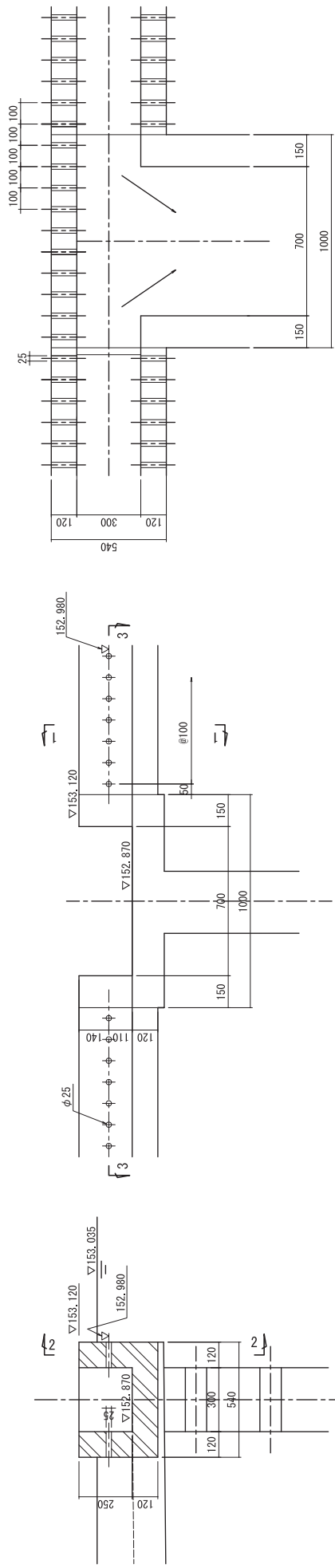


① - ① section
Scale=1/100



1 - 1
Scale=1/20

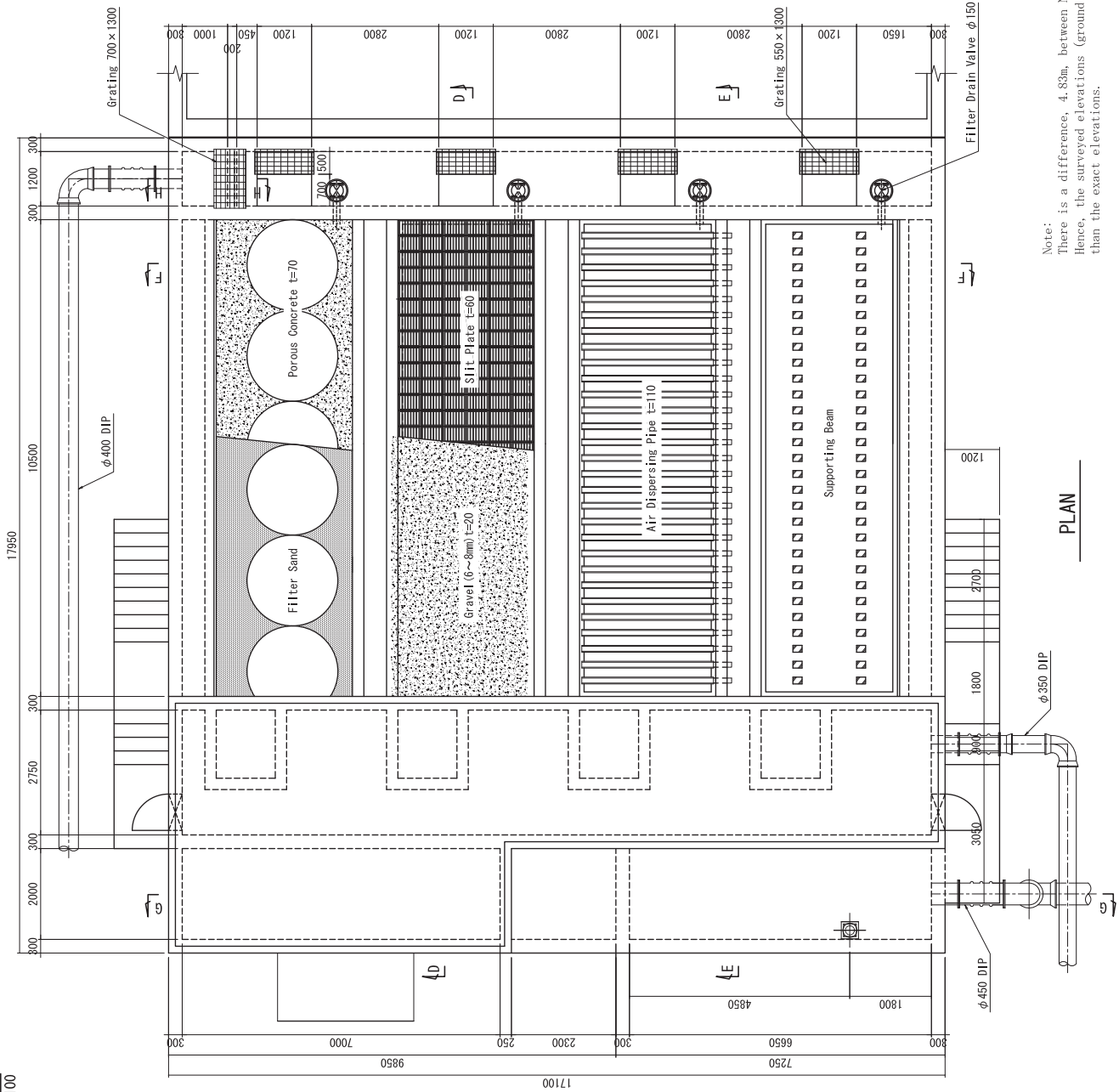
2 - 2
Scale=1/20

3 - 3
Scale=1/20

Note:
There is a difference, 4.83m, between National BM and Original BM obtained from NPKMM.
Hence, the surveyed elevations (ground levels) shown in the drawing are 4.83m higher
than the exact elevations.

PROJECT	DESCRIPTION	Preparatory Survey on Thakhek Water Supply Development Project in Khammouane Province in Lao People's Democratic Republic	
		NSC	NIHON SUJIDO CONSULTANTS CO., LTD.
APPROVE BY	DATE	APPROVE BY	DATE
PREPARED BY	DATE	PREPARED BY	DATE
DRAWING No	C.S	DRAWING No	C.S
SCALE	1:100	SCALE	1:100

RAPID SAND FILTER
Structure (1/4) Scale=1/100

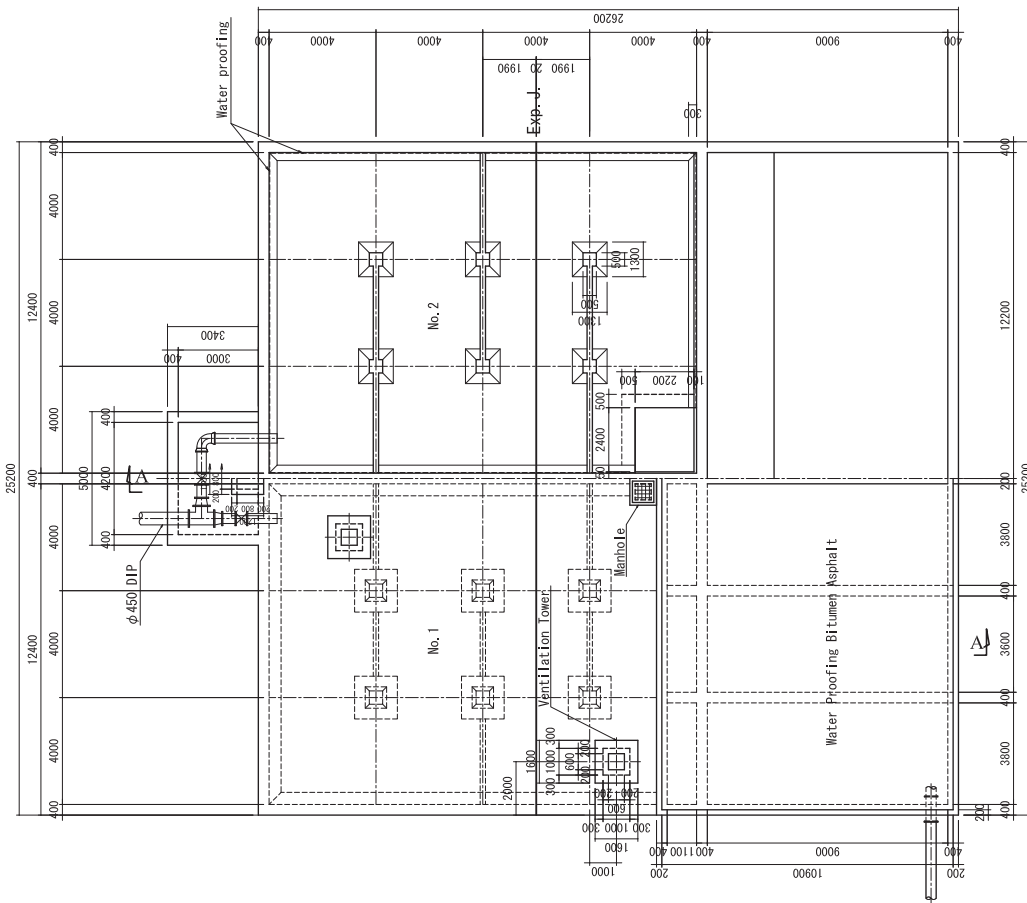


Note:
There is a difference, 4.83m, between National BM and Original BM obtained from NPKM.
Hence, the surveyed elevations (ground levels) shown in the drawing are 4.83m higher
than the exact elevations.

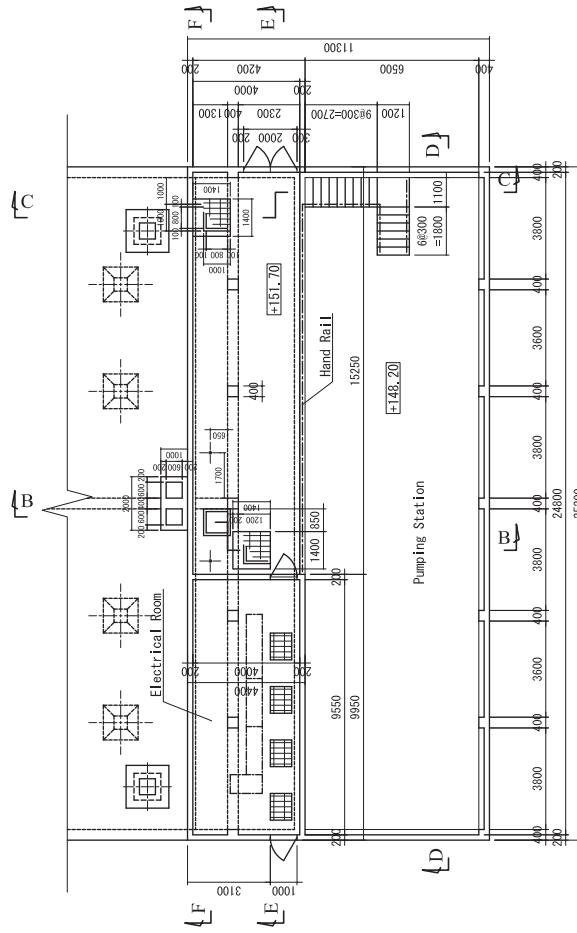
PLAN

PROJECT	Preparatory Survey on Thakhek Water Supply Development Project in Khammoutane Province in Lao People's Democratic Republic	DESCRIPTION	Filtration(1)
	APPROVE BY	DATE	DRAWING No C6
	PREPARED BY	DATE	SCALE 1:100
	NSC NIHON SUJIDO CONSULTANTS CO., LTD.		

Clear Water Reservoir
Structure (1/5) Scale=1/200



PLAN, G-G Section

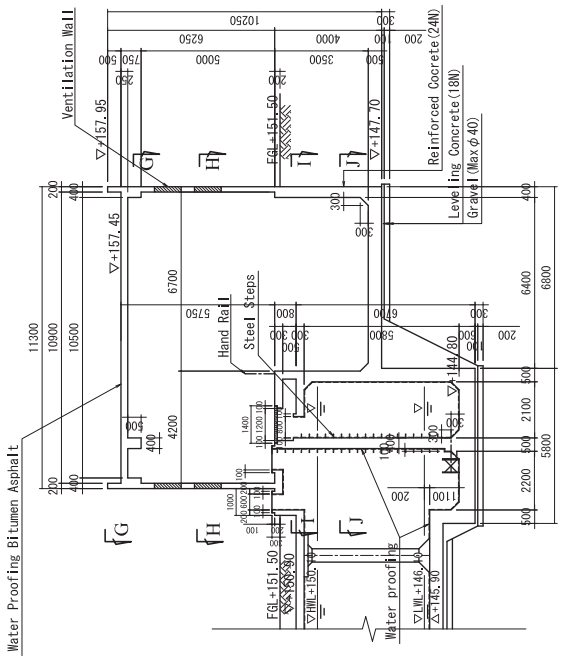


H-H Section

Note:
There is a difference, 4.83m, between National BM and Original BM obtained from NPKMM.
Hence, the surveyed elevations (ground levels) shown in the drawing are 4.83m higher
than the exact elevations.

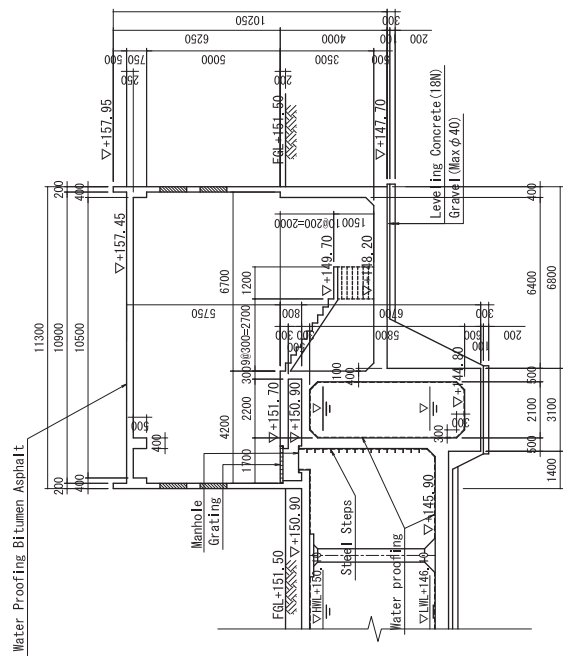
PROJECT	Preparatory Survey on Thakhek Water Supply Development Project in Khammouane Province in Lao People's Democratic Republic	DESCRIPTION	Clear Water Reservoir(1)
NSC	NIHON SUIDO CONSULTANTS CO., LTD.	APPROVE BY	DATE
NSC	NIHON SUIDO CONSULTANTS CO., LTD.	PREPARED BY	DATE
NSC	NIHON SUIDO CONSULTANTS CO., LTD.	DRAWING No	CS
NSC	NIHON SUIDO CONSULTANTS CO., LTD.	SCALE	1:200

Clear Water Reservoir Structure (3/5) Scale=1/200



A-A Section

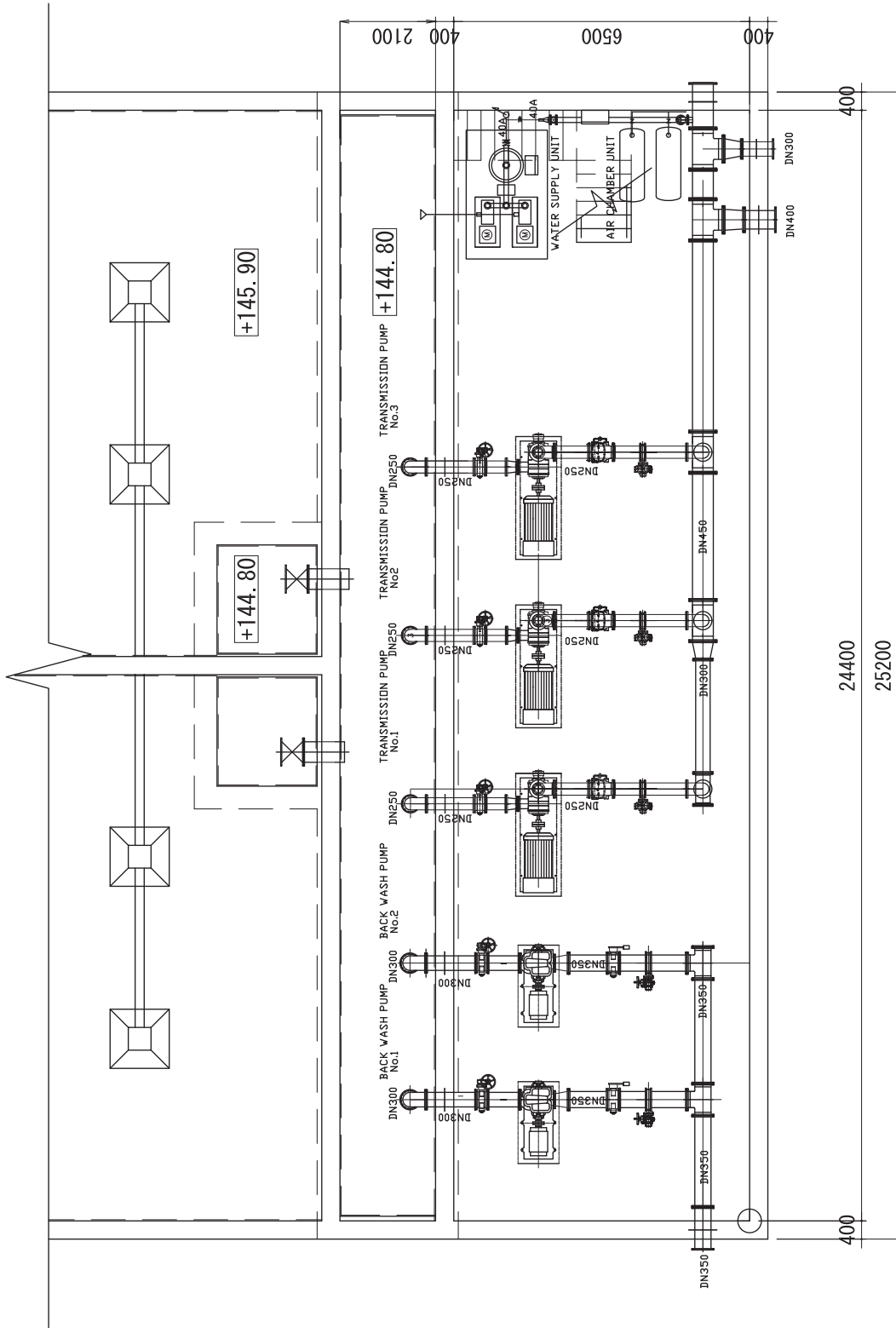
B-B Section



C-C Section

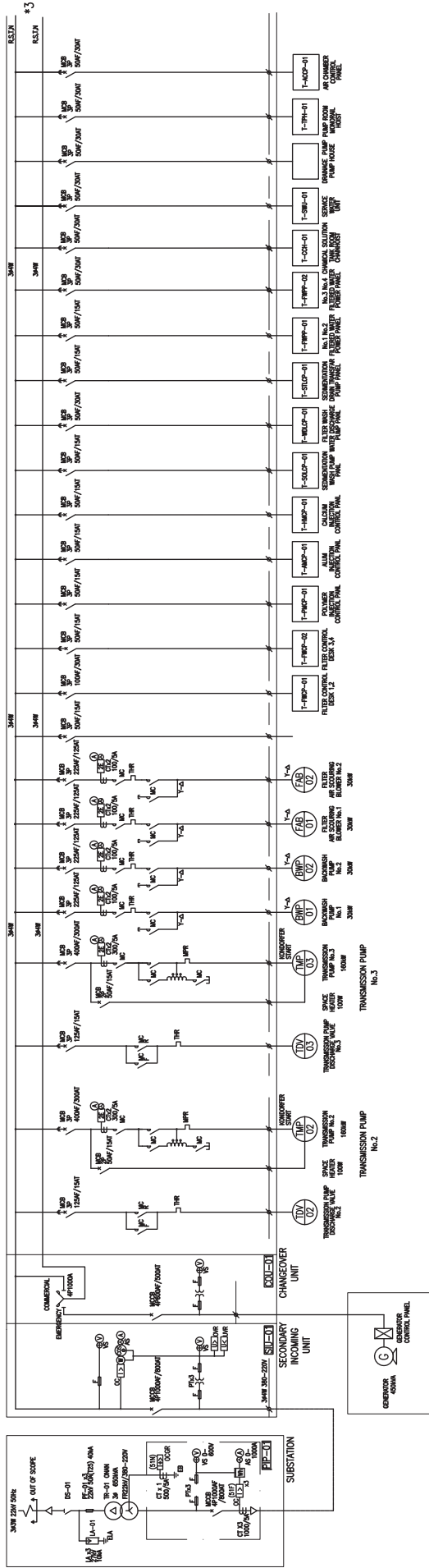
Note:
There is a difference, 4.83m, between National BM and Original BM obtained from NPMN.
Hence, the surveyed elevations (ground levels) shown in the drawing are 4.83m higher
than the exact elevations.

PROJECT	DESCRIPTION	APPROVE BY	DATE	DRAWING No
		PREPARED BY	DATE	C9
Preparatory Survey on Thakhek Water Supply Development Project in Khammouane Province in Lao People's Democratic Republic		NSC	NIHON SUIDO CONSULTANTS CO., LTD.	SCALE 1:200

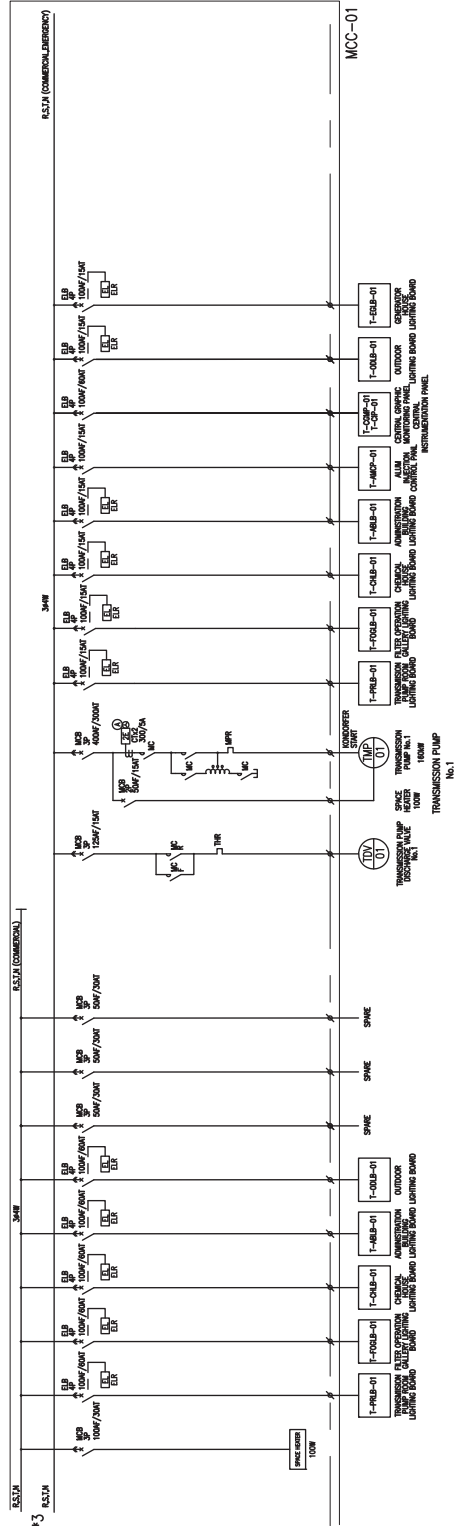


PROJECT	DESCRIPTION	APPROVED BY :	DATE :	DRAWING NO. :
			DATE :	C-10
Preparatory Survey on Thakhek Water Supply Development Project in Khammouane Province in Lao People's Democratic Republic	Transmission Pump	NSC NIHON SUIDO CONSULTANTS CO., LTD.	DATE :	SCALE :
			DATE :	S=1:100

COMMERCIAL SOURCE



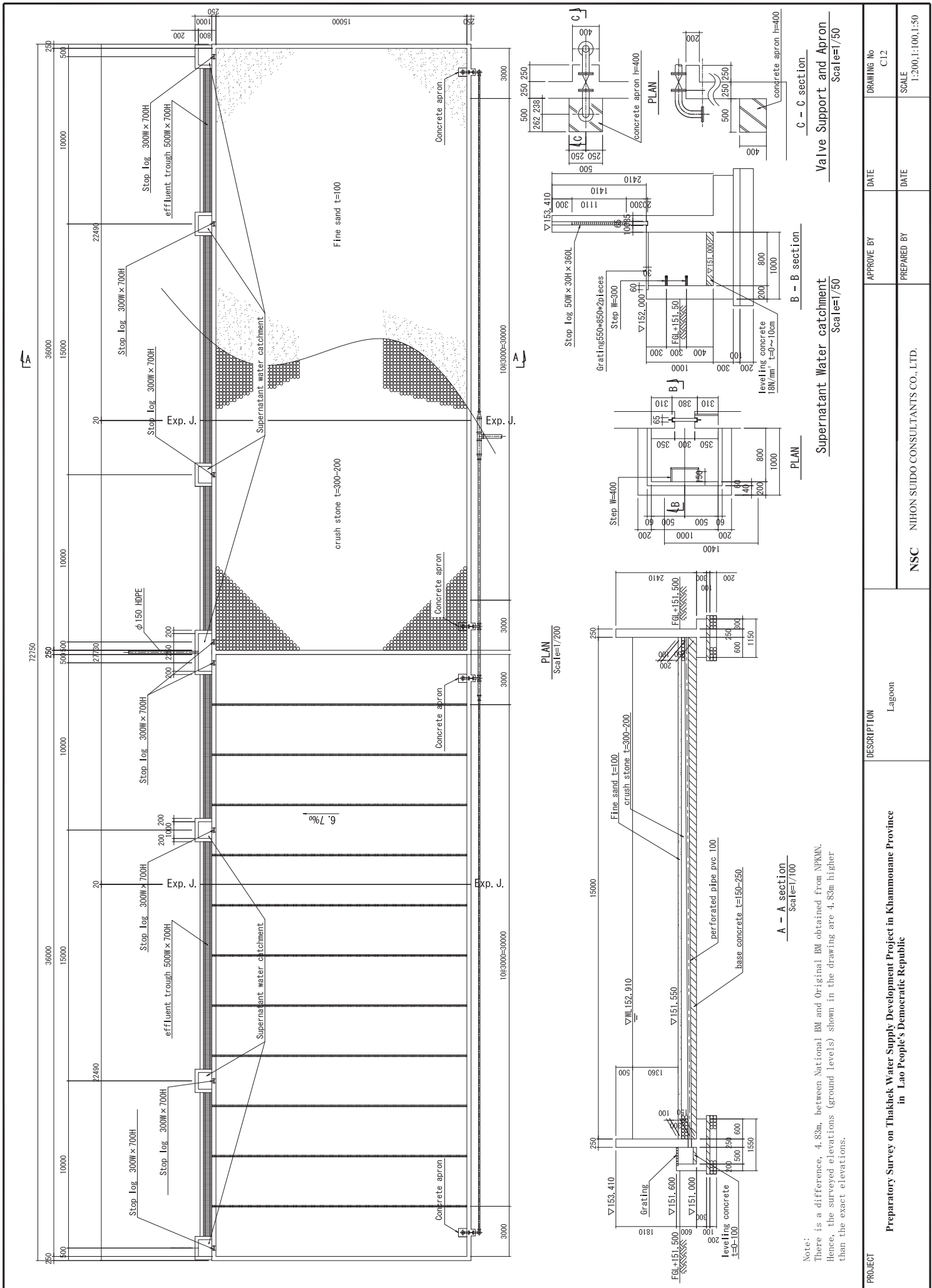
COMMERCIAL EMERGENCY SOURCE



(EMERGENCY SOURCE)

TREATMENT PLANT PANEL SINGLE LINE DIAGRAM

PROJECT	Preparatory Survey on Thakhek Water Supply Development Project in Khammouane Province in Lao People's Democratic Republic	DESCRIPTION	JICA JAPAN INTERNATIONAL COOPERATION AGENCY		APPROVED BY :	NONE	DATE :	NONE	DRAWING NO. :	C-11
			NSC NIHON SUIDO CONSULTANTS CO., LTD.		PREPARED BY :	NONE	DATE :	2012/10	SCALE :	NONE



PROJECT	DESCRIPTION	APPROVE BY	DATE	DRAWING No
Preparatory Survey on Thakhek Water Supply Development Project in Khammouane Province in Lao People's Democratic Republic	Lagoon			C12
		NSC	NIHON SUIDO CONSULTANTS CO., LTD.	SCALE 1:200, 1:100, 1:50

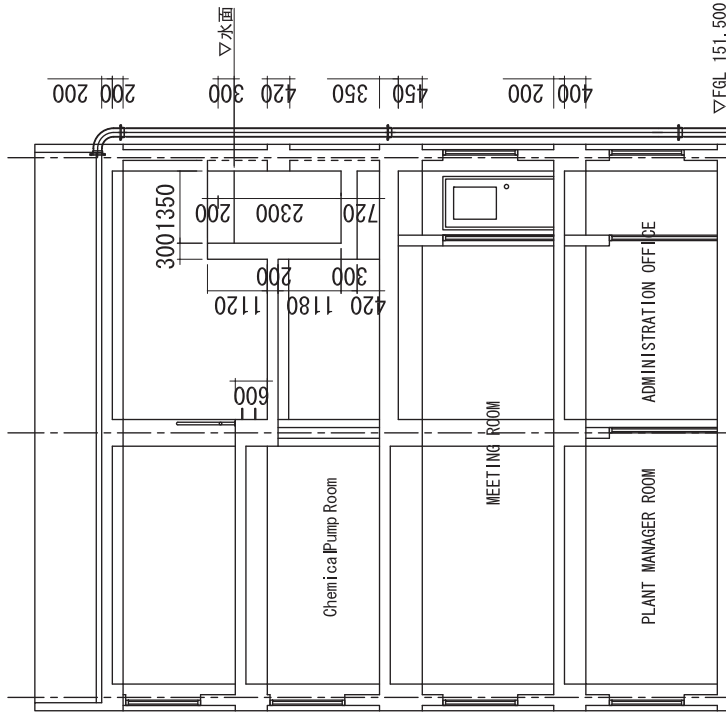
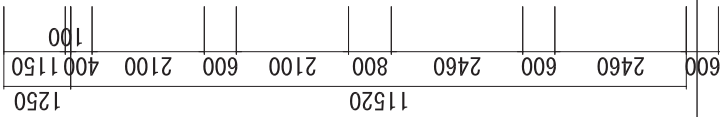
300 4650 300 200



Leveling Concrete
t: 100 mm
Crush Stone
t: 200 mm

(A) (B) (C)

SECTION B-B



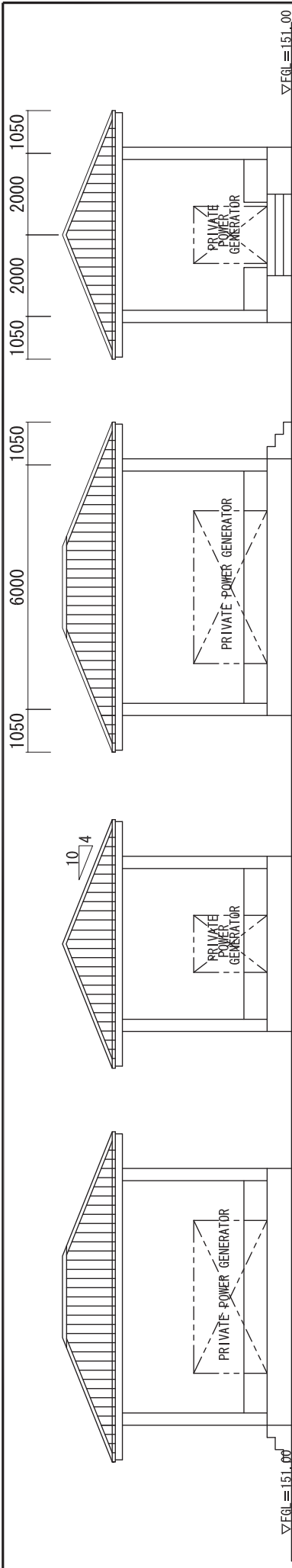
Leveling Concrete
t: 100 mm
Crush Stone
t: 200 mm

(A) (B) (C)

SECTION C-C

Note:
There is a difference, 4.83m, between National BM and Original BM obtained from NPKM.
Hence, the surveyed elevations (ground levels) shown in the drawing are 4.83m higher
than the exact elevations.

PROJECT	DESCRIPTION	Administration Building(2)	
		Preparatory Survey on Thakhek Water Supply Development Project in Khammouane Province in Lao People's Democratic Republic	
NSC	NIHON SUIDO CONSULTANTS CO., LTD.	APPROVE BY	DATE
		PREPARED BY	DATE
		DRAWING No	C14
		SCALE	1:100

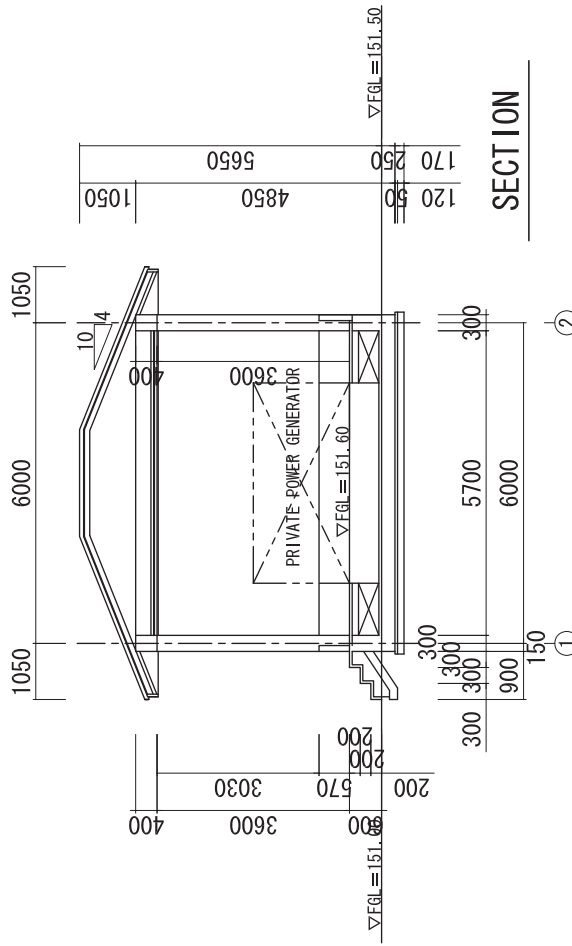


ELEVATION (1)

ELEVATION (2)

ELEVATION (3)

ELEVATION (4)

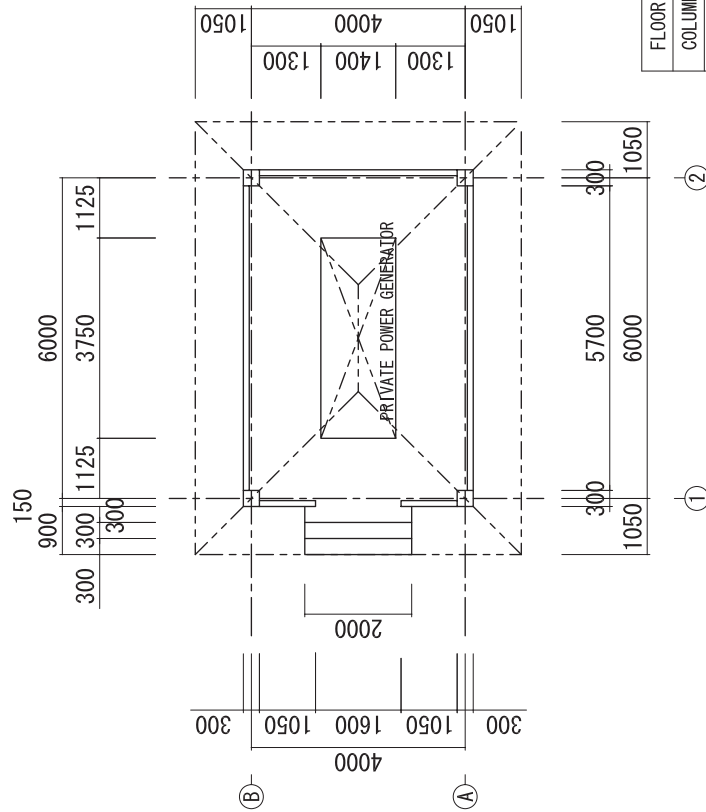


INTERIOR FINISH

FLOOR	STEEL TROWEL FINISH FLOOR CONCRETE
COLUMN & GIRDER	EMULSION PAINT ON EXPOSED CONCRETE
WAINSCOT	EMULSION PAINT ON CEMENT MORTAR
CEILING	EMULSION PAINT ON CALCIUM SILICATE BOARD

EXTERIOR FINISH

ROOF	PANTILE ROOFING
COLUMN & GIRDER	EMULSION PAINT ON EXPOSED CONCRETE
WAINSCOT	EMULSION PAINT ON CEMENT MORTAR



PLAN

Note:
There is a difference, 4.83m, between National BM and Original BM obtained from NPKM.
Hence, the surveyed elevations (ground levels) shown in the drawing are 4.83m higher
than the exact elevations.

PROJECT

Preparatory Survey on Thakhek Water Supply Development Project in Khammouane Province
in Lao People's Democratic Republic

DESCRIPTION

Generator Plan

APPROVE BY

DATE

DRAWING No

C15

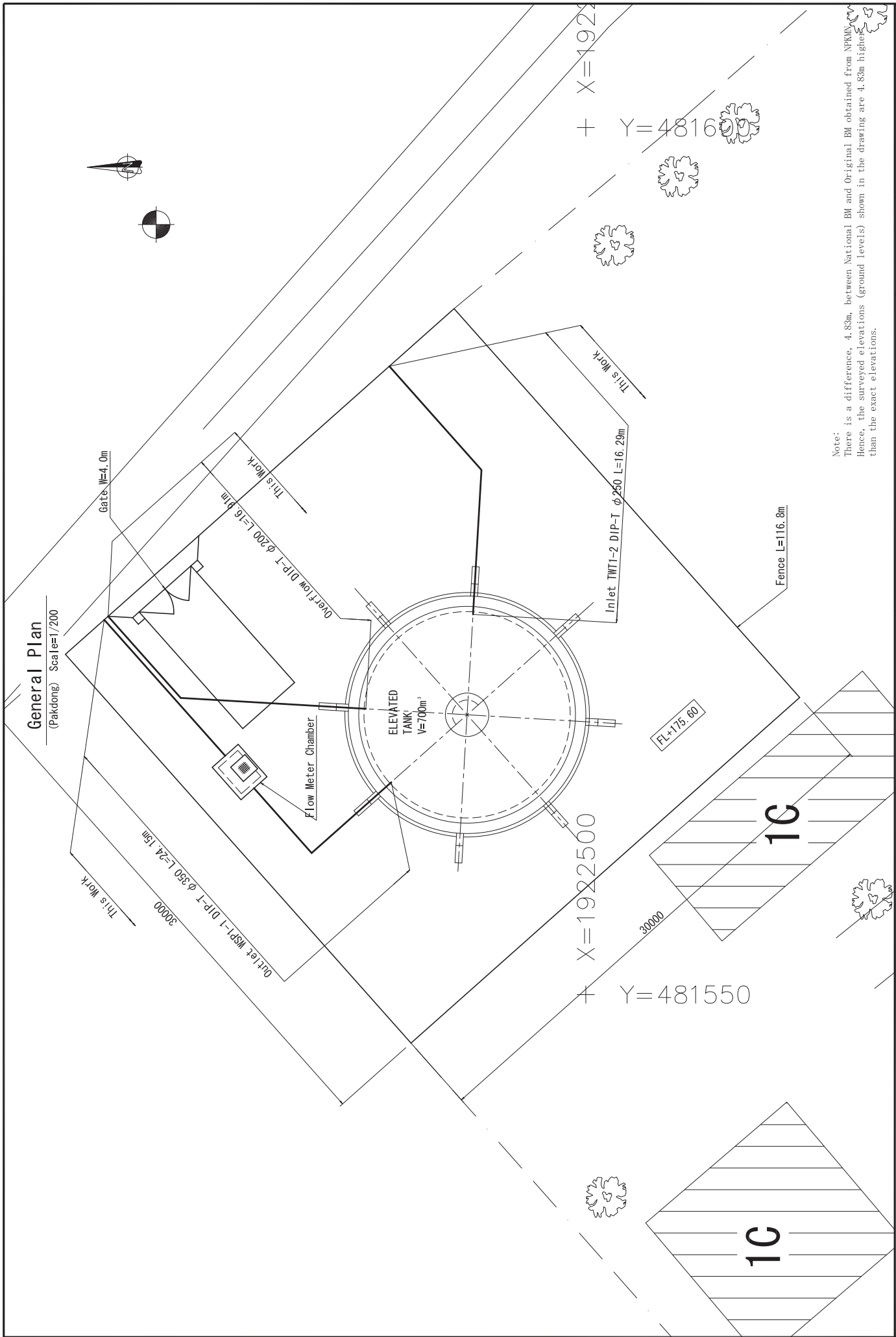
PREPARED BY

DATE

SCALE

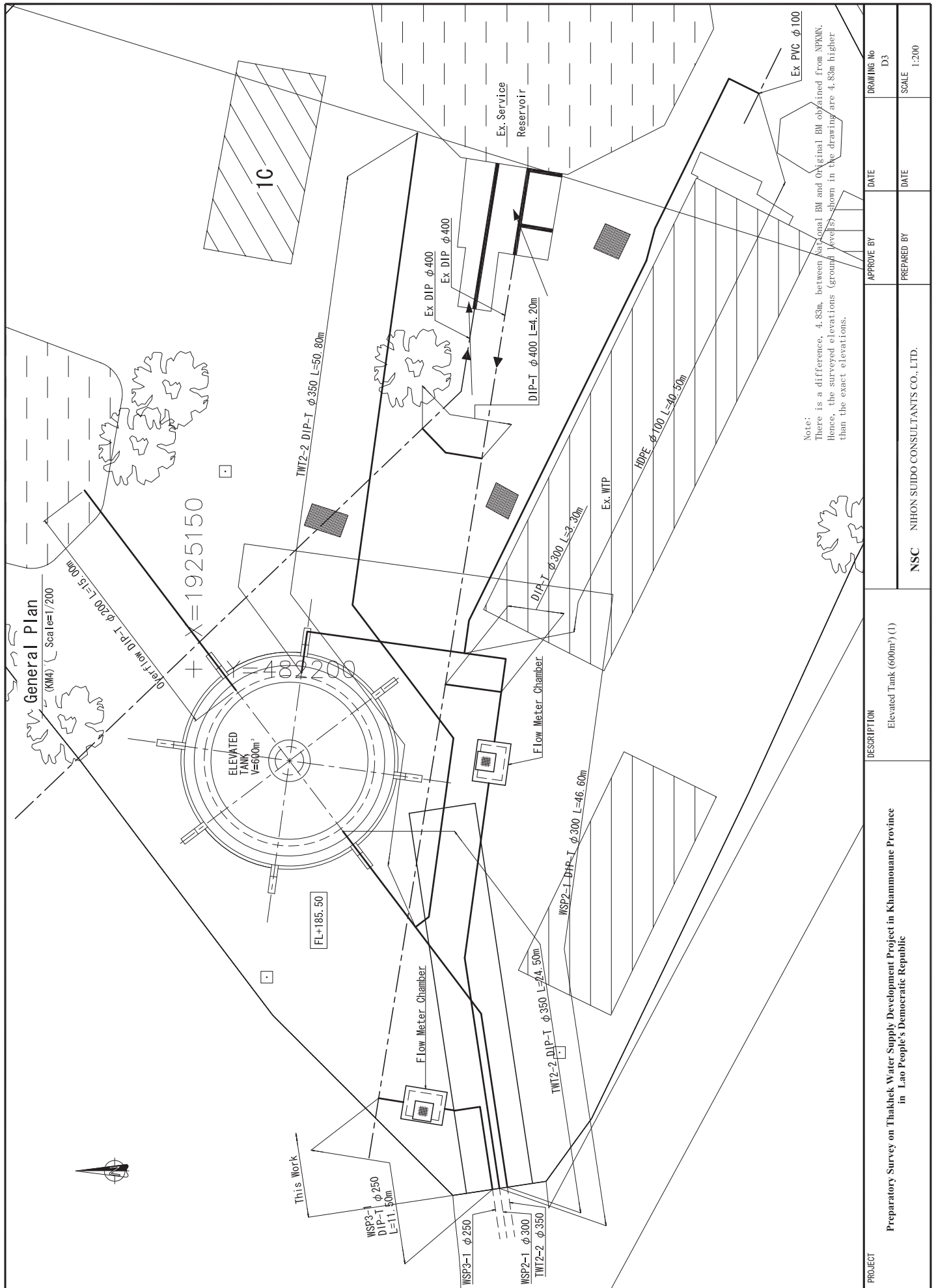
1:100

NSC NIHON SUJIDO CONSULTANTS CO., LTD.



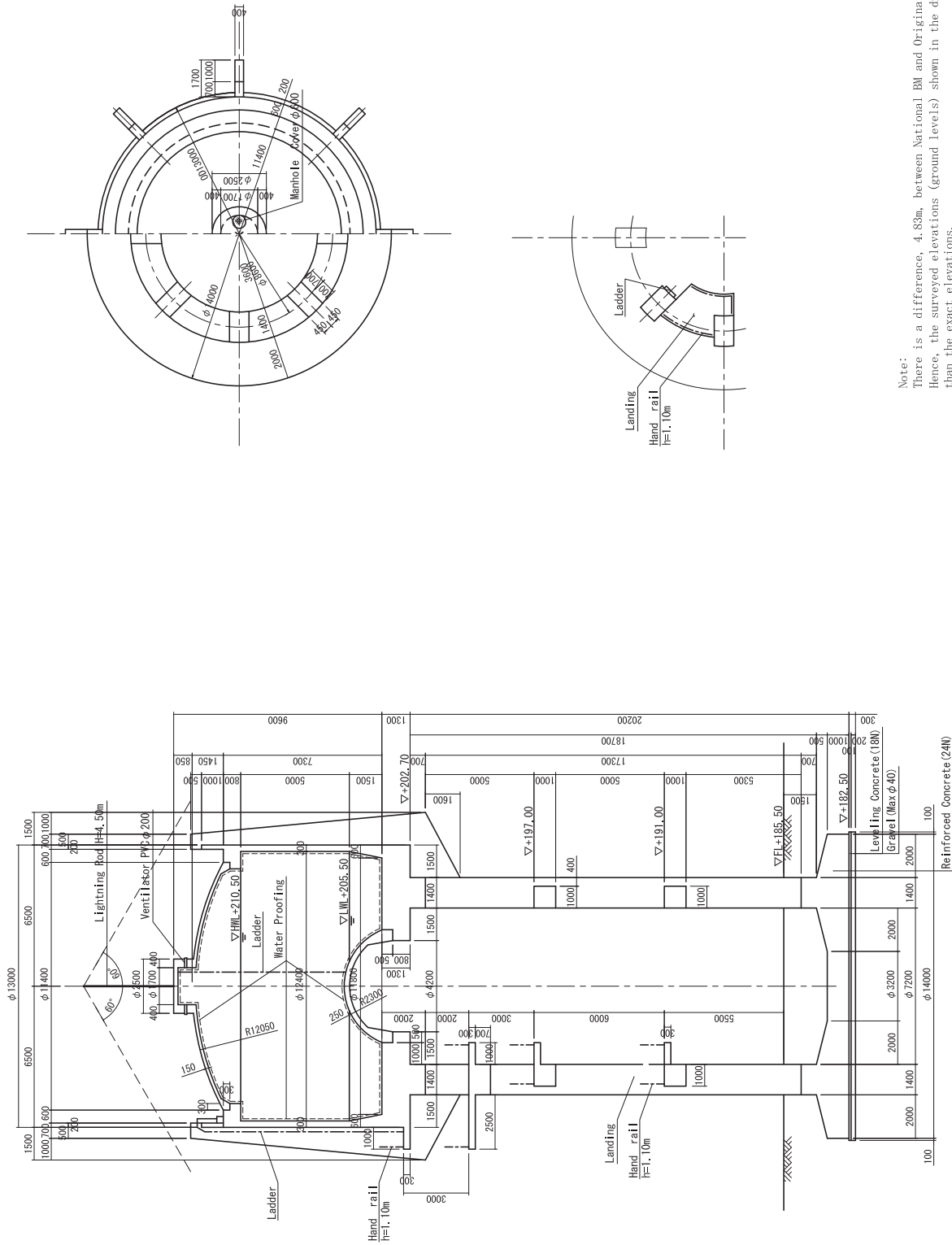
Note:
 There is a difference, 4.83m, between National BM and Original BM obtained from NPKMM.
 Hence, the surveyed elevations (ground levels) shown in the drawing are 4.83m higher
 than the exact elevations.

PROJECT	DESCRIPTION	APPROVE BY	DATE	DRAWING No
Preparatory Survey on Thakhek Water Supply Development Project in Khammoutane Province in Lao People's Democratic Republic		PREPARED BY	DATE	SCALE
		NSC		1:200



Elevated Tank (KM4)

(Structure) Scale=1/200

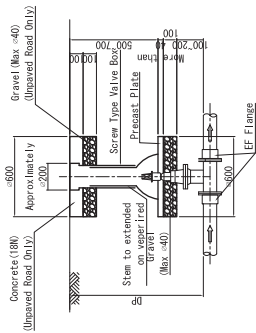


Note:
There is a difference, 4.83m, between National BM and Original BM obtained from NPKM.
Hence, the surveyed elevations (ground levels) shown in the drawing are 4.83m higher
than the exact elevations.

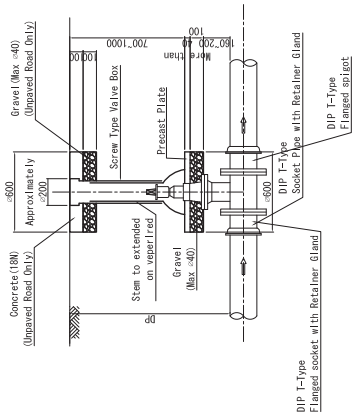
PROJECT	DESCRIPTION	APPROVE BY	DATE	DRAWING No
Preparatory Survey on Thakhek Water Supply Development Project in Khammouane Province in Lao People's Democratic Republic	Elevated Tank (600m ³) (2)			D4
		PREPARED BY	DATE	SCALE
		NSC	NIHON SUJIDO CONSULTANTS CO., LTD.	1:200

TYPICAL DRAWING FOR SEVERAL KINDS

SLUICE VALVE INSTALLATION
(DIP ϕ 100, ϕ 150mm) Scale=1/40

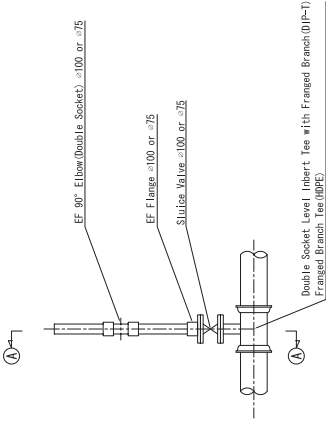


SLUICE VALVE INSTALLATION
(DIP ϕ 200, ϕ 450mm) Scale=1/40



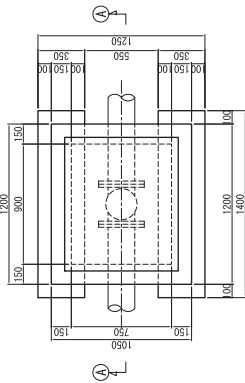
Blow off
Scale=1/100

PLAN

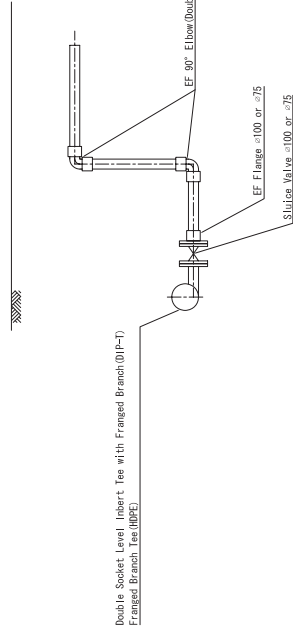


MANHOLE (Air Valve)
Scale=1/40

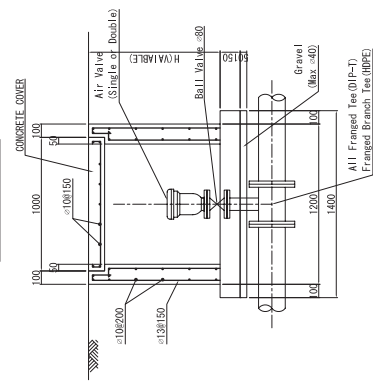
PLAN



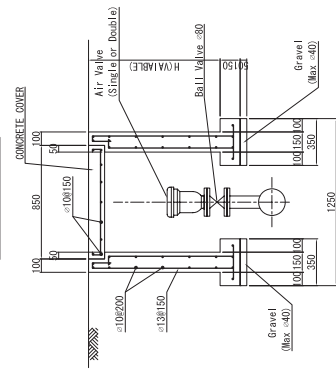
SECTION A-A



SECTION A-A



SECTION B-B



CRITERIA FOR AIR VALVE AND WASH OUT

MAIN PIPE MATERIAL	MAIN PIPE DIAMETER	BRANCH-PIPE FOR AIR VALVE	AIR VALVE	BRANCH-PIPE FOR WASH OUT
DIP	ϕ 100	ϕ 100	Single Orifice ϕ 13	ϕ 75
	ϕ 150	ϕ 150	Single Orifice ϕ 20	ϕ 75
	ϕ 200	ϕ 200	Single Orifice ϕ 30	ϕ 75
	ϕ 250	ϕ 250	Single Orifice ϕ 35	ϕ 75
	ϕ 300	ϕ 300	Single Orifice ϕ 45	ϕ 75
	ϕ 350	ϕ 350	Single Orifice ϕ 55	ϕ 100
	ϕ 400	ϕ 400	Double Orifice ϕ 75	ϕ 100
	ϕ 450	ϕ 450	Double Orifice ϕ 75	ϕ 100

Note:
1. ALL SLUICE VALVES LESS THAN 400mm DIA WILL HAVE NO CHAMBERS AND WILL BE INSTALLED SIMILAR TO WASH OUT VALVES HEAVY-DUTY SURFACE BOXES TO THE ROAD LEVEL TO OPERATE THEM.
2. ALL DIMENSIONS ARE IN mm.

PROJECT

DESCRIPTION

Preparatory Survey on Thakhek Water Supply Development Project in Khammouane Province in Lao People's Democratic Republic

Air Valve, Blow Off, Sluice Valve

NSC

NIHON SUJUDO CONSULTANTS CO., LTD.

APPROVE BY

DATE

DRAWING No

PREPARED BY

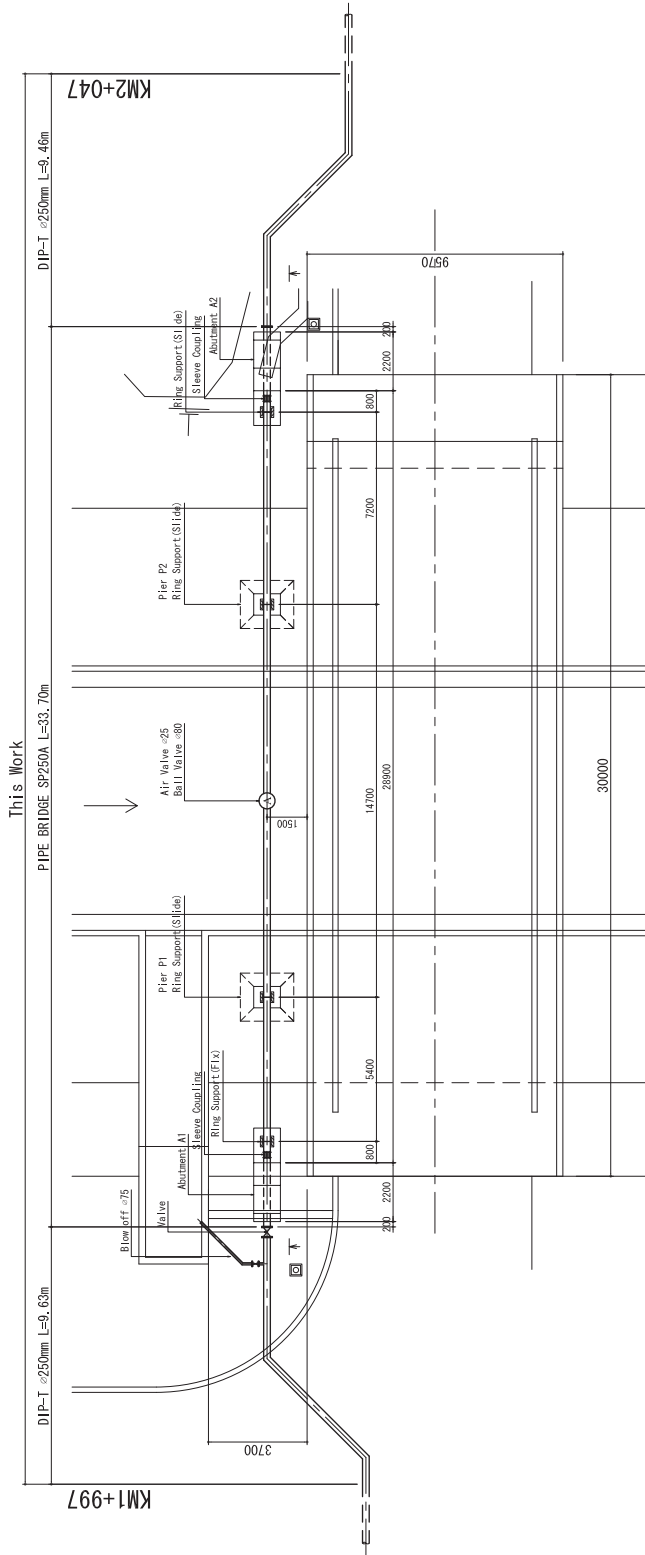
DATE

SCALE

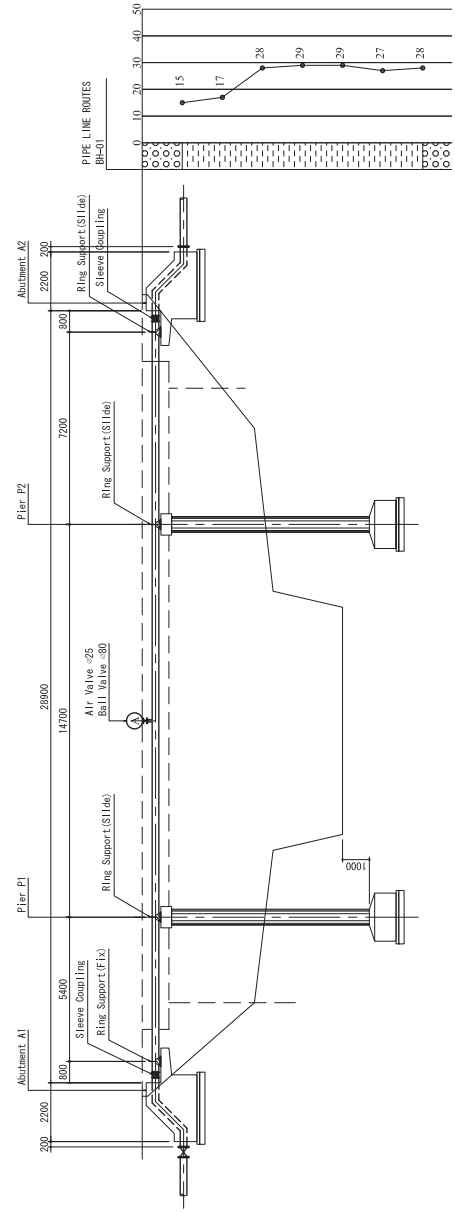
As Shown

PB-1 PIPE BRIDGE TWT1-2 ϕ 250mm Scale=1/200

PLAN



VIEW



Note: 1. All dimensions are in millimeters. 2. All dimensions are in millimeters. 3. All dimensions are in millimeters. 4. All dimensions are in millimeters. 5. All dimensions are in millimeters. 6. All dimensions are in millimeters. 7. All dimensions are in millimeters. 8. All dimensions are in millimeters. 9. All dimensions are in millimeters. 10. All dimensions are in millimeters.

PROJECT	DESCRIPTION	Pipe Bridge	APPROVE BY	DATE	DRAWING NO
			PREPARED BY	DATE	SCALE
Preparatory Survey on Thakhek Water Supply Development Project in Khammouane Province in Lao People's Democratic Republic			NSC	NIHON SUIDO CONSULTANTS CO., LTD.	E2 1:200

7-3 Results of Questionnaire on Socio & Economic Conditions

The purpose of the Questionnaire survey is to obtain the information related to usage condition of public water supply, resident consciousness, level of income and willingness to pay. Questionnaire also covers the questions for environmental and social consideration. Final questionnaire is attached to the appendix of this report.

In the 1st field work of the JICA Survey Team, mapping was conducted with the participation of Director, chief of division, manager, in order to decide the sampling places and number of samples of each place to collect 200 answers. General information was obtained by mapping concerning water supply condition, residential areas for each income level, condition of ground water or well. Based on the information, sampling design was tentatively determined as shown in **Table 7.4-1**.

Table 7.4-1 Draft Sampling Design of Questionnaire Survey

No.	Target Areas	Area Code *1						No. of samples
1	Intermittent water supply areas in the existing water supply	H2	H3	I2	I8			30
2	Low water pressure areas in the existing water supply	H5						15
3	Low income residential areas	C1	G4	J4	J8	I7	I8	45
4	Middle income residential areas	E1	E2	J6				25
5	High income residential areas	G1	J1	J6	I1	I3		15
6	Areas easy to obtain shallow well without public water supply	A1	A2	A3	A5	F2	G2	35
7	Areas difficult to obtain shallow well without public water supply	B1	C2	D1	D2	G1	F1	35
		Total						200

Notes: Red color : Now without public water supply but expected to be included in future water supply areas.

Blue color : Existing water supply areas

*1; Area Code in Thakhek district, based on the data of NPKMN.

Source: JICA Survey Team

In the 2nd field survey of JICA Survey Team, questionnaire survey to 200 households was implemented based on the above sampling design. The survey was in the form of interview that local surveyor groups (consist of 2 staff) visited each house, asked questions, and filled the answers into the questionnaire. The survey was implemented directly by JICA Survey Team with hiring the local supporting staffs. Each survey group was directed to visit 1 to 2 places per day to cover all the areas in Table 7.4-1, and directed to collect around 7 to 10 answers per day. Finally, surveyor groups visited the areas in Table 7.4-2, and collected the numbers of answers in each area as shown in the same table.



Table 7.4-2 Numbers of Answers in Each Area of Interview Survey

No.	Target Areas	Area Code / Number of Answers						Plan	Actual	
1	Intermittent water supply areas in the existing water supply	H2/5	H3/8	I2/10	I8/7			30	30	
2	Low water pressure areas in the existing water supply	H5/8						15	8	
3	Low income residential areas	G4/10	J4/10	J8/10	I7/9	I8/3		45	42	
4	Middle income residential areas	E1/8	E2/7	J6/8				25	23	
5	High income residential areas	J1/8	I1/4	I3/4				15	16	
6	Areas easy to obtain shallow well without public water supply	A2/9	A3/9	A5/10	F2/10	G2/8		35	46	
7	Areas difficult to obtain shallow well without public water supply	B1/5	C2/8	D1/4	D2/4	G1/6	F1/8	35	35	
								Total	200	200

Source: JICA Survey Team

Summary of survey results is shown in **Table 7.4-3**. Detailed results of the survey are attached in appendix of this report.

Table 7.4-3 Summary of Results of Residential Questionnaire Survey

No.	Items	Value / No. of answers		Notes
1	No. of answers collected	200 cases		
1.1	Households (HHs) using public water supply	82 cases		
1.2	HHs without public water supply	118 cases		
2	Types of well (a. Open well, b. Shallow well & hand pump, c. Deep well & pump, d. Others)	a. 79 c. 22	b. 17 d. 0	
2.1	Average depth of well (Non public water users)	12.7 m		
3	Average monthly water charge (Public water users)	92,622 Kip/month		
4	Monthly payment for water other than public water supply (Non public water users)	31,667 Kip/month		
5	Paid amount to water vender (20ℓ tank)	3,027 Kip/tank		
6	Water supply hours (Public water users)	24 hours/day × 7 days/week		
7	Are water volume and pressure enough?	Yes: 66	No: 16	Multiple answers

		Volume not enough: 15	Pressure not enough: 11	allowed for Volume and pressure.	
8	Are there any problems in water quality of existing public water?	Yes: 18	No: 64		
8.1	Types of problems (a. smell, b. turbidity, c. color)	a. 14	b. 6	c. 0	Multiple answers allowed
9	Do you store water in household?	Yes: 179	No: 21		
9.1	Types of water tank (a. underground tank, b. Tank on the ground, c. tank on the roof)	a. 1	b. 176	c. 2	
9.2	Average size of water tank	182.4 liter			
10	Do you have pump for the above water tank?	Yes: 2	No: 177		
11	In case of public water users, what is the purpose of using the water? (a. drinking ((a) without boiling, (b) after boiling), b. cooking, c. laundry, d. bathing / shower, e. gardening / washing car)	a. 18	(a) 0	(b) 18	Multiple answers allowed
		b. 53	c. 82	d. 82	
		e. 74	/		
12	In case of non public water users, what is the purpose of using water? (a. drinking ((a) without boiling, (b) after boiling), b. cooking, c. laundry, d. bathing / shower, e. gardening / washing car)	a. 51	(a) 3	(b) 48	Multiple answers allowed
		b. 112	c. 114	d. 118	
		e. 103			
13	Do you buy bottle water?	Yes: 167	No: 33		
13.1	For what purpose do you buy bottle water?	Drinking: 167	Cooking: 41	Answer by writing	
14	(To public water users) Do you have any requests for public water supply service?	Yes: 40	No: 42		
14.1	If "Yes", what kind of request do you have? (a. supply volume, b. supply hours, c. pressure, d. water quality, e. tariff ((a)high, (b)too low), f. Tome to repair if leaked, g. Others)	a. 0	b. 0	c. 0	Multiple answers allowed
		d. 3	e. 39	(a) 39	
		(b) 0	f. 0	g. 0	
15	(To public water users) Willingness to pay for improvement of water supply service.	46,402 Kip/month			
16	(To non public water users) Do you want to use the public water supply, if a pipe comes near your house?	Yes: 111	No: 4	No idea, no answer: 3 cases	
16.1	If "Yes", how much are you willing to pay for public water supply with good quality?	34,685 Kip/month			
17	How often is your family suffered from water borne diseases?	1.24 times/year			
17.1	Type of water borne diseases (a. diarrhea, b. typhoid, c. cholera)	a. 64	b. 22	c. 1	
17.2	How much do you spend for doctor inspection,	313,882 Kip/case			

	medicines, as far as hospital stay, for water borne diseases?			
18	How many persons are there in your family?	4.70 persons		
19	Average household income	1,370,352 Kip/month		
20	How much does your family pay for electricity?	83,105 Kip/month		
21	How much does your family pay for telephone?	72,633 Kip/month		
			Including mobile	
22	How many following assets does your family have? (a. TV, b. motorcycle, c. car)	a. 1.16	b. 1.45	c. 1.17
23	How long can you bear temporary noise and vibration caused from construction? a. not acceptable, b. a week, c. 2 weeks, d. a month, e. a few month, f. a half year, g. an year, h. do not care.	a. 0	b. 18	c. 14
		d. 23	e. 5	f. 0
		g. 0	h. 140	

Source: Questionnaire Survey (May 2012)

Average willingness to pay for public water supply is 34,685 Kip/month in case of households who have not yet using the public water supply (**Table 7.4-3**, No. 16.1). Considering the present unit price of water (2,800 Kip/m³), monthly water consumption is estimated at only 12.4 m³, in other words, willingness to pay of non public water users is low. Nevertheless, number of households who want to connect to public water (**Table 7.4-3**, No. 16) is as many as 111 cases (94%) among 118 cases. In the existing water supply area including local areas, 2 years have already been passed since the current water tariff was applied. Number of customers has been increasing for these 2 years. Therefore, it cannot be said that low willingness to pay leads to avoid the increase of new connections. However, tariff raise from now on, if necessary, should be planned with the greatest care.

In the existing public water supply areas, number of households who have problems in any of water volume and/or pressure (**Table 7.4-3**, No. 7) is 16 cases (20%) among 82 cases. Households who have problems in water quality (**Table 7.4-3**, No. 8) are 18 (22%) cases among 82 cases. On the other hand, number of households, who think the water tariff is high (**Table 7.4-3**, No. 14.1), is as many as 39 cases (48%) among 82 cases.

Among public water users and non public water users, households who reserve the water (**Table 7.4-3**, No. 9) is counted at 179 cases among 200 cases, that is, it was found that around 90% of total households own the water tank.

18 (22%) among 82 public water users drink water after boiling (**Table 7.4-3**, No. 11). There were no households who directly drink public water without boiling. It was found that people in Thakhek does not have the custom of drinking public water directly from tap in general. 167

households among total 200 cases buy bottled water for the purpose of drinking (and partially for cooking) (**Table 7.4-3**, No. 13). It is considered that bottled water is used for direct drinking which water vender is selling by 20 liter big bottle at around 3,000 Kip.

7-4 Environmental Check List and Proposed Monitoring Plan (Environmental and Social Considerations)

Environmental Social Consideration Check List

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) Y (c) N (d) Y	(a)(b) The IEE report was prepared and was approved (c) No conditions added (d) The approval of usage of Mekong River for the intake tower was completed
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) By holding the stakeholder meeting, adequate explanation was done and stakeholders agreed the project basically. (b) Comments were stated and requests were submitted from the stakeholders and countermeasures will be disclosed.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Alternative plans are partially explained in the stakeholder meeting and fully described in the report.
2 Pollution Control	(1) Air Quality	(a) Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Are any mitigating measures taken? (b) Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	(a) N (b) Y	(a) Low concentration chlorine (e.g. 2%) is planned to be used for good working condition and prevention of air pollution. (b) By using low concentration chlorine and installing ventilators, the safety standard (3mg/m ³) will be complied with.
	(2) Water Quality	(a) Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?	(a) Y	(a) Except SS, even raw water can comply with the standards already. SS is going to be removed in a sludge pond and only purified supernatant will be discharged.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(3) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed in accordance with the country's regulations?	(a) Y	(a) The country's regulation allows to discharge sludge directly but a sludge pond will separate sludge and it will be dried, transferred and dumped in a designated site, according to the current design.
	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	(a) Y	(a) The intake pump will be installed under water and little noise can be produced. The transmission pump will be installed in the WTP site being covered with RC walls and noise will not reach the boundary of the site.
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N/A	(a) No groundwater will be exploited.
3 Natural Environment	(1) Protected Areas	(a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) The project sites are all outside of protected areas. No adverse impacts are expected by the project.
3 Natural Environment	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?(b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?(c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?(d) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) N(b) N(c) N/A(d) N	(a) The sites are all within developed lands.(b) As above(c) As above(d) Even in a significant dry season, the intake will affect only 0.01% of Mekong River water flow.
	(3) Hydrology	(a) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect surface water and groundwater flows?	(a) N	(a) Even in a significant dry season, the intake will affect only 0.01% of Mekong River water flow.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	<p>(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?</p> <p>(b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement?</p> <p>(c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?</p> <p>(d) Is the compensations going to be paid prior to the resettlement?</p> <p>(e) Is the compensation policies prepared in document?</p> <p>(f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?</p> <p>(g) Are agreements with the affected people obtained prior to resettlement?</p> <p>(h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?</p> <p>(i) Are any plans developed to monitor the impacts of resettlement?</p> <p>(j) Is the grievance redress mechanism established?</p>	<p>(a) N</p> <p>(b) N/A</p> <p>(c) N/A</p> <p>(d) N/A</p> <p>(e) N/A</p> <p>(f) N/A</p> <p>(g) N/A</p> <p>(h) N/A</p> <p>(i) N/A</p> <p>(j) N/A</p>	<p>(a) No resettlement occurs</p> <p>(b) As above</p> <p>(c) As above</p> <p>(d) As above</p> <p>(e) As above</p> <p>(f) As above</p> <p>(g) As above</p> <p>(h) As above</p> <p>(i) As above</p> <p>(j) As above</p>
4 Social Environment	(2) Living and Livelihood	<p>(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?(b) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses?</p>	<p>(a) Y</p> <p>(b) N</p>	<p>(a) Construction activities can cause inconvenience to inhabitants but the countermeasures for impact minimization were agreed in the stakeholder meeting.(b) Positive impact such as prevention of ground water exploitation is possible, instead.</p>

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) The sites are all within developed lands and no heritage exists there.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) Intake tower will locate out of sight from public places. Other facilities will locate in local areas that are not specially considered in light of scenery. DNRE admitted no special consideration is necessary.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N (b) N/A	(a) No ethnic minorities or indigenous peoples inhabit in the site. (b) As above
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a) Labor Law, 2007, Charter 6: Prevention of Labour, Article 42 will be complied with. (b) Law as above stipulates safety considerations (c) Adequate program will be held by consultation with the Department of Labor & Social Welfare (d) As above

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?	(a) Y (b) N/A (c) Y (d) Y	(a) Any possible impacts are considered and mitigations are suggested in the EMP (b) The sites are all within developed lands and no impacts on ecosystem are expected. (c) Construction activities can cause inconvenience to inhabitants and the countermeasures for impact minimization were agreed in the stakeholder meeting. (d) Construction activities in the city center area were avoided by bypassing and the number of cross traffic constructions were minimized into only 3 sites.
5 Others	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?(b) What are the items, methods and frequencies of the monitoring program?(c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?(d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a) The monitoring plan was prepared according to the EMP.(b) The monitoring contents were decided by consultation between the proponent and authorities(c) The monitoring plan includes such components.(d) As above
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Dam and River Projects checklist should also be checked.	(a) N/A	(a) No dams are included as project components and the impact to Mekong River is very little.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N/A	(a) The project does not have possibility of significant adverse impacts on environment.

1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate

standards of other countries (including Japan's experience).

2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which the project is located.

Monitoring Form (Environmental and Social Considerations)

Monitoring Results of Thakhek Water Supply Development Project (Before and During the Construction Phases)

1. Monitoring Results of Noise Pollution

Table M-1-1 Results

Item: Noise

Unit: dB(A)

No.	Date	Measured Value														
		St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8	St.9	St.10	St.11	St.12	St.13	St.14	St.15
Pre-Construction Phase (Baseline)																
1																
2																
Construction Phase																
1																
2																
3																
4																
5																

Table M-1-2 Station

Measured Station	Adopted Standard*)	Detailed location
St.1		
St.2		
St.3		
St.4		
St.5		
St.6		

St.7		
St.8		
St.9		
St.10		
St.11		
St.12		
St.13		
St.14		
St.15		

*) Refer to Table M-1-3

Table M-1-3 National Standard values (Lao PDR)

Type of Area	Standard Value in dB(A)		
	6.00-18.00	18.00-22.00	22.00-6.00
Quiet areas: hospitals, libraries, treatment places, kindergarten and schools	50	45	40
Residential areas: hotels and houses	55	55	45
Commercial and service areas	70	70	50
Small industrial factories located in residential areas	70	70	50

Table M-1-4 Other Standard values

Country	Industrial Area	Commercial Area	Residential Area	Silence Zone
U.S(E.P.A)	70	60	55	45
W.H.O	65	55	55 / 45 (day / night)	45 / 35 (day / night)
E.C	65	55	55 / 45 (day / night)	45 / 35 (day / night)

2. Monitoring Results of Dust Pollution

Table M-2-1 Results

Item: Dust

Mark: “✓”

No.	Date	Measured Value														
		St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8	St.9	St.10	St.11	St.12	St.13	St.14	St.15
Construction Phase -1 st Year																
1																
2																
3																
4																
5																
6																
Construction Phase -2 nd Year																
1																
2																
3																
4																
5																
6																
Construction Phase -3 rd Year																
1																
2																
3																

App 7 - 62

Table M-2-2 Station

Observed Station	Detailed location	Remark
St.1		
St.2		
St.3		

St.4		
St.5		
St.6		
St.7		
St.8		
St.9		
St.10		
St.11		
St.12		
St.13		
St.14		
St.15		

Table M-2-3 Standard values Item: Dust (as PM10) Unit: µg/m3

Country	Annual mean	Daily mean
Lao PDR	-	-
U.S(E.P.A)	50	150
W.H.O	20	50
E.C	40	50

3. Monitoring Results of Waste Management

Table M-3 Result as of (Date: _____)

Item: Waste Management

Mark: “✓” if

management is good

Station	Location	Kind of Waste	Whole amount (m ³)	Receiving Dumping Site	Situation of General Waste Management / Remark
Construction Phase - No. (1 / 2)	1 st Year / 2 nd Year / 3 rd Year				

St. 01					
St. 02					
St. 03					
St. 04					
St. 05					
St. 06					
St. 07					
St. 08					
St. 09					
St. 10					
St. 11					
St. 12					
St. 13					
St. 14					
St. 15					
St. 16					
St. 17					
St. 18					
St. 19					
St. 20					

4. Monitoring Results of Safety Management

Table M-4 Result as of (Date: _____)

Item: Safety Management

Mark: “✓” if

management is good

Station	Location	Description of Incident (Injury, Accident and so on)	Situation of Fencing and Other Safety Management / Remark
Construction Phase - 1 st Year / 2 nd Year / 3 rd Year No. (1 / 2)			

St. 01			
St. 02			
St. 03			
St. 04			
St. 05			
St. 06			
St. 07			
St. 08			
St. 09			
St. 10			
St. 11			
St. 12			
St. 13			
St. 14			
St. 15			

5. Monitoring Results of Sanitary Management

Table M-5-1 Result as of (Date: _____)

Item: Sanitary Management

Mark: “✓” if the item is well

conducted

Interviewee	Items indicated by Sanitary Program				Remark
	i)	ii)	iii)	iv)	
Construction Phase - 1 st Year / 2 nd Year / 3 rd Year					
No. (1 / 2)					
In and around the Labour Camps					
LC-01					
LC-02					
LC-03					
LC-04					
LC-05					
LC-06					
LC-07					
LC-08					
LC-09					
LC-10					
LC-11					
LC-12					
LC-13					
LC-14					
LC-15					
In and around the Construction Sites					
St.1-1					
St.1-2					
St.1-3					
St.2-1					
St.2-2					

St.2-3					
St.3-1					
St.3-2					
St.3-3					
St.4-1					
St.4-2					
St.4-3					
St.5-1					
St.5-2					
St.5-3					
St.6-1					
St.6-2					
St.6-3					
St.7-1					
St.7-2					
St.7-3					
St.8-1					
St.8-2					
St.8-3					
St.9-1					
St.9-2					
St.9-3					
St.10-1					
St.10-2					
St.10-3					
St.11-1					
St.11-2					
St.11-3					
St.12-1					
St.12-2					

St.12-3					
St.13-1					
St.13-2					
St.13-3					
St.14-1					
St.14-2					
St.14-3					
St.15-1					
St.15-2					
St.15-3					

Monitoring Results of Thakhek Water Supply Development Project (Operation Phase)

Monitoring Results of Total Suspended Solids

Table 1 Concentration Values of Total Suspended Solids (TSS) Unit: mg/L Country's Standard: 40 mg/L(EC: 35 mg/L, WB:50mg/L)

Y / M	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015												
2016												
2017												
2018												
2019												
2020												

Table 2 Detail of Measurement

Year	Month	Day	TSS Value (mg/L)	Measurer	Certifier	Remark
2015	1					
	2					
	3					

7-4-3 Minutes of the Meeting for The Stakeholders' Meeting

**Minutes of the Meeting for
The Stakeholders' Meeting for Public Consultation for
Thakhek Water Supply Development Project in Khammouane Province in Lap PDR
18th May 2012 by DPWT & NPKMN
in collaboration with JICA Preparatory Survey Team**

On May 18,2012 the meeting on Water Supply development at Thakhek district was held at the conference room of DPWT Khammouane province. There were 71 people from different concerned sections attended. This Minutes of the Meeting was translated into Lao and distributed to attendants.

Presentations		
Mr. Chanh B. head of DPWT Khammouane province gives a short speech about Khammouane province background, he said; there are 10 districts in the province.		
Mr. KhanNgeun S. head of NPKMN has informed participants regarding the purpose of the meeting and a brief report of the first and second preparatory survey on Water Supply development at Thakhek district.		
Mr. Hoshino, Deputy Chief Consultant has explained about expansion of service area and location of new WTP, new elevated tank, planned distribution pipe line planned transmission pipe lines, planned Intake Facility and target goal of Water Supply development project from now to 2020 with expectation of serving people up to 80% .		
Mr. Kimura, Water and Environmental Consultant has explained regarding possible environmental impact during construction of the project.		
Consultation		
No.	Opinions / comments	Reply / countermeasure
Mr. Khamthavy		
1	The water is not enough for the time being.	The project expands the service area.
2	While building a new Intake tower, should the old one be protected from the turbidiness?	By the adopted sheet pile method, only a limited turbidiness is produced at the beginning of construction and the concern is not necessary.
3	Pipelines are being laid only under roads? No private land effected?	Pipelines are being laid only under public roads.
Deputy of planning and investment		
4	Is the 80% only of Thakhek or of whole province?	That is 80% of Thakhek
Representative of Chom keo village		
5	Where does the WTP discharge go?	Waste water from WTP shall be stored and only supernatant shall be discharged. Sludge left shall be dried and transferred to dumping sites.
Representative of Houe nam li village		
6	We agree to construct new components and no compensation should be necessary.	Thank you for your understanding and cooperation.
7	I will explain to villagers about this and get the agreement because much more benefit should be.	
Representative of Phonesa-ad village		
8	The current water supply is not potable so new one should be.	WTP is designed to produce drinking water and new pipelines and elevated tanks are to keep sterile. However, new pipelines are to be connected to old ones and further investigation is necessary to assure that the tap water is potable.
9	Villagers request to be connected to all households in the village, not only in a limited area.	In selected villages, no misdistribution should not occur.
Representative of Thakhekang village		
10	Each household should be connected.	In selected villages, no misdistribution should not occur.
President of DNRE		

11	Which IEE or EIA shall apply to the project?	IEE
12	Should there be an EMP?	EMP shall be prepared in the said IEE
13	Shall surrounding people be notify in advance of construction?	DPWT will be responsible for that.
Dr. Phasouk; Vice director of provincial public health		
14	The public health should be involved in light of water safety and HIV AIDS problems	That will be mentioned in the EMP.
15	In case of problems happening just feel free to consult any time.	Thank you for your understanding and cooperation.
Mr. Khampeng D. Vice district governor		
16	Before construction of main distribution pipe line, the district should be involved in order to notify to the people to be aware about project construction to avoid problems which might be occurred during constructions.	DPWT will be responsible for that.
17	How far is new intake facility from new WTP ?	About 40m as shown in the handout.
18	Some traffic and dust problems happen during constructions, what type of solution do you have?	The construction design had minimized the impact to traffic by reducing cross-road section as few as possible (approx. 3 parts only in the current design). Consideration including load covering and watering for dust prevention is already planned.
Mr. Daddavong, deputy head of DPWT Khammouane		
19	In case of power off for long time we will have trouble with Nam Pa-Pa, therefore we should have spare generator for using just in case of emergency.	The generator for power cuts are planned to be introduced.
20	Fire Department is asking for more public Fire hydrant in case of fire	Fire hydrants as many as villages will be available in the current design.
Mr. Saysongkham, Road and water control section		
21	The new intake tower should be away from river bank at least 30-40 meters in order to prevent soil erosion.	It will be about 40m away from the bank and soil erosion should not occur because the design is considering the result of drilling investigation.

Anonymous Opinions

During and after the meeting, in order to reflect as many opinions as possible, anonymous opinions were collected with distributed sheets of paper. The opinions were summarized in the table below with replies or countermeasures for each.

No.	Opinions / comments	Reply / countermeasure
Intake Tower		
1	It is proposed to make intake tower because it is based on needs by villagers in the proposed area	N/A
2	We need a quality intake tower and high technology in comparison with the old one , at present in some parts, there is not enough water for consumers	The requests shall be satisfied by the current plan.
3	The old one was made as a floating intake and insufficient during raining season	N/A
4	New intake tower should comply with international criteria or standards	Basically, the design of all components comply with the Lao's standard "Management and Technical Guidelines Water Supply" by MPWT which is based on international standards. In case some details are not mentioned in the guideline, Japanese or other international standards are referred.
5	When you are constructing the intake tower, you should consider where the soil will be transferred, it should not be thrown to Mekong river	Soil shall be stored, utilized or dumped in certain sites.

No.	Opinions / comments	Reply / countermeasure
6	It should be working well both in drying and raining season	The request shall be satisfied by the current plan.
7	It is agreed to make it permanent	The request shall be satisfied by the current plan.
8	When the company starts to construct, it should be careful about waste falling down to the road which will makes it dirty and should cover the transportation truck all of the time.	Consideration including load covering is already planned.
9	To make it convenient in the pipeline for transfer the water to lower and higher location including easy to manage and to protect the pipeline without broken and clean enough for people consumers	The requests shall be satisfied by the current plan.
10	During we are waiting for the new Intake Tower, you should fix the old one for using until completion of the construction and try to reduce negative impact for household water consumers	The old one still works. The reason the same floating pump was not adopted is that it is basically temporary facility and not permanently strong against flood, driftwood and so on.
11	Intake Tower builds far from the bank of the Mekong. 40 meter is far enough for soil erosion and not necessary to be protected and without any risk on raining and dry season	N/A
12	Should be long use and sustainable in future and easy to manage, safety for people and environment	The requests shall be satisfied by the current plan.
13	Should not take long time, if the construction is hurried up, much better	The construction shall be conducted according to appropriately designed plan.
14	It's requested to lower negative impact to social and environment aspect, people in nearby project site can be cooperative, on the top of Intake tower should be equipped with a light, for prevention of accidents because in proposed area is many fish man fishing at night	By the adopted sheet pile method, only a limited turbidness is produced at the beginning of construction which minimize the impact. The lights on the Intake tower are planned to be installed.
Pipelines		
1	It is proposed to make big pipes, but transmission pipeline should go into small road also. And it should be implemented when it is expanding of the new road for saving the budgets	It had been agreed that the demarcation of the pipelines as following; Main: JICA, Service pipe: GOL, Pipes in premises: Consumer
2	The pipe in the past was damaged and broken inconveniences for people usage in the households	Durable HDPE pipes are planned to be used and the request shall be satisfied by the current plan.
3	It's requested to expand water supply for new villages which are not access to water supply yet	The request shall be satisfied gradually because the current plan follows the governmental one which aims to accomplish 80% in 2020, not 100%.
4	The pipeline should be expanding because it is not enough for villagers consumers at present	
5	New pipe should be consider for an enough transmission pipe line to people use	
6	The pipeline should comply with international standards	Refer to Intake tower No.4
7	When you are constructing the pipeline, you should consider where the soil transfer to , it should not throw to Mekong river	Soil shall be stored, utilized or dumped in certain sites.
8	The pipeline should be strong enough to transfer water to reach target villages	Durable HDPE pipes are planned to be used and the request shall be satisfied by the current plan.
9	We need big pipelines without rust and security for people health and water should be good quality and safety	
10	Try to construct the pipeline without impact or very small impact to people, if any large affected to people by the project should be considering the compensation	All pipelines are to be lain under public roads only.
11	Transmission pipeline set up, if any affected to private	

No.	Opinions / comments	Reply / countermeasure
	land use, it should be consider the some of compensation if needs	
12	The pipeline should be expanded to develop economy of the community areas	N/A
13	The new and old pipe should be connected to each other to avoid rebuilding.	They are to be connected.
14	In Pakdong village is not enough water, some of villagers collect water at night time, that is why we need to expand the pipes	The problem shall be solved by the current plan.
15	The plan of pipelines is agreed with the Japanese expert's explanation , ex: beside of road	N/A
WTP		
1	Requested to make new WTP with good quality, clean, enough and without any disease, turbidiness.	WTP is designed to produce drinking water and new pipelines and elevated tanks are to keep sterile. However, new pipelines are to be connected to old ones and further investigation is necessary to assure that the tap water is potable.
2	Make good quality produce without negative others impact	
3	Without turbidiness	
4	People wants directly to drink the cleaning water	
5	Product of water supply should be enough for consumers of people in both dry and raining season	No difference between wet and dry seasons in production is expected and the amount should be maintained as planned.
6	Should be enough produce for people consumers	
7	Agreed to make new one but it should not throw the sludge to Mekong river	Sludge shall be dried and dumped in certain sites.
8	100% good facility without negative material	Construction material with safety guarantee shall be used for any water facility.
9	During the construction should reduce or prevent the air pollution from the transportation truck	Consideration including load covering is already planned.
10	We do not need odor by chorine remaining, sometimes even after boiling also could not drink	Water quality is expected to be improved by the current plan. Chlorine should be added for sanitary purpose but it should be considered not to be added too much.
Elevated Tank		
1	Proposed to make by concrete in order to protect rust	It shall be made of reinforced concrete (RC) and the water quality should be kept high because it is sent directly from the new WTP. The size is considered well with water demand.
2	Agreed to make Elevated tank which is consisting many cubic matters with very clean water	
3	The old made by iron deteriorates and small	
4	Improve for reaching a good quality, because at present is rust too many ,it may dangerous to consumers	
5	In the old ,some time water is red color may be causes from rust inside of elevated tank	
6	To make new one, it should be considered that a good quality and good standards and enough for all target villages	
7	Quality equipment without rust and scale should be used	
8	At present the population is increasing year by year to build new permanent elevated tank is needed for consumers	
9	We need big and high one without rust and turbidiness	
10	The elevated tank should be improved to comply with international standards	Refer to Intake tower No.4
11	To fix the old may reduce construction cost	Either way, another tank is necessary in terms of capacity deficiency. If two of them should be in control, it will cost more than one.
12	Make it by following up all of originally designed procedure for constructing of the elevated tank and the tank should be good quality, not rust, slump and scale.	The construction shall be conducted according to the detailed design with certain materials.
13	During the cleaning of the tank should be consider where	A drain pipe separated from water use pipes is

No.	Opinions / comments	Reply / countermeasure
	to throw the sludge, it should be separate from the water use pipeline	designed.
14	Low elevated tank makes it difficult to transfer the water to people for consumers and if we have high elevated tank it should be easy and convenient of water transferring to any location as needs	The height of the tank is designed appropriately by hydrologic accounting.
15	The new one should be much more convenient than the old one	N/A
Other		
1	It is requested to make the project faster	The construction shall be conducted according to appropriately designed plan.
2	On behalf of villagers I would like to say we agree with all of the construction of 4 components because I want all people in our villages to use water supply as soon as possible	
3	It is requested to Nampapa to build security pipes for fire truck in the main and small road	Fire hydrants as many as villages will be available in the current design.
4	Thank you for good cooperation of the Japanese country to help Lao people	N/A
5	To consider more about environmental aspects ex: Air pollution, vibration should be lower values and the waste from construction should have storage holding area	For air pollution, dust should be the only concern and shall be taken good care of. There is no vibration standard but by complying noise standard it should be no problem. Any kind of waste shall be accepted by dumping sites.
6	Agreed by knowing that the designing is appropriate for social development.	N/A
7	Water from wells and Mekong in raining season should be under control because the water quality sometimes has problems such as scale and turbidness in household jars	Water quality is expected to be improved by the current plan.
Questions		
1	When we drink Nampapa water, is it bad impact to our body?	According to JPST's water quality test result, no harmful materials are found but by capacity-over operation causes insufficient reduction of organic materials. It is not correct to declare it is harmful but not perfect for drinking for the time being
2	When we are boiling water for drinking, we always have been seen the scale, is it dangerous to our body?	Scale production after boiling is normal reaction. Scale is made from Calcium which you may know is not dangerous but essential to our body.
3	When we are cleaning the WTP each time as need, where is the waste should go?	Sludge shall be dried and dumped in certain sites.

7-5 Network Analysis of Distribution System

7-5-1 Outline of Network Analysis

The hydraulic network analysis was conducted using EPANET ver 2.0 based on the following conditions:

- Equation applied : Hazen Williams Equation
- Flow velocity coefficient : 110
- Minimum Residual Pressure : 15 m
- Hourly Peak Factor : 1.5 (see **Figure 7.5-1**)

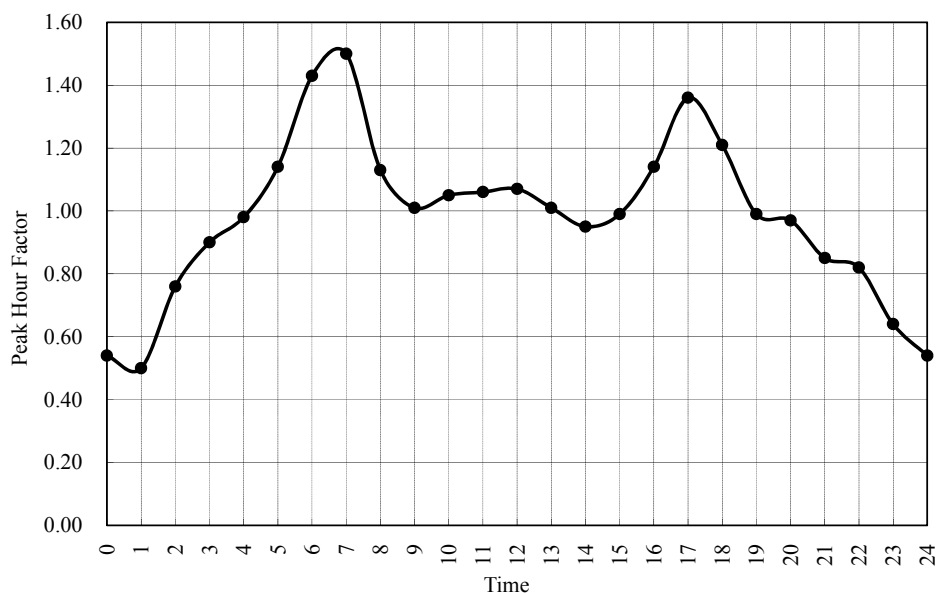


Figure 7.5-1 Demand Pattern

For the network analysis for transmission and distribution facility planning, the important points to note are as follows;

- Water level of the new elevated tanks and diameters of pipelines should be selected to ensure adequate residual water pressure.
- Capacity of elevated tank should meet hourly demand fluctuations.

Model for the network analysis is shown in **Figure 7.5-2** and results of the analysis are mentioned hereinafter.

7-5-2 Node Data

Node ID	Elevation	Base Demand (m ³ /d)	Residual Pressure at (m)			
	(m)		01:00	07:00	13:00	19:00
Junc 0	183.1	294.6	25.1	24.0	23.9	23.3
Junc E1	185.5	226.8	22.7	20.8	21.2	20.6
Junc 152	178.0	61.6	30.1	28.8	28.8	28.2
Junc 161	178.0	360.8	30.1	29.0	28.9	28.3
Junc G10	159.0	242.4	29.3	26.9	27.5	26.7
Junc G11	159.0	242.4	28.8	23.1	25.7	24.9
Junc G2	155.9	358.8	31.6	23.6	27.5	26.8
Junc G4	156.0	295.2	30.4	15.2	23.4	22.9
Junc 59	159.0	371.9	29.0	23.1	25.8	25.1
Junc 52	152.0	381.0	36.0	29.7	32.6	31.9
Junc 49	152.0	190.3	35.8	28.3	32.0	31.3
Junc 48	152.0	88.4	35.7	27.5	31.6	31.0
Junc 46	151.0	546.3	36.6	27.5	32.2	31.5
Junc 44	150.0	455.4	37.6	27.9	32.9	32.3
Junc 41	150.8	197.7	36.7	26.0	31.6	31.0
Junc 51	152.0	141.3	35.8	28.0	31.9	31.2
Junc 50	151.0	326.0	36.7	27.5	32.3	31.7
Junc 62	156.0	677.4	31.4	21.4	26.6	25.9
Junc 86	151.4	47.2	36.0	25.2	30.9	30.3
Junc 85	150.0	47.2	37.5	27.0	32.5	31.8
Junc 88	151.0	292.6	36.4	25.7	31.3	30.7
Junc 87	151.4	103.6	36.0	25.1	30.9	30.2
Junc 79	151.0	283.9	36.5	26.5	31.7	31.1
Junc 74	151.0	236.7	36.4	25.6	31.3	30.6
Junc 81	152.0	147.3	35.4	24.3	30.2	29.5
Junc 73	152.0	364.0	35.2	23.4	29.7	29.1
Junc 66	160.0	326.0	26.6	11.0	19.6	19.0
Junc 165	156.0	421.3	39.0	23.0	30.7	30.3
Junc 10	152.0	275.7	35.6	21.7	29.4	28.8
Junc 7	152.4	375.3	34.9	18.1	27.6	27.1
Junc 22	152.0	429.0	35.6	25.2	30.6	30.0
Junc 21	150.0	472.8	37.5	26.6	32.4	31.8
Junc 20	150.8	185.1	36.6	24.5	31.1	30.5
Junc 70	160.0	88.4	27.5	17.6	22.8	22.1
Junc 69	164.0	190.3	23.5	13.8	18.8	18.2
Junc G3	154.0	336.0	32.1	15.2	24.5	23.9
Junc 56	152.0	0.0	35.9	29.5	32.6	31.8
Junc 72	156.0	0.0	31.2	19.3	25.6	25.0
Junc 43	150.0	0.0	37.6	27.8	32.9	32.2
Junc 12	152.0	0.0	35.6	24.7	30.5	29.8
Junc 177	156.0	0.0	32.5	18.7	26.2	25.6
Junc ET-67	154.0	119.7	32.6	16.6	25.4	24.8
Junc ET-B10	160.0	0.0	38.1	35.0	36.0	35.3
Junc ET-91	150.5	221.7	47.3	42.2	44.4	43.7
Junc ET-90	150.1	164.4	46.8	35.7	41.5	40.9
Junc ET-99	161.5	303.5	36.3	31.2	33.4	32.7
Junc ET-E21	156.1	109.8	41.8	37.1	39.1	38.4
Junc ET-B11	164.4	103.2	34.0	33.4	33.0	32.2
Junc ET-H5	176.2	239.4	22.3	22.4	21.5	20.8

Node ID	Elevation	Base Demand	Residual Pressure at (m)			
	(m)		(m3/d)	01:00	07:00	13:00
Junc ET-F10	157.6	190.8	39.8	32.2	35.9	35.3
Junc ET-F11	155.2	190.8	41.8	31.6	36.9	36.3
Junc ET-F2	160.8	286.8	34.8	15.2	26.1	25.7
Junc ET-E20	166.4	201.7	31.0	23.1	26.9	26.3
Junc ET-J9	151.7	274.2	45.5	36.7	41.1	40.5
Junc ET-A3	150.1	468.0	46.9	36.8	42.0	41.5
Junc ET-A2	151.5	357.0	45.2	32.7	39.3	38.8
Junc ET-A1	151.6	426.0	43.8	23.1	34.7	34.3
Junc ET-A4	152.0	725.4	42.4	15.2	30.7	30.4
Junc T1	146.0	0.0	84.3	84.4	84.0	83.6
Junc T2	173.0	0.0	50.6	50.7	50.1	49.7
Junc T4	142.0	0.0	85.9	86.1	85.6	85.2
Junc GR1	185.5	0.0	9.5	9.5	9.5	9.5
Junc GR2	185.5	0.0	3.2	3.6	2.5	1.6
Junc WTP1	150.6	0.0	13.9	13.9	13.9	13.9
Junc WTP2	150.6	0.0	2.0	2.1	2.1	2.0
Junc T3	173.0	0.0	48.8	48.9	48.3	47.9
Junc 62a'	158.0	0.0	29.4	19.4	24.6	23.9
Junc 168	156.0	0.0	35.9	22.1	28.8	28.3
Junc 6	152.2	0.0	35.1	17.2	27.4	26.9
Junc 2	150.6	462.0	36.6	16.7	28.2	27.8
Junc 1	150.4	96.0	36.8	16.6	28.3	27.9
Junc 111	150.8	0.0	36.4	16.2	27.9	27.5
Junc 110	151.0	0.0	36.3	16.0	27.8	27.4
Junc J8	151.4	401.4	36.0	15.5	27.4	27.0
Junc l8	152.3	209.4	41.9	21.4	32.8	32.5
Junc C0	180.2	0.0	27.2	23.4	24.9	24.4
Junc C1	178.1	211.9	29.5	26.2	27.4	26.9
Junc C2	174.5	429.6	32.3	26.0	29.0	28.5
Junc D1	180.3	220.8	25.9	17.5	21.6	21.2
Junc 3	156.0	0.0	31.8	25.7	28.4	27.7
Junc 4	155.0	0.0	32.4	24.1	28.2	27.5
Junc 9	185.5	0.0	23.0	23.0	22.2	21.6
Junc 11	183.1	0.0	5.5	5.3	4.6	3.7
Junc 13	178.0	0.0	30.2	29.3	29.0	28.5
Junc ET-01	158.0	0.0	38.8	27.1	33.2	32.7
Junc ET-03	152.0	0.0	43.1	20.4	33.1	32.8
Junc 14	183.9	0.0	24.5	24.3	23.7	23.1
Junc 15	185.5	0.0	23.2	23.3	22.5	21.9
Junc 16	176.6	607.2	29.5	21.0	25.2	24.8
Junc 17	178.0	0.0	30.1	28.7	28.7	28.2
Junc 18	185.6	0.0	3.2	3.6	2.5	1.6
Resvr WTP	160.0		0.0	0.0	0.0	0.0
Resvr Well	195.0		0.0	0.0	0.0	0.0
Tank ET	195.5		3.1	3.4	2.4	1.6
Tank GR	185.6		3.1	3.5	2.4	1.5
Tank GR-WTP	146.1		2.0	2.1	2.1	2.0
Tank 8	205.5		3.0	3.0	2.2	1.7
Total		17101.4				

7-5-3 Pipeline Data

Link ID	Start Node	End Node	Length	Dia.	01:00		07:00		13:00		19:00	
					Flow	Velocity	Flow	Velocity	Flow	Velocity	Flow	Velocity
					m3/d	m/s	m3/d	m/s	m3/d	m/s	m3/d	m/s
Pipe 4	59	52	120	400	3,294	0.30	11,393	1.05	7,437	0.68	7,269	0.67
Pipe 5	52	49	490	300	1,346	0.22	4,788	0.78	3,107	0.51	3,036	0.50
Pipe 8	G10	G11	1,050	200	616	0.23	1,849	0.68	1,245	0.46	1,220	0.45
Pipe 9	G11	G2	580	150	327	0.21	981	0.64	661	0.43	647	0.42
Pipe 12	49	51	60	300	1,552	0.25	5,718	0.94	3,679	0.60	3,592	0.59
Pipe 13	51	46	600	300	1,272	0.21	4,445	0.73	2,906	0.48	2,840	0.47
Pipe 14	49	48	240	250	907	0.21	3,141	0.74	2,055	0.48	2,009	0.47
Pipe 15	48	46	420	250	741	0.17	2,640	0.62	1,718	0.41	1,679	0.40
Pipe 16	46	44	290	200	373	0.14	1,319	0.49	860	0.32	840	0.31
Pipe 18	46	44	290	250	670	0.16	2,372	0.56	1,546	0.36	1,511	0.36
Pipe 19	44	41	400	150	183	0.12	764	0.50	485	0.32	472	0.31
Pipe 20	41	86	460	65	18	0.06	26	0.09	22	0.08	22	0.08
Pipe 21	86	87	230	100	36	0.05	99	0.15	68	0.10	67	0.10
Pipe 23	44	79	240	200	393	0.14	1,198	0.44	803	0.30	787	0.29
Pipe 24	79	85	225	150	228	0.15	710	0.47	473	0.31	463	0.30
Pipe 25	85	88	220	150	162	0.11	495	0.32	332	0.22	325	0.21
Pipe 27	85	86	360	100	42	0.06	144	0.21	94	0.14	92	0.13
Pipe 28	88	87	330	80	16	0.04	57	0.13	36	0.08	36	0.08
Pipe 30	46	74	330	150	380	0.25	1,117	0.73	755	0.49	741	0.49
Pipe 31	74	81	70	150	285	0.19	824	0.54	559	0.37	549	0.36
Pipe 32	81	73	200	150	331	0.22	984	0.64	664	0.43	651	0.43
Pipe 33	74	79	1,630	80	-23	0.05	-62	0.14	-43	0.10	-42	0.10
Pipe 34	49	69	350	100	137	0.20	431	0.63	287	0.42	281	0.41
Pipe 35	69	70	110	100	42	0.06	145	0.21	95	0.14	93	0.14
Pipe 36	70	81	230	100	120	0.18	381	0.56	253	0.37	248	0.37
Pipe 37	48	70	340	100	122	0.18	369	0.54	248	0.36	243	0.36
Pipe 39	50	22	920	150	165	0.11	536	0.35	368	0.24	361	0.24
Pipe 40	22	21	180	150	235	0.15	787	0.52	519	0.34	507	0.33
Pipe 41	21	20	425	150	157	0.10	785	0.51	485	0.32	471	0.31
Pipe 42	0	161	400	100	72	0.11	97	0.14	85	0.13	85	0.13
Pipe 43	161	165	1,250	100	529	0.78	797	1.17	668	0.98	666	0.98
Pipe 45	10	7	660	100	93	0.14	351	0.52	224	0.33	219	0.32
Pipe 80	50	51	280	150	-210	0.14	-1,061	0.69	-630	0.41	-612	0.40
Pipe 81	46	22	560	200	316	0.12	1,458	0.54	911	0.34	886	0.33
Pipe 83	44	21	520	150	159	0.10	707	0.46	444	0.29	432	0.28
Pipe 84	41	20	480	150	147	0.10	780	0.51	478	0.31	464	0.30
Pipe 85	20	7	640	150	212	0.14	1,288	0.84	776	0.51	752	0.49
Pipe 87	177	10	570	100	200	0.29	201	0.30	175	0.26	177	0.26
Pipe 11	52	49	490	300	1,346	0.22	4,788	0.78	3,107	0.51	3,036	0.50
Pipe 22	52	56	100	200	412	0.15	1,247	0.46	838	0.31	821	0.30
Pipe 26	56	62	580	150	412	0.27	1,247	0.82	838	0.55	821	0.54
Pipe 29	73	72	125	150	149	0.10	438	0.29	297	0.19	291	0.19
Pipe 44	72	66	575	100	149	0.22	438	0.65	297	0.44	291	0.43
Pipe 53	44	43	145	150	81	0.05	339	0.22	215	0.14	209	0.14
Pipe 54	43	41	230	100	81	0.12	339	0.50	215	0.32	209	0.31
Pipe 55	22	12	300	150	32	0.02	563	0.37	327	0.21	315	0.21
Pipe 56	12	10	250	100	32	0.05	563	0.83	327	0.48	315	0.46
Pipe ET-1	ET	ET-H5	135	350	2,131	0.26	6,394	0.77	4,305	0.52	4,220	0.51
Pipe ET-2	ET-H5	ET-B11	440	350	1,830	0.22	5,489	0.66	3,696	0.44	3,623	0.44
Pipe ET-3	ET-B11	ET-B10	1,350	300	1,318	0.22	3,955	0.65	2,663	0.44	2,610	0.43
Pipe ET-5	ET-B10	ET-91	470	250	1,318	0.31	3,955	0.93	2,663	0.63	2,610	0.62
Pipe ET-6	ET-91	ET-90	330	65	82	0.29	247	0.86	166	0.58	163	0.57
Pipe ET-7	ET-91	ET-J9	1,150	250	1,125	0.27	3,376	0.80	2,273	0.54	2,228	0.53
Pipe ET-8	ET-J9	ET-A3	490	250	988	0.23	2,965	0.70	1,996	0.47	1,957	0.46
Pipe ET-9	ET-A3	ET-A2	1,520	250	754	0.18	2,263	0.53	1,523	0.36	1,493	0.35
Pipe ET-10	ET-A2	ET-A1	2,970	200	576	0.21	1,727	0.64	1,163	0.43	1,140	0.42
Pipe ET-13	ET-B11	ET-E21	920	100	118	0.17	353	0.52	238	0.35	233	0.34
Pipe ET-14	ET-H5	ET-99	530	100	182	0.27	546	0.80	367	0.54	360	0.53

Link ID	Start Node ID	End Node ID	Length m	Dia. mm	01:00		07:00		13:00		19:00	
					Flow	Velocity	Flow	Velocity	Flow	Velocity	Flow	Velocity
					m3/d	m/s	m3/d	m/s	m3/d	m/s	m3/d	m/s
Pipe ET-15	ET-99	ET-E20	1,340	100	80	0.12	240	0.35	162	0.24	158	0.23
Pipe ET-16	ET-99	ET-E21	530	100	-50	0.07	-150	0.22	-101	0.15	-99	0.15
Pipe ET-17	ET-E21	ET-F10	650	150	355	0.23	1,065	0.70	717	0.47	703	0.46
Pipe ET-18	ET-F10	ET-F11	1,180	150	239	0.16	716	0.47	482	0.32	473	0.31
Pipe ET-21	ET-E20	ET-F10	1,650	100	-21	0.03	-62	0.09	-42	0.06	-41	0.06
Pipe T5	T1	T4	1,000	300	4,262	0.70	4,248	0.70	4,287	0.70	4,317	0.71
Pipe T6	T4	ET	5,105	250	4,262	1.00	4,248	1.00	4,287	1.01	4,317	1.02
Pipe 47	Well	GR1	10	400	2,100	0.19	2,100	0.19	2,100	0.19	2,100	0.19
Pipe 48	GR2	GR	10	400	2,100	0.19	2,100	0.19	2,100	0.19	2,100	0.19
Pipe 50	WTP	WTP1	10	700	15,000	0.45	15,000	0.45	15,000	0.45	15,000	0.45
Pipe 51	WTP2	GR-WTP	10	700	15,000	0.45	15,000	0.45	15,000	0.45	15,000	0.45
Pipe T2	T1	T2	2,100	400	10,681	0.98	10,690	0.98	10,775	0.99	10,831	1.00
Pipe 58	T2	T3	565	400	10,681	0.98	10,690	0.98	10,775	0.99	10,831	1.00
Pipe 62	66	ET-67	300	100	60	0.09	180	0.26	121	0.18	119	0.17
Pipe 64	62	62a'	330	200	74	0.03	230	0.08	154	0.06	150	0.06
Pipe 63	62a'	66	950	80	74	0.17	230	0.53	154	0.35	150	0.35
Pipe 66	165	168	260	80	318	0.73	165	0.38	243	0.56	249	0.57
Pipe 67	168	177	650	80	200	0.46	201	0.46	175	0.40	177	0.41
Pipe 68	168	50	770	65	119	0.41	-36	0.13	67	0.24	72	0.25
Pipe 69	161	165	1,250	150	0	0.00	0	0.00	0	0.00	0	0.00
Pipe 70	165	168	260	150	0	0.00	0	0.00	0	0.00	0	0.00
Pipe 6	7	6	210	150	118	0.08	1,075	0.70	621	0.41	599	0.39
Pipe 17	6	2	385	150	118	0.08	1,075	0.70	621	0.41	599	0.39
Pipe 38	2	1	280	100	10	0.01	147	0.22	73	0.11	70	0.10
Pipe 46	1	111	110	100	-38	0.06	3	0.00	-24	0.04	-25	0.04
Pipe 60	111	110	325	80	-38	0.09	3	0.01	-24	0.06	-25	0.06
Pipe 71	110	J8	560	65	-16	0.06	24	0.08	6	0.02	5	0.02
Pipe 72	J8	I8	2,200	65	-88	0.31	-89	0.31	-85	0.30	-85	0.30
Pipe 74	C0	C1	310	250	-1,095	0.26	-2,564	0.60	-1,830	0.43	-1,803	0.43
Pipe 75	C0	C2	1,370	250	1,095	0.26	2,564	0.60	1,830	0.43	1,803	0.43
Pipe 86	I8	J8	2,200	100	274	0.40	275	0.41	263	0.39	265	0.39
Pipe 89	J8	110	560	150	145	0.09	-215	0.14	-52	0.03	-42	0.03
Pipe 90	C2	D1	2,080	250	880	0.21	1,920	0.45	1,396	0.33	1,378	0.32
Pipe 10	G11	3	350	150	168	0.11	504	0.33	339	0.22	333	0.22
Pipe 76	3	G3	1,300	100	168	0.25	504	0.74	339	0.50	333	0.49
Pipe 88	G2	4	390	150	148	0.10	443	0.29	298	0.20	292	0.19
Pipe 91	4	G4	1,040	100	148	0.22	443	0.65	298	0.44	292	0.43
Pipe 7	11	G10	1,460	250	737	0.17	2,212	0.52	1,490	0.35	1,460	0.34
Pipe 2	11	59	1,600	400	3,480	0.32	11,951	1.10	7,812	0.72	7,638	0.70
Pipe 1	GR	11	125	400	4,217	0.39	14,163	1.30	9,302	0.86	9,098	0.84
Pipe 94	8	9	10	300	2,202	0.36	5,095	0.83	3,665	0.60	3,613	0.59
Pipe 95	9	E1	475	100	113	0.17	340	0.50	229	0.34	225	0.33
Pipe 96	9	0	125	100	219	0.32	539	0.79	383	0.56	377	0.56
Pipe 101	2	110	715	150	-123	0.08	235	0.15	81	0.05	72	0.05
Pipe 103	161	152	300	100	31	0.05	92	0.14	62	0.09	61	0.09
Pipe 3	ET-B11	ET-E21	920	150	342	0.22	1,026	0.67	691	0.45	677	0.44
Pipe ET-19	ET-F11	ET-01	1,730	150	143	0.09	430	0.28	290	0.19	284	0.19
Pipe ET-20	ET-01	ET-F2	1,270	100	143	0.21	430	0.63	290	0.43	284	0.42
Pipe ET-11	ET-A1	ET-03	1,740	200	363	0.13	1,088	0.40	733	0.27	718	0.26
Pipe ET-23	ET-03	ET-A4	930	150	363	0.24	1,088	0.71	733	0.48	718	0.47
Pipe 65	9	14	125	300	1,870	0.31	4,215	0.69	3,053	0.50	3,011	0.49
Pipe 82	14	13	400	300	1,870	0.31	4,215	0.69	3,053	0.50	3,011	0.49
Pipe 97	13	161	40	150	668	0.44	1,333	0.87	1,010	0.66	999	0.65
Pipe 59	T3	15	2,140	350	10,681	1.28	10,690	1.29	10,775	1.30	10,831	1.30
Pipe 78	15	8	20	200	3,581	1.32	3,590	1.32	3,675	1.35	3,731	1.37
Pipe 99	I8	16	1,440	100	-466	0.69	-678	1.00	-560	0.82	-558	0.82
Pipe 100	D1	16	255	250	770	0.18	1,589	0.37	1,173	0.28	1,159	0.27
Pipe 73	13	17	525	300	1,201	0.20	2,882	0.47	2,044	0.33	2,013	0.33
Pipe 77	17	C1	850	250	1,201	0.28	2,882	0.68	2,044	0.48	2,013	0.47
Pipe 98	18	GR	10	300	7,100	1.16	7,100	1.16	7,100	1.16	7,100	1.16

7-5-4 Data on Reservoirs and Elevated Tanks

Time	Water Level at Reservoir/Elevated Tank (m)			
	KM4 GR	KM4 ET	Pakdong ET	WTP GR
0:00	2.50	2.50	2.50	2.00
1:00	3.11	2.95	3.09	2.00
2:00	3.77	3.43	3.72	2.00
3:00	4.08	3.63	4.01	2.02
4:00	4.22	3.69	4.13	2.04
5:00	4.24	3.67	4.14	2.06
6:00	4.05	3.49	3.95	2.08
7:00	3.49	3.02	3.40	2.09
8:00	2.83	2.50	2.76	2.10
9:00	2.66	2.38	2.60	2.10
10:00	2.64	2.38	2.59	2.09
11:00	2.58	2.34	2.54	2.09
12:00	2.50	2.29	2.47	2.08
13:00	2.41	2.23	2.38	2.08
14:00	2.39	2.23	2.38	2.07
15:00	2.46	2.29	2.45	2.06
16:00	2.47	2.31	2.47	2.06
17:00	2.29	2.18	2.30	2.05
18:00	1.81	1.83	1.85	2.04
19:00	1.54	1.65	1.60	2.03
20:00	1.55	1.69	1.63	2.01
21:00	1.59	1.74	1.68	2.00
22:00	1.79	1.92	1.89	1.98
23:00	2.03	2.12	2.13	1.97
0:00	2.50	2.49	2.59	1.96
1:00	3.11	2.94	3.17	1.96
2:00	3.77	3.41	3.80	1.97
3:00	4.09	3.62	4.09	1.99
4:00	4.22	3.68	4.21	2.01
5:00	4.24	3.66	4.22	2.03
6:00	4.06	3.48	4.03	2.04
7:00	3.49	3.01	3.47	2.06
8:00	2.83	2.49	2.84	2.07
9:00	2.66	2.37	2.67	2.07
10:00	2.65	2.37	2.66	2.06
11:00	2.58	2.33	2.60	2.06
12:00	2.50	2.28	2.53	2.05
13:00	2.41	2.22	2.45	2.05
14:00	2.39	2.22	2.44	2.04
15:00	2.46	2.28	2.51	2.04
16:00	2.47	2.30	2.53	2.03
17:00	2.29	2.17	2.36	2.03
18:00	1.81	1.82	1.91	2.02
19:00	1.54	1.64	1.66	2.01
20:00	1.55	1.68	1.69	1.99
21:00	1.59	1.74	1.74	1.98
22:00	1.79	1.91	1.94	1.96
23:00	2.03	2.11	2.18	1.95
0:00	2.50	2.48	2.64	1.94