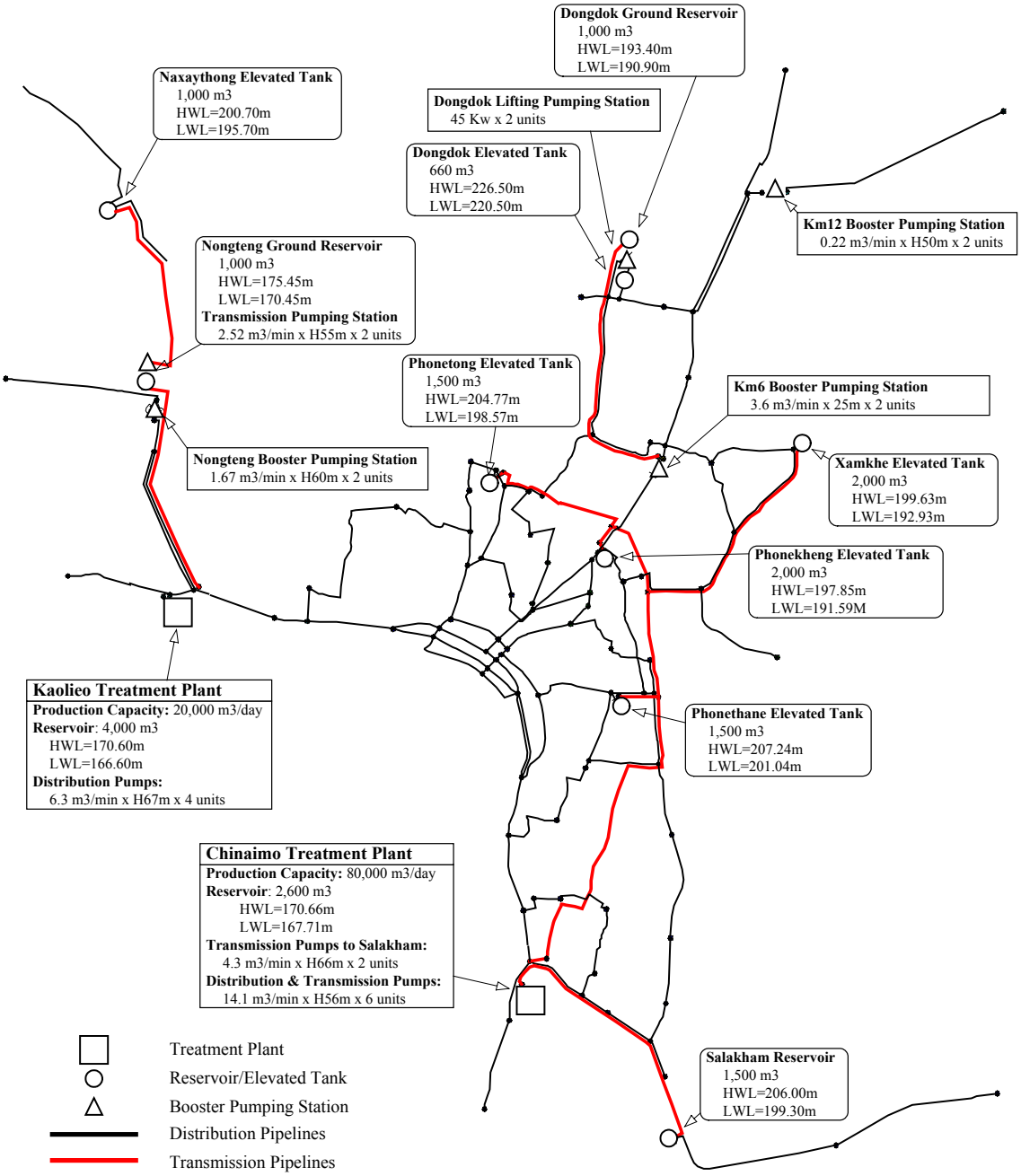
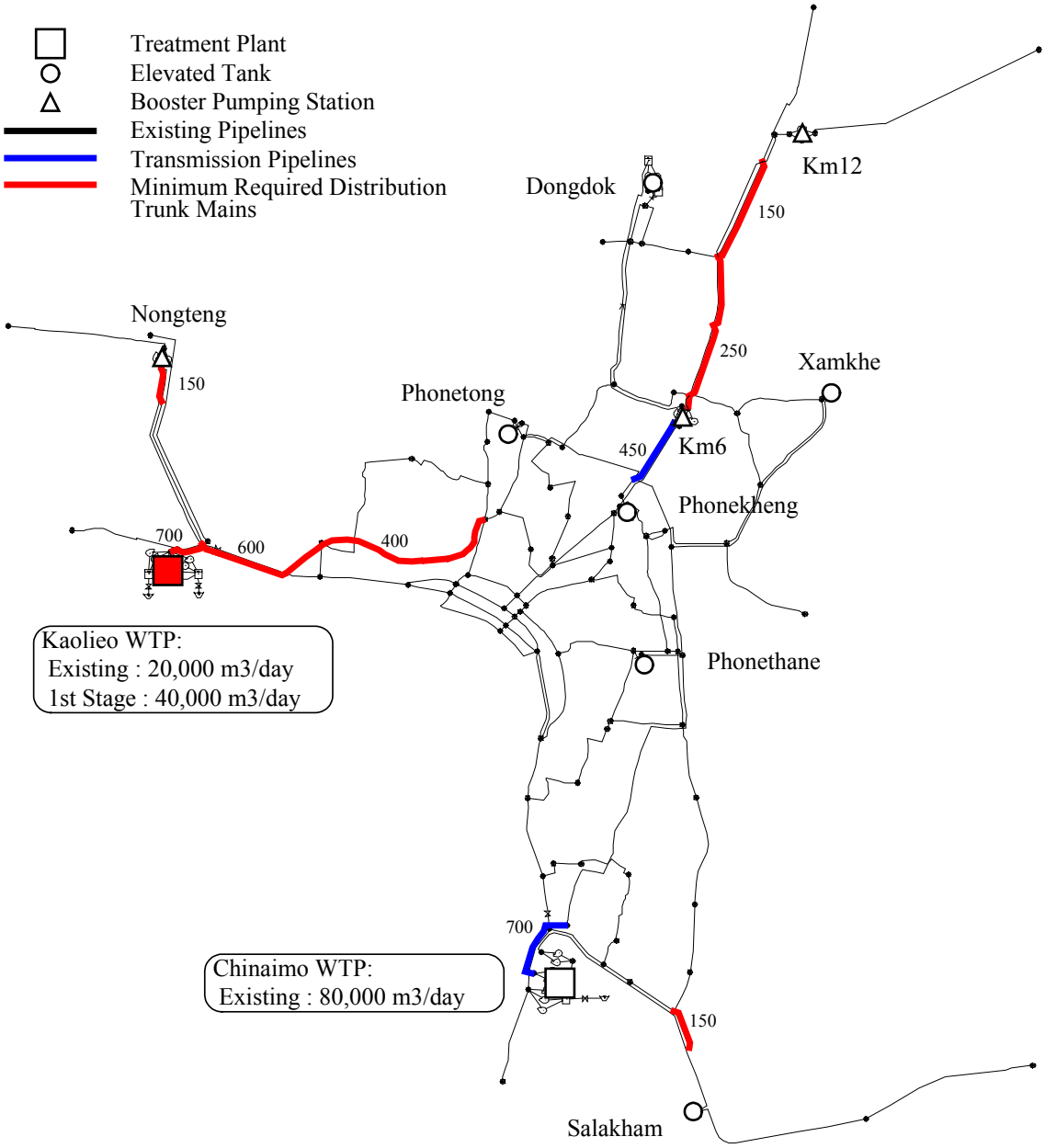
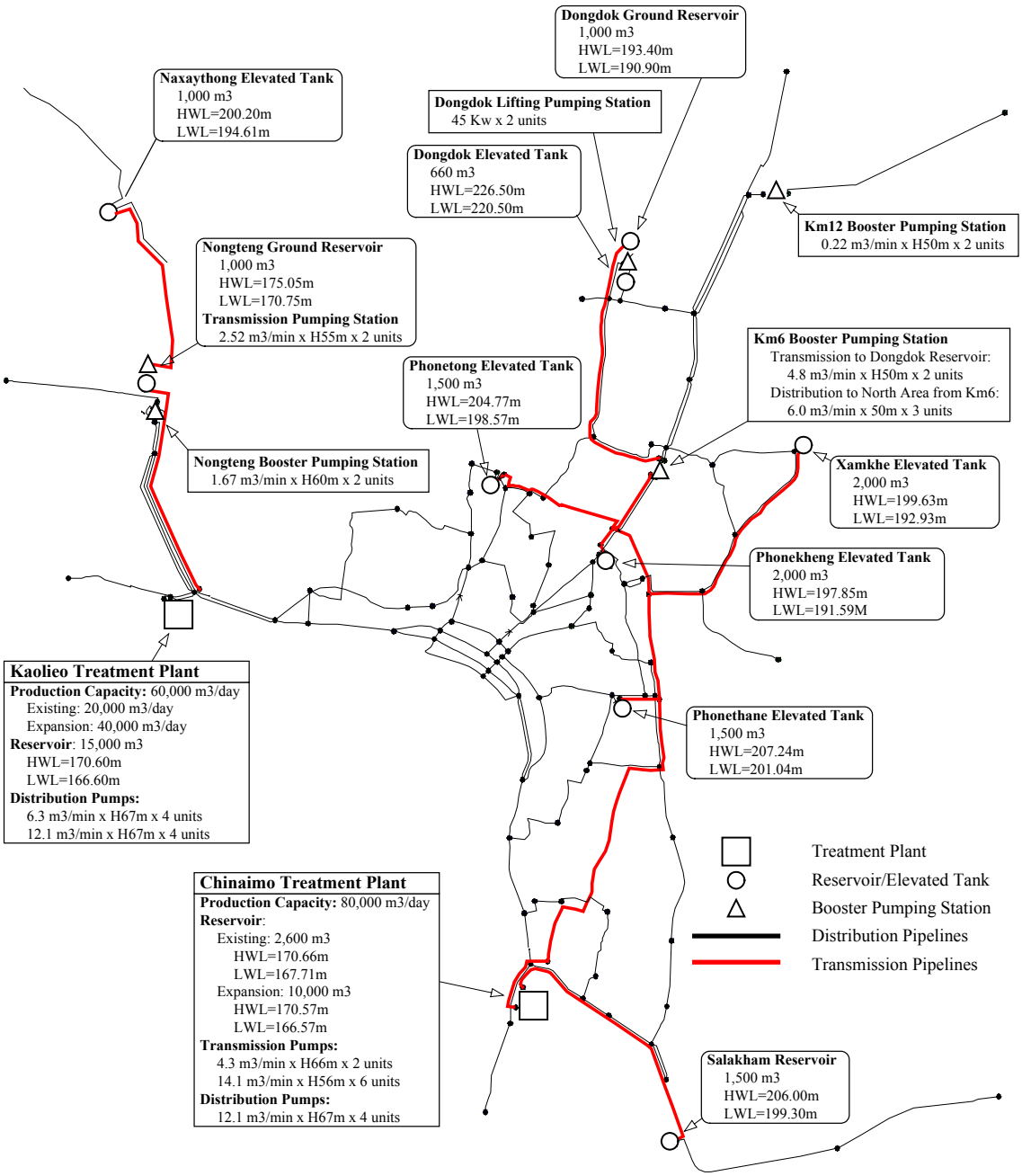
Existing Water Supply System in Vientiane



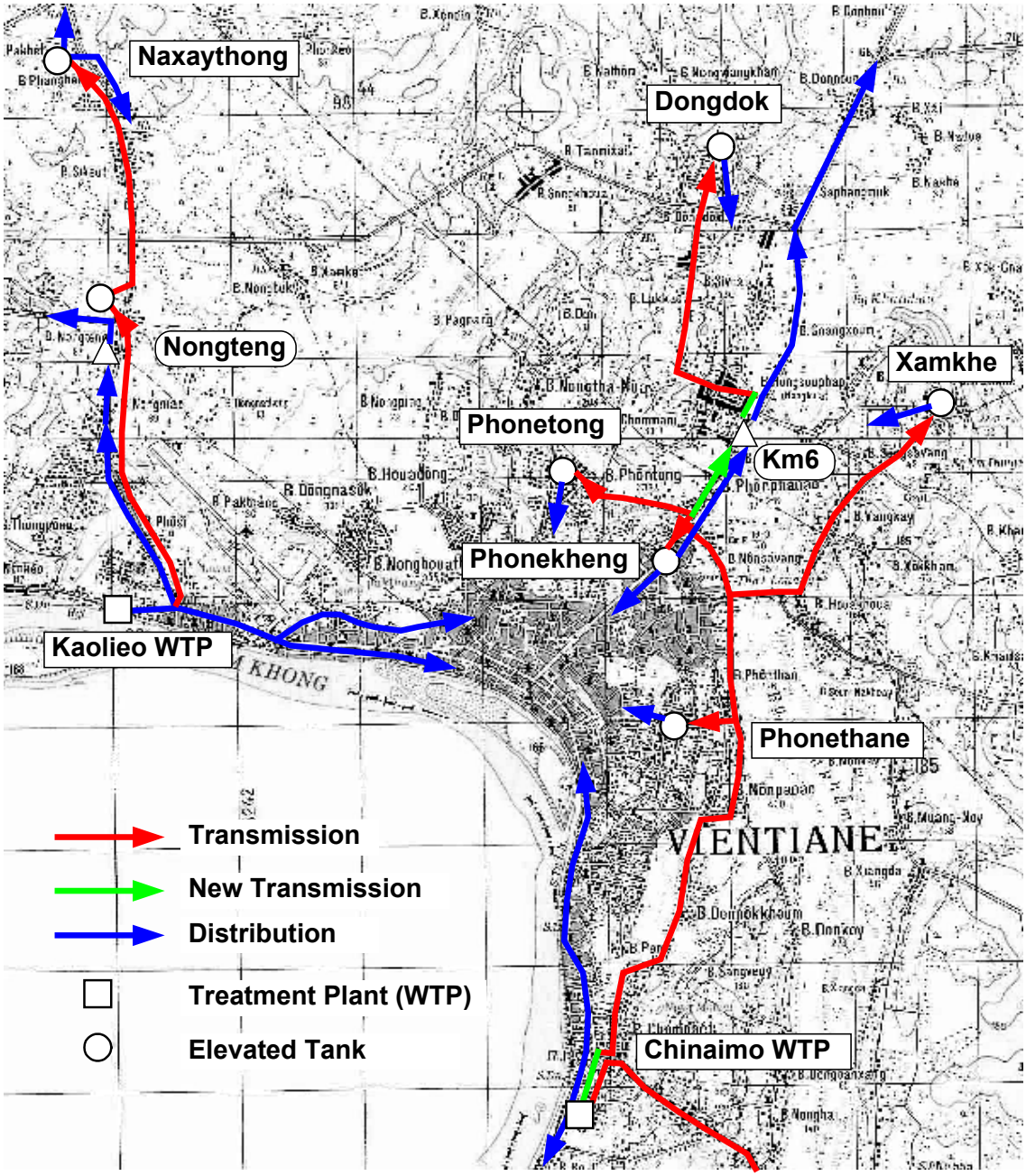
Scope of the Priority Projects



Future Water Supply System in Vientiane upon Completion of the 1st Stage Project



Transmission and Distribution System upon Completion of the 1st Stage Project



THE STUDY
ON
VIENTIANE WATER SUPPLY DEVELOPMENT PROJECT IN
LAO PEOPLE'S DEMOCRATIC REPUBLIC

FINAL REPORT

Volume III : Main Report : Feasibility Study

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ABBREVIATIONS

ADB	Asian Development Bank
AFD	French Development Agency
B/C	Benefit/Cost Ratio
CPC	Committee for Planning and Cooperation
CPI	Consumer Price Index
DCTPC	Department of Communication, Transport, Post and Construction, Vientiane Capital City
D/D	Detailed Design
DGM	Deputy General Manager
DHUP	Department of Housing and Urban Planning, MCTPC
DSCR	Debt Service Coverage Ratio
DSR	Debt-service Ratio
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
F/S	Feasibility Study
GDP	Gross Domestic Product
GM	General Manager
GOJ	Government of Japan
GOL	Government of Lao PDR
GRDP	Gross Regional Domestic Product
GVA	Gross Value Added
Hhlds	Households
JICA	Japan International Cooperation Agency
Lao PDR	Lao People's Democratic Republic
LDCD	Leakage Detection and Control Division, NPVC
LLCR	Loan Life Debt Service Coverage Ratio
LLDC	Least Less Developed Countries
lpcd	litre per capita day, unit water consumption per day per capita
LRAC	Long-Run Average Cost
MCTPC	Ministry of Communication, Transport, Post and Construction
MOF	Ministry of Finance
MPH	Ministry of Public Health
NPL	Nam Papa Lao
NPSE	Nam Papa State-Owned Enterprise
NPVC	Nam Papa Vientiane Capital City, Water Supply Company of the Vientiane Capital City
NPV	Net Present Value
NPVC Master Plan	Master Plan: Vientiane Water Supply Development Project, November 1999
NRW	Non Revenue Water

NSC	National Statistical Centre
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
PPP	Public Private Partnership
popn	Population
ROE	Return on Equity
ROI	Return on Investment
S/V	Construction Supervision
UFW	Unaccounted-for Water
UNCHS	United Nations Centre for Human Settlements
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
URI	Urban Research Institute, MCTPC
V. C. City	Vientiane Capital City
VUDAA	Vientiane Urban Development and Administration Authority
VUDMP	Vientiane Urban Development Master Plan
WASA	Water Supply Authority, DHUP, MCTPC
WRCC	Water Resources Coordination Committee
WTP	Water Treatment Plant

SUMMARY OF
THE FEASIBILITY STUDY

SUMMARY OF THE FEASIBILITY STUDY

S.1 Background of the Study

The development of the water supply system in Vientiane started with the construction of the Kaolieo Treatment Plant in 1964. The Kaolieo Treatment Plant was rehabilitated in 1983. The Chinaimo Treatment Plant was established in 1980 by the ADB and was expanded and rehabilitated from 1992 to 1996 by Japan's Grant Aid. Japan's assistance has provided not only facilities for the construction, expansion and rehabilitation works, but also for technical assistance through dispatching JICA experts, senior overseas volunteers and JICA overseas cooperation volunteers to Lao PDR.

The status and condition of the water supply in Vientiane has been aggravated by an increasing water demand as a result of population growth, increased living standards, and the expansion of industrial and housing areas. The two existing treatment plants have been obliged to operate at an overloaded condition to meet increasing water demand. At the same time, the existing water supply facilities are decrepit, and the problem of high unaccounted-for water ratio becomes more serious every year. Low pressures and an unstable supply are common in the service area.

Vientiane as the capital city of Lao PDR, has set a target that the water service ratio in urban area should be increased by 80 % by 2020. To help achieve this, the Government of the Lao PDR (hereinafter referred to as GOL) requested the Government of Japan (hereinafter referred to as GOJ) to conduct "The Study on Vientiane Water Supply Development Project". In response to the request of the GOL, the GOJ decided to conduct the study, and JICA, the official agency responsible for the implementation of the technical cooperation programs of the GOJ, dispatched the Preparatory Study Team to the Lao PDR in August 2002. At this time, the purpose of the study and the scope of work were agreed to and confirmed between the JICA and GOL.

In March 2003, the JICA Study Team of 10 study team members from Nihon Suido Consultants Co., Ltd, Tokyo, Japan, were dispatched to the Lao PDR and commenced its study work and the field investigations were completed in November 2003. At the end of the second field investigation, results of the study were agreed between the agencies concerned in Lao PDR and the Japanese side. Based on the agreements, the final report was prepared and submitted in January 2004.

The objectives of the Study are:

1. To prepare a long term master plan for the Vientiane water supply. Target year of the master plan is the year 2020; the target year for facility planning is 2015.
2. To conduct a feasibility study on the priority project(s) identified in the master plan
3. To pursue technology transfer to counterpart personnel throughout the course of the study.

The study covers the present and planned serviced areas of the "Master Plan: Vientiane Water Supply Development Project, November 1999" (hear in after referred to as the "NPVC Master Plan").

The Study was conducted in three phases as follows:

Phase I: Reconnaissance Survey
Phase II: Preparation of the Master Plan
Phase III: Feasibility Study on the Priority Project/s

This Volume III report is prepared to explain the results of the Phase III: Feasibility Study on the Priority Projects. Phase III was conducted during the second field investigation in Lao PDR from August to November in 2003 and the subsequent work from that phase was conducted in Japan from December 2003 to January 2004.

S.2 Framework of the Feasibility Study

The feasibility study is conducted focussing on the priority projects which were identified during the Master Plan. Taking into account the significance and urgency to solve problems which the NPVC and the people of Vientiane are encountering, the restoration work of the existing water supply system, the rehabilitation of the Kaolieo Treatment Plant and improvement of the Chinaimo Treatment Plant, and the expansion of the Kaolieo Treatment Plant and reforms to the transmission/distribution pipelines are selected as the priority projects. These projects are indispensable to improve the water supply conditions in Vientiane and are urgently required to meet increasing water demand. For the selection of the priority projects, the Lao PDR side and the JICA Study Team have mutually agreed on the projects and priorities and the scope of the priority projects are as follows.

- Rehabilitation of the existing Kaolieo Treatment Plant which has a production capacity of 20,000 m3/day

- Improvement of the Chinaimo Treatment Plant which has a production capacity of 80,000 m3/day. This includes:
    - Expansion of the reservoir (10,000 m3), including additional distribution pumping facilities
    - Installation of a new transmission pipeline from Chinaimo Treatment Plant to the existing transmission pipeline (separation of the transmission and distribution systems)
- Expansion of the Kaolieo Treatment Plant, to increase the capacity of 40,000 m3/day, so that the total capacity of the plant will become 60,000 m3/day
- Improvement of the Km6 BP Station
- Installation of 2.2 km of transmission mains
- Installation of 15.2 km of distribution mains

The target year of the feasibility study was set as 2007, the time of completion of the priority projects of the 1st stage of the project. The population, served population, and service ratio were estimated and calculated, as shown in Table S2-1.

Table S2-1 Population, Served Population, and Service Ratio

	Unit	2003	2004	2005	2006	2007
Capital City Population	People	651,850	669,467	687,084	707,300	727,516
Served Population	People	251,549	263,558	275,567	294,508	313,448
Service Ratio in Capital City	%	38.5%	39.3%	40.1%	41.5%	42.9%
Population in Service Area	People	347,235	363,789	380,342	404,221	428,100
Served Population	People	251,549	263,558	275,567	294,508	313,448
Service Ratio in Service Area	%	72.4%	72.4%	72.5%	72.8%	73.1%

The service area in the target year 2007 will cover the existing service area and the expanded service area by the AFD distribution pipeline project.

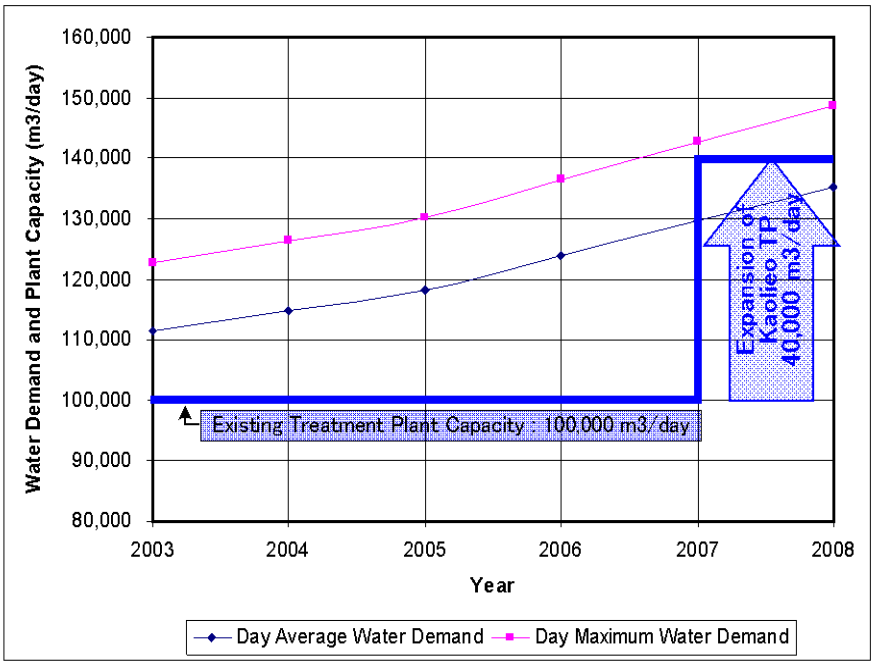
Based on the net water demand, the daily average water demand was calculated based on the estimated UFW ratio. The daily maximum water demand was calculated from the daily average water demand and the peak factor.

Table S2-2 Day Average and Day Maximum Water Demand

	Unit	2003	2004	2005	2006	2007
Total Net Water Demand	m3/day	78,251	81,714	85,177	90,133	95,089
UFW Ratio	%	30.0%	29.0%	28.0%	27.4%	26.8%
Daily Average Water Demand	m3/day	111,496	114,899	118,302	123,963	129,625
Daily Maximum Water Demand	m3/day	122,645	126,389	130,132	136,360	142,587

Based on the forecast water demand, the priority projects were planned. To meet the future daily maximum water demand in 2007, it was planned to expand the existing Kaolieo Treatment Plant to have an additional capacity of 40,000 m3/day, bringing the total supply capacity to 140,000 m3/day, upon completion of the priority projects as shown in Figure S2-1.

Figure S2-1 Water Demand and Supply Capacity



As shown in this figure, it is apparent that the existing supply capacity, 100,000 m3/day, is far smaller than the daily maximum water demand. To relieve or mitigate the water shortage situation in the very near future, it is strongly recommend to reduce the unaccounted-for water ratio (UFW), and initiate the promotion of water conservation and water demand management programmes.

S.3 Preliminary Design of the Priority Projects

Rehabilitation of Kaolieo Treatment Plant

The Kaolieo Treatment Plant which was constructed in 1964 with a production capacity of 20,000 m3/day and rehabilitated in 1983. It is the oldest plant in Vientiane, therefore deterioration of facilities and equipment has become a significant problem for the stable operation of the plant. Operators are struggling against such deterioration without sufficient spare parts under overloaded conditions to meet an increasing water demand. Therefore, in order to secure water supply to the existing service area from the Kaolieo Treatment Plant, it has been judged that the rehabilitation works for the Kaolieo Treatment Plant is indispensable and is selected as one of the priority projects.

The rehabilitation works of the existing Kaolieo Treatment Plant are as shown on Table S3-1.

Table S3-1 Rehabilitation Work of the Existing Kaolieo Treatment Plant

Name of Facility	Name of Component		Specifications
Intake Facilities	Intake Pump	Replace	7.65 m3/min×19.5 m×37 Kw×3 Units
			Check and Sluice Valves with Motorized Operation
	Butterfly Valve	Replace	D500mm with Motorized Operation for Flow Control
	Crane	Replace	Electric Hoist Crane
	Maintenance Bridge	Repair	
	Bank Protection	Improve.	River Bed and River Bank Protection: L=45 m
Raw Water Transmission Pipe	Flow Meter & Control Panel	Replace	Ultrasonic Flow Meter at Maintenance Bridge
			Flow Control Panel
Mixing Well	Flash Mixer	Replace	Repairing the Structure and Valves if necessary
Flocculation & Sedimentation Basins	Flocculation Basin	Replace	D400mm of Inlet Valves
			D250mm of Sludge Drain Valves
			Up and Down Flow Baffle Walls
	Sedimentation Basin	Improve.	Substitute Outlet Launders for Gravel Filter
		Replace	D150mm of Drain Valves
		Improve.	Pressurized Cleaning Piping System
		Repair	Structural Wall's Clacks
Filtration Facilities	Filter Media	Replace	Effective Size=0.6mm, Depth of Sand=0.70m
	Underdrain System	Improve.	Precast Concrete Perforated Lateral System
	Operating Valves for Filtration	Replace	Inlet & Outlet Valves with Motorized Operating Stand
		Replace	Motorized Drain, Backwash & Surface Wash Valves
		Replace	Flow Controller
	Surface Wash System	Improve.	Surface Wash Equip. and Flow Meter & Control Valves
	Backwash Pump	Replace	27.1 m3/min×55 Kw×2 Units
Clear Water Reservoir		Repair	Repairing the Structure and Valves if necessary
Distribution Facilities	Distribution Pump	Replace	6.3 m3/min×67 m×110 Kw×4 Units
		Replace	Check and Sluice Valves with Motorized Valves
		Replace	Vacuum Pump and Incidental Accessaries
	Hoist Crane	Replace	Electric Hoist Crane
	Distribution Pipe	Improve.	D450mm×65 m
Chemical Feeding Facilities	Chemical Building	New	Located in the Expanded Administration Building
	Feeding Equipment & Solution Tank	New	Aluminium Sulfate in the Chemical Building
		New	Polymer in the Chemical Building
		Replace	Calcium Hypochlorite at the Clear Water Reservoir

Name of Facility	Name of Component		Specifications
Electrical Facilities	Power Receiving Facility	Replace	Using the Expanded Power Receiving and Transformer Equipment
	Power Supply Facility	Replace	Intake Pump Control Panel
		Replace	Distribution Pump Control Panel
		New	Operation of Filtration Control Panel
		New	Central Supervising Panel
	Emergency Generator Facility		Located in the Expanded Generator Room
			Generator Capacity for 1/3 Distribution Pump Capacity
	Instrumentation Facility	New	CRT Supervising Equipment
		Replace	Intake Level Meter
		Replace	Raw Water Flow Meter (Ultrasonic Type)
		New	Filtered Water Flow Meter (Oriffice Type)
		Replace	Head Loss Meter
		Replace	Clear Water Reservoir Level Meter
		Replace	Pressure Meter of Distribution Line
		Repair	Distribution Flow Meter(Ultrasonic Type)
Administration Building			Using the Expanded Administration Building
Laboratory			In Preparation for Expanded Administration Building
Landscaping and Others			Site Preparation, Embankment, Roads, Lighting, etc.
			Including Demolision and Relocation of the existing housings

Improvement of Chinaimo Treatment Plant

The Chinaimo Treatment Plant was originally designed for water to be transmitted to elevated tanks and reservoirs throughout the town. Therefore, the total capacity of the pumps in the Chinaimo Treatment Plant is 80,000 m3/day, the same volume as the capacity of the plant. This means that the plant is not able to distribute water which has hourly fluctuations. Accordingly, the capacity of reservoirs is about 3,000 m3, equivalent to less than 1 hour of plant production capacity.

Although the plant was designed only for transmitting water to the elevated tanks and reservoirs, distribution lines are branched from the transmission pipeline to distribute water directly to the town. By the mixture of the distribution and transmission systems, the distribution system now cannot meet hourly fluctuations and the transmission system becomes unstable depending on the quantity of the volume of the distributed water. Given these conditions, it is considered that the separation of the transmission and distribution systems is indispensable to achieve a stable water supply. For this system separation, the major work items for the improvements to the existing Chinaimo Treatment Plant are summarised in Table S3-2.

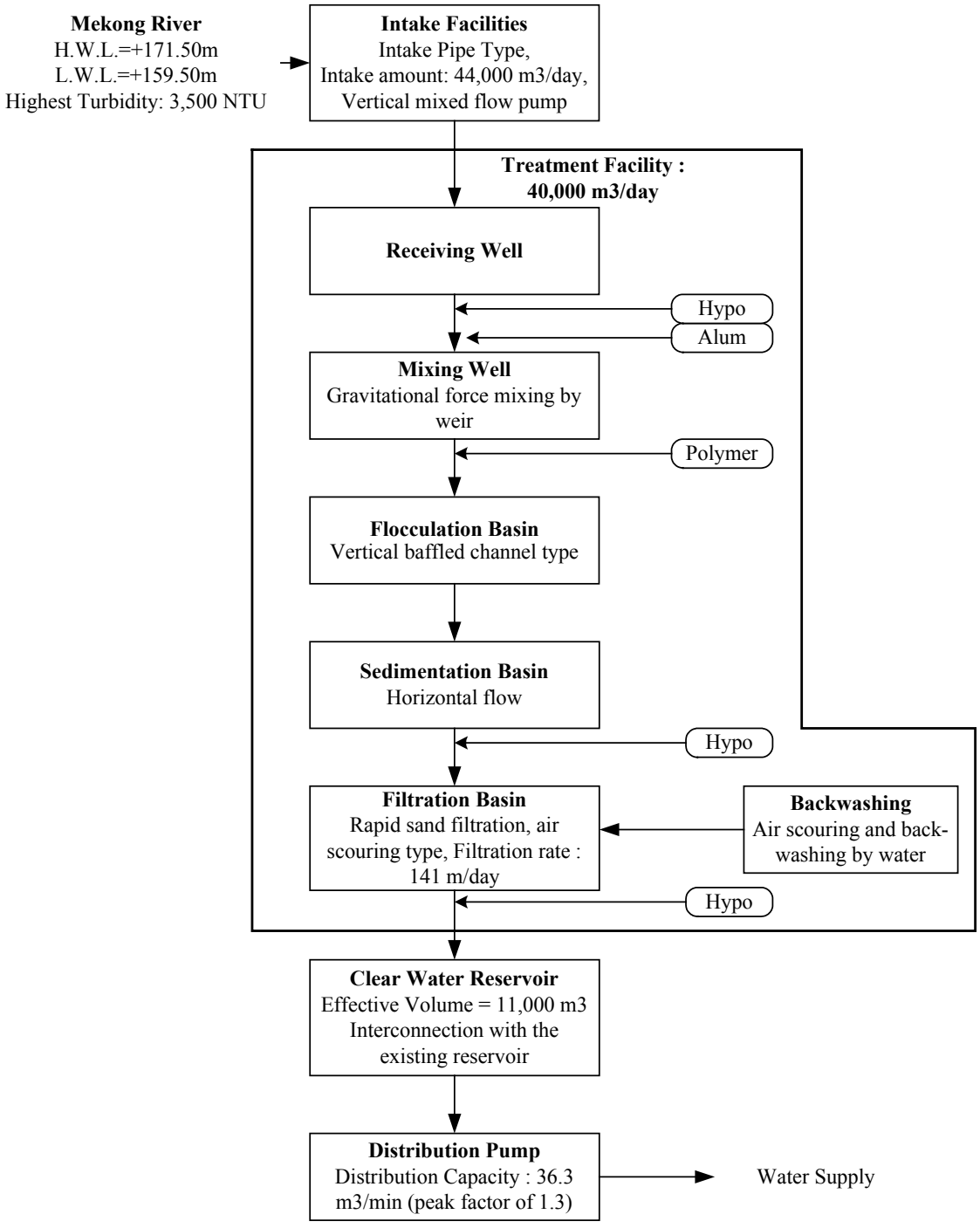
Table S3-2 Improvement Work of the Existing Chinaimo Treatment Plant

Name of Facility	Name of Component	Specifications
Clear Water Reservoir	Clear Water Reservoir	V=10,000 m3, Detention Time=6 hr
	Operating Valves and Piping	D1,100mm Butterfly Valves with Manual Operating Stand
		D800mm Butterfly Valves with Manual Operating Stand
		D1,100mm Inlet Pipe×50 m
Distribution Pumping Facilities	Distribution Pump Building	Area=250 m2 Beside the Clear Water Reservoir
	Distribution Pump	12.1 m3/min×67 m×195 Kw×4 Units
		Check and Sluice Valves with Motorized Valves
		Vacuum Pump and Incidental Accessaries
	Hoist Crane	Electric
	Operating Distribution Pipe	D700mm×76 m and D1,000mm×25 m
	Operating Valves	D700mm and D1,000mm Butterfly Valve
Electrical Facilities	Power Receiving Facility	Branch Power Source from the Existing Power Receiving and Transformer Equipment
	Power Supply Facility	Low Voltage Power Receiving Panel
		Distribution Pump Control Panel
		Supplementary Power Supply Panel
	Emergency Generator Facility	Generator Room with Fuel Tank
		Generator Capacity for 1/3 Distribution Pump Capacity
	Instrumentation Facility	Replacement the Existing Monitoring Panel
		Replacement of Ultrasonic Flow Meter for Thaduea
Landscaping and Others		Site Preparation, Embankment, Roads, Lighting, etc.

Expansion of Kaolieo Treatment Plant

The first stage expansion of the Vientiane Water Supply Development Project will be 40,000 m3/day to meet the daily maximum water demand in 2007. The expansion of the Kaolieo Treatment Plant includes intake facilities, treatment facilities with chemical feeding facilities, distribution facilities, electrical facilities and other miscellaneous works. Figure S3-1 shows the flow diagram of the treatment process for the proposed expansion works.

Figure S3-1 Proposed Treatment Process for Extension of Kaolieo Treatment Plant



The results of the preliminary design of the Kaolieo Treatment Plant are summarised in the Table S3-3.

Table S3-3 Expansion Work of the Existing Kaolieo Treatment Plant

Name of Facility	Name of Component	Specifications
Intake Facilities	Intake Structure	Construction of New Intake Pipe Type
	Bank Protection	River Bed and River Bank Protection: L=20 m
	Intake Pump	15.3 m3/min×18.5 m×70 Kw×3 Units
		Check & Sluice Valves with Motorized Operating Stand
	Inlet Pipes & Butterfly Valves	D1,000mm×3 Units with Manual Operating Stand
	Flashing Piping & Valves	D300mm with Manual Operating Stand
	Stop Valve for Discharge Main	D700mm Butterfly Valve with Manual Operating Stand
	Hoist Crane	Electric Crane with Associated Equipment
	Stop Log for Bottom Pipe	D1,000mm with Manual Operating Stand
Raw Water Transmission Pipe	Raw Water Transmission Main	D700mm×40 m
	Flow Meter & Flow Control Valve Chamber	Meter and Valve Chamber
		Ultrasonic Flow Meter
		Raw Water Flow Control Valve and Panel
Receiving Well & Mixing Well	Receiving Well	1 Basin, Detention Time=2.3 min
	Mixing Well	Gravity Type(Weir), 1 Basin, Detention Time=1.0 min
Flocculation & Sedimentation Basins	Flocculation Basin	Up and Flow Baffle Channel Type, 4 Basins
		Detention Time=23.7 min
		D300mm Sludge Valve with Manual Operating Stand
	Sedimentation Basin	Horizontal Flow Type with Outlet Launder, 4 Basin
		Detension Time=2.1 hr (Substantial D. Time=3.5 hr)
		D300mm Sludge Valve with Manual Operating Stand
		Pressurized Cleaning Piping System
Filtration Facilities	Filter Basin	Air-Scouring Type, Filter Area=49.35 m2/Basin
		6 Basin, Filtration Rate=148.6m/d
	Filter Media	Effective Size=1.0mm, Depth of Sand=1.0m
	Underdrain System	Pourous Concrete Type
	Rate of Backwashing and Air-scouring	Backwash Rate=0.40m3/min/m2,
		Air-scouring Rate=1.00m3/min/m2
	Oprerating Valves for Filtration	Inlet Gate with Motorized Operating Stand
		Motorized Outlet, Backwash & Air-scouring Valves
		Flow Controller (Volvoset)
	Backwash Pump & Air Blower	Backwash Pump:19.74 m3/min×30 Kw×2 Units
		Air Blower: 49.35 m3/min×45 Kw×2 Units
Measurement & Mixing Chamber	Flow Measurement Chamber	1 Basin, Detention Time=1.8 min
	Chlorine Mixing Chamber	Gravity Type (Weir), 1 Basin, Detention Time=0.7 min
Clear Water Reservoir	Clear Water Reservoir	V=10,000 m3 (11,000 m3), Detention Time=6 hr
	Operating Valves and Piping	D700mm Butterfly Valves with Manual Operating Stand
		D700mm Inlet Pipe & D600mm Connecting Pipe

Name of Facility	Name of Component	Specifications
Distribution Facilities	Distribution Pump Building	Area=300 m2 on the Clear Water Reservoir
	Distribution Pump	12.1 m3/min×67 m×195 Kw×4 Units
		Check and Sluice Valves with Motorized Valves
		Vacuum Pump and Incidental Accessaries
	Hoist Crane	Electric
	Flow Control Valve	Motorized Butterfly Valve
	Distribution Pipe	D700mm×80 m
Chemical Feeding Facilities	Chemical Building	Located in the Administration Building
	Feeding Equipment & Solution Tank	Aluminium Sulfate & Polymer in the Chemical Building
		Calcium Hypochlorite at the each Local Feeding Point
Electrical Facilities	Power Receiving Facility	Power Receiving and Transformer Equipment
	Power Supply Facility	Intake Pump Control Panel
		Distribution Pump Control Panel
		Operation of Filtration Control Panel
		Central Supervising Panel
	Emergency Generator Facility	Generator Room with Fuel Tank
		Generator Capacity for 1/3 Distribution Pump Capacity
	Instrumentation Facility	CRT Supervising Equipment Facility
		Intake Level Meter
		Raw Water Flow Meter (Ultrasonic Type)
		Filtered Water Flow Meter (Weir Type by Float)
		Filtered Head Loss Meter
		Clear Water Reservoir Level Meter
		Pressure Meter of Distribution Line
		Distribution Flow Meter (Ultrasonic Type)
Administration Building		A=200 m2×2F on the Clear Water Reservoir
Laboratory		Located in the Administration Building
		Water Quality Analysis Equipment and Reagent
Landscaping and Others		Site Preparation, Embankment, Roads, Lighting, etc.
		Including Demolition and Relocation of the existing housings

An additional water source will be required for the expansion of the existing Kaolieo Treatment Plant. The quantity of additional raw water required will be 44,000 m3/day, including 4,000 m3/day to cover the expected treatment losses which are unavoidable within the treatment process.

Based on the Water and Water Resources Law which was enforced in November 1996 by the Presidential Statement and Decree to Implement the Law on Water and Water Resources issued in October 2001 by the Prime Minister, the WASA, DHUP, MCTPC confirmed that the additional raw water source from the Mekong River would be secured by the MCTPC.

Improvement of Km 6 Booster Pumping Station

According to the network analysis, the improvement works for the Km6 Booster Pumping Station are outlined in Table S3-4. The transmission pumps for pumping the water directly to the Dongdok Reservoir, and the distribution pumps for distributing water to the northern area along the National Roads No.10 & No.13 will be installed for the booster pumping station at the existing site. An expansion of the pumping building will be necessary for the new transmission pumps. For the replacement of the distribution pumps, the existing pumping building can be utilised.

Table S3-4 Improvement Work of Km6 Booster Pumping Station

Name of Facility	Name of Component	Specifications
Pump Facilities	Pumping Building	Area=35 m2×B1×2F
	Transmission Pumps	4.8 m3/min×50 m×57 Kw×2 Units
		Check and Sluice Valves with Motorized Valves
	Distribution Pumps	6.0 m3/min×50 m×72 Kw×3 Units
		Check and Sluice Valves with Motorized Valves
Electrical Facilities	Power Receiving Facility	Power Receiving and Transformer Equipment
	Power Supply Facility	Distribution Pump Control Panel
		Transmission Pump Control Panel
	Emergency Generator Facility	Generator Room with Fuel Tank
		Generator Capacity for 1/3 Dist. & Trans. Pump Capacity
	Instrumentation	Pressure Meter of Distribution and Transmission Line
		Supervising Panel
Landscaping and Others		Site Preparation, Lighting, etc.

Improvement of Transmission and Distribution System

During the preparation of the master plan, the lengths of the proposed pipelines were estimated from drawings supplied by the NPVC. Based on the results of the field survey during the feasibility study, considering the results of detailed filed investigation and referring to the on-going projects, the length of the proposed pipelines estimated during the mater plan was altered, as shown in Table S3-5. For a network analysis of the 1st Stage Project, the pipeline lengths obtained from the survey shown on Table S3-5 were used. The distribution system was studied by AFD project and the minimum required distribution pipelines which were included in the 1st Stage Project is the minimum requirements for the pipeline to distribute water from the expanded Kaolieo Treatment Plant.

Table S3-5 Pipeline Length for Minimum Required Distribution and Transmission Pipelines

Dia (mm)	Minimum Required Distribution Pipeline (km)	Transmission Pipeline (km)
150	4.57	-
250	3.24	-
400	4.65	-
450	-	1.88
600	1.62	-
700	0.50	0.72
Total	14.58	2.60

The results of the analysis confirm that the average residual pressure at each junction will be maintained at more than zero in the situation where the minimum required distribution mains were installed at the same time as the expansion of treatment plant capacity and the development of the transmission system.

It is, however, noted that to install only the minimum required distribution mains is not the appropriate development of the distribution network system in 2007. Essentially, the most appropriate development should follow the master plan. A detailed study on the distribution network system will be conducted by the AFD study.

S.4 Water Conservation and Water Demand Management

In the master plan, augmentation of the water supply by improvement of the infrastructure is planned, and the priority projects are selected. However, it is projected that even the consecutive implementation of the projects could not satisfy the increasing demand in Vientiane Capital City due to multiple factors and variables such as, the growing population, expansion of served areas, the time lag between construction and supply, and so forth. Therefore, the problem of water availability shall be solved by using an appropriate mix of supply- and demand- side measures.

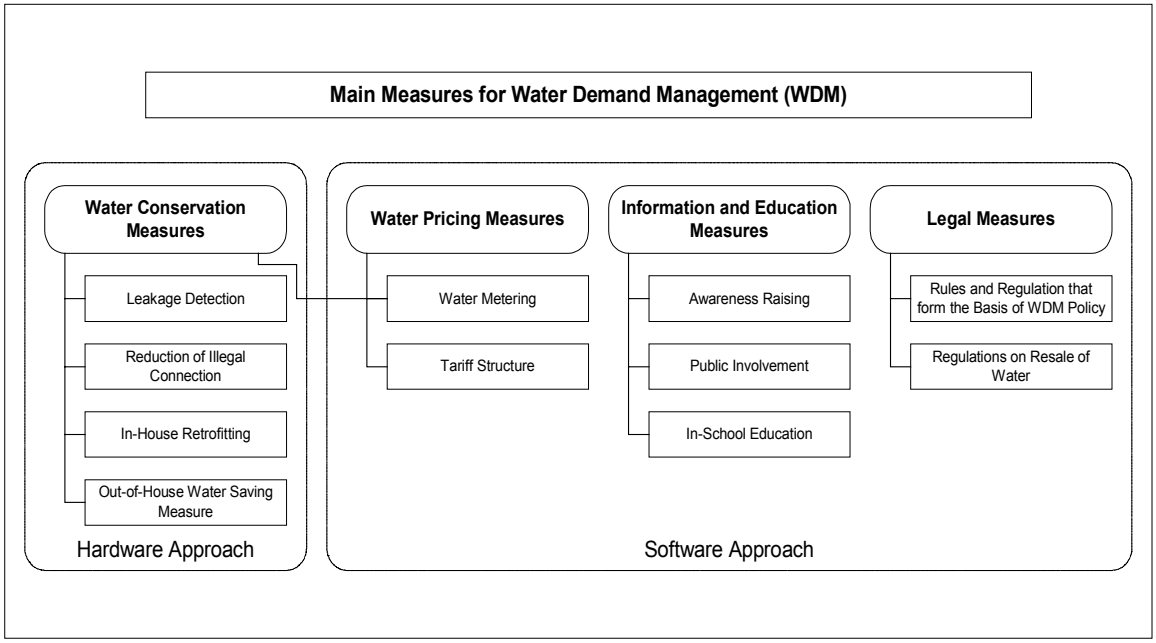
Attention must be devoted to managing the increasing demand for water, to achieve a sustainable long-term balance between water availability and water requirement in an equitable manner. Thus, water conservation and water demand management programmes should be given significance in the development of the water supply in Vientiane Capital City.

It has been demonstrated in many countries that saving water rather than the development of new

water sources is a more economical option. A comprehensive water demand management programme is therefore seen as the preferred alternative to meet the increasing water demand in Vientiane, and can be defined as a strategy to improve the efficiency and sustainable use of water resources, taking into economic, social, and environmental considerations.

A comprehensive program for water demand management includes software and hardware components. The major measure for demand control can be further divided into; 1) water conservation measures, 2) water pricing measures, 3) information and education measures, and 4) legal measures. These main measures involves several sub-measures or methods.

1. Water conservation measures includes; 1) leakage detection, 2) reduction of illegal connections, 3) in-house retrofitting, 4) out-of-house water saving measures.
2. Water pricing measures, which involve 1) water metering, 2) tariff structure.
3. Information and education measures, which includes 1) awareness raising, 2) public involvement, 3) in-school education.
4. Legal measures, which includes 1) rules and regulations that form the basis of the WDM policy, 2) regulations on the resale of water



The public water supply service will become viable and sustainable when mutual confidence and cooperation is increased between the service provider and consumers. This can be achieved by the service provider committing itself to an improvement in service quality, and consumers placing a

higher value on the services provided and utilizing the service in a responsible manner.

Having no specific customer service and public relations department, the NPVC is hindered in the attempts to improve customer services and public relations. Improvements to customer service and public relations are indispensable to increase public awareness of water issues, and to obtain the cooperation of customers in the water supply service, in particular when some crucial actions such as pricing measures and the campaign for water conservation and water demand control are taken. Disclosure of information by the NPVC through the media, and the publication of annual report, discussing factors such as financial status and how the revenue collected is utilized, is another measure to increase the transparency of the service provider, thus increasing users' awareness and cooperation. Mitigation of users' dissatisfactions and claims would also contribute to convincing consumers of the intentions of the NPVC.

It is repeatedly emphasized, however, that the improvement of public relations, of which information flows are often one sided from the service provider to consumers, alone can not increase user awareness and responsibility for the water supply service, without the provision of improved services, such as a swift response and action by the service provider for claims and suggestions by consumers. It can be said that mutual communication between the service provider and consumers ensures a level of mutual confidence and cooperation as mentioned previously.

S.5 Preliminary Cost Estimates for the 1st Stage Project

Results of the preliminary cost estimates are shown on Table S5-1.

Table S5-1 Project Costs for the 1st Stage (x 1,000US$)

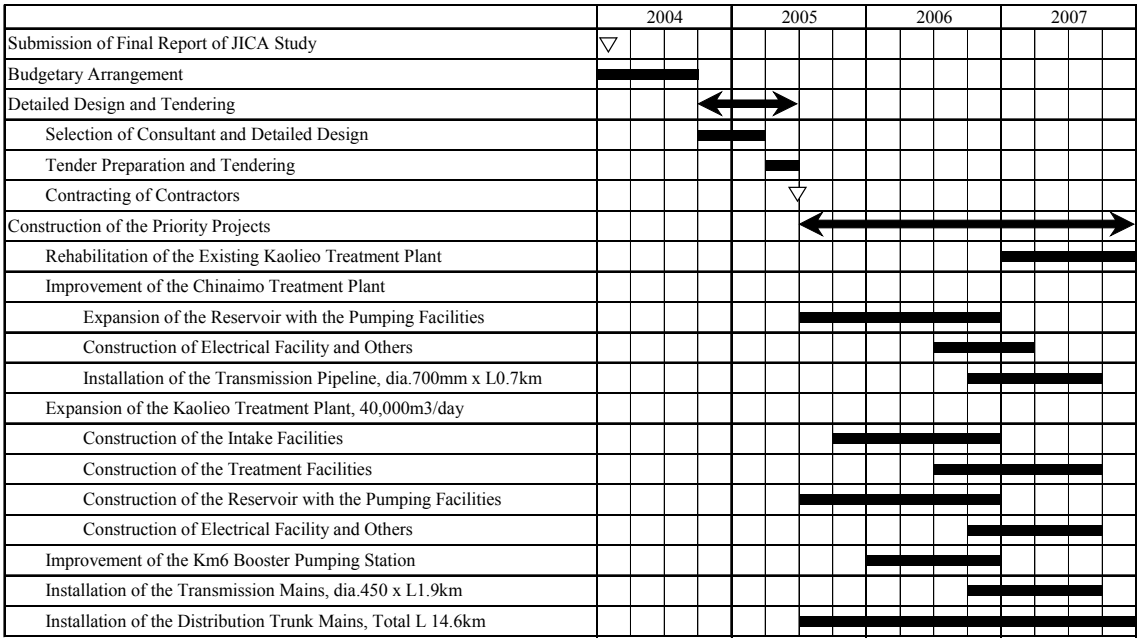
		Total	Foreign	Local
A. Priority Projects by JICA Study				
A1. Construction Cost		20,312	13,341	6,971
A1.1 Rehabilitation of Kaolieo T.P.		3,024	2,217	806
A1.2 Improvement of Chinaimo T.P.		2,433	1,428	1,004
Reservoir with Pumping Facilities		1,841	902	939
Electrical and Other Facilities		592	526	66
A1.3 Expansion of Kaolieo T.P.		9,625	5,723	3,902
Construction of Intake Facility		2,002	1,365	637
Construction of Treatment Facility		3,193	1,521	1,672
Construction of Distribution Facility		2,085	1,021	1,065
Electrical and Other Facilities		2,345	1,817	528
A1.4 Improvement of Km6 BP Station		736	634	102
A1.5 Installation of Transmission Mains		1,211	970	240
A1.6 Installation of Distribution Mains		3,285	2,369	916
A2. Consulting Services, D/D and S/V	7%	1,422	934	488
A3. Contingencies		4,637	3,064	1,573
A3.1 Physical Contingency = (1.+ 2.)×	(10)%	2,173	1,427	746
A3.2 Price Contingency = (1.+ 2. + 3.1)×rate$^{2004\sim}$	(3)%	2,463	1,637	827
A4. Administration Cost = (1.+ 2. +3.)×	5%	1,319	0	1,319
Total Project Costs for A = (1.+ 2. +3. +4.)		**27,689**	**17,339**	**10,350**
B. Other Projects				
B1. Construction Cost		5,711	4,107	1,604
B1.1 Installation of Distribution Mains		3,108	2,325	783
B1.2 Secondary & Tirtially Distribution Mains		606	510	96
B1.3 House Connection Installation		752	620	132
B1.4 Unaccounted-for Water Reduction		1,245	652	593
B2. Consulting Services, D/D and S/V	7%	400	287	112
B3. Contingencies		1,214	877	337
B3.1 Physical Contingency = (1.+ 2.)×	(10)%	611	439	172
B3.2 Price Contingency = (1.+ 2. + 3.1)×rate$^{2004\sim}$	(3)%	603	437	165
B4. Administration Cost = (1.+ 2. +3.)×	5%	366	0	366
Total Project Costs for B = (1.+ 2. +3. +4.)		**7,691**	**5,271**	**2,420**

S.6 Project Implementation Schedule

To satisfy the increasing water demand in the service area, the implementation of the priority projects should not be delayed from this proposed schedule, because the production capacity of 140,000 m3/day in 2007, after the completion of the 1st stage, will not meet the daily maximum water demand after 2007.

In order to complete the priority projects by the end of 2007, the projects should commence in the middle of 2005, taking into account the magnitude of the projects. The construction works for the priority project will take at least two and half years. It is therefore necessary to start the detailed design and tendering works from the end of 2004 following the budgetary arrangement.

Figure S6-1 Implementation Schedule of Priority Projects



S.7 Financial and Economic Analysis

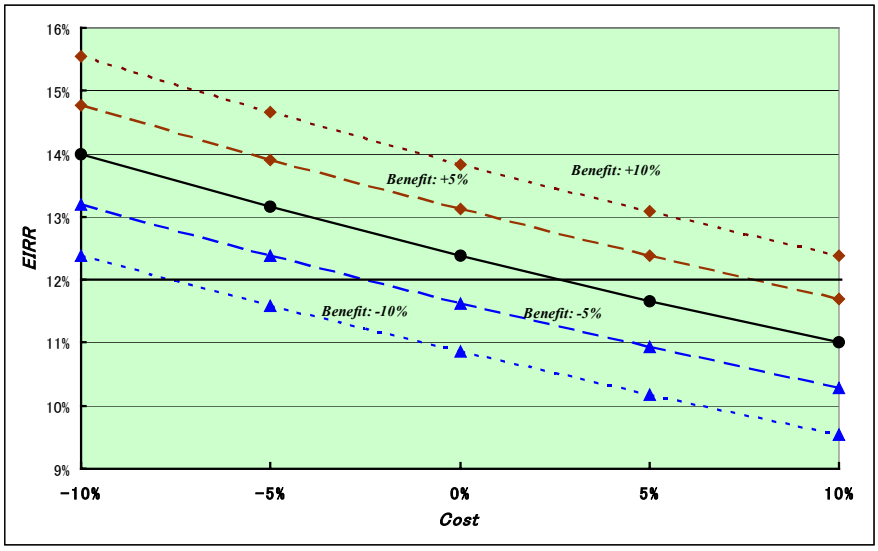
(1) Economic Evaluation

The evaluation indices of the 1st stage project are shown in the table below. Under the present socio-economic conditions, the indices were 8.1% for the EIRR, minus US$5.8million for NPV, and 0.77% for the B/C. Thus, the 1st stage project is deemed to be not feasible, because the EIRR is lower than the economic opportunity cost of capital (12%). With a projected increased economic growth in the future, however, the indices are calculated to be 12.4% for the EIRR, US$0.68 million for the NPV and 1.03% for the B/C. Given these different calculations, the project could then be feasible from an economic point of view.

Item	EIRR (%)	NPV* (US$ Million)	B/C*
Under Present Conditions	8.1	-5.84	0.77
With Economic Growth Conditions	12.4	0.68	1.03

Note: * Discounted at 12%.

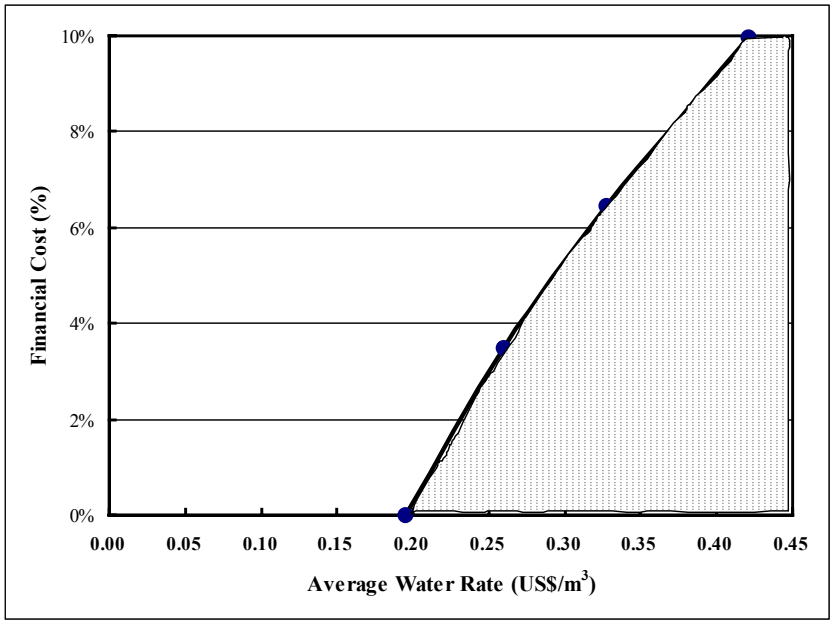
According to the sensitivity analysis, the allowance of the investment cost for project's feasibility was too small, as shown in the figure right. For instance, once the construction costs increases 5% more than the original estimate, the EIRR would be reduced to 11.7%, lower than 12%, the economic opportunity cost of the capital. At the implementation stage, thus, the investment and O&M costs should be estimated with prudence, taking particular account of cost over-runs.



(2) Financial Analysis

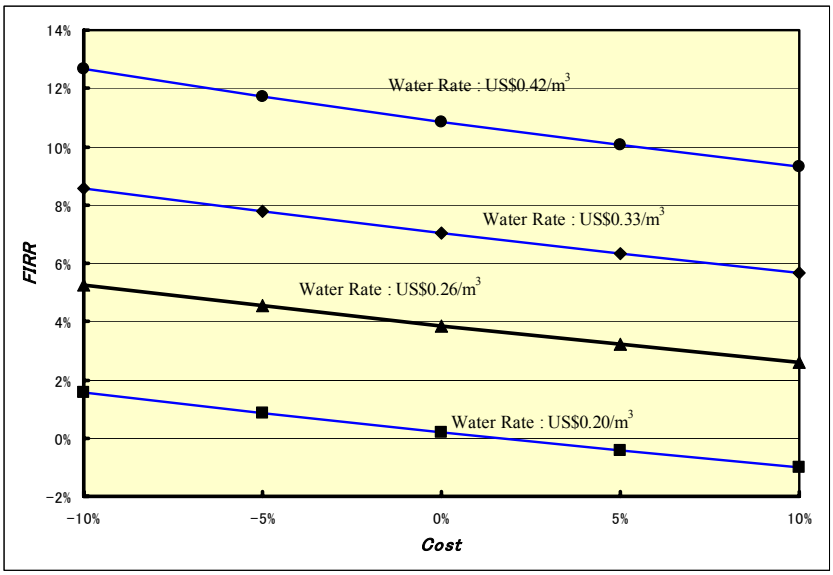
In the financial analysis, the evaluation indices of the 1st stage project were 0.12 of B/C and minus US$5.8 million of NPV, which were discounted at 12%. The FIRR was not calculated because the revenue from the beneficiaries is small compared with the investment and O&M costs. Based on

this result of the financial costs and revenues, the relationship between water tariffs and the financial costs were analysed and depicted to show the financially feasible positions in the graph below.



The area shaded in the graph indicates the effective combination of the financial costs and water charges. Through this analysis, the following case is considered as the most presumable condition from the viewpoint of the past performance of the NPVC. The financial source is to be procured at a financial cost of 3.5% per annum, and the water tariff is US$0.26/m^3 on average, corresponding to 5.2 times the present water rate. These financial costs were already applied in Chinaimo Expansion Project.

The FIRR indicates the marginal efficiency of the investment. In the case where water rates are US$0.26/m^3, the FIRR of the original cost estimate was 3.5%, as analysed above. Then, the project could have 3.5% of marginal efficiency for the investment, if it were managed in the most efficient conditions. In other words, the project could be viable from a financial point of view if the financial source providing an interest rate of less than 3.5% was procured for the execution of the project. According to the sensitivity analysis, however, if the cost increased to 10% more than the original estimate, the FIRR (marginal efficiency for investment) might



be reduced to 2.2%, as shown in the figure at right. Thus, the investment cost would directly influence the financial cost so all costs must be carefully reviewed at the design stage.

To recover the total input for the 1st stage project, the project entity is expected to manage its revenues and costs diligently throughout the project life. To attain a full cost recovery policy, the water tariff based on the Long Run Average Cost (LRAC) will be introduced at the beginning, or in the middle of the target year in case of approving of a raise of water tariff. Then, the initial tariff is to be raised over a prolonged period of time, relative to the LRAC. Finally, the management will strive to recover the total costs by the end of the project life. As a result, the projected cash flow of the project could cover the total amount of the loan within the project life, verified by the Loan Life Debt Service Coverage Ratio (LLCR) of 1.016.

There are some difficulties however for the management of the project operation. To attain the average water tariff of US$0.26/$m^3$ the management has to wait until 2020 because the water tariff originates from the present level because the tariff increases incrementally. Thus, the management has a large projected deficit for the first half of the project life. In the second half of the project then the NPVC has to cover these deficits by means of utilising the net profits. Finally, the debt service was covered by the end of the project life.

Regarding the water charge for domestic consumers, the ratio of the charge to household income is set to 1.1% of the household income at the beginning year. The ratio is 2.2% only even in the year 2037. This ratio could satisfy the beneficiaries of domestic users. The water tariff for non-domestic consumers could keep the same rate of two times higher than that of domestic consumers even in the year 2037.

Furthermore, the 1st stage project was analysed to find the necessary conditions for a financially sustainable management from the viewpoint of commercial financial viability. If the project was managed under sustainable financial conditions, the project would be able to stand alone. According to the results of the cash flow analysis, however, it would be very difficult to attain financially sustainable conditions within the project life. To reach these financially sustainable conditions, the management of the NPVC has to obtain 37% more revenue than that in the previous analysis result. The average water rate was calculated at US$0.37/$m^3$ at 2003 economic conditions, which was also 42% higher than the previous management case and 7.4 times more than the average water rate in 2003. Accordingly, as an immediate target, the management of the 1st stage project should aim for a policy of full cost recovery by the end of project life, instead of the financial sustainable management level.

S.8 Environmental Impact Assessment

The Initial Environmental Examination (IEE) and the Environmental Impact Assessment (EIA) were conducted as part of this study. Both the IEE and the EIA have been carefully evaluated for possible impacts on the environment which might be derived from the implementation of the priority projects. These evaluations indicated that the project can be implemented and maintained without adversely affecting the environment throughout the stages of construction and operation, with implementation of the recommended mitigation measures.

S.9 PROJECT EVALUATION

To secure sustainability of the water supply system as the sole source of water supply to people living in Vientiane, the JICA Study Team adopted the following as the basic engineering strategies for the planning and designing of the water supply infrastructure for the 1st Stage Project.

- Selection of an adequate intake facilities
- Use of a vertical mixed flow type intake pump
- Use of hydraulic energy for chemical mixing and flocculation, instead of adopting mechanical agitators and flocculators at water treatment works
- Adoption of horizontal flow sedimentation basins
- Use of air scouring type filtration basin
- Rehabilitation of the existing Kaolieo Treatment Plant
- Separation of the treated water transmission mains from that of distribution mains
- Adequate technology level

The 1st Stage Project was planned and designed through careful technical examination and the project does not require any new, advanced technology for its operation and maintenance.

In the economic evaluation, the 1st stage project was evaluated through the use of evaluation indices. With the projected economic growth in the future, however, the indices became 12.4% for the EIRR, US$0.68 million for the NPV, and 1.03 for the B/C. In these changed socio-economic conditions therefore, the project could be feasible from an economic point of view. However, the allowance of the investment cost for the project's feasibility border line was too small. For instance, once the construction costs increases to 5% more than the original estimate, the EIRR would go down to 11.7%, lower than the 12% threshold. At the implementation stage thus, the investment and O&M

costs should be estimated with prudence, taking into account any cost over-runs.

In the financial analysis, the FIRR was not calculated because the revenue from the beneficiaries is small compared with the investment and O&M costs. Based on these financial cost and revenue results, the relationship between water tariffs and the financial costs were analysed, and a feasible financial position was assessed. The financial source is to be procured at a financial cost of 3.5% per annum and the water tariff will need to be US$0.26/m^3, on average. This financial cost was already applied in the Chinaimo Expansion Project.

To recover the total input for the 1st stage project, the project entity is expected to manage its revenues and costs with care for the life of the project. The water tariff is based on the Long Run Average Cost (LRAC), to be introduced at latest in the middle of the target year. Then, the initial tariff will be raised over a prolonged period of time relative to the LRAC. Finally, the management of the NPVC should attain recovery of the total costs by the end of the project life. The LLCR was calculated at 1.016, so the project cash flow could cover the total amount of the loan within the project life

In the financial analysis, the average water tariff was proposed as US$0.26/m^3 for the 1st stage project. This is almost five times more than the present average tariff. To mitigate the financial burden to water users then, the tariff structure was designed to start at the present water tariff level and to raise the water tariff in accordance with a projected increase of household income in order to attain the full cost recovery policy.

Regarding the water charge for domestic consumers, the ratio of the charge to household income is set to 1.1% of the household income at the beginning year. The ratio is 2.2% only even in the year 2037. This ratio could satisfy the beneficiaries of domestic users. The water tariff for non-domestic consumers could keep the same rate of two times higher than that of domestic consumers even in the year 2037.

S.10 Conclusions and Recommendations

Conclusions

For the reasons outlined below, the proposed priority projects can be assessed as feasible.

Throughout the planning process of the water supply system improvement works for the 1st Stage

Project, continuous attention was paid by the JICA Study Team to ensure that any improvement works to be proposed can be implemented, operated and maintained within the level of technical skills and engineering capacity currently available in Vientiane and in Lao PDR. It is therefore expected that the priority projects can be implemented within the time frame envisaged, and that the project, once it has been implemented, can be managed on a sustainable basis.

The water resources available from the Mekong River required for the expansion of the exiting Kaolieo Treatment Plant has been confirmed as having the necessary quantity to meet the additional raw water requirement for the proposed Kaolieo Treatment Plant (44,000 m3/day including unavoidable losses within the plant).

The priority projects will increase the supply capacity of the NPVC water supply system from the present 100,000 m3/day to 140,000 m3/day. This drastic increase in supply capacity is expected to alleviate the chronic water shortage situation in Vientiane. The priority projects also includes the rehabilitation of the existing Kaolieo Treatment Plant to secure its function for several decades, and the improvement of the existing Chinaimo Treatment Plant to ensure stable water transmission and distribution to the whole service area including the Dongdok area where severe water shortages occurs. Additional transmission pipelines and distribution pipelines also will be installed under the priority project so as to distribute additional treated water from the expanded Kaolieo Treatment Plant.

Recommendations – Engineering Aspects

(1) Coordination with AFD Study

Unfortunately, because the procurement procedures of the AFD consultants to execute the study on the distribution system and household connections were delayed, the timing of the completion of the studies by the JICA and AFD are not coordinated. The AFD study concerning the distribution system will be continued until the middle of year, 2004. During the stages of the master plan and feasibility study by JICA, the JICA Study Team and the AFD consultant have exchanged information to maintain the consistency of these two studies. The feasibility study is to be completed by the time of submission of this report. The Lao PDR is recommended to coordinate with the AFD and AFD consultant about the AFD study conforming to the results of the JICA study.

(2) Coordination with the AFD Training Centre Project at Chinaimo Treatment Plant

Since the detailed design for the AFD Training Centre has not yet commenced, the NPVC could not confirm the exact location of the training centre in the Chinaimo Treatment plant premises. The Lao PDR is recommended to secure and reserve the land space required for the additional distribution

reservoir which will be constructed under the 1st Stage Project at the Chinaimo Treatment plant.

(3) Careful Consideration of River Bank Protection at the Intake of Kaolieo Treatment Plant

The type of the river bank protection will be decided during the detailed design of the project. It should be discussed among the MCTPC and DCTPC which have responsibility for the river bank protection of the Mekong River. It also recommended to refer the results and recommendations of the river bank protection project which is under implementation by JICA. The river bank protection project will provide a good example of the river bank protection near the Kaolieo Treatment Plant.

(4) Reduction of UFW

Upon improvement of water supply pressure, underground invisible leakages will become above ground, visible leakages. This will be a chance to find and repair current underground leakages. If the leakage repair work is not implemented by the NPVC, the ratio of UFW will increase rapidly from the pressure increase in the system. To implement the necessary actions against increasing leakages, it is recommended to do a budgetary arrangement and staff assignment for the leakage repair work.

At the completion of the 1st Stage of the project in 2007, the total production capacity of the system will be 140,000 m3/day, the same as the daily maximum water demand in 2007. This means that from the time of completion of the 1st Stage, production capacity will be less than the water demand until 2012, when the 2nd Stage of the project will be completed. Reduction of UFW and water conservation promotion, which is discussed below, will be a key factor for the alleviation of water shortages up to 2012.

For the reduction of UFW, the JICA will carry out a cooperative project for capacity building of NPVC employees. As part of the cooperation, a Japanese expert in UFW reduction will be assigned to the NPVC, and will be prove to be of great assistance for the future of the NPVC UFW reduction activities.

To prevent leakage, pressure control in the distribution system is indispensable. To conduct pressure control, the NPVC should know the pressure distribution in the service areas. It is recommended to establish fixed pressure monitoring points at the same places as the water quality monitoring points as described below, and pressures should be measured periodically. Based on the pressure records from these fixed monitoring points, valve adjustment should be conducted to avoid extreme high pressure and to stabilize pressure distribution in the service area.

The definition of unaccounted-for water (UFW) is difference between total distributed water quantity and total metered water quantity at customers' connections. Therefore, water quantity equivalent to unpaid water bill, which is not paid by customer, is not included in the UFW. Needless to say, the unpaid water quantity should also be reduced as reduction of the UFW.

(5) Monitoring water quality and quantity

Water quality should be analyzed at the respective treatment plants to decide the adequate chemical dosage rates and to supply safe water to customers. Water quality monitoring is recommended not only at the treatment plant, but also at service connections periodically selected within the service area. The NPVC is recommended to select several tens of fixed point for monitoring residual chlorine and other necessary water quality indices. These results should be disclosed to customers so as to raise the awareness of the safety of the distributed water.

(6) Adequate Operation and Maintenance

The role of coordination or management by a management level higher than technicians or workers, such as engineer level or manger level is very important. Furthermore, maintenance work seems to be conducted in an allopathic manner. However, equipment usually requires periodical maintenance, such as lubrication, in order to prevent malfunction. The engineering or managerial level staff should prepare periodical maintenance schedules with the required frequency, such as daily, monthly, and yearly for the necessary maintenance work.

(7) Recruiting and training of additional staff

Additional staff for the expanded Kaolieo Treatment Plant and the expanded pipeline system will be required. It is recommended to start arrangements for recruiting additional staff and provide training for them. The training program is presented in the previous chapter.

(8) Feasibility Study and Review of the Master Plan will be required

Upon completion of the 1st Stage, a feasibility study will be required for the 2nd Stage for its successful implementation. At the same time, a review of the master plan will also be required. The master plan is the long term plan, and the Vientiane water supply situation will change because of unforeseen factors. Therefore, the master plan should be reviewed at every turning point during the progress of the water supply development. After completion of the 1st Stage of the project, a feasibility study will be required to implement the 2nd Stage. During the feasibility study for the 2nd Sage, the scale of the 2nd Stage will be reviewed. If the situation is that the maximum water demand

is reduced by the promotion of water conservation, and the reduction of UFW is greater than estimated by the study, the scale of the 2nd Stage should be reviewed during the feasibility study for the 2nd Stage.

(9) Coordination with Road Improvement Project by the Japan's Grant Aid

The project for the improvement of the road passing through the centre of the city including the Luang Prabang Road in front of the Wattai International Airport is an ongoing project by Japan's Grant Aid. The priority project includes the installation of distribution mains for about 1.6 km along the Luang Prabang Road. If the implementation of the pipeline installation is after the road construction, the new road constructed by the Japan's Grant Aid should be demolished and restored. The construction works for the road improvement will start from 2004 and it will take about 2 years. Therefore, depending on the timing of each construction, and the coordination between the road project and this project, there is a possibility that the two projects could be constructed concurrently.

Recommendations – Institutional Aspects

The NPVC is required to achieve the targeted performances, and the achievements of these performances are the responsibility of the General Manager as the senior manager of the enterprise. To achieve the set performances requires a certain amount of autonomous status for the General Manager. According to Article 11 (Regulation of Enterprise, 1999), the Administrative Council (AC) shall supervise the GM, but not directly join to manage the daily operations of the GM, except if the GM is a member of the AC. The supervision of the GM by the AC includes orders in general, and this is not deemed to be a suitable method of business operations.

Considered from a view point of an efficiency oriented corporate management, reforms will be necessary, to be taken in various managerial phases. It is considered that one of the measures, PPP is worth studying as a reform which could be adopted.

The mission of a water supply utility is to supply safe and potable water to the inhabitants of the community, and not low quality water which one cannot drink without boiling. The supply of water which one cannot drink without boiling is unsatisfactory, compared with the stated mission of the water utility. A continuous effort and a large amount of investment will be necessary to improve such a situation. The production and sale of bottled water by the NPVC seems to weaken such an effort. It is considered that water quality is sufficient when it meets the guidelines of the WHO. It seems unnecessary to produce special quality water named Crystal, when the price is taken into account. It is considered that an effective alternative to bottled water is the improvement of the quality of tap water.

Recommendations – Water Conservation and Water Demand Management

In a situation of water shortages, the appropriateness and cost effectiveness of demand-side solutions must be considered and emphasized, along with supply-side augmentation options. Attention must be devoted to managing the increasing demand for water to achieve a sustainable long-term balance between water availability and water requirement in an equitable manner.

The proposed comprehensive program for water demand management includes four major measures with sub-measures as followed:

- Water conservation measures, which include 1) leakage detection, 2) reduction of illegal connections, 3) in-house retrofitting, 4) out-of-house water saving measures.
- Water pricing measures, which involve 1) water metering, 2) tariff structure.
- Information and education measures, which include 1) awareness raising, 2) public involvement, 3) in-school education.
- Legal measures, which include 1) rules and regulations that form the basis of WDM policy, 2) regulations on resale of water

Water pricing measures are one of the most effective measures for water demand control and water conservation, with the introduction of a progressive block tariff system, or increasing tariff system. Thus, it is recommended for the WASA/NPVC to formulate an appropriate tariff structure in an equitable manner which is sensitive to the needs of the poor, taking into consideration of any adverse effects. It is emphasized that the effectiveness of the measures is assured in combination with an extensive awareness raising campaign among consumers.

Awareness issues are important particularly when dealing with difficult decisions like the introduction of pricing measures (i.e. introduction of progressive tariff structure). As for any issue of public policy, the public is more likely to accept such a difficult decision if it is well aware of the commitment and efforts of the service provider to provide improved services in a cost effective way. The specific needs and opportunities are identified, through the study, for an increase of public awareness in the following areas.

- The NPVC's commitment to the management, operation and maintenance of the public water supply service
- User-Pay-Principle in the management, operation and maintenance of public water supply service

- The NPVC's efforts to provide safe water (improved water quality)
- The understanding of water as a common and vital necessity of life, but a necessity with limited resources

Public education is certainly one of the most important instruments for achieving a successful campaign for water conservation and water demand management.

It is realized that some government institutions categorized as non-domestic users, distribute large quantities of water provided for staff accommodation in their residential areas, while accumulating large amounts of water bills and are well into arrears. It is also assumed that officers and staff in those government residential areas are not water-saving consciousness consumers since many government institutions have a policy to subsidize the employee's water bills. Thus, re-classification of domestic and non-domestic use in government organizations is an important reform, and water use in their residential areas and accommodation should be regarded as domestic use. These measures are to be followed by the introduction of an individual meter reading and billing system, whether or not those bills are subsidized by those government institutions. The regular procedures for non-payment of bills, such as disconnection, shall be taken for those residences if an unacceptable level of arrears are observed, which can also have the effect as pressure for the government organizations to pay the bills where they have a subsidizing policy.

Having no specific section for customer service and public relations, the NPVC is hindered in its attempts to increase users' awareness and cooperation in the public water supply service. The public water supply service will become viable and sustainable when mutual confidences and cooperation is increased between the service provider and consumers.

Improvement of customer service and public relations become are indispensable to increase the awareness and cooperation of users in the water supply service, in particular, when some crucial decisions are taken, such as the introduction of pricing measures and a campaign for water conservation and water demand management. Disclosure of information by media, and the publication of annual reports, such as financial status and how the revenue collected is utilized, is another measure to increase the transparency of the service provider, thus increasing users' awareness and cooperation.

Recommendations – Financial Aspects

The NPVC has to make all members in the company have full cost recovery as a common characteristic. It will be hard for the NPVC to attain full cost recovery for the 1st stage project by the

end of the project life. Therefore, all members of the NPVC have to have a correct understanding of the cost recovery process, and to carry out their duties to realize the target of full cost recovery. Every section of the NPVC needs to perform the recommended financial procedures extracted from the financial analysis for full cost recovery of the project.

Raising the water tariff for every water consumer is indispensable for the success of the 1st stage project. The tariff structure was designed to start at the present water tariff level and to then raise the water tariff in accordance with the projected increase in household income in order to attain the goals of the policy of full cost recovery. For pursuance of this policy, financial incentives are essential to ensure the participation in the 1st stage project of all stakeholders concerned in the project, and to understand each other.

Recommendations – Environmental Aspects

Even though the forecasted environmental impacts by the implementation or operation of the priority projects are very limited or only during the short period, it is recommended to implement mitigation measures which are descried in this report.

Recommendations - Project Implementation

The water shortage situation in Vientiane is in a state where it is expected that it will worsen every year. Therefore, it is strongly recommended to implement the priority projects as recommended in the Feasibility Study. The Lao PDR side is recommended to initiate budgetary arrangements to finance the project implementation.

For the implementation of the projects, it is recommended to establish a Project Implementation Unit (PIU), which will consist of representatives from the WASA, DHUP, MCTPC, NPVC and DCTPC.