector

Prime Minister (PM) Decision No. 37 on the Management and Development of Water Supply and Wastewater Sector, issued on 30th September 1999, establishes the key institutions in the sector. At the central level, the Ministry of Public Works and Transport (MPWT) is assigned for urban water supplies. The water supply law, approved by the National Assembly and President of the Lao PDR since July 2009, aims to consolidate the water supply legislation and strengthen the legal basis for the provision of sanitation services. This law determines principles, regulations and management principles for construction of urban water supply system.

3.2.2 Policies and Plans in Water Supply Sector

The responsibility of the urban water sector is born by MPWT, whereas rural areas are under the scope of the Ministry of Public Health. According to the GOL's 1999 policy statement (PM Decision No. 37), the sector target is to provide 24-hour access to safe drinking water for 80% of the urban population by 2020. To achieve this goal, the GOL has progressively developed water supplies in Vientiane Capital and the provincial centers, and, since 1999, has given increasing focus to development of piped water supplies in the small towns[3] to support economic development.

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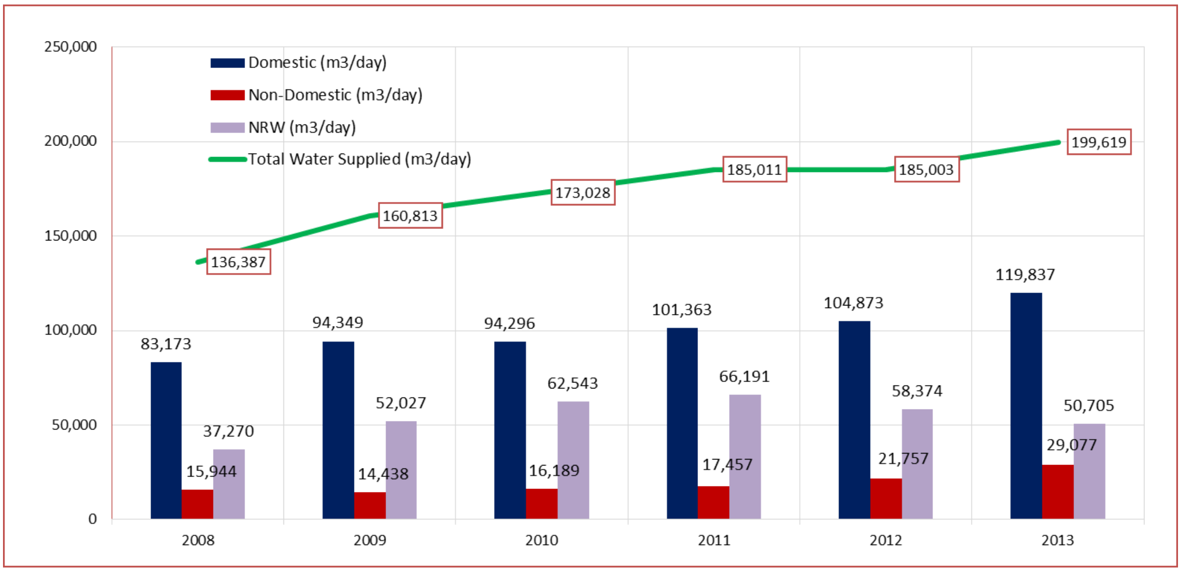
[2] This was agreed on the fifth party's meeting of party's member committee in Vientiane capital.

[3] Small towns are rural bases to provide public, commercial, and logistical services to surrounding rural villages, and are prospected future economic growth as well as urban development.

3.3 Amount of Water Supplied in Vientiane Capital

According to the 1999 policy statement (PM Decision No. 37), NPNL has made strenuous effort to increase the percentage of population served by pipe water from NPNL. With the improvement of service ratio, water supply amount has been also increased from 136,387 m^3/day in 2003 to 199,619 m^3/day in 2013 as shown in Figure 3.1.



Source: NPNL

Figure 3.1 Amount of Water Supplied from 2008 to 2013 by NPNL

3.4 Current Status of the Water Supply Amount and Capacity of the Existing Water Supply Facilities

Water supply in Vientiane Capital is currently dependent on two (2) raw water sources, namely the Mekong River and the Nam Ngum River. There are four (4) water treatment plants. The locations of the water treatment plants are shown in Figure 3.2.

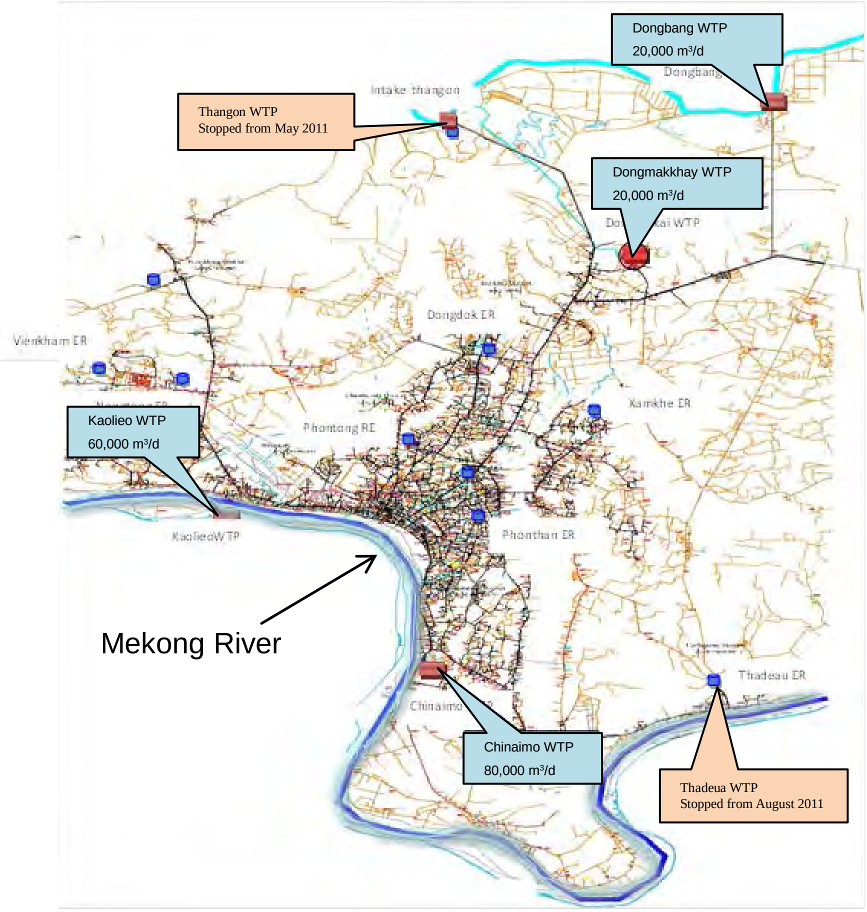
The total design production capacity of these four water treatment plants is 180,000 m^3/day. The actual daily production recorded in the year 2013 was, however, exceeding the nominal design capacity. Table 3.1 compares the design capacities and actual production for each water treatment plant.

Table 3.1 Design Capacities and Actual Production of Existing Water Treatment Plants

Name of WTP	Design Capacity (m^3/d)	Actual Daily Average Production in 2013 (m^3/d)	Rate of Overloading (%)	Year of Operation Start	Source of Fund or Donor
Chinaimo WTP	80,000	93,272	+16.6%	40,000 in 1983 + 40,000 in 1996	ADB GOJ (Grant)
Kaoleio WTP	60,000	68,084	+13.5%	20,000 in 1964 + 40,000 in 2009	GOJ (Grant) GOJ (Grant)
Dongmakkhay WTP	20,000	22,992	+15.0%	2006	GOL own fund
Dongbang WTP	20,000	15,271	-24.0%	2009	NPNL& Vietnam Private Company
Total	180,000	199,619	-		

* Operations in Thangon WTP and Thadeua WTP were stopped in 2011.
Source: JST

Among the four water treatment plants, Chinaimo WTP and Kaoleio WTP are being overloaded by 16.6% and 13.5% on annual average, respectively. Dongmakkhay WTP is also overloaded by 15%, while Dongbang WTP is operated at 76 % of its design capacity due to the decreased production during high raw water turbidity seasons and frequent operation halts caused by leak repair of the transmission pipelines.



Source: NPNL

Figure 3.2 Locations of Existing Water Treatment Plants

3.5 Current Conditions of Non-revenue Water

Non-Revenue Water (NRW) in Vientiane Capital had increased until the year 2010, reaching 36%. Then, the ratio started declining since the year 2011, and decreased to 25% in the year 2013.

3.6 Comprehensive Plan for Water Supply Facilities in Vientiane Capital

NPNL's basic concepts of the comprehensive development plan for the future water supply facilities are described in the following:

- The service areas presently identified with water shortage or low water pressure should be addressed for the immediate improvement.

- In order to cope with increasing water demands due to the future development projects such as special economic zones (SEZ) and industrial zones, water supply facilities should be strategically developed so as to accommodate these water demands in time.
- The government offices and political functions of Vientiane Capital will be relocated to Thangone Area, which is located at the northern edge of Vientiane Capital.

3.7 Current Projects for Water Supply Sector in Vientiane Capital

Current projects related to water supply sector are listed in Table 3.2. These projects will be discussed in a later part of this Chapter.

Table 3.2 Summary of Current Projects Related to Water Supply in Vientiane Capital

Project Name	Financed by	Remarks	Status
Nam Papa Nakhone Luang Water Supply Assets Master Plan, September 2014	AfD	Water supply master plan preparation for the target year of 2030.	Prepared final report in Sep. 2014.
Replacement of GSP Pipes for Nakhone Luang Water Supply System – Phase II	AfD	Existing pipe replacement project	Completion of financial support by Nov. 2013
Dongmakkhay Extension Water Supply System	China Exim Bank Loan	Dongmakkhay WTP expansion (100,000 m^3/day) and pipe installations by EPC	Under construction, expected completion in the end of 2015
Vientiane Capital Water Supply Expansion Project	JICA	Chinaimo WTP expansion (40,000 m^3/day in Phase 1 and more 40,000 m^3/day in Phase 2) and pipe installations	Prepared the final report in June 2015.
Capacity Building Project for Water Supply Authorities	JICA	Technical cooperation project	On-going, continue to Aug. 2017
Thadeua Water Supply Project	Local Private Investor	Thadeua WTP construction (20,000 m^3/day) and pipe installations by BOT	Under construction (started since Jan. 2015), and expected completion in 2016.
Sendin Water Supply Project	Local Private Investor	Sendin WTP construction (20,000 m^3/day) and pipe installations byBOT	MOU was signed in May 2014. Contract signing would be in July 2015, and expected operation starts from 2017.
Dongbang Expansion Project	Under Consideration	Dongbang WTP expansion (20,000 m^3/day) and pipe installations	

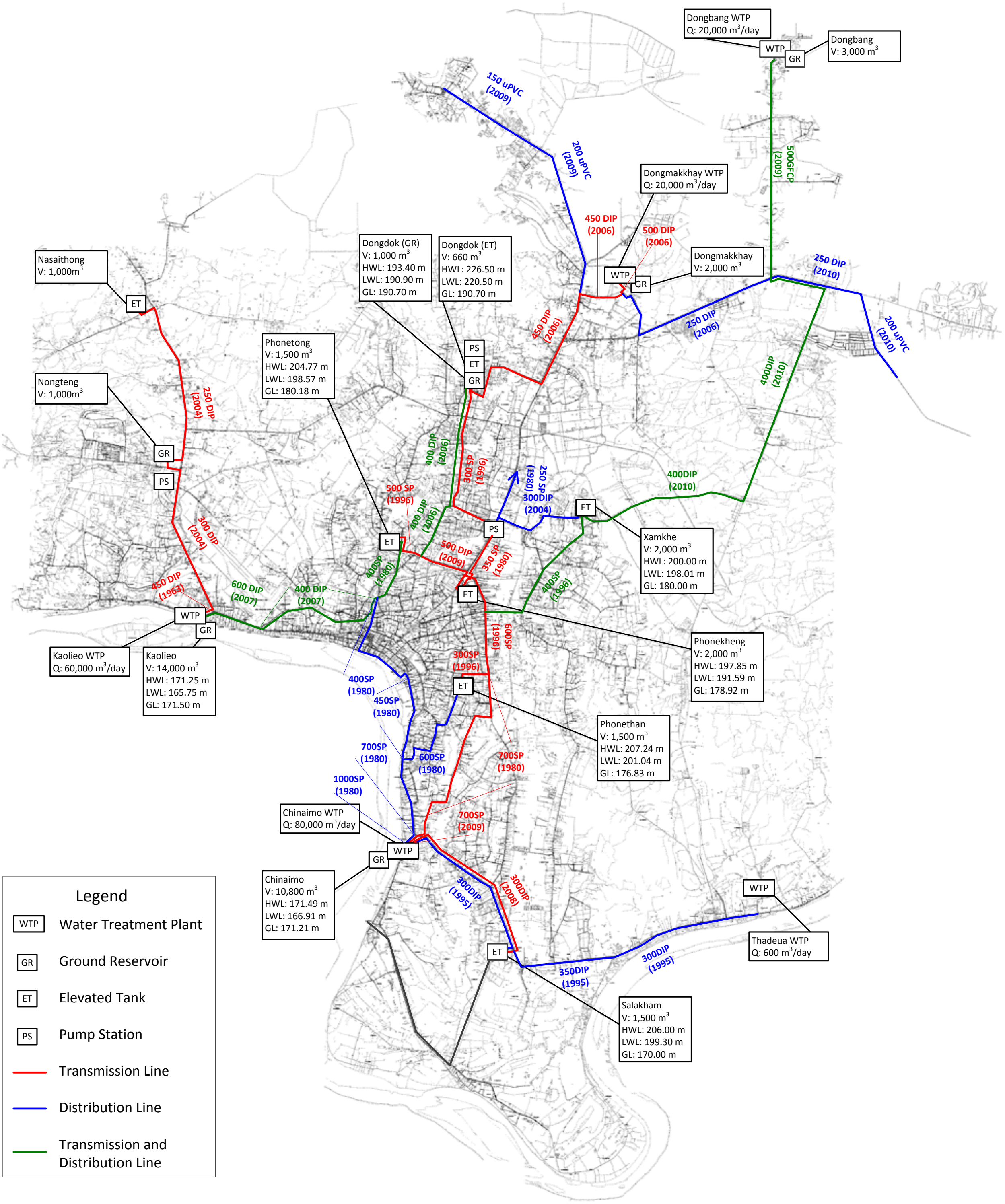
Source: JST

The projects listed above will be discussed in a later part of this Chapter.

3.8 Existing Water Supply Facilities in Vientiane Capital

General layout of the existing water supply facilities in Vientiane Capital is illustrated in Figure 3.3.

There are four main water treatment plants. Treated water from the water treatment plants is once transmitted to the elevated tanks located at strategic locations in the distribution network to supply water to customers by gravity, or distributed directly by pumping from the water treatment plants to customers. Due to recent water shortages, the existing elevated tanks are, however, not utilized and by-passed.



Source: Prepared by JST from NPNL data

Figure 3.3 General Layout of the Existing Water Supply Facilities in Vientiane Capital

3.9 Existing Facilities in Chinaimo WTP

3.9.1 Intake Facility in Chinaimo WTP

Although the existing raw water intake pump station has been in service for more than 35 years, the structure itself had no severe or critical damage~~s~~ according to the visual inspection. No trash racks or screens were provided to prevent floating foreign matters, such as driftwood pieces and plastic rubbish, from entering the pump suction well. There are six raw water intake pumps in total, and the raw water intake pumps No. 1, 2, 3 and 4 are vertical mixed flow pumps, and No.5 and 6 pumps are submersible pumps. The pumps are well maintained and operated without any noise or vibration. The motor of pump No.1 was, however, removed for repair, and pump No.6 was out of service due to the damage of the insulating part of the motor during JST's visit. The total pump discharge flow indicated at the monitor and control panel was about 4,000 m^3/hr (96,000 m^3/day) during the inspection, which exceeded the designed raw water intake amount.

3.9.2 Water Treatment Facility in Chinaimo WTP

At flocculation basins, it is judged that rapid mixing, mixing raw water and coagulant, is achieved relatively well but it is understood that coagulated water after alum injection is given high hydraulic energy by water falling at flow split weirs, and there is possibility to hinder appropriate floc formation due to high hydraulic energy. It is recommended to dose coagulant, alum over the flow splitting weirs by using alum dosing showers as originally designed and provided. The performance of the flocculation and sedimentation processes is, however, judged to be satisfactory to deliver the settled water with turbidity low enough for the following filtration process.

There are eight filters. Filter type is of common inlet and outlet water level type, and constant filtration rate with the use of filter outlet flow control device (Valvocet) is adopted. During the inspection, seven filters were in service and one filter was out of service for repairing filter false floor that is made of porous concrete. It is supposed that cracking damage of the false floor occurred due to insufficient air venting after air scouring of the filter. Air vent valves are provided in the air scouring pipes, and it is recommended to pay due attention for air venting by opening air vent valve of each filter after air scouring process.

Filter washing facilities are well maintained while all of the pumps and one blower manufactured in 1978, and have been in service for over 35 years, and one blower also has been in service for over 20 years.

There are two pump stations. The old pump station has been in service for more than 35 years and is located beside the filter outlet conduit. This old pump station is now used as the transmission pump station. There is another new distribution pump station, which was constructed during 2006 – 2009. All of the pumps are kept in good condition.

All electrical equipment of electric power receiving and distribution system is well maintained and is in service. Electric power supply from the electric power supply company is stable and reliable as loop electric power supply system is provided.

3.9.3 Transmission and Distribution Facility in Chinaimo WTP

Chinaimo WTP was originally designed to transmit water to elevated tanks located in the city. However, distribution pipes had been branched from the transmission mains to cope with the increasing water demand in past times. Modification to separate the transmission main and distribution main was conducted under the Project for the Vientiane Water Supply Development (2006-2009) to improve water distribution to meet fluctuating water demands and water transmission to supply stable amount of water to the elevated tanks.

3.9.4 Power Availability

Power supply to Chinaimo WTP is supplied by Electricite du Laos (EDL), which is state-owned enterprise under Ministry of Energy and Mines. Chinaimo WTP site is located within the double 115 kV main transmission network of the existing EDL national power grid, which can supply to the WTP from the branched 22 kV loop line from the two different directions.

3.10 Operation and Maintenance

3.10.1 Water Treatment Plants

Water treatment processes of the existing water treatment plants are operated by monitoring the raw water quality, clarified water quality from sedimentation basins, and filtered water quality, and chemical dosages are adjusted based on Jar test results conducted by laboratory staff. NPNL has long-term operation experience of conventional rapid sand filter systems, and the finished water quality is consistently satisfactory for drinking water quality standards, even when raw water turbidity levels reach several thousand NTU

3.10.2 Water Transmission and Distribution Network

The existing distribution network has not been properly arranged to distribute water evenly within proper water pressure range to customers. This is due to the fact that many small diameter pipes were installed on a patchwork basis without proper hydraulic design to catch up with the past increasing water demands. Substantial sections of the existing service area are now subject to low water pressure, and it is indicative that there are a lot of bottle-neck pipes in the network system. What is worse, most of the transmission mains are presently utilized for distribution pipes as the elevated tanks are by-passed due to the lack of water transmitted from the water treatment plants to the elevated tanks. This situation makes it difficult for NPNL to control the transmission and distribution system as the present practice of NPNL is only operating the network valves and brings very limited effects.

3.11 Water Supply Sector Organizations

At the national level, the Ministry of Public Works and Transportation (MPWT) is responsible for urban water supply in the Lao PDR. The MPWT mandate includes planning and programming, mobilizing financing, developing guidelines for design, construction, and operation and maintenance of urban water supply facilities, and technical assistance to Water Supply State Enterprises (i.e. State-owned Provincial Nam Papa, PNP). Within MPWT, this responsibility is lodged with the Department of Housing and Urban Planning (DHUP), and further delegated to the Water Supply Division (WSD). Water Supply Regulatory Committee (WSRC) under MPWT regulates both public and private service providers. It is chaired by MPWT's Vice Minister and has nine members including representatives from the government, the private sector industry, consumers, and water operators. Water Supply Regulatory Office (WaSRO) as the secretariat of WSRC is responsible for drafting of regulatory plans, regulations and guidelines, and monitoring and evaluation of providers' performance.

3.12 Water Tariff Setting

Water tariff table is shown in Table 3.3. This tariff table was agreed with Governor of Vientiane Capital and noticed by General Director of NPNL in September 2014. This water tariff table also describes the planned future water tariffs, which have been already approved. NPNL will raise it 3% to 5% every year up to the year 2018, continuously.

Table 3.3 Present and Future Water Tariff of NPNL (effective from the end of Sept. 2014)

Category	Type of User	Change of Unit price (LAK/m^3) of each year				
		2014	2015	2016	2017	2018
		-	3%	3%	4%	5%
1	Category 1: Household					
	1-10 m^3/month	1,300	1,339	1,379	1,434	1,560
	11-30 m^3/month	1,800	1,854	1,910	1,986	2,085
	31-50 m^3/month	2,300	2,369	2,440	2,538	2,665
	51m^3/month and more	2,800	2,884	2,970	3,089	3,244
2	Category 2: Governmental, embassy, and international organization	2,300	2,369	2,440	2,538	2,665
3	Category 3: Business industry & commercial	2,800	2,884	2,971	3,089	3,244

Note: The above water tariff is effective from September 2014 until 2018

Source: Agreement No.900, dated 4 September 2014, Vientiane Capital Governor

3.13 Financial Analysis of NPNL

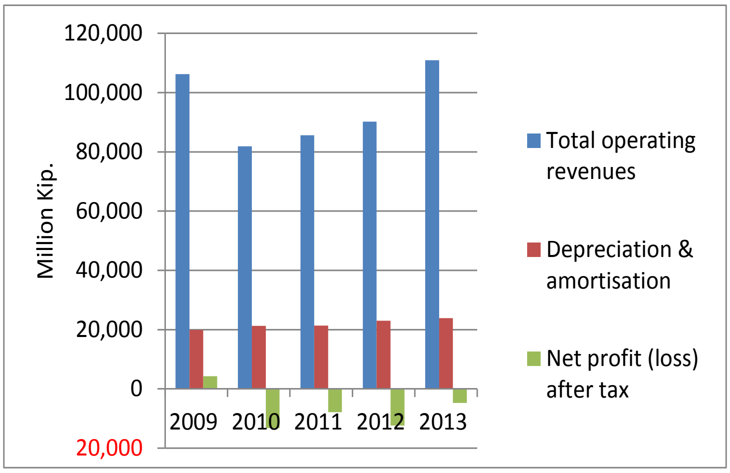
3.13.1 Management Conditions of NPNL

The management indicators suggest some management conditions of NPNL.

- "NRW ratio" is still high around 25% to 36%, but the number has been decreasing (improving) for the past 3 years.
- "Bill collection efficiency" was high and still improving for these years.
- "Staff per 1,000 connections" (5.49 to 6.97) is relatively good, compared to the international data (7.2 to 8.3).
- "Average tariff" was 1,815 LAK/m^3 (0.23 USD) in 2013. "Unit production cost" was 1,605 LAK/m^3(0.20 USD).
- "Water consumption / customer" was about 44 m^3/month from 2010 to 2012. Then, it was increased to 47 m^3/month in 2013. "Average tariff" and "Water billing/customer" were also increased in 2013.

3.13.2 Financial Conditions of NPNL

The amount of losses (Net loss after tax) was approximately 4% to 16% of its annual operating revenues of each year as shown in Figure 3.4 NPNL have recorded annual net loss. However, the cost item includes depreciation & amortisation, which are larger than net loss of each year. Since the depreciation & amortisation cost is an accounting procedure and not an actual cash outflow, it is considered that NPNL still has a certain amount of annual cash flow.



Source: JST

Figure 3.4 Operating Revenues and Net Loss of NPNL (last 5 years)

3.14 Related On Going Studies and Projects

3.14.1 Water Supply Master Plan 2014 by AfD

With assistance by AfD, a water supply master plan, Nam Papa Nakhone Luang Water Supply Assets Master Plan (WSM/P 2014) has been prepared. The objectives of WSM/P 2014 are:

- To design 10 year scale master plan to assist NPNL’s projects.
- To review the water supply system in Vientiane Capital, especially to address NRW issues.
- To elaborate the priority project and cost estimation for the asset.
- To overlay the urban development master plan approved by Vientiane Capital.
- To propose future water supply plan and development orientation

3.14.2 Pipe Replacement Project by AfD

A Pipe replacement project has been implemented as a part of the project “Alimentation d’Eau Potable (AEP-II)”, and started in 2007 under the grant financing of AfD which amounted to 5.2 million euro, in conjunction with JICA grant aid for Vientiane Water Supply Development Project (2006-2009). The original project scope and budget demarcation between JICA and AfD are shown in Table 3.4. JICA financed the expansion of Kaoleio WTP and a part of transmission and distribution mains, while AfD covered the rest of the scope.

Table 3.4 Original Project Scope and Budget Demarcation between JICA and AfD

Unit: million euro

Component 1	Scope	JICA	AfD	Lao	Total
1.1	Expansion of Kaoleio WTP	12.57		0.28	12.85
1.2	Transmission & Distribution Mains	3.46	4.00	0.58	8.04
1.3	Consultant Services	1.12	0.25	0.08	1.45
1.4	Contingency	2.23	0.25	0.28	2.76
Component 2					
2.1	Billing System Establishment	-	0.45	0.05	0.50
2.2	GIS Development	-	0.15	0.05	0.20
2.3	Water meters procurement	-	0.15	0.05	0.20
2.4	Initial Sewerage Study	-	0.15	-	0.15
2.5	Contingency	-	0.10	-	0.10
Total		19.38	5.50	1.37	26.25

Note: Component 2.4 Initial Sewerage Study was not implemented.

3.14.3 Dongmakkhay Expansion Project

The expansion of Dongmakkhay water supply system is presently underway with the concessional loan from the Export-Import Bank of China under EPC contract between MPWT and China Yunnan Construction Engineering Group Co., Ltd. The major project scope of the expansion work is as follows:

- New intake at Nam Gum River
- Raw water transmission pipelines (2 lines each 18.9 km, DN 1000, reinforced plastic mortar pipes (RPMP))
- Water treatment plant with the capacity of 100,000 m^3/day
- Clear water transmission pipelines (19.5 km, DN 1200 – DN 500, DCIP)
- SCADA system

3.14.4 Technical Cooperation Project by JICA

The Capacity Development Project for Improvement of Management Ability of Water Supply Authority was started in August 2012 and will be completed in August 2017. The Project aims for the capacity development of nationwide water supply authorities including MPWT and provincial PNPs (three pilot PNPs, i.e. NPNL, Nam Papa Luang Prabang and Nam Papa Khammouane, were selected) by the following five approaches: 1) strengthening the data management for corporate planning at the pilot PNPs, 2) establishing the management based on the long-term, mid-term and short-term corporate planning at the pilot PNPs; 3) strengthening the monitoring of the performance of the pilot PNPs; 4) developing the technical guidelines on corporate planning; and 5) developing the dissemination mechanism relevant to the new technical guidelines.

3.15 Other Projects by PPP in Water Supply Sector

3.15.1 Thadeua Project

Thadeua Project is the construction of water supply system in Hatsaifong District, Vientiane Capital. The capacity is 20,000 m^3/day. This project will be carried out by BOT of private local company, Vientiane Automation and Solution Engineering Company (VASE). The project consists of:

- Construction of intake, with capacity to pump 21,000 m^3/day from the Mekong River
- Construction of water treatment plant including: coagulation, flocculation, sedimentation, filtration, water tank, pumping system,
- Installation of pipeline system, main pipe DN 250-DN 600 mm, length 25,026 m, and uPVC length 58,808 m (but the connection pipes to the house are not included)

3.15.2 Sendin Project

Sendin Projct is the construction of water supply system in Naxaythong District, Vientiane Capital. The capacity is 20,000 m^3/day. This project will be carried out by BOT of private local company. The project consists of:

- Construction of intake from the Nam Ngum River
- Construction of water treatment plant with the capacity of 20,000 m^3/day,
- Construction of clear water tanks (2 elevated tanks)

- Installation of transmission pipe from intake to water treatment plant, and from treatment plant to elevated reservoir with a total length of 5,500m
- Installation of distribution pipe with a total length of 147,900m

3.15.3 Dongbang Expansion Project

The existing Dongbang WTP (Capacity of 20,000m^3/day) was the first joint venture project, with an investment capital of US $10 million, in Vientiane water supply system between NPNL and Vietnamese private company, Mai Dong company. Capital investment cost was borne by NPNL (51%) and Mai Dong (49%), and the water treatment plant has been in operation since 2009. NPNL is, at present, seeking a donor and fund, from the including private sector for Dongbang Expansion Project.

3.16 Long-term Plan for Improvement of Water Supply Facilities

Water Supply Master Plan for Vientiane Capital (WSM/P2014) has been prepared with the project horizon up to the year 2030 by AfD. From the WSM/P2014, current long-term plan for improvement of water supply facilities by NPNL is interpreted as the follows options.

Table 3.5 Main Technical Characteristics of the Three Scenarios for 2030

Technical Characteristics	Option 1	Option 2	Option 3
Water Demand (m^3/day)	373,000 m^3/day	408,000 m^3/day	408,000 m^3/day
Total Pipe Extensions (km) (> dia. 200 mm)	436 km	436 km	436 km
Total Pipe Reinforcements	60 km	99 km	135 km
	(Replacement of pipes with high head loss gradients)		
WTP Production Expansion (m^3/day)	Existing: 180,000 Dongmakkhay: 100,000 Chinaimo: 40,000 Thadeua: 20,000 Sendin: 20,000 Thangone*: 40,000 Nongda*: 20,000 420,000	Existing: 180,000 Dongmakkhay: 100,000 Chinaimo: 40,000 Thadeua: 20,000 Sendin: 20,000 Thangone*: 40,000 Nongda*: 20,000 420,000	Existing: 180,000 Dongmakkhay: 100,000 Chinaimo: 40,000 Thadeua: 20,000 Sendin: 20,000 Chinaimo*: 20,000 Dongban*: 20,000 Thadeua*: 20,000 420,000
Storage (m^3)	10,000	50,000	25,000

Source: Prepared from NPNL Water Supply Assets Mater Plan, AfD 2014

*: WTPs to be expanded in order to increase production capacity more 60,000 m^3/day by 2030.

3.17 Long-term Financial Plan

As a Long-term Financial Plan, the NPNL is preparing the financial plan (composed of financial analysis of the NPNL and business plan for the future) with the support of AfD.

Business plan is considered to provide a lot of important suggestions to NPNL with some of the ideas already realized. However, it includes some old or faulty assumptions in it as follows;

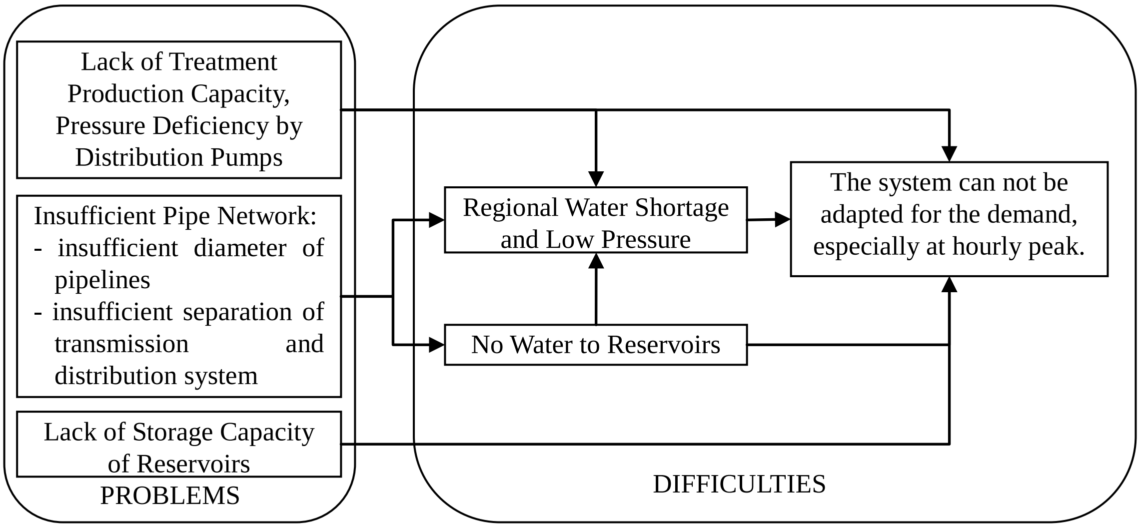
- Old water tariff table is still utilized.
- Future approved water tariff raises in the year 2015, 2016, 2017, 2018 are not applied for the projection. These certainly contribute to make the projection result better.
- Costs for new NPNL's office building construction (30.1 billion LAK), on the way, may not be considered in the business plan.

It is indispensable for the financial planning of this survey to consider the above changes of situations with respecting on the results of several scenarios of the business plan prepared by GRET supported by AfD.

3.18 Identification and Evaluation of Present Water Supply Conditions

3.18.1 Technical Aspect

There are some problems in Vientiane Water Supply System. The reasons are summarized as shortage of water treatment production capacity, pressure deficiency by distribution pumps, insufficient pipe network accounting for regional water shortage, low pressure, and lack of storage capacity of reservoirs. Therefore, the system cannot be adapted for the demand, especially in peak periods. Figure 3.5 illustrates the problems of the existing water supply system in view of technical aspect.



Source: JST

Figure 3.5 Problem and Difficulty of Current Water Supply System in Vientiane Capital

Although the total production capacity of the existing treatment plants, Chinaimo and Kaolieo, Dongmakkhay, Dongban is 180,000 m^3/day, the average daily discharge in 2013 was over 199,000 m^3/day as discussed in previous Section. Therefore the existing treatment plants are operating under overloaded conditions, beyond their rated production capacity. In order to secure a stable and steady water supply service to meet the demand for water, it is obvious that the Vientiane Water Supply System is facing a situation where the treatment production capacity needs urgent improvement.

Although the pipe network has been extended to the outer areas from central city zone, distribution pump heads seem~~s~~ insufficient to these areas. With zoning plan, pump heads should also be examined. WSM/P 2014 points out the main reason for lack of water and low pressure due to piped network hydraulic arrangements and under sized pipes (critical linear head loss). According to the results of pipeline network analyses in WSM/P 2014, reinforcement of pipelines to adequate size is required.

The total amount of storage capacities for the existing reservoirs is 12,560 m^3, and this is less than two (2) hours for designed water supply capacity (180,000 m^3/day) from the existing WTPs. Because reservoir has the buffer function in the hourly peak demand, increase of storage capacity is required as well as increase of water supply amount by expansion of WTPs.

3.18.2 Operational Aspect

The present NRW ratio is reported to be 25%. Although the leakage ratio cannot be presently estimated, it is necessary to analyze the components of NRW correctly to conduct effective countermeasures for the reduction of NRW. NPNL has started the measurement of minimum night flow at two pilot areas in 2014. It is expected that the experiences in these pilot areas will be disseminated to the other service areas of NPNL and contribute the further reduction of NRW ratio in the near future.

The current water treatment plant overloading ratio, 110.9%, indicates the delay of the implementation of water production facility development plan against the rapidly increasing water demand in Vientiane Capital. This is because finished water quality cannot be guaranteed under the overloaded conditions of water treatment processes, and water supply pressure at customers' taps declines resulting in the increase of customers' complaints.

Since most of the existing pipelines were installed after the 1980's in Vientiane this ratio is still low. However, proper pipe asset management plan will be required in the near future as aged pipes over 40 years will be increasing after the 2020's. NPNL is presently establishing GIS, and it is expected that this will contribute the preparation of correct inventory of existing pipe data and the development of the future pipe asset management plan.

Water quality of distributed water is presently examined at ninety six (96) sampling points in the distribution network once a month. Turbidity, pH and residual chlorine are measured as indicators, and 5.5% of the total samples examined in 2013 failed to conform to the drinking water quality criteria. According to Chinaimo laboratory, however, sampling was not conducted at some sampling points due to low water pressure or no water supply. As such samples are also counted as failed samples, it is presumed that the figure by only water samples actually examined is lower than 5.5%. The safety of the water quality in the distribution network can be guaranteed only when appropriate water pressure is constantly maintained in the distribution network.

NPNL is fully dependent on pumping both for raw water abstraction and distribution of treated water to customers due to rather flat topographic conditions all over the service area. NPNL's annual electricity consumption presently accounts for approximately 1% of the total electricity consumption in Vientiane Capital. Further efforts for optimum operation of pumps in conjunction with the employment of high efficiency pumps and control system will be important for holding down the operation costs of the pumping facilities.

The indicator regarding customer complaints shows very high value. It is inferred that there are some service areas where water pressure is very low or nil and many complaints are derived from these areas. Types of complaints are not categorized at present, and only the number of complaints is being monitored by NPNL. Categorizing the customer complains in terms of water pressure, water quality, leakage and others would help NPNL analyze the problems and undertake proper countermeasures.

3.18.3 Financial Aspect

NPNL has increased operating revenue for the last four (4) years (2010 to 2013) by customer number increase and water consumption volume increase, especially in 2013. On the other hand, the water tariff have not been revised and expenses have increased, largely due to personnel expenses and outsourcing expenses. As a result, NPNL has made annual net loss for the last 4 years. However, the size of net loss is still smaller than the amount of depreciation cost. Therefore, NPNL has not yet faced the cash flow problem.

As a result of evaluation of financial indicators, it is considered that the total loan amount and burden of interest and principal payment is still under the ceiling of the payment capacity of NPNL. New water tariff was effective in October 2014. NPNL's financial condition will be better after the year 2015 from revenue increases provided the by tariff raise.

3.18.4 Human Resources Aspect

The total number of NPNL staff is 533 including 53 nonpermanent staff. Staff productivity is measured as the number of staff per 1,000 connections. In case of NPNL the number of staff per 1,000 connections is 5.2 staff and it can be said that its productivity is almost appropriate based on the international benchmarking standards (5 staff per 1,000 connections).

Regarding human resources development, NPNL has a technical training center, which was established by the assistance from AfD, within the compound of the Chinaimo water treatment plant. JICA also supported the development of the NPNL training systems including ToT (Training of Trainers), preparation of textbooks, etc through "Project for Capacity Development of Urban Water Supply Authorities (2003-2006)"

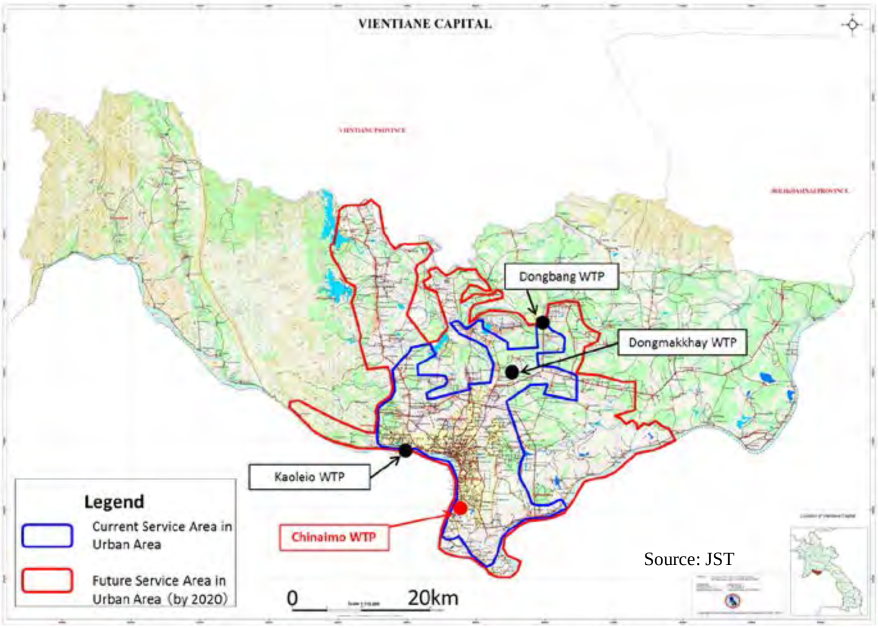
According to the Prime Minister's proclamation (PM Decision No.37), the NPNL is required to offer technology development, courses and workshops for the training of all water supply enterprises in Lao PDR. NPNL is also given the responsibility to spread information about training, manuals and staff development methods. Therefore, the technical training center is utilized not only for NPNL but also for all water supply enterprises in Lao PDR. Most of the trainers are staff of NPNL and each water supply enterprise pays training fees to the technical training center. In 2013 NPNL paid 244,197,727 LAK for the training courses, while the other enterprises paid 75,966,000 LAK in total. Although NPNL planned to send 475 staff to training courses in 2013, only 361 staff received the trainings because of their busy daily works.

Compared other water supply enterprises, NPNL has many experienced and capable staff. However, it is pointed out that there are still less experienced staff and basic trainings are necessary for them. Especially for maintenance management works, the number of engineers is limited and fixing broken equipment in an expedient manner is found to be difficult. Outsourcing of the maintenance works will be examined for more efficient operation and maintenance.

Chapter 4 PLANNING OF THE PROJECT

4.1 Water Demand Projection by 2030

NPNL has supplied water to urban area by the four (4) water treatments plant. This urban water supply area has spread to seven (7) districts. Figure 4.1 shows the urban water supply area currently and in future to be expanded by 2020. The following sections will discuss this design service area (i.e. current and future service area in urban area of Vientiane Capital).



Source: JST

Figure 4.1 Current and Future Water Supply Area

With analyzing baseline data in 2013 obtained, and setting served population, per capita consumption, percentage of non-domestic water demand, NRW ratio, day average water demand, peak daily factor, day maximum water demand, etc., Table 4.1 shows the summary of projected water demand up to 2030.

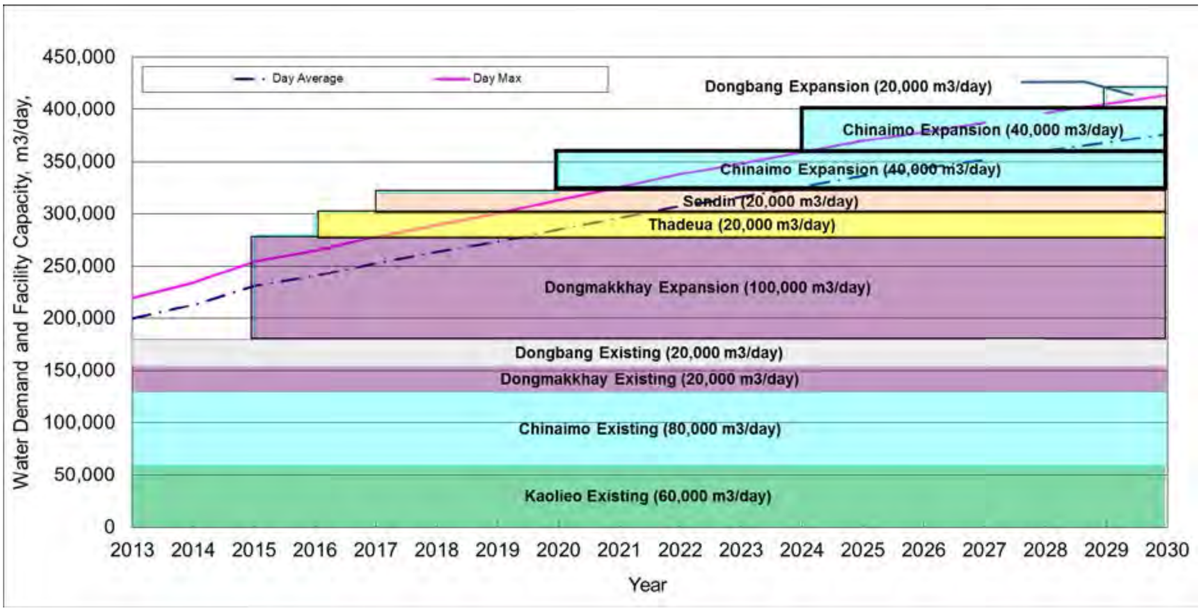
Table 4.1 Summary of Water Demand Projection

	Unit	2013	2015	2020	2025	2030
Population	person	854,069	906,082	1050,397	1,217,698	1,411,648
Population in Urban Area*	person	675,751	700,498	766,891	840,368	921,787
Served Population	person	489,175	557,287	689,167	804,207	921,787
Service Ratio	%	72%	80%	90%	96%	100%
Per Capita Consumption	lpcd	245	245	245	245	245
Total Domestic Water Demand	m^3/day	119,848	136,535	168,846	197,031	225,838
Non-Domestic Water Demand	%	24%	27%	35%	45%	50%
	m^3/day	28,764	36,864	59,096	88,664	112,919
Total Water Demand	m^3/day	148,612	173,399	227,942	285,695	338,757
Non-Revenue Water (NRW)	%	25%	25%	20%	15%	10%
	m^3/day	49,537	57,800	56,986	50,417	37,640
Day Average Water Demand	m^3/day	199,619	231,199	284,928	336,112	376,397
Peak Daily Factor		1.1	1.1	1.1	1.1	1.1
Day Maximum Water Demand	m^3/day	219,600	254,300	313,400	369,700	414,000

Urban Area* is future water supply area extended to 4 districts and partway of 3 districts (i.e. urban area of 7 districts: 1.Chanthabouly, 2.Sikhottabong, 3.Xaysetha, 4.Sisattanak, 5.Naxaithong, 6.Xaythany, and 7.Hadxaifong)
Source: JST

4.2 Setting Necessary Capacity of the Proposed Water Supply Facilities

The total of the existing WTP capacities is 180,000m^3/day (i.e. 80,000 m^3/day in Chinaimo WTP, 60,000 m^3/day in Kaolieo WTP, 20,000 m^3/day in Dongmakkhay WTP, and 20,000 m^3/day in Dongbang WTP). At present, Dongmakkhay WTP expansion project, with a capacity of 100,000 m^3/day, is under construction and it is expected to complete in 2015. Also, construction of Thadeua WTP with a capacity of 20,000 m^3/day has been underway since January 2015, and its operation is expected to start~~s~~ from 2016. Sendin WTP, with a capacity of 20,000 m^3/day, is also expected to start operation from 2017. Considering these factors, Figure 4.2 shows a development plan for the Chinaimo WTP expansion.



Source: JST

Figure 4.2 Development Plan (Chinaimo WTP Expansion Plan)

Initially, the request from the GOL was an expansion of 40,000 m^3/day in the existing Chinaimo WTP. However, from the results of the water demand projection in this survey, even if Chinaimo WTP is expanded up to 120,000 m^3/day in the design capacity with the expansion of 40,000 m^3/day by 2020, the water supply amount from the WTPs would dip from the day maximum water demand after 2024, and then, water shortage would again occur in urban area of Vientiane Capital. Therefore, in Chinaimo WTP expansion, it was proposed a stepwise development plan shown in Figure 4.2, i.e. expansion of 40,000 m^3/day by 2020 as Phase 1 and further expansion of 40,000 m^3/day by 2024 as Phase 2, up to 160,000 m^3/day in the design capacity which is the maximum expansion capacity within the limited site (property) of Chinaimo WTP. The GOL agreed to the proposal. Table 4.2 shows the summary of the stepwise expansion in Phase 1 and Phase 2.

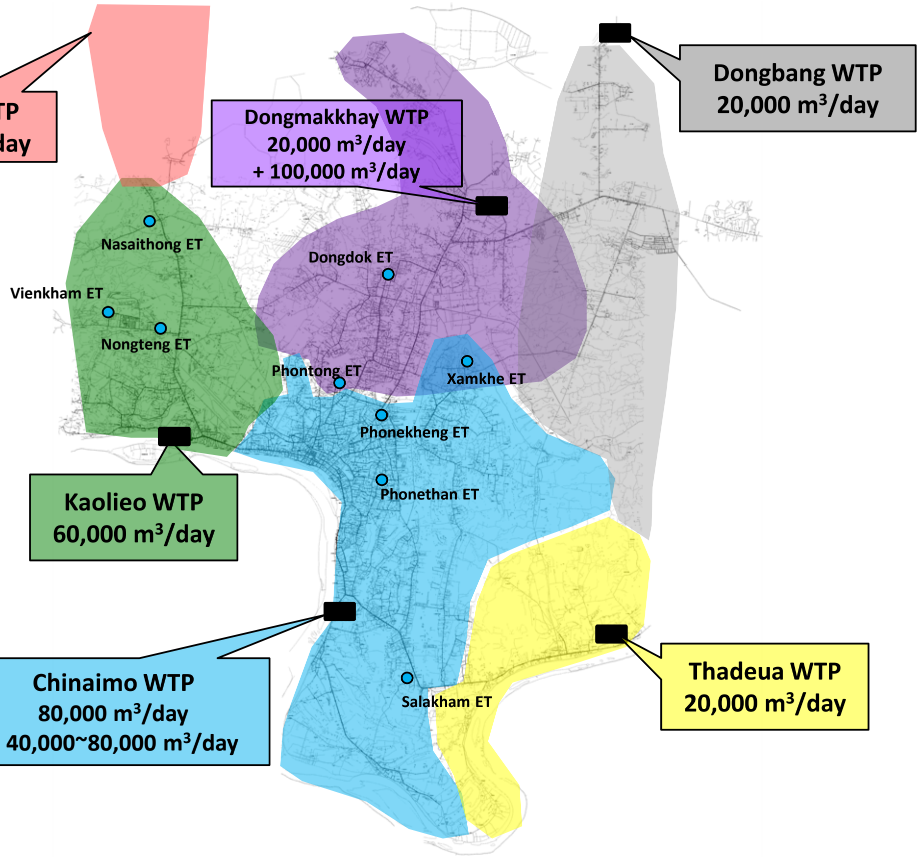
Table 4.2 Summary of Phase 1 and Phase 2 for Chinaimo WTP Expansion

Phase	Design Capacity of Chinaimo WTP	Remarks
Phase 1	120,000m^3/day	40,000 m^3/day expansion from 80,000 m^3/day capacity
Phase 2	160,000m^3/day	40,000 m^3/day expansion from 120,000 m^3/day capacity

Source: JST

4.3 Identification of Supply Area from Expanded the Chinaimo Water Treatment Plant and Other Water Treatment Plant(s)

The basic idea of water distribution demarcation among the future water treatment plants are generally understood among the officials concerned, as illustrated in Figure 4.3.



Source: JST

Figure 4.3 General Concept of Water Distribution Demarcation by WTPs

Chinaimo WTP will be a main supply source for the center of Vientiane Capital, as well as the southern tip of the capital including the area along Thadeua road to Salakham ET. Supply to the center of Vientiane Capital will be provided through Phonetang ET, as well as direct pumping supply to the consumers. Thatlouang New Town project will be also supplied mainly from Chinaimo WTP.

4.4 Planning of the Water Supply Facilities for the Project

With careful consideration of the present constraints of water supply in Vientiane Capital and the existing facility conditions of Chinaimo WTP system, the following basic concepts are adopted in planning the water supply facilities for the expansion project:

(1) The first operation of Chinaimo WTP (Phase 1 project) dates back to the year 1980 with the production capacity of 40,000 m^3/d. In 1993 – 1996, Phase 2 of the project was implemented to rehabilitate the Phase 1 facilities and construct new facilities for the expansion up to the total production capacity of 80,000 m^3/d. The mechanical and electrical equipment such as pumping

facilities installed during these past projects have been still in use but have already got aged, reaching more than 25 to 40 years by the year 2020. Further continuous use of these facilities after the year 2020 is not recommendable since unforeseeable sudden failures due to their ages and the difficulty of procuring old type spare parts are anticipated. In the proposed plan, the renewal of most of these existing old mechanical and electrical equipment should be included so as to ensure the current production capacity of 80,000 m^3/d of the existing facilities beyond the year 2020.

(2) The water source for the project is the Mekong River, which has a tendency of very high turbidity (around 4000 NTU according to the past records) during the rainy season. The planned water treatment plant should be able to treat such high turbidity water continuously to secure the designed production and treated water quality constantly throughout the year.

(3) The water level of the Mekong River fluctuates seasonally more than 10 meters. The planned raw water intake pump facilities should be able to deliver sufficient raw water continuously and efficiently to the WTP throughout the year.

(4) The facility plan will include the modification and rehabilitation of the existing treatment facilities, such as filters and chemical feeding systems, so as to facilitate or improve the operation and control of the treatment processes.

(5) Due to the limited land availability of the Chinaimo WTP premises, compact facility arrangement would be required.

(6) Upon definition of the service areas supplied by gravity through the elevated tanks and by direct pumping from Chinaimo WTP, the effective use of the existing elevated tanks should be considered. The distribution areas covered by Chinaimo WTP will then be divided into the areas supplied by direct pumping from the WTP and those supplied by gravity from Phonetang, Xamkhe and Salakham ETs for easier operation.

(7) The new water transmission and distribution pump systems should be controlled effectively and efficiently in consideration with simple and reliable operation as well as less maintenance.

4.5 Overall Planning for the Project

By the project horizon of the year 2024, Chinaimo WTP needs to be expanded up to 160,000 m^3/d of the production capacity. The phased expansion work could be, however, implemented by two phases so as to meet the increasing water demand in a timely manner and hold down the initial investment costs. Major contents of project scope for each phase is shown in Table 4.3.

Table 4.3 Major Contents of Project Scope for Each Phase

Project Components	Phase 1 Scope	Phase 2 Scope
1) Expansion of Chinaimo Raw Water Intake Pump Station	• Construction of new raw water intake civil structure • Installation of new raw water pump facilities for the production of 120,000 m^3/d • Installation of new raw water transmission pipe • Installation of new power substation	• Installation of new raw water pump facilities for additional production of 40,000 m^3/d
2) Expansion of Chinaimo Water Treatment Plant	• 40,000 m^3/d Treatment facilities expansion (receiving well, flocculation basin, sedimentation basin, filters, chemical feeding facilities) • Installation of new power substation • Installation of new transmission and distribution pump facilities • Construction of new administration building • Construction of new transmission and distribution pumping station • Construction of new chemical building • Construction of new clear water reservoir • Modification of the existing filtration system	• 40,000 m^3/d Treatment facilities expansion (flocculation basin, sedimentation basin, filtration basin, chemical feeding facilities) • Installation of additional transmission and distribution pump facilities
3) Salakham Distribution Center Construction	• Construction of Salakham Distribution Center(incl. new ground reservoir with high lift pump facilities and new elevated reservoir)	• Installation of additional high lift pump facilities
4) Expansion of Transmission and Distribution Pipes	• Installation of transmission pipes to Salakham Distribution Center (5,815 m) • Installation of branch pipes from the existing transmission pipe to Phonethan elevated tanks (885 m) • Installation of distribution pipes (Approx. 43 km)	• Installation of distribution pipes (Approx. 98 km)

Source: JST

Chapter 5 OUTLINE OF THE PROJECT

5.1 Outline of Planned Water Supply Facilities

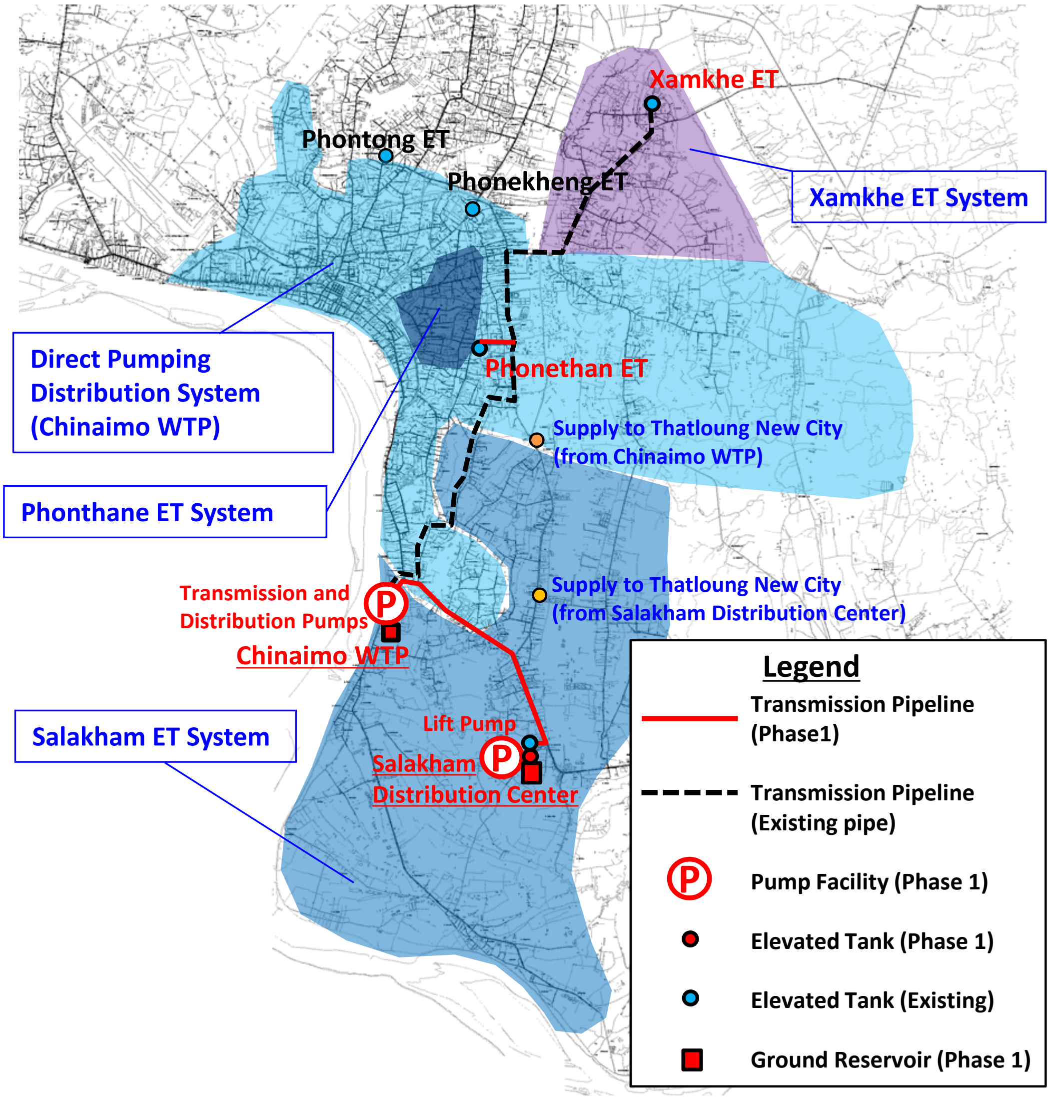
General layout plan of the expanded Chinaimo raw water intake pump station and water treatment plant in the year 2030 is illustrated in Figure 5.1.

Source: JST

Figure 5.1 Layout Plan of the Expanded Chinaimo WTP and Raw Water Intake Pump Station

Figure 5.2 shows the outline of the expansion of the transmission and distribution system from Chinaimo WTP, which is composed of the following three systems:

1) Transmission System to Xamkhe and Phonethan Elevated Tanks and Distribution System
2) Transmission System to Salakham Distribution Center and Distribution System
3) Direct Pumping Distribution System from Chinaimo WTP



Source: JST

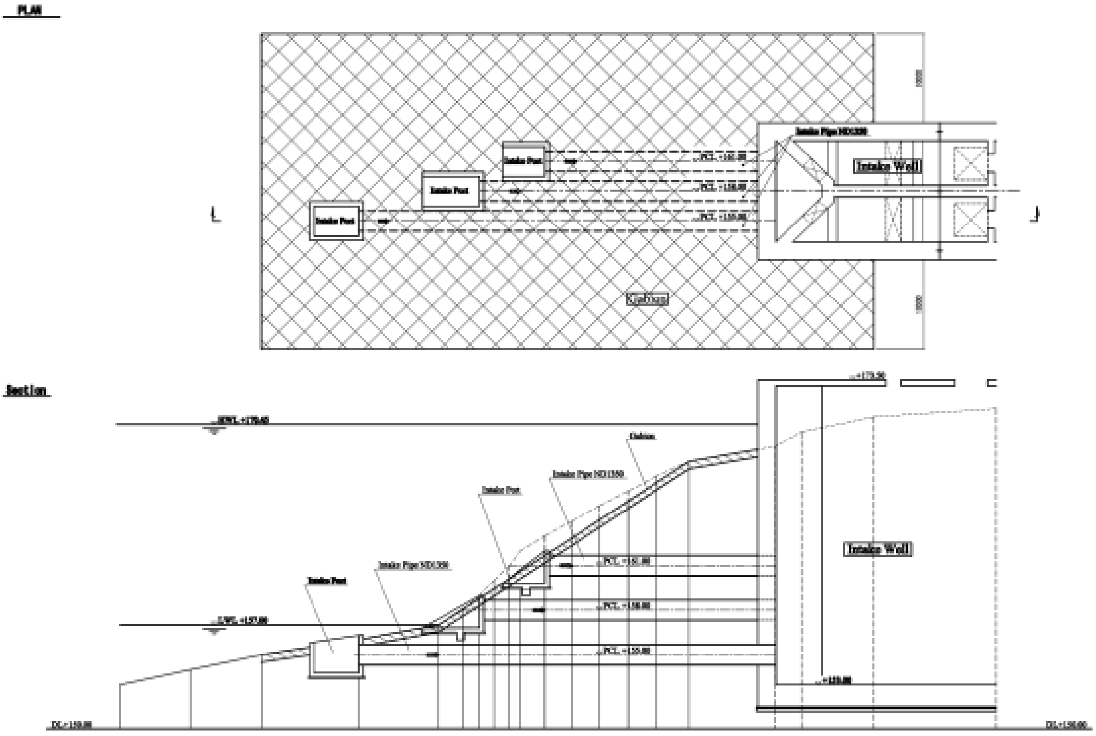
Figure 5.2 Transmission Pipeline from Chinaimo WTP

There will be two transmission mains extending from the Chinaimo WTP. One will be to the existing PhonethanET and Xamkhe ET, and the other will be to the newly constructed Salakham Distribution Center.

5.2 Design of Facilities

5.2.1 Chinaimo Raw Water Intake Pump Station

Figure 5.3 illustrates the plan and section of the new raw water intake pump station.



Source: JST

Figure 5.3 Plan and Section of the New Raw Water Intake Pump Station

Basic design conditions for new raw water intake pumps are summarized in Table 5.1.

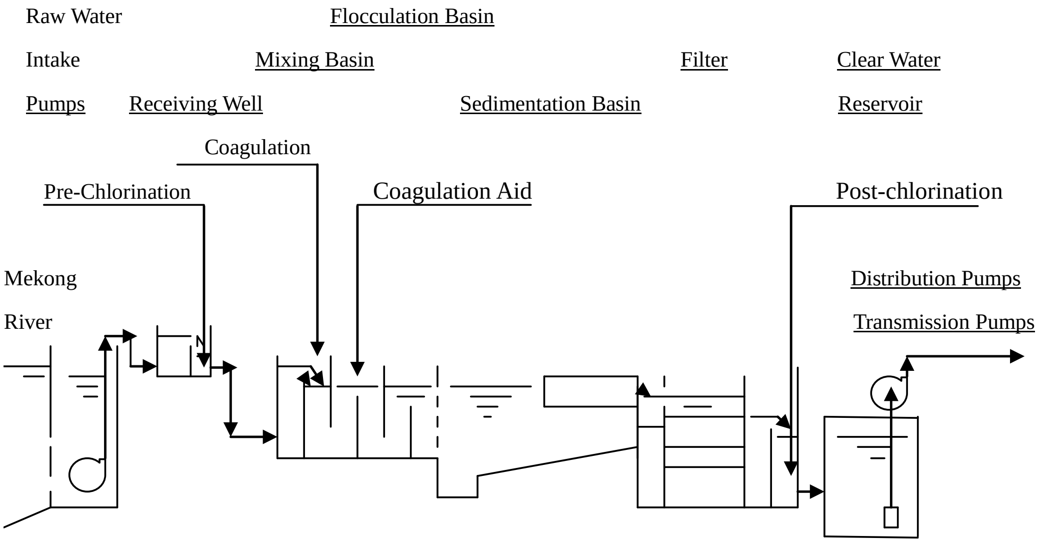
Table 5.1 Basic Design Factors for Raw Water Intake Pumps

Design Factor		Remarks
Required Total Pump Discharge	127,400 m^3/d (168,000 m^3/d)	Phase 1 (Phase 2)
Lowest Suction Water Level	+157 m	LWL
Average Suction Water Level	+164 m	Adopted as the design pump duty point (average water level of Mekong River)
Maximum Static Pump Head	Max.: +19.5 m	Water level at new receiving well of +16.5 m – LWL of +157 m
Pump Discharge Pipe Loss of Head	1.5 m	
Loss of Head Allowance	1.0 m	
Maximum Dynamic Pump Head	22 m	19.5 m + 1.5 m + 1.0 m= 20 m

Source: JST

5.2.2 Chinaimo Water Treatment Plant

The flow diagram of proposed water treatment processes and chemical application are shown in the flow diagram in Figure 5.4.



Source: JST

Figure 5.4 Water Treatment Process Flow Diagram for New Chinaimo WTP

Basic design conditions for new water treatment plant are summarized in Table 5.2.

Table 5.2 Basic Design Dimensions and Specifications for Water Treatment Plant

Design Factor	Dimensions, Type, Specifications
Receiving Well	Reinforced Concrete Structure Quantity: 1 Water Level：HWL＋176.50m LWL+175.50m Detention Time：T= 2min, Volume：V= 240 m^3
Rapid Mixing Basin	Reinforced Concrete Structure Quantity: 1 (44,000 m^3/day) Type: Hydraulic mixing
Flocculation Basin	Reinforced Concrete Structure Quantity: 4 (44,000 m^3/day) Type: Up-down zig-zag flow Detention Time：T= 21min, Mean Velocity：V= 12.20 cm/s
Sedimentation Basin	Reinforced Concrete Structure Quantity: 2 (44,000 m^3/day) Surface Loading：Q/A=17 mm/min、Mean Velocity：V=0.38 m/min
Filter	Reinforced Concrete Structure, Spread Foundation Quantity: 4 (44,000 m^3/day) Filtration Area: 77 m^{2}each, Filtration Rate：V=143.00 m/day
Backwash Pumps	Type: Water sealed submersible motor pump Number: 3 units (2 duty + 1 standby) Capacity: 15.5 m^3/min, Head: 10 m, Motor output: 45 kW
Blowers	Type: Rotary, positive displacement roots type with acoustic box Number: 2 units (1 duty + 1 standby) Capacity: 96 m^3/min, Pressure: 35 kPa, Motor output: 110 kW
Clear Water Reservoir	Reinforced Concrete Structure, Spread Foundation Quantity：1 Water Level：HWL＋170.61m LWL+165.61m Effective Volume：V=9,800 m^3 (4,900m^3 × 2)

Source: JST

5.2.3 Treated Water Transmission and Distribution Pump Systems

Basic design flows for transmission and distribution facilities such as daily average flow, daily maximum flow and peak hourly flow from Chinaimo WTP system are tabulated in Table 5.3.

Table 5.3 Basic Design Flows for Transmission and Distribution Facilities

Phase	Daily Average (Daily Max. x 1/1.1)	Daily Maximum	Peak Hourly (Day Max. x 1.54)
Phase 1	109,000 m^3/d	120,000 m^3/d	185,000 m^3/d
Phase 2	145,000 m^3/d	160,000 m^3/d	246,000 m^3/d

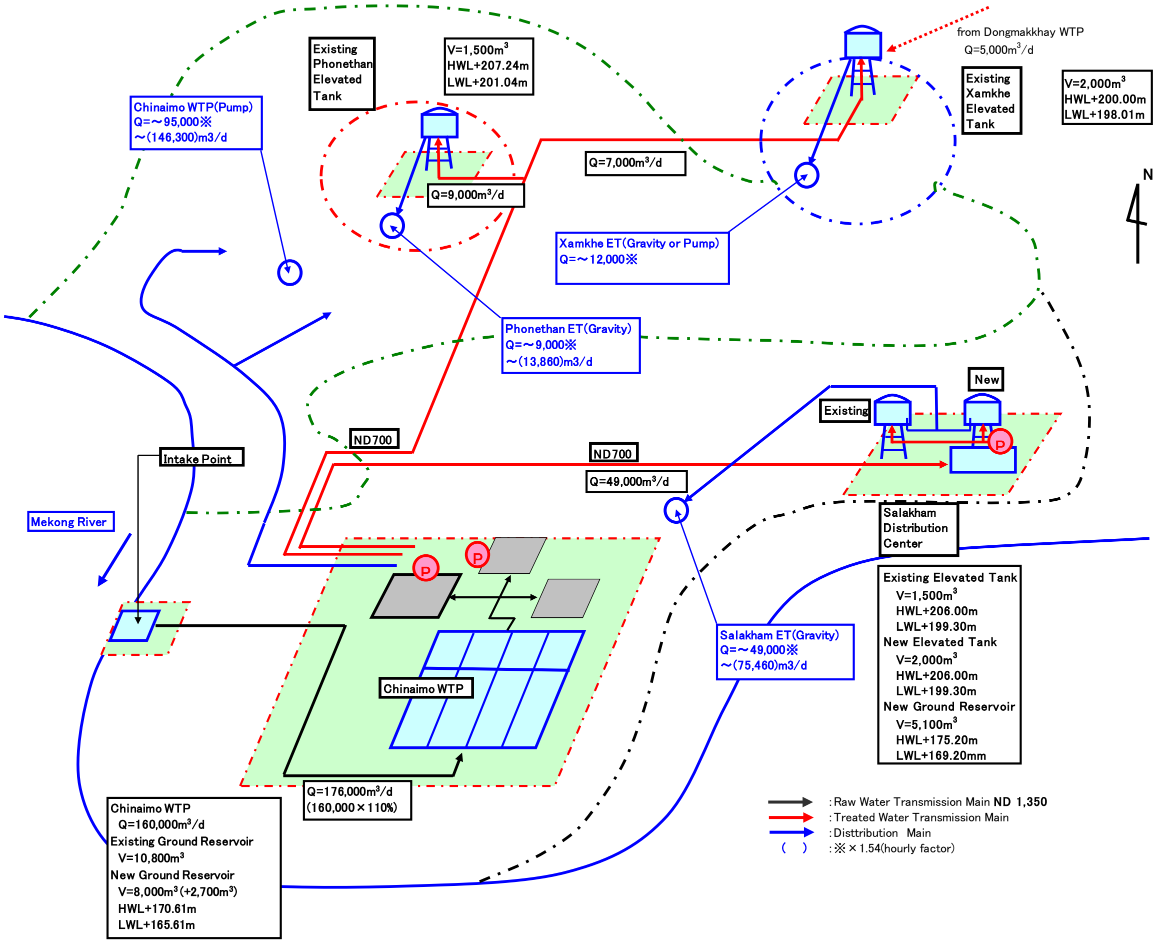
Source: JST

Table 5.4 summarizes the demarcation of the water distribution to the above three systems, also Figure 5.5 shows its schematic flow.

Table 5.4 Demarcation of Water Distribution for the Three Systems

	Transmission System to Xamkhe ET	Transmission System to Salakham D.C.	Direct Distribution from Chinaimo WTP	Total
Phase 1 Daily Max. Flow	12,000 m^3/d	37,000 m^3/d	71,000 m^3/d	120,000 m^3/d
Phase 2 Daily Max. Flow	16,000 m^3/d	49,000 m^3/d	95,000 m^3/d	160,000 m^3/d

Source: JST

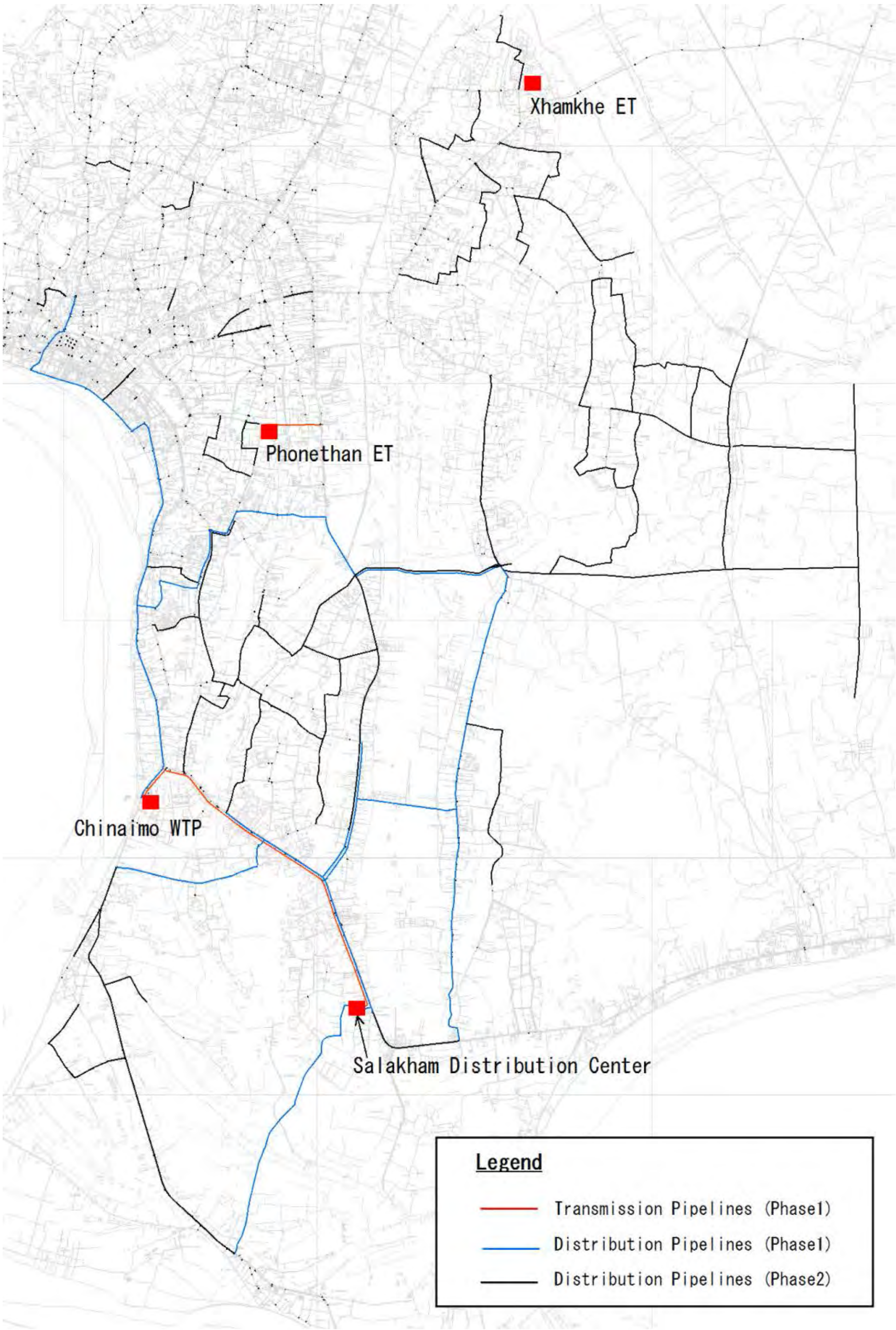


Source: JST

Figure 5.5 Schematic Flow for Water Distribution from Chinaimo WTP

5.2.4 Transmission and Distribution Pipe Facilities

The location of transmission and distribution to be constructed in Phase1 and Phase2 is shown in Figure 5.6. The information on pipeline length to be constructed is shown in Table 5.5.



Source: JST

Figure 5.6 Outline of Pipeline Augmentation and Expansion in the Project (Phase1 and Phase2)

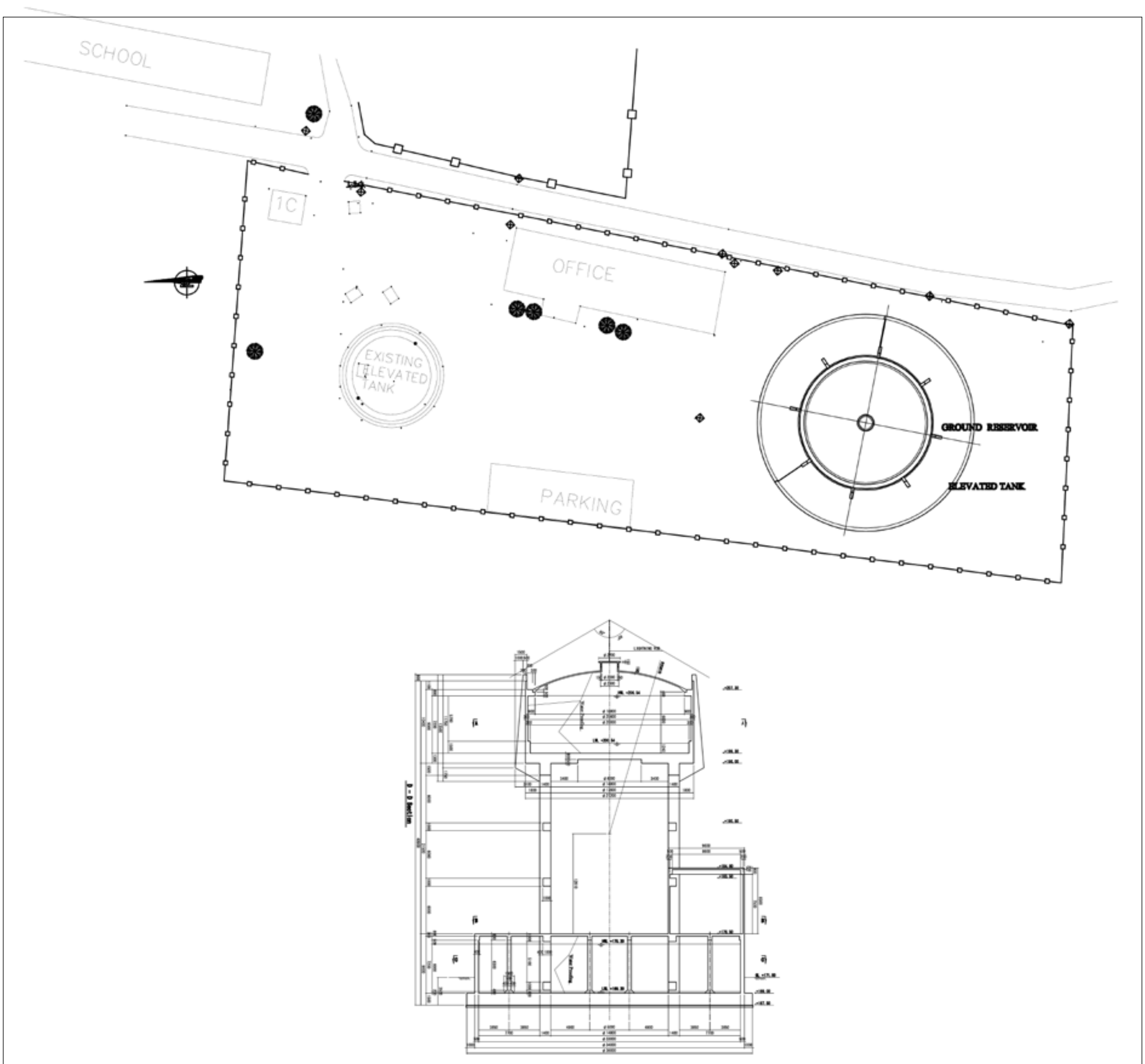
Table 5.5 List of Distribution Pipelines to be Augmented or Newly Installed in the Project (Phase1/Phase2)

Phase	Transmission /Distribution	Diameter	ipe Materi	Length (m)
Phase 1	Transmission	450	DIP	885
		700	DIP	5,815
	Sub-Total			6,700
	Distribution	300	DIP	2,308
		350	DIP	6,221
		400	DIP	11,086
		500	DIP	724
		600	DIP	1,669
		700	DIP	2,031
		800	DIP	5,930
		1,000	DIP	9,306
		1,100	DIP	258
		1,200	DIP	3,156
	Sub-Total			42,689
Phase 1 Total				49,389
Phasae 2	Distribution	150	DIP	29,643
		200	DIP	23,885
		250	DIP	9,677
		300	DIP	18,277
		350	DIP	6,856
		400	DIP	3,256
		450	DIP	210
		500	DIP	2,607
		600	DIP	845
		700	DIP	2,308
Phase 2 Total				97,564
Grand-Total				146,953

Source: JST

The detailed information such as pipe diameter and length in each area (Salakham Distribution Center area and Chinaimo direct pumping area) are described below.

Figure 5.7 shows the plan of Salakham Distribution Reservoir and Section of the new ground reservoir and elevated tank.



Not to Scale

Source: JST

Figure 5.7 Plan of Salakham Distribution Center and Section of New Ground Reservoir and Elevated Tank

The transmission pipe from Chinaimo WTP to Salakham Distribution Center will be augmented by the installation of diameter 700 mm pipe with the total length of 5,825 m.

Distribution from the Salakham Distribution Center to customers is by gravity flow through the existing and newly installed distribution pipes. The list of distribution pipes in the area covered by Salakham Distribution Center is shown in Table 5.6.

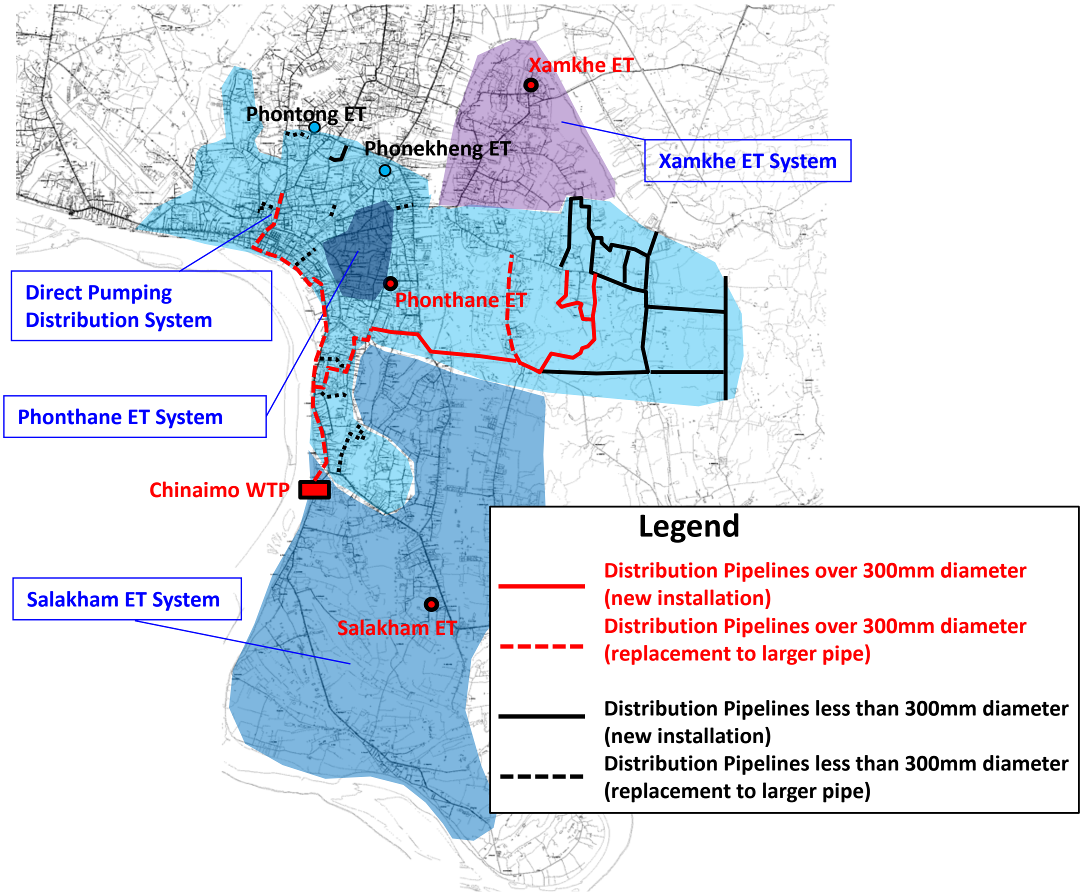
Table 5.6 List of Distribution Pipes in the Area Covered by Salakham Distribution Center

Phase	Transmission / Distribution	New Installation /Renewal	Diameter	Material	Length (m)
Phase 1	Transmission	Renewal	700	DIP	5,815
	Distribution	New Installation	300	DIP	2,308
			500	DIP	6,221
			600	DIP	10,209
			Sub-Total		18,738
		Renewal	400	DIP	877
			500	DIP	724
			600	DIP	1,093
			800	DIP	1,341
			1000	DIP	2,224
			1100	DIP	258
			Sub-Total		6,517
		Total			25,255
	Phase 1 Total				31,070
Phase 2	Distribution	New Installation	150	DIP	6,896
			200	DIP	6,879
			250	DIP	3,532
			300	DIP	2,408
			Sub-Total		19,715
		Renewal	150	DIP	2,682
			200	DIP	420
			250	DIP	2,487
			300	DIP	6,765
			350	DIP	841
			400	DIP	1,679
			Sub-Total		14,874
	Phase 2 Total				34,589
Phase1&2 Total					65,659

Source: JST

According to the results of the hydraulic analysis of the future distribution network, replacement of distribution pipes with larger diameters and new distribution pipe installation are required.

The existing distribution pipelines from Chinaimo WTP which should be augmented or newly installed are identified in Figure 5.8.



Source: JST

Figure 5.8 Distribution Pipelines to be Augmented or Newly Installed in Direct Pumping Distribution System

Table 5.7 shows the list of distribution pipelines to be augmented or newly installed in diameters.

Table 5.7 List of Distribution Pipelines to be Augmented or Newly Installed in Direct Pumping Distribution System

Phase	Transmission / Distribution	New Installation /Renewal	Diameter	Material	Length (m)
Phase 1	**Distribution**	New Installation	1000	DIP	2,354
			Sub-Total		2,354
		Renewal	600	DIP	576
			700	DIP	2,031
			800	DIP	4,589
			1000	DIP	4,728
			1200	DIP	3,156
			Sub-Total		15,080
	Distribution Total				17,434
Phase 2	**Distribution**	New Installation	150	DIP	11,838
			200	DIP	13,112
			250	DIP	2,877
			300	DIP	1,623
			350	DIP	3,890
			400	DIP	714
			500	DIP	2,607
			600	DIP	845
			700	DIP	2,308
			Sub-Total		39,814
		Renewal	150	DIP	1,539
			200	DIP	249
			300	DIP	698
			350	DIP	2,125
			400	DIP	863
			Sub-Total		5,474
	Distribution Total				45,288
Phase1&2 Total					62,722

Source: JST

5.3 Operation and Maintenance Plan for the Facilities of the Project

Corresponding to the design concepts described in the previous sections, the operation and maintenance plan for the main water supply facilities is prepared as shown in Table 5.8.

Table 5.8 Operation and Maintenance Plan for the Major Water Supply Facilities

Facilities	Operation	Maintenance
Intake Screens	• Basically automatic operation adjusted by timer or water level setting • Manual operation for checking the performance at least twice (say, morning and evening) a day.	Mechanical maintenance in accordance with manufacturers' recommendations should be applied.
Raw Water Intake Pumps	• Optimum shifting of pumps • Pump discharge head monitoring	• N/A
Raw Water Intake Pump Well	• Periodical desludging	• N/A
Rapid Mixing Basin	• Mixing by hydraulic water jump • Optimum dilution of alum solution by water	• Cleaning of feeding pipe shower orifices
Flocculation Basin	• Hydraulic up-and-down tapered flocculation • Intensity of flocculation can be adjusted by baffled plates	• Periodical desludging
Sedimentation Basin	• Manual desludging with flush water at the appropriate frequency dependent on raw water turbidity conditions	• N/A
Filter	• Monitoring of filtered water flow • Optimum air-water concurrent backwash • Maintaining the normal filter run time at 24 hours	• Periodical sieving of surface sand and refill of sand as required
Alum Feeding System	• Adjustment of correct alum solution concentration • Optimum dosage adjustment	• Cleaning and flushing of feeding pumps
Polymer Feeding System	• Make up polymer solution with optimum concentration • Optimum dosage adjustment	• Cleaning and flushing of feeding pumps
Chlorination System	• Same conditions quantity and temperature • Optimum dosage adjustment • Periodical test run of neutralization system	• Periodical check of leak detection system
Transmission Facilities to Salakham	• Transmission flow control at the pumping station by automatic or manual mode • Optimum shifting of the pumps	• Periodical check and refill of seal water
Transmission Pump Facilities to Phonethang ET and Xamkhe ET	• Transmission flow control at the pumping station by automatic or manual mode • Optimum shifting of the pumps	• Periodical check and refill of seal water
Distribution Pump Facilities to Vientiane City	• Pump discharge pressure control by using operation unit control to secure required water pressure	• Air venting by opening the vent valve at the top of the pump casing. • Adjustment of gland packing

N/A: Non Particular Maintenance Required

Source: JST

5.4 Overall Project Cost

5.4.1 Project Components

Overall project contents of Phase 1 and 2 consist of following works.

1) Chinaimo Raw Water Intake Pump Station
2) Chinaimo Water Treatment Facilities Expansion
3) Salakham Distribution Center
4) Expansion of Transmission and Distribution Pipeline

5.4.2 Base Cost

Base cost based on the above project contents is shown in Table 5.9.

Table 5.9 Overall Base Cost (Phase 1 and Phase 2)

Facility	Phase I			Phase II			Total		
	FC (Million JPY)	LC (Million LAK)	Sub-total (Million JPY)	FC (Million JPY)	LC (Million LAK)	Sub-total (Million JPY)	FC (Million JPY)	LC (Million LAK)	Sub-total (Million JPY)
Intake (G)	221	14,930	444	1	307	6	223	15,237	450
Intake pump Mechanical	387	484	394	122	121	124	508	605	517
Inteke pump Electrical	244	484	251	83	121	85	327	605	336
Chinaimo WTP (G)	138	37,257	693	67	18,132	338	206	55,389	1,031
Transmission and distribution pump Mechanical	386	1,210	404	74	323	79	460	1,533	483
Transmission and distribution pump Electrical	485	1,210	503	31	323	36	516	1,533	539
Chemical feed system Mechanical (E)	251	726	262	18	162	20	269	888	282
Chemical feed system Electrical (E)	97	726	108	2	162	5	100	888	113
Monitoring system (E)	130	81	131	0	0	0	130	81	131
Method of non-suspension water	300	0	300	0	0	0	300	0	300
Salakham (G)	33	8,818	164	0	0	0	33	8,818	164
Salakham pump Mechanical	156	81	157	31	20	31	187	101	188
Salakham pump Electrical	190	81	191	12	20	13	203	101	204
Raw water pipeline (G)	65	4,360	130	26	1,744	52	91	6,104	181
Transmission pipeline (G)	282	4,270	346	0	0	0	282	4,270	346
Distribution pipeline (G)	1,838	23,730	2,191	1,140	20,280	1,442	2,978	44,010	3,633
Rehabilitation	105	1,765	131	0	0	0	105	1,765	131
Laboratory Equipment	100	0	100	0	0	0	100	0	100
Dispute Board	25	0	25	25	0	25	49	0	49
Total	5,432	100,213	6,925	1,632	41,716	2,254	7,064	141,929	9,178

*(G): “General” including civil, pipeline and building works.
*(E): “Equipment” including mechanical and electrical works for pumps and these appurtenances.
Source: JST

5.4.3 Operation and Maintenance Cost

Operation and Maintenance cost projection for Chinaimo WTP and Salakham Distribution Center from present to 2050 is shown in Table 5.10.

Table 5.10 Operation and Maintenance Cost

Unit: LAK

Year	Chinaimo		Salakham		Total/year	Total/year	Remarks
	Electricity, Chemical	Others	Electricity	Others	(LAK)	(JPY)	
2015	9,662,691,690	1,229,008,717	0	0	10,890,000,000	162,261,000	Chinaimo 80,000 m^3/day
2016	9,662,691,690	1,229,008,717	0	0	10,890,000,000	162,261,000	
2017	9,662,691,690	1,229,008,717	0	0	10,890,000,000	162,261,000	
2018	9,662,691,690	1,229,008,717	0	0	10,890,000,000	162,261,000	
2019	9,662,691,690	1,229,008,717	0	0	10,890,000,000	162,261,000	
2020	10,870,528,151	1,391,234,807	1,160,700,000	245,801,743	13,670,000,000	203,683,000	Chinaimo 120,000 m^3/day
2021	11,595,230,028	1,553,460,896	1,238,080,000	245,801,743	14,630,000,000	217,987,000	
2022	12,319,931,905	1,553,460,896	1,315,460,000	245,801,743	15,430,000,000	229,907,000	
2023	13,044,633,782	1,553,460,896	1,392,840,000	245,801,743	16,240,000,000	241,976,000	
2024	13,769,335,658	1,553,460,896	1,470,220,000	245,801,743	17,040,000,000	253,896,000	
2025	14,494,037,535	1,553,460,896	1,547,600,000	245,801,743	17,840,000,000	265,816,000	
2026	15,460,306,704	1,877,913,076	1,845,440,000	245,801,743	19,430,000,000	289,507,000	Chinaimo 160,000 m^3/day
2027	16,426,575,873	1,877,913,076	1,960,780,000	245,801,743	20,510,000,000	305,599,000	
2028	17,392,845,042	1,877,913,076	2,076,120,000	245,801,743	21,590,000,000	321,691,000	
2029	18,359,114,211	1,877,913,076	2,191,460,000	245,801,743	22,670,000,000	337,783,000	
2030	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2031	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2032	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2033	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2034	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2035	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2036	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2037	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2038	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2039	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2040	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2041	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2042	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2043	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2044	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2045	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2046	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2047	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2048	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2049	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2050	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	

1 LAK = 0.0149 JPY

Source: JST

5.5 Outline of the Project for Phase 1

Previous section discussed for Phase 1 and Phase 2 projects regarding necessary facility plan for the Chinaimo Expansion Project. In this section, only Phase 1 Project is focused and examined.

5.5.1 Contract Packages

The study team recommends that the contracts for construction and equipment purchase to be grouped into packages as shown in Table 5.11.

Table 5.11 Contract Packages for the Phase 1 Project

Package	Scope	Component	ICB/LCB
Package 1	- Intake (G) - Raw water pipeline (G) - Chinaimo WTP (G) - Chinaimo WTP (E) - Laboratory equipment - Salakham Reservoir (G) - Transmission Pipeline (G) - Distribution Pipeline (G)	- Intake Civil (160,000m^3/day) - Pipe jacking at intake pipe - Raw water pipeline (225m) - Chinaimo WTP Civil and Building (40,000m^3/day) - Method of non-suspension water - Chinaimo WTP Mechanical and Electrical Equipment such as Chemical feed system (excluding pump equipment) - Equipment for laboratory in Chinaimo WTP - Salakham Reservoir Civil (5,100 m^3+2000m^3) - Transmission pipeline (6,700m) - Distribution pipeline (42,689m)	ICB
Package 2	- Intake pump (E) - Transmission and distribution pump (E) - Salakham pump (E) - Monitoring System	- Intake pump and related facilities (120,000 m^3/day) - Transmission and distribution pump and related facilities (120,000 m^3/day) - Salakham high lift pump and related facilities (37,000 m^3/day) - Monitoring System	ICB

(G) means “General” works including civil, pipeline and building works.
(E) means “Equipment” works including mechanical and electrical works.
Source: JST

It should be noted that, in the bidding for Package 2, not only initial equipment cost but also operation energy cost would be evaluated as a part of the bid prices from bidders in terms of evaluation for total cost during the equipment life cycle.

5.5.2 Recommendation of TOR for Consulting Service (Detailed Design, Tender Assistance, Construction Supervision, etc.)

In order to carry out effective consulting service, following activities are recommended to be included in TOR for consulting service,

Detailed Design

- Review all documents relating to the project including F/S and Preparatory Study reports.
- Discuss and clarify the requirements of the project with Executing Agency (EA) and its subordinate organization delegated some responsibility from the EA..
- Carry out Basic Design and Detailed Design
- Carry out topographic and pipeline survey for construction of intake, Chinaimo WTP expansion, Salakham Distribution Center, and transmission and distribution pipeline.
- Carry out geotechnical survey for construction of intake, Chinaimo WTP expansion, Salakham Distribution Center, transmission and distribution pipelines.
- Chinaimo WTP has to be expanded during opreration of existing WTP. In order to avoid affecting operation of existing WTP, method of non-suspension water has to be considered.
- Carry out test pit survey for construction of Chinaimo WTP expansion and transmission and distribution pipeline in order to avoid water supply suspension due to damage to existing pipeline during construction stage.

Tender Assistance

- Pre-qualification tasks;
- Preparation and modification of tender document;
- Evaluation of bid;
- Contract negotiation.
- Support the procedures of the LCC bidding

Construction Supervision

- Review the construction schedule proposed by the contractor;
- Monitor the progress of work and instruct the contractor to update the schedule when required;
- Assist Executing Agency (EA) and its subordinate organization with progress meetings;
- Review construction shop drawings submitted by the contractor;
- Process contractor’s progress and final payment requisitions and issue progress certificates for EA /JICA approval/concurrence.
- Monitor and advise EA and its subordinate organization of the financial progress of the work;
- Advise EA and its subordinate organization on contract variations and claims issues;
- Provide quality assurance during construction phase through supervision of civil and geotechnical engineering works and M&E plant installation work;
- Check and approve contractor’s O&M manual and as-built drawings.

Capacity Building

- The Consultants would deliver an operator training program for NPNL through O&M training program for expanded Chinaimo WTP.

5.5.3 Preliminary Cost Estimation with Demarcation of Foreign Currency and Local Currency as for Japanese ODA Loan Projects

The result of preliminary cost estimation based on the following conditions is shown in the Table 5.12.

Table 5.12 Result of Preliminary Cost Estimation for the Phase 1 Project

Discription			Total				Percentage
			FC	LC	Total	Total	
			Million	Million	Million	Million	
			JPY	LAK	JPY	USD	
A. ELIGIBLE PORTION			7,266	179,097	9,934	82.5	92%
	Ⅰ)	Procurement / Construction	6,472	149,750	8,703	72.3	-
		Base Cost	5,432	100,213	6,925	57.5	-
		Package 1	3,454	96,582	4,893	40.6	-
		Package 2	1,978	3,630	2,032	16.9	-
		Price escalation	452	35,924	987	8.2	-
		Physical contingency	588	13,614	791	6.6	-
	Ⅱ)	Consulting services	794	29,347	1,231	10.2	-
		Base cost	710	21,688	1,033	8.6	-
		Price escalation	45	6,261	139	1.2	-
		Physical contingency	38	1,397	59	0.5	-
B. NON ELIGIBLE PORTION			0	52,593	784	6.5	7%
	a	Procurement / Construction	0	0	0	0.0	-
	b	Land Acquisition	0	0	0	0.0	-
	c	Administration cost	0	33,336	497	4.1	-
	d	VAT	0	17,910	267	2.2	-
	e	Import Tax	0	0	0	0.0	-
	f	Front End Fee	0	1,347	20	0.2	-
C. Interest during Construction			103.1	0.0	103.1	1.1	1%
	i	Interest during Construction(Const.)	102.8	0.0	102.8	0.9	-
	ii	Interest during Construction (Consul.)	0.3	0.0	0.3	0.3	-
GRAND TOTAL (A+B+C)			7,369	231,690	10,821	90.1	100%
D. JICA finance portion incl. IDC (A + C)			7,369	179,097	10,037	83.6	93%

Source: JST

5.5.4 Comparison of the estimated Project Cost with that of Other Similar Projects in order to verify the Appropriateness of the Project Cost

Comparison of the estimated project cost with that of other similar projects is carried out in order to verify the appropriateness of the project cost. List of the target for comparison is shown in Table 5.13.

Table 5.13 List of other similar project for comparison

Country	Main Location	Treatment Capacity (m^3/day)	Project Cost (Million JPY/ Million USD)	Remarks
Laos	Chinaimo WTP	40,000 (Expansion)	10,821 Million JPY (90.1 Million USD)	This project
	Kaolieo WTP[1)]	40,000 (Expansion)	2,870 Million JPY	Japan Grant Aid (2005)
	Thakhek[2)]	15,000 (New)	1,560 Million JPY	Japan Grant Aid (2013)
	Dongmakkhay[3)]	100,000 (Expansion)	78.6 Million USD	preferential loan from the Export-Import Bank of China (F/S in 2011)
Cambodia	Niroth	130,000 (New)	6,352 Million JPY	Cofinance by Japan and France ODA (2008 to 2013)
	Kampong Cham[4)]	11,500 (New)	3,360 Million JPY	Japan Grant Aid (2013)
	Battanbang[4)]	22,000 (New)		
India	Salaulim WTP[5)]	100,000 (Expansion)	14,778 Million JPY	Japan ODA Project (F/S in 2006)

1) Vientiane Water Supply Development Project (2005)
2) Thakhek Water Supply Development Project (2013)
3) Feasibility Study Report (Fsr) Dongmakkhay Water Treatment Plant, Phase Ii (2011)
4) Expansion of Water Supply Systems In Kampong Cham And Battanbang (2013)
5) Study On Augmentation of Water Supply And Sanitation for The Goa State in The Republic of India (2006)

Source: JST

- This project includes not only expansion of capacity 40,000 m^3/day, but also the renewal of exiting mechanical and electrical equipment corresponding to 80,000 m^3/day.
- Intake facility is constructed with capacity 160,000 m^3/day for the renewal of existing intake and adjustment final capacity (Phase 2)
- Pipe diameter and length are different by each project.

5.5.5 Rehabilitation and Renewal Cost

Considering renewal costs for: civil structure, mechanical and electric equipment, the renewal cost up to the year 2050 is shown in Table 5.14.

Table 5.14 Renewal Cost up to 2050 for the Phase 1 Project

Year	Total Cost for Rehabilitation and Renewal (Million JPY)	Total Cost for Rehabilitation and Renewal* (Million LAK)	Chinaimo Capacity
2015	-	-	80,000m^3/day
2016	-	-	-
2017	-	-	-
2018	-	-	-
2019	-	-	-
2020	-	-	120,000m^3/day
2021	-	-	-
2022	-	-	-
2023	-	-	-
2024	-	-	-
2025	-	-	-
2026	-	-	160,000m^3/day
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-
2031	6.2	416	-
2032	6.2	416	-
2033	6.2	416	-
2034	6.2	416	-
2035	832.2	55,852	-
2036	6.2	416	-
2037	6.2	416	-
2038	6.2	416	-
2039	6.2	416	-
2040	832.2	55,852	-
2041	6.2	416	-
2042	6.2	416	-
2043	6.2	416	-
2044	6.2	416	-
2045	6.2	416	-
2046	6.2	416	-
2047	6.2	416	-
2048	6.2	416	-
2049	6.2	416	-
2050	6.2	416	-
Total	1,776.0	119,192	

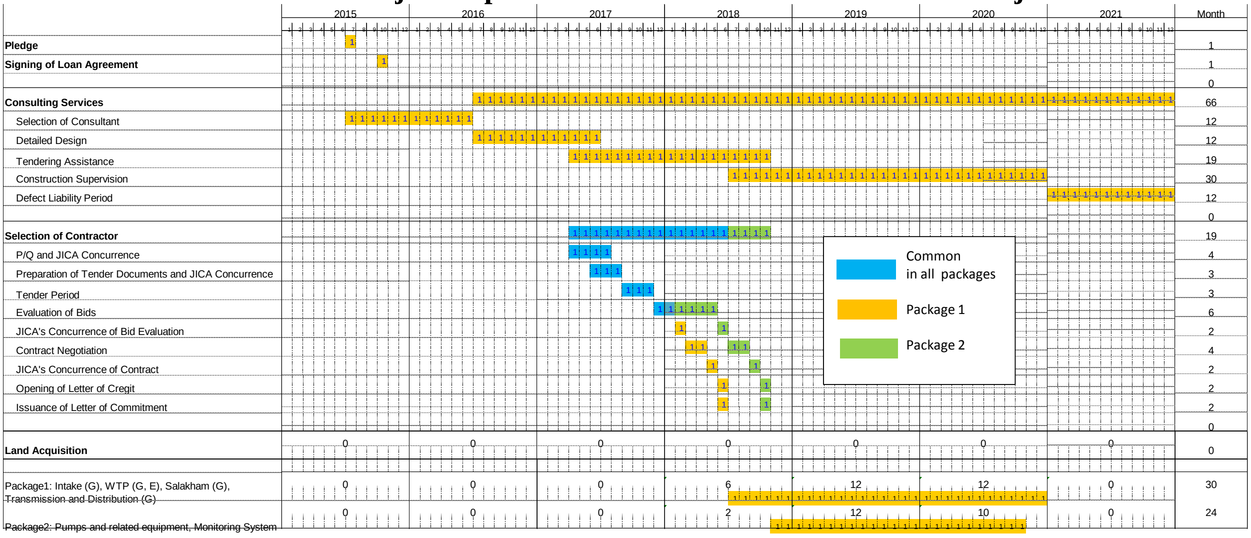
*1LAK=0.0149JPY

Source: JST

5.5.6 Project Implementation Schedule

The project implementation schedule for the Phase 1 Project is shown in Table 5.15.

Table 5.15 Project Implementation Schedule for the Phase 1 Project



	2015	2016	2017	2018	2019	2020	2021	Month
Pledge								1
Signing of Loan Agreement								1
								0
Consulting Services								66
Selection of Consultant								12
Detailed Design								12
Tendering Assistance								19
Construction Supervision								30
Defect Liability Period								12
								0
Selection of Contractor								19
P/Q and JICA Concurrence								4
Preparation of Tender Documents and JICA Concurrence								3
Tender Period								3
Evaluation of Bids								6
JICA's Concurrence of Bid Evaluation								2
Contract Negotiation								4
JICA's Concurrence of Contract								2
Opening of Letter of Cregit								2
Issuance of Letter of Commitment								2
								0
Land Acquisition	0	0	0	0	0	0	0	0
Package1: Intake (G), WTP (G, E), Salakham (G), Transmission and Distribution (G)	0	0	0	6	12	12	0	30
Package2: Pumps and related equipment, Monitoring System	0	0	0	2	12	10	0	24

Source: JST

5.5.7 Formulation of Construction Plan

General

The construction of Chinaimo intake, Chinaimo WTP and Salakham Distribution Center ~~needs~~ to be carried out while continuing to operate exiting facilities to avoid disruptions to water supply. Therefore, elaborate understanding of operation methods of existing facilities, and locations of existing facilities such as pipelines and wiring by field surveys, including test pit survey, is required.

Flexible pipe made by ductile iron and steel is applied to connecting part of structure.

Intake facility

Sheet pile will be applied to the construction of the structure, since the site has existing intake facility and the construction is in narrow area. The earthworks are carried out by machine such as backhoes and clamshells. Lead-pipe jacking method is applied to the construction of intake pipe. Sheet pipe for the construction of receiving well is used as departure shaft for the pipe jacking. Arrival shaft for the pipe jacking is constructed in the Mekong River by temporary construction. The temporary construction is constructed by sheet pile which stops the river water into the arrival shaft. Bank protection work is required after the construction of intake pipe. The bank protection work is carried out to guard against corrosion and collapse by bank sliding.

Water treatment facility

The water treatment facility constructed by expansion in Phase 1 will be located very close to the land boundary between Chinaimo WTP and Military grounds. Therefore, the construction requires borrowing the Military land during the construction works. It is necessary to borrow approximately 5 or 10 meters from the current boundary for the construction works. Removal of an existing fence before construction, and restoration after construction are required. The construction needs to be carried out so as to not affect the existing buildings on Military land near the boundary fence.

Non-suspension water method will be applied to change the existing pipe route for the construction of new connecting pipe to expanded facility, since the existing WTP will be in operation during the construction.

Transmission and Distribution pipeline

Ductile iron pipe will be applied to all of the transmission lines and distribution pipelines based on the NPNL guideline (NPNL guideline accepts the use of DIP and uPVC for pipelines under 250 mm in diameter. This project uses DIP for all pipelines under 250 mm diameters, since the pipelines which will be installed in this project have important functions for water supply in the target area).

Open cut method will be applied to the entire pipeline route. Retaining walls will be applied for the safety of workers with the depth over 2 meters considering the past actual situation. Excavation without retaining walls will be applied to the depth under 2 meters.

5.5.8 Procurement Plan and Method for Construction Materials and Equipment

The following materials and construction methods need to be imported for the project. Other materials such as cement, stone, brick, sand, timber, plywood, concrete block, fence, gabion mesh, wire nail, gasoline, diesel, lubricant, scaffolding and various small items are available in Lao PDR.

Imported Materials

- Mechanical equipment (various pumps, motor, flow meter, various valves and flexible joint .etc)
- Electrical equipment
- Pipe materials (Ductile Iron Pipe)
- Steel (for temporary works)

Imported Construction Method

- Pipe jacking method (for construction of intake pipe)
- Method of non-suspension water (for the expansion of WTP during operating existing WTP)

Chapter 6 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

6.1 Environmental Requirement

Based on the legislation in the Ministerial Agreement on the Endorsement and Promulgation of List of Investment Projects and Activities Requiring for Conducting the Initial Environment Examination or Environmental and Social Impact Assessment (No.8056/MoNRE 2013), the Project falls under the item "3.35 Water Supply Processing Factory" in Group 1 project, which requires conducting an Initial Environmental Examination (IEE). Accordingly, IEE was carried out based on the Ministerial Instruction on the Process of Initial Environmental Examination of the Investment Projects and Activities (No.8029 /MoNRE). In case of the project, the project developer shall submit the IEE report to Department of Natural Resources and Environment (DONRE) in Vientiane Capital Government for obtaining the Environmental Compliance Certificate (ECC). [4]

After submitting the IEE report to DONRE, it was reviewed with two stakeholder meetings (village/district level and district /Vientiane Capital level). Then, the ECC was issued on 17 February, 2015 by DONRE.

6.2 Alternatives

Intake Location

After the examination, alternative 2, in which the intake will be constructed in the premises of the existing Chinaimo Intake, was selected as the most feasible option among other options (without project case which uses existing intake with expanding water intake capacity, and option 2, which the same type of intake to be constructed using land adjacent to the existing intake).

Water Treatment Plant Location

After the examination, alternative 2, in which the water treatment plant is to be constructed in the premises of the existing Chinaimo Water Treatment Plant, was selected as the most feasible option among other options (without project case which uses existing water treatment plant, and alternative 1, which the same type of water treatment plant to be constructed using land adjacent to the existing water treatment plant).

Water Elevated Tank Location

After the examination, alternative 3, in which the water elevated tank is to be constructed in the premises of the existing Salakham Water Elevated Tank, was selected as the most feasible option among other options (alternative 1 which rebuilds Phonekheng Water Elevated Tank and rebuilds new tank with larger capacity, and alternative 2, which constructs new water elevated tank in another location with land acquisition).

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[4] Article 2.4 Review of the Initial Environmental Examination Report, Ministerial Instruction on the Process of Initial Environmental Examination of the Investment Projects and Activities No.8029/MONRE)

6.3 Result of the IEE

The IEE was conducted by examining available data, hearing from stakeholders, and carrying out site reconnaissance. According to the result of the IEE, it was concluded that no significant negative impacts were predicted, and the predicted minor impacts could be avoided or minimized by applying countermeasures. The main negative impacts include temporary and site specific pollution such as air pollution, water pollution, waste generation, and noise and vibration due to construction activities in the construction phase.

There are no specific stipulations addressed on taking water from the Mekong River in the legislations of the Lao PDR for water supply project. Thus, it is not necessary to apply for taking water from the Mekong River.

The project was reviewed in the light of environmental and social considerations. Based on the scoping result, it is concluded that no significant negative impact is predicted.

6.4 Resettlement, Land Acquisition and Compensation

The proposed project sites are located on governmental land. Thus, no resettlement, land acquisition or compensation is incurred due to the Project. The proposed sites of intake and water treatment plant are to be constructed in the existing Chinaimo Water Treatment Plant premises. Similarly, the proposed water elevated tank is to be constructed in the existing Salakham water elevated tank premises. As for the water pipelines, such as raw water transmission pipeline, treated water transmission pipeline, and distribution pipeline, they are to be installed under public roads.

In case of water pipeline installation, the following policies have been applied to the water pipeline installation project in the past. Similarly, the policies will be applied to the Project.

- Water pipelines are to be installed while avoiding assets such as electric polls and telecommunication towers constructed in the area of public roads, as well as private assets such as fences partly occupying the area of public roads.[5]

- After completion of the installation, the sites are to be rehabilitated to the previous condition.

The water pipeline route will be finalized among stakeholders at the land clearance committee, which is to be established during detail design phase.

6.5 Environmental and Social Management and Monitoring Plan

Based on the IEE result, the mitigation measures are prepared for each predicted environmental impact. The state of mitigation activities will be monitored regularly. During the construction phase, based on the ESMMP, the environmental staff in the Executing Agency (EA) and its subordinate organization delegated some responsibility from the EA will supervise the mitigation activities by the construction contractor. In the operation phase, newly constructed facilities will be managed together with the existing facilities by NPNL.

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[5] The total area of the road is defined as the road includes road surface, road shoulder, footpaths, drainage channels, road slope and delimitation area for public road (Article 20, Public Road Law 1999)

The ESMMP will be reviewed and finalized during the detailed design phase. In line with the ESMMP, the construction contractor will prepare the contractor’s ESMMP (CESMMP) and obtain approval by the environmental engineer before commencement of construction activities.

6.6 Consultation Meeting

Various types of consultation meetings were held while conducting the IEE. The information obtained from administrative bodies, as well as opinions collected from individuals, focus groups and stakeholders meetings were reflected on the project design.

6.7 Procedures Ahead for the Project Implementation

The following procedures need to be carried out for the project implementation;

- Coordination to be made with Ministry of Defense for the land adjacent to Chinaimo WTP

Chapter 7 INSTITUTIONAL ARRANGEMENTS

7.1 Project Implementation Framework

7.1.1 Organization for Project Implementation in Water Supply Works

Ministry of Public Works and Transport (MPWT) and Ministry of Public Health (MPH) are responsible for the urban and rural water supply project, respectively. Urban water supply projects have been classified into a macro level and local level. A policy delegating the responsibilities from the central government (Ministry Level) to the local government (Municipality / Provincial Level) has been promoted after the MPWT Minister's Decision in 2012.

(1) Ministry Level

Ministry of Public Works and Transport (MPWT)

MPWT is responsible for the coordination of the development process for water supply in urban areas throughout the country.

Department of Housing and Urban Planning (DHUP)

DHUP plans and develops water supply facilities in other towns where development is lacking, under the supervision of the project steering committee of MPWT.

Water Supply Division (WSD)

WSD, which belongs to DHUP, sets out the developing water supply sector policies, strategies and investment plans, mobilizing funding, developing and supervising investment projects, preparing and implementing standards and guidelines, and developing human resources of water sector institutions.

Water Supply Regulatory Committee (WSRC)

WSRC is a state organization under MPWT. It studies draft strategies, policies, regulations and other legislation concerning the regulation of the water supply services, including directing the regulation of the urban water supply operations throughout the country.

Water Supply Regulatory Office (WaSRO)

The secretariat of WSRC is WaSRO. WaSRO carries out developing and monitoring the compliance with these regulations. WaSRO also advises on water tariff determination and produces statistics and annual reports on the performance of the sector.

(2) Municipality / Provincial Level

Department of Public Works and Transport (DPWT)

DPWT is the guiding and managing body for implementation of activities at the provincial level while the district field office is responsible for district level.

State-owned Provincial Nam Papa (PNP)

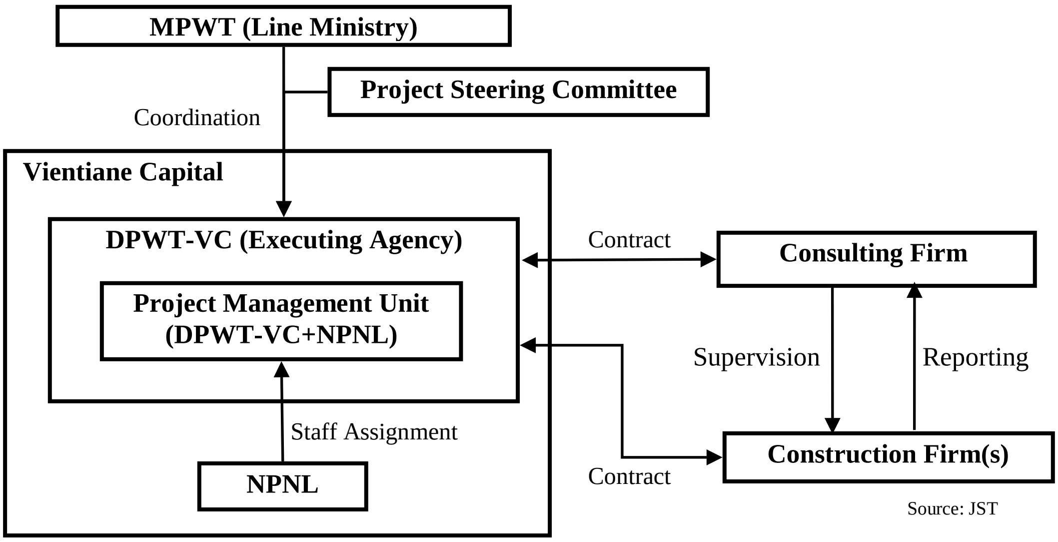
Operational responsibility for urban water supply has been delegated to the province. The organization officially responsible for operation and maintenance (O&M) for the urban water supply facility is PNP. All PNPs are under the authority of the municipality or province.

7.1.2 Project Implementation Agencies in the Project

The implementation framework for this project was discussed among DHUP, DPWT, and NPNL, and the Lao side proposed the line ministry, executing agency, project management unit, and project steering committee as follows.

- Line Agency will be MPWT,
- Executing agency will be DPWT-VC,
- Project Management Unit, PMU, will be established (composing of DPWT-VC and NPNL) under DPWT-VC
- Project Steering Committee, PSC, will be established (among ministries and departments concerned) for coordinating the project.

Figure 7.1 shows a brief overview of the implementation framework for this project.



Source: JST

Figure 7.1 Implementation Framework for the Project

7.2 Management and Operation & Maintenance

7.2.1 Management and Operation & Maintenance (O&M) Plan

Operation and maintenance plan for smooth implementation and operation of the proposed Chinaimo WTP expansion project is summarized as below.

(Water quality management)

Four laboratories in water treatment plants collect and analyze turbidity, residual chloride and color of 98 samples monthly in order to supply clean and safe water for 24 hours. In fact, water quality analysis is conducted on a daily basis and the results are recorded satisfactorily. It is a challenge of water quality management for NPNL to increase the number of water quality analysis items.

(Reduction of NRW)

Despite of the efforts to reduce NRW by replacement of old GSP pipes and quick response to repair, the NRW ratio was still 25% in 2013, and continued and long-term implementation of the NRW management plan is required, as described below. Upskilling for plumbers is also required. It is necessary to introduce systematic training programs especially for plumbers by OJT and at NPNL technical training center.

(Operation & Maintenance of Equipment)

Lack of engineers who can repair broken equipment, such as pumps, is a serious problem for operation & maintenance. Although it is required to increase mechanical/electrical engineers, outsourcing of maintenance management service will be provided as another solution.

(Human resources management)

It is necessary to increase the number of to reflect the increasing supplied water volume and customers. While increasing the number of staff, it is also necessary to improve the efficiency of each staff member with adequate training.

(Corporate plan)

NPNL is currently preparing "Long-term plan 2020" under MAWASU project. The Long-term plan 2020 will be a foundation of long-term management plan for NPNL. NPNL annual programs and/or activities are expected to be implemented along with the long-term plan. Therefore, it is strongly required to incorporate the proposed project into the long-term plan accordingly and to implement the long-term plan with monitoring and review.

The long-term plan of October 22, 2014 includes detailed plans based on three pillars of 1) Safe water supply, 2) Stable water supply, and 3) Sound management.

It is scheduled that monitoring and review of the long-term plan will be carried out by the end of MAWASU project in August 2017. Therefore, it is proposed to follow-up on the implementation of the long-term plan by utilizing the Chinaimo WTP expansion project for effective collaboration with the technical cooperation project.

7.2.2 Examination of Technical Assistance and Cooperation

The outline of the proposed technical assistance component is shown in Table 7.1.

Table 7.1 Proposed technical assistance component

Objective	Input	Activities
Follow-up & promotion of the long-term plan 2020	● WTP O&M Expert 1.4MM (0.47 * 3times) ● Pipeline Development and O&M Expert (0.47 * 3times) ● Expert for Finance (0.47 * 3times)	● To monitor the progress of activities based on the long-term plan ● To advise how to review the long-term plan 2020
Examination for introduction of outsourcing	● Training in Japan (2weeks, 6 persons) ● Contract Expert 0.93MM (0.47 * 2 times)	● To advise for introduction of outsourcing based on Japanese water works practices ● To provide necessary advice on the contracts/agreements with a private company for outsourcing

Source:JST

Chapter 8 Life Cycle Cost Bidding

8.1 Purpose of Introducing Life Cycle Cost Bidding

The purpose of introducing Life Cycle Cost (LCC) bidding, which takes into account the initial costs including capital investment costs, purchase, and installation costs; the future costs such as operating and maintenance costs (O&M costs) and capital replacement costs over the life-time of the project, is to ensure the concept of lowest cost of ownership and best value of the equipment purchased.

8.2 Applicable LCC Bidding Patterns

8.2.1 Case of Sewage Treatment Plant Construction Project under the World Bank Loan

LCC evaluation was applied for the bid of selecting a contractor for the design build contract of sewage treatment plant construction. LCC is defined as the certain period (life cycle) costs composed of the cost breakdown of initial cost (including construction cost, design cost, installation cost, etc.) and O&M cost as indicated in Table 8.1.

Table 8.1 Breakdown of LCC

LCC Breakdown	O&M Breakdown
1. Construction Cost	1. Personnel Cost
2. Design Cost	2. Electric Power Cost
3. Installation Cost	3. Chemical Cost
4. Spare Parts Cost	4. Parts Replacement Cost
5. O&M Cost	5. Sludge Treatment and Disposal Cost

Source: JICA Study Meeting on August 25, 2014

8.2.2 Case of Water Supply Project under Japanese ODA Loan

In the water supply project of the Metropolitan Waterworks Authority, MWA, in Kingdom of Thailand, the pump operating costs computed from the pump efficiency were used for bid evaluation. The pump operation costs together with the pump body price and installation costs are combined and defined as the evaluated bid price. One single package, which consists of pumps, pipes surrounding pumps, electrical power receiving equipment, and pump panels, was formulated for this evaluation to separate the pump facilities from other construction packages. Penalties against failing the guaranteed efficiencies are also defined in this method. The evaluated bid price was composed of the cost breakdowns shown in Table 8.2.

Table 8.2 Breakdown of Evaluated Bid Price in the Water Supply Project in Bangkok

No.	Work Item	Amount
Initial Costs	- Intake Pumps and Spare Parts - Transmission Pumps and Spare Parts	
Installation Costs	- Transportation and Installation - Testing and Commissioning	
Operation Costs	- Operation Energy Cost for Intake Pumps for 20 years - Operation Energy Cost for Transmission Pumps for 20 years	
	EVALUATED BID PRICE	

Source: JST

8.3 Potentiality of Introducing LCC Bidding to the Project

8.3.1 Main Considerations on Introducing LCC Bidding

The following three conditions should be taken into account for introducing LCC bidding in the Project.

① While the existing treatment system in Chinaimo WTP is the conventional treatment system composed of horizontal flow sedimentation basins and rapid sand filters, it is necessary to select the most appropriate treatment system for the expansion.

② Raw water turbidity of Mekong River becomes very high (sometimes over 3000 NTU) during the rainy seasons. This fact would limit the selection of applicable treatment processes, and NPNL's operation skills and experiences are another important factors for the selection.

③ Due to rather flat topographical condition of Vientiane Capital which does not allow gravity flow, raw water intake as well as water transmission/distribution should be totally dependent on pumping.

8.3.2 Recommended LCC Bidding

Table 8.3 compares three alternative treatment methods considered for the expansion of Chinaimo WTP. Among which, 2) Upflow clarifier and 3) Ceramic filtration are not able to treat high raw water turbidity effectively and economically. In contrast, 1) Conventional type has proven its good performance against high raw water turbidity for a long period of time. Furthermore, the project aims at expanding the existing treatment plant which has 80,000 m^3/d by 40,000 m^3/d, and the land space for the expansion is reserved parallel to the existing treatment processes. Cognizant of the above, it is not recommendable to introduce a different treatment process for the expansion as it may cause complexity of operation and increase burden to the plant operators.

Table 8.3 omparison of Treatment Methods Applicable to Chinaimo WTP

Comparison Item	1) Conventional （Horizontal flow sedimentation + Rapid sand filtration）	2) Upflow Clarifier + Rapid Sand Filtration	3) Ceramic Filtration
Operation Experience in Lao PDR	More than 45 year	i. Upflow sludge blanket type is being operated at Dongbang WTP. ii. Upflow clarifier (slurry circulation type) with 16,000 m^3/d, belong to Beer Lao Factory, which treats Mekong river raw water has started since July 2014.	Non
Treatment Capability against High Raw Water Turbidity (Mekong River raw water tends to elevate over 3000 NTU.)	Treated water conforms to the drinking water quality standards for dry and rainy seasons throughout year	i. Production amount of Dongbang declines when raw water turbidity of Nam Gum river increses. （approx. 20% loss annually in treated water amount） ii. Upflow clarifier at Beer Lao Factory is being operated presently at only 50% of the nominal capacity and the treated water quality is acceptable. It is not proven whether it can treat very high turbidity at full-capacity operation. iii. According to Japanese design criteria for clarifier, water production of such clarifier decreases by 10% when raw water becomes 1000 NTU. (If raw water turbidity is 3000 NTU about 30% of water produced will be lost with sludge extraction from the clarifier to maintain the adequate sludge concentration in the clarifier.	i. No performance data for high water turbidity ii. Pretreatment processes such as coagulation/flocculation basin and sedimentation basin are required to reduce turbidity.
Major Mechanical and Electrical Facilities which significantly affects O&M Costs	i. Chemical feeding facilities ii. Filter backwash system iii. Desludging is manually operated.	i. Chemical feeding facilities ii. Filter backwash system iii. Circulator of clarifier iv. Automatic desludging system required	i. Chemical feeding facilities ii. Filter pumps iii. Ceramic filter backwash water system and compressed air system (Ceramic filter requires backwash at intervals of 4 ～12hours.)
Construction Cost*	1	0.8～1	1.5～2times
Chemical Cost*	1	0.9	Same as ① during high turbidity. Lower than ① during low turbidity.
Power Cost*	1	Slightly higher than ①	Rather higher than ①
Overall Evaluation	○	△	X

Note: The cost for conventional type is regarded as 1 for the above cost comparison

Source: JST

The expansion of Chinaimo WTP would be planned accordingly to employ the same type as the existing conventional treatment processes designed by consultants, and the bidding for the construction contact for expansion work be carried out separately based on the consultants' design (i.e DBB).

On the other hand, it is a fact that power cost which comprises approximately 70% of O&M cost is mainly derived from the operation of pumping facilities for water intake, transmission and distribution. It is anticipated that future O&M costs can be reduced if pumps with better efficiencies are procured under the project. It is proposed to apply LCC bidding, similar to Bangkok water supply project under Japanese ODA Loan, for the package which includes only pumping facilities.

Table 8.4 shows the contents of the pump facilities package. It is envisaged that the scale of the package is large enough to formulate one independent package for international bidding.

Table 8.4 Contents of the Pump Facilities Package

Scope of Package for Pump Facilities	Contents
- Intake Pump (120,000 m^3/day) - Transmission and Distribution Pump (120,000 m^3/day) - Salakham Pumps (36,818 m^3/day)	pumps, pipes surrounding pumps, electrical power receiving equipment, and, pump panels

Source: JST

8.3.3 Laws and Regulations related to Procurement in Lao PDR

The following contents are incorporated into the " Article 29: Award Criteria, Part VI: Criteria for Awarding Contracts " of *Implementing Rules and Regulations on Decree of Government Procurement of Goods, Work, Maintenance and Services No. 063/MOF*, Dated 12 March 2004 as an article related to LCC.

"In addition to price, the evaluation criteria may include the following which shall be qualified in monetary terms in the tender documents. Evaluation criteria that are not quantifiable in monetary terms shall be expressed in terms of pass-fail criteria.

(a) Period for completion of works and services and/or delivery of goods;
(b) Life-cycle operating costs*;*
(c) After-sale services and technical assistance;
(d) Supply of spare parts related to the use of goods;
(e) Payment terms"

According to the above description a bidding system based on LCC concept is considered applicable in Lao PDR.

8.3.4 Justification of the Application of LCC Bidding to the Project

In contrast to the case by the World Bank loan where design-build contract bidding is allowed to design and construct the entire sewage treatment plant as a whole by one contractor, the design by consulting engineers as the conventional treatment method is employed for the case of Chinaimo WTP expansion is recommended due to the natural conditions such as raw water turbidity and operational constraints of treatment processes envisaged in the Project.

On the other hand, the intake, transmission and distribution pumping facilities will increase the flow capacities more, and the power cost, which is the major component of the O&M cost, will become accordingly to substantial amount. In this regard, the selection of optimum pumping facilities with better efficiencies is very important to reduce the future costs. It is very advantageous to introduce LCC bidding, which can evaluate the overall costs of the pumping facilities including the O&M costs.

8.4 Procedure and Evaluation Method for LCC Bidding

8.4.1 Evaluated Bid Price

Submitted bids will be evaluated with the evaluated bid prices obtained by adding the power costs in a prescribed number of years (Life Cycle) to the pump, spare parts, and installation costs as shown in Table 8.5.

Table 8.5 Summary of Evaluated Bid Price for Pump Facility Package in the Project

Item	Contents	Amount
Initial Costs	- Intake Pumps and Spare Parts - Transmission & Distribution Pumps and Spare Parts - Salakam High Lift Pumps and Spare Parts - Monitoring System and Spare Parts	
Installation Costs	- Transportation and Installation - Testing and Commissioning	
Operating Costs	- Operation Energy Cost for Intake Pumps for 15- 20 years - Operation Energy Cost for Transmission and Distribution Pumps for 15-20 years - Operation Energy Cost for Salakam High Lift Pumps for 15-20 years	
	EVALUATED BID PRICE	

Source: JST

For calculation of the amount of electric power consumption, guaranteed values by the supplier for the parameters shown in Table 8.6 are used.

Table 8.6 Guaranteed Values by Bidders

Item	Guarantee Value
1. Discharge of Pump, Q, (CMM)	
2. Speed (RPM)	
3. Rated Head of Pump, H, (m)	
4. Pump Efficiency, np	
5. Motor Efficiency, nm	

Source: JST

From the above guaranteed values, power consumption will be calculated, and by multiplying the specified electricity unit cost and operation period by hours, the electricity costs of the project life are able to be estimated.

On the other hand, penalty is also provided on the efficiency as described later if the result of factory inspection does not satisfy the efficiency guaranteed by the supplier, the pump is rejected or the supplier should pay for corresponding fines depending on the conditions of the contract.

8.4.2 Proving Energy Consumption (Factory Inspection)

In the package of pump facilities, in order to measure the pump performance proposed and gathered at the time of bidding, the factory inspection will be carried out before shipment. Examination contents associated with LCC includes the items shown in Table 8.7. When any result has a value out of the rated value specified, the pump will be rejected.

Table 8.7 Items of Factory Inspection for Pump Equipment

Test Item	Result
1. Discharge of Pump, Q, (CMM)	
2. Speed (RPM)	
3. Rated Head of Pump, H, (m)	
4. Pump Efficiency, np	
5. Motor Efficiency, nm	
6. Suction Performance	

Source: JST

8.4.3 Penalty

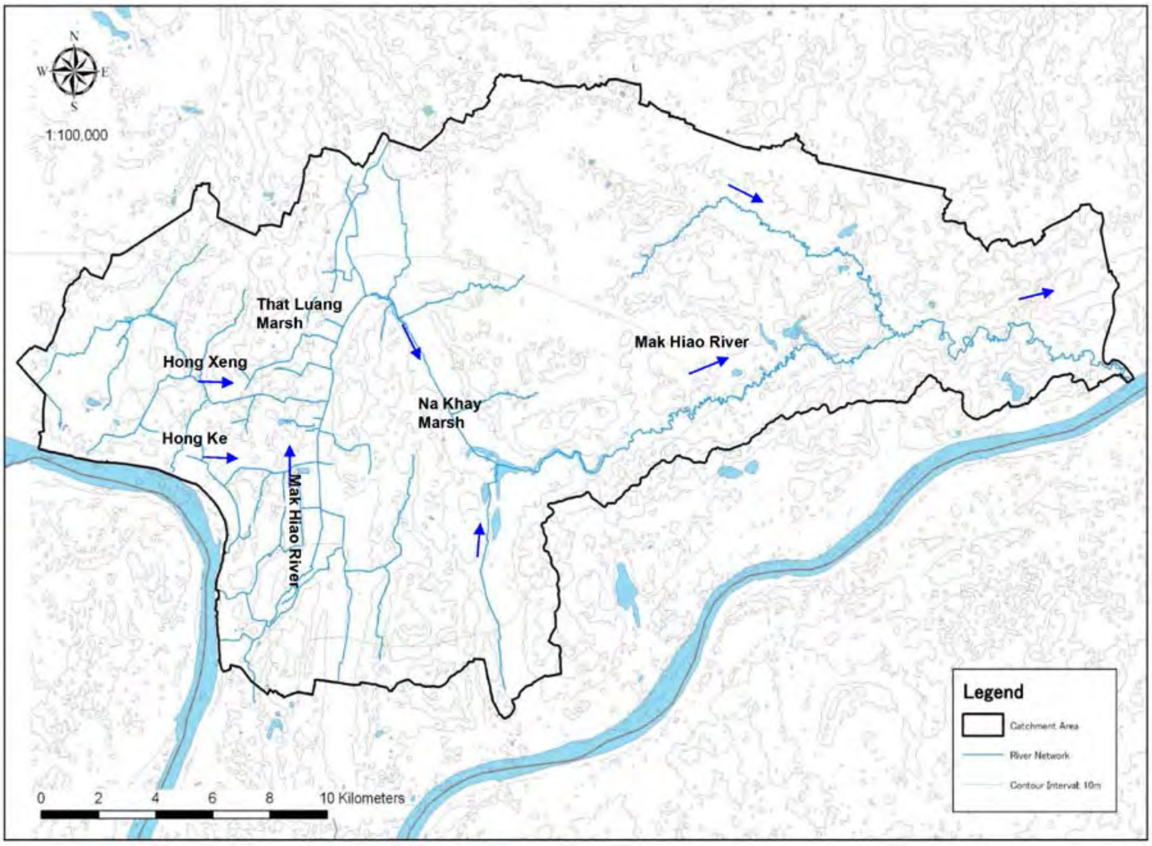
Even though the factory inspection results satisfy the minimum efficiency specified in technical specifications, if the pump performance could not reach the efficiency guaranteed by the supplier, the supplier shall pay penalties (fines).

Chapter 9 ANALYSIS OF SEWARAGE AND DRAINAGE SECTOR

9.1 Current Situation and Problem on the Sewerage and Drainage Sector

9.1.1 Current Situation on the Sewerage and Drainage Sector

With the exception of three (3) Decentralized Wastewater Treatment System(DEWATS), Vientiane Capital has no centralized wastewater treatment plants at the moment, and only has the drainage networks. Sewerage flows into the drainage networks and flows down the Hong Xeng Hong Ke, then reaches the MaK Hiao River, except for a channel of water in front of the Don Chan Palace Hotel that discharges directly to the Mekong River by pump station. After that, the sewerage passes the That Luang Marsh and Na Khay Marsa, and finally joins the Mekong River at a point about 30km east of the Vientiane Capital downtown. (see Figure 9.1)



Source : The Study on Inprovemnt of Water Environment in Vientiane City, 2011

Figure 9.1 Target area

9.1.2 Current Problem on the Sewerage and Drainage Sector

Sewerage and Drainage Network in Vientiane Capital has the following features and problems.

1) Sewerage and Drainage formed in Vientiane Capital connect to the Mekong River at a point about 30km east of the Vientiane Capital downtown via marsh and the MaK Hiao River. The water quality at the effluent point is good. (BOD2～3mg/l)

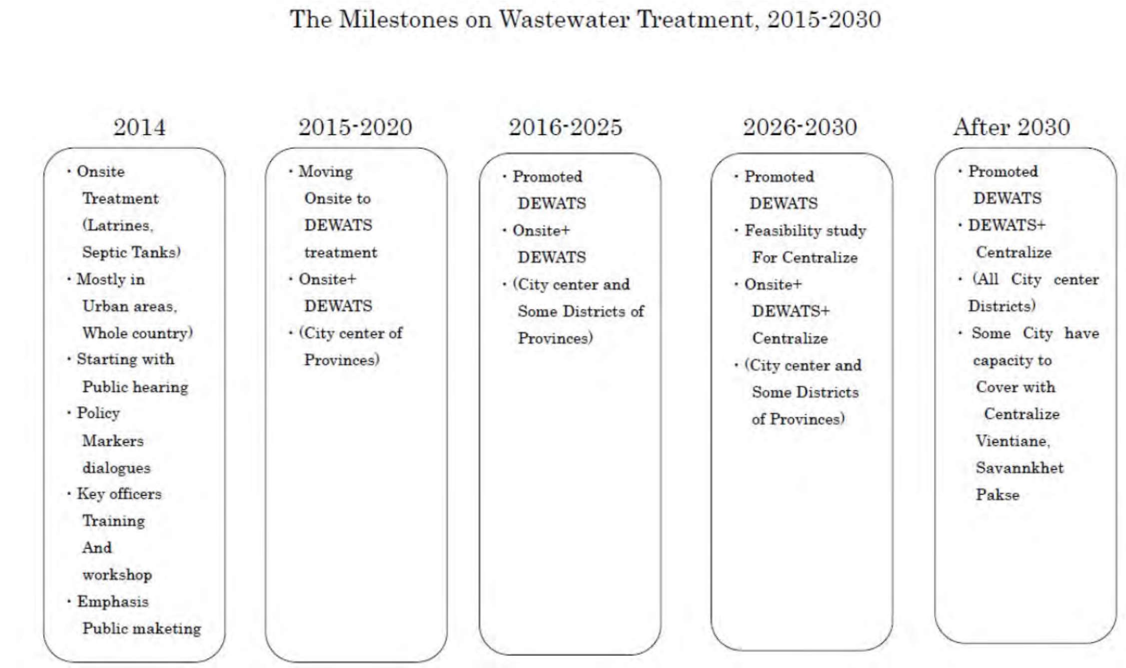
2) Vientiane Capital has clearly rainy season and dry season. Hence, inflow amount to the drainage is different depending on the season. The size of the canal is determined by inflow amount during rainy season. However, there is only septic tank overflow and gray water flow in the canal during dry season. Therefore, sewerage is stagnant at the end of the branch river, and garbage is floating in the river. Occasionally, nasty odor is caused by these situations

3) Improved living standards with economic growth, increasing population, and the expansion of urban area are influential to a large amount of untreated gray water, and thus sewage amount is certainly increased.

4) There are no sewage treatment plants in Vientiane Capital. Purification of water depends on septic tanks and purification capability of marshes and rivers. The increase of the polluting load might cause the river water quality and hygienic environment to become worse.

9.2 Policies and Plans of the Sewerage and Drainage Sector

Action Plan toward 2030 of the Sewerage and Drainage Sector in Vientiane Capital is shown below.



The Milestones on Wastewater Treatment, 2015-2030

2014	2015-2020	2016-2025	2026-2030	After 2030
· Onsite Treatment (Latrines, Septic Tanks) · Mostly in Urban areas, Whole country) · Starting with Public hearing · Policy Markers dialogues · Key officers Training And workshop · Emphasis Public maketing	· Moving Onsite to DEWATS treatment · Onsite+ DEWATS · (City center of Provinces)	· Promoted DEWATS · Onsite+ DEWATS · (City center and Some Districts of Provinces)	· Promoted DEWATS · Feasibility study For Centralize · Onsite+ DEWATS+ Centralize · (City center and Some Districts of Provinces)	· Promoted DEWATS · DEWATS+ Centralize · (All City center Districts) · Some City have capacity to Cover with Centralize Vientiane, Savannkhet Pakse

Figure 9.2 The Milestones on Water Treatment

9.3 The Impacts of Water Supply Expansion toward Sewerage and Drainage in Vientiane Capital

At the moment, Vientiane Capital has nine (9) districts. Among them, water supply area is 72% in the urban area of seven (7) districts. The four (4) water treatment plants have the capacity of 180,000m^3/d, but supplied 199,000 m^3/d in 2013. “The Study on Improvement of Water Environment in Vientiane City”（09/2011）has not studied the above mentioned water supply expansion, but has done the water quality prediction calculation based on increasing population and economic growth. According to the calculation, water quality (BOD) at the estuary of the MaK Hiao River is estimated to rise from 1.9mg/l in 2009 to 3.1mg/l in 2020. Thus, water quality is getting worse in 2030, target year of water supply expansion.

9.4 Comprehensive Plan for the Sewerage and Drainage Facilities in Vientiane Capital

Water quality at the estuary of the MaK Hiao River will not deteriorate significantly even if sewerage amount in Vientiane Capital increases. On the other hand, water quality of drainage canals in Vientiane Capital are expected to exceed 30mg/l (BOD) before flowing into the MaK Hiao River or marsh. Therefore, the current odor problem may become further exasperated. Especially, without flow quantity, the flow becomes stagnant at the end of river branches in most-place~~s~~. “The Study on Improvement of Water Environment in Vientiane City”（09/2011） suggested not installing canal covers as one structural method from the aspect of environmental education. Furthermore, both main and branch rivers have wide river widths. Thus it is difficult to cover the river. For these reasons, it is conceivable that trapezium natural channel (roughness coefficient is big) will be converted to rectangle box culvert (roughness coefficient is small). There is an example of a culvert constructed without using the public funds.

In Hon・Xeng drainage, Sewage of each home comes into the drainage network through the drainage pipe. In the dry season, the drainage pipe plays a role of the sewage pipe. Thus, it is conceivable to purify the river water directly. There are purification facilities provided in high-water channels in Japan, but there are no appropriate high-water channels in the Hon･Xeng drainage. So, it is suggested to construct the purification facilities by using the farmland. The installation site is a place where confluence of the Hong Wattay and Nam Pasak further confluent with the Hong Pasak, so that the purification of almost three tributaries can be done at one point.

In Hon ke drainage, it is difficult to install river treatment plant because of site limitation. As a possible method, it is suggested to construct the purification facilities at places where high-water flood channel is built. Another option is constructing the purification facilities underground at mall sites.

To summarize the contents of which have been described above, Vientiane Capital’s sewerage and drainage do not flow out to the Mekong River directly and is partly processed by the purification capability of marsh and river. The water discharged from the MaK Hiao River is in good condition without a sewerage treatment plant. In view of this fact, promotion of developing sewerage networks with secondary treatment plants are considered not to be undertaken immediately.

To keep the marsh and rivers of purification capacity is particularly important conservation of marsh. To do this, the prohibition of development activities in the marsh and strengthening of drainage regulations with development are needed.

With the current status of increasing economic growth and population of Vientiane Capital, and expansion of city area, water quality deterioration and odor problems may occur. Countermeasures have 1) promotion to install inexpensive wastewater treatment system like DEWATS in the places where are available, 2) promotion to the lid hanging in the places where are available, 3) construction of the facilities purifying the river water directly. Using these measures, it should be done to conserve the marsh and to improve water quality in the drainage networks.

Chapter 10 ASSESSMENT OF PROJECT EFFECTIVENESS

10.1 Calculation of the Project's Economic Internal Rate of Return (EIRR) and Financial Internal Rate of Return

10.1.1 Financial Analysis

In case without unit water price increase in constant price after scheduled tariff raise up to 2018, financial internal rate of return (FIRR) is calculated at 9.29%, which is higher than WACC at 4%. As a result, proposed water supply project is financially feasible under the present water rate.

10.1.2 Economic Analysis

Results of economic analysis of this Project are shown as follows.

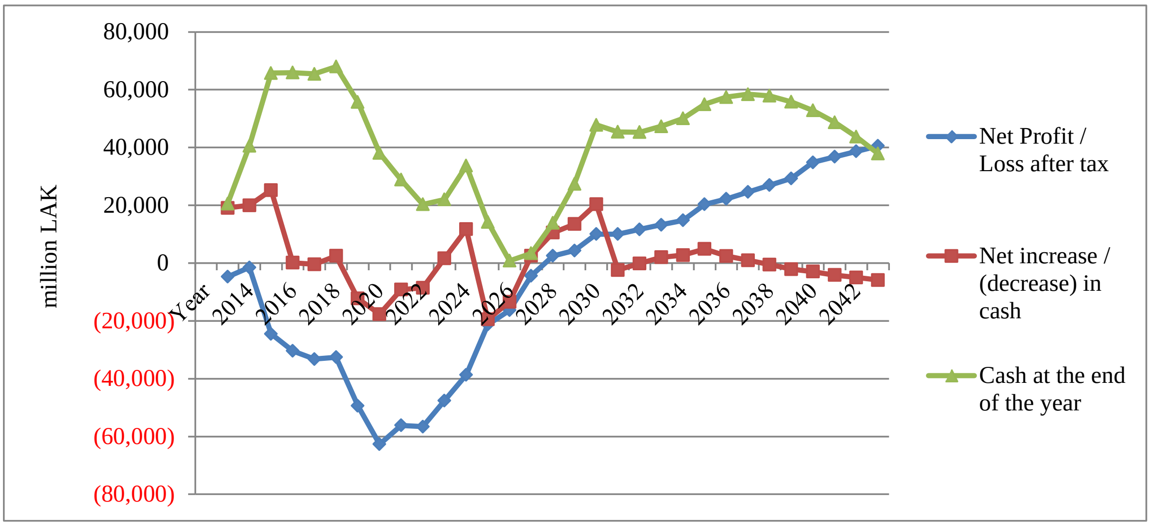
	Economic Internal Rate of Return (EIRR)	NPV	B/C
Water Supply Project	**27.30%**	**6,707 million JPY**	**2.15**

Note: NPV and B/C are computed using the 12% opportunity cost of capital as discount rate.

Computed EIRR is over the opportunity cost of capital (12%). Therefore, this Project is economically viable.

10.1.3 Financial Plan

Figure 10.1 is the simulation with additional water tariff raise at 3.5% once every 5 years, starting from 2020. In other words, tariff raises of 3.5% are scheduled in the year 2020, 2025, 2030, 2035, and 2040.



Source: prepared by JST

Figure 10.1 Net Profit / Loss and Cash Flow Balance Projection for NPNL (2^{nd} Scenario)

In this Scenario, 3.5% tariff raise over inflation adjustment is scheduled once every 5 years, NPNL will have positive cash flow balance for all 30 years, while repaying all loan principals and interests with conducting the Master Plan by AfD (pipe extension and reinforcement, etc.).

It should be noted that the above mentioned 3.5% tariff raise every 5 years is the constant prices (real term) excluding price escalation. For example, if the inflation rate is at 6%, NPNL is required to plan 6% tariff raise every year, or 19% raise once every 3 years, only for inflation adjustment.

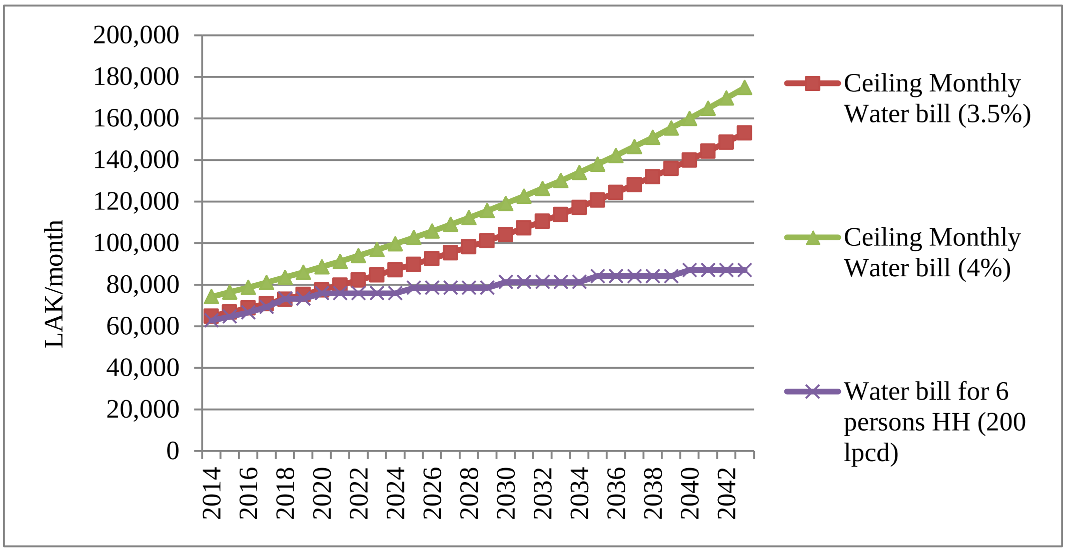
10.1.4 Analysis of Impact on Water Tariff Rate by the Project

The purpose of this analysis is to check whether expected water tariff raise by this project is payable by low income households or not. Based on the financial analysis, tariff raise is not necessary for this project to be financially feasible. However, financial plan covering all the other conditions has a result that NPNL should conduct the water tariff raise at 3.5% once every 5 years over the inflation adjustment from 2020 to 2040, in order to make positive cash flow balance for the next 30 years.

By utilizing the data of the Socio-economic survey (Interview survey), average monthly income of low income households is estimated at 1,853,920 LAK/month. Affordability to pay for water supply is set by international organizations (IBRD, and Pan American Health Organization) at 3.5% or 4% of household income.

Per capita GDP in real term has grown at 5.9% on average from 2005 to 2013. If it is assumed that average income for low income household will increase at 3% on average in the future, the ceiling of water bill calculated from average income and typical water bill for low income households are estimated as Figure 10.2.

The purple line shows the water bill increase for a six person household with 3.5% tariff increase once every 5 years. Green and red lines are ceiling monthly water bills as 3.5% and 4% of average income of low income household with 3% annual income growth. For 30 years, purple line is always under the green and red lines. It is considered that the planned tariff raise (3.5% every 5 years after 2020) is payable or under the ceiling of affordable water bill amount even for low income household by considering the future modest income growth.



Source: prepared by JST

Figure 10.2 Projection of the Ceiling Monthly Water Bill and Typical Water Bill for Low Income Household (with 3% income growth)

10.2 Selection and Calculation of Performance Indicators (Operation and Effect Indicator) and Setting-up Baseline and Target Data

Quantitative Effects

In this Phase 1 project, the target year is assumed set in 2023, which is 2 years after completion of the project. Table 10.1 shows quantitative effects measured in the target year. As reference, the following table also shows the year of 2024 when Chinaimo WTP expanded by Phase 1 project will be in full production.

Table 10.1 Quantitative Effect for Indicators by Chinaimo Expansion

No.	Parameters	Present (2013)	Target Year (2023)
1.	Population Served from Chinaimo WTP* (person)	230,000	295,000
2.	Amount of Water Supply from Chinaimo WTP as Day Average (m^3/day)	93,272	103,800 (114,200 as Day Max.)
3.	Rate of Facility Utilization in Chinaimo WTP (%)	116.6%	86.5 % (95.2% as Day Max.)

* marked with an asterix (*) may be affected by the performance of NPNL that have responsibility for water supply distribution pipes, service pipes, and house connections after expansion of Chinaimo WTP.

As reference, Table 10.2 shows quantitative effects for the urban water supply area in Vientiane Capital.

Table 10.2 Quantitative Effect for Indicators in Urban Water Supply Area of Vientiane Capital

No.	Parameters	Present (2013)	Target Year (2023)
1.	Population Served in Urban Area* (person)	489,175	760,840
2.	Amount of Water Supply in Urban Area as Day Average (m^3/day)	199,619	316,665
3.	Rate of Population Served* (%)	72%	94 %

* marked with an asterix (*) may be affected by the performance of NPNL that have responsibility for water supply distribution pipes, service pipes, and house connections, and performances of WTPs supplying to urban area other than Chinaimo WTP.

Qualitative Effects

In addition to the above, the following qualitative effects are expected by the project

1. The project will enable stable water supply, aiming at 24-hour continuous supply.
2. The project will contribute to improvement of public hygiene condition

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Chapter 11 PROJECT EVALUATION AND RECOMMENDATIONS

11.1 Evaluation

The proposed Phase 1 project can be assessed as feasible.

Phase 1 project, Chinaimo WTP expansion with a capacity of 40,000m^3/day, will increase the supply capacity of the NPNL's water supply system from the present 180,000 m^3/day to 360,000 m^3/day including three (3) other undergoing projects which are: Dongmakkhay WTP expansion with a capacity of 100,000m^3/day, Thadeua WTP BOT Project with a capacity of 20,000m^3/day, and Sendin BOT Project with a capacity of 20,000m^3/day. This drastic increase in supply capacity is expected to alleviate the chronic water shortage situation in Vientiane Capital. Additional transmission and distribution pipelines also will be installed under the Phase 1 project so as to distribute additional treated water from the expanded Chinaimo Treatment Plant.

The results of the analysis for Economic Internal Rate of Return (EIRR) and Financial Internal Rate of Return (FIRR), as shown in Table 11.1, are to show economic viability and financial feasibility of the project without any tariff increases in addition to those which have already been scheduled by NPNL up to 2018. It can be said that it is highly recommended to implement this project from the financial and economic points of view.

Table 11.1 Results of Financial and Economic Analysis of the Project

Types of Analysis	Value of Indicator	Evaluation of the Value	Results
Financial Analysis	FIRR: 9.29%	More than discount rate: 4%	The Project is financially feasible
Economic Analysis	EIRR: 27.30%	More than discount rate: 12%	The Project is economically viable

Source: prepared by JST

In order to evaluate the Project's feasibility from the environmental and social points of view, the IEE was conducted by examining available data, hearing from stakeholders, and carrying out site reconnaissance. According to the result of the IEE, it was concluded that no significant negative impacts were predicted. As for the selection of the project locations, design efforts were made to avoid any land acquisition or resettlement. Consequently, there will be no land acquisition or resettlement incurred because the proposed new facilities will be either constructed within the existing facilities owned by NPNL, or installed under public roads. The main negative impacts include temporary and site specific pollution such as air pollution, water pollution, waste generation, and noise and vibration due to construction activities in the construction phase. The impacts could be avoided or minimized by applying countermeasures proposed in the IEE report as an Environmental and Social Management and Monitoring Plan (ESMMP).

11.2 Recommendations

(1) Coordination with the Existing Plan Relevant to Water Supply Sector

The existing M/P and Long Term Plan related to water supply sector in Vientiane Capital should be updated by NPNL considering the contents of this final report for the preparatory survey.

(2) Future Chlorine Agent

Regarding the disinfection method, the use of chlorine gas instead of the current use of bleaching powder was proposed in Chinaimo WTP after expansion. This matter should be also discussed again in the future stage.

(3) Coordination with Ministry of Defense for the Land neighboring Chinaimo WTP

During the construction, it will be necessary to use some land that belongs to a military school located on the east side of the existing Chinaimo WTP. Acquisition of military school land on the south side of the existing Chinaimo WTP is also proposed for the construction of the new chemical building near the injection point for efficient operation and maintenance.

(4) Future Sludge Treatment

Currently, there is no regulation about sludge disposal to the Mekong River. However, if the policy or the circumstance is changed, the sludge treatment facility may be required in the future, and the land for the facility should be considered.

(5) Reduction of NRW

It is strongly recommended that the NPNL concentrate fully on reinforcing the existing pipeline networks and reducing the leakages upon completion the projects.

(6) Recruiting and Training of Additional Staff

It is necessary to recruit additional staff and provide training for them.

(7) Review of the Master Plan and Implementation of Feasibility Study for Phase 2

M/P should be reviewed at every turning point during the progress of the water supply development. Also, a F/S will be required to implement the Phase 2. The scale of the Phase 2 will be reviewed to optimize the plan and investment for Phase 2.

(8) Environmental Requirement

The monitoring plan in an operation phase shall be finalized at the end of construction phase in line with the latest legislation requirement and situation.

(9) Installation of Distribution, Service Pipes, and House Connections

For achievement of the project objective, it is significant to improve distribution network. The GOL is required to implement constantly installation of distribution and lateral pipelines and house connections with service pipes during and after this project. NPNL or the GOL should reliably perform a budget allocation based on the long-term plan up to 2020 or more.

(10) Response to Climate Change

In recent years, the central and southern parts of the Lao PDR are facing problems, such as floods in rainy season and decrease in water level of the Mekong River in dry season. In the detailed design stage, with obtaining data concerning flood/inundation records and changes in the Mekong River water level around the construction site of this project, appropriate measures should be considered in the facility design if there is future possibility of any prospective effect on the facility to be constructed by this project.