(5) Design Conditions of Transmission and Distribution Pipe

For hydraulic calculation of transmission and distribution pipe, the following formula and values are employed:

(a) Hydraulic Formula: Hazen-William's Formula

$H=10.666 \times C^{(-1.85)} \times D^{(-4.87)} \times Q^{(1.85)} \times L$

Whereas,

H: Water Head Loss (m)
C: Velocity Coefficient (120)
D: Pipe Diameter (m)
Q: Flow Rate (m3/sec)
L: Pipeline Length (m)

(b) Maximum Daily Demand/Average Daily Demand: 1.2

(c) Hourly Demand Fluctuation (Maximum Hourly Demand/Maximum Daily Demand): 1.2

(d) Minimum Residual Pressure at the End of Distribution Pipe : 1.5kg/cm2

4.3 Basic Plan

4.3.1 Upgrading and Rehabilitation of Chinaimo WTP (Referred to Figs 4-2 to 4-7)

(1) Intake Facility

Intake Facility: The production capacity of Chinaimo WTP will be expanded from the existing capacity of 40,000 cmd to 80,000 cmd. For this upgrading, the capacity of the intake facility shall be also expanded. The designed intake capacity shall be the planned treated water (the outflow from the plant) plus miscellaneously used water at the plant such as backwash water at the filters, desludging water at the sedimentation basins, etc. The quantity of water miscellaneously used in the plant is estimated at about 5-6% of the treated water. But 10 % is employed with the designed intake capacity of 88,000 m3/d to aim at providing extra capacity for safety.

At present there are four(4) intake pumps (vertical shaft type) in the intake tower pump room.

Among them one(1) is for standby, therefore, the total intake capacity by three pumps is 77,760 m3/d.

For expanding the treatment capacity therefore addition of intake pumps or replacement of the existing pumps with the others having large capacity are inevitable.

Although there will be several alternatives to augment the intake capacity, the following three(3) cases are considered in selection, considering the existing pump room and pump layout.

Case 1 : All existing pumps replaced by four new pumps, vertical shaft type, with a discharge of Q=20.4 m3/m each (1 standby)

Case 2 : Two existing pumps replaced by two new pumps, vertical shaft type, with a discharge of Q=25.1 m3/m each,

Case 3 : Installation of two new pumps, submersible type, with a discharge of Q=18.0 m3/m each, in addition to the existing four pumps (Q=18.0 m3/m) (1 standby)

Studying the above three cases, Case 3 is concluded most appropriate because of the following reasons:

(a) By utilizing fully the existing equipment, the cost can be minimized.

(b) Installation of additional pumps is easier than replacement of the existing pumps.

(c) Standby capacity is the largest among others and it serves to increase the reliability of the facility.

(d) The discharge capacity of the each pump is same, and minimal among three cases. In addition the number of pump unit is more than the other cases. Therefore Case 3 is convenient for fine pump operation to meet the required quantity.

Silt Removal: The maintenance problem involved at the intake is silt accumulated in front of the intake tower, which interferes water intake. In order to remove this deposit, NPL has been renting a dredging boat every year and spent 4 million Kips/year. In this removal work, NPL's work force has been also injected to remove the deposit which could not be removed by machine. In order to rectify the circumstance, the following dredging method is examined:

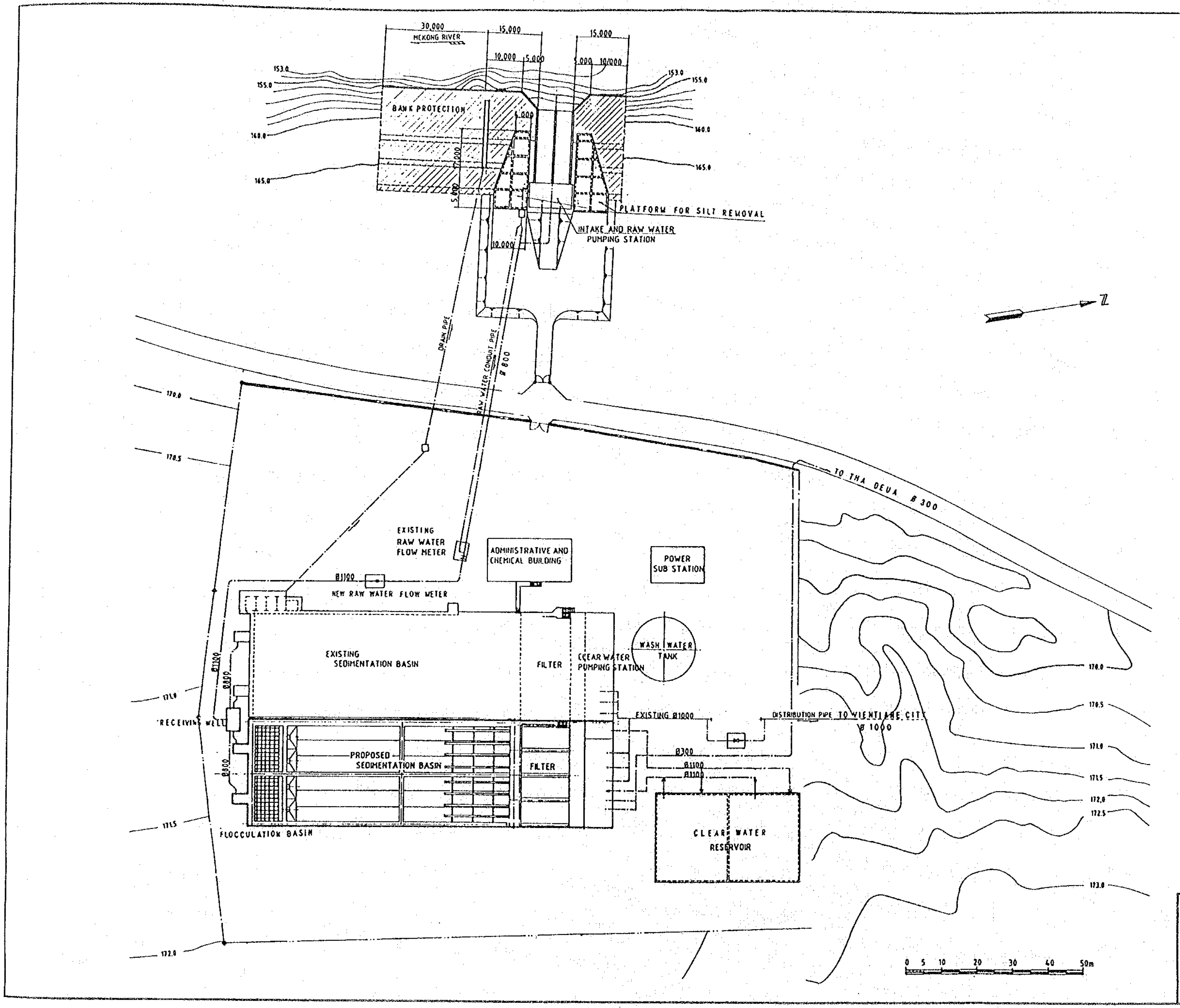


Fig.4.2
GENERAL PLAN OF CHINAIMO WATER TREATMENT PLANT

S=1:1000

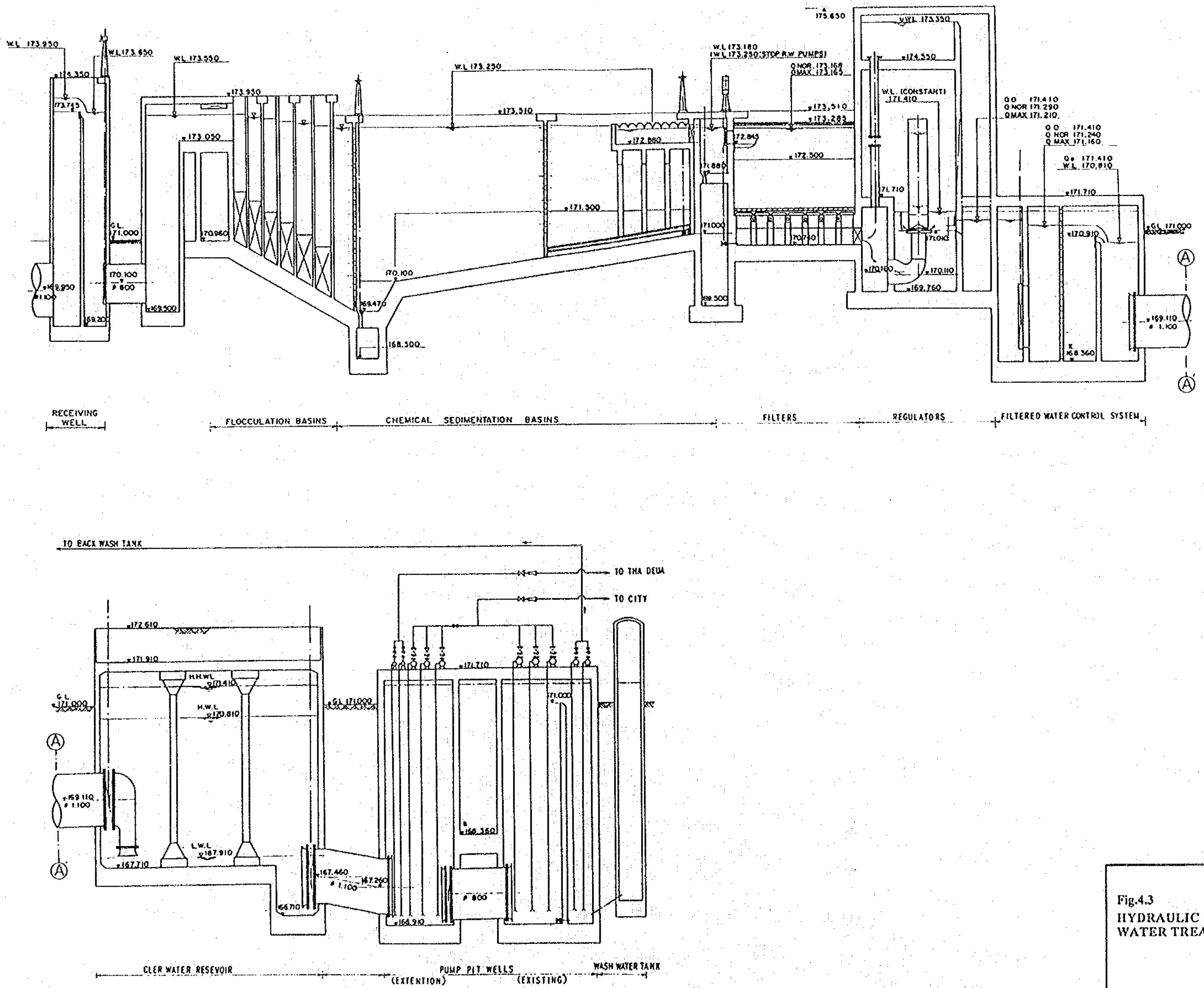


Fig.4.3
HYDRAULIC PROFILE OF CHINAIMO WATER TREATMENT PLANT

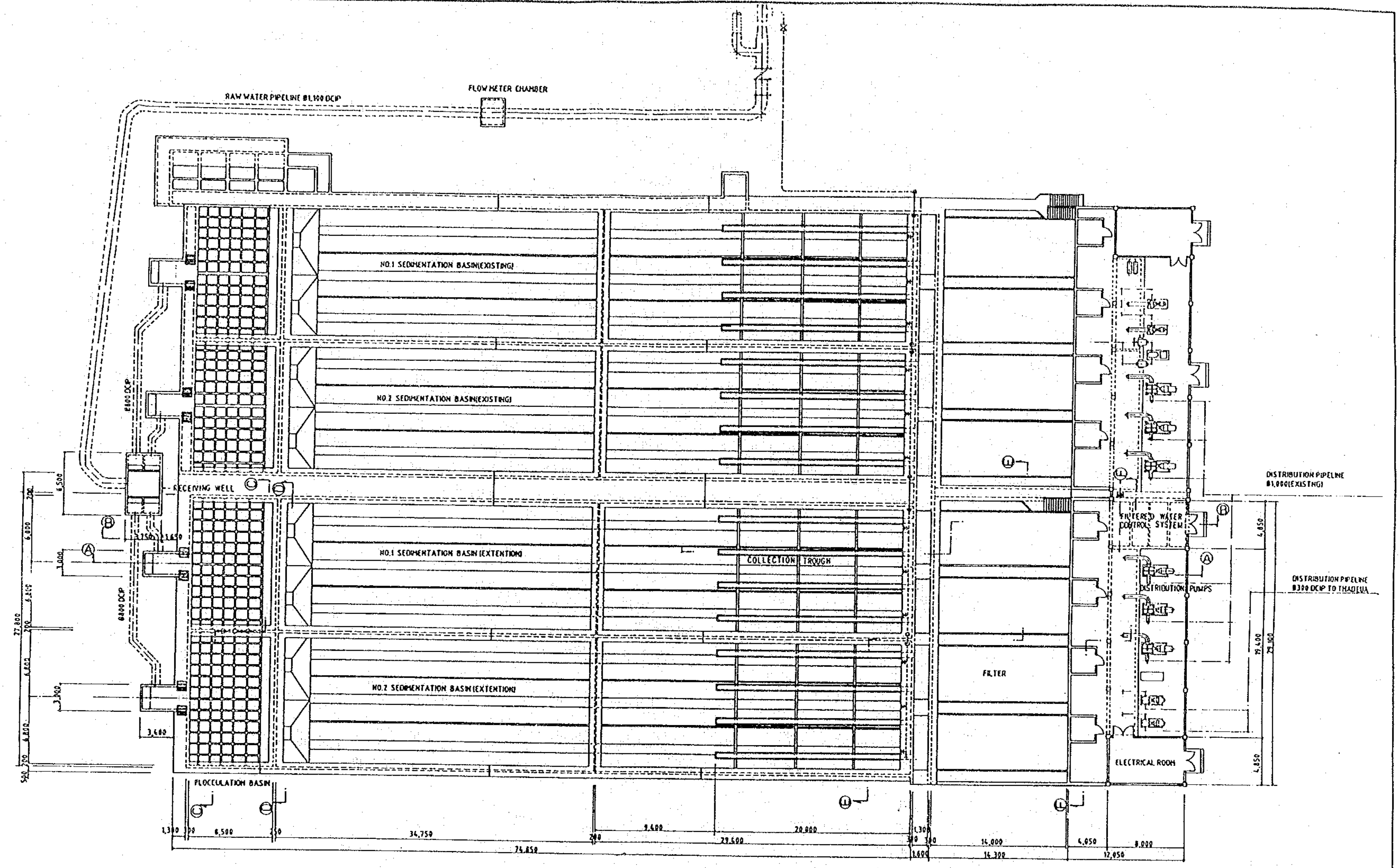


Fig.4.4
PLAN OF SEDIMENTATION BASINS AND FILTERS

S=1:400

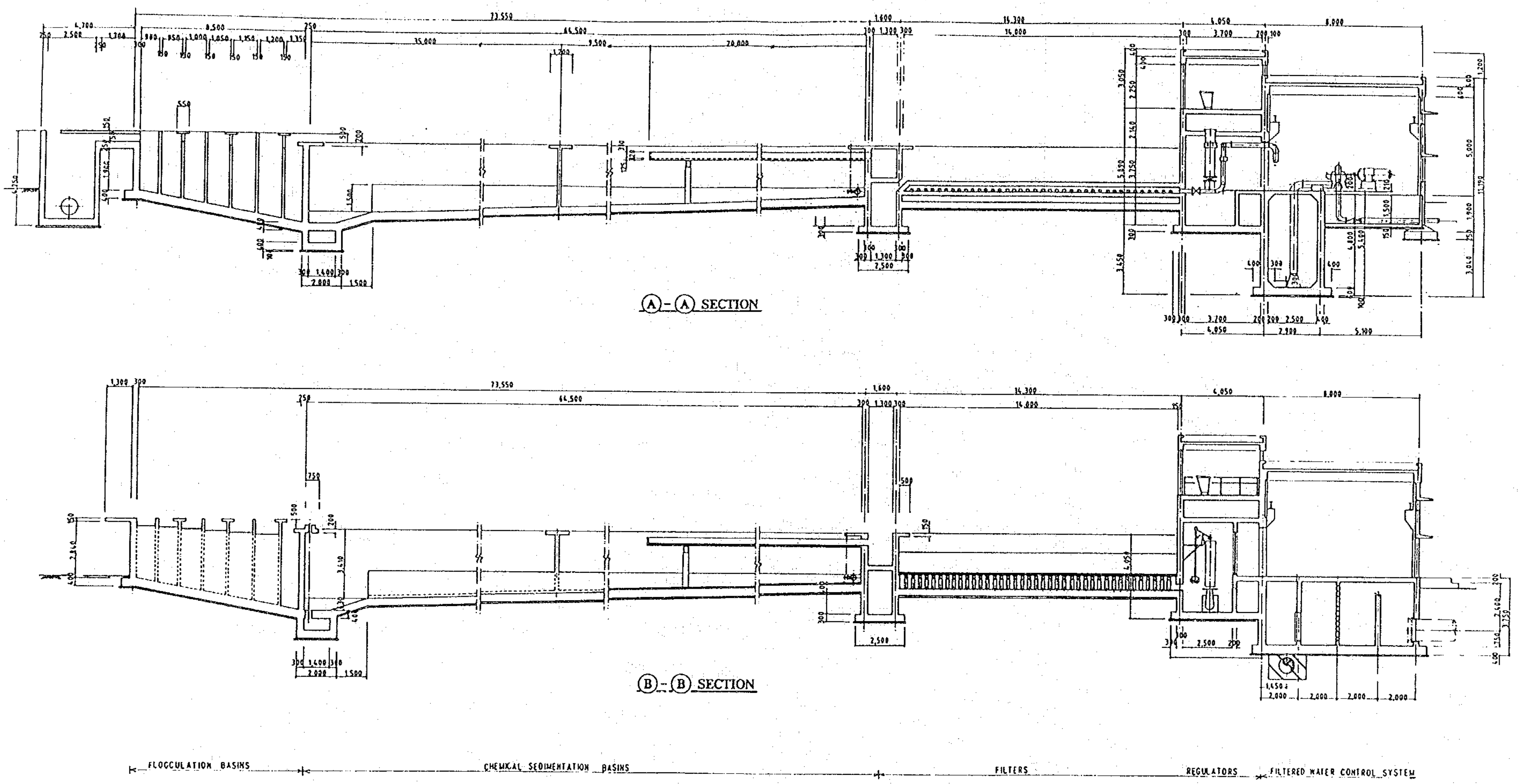
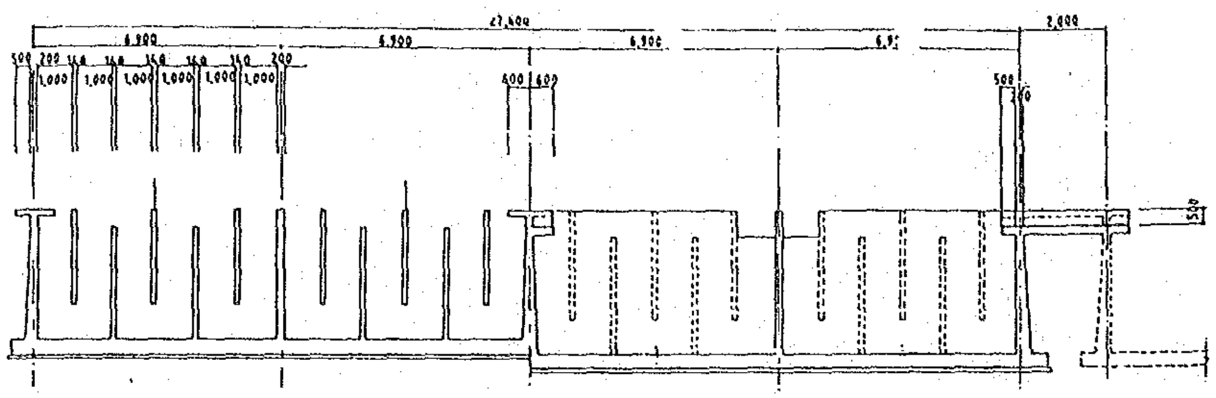
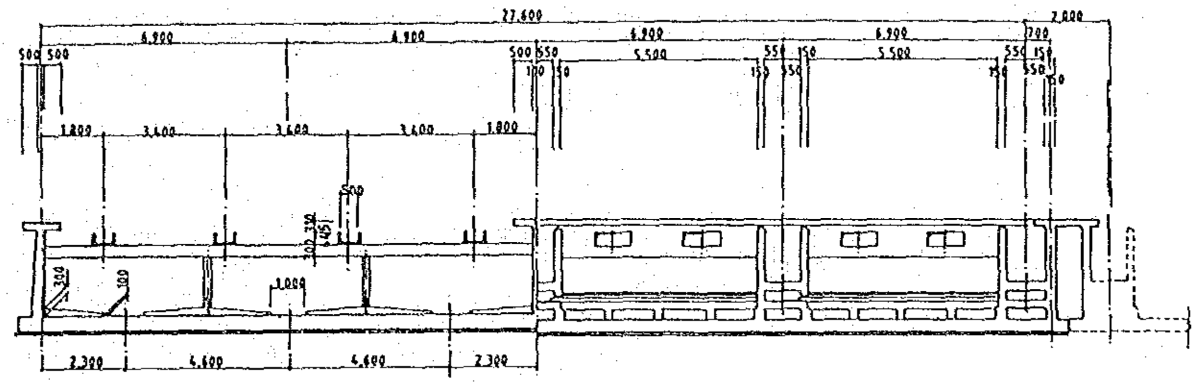


Fig.4.5
SECTION OF SEDIMENTATION BASINS AND FILTERS (PART 1)

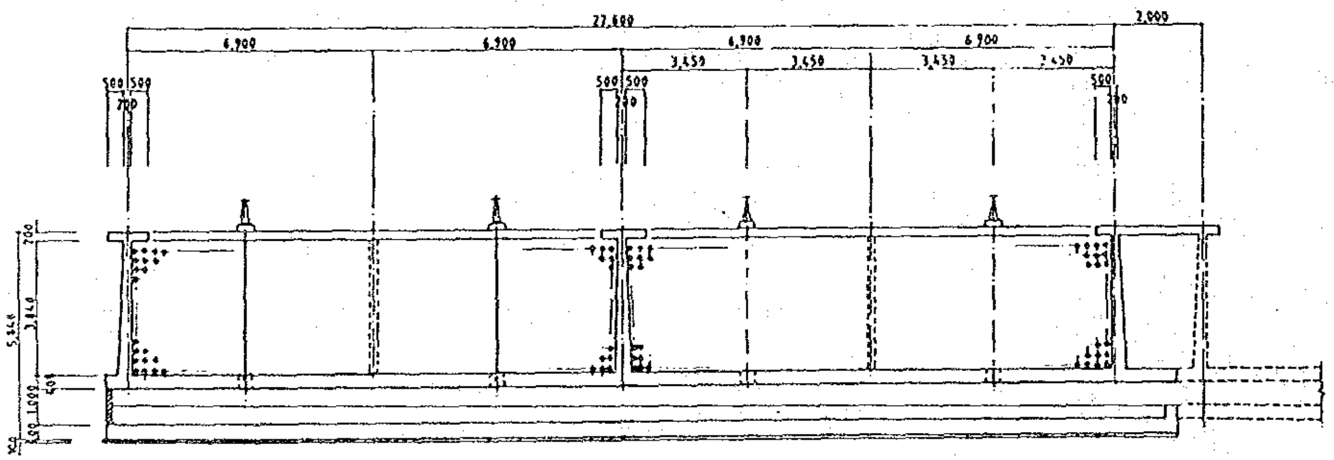
S=1:200



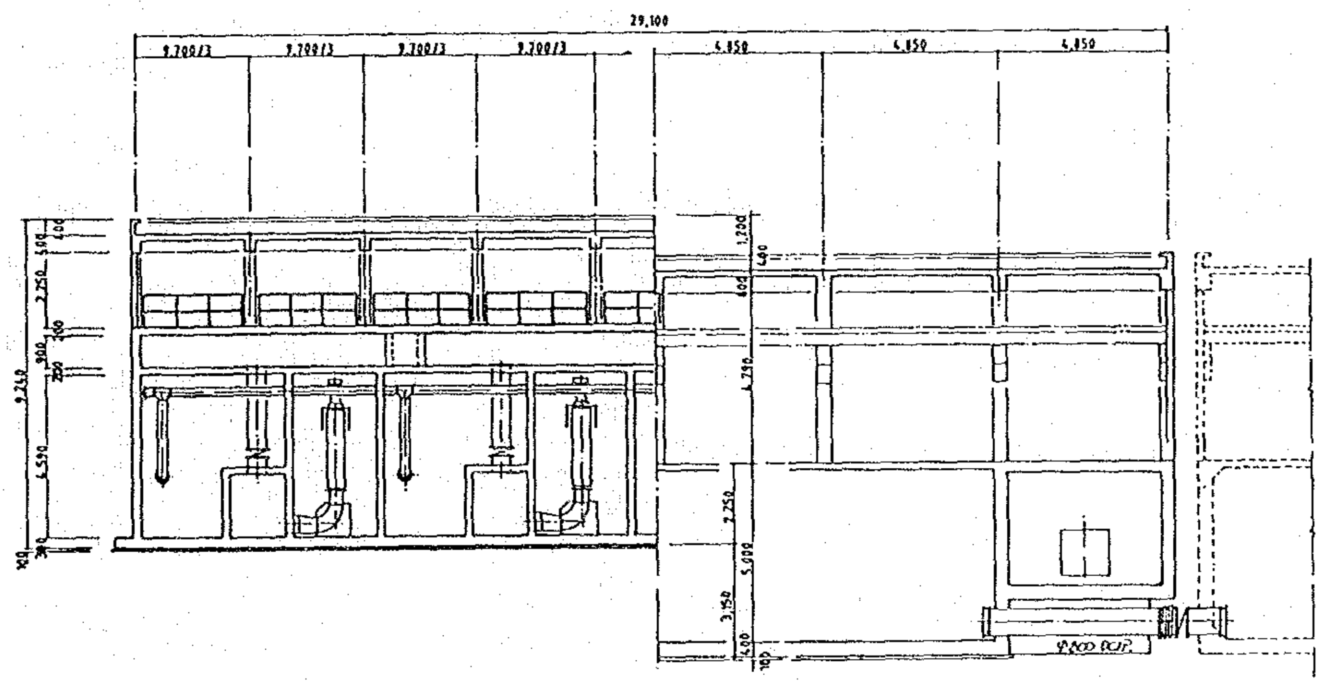
Ⓒ-Ⓒ SECTION



Ⓔ-Ⓔ SECTION



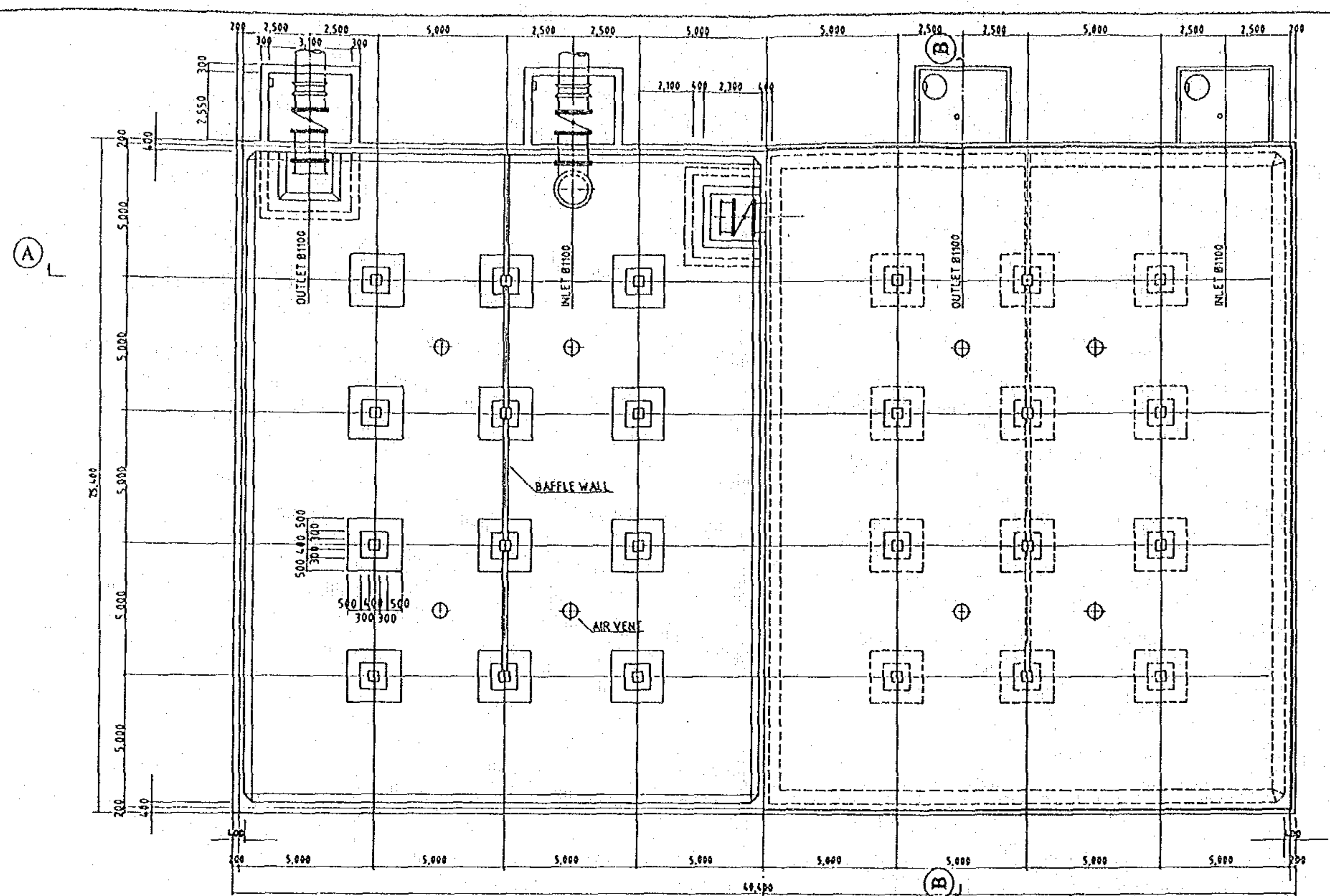
Ⓓ-Ⓓ SECTION



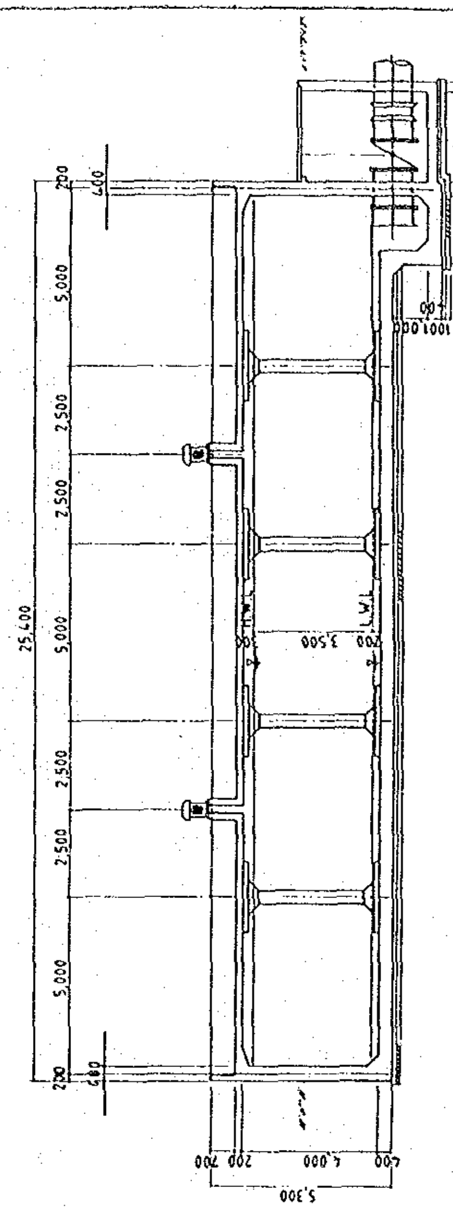
Ⓕ-Ⓕ SECTION

Fig.4.6
CROSS SECTION OF SEDIMENTATION BASINS AND FILTERS (PART 2)

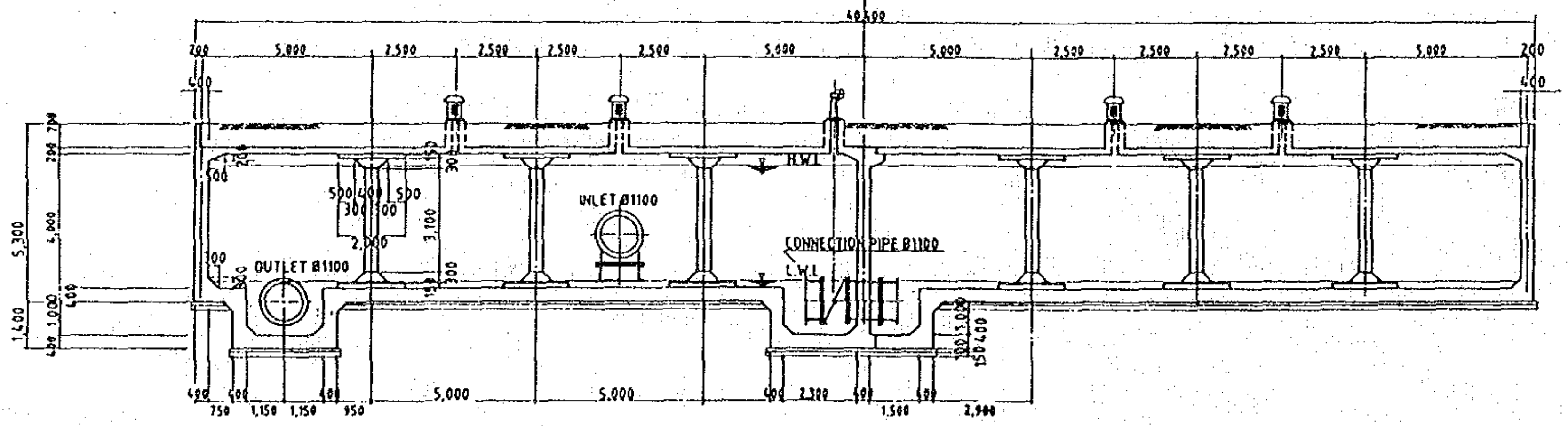
S=1:200



PLAN



Ⓑ - Ⓑ SECTION



Ⓐ - Ⓐ SECTION

Fig.4.7
PLAN AND SECTION OF
CLEAR WATER RESERVOIR

S=1:200

Case 1 : Dredging pump suspended by gate crane
Case 2 : Clamshell installed on fixed crane
Case 3 : Oil pressure driven excavator with caterpillar(telescopic type clamshell)

Among the above, Case 3 is proposed because of the following reasons:

(a) According to information from staff concerned, the flow velocity of the Mekong River reached 3 m/s and lots of floating woods came around the intake tower. Case 1 which requires construction of many columns is therefore not suitable since floating woods may hit these columns, eventually destructing the whole dredging facility.

(b) The existing soil deposit area is wide and lengthy and the fixed type clamshell crane (Case 2) shall have the wide working range (about 16 m in diameter). The wider the working range, the longer boom and the larger lifting (60 tons) the crane shall have as its capacity. The clamshell crane prevailing in the market, however, has the capacity of around 20 tons at most. Even if 60-ton clamshell could be purchased on order basis, their effective maintenance might not be attained due to limited spare parts in the Lao PDR.

(c) Oil pressure driven excavators with caterpillar is mass-produced and available at a relatively low price. Further, construction of an access platform at both sides of the grit chamber is considered effective for dredging the base of the intake channel 14.5 m below. The upper slab of access platforms shall be not lower than the HWL (171.45 m) of the river (Refer to Fig. 4-2).

Geared Trolley Type Hoist Chain: In the intake pump room there is a chain hoist of manual type (chain block type, 5 tons capacity) installed. This hoist shall be replaced to the electric type by which the working hour to move the pump equipment can be reduced. In addition one set of the new chain hoist shall be extended since the number of the pump units is increased under the present project.

MCC(Motor Control Center): MCC for the submersible pumps is to be installed. While the existing MCC will be used for the existing pumps, electrical appurtenances such as magnet switches, etc. which have been worn down are to be overhauled.

Water Level Meter: The existing differential pressure type level meter installed at the intake pump chamber is not functioning due to silts accumulated inside the meter casing. To ensure reliability and accuracy of monitoring, ultrasonic type level meter, instead, is recommended.

Bank Protection: Existing drain channel discharges the waste from the plant to the Mekhong River. The bank where the channel is installed is scoured by the river flow. To avoid sliding of the channel, the bank protection by armored gabion is definitely required.

(2) Raw Water Transmission Facility

Raw Water Transmission: The existing raw water conduit is steel pipe of 800 mm in diameter. When the existing treatment capacity is expanded, the present raw water conduit can not capacitate the increased quantity. Thus the new raw water conduit of the same diameter shall be installed from the intake chamber to the existing flow meter chamber, in parallel with the existing conduit. As explained in the section of the receiving well, a new receiving well shall be constructed under the project. The new raw water conduit between the existing flow meter chamber and the new receiving wells will be ductile cast iron pipe of 1,100 mm in diameter.

Raw Water Flow Control Valve: The existing plant has an overflow discharge facility from where the excess quantity of the raw water is discharged to the Mekong River when it is overpumped. This is obviously waste of the energy. Under the present design, therefore, a raw water flow control valve will be installed to maintain the constant water level at the settled water channel (the channel between the sedimentation basins and the filters) so that the settled water can be controlled and the wasteful overflow can be avoided.

Chemical Dosing Point and Rapid Mixing: The existing rapid mixing basin was constructed as one structure together with the sedimentation basin and are located between the receiving well and the flocculation basins. The mixing equipment is of mechanical type and three (3) units of mixer (5.5kW each) are currently under operation. The problems involved in this system are that (a) the distance between the feeders in the chemical building and the rapid mixer is far, because of which alum dosing pipe is frequently clogged by the precipitates and (b) some maintenance services such as replacement of belts, painting of metal parts, etc. are needed.

In order to solve these maintenance problems, the present design proposes changes of the chemical dosing point and the mixing method. The proposed dosing point is right after the raw water flow control valve and alum and pre-chlorine are to be dosed therein. By this change, the length of alum pipe can be shortened by about 40 m. Right after the dosing point, an orifice plate will be installed to mix the raw water and the chemical. The rapid mixing will be made through the turbulent flow caused by the combination of the flow control valve and the orifice plate. Since the proposed system has no movable units, easy maintenance can be attained.

Raw Water Flow Meter: A raw water flow meter of ultrasonic type is proposed about 20 m downstream of the raw water control valve. The purpose of this meter is to determine the dosage rate of chemicals, in particular, alum dosage which shall be controlled subject to changes of the quantity and quality of the raw water. To this end it is indispensable to know the exact quantity of raw water for operation.

Receiving Well: By expansion of the treatment plant, there will be four(4) sedimentation basins including the existing two basins. To distribute the raw water equally to each of the four sedimentation is very important in water treatment. By having the equal distribution of the raw water to the basins, it can be possible to maintain the constant flow to the flocculation basins and to attain the designed velocity and retention time at the flocculation basins. Consequently, large floc and efficient sedimentation are expected.

The existing facility which connects the rapid mixer and the flocculation basins by the open channel is not preferable in terms of having equal distribution. From this standpoint, the present design proposes construction of a receiving well with a weir which can distribute the water equally to the sedimentation basins. At each of the outlet of the basin, an open/close gate is to be installed so that each of the sedimentation basins can be operated independently.

Raw Water Sampling: There is a raw water sampling pump (35 l/m) equipped in the existing raw water flow meter chamber to collect the raw water for testing. However this pump is out of order at the moment. Therefore, sampling system by means of raw water intake pump is proposed instead of using sampling pump, by modifying the existing piping. Sampled water will be directly transferred to the laboratory by water pressure generated by the raw water pump. An absence of sampling pump will result in the system having less mechanical troubles.

(3) Flocculation

Receiving Well-Flocculation Basins Connecting Pipe: Ductile cast iron pipe will be used to connect the receiving well with the flocculation basins.

Flocculation Basins: The existing flocculation basins are of mechanical type equipped with four(4) units of flocculators. The flocculator consists of driving units and mixing vanes. A driving unit requires periodical maintenance services such as lubrication, overhaul, etc., while vanes shall be periodically painted for rust prevention. The vanes have been often repaired because of damages caused by sludge accumulated on the bottom of the basin. In order to alleviate such maintenance troubles and formulate good flocs, a zigzag flow type flocculation basin is recommended. For this purpose the existing flocculation basins shall be partly modified. Flocculation basins of zigzag flow type is to achieve slow agitation by utilizing hydraulic energy of the water flowing in the basin. Thus no mechanical equipment is needed and easy maintenance is attained. As seen in Kaolieo WTP, good flocculation can be expected by this method.

At the inflow side of the flocculation basin, there are gates (700 mm x 700 mm), which will be no more necessary upon completion of the receiving well. Therefore, this gate will be removed and located at the settled water channel.

(4) Sedimentation Basin

The existing sedimentation basins will be modified by the reasons stated below. The new sedimentation basins will be exactly of same structure as the modified sedimentation basins.

Overflow Weir: The existing sedimentation basin is not working efficiently. In general the turbidity of the settled water is around 5-6 NTU or less, but at the time of investigation, it was around 15-40 NTU. This is conceivably due to the density flow currently occurring in the basins because of difference in temperature of the water between the upper and the lower layers. Namely there are two water layers, warm water in the upper layer and less warm water in the lower layer which do not mix together, and the water in the lower layer flows faster than the other, resulting in lowering the efficiency of sedimentation. In order to improve this condition, the existing PVC outlets are replaced by effluent troughs with 20m long along the water flow direction.

Inlet Perforated Wall: The existing sedimentation basins are equipped with the inlet baffle wall called split roll which presumably causes the density current. To rectify this phenomenon the wall shall be reconstructed with a 6 % opening ratio.

Intermediate Perforated Wall: In order to lessen the density current, an intermediate perforated wall is proposed with the same design as the inlet perforated wall.

Separation Walls: In order to facilitate sludge removal which has been done by manpower, separation walls are recommended on the bottom of the basins. The wall is about 0.5 - 1.0 m deep and be installed in two numbers along the water flow direction.

Flush Water Pipe for Sludge Removal: At the far end of the sedimentation basins, a pipe of 250 mm in diameter which is branched from the raw water conduit is to be installed to flush sludge accumulated on the bottom of the basins. A gate valve of 150 mm in diameter is to be installed on the pipe for each partitioned basin. In case of sludge removal from the basin the valve will be opened.

Desludging Valve: At the sedimentation basins, desludging valves are installed but not functioning well with leak. Valve bodies and shafts made of forged iron are to be replaced by those made of stainless steel.

Washing Pipes: The existing submerged washing pipes (75 mm in dia.) will be reinstalled above the surface of the water in the sedimentation basin for maintenance purpose.

Washing Pump: The existing pump will be replaced by new one because of its age. Current water source for washing is raw water in the existing receiving well. The source will be changed and taken from pressured water in the flush water pipe.

Partition Gate: The existing settled water channels can not be dried independently. In order to facilitate operation and maintenance including washing, the gates are installed to separate each channel. For this, the gates existing at the inlet channel of flocculation basins are used.

Drain Valve of Settled Water Channel : In parallel with installation of the partition gate, drain valves(150 mm) will be installed at each unit of the partitioned channels.

Water Level Meter: The existing water level meter of air bubble type measures the water level of the settled water channels and regulates the operation of raw water pump by automatic control unit (AMPLICET). But this meter shall be replaced with electrode type water level gauge in two (2) numbers (1 standby) and it regulates the raw water control valve.

(5) Filter

A planned filter to be constructed is of the same type as the existing one. The following describes the repair and remodeling of the existing filters.

Inlet Valve: At the inlet of the filter basin there are flap valves installed. The flap valves are all deteriorated and not working satisfactorily. They shall be replaced with gates made of cast iron (pneumatic type) and the same type of gates are also installed at the new filters.

Air Blower: There is only one unit of air blower for air scouring, installed in the pumping station with no standby unit. But when the treatment plant is expanded, frequency of air scouring increases. Therefore one standby unit is added under the project to increase reliability of the system.

Air Compressor: The existing two air compressors are running at the moment but they shall be overhauled to secure reliable operation in the future.

Clogging Meter: There is a pressure gauge of air bubble type installed at each of the filter basins to measure the filter loss head. But this type of gauge is not appropriate to measure small changes of loss head. Therefore a pressure gauge of differential pressure type is proposed to replace the existing ones. The head loss will be shown on the console desk of each filter and the graphic panel of the central control room.

Flow Rate Controller (Valvocet): Some of the flow rate controllers are not working satisfactorily when investigated. Since these controllers are important equipment among others for filtration they shall be totally overhauled.

Filter Sand and Underdrain System: The existing underdrain system is constructed of porous concrete slab which however has been sometimes damaged and repaired. The reason of damage is that the porosity of the slab has deteriorated and been broken during backwashing. According to NPL staff, this damage has occurred at every filter basin. Therefore it is necessary to repair the damaged underdrain system and reconstruct the porous concrete slab. At the same time filter sand must be sieved and graded to meet the required uniformity coefficient and sand be added where necessary.

Total Filtered Water Controller: The existing treatment plant has no system to control the total filtration quantity which is necessary when the total production is increased from 40,000 cmd to 80,000 cmd. In order to provide such operation as to meet variable water demand, a total filtered water controller consisting of a weir, a flow meter of float type and a gate will be installed after the filter basins so that the required quantity of filtered water can be set. The location of the controller is inside the distribution pump room and between the existing and the new pump wells.

Water Level Meter at Wash Water Tank: There is a water level meter of electrode type in the wash water tank. But this meter is seriously eroded and not working well. Thus it should be replaced with a new one.

Expansion of Treatment Plant: In addition to the above facilities, construction of flocculation basins, sedimentation basins, filters, transmission pump room, pump well and clear water reservoir is needed to expand the production capacity by 40,000 cmd. Among them, flocculation and sedimentation basins are of same construction as of the existing ones. The flow controller of filters is also the same as the existing one.

(6) Distribution Facility

Transmission and Distribution Facility: Upon expansion of production capacity by 40,000 cmd, the number of transmission (distribution) pumps shall be increased. For the existing service area, three(3) units of transmission pumps of the same capacity (14 m3/m x 56 m x 180kW) as of the existing one are installed, out of which one is for standby. Therefore the total number of pumps after expansion is six(6) units out of which two(2) are for standby. The existing three(3) pump units are to be overhauled and three(3) motor units are to be replaced by brushless type.

For Tha Deua district, two(2) units of transmission pumps (4.3 m3/m x 66 m x 80 kW) which can exclusively transmit the water to the district are to be installed. By this way an elevated storage tank to be constructed on the midway to Tha Deua can be filled with the water all the time.

<u>Gate Valve for Transmission Pump</u>: There is an open-close gate valve of manual type installed at each delivery pipe of the existing transmission pump. But this will be replaced by motor driven type in order to have the automatic pump operation. The automatic operation method is discussed in detail in section (8).

<u>Vacuum Pump</u>: The existing vacuum pump for starting the transmission pump is to be overhauled.

<u>Clear Water Reservoir</u>: No clear water reservoir is existing at the moment. So a new reservoir with the capacity of 3,300 m3 will be constructed. Detailed discussion on the storage capacity of reservoir is made in section 4.2.1 (5). The connecting pipe from the total filtered water controller to the clear water reservoir and the pump well is ductile cast iron pipe of 1,100 mm in diameter.

<u>Transmission and Distribution Flow Meter</u>: On the transmission main there is a flow meter of dull tube type in 600 mm installed, which however is out of order at the moment. The measuring range is up to 48,000 m3/d. Therefore it shall be replaced with the one of ultrasonic type having the measurable range of up to 100,000 m3/d, considering the accuracy and easiness of maintenance. For Tha Deua district, the same type of meter having a measurable range of 0 to 7,500 m3/d will be installed.

<u>MCC</u>: The motor control center (MCC) for the existing air blower, backwash pump and vacuum pump is to be overhauled and the MCC for the distribution pumps is to be replaced. The new MCC for air blowers and transmission pumps including those for transmission to Tha Deua district will be installed inside the electric room of the new pump station.

(7) Chemical Feeding Facilities

Alum Solution and Feeding Facility: In order to expand the production capacity to the proposed level, it is necessary to double the existing capacity of alum solution and feeding facility. At the moment there are two(2) units of solution tanks with the capacity of 7.25 m3 each. Although it is theoretically possible to add two(2) units to meet the production increase, such is not advisable because the existing tanks are deteriorated seriously with lack of antiacid tiles dropping from the wall and the concrete wall eroded. Because this reason, construction of four(4) units of the alum solution tanks with epoxy lining is proposed.

The existing mixer is eroded seriously and is considered not possible to be transferred to the newly constructed tanks, thus the new equipment is installed.

The existing alum doser, rather important among others, is heavily damaged and is no longer functioning. Therefore two(2) sets of doser (one for standby) of gravity feeding type is to be employed.

Hypochlorite Solution and Feeding Facility: There are two(2) units of hypochlorite solution tanks with the capacity of 1.0 m3 each. In order to meet the expanded production capacity, one(1) solution tank will be constructed. The existing tanks are to be improved. The tanks are of RC construction with epoxy lining.

The existing mixers are seriously eroded by chlorine and are not possible to be transferred to the new tanks. Thus new mixers are installed. The hypochlorite dosers are of same type as that employed for alum and installed in three(3) numbers.

Slaked Lime Feeding Equipment: The existing slaked lime feeding equipment was designed for pre and post alkaline feeding but the feeding pump is removed and the equipment is not working at the moment.

According to the raw water analyses and jar testing conducted in Japan, it is not necessary to make pre alkaline feeding because the alkalinity of the raw water is constantly around 100 to 115 over the year, no less than 100. Although the alkalinity will decrease by dosing of alum (alkaline 0.45 mg/l decrease against alum 1.0 mg/l dosage), the alkalinity of the settled water will drop to 28 degree only when alum of 160 mg/l (at maximum) is injected to the raw water with 100 mg/l alkalinity. Considering the point that alkalinity of 20 degree is necessary to attain satisfactory flocculation, the raw water meets this level, thus no pre lime feeding is necessary.

The pH level of the water also decreases when alum is injected. According to the result of jar testing, it is considered that the pH level will decrease to about 6.3 when alum of 160 mg/l is dosed. This value is less than what is designated by WHO (6.5<pH<8.5). During the period when the high turbidity occurs, therefore, post alkaline dosing is necessary to raise pH from 6.3 to 6.5 by injecting about 10 mg/l of slaked lime.

The post alkaline shall be dosed to the filtered water and the dosing point at the downstream of the total filtered water controller is considered appropriate because of sufficient mixture with the filtered water expected therein.

The existing feeding system transfers the lime slurry by the pump through the pipe. But this system involves scale sedimentation inside the pipe as well as transferring the residual to the clear water reservoir. In order to rectify this problem, construction of a saturator (a tank to produce the saturated slaked lime) is proposed. The saturator is of rectangular shape and to saturate the slaked lime by injecting the clean water from the bottom of the tank and collecting the saturated slaked lime (0.17 %) from the top of the tank through a weir. The saturator is of RC construction with the capacity of 45 m3, equipped with a mixer and slurry transfer pump.

MCC: The existing MCC for the chemical feeding facility is replaced by the new one to cope with the increased number of the mixers.

(8) Electric and Instrumentation Equipment

Power Substation: The existing substation has a capacity of 1,000 kVA and no standby equipment is existing. In order to increase the treatment production, this capacity should be increased to 2,000 KVA. Without stopping the plant operation, a new facility of 2,000 kVA will be constructed first and the wire connection work to the existing equipment be made later so that the plant operation is stopped at minimum. Upon completion of the new substation, the existing is reserved as 50 % standby.

Monitoring Panel: For expansion of the treatment plant, the monitoring panel will be improved so that the overall plant operation can be easily monitored. Although the existing system is equipped with water level meters, flow meters and other gauges which indicate the operation status of each equipment, they can not serve for the operators to tell what these data from the existing meters and gauges indicate in the plant operation. Therefore it is difficult for them to take quick actions toward the plant operation even if necessary.

In order to improve this circumstances, installation of a graphic panel visualizing the treatment process is proposed in the central control room. From this panel, operators can monitor easily what are happening at each of the facilities and can take quick actions considered necessary.

The graphic panel will show the following information:

(a) Intake Facility: Status of pump operation including out-of-order condition, water level at the pump well and alarming.

(b) Raw Water Conduit: Flow rate and integral calculation

(c) Sedimentation Basin: Water level alarm at the settled water channel

(d) Filter: Filtration head loss and alarm, total filtration rate and integral calculation, backwash pump operation including out-of-order condition, blower operation including out-of-order condition and water level at the wash water tank and alarm

(e) Distribution Facility: Distribution pump operation including out-of-order condition, pump delivery head and alarm, flow rate and integral calculation, water level at the clear water reservoir and alarm and opening ratio of the distribution flow control valve.

(f) Chemical Feeding Facility: Water level at the alum solution tank and alarm, operational condition of mixers for alum, hypochlorite and slaked lime saturator

Automatic Control for Transmission Pump: Water transmission will be made by pumps to deliver water to the city area and to Tha Deua district. Because of difference in geographical conditions, different control system will be employed for each district. Namely, for the city area, the automatic control system must be such as to control or determine the number of pumps to be operated and the opening ratio of the flow control valve since the water shall be transmitted according to the predetermined water pressure. However, for Tha Deua district, the system will be on-off control type since the pump is to be operated when the water level of the elevated storage tank is low and stopped when the water level reaches the designed high water level. For both systems, manual operating system is also equipped for backup purpose.

(9) Others

Interphone System: Although there is an interphone system in the plant it is out of order and not used at present. For expansion of the plant it is necessary to have close communication among the central control room, the intake site, the distribution pump room and the laboratory. Therefore, a new interphone system is proposed, instead of repairing the existing system, in order to secure a reliability of the system operation.

Draft Chamber: There are two(2) sets of draft chambers (a table with blower for test by which toxic gas emerged). But the sink and the table legs are eroded causing leaks. Therefore these chambers are removed and a new draft chamber and a sink are to be installed.

Jar Tester: There is a 5-series of jar tester in Kaolieo WTP which is supposed to test five test samples at one time. But this tester has already got old and only three samples can be tested. Since the jar tester is the one to determine the optimum chemical dosage rate by changing chemical dosage at the different levels, several numbers of testers shall work satisfactorily at the same time. Therefore a new set of jar tester is to be purchased.

Electrical and Mechanical Tools: In operating the treatment facilities, maintenance services including testing, checking and repair are the daily activities of the working staff. Although substantial repair requires exclusive expertise, minor repair and maintenance services shall be carried out by the NPL personnel for which electrical and mechanical tools should be provided. The list of tools which are minimum necessity is shown in Table 3.4.

4.3.2 Pipeline Extension to Tha Deua (Referred to Figs 4-8 and 4-9)

As stated in Section 4.2, the pipeline extension to Tha Deua district includes a pumping system to transmit water from the treatment plant to the elevated storage tank and a gravity system from the elevated storage tank to the service area. The elevated storage tank is to be constructed 6.2 km east to Chinaimo WTP along Route No.2. The major facilities included are (1) transmission mains from the treatment plant to the elevated storage tank, (2) the elevated storage tank and (3) distribution mains to Tha Deua district.

(1) Transmission Mains

Pipe Length and Flow: The pipe length between the plant and the elevated storage tank is 6,200 m and the designed flow capacity is 6,080 m3/d.

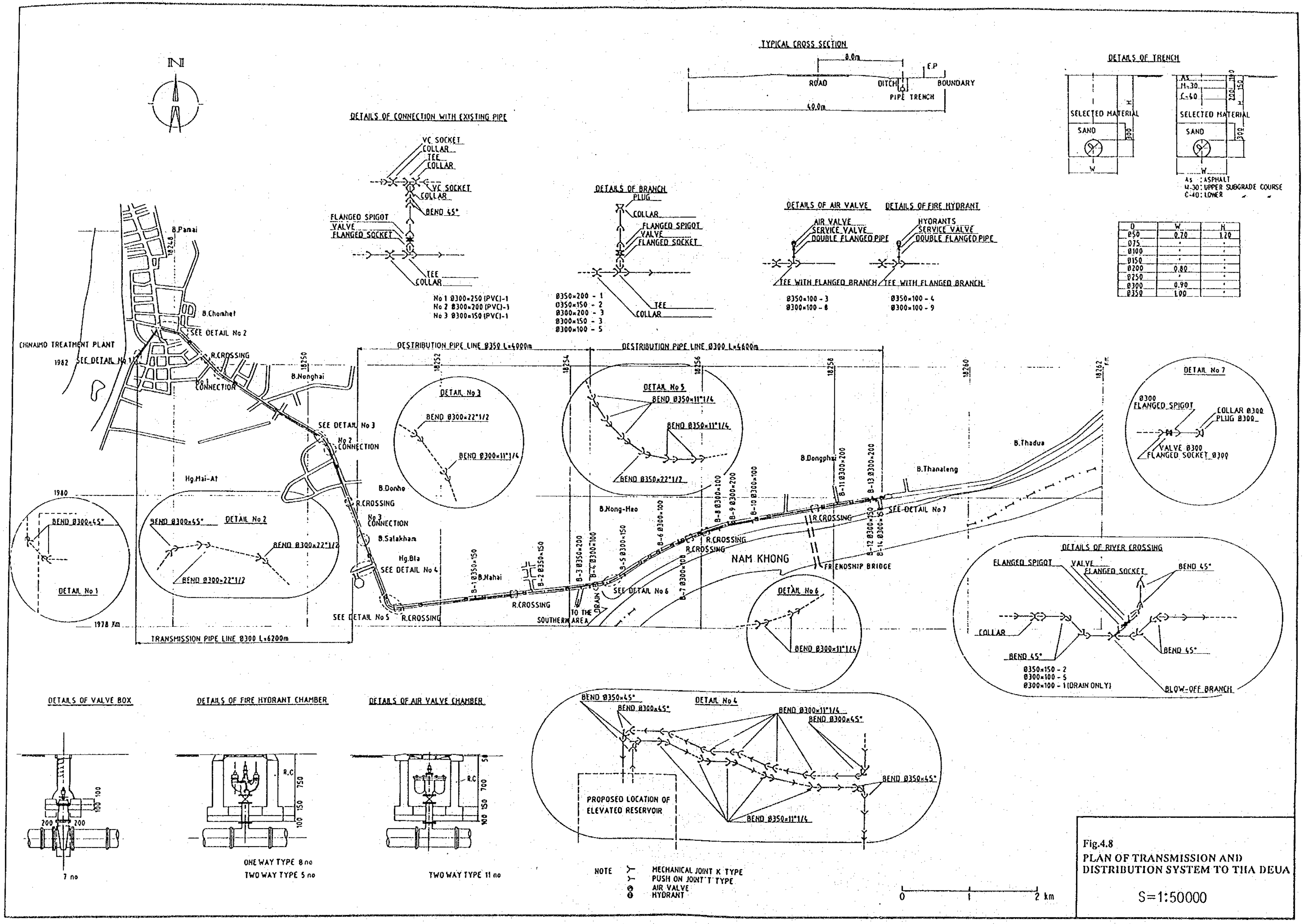
Determination of Optimal Pipe Diameter: The optimal pipe diameter should be so determined as to lead the total cost of construction and operation to the minimum. Namely the construction cost includes those of pipe materials and installation and pump equipment, and the operation/maintenance cost involves the cost of pump operation. The smaller the pipe diameter is, the greater the pump lift is required and vice versa. From this point of view, a cost comparison including the construction and operation costs are made for three different pipe diameters. The installed pumps will be replaced after passage of 20 years (life span). The cost estimate is made by employing 30 year calculation period and 8.0 % discount rate. The maximum pumping head is set at 36.0 m because of construction restraint of the elevated storage tank. The result of calculation is shown below:

Item	Alt. 1	Alt. 2	Alt. 3
pipe dia.(mm):	250	300	350
pump delivery head(kg/cm2)	10.1	6.6	5.3
motor output(kW)	100	75	55
construction cost(1,000 yen)	150,100	174,400	205,400
operation cost(1,000 yen/year)	2,044	1,533	1,124
Economic Evaluation Based on the Present Value Method			
Present Value in 30 years (1,000 yen)	176,561	194,541	220,568

Among three alternatives, Alternative 1 is the lowest in the total of construction and operation costs. However Alternative 1 which requires the pump delivery head of 10.1 kg/cm2 is not considered appropriate. It is dangerous for pipeline in case of power failure. On the contrary, the pump delivery head in case of Alternative 2 or 3 is within the reasonable range and involves no substantial problems in respect with operation and maintenance of pipelines. Accordingly Alternative 2 is recommended.

Pipe materials: Ductile cast iron pipe is recommendable, considering the cost and easiness of construction. Although there are two kinds of pipe, ductile cast iron pipe and steel pipe, the cost of steel pipe is about 40 % higher than that of ductile cast iron pipe. Adding the cost of welding work and testing, this difference becomes bigger. In respect with the workability, ductile cast iron pipe of push-on type does not require any skill while steel pipe which shall be welded requires skill and experiences. In addition, the period of jointing steel pipes is longer than that of ductile cast iron pipe. The workability of ductile cast iron pipe, thus, is superior to that of steel pipe.

Location of Pipe Routes and Earth Covering : Along the left side strip of the road between Chinaimo WTP and the planned elevated storage tank, the existing distribution pipelines are installed. The transmission main will be installed at the opposite right side of the road (at 8 m from the road center). Either side of the road is occupied by electric and telephone poles. As these poles run just beside the road, the pipes can be installed not to intervene the poles. In addition, there are no plans that these cables will be installed into the ground in the near future.



D	W	H
Ø50	0.70	1.20
Ø75	"	"
Ø100	"	"
Ø150	"	"
Ø200	0.80	"
Ø250	"	"
Ø300	0.90	"
Ø350	1.00	"

Fig.4.8
PLAN OF TRANSMISSION AND DISTRIBUTION SYSTEM TO THA DEUA

S=1:50000

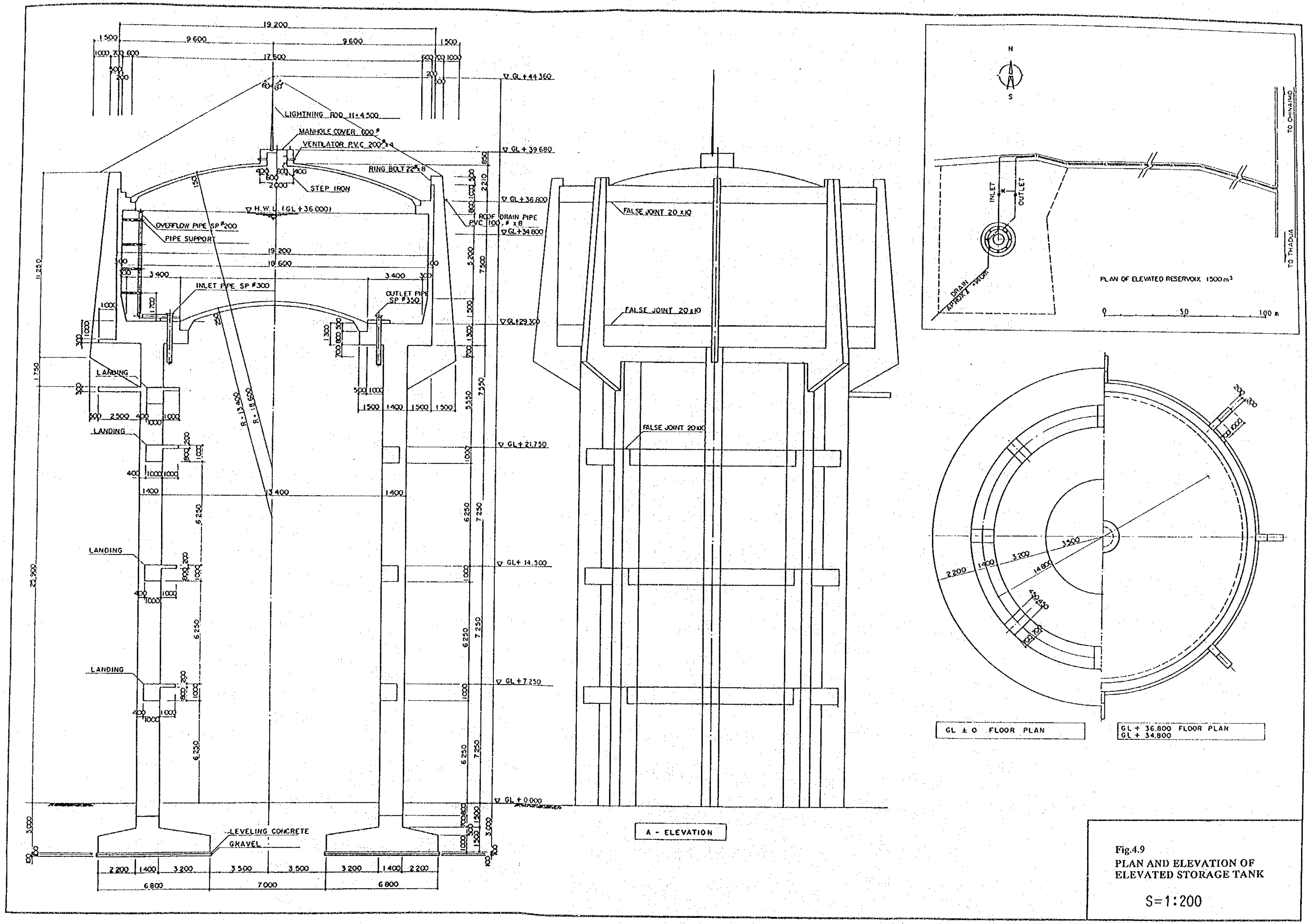


Fig.4.9
PLAN AND ELEVATION OF ELEVATED STORAGE TANK

S=1:200

The traffic of Route No.2 will remarkably increase after completion of Laos-Thailand Friendship Bridge. At the same time, heavy traffic as well will increase. The earth covering of the transmission pipes should be of enough depth against such traffic load. From these viewpoint the earth covering of the transmission pipes is decided 1.2 m at minimum.

River Crossing : There are two rivers along the transmission pipelines. For the crossings of rivers, two ways are generally employed: pipes supported by existing bridge, and invert siphon in river bed. In this basic study, the latter way is employed. "Pipes supported by bridge" way will be disturbed with pipes set above the ground against the future road expansion works. Contrary to this, invert siphon pipes are installed into river bed, and there will be no obstacle for future expansions.

Connection with the Existing Pipe : In order to supply water between the newly installed transmission pipes and existing distribution pipes in case of emergency, both pipes are connected at three places each other. At the connecting lines, valves are installed. The valves keep close usually and are opened only at emergency.

Drain Valves: Foreign materials like sand and mud are easy to settle down at low places of pipelines. The drain valves are set to remove the settled foreign matters in the pipes. In the Project the drain valves are set just after the river crossings (two sites).

Air Valves : Air is easy to store in convex pipe routes and the stored air impedes flow. To make the flow easy, air valve is installed at such places. The doubled-outlet type air valve, 75 mm in size, is employed.

(2) Elevated Storage Tank

Capacity and Dimension: As stated in the previous section 4.2.2, detention time of the elevated storage tank is designed as a capacity equivalent to 6 hours of daily maximum supply capacity (6,080 m3/day). Therefore, the effective capacity of the tank is 1,500 m3. The tank is made from reinforced concrete in cylinder type with depth 6.0 m.

Water Level and Height: Height of the elevated tank is planned as less than 40 m even in the water level located at the highest site, taking into account the structure and construction condition. The low water level (LWL, +200m) of elevated tank is computed from the minimum water head (15 m) and the elevation (+166.0 m) at the pipe end of distribution system, and the friction loss in the pipelines 19.0 m. The high water level (HWL, +206.0 m) of the tank is obtained from the LWL +200.0 m and the effective depth (6.0 m) of the tank.

Appurtenances: Drain pipes, over-flow pipe and float valve are installed as the appurtenances of the elevated tanks.

(3) Distribution Pipes

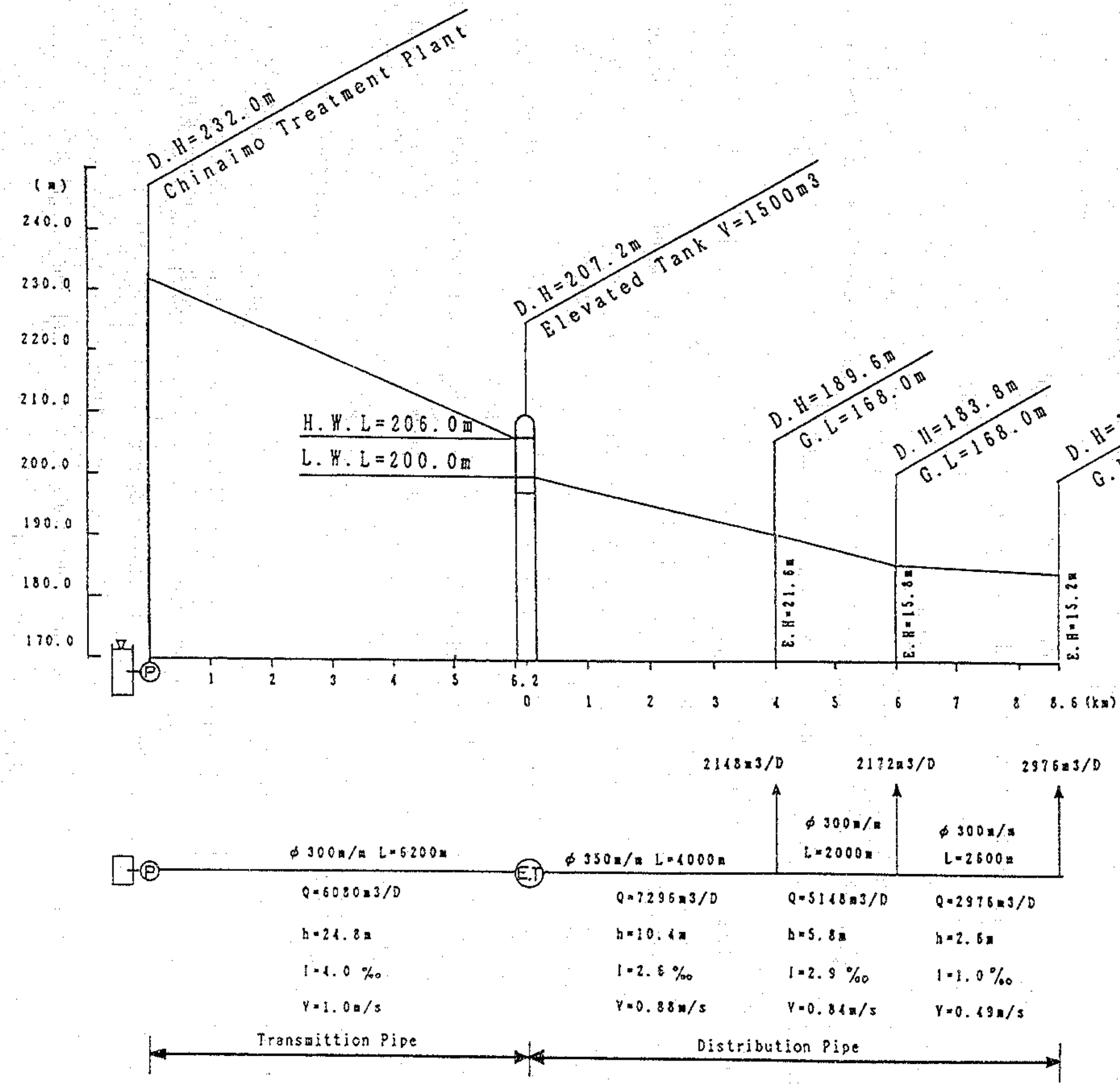
Capacity to be Distributed to the Area and Pipe Diameter: Hydraulic profile of water transmission/distribution from Chinaimo WTP to Tha Deua area is shown on Fig 4-10. The most appropriate pipe diameter is obtained from the hydraulic analysis based on the areal demand, minimum dynamic pressure at the pipe end, and the LWL of the elevated tank. The diameters of the distribution pipelines and their length are as follows:

Pipe Route	Dia.(mm)	Length (m)
From Elevated Tank to Branch to the Southern Area	350	4,000
From the Branch to Tha Deua	300	4,600

Items in Common with Transmission Pipelines: There are a number of the common items between the distribution and transmission pipelines in terms of the water supply engineering. The engineering employed in the transmission pipes, therefore, can be used for the distribution pipelines as well. To avoid redundant descriptions between both pipelines, the common items are described below:

- Pipe Material (Ductile Cast Iron)
- Pipe Location and Earth Covering
- River Crossing
- Drain System
- Air Valve

Fire Hydrant: For the purpose of the fire protection along the pipe routes, fire hydrants are laid. Fire hydrants are installed at (a) existing hamlets, (b) places where large scale factories are located, (c) and newly developed commercial area adjacent to Laos-Thailand Friendship Bridge. The distance between the hydrants is planned as 200 m. Because, the appropriate fire protecting radius is estimated some 100 m in this case. The sizes of the fire hydrants are: for the newly developed commercial area where deemed crowded, double-socket hydrants are selected, and for the areas other than stated above, single-socket hydrants are employed. In addition, every fire hydrant type is selected as subsurface type, considering future expansion of the road.



D.H=Dynamic Head

E.H=Effective Head

G.L=Ground Level

Q =Quantity

h =Head Loss

I =Hydraulic Gradient

V =Velocity

Fig. 4.10

HYDRAULIC PROFILE
IN Tha Deua AREA

Branches: Branching pipes are installed at all paths and lanes joining to Route No.2 and at the areas where future development is expected. At every branch end, valves are installed for future pipe extension work under pressure.

4.4 Implementation Plan

4.4.1 Principle of Executing Construction

This project is composed of the following main construction items:

(1) Upgrading of Chinaimo WTP,
(2) Rehabilitation of Chinaimo WTP, and
(3) Construction of Transmission/Distribution Facilities for Tha Deua area.

In order to minimize suspension of water supply services during the construction, to carry out these works effectively and to fully function project facilities immediately after their completion, one of the key points is how to proceed every related item of the construction works.

For Chinaimo WTP, the upgrading works such as sedimentation basins and rapid sand filters shall be carried out first. The completion of these works will enable to produce the potable water of 40,000 m3/day, same amount as currently produced, from the new facilities, and also enable to stop the operation of the existing facilities.

The necessary rehabilitations of the sedimentation basins and filters are carried out after the completion of the above expansion works. Such works as chemical dosing which are able to rehabilitate independently from others are to be constructed in parallel with the expansion works, as a rule of thumb.

(1) Detailed Design

The detailed design works are commenced at least one month after exchange of note (usually abbreviated as E/N) between the Governments. Together with the design works, topographic surveys are to be started at the respective sites of Chinaimo WTP, the elevated storage tank and the pipeline route to Tha Deua. Design engineer(s) supervise survey activities at the sites. The obtained data are utilized fully as input to detailed design. The necessary period for these tests is estimated two months.

The detailed design will be executed in Japan to work effectively and to minimize the design period. The period required for the first step detailed design will be about 5 months inclusive of 2 month topographic surveys. The main items of the detailed design are:

- Preparation of structural drawings for the facilities, including reinforcement,
- Structural analyses (to study and analyze the safety and stability of the structures),
- Hydraulic analyses (to decide hydraulic section, appropriate pipe diameter, pump head and the like by means of hydraulic calculation),
- Design for electrical and mechanical facilities,
- Preparation of tender documents (bill of quantities, specification, drawings and documents required), and
- Necessary comparative studies and others.

(2) Construction Management

It is recommended that NPL, the executing agency for the Project, should be responsible for establishing Project Managing Unit (PMU) at the NPL office in Vientiane and Project Implementation Office (PIO) at Chinaimo WTP as suggested in the ADB report. PMU and PIO will be staffed with sufficient number of appropriately qualified personnel as tabulated below.

Table 4-1 PROPOSED PMU STAFFING

Professional Staff	No.	Reports To
PMU manager	1	General Manager, NPL
Engineer	2	PMU Manager
Procurement Manager	1	PMU Manager
Administrator	1	PMU Manager
Accountant	1	PMU Manager
Translator	1	Administrator
Total Professional Staff	7	
Supporting Staff		
Clerk/Secretary	2	PMU Manager/Engineer
Administrator/Accountant	1	Administrator
Driver/Messenger	1	Administrator
Total Supporting Staff	4	
Total PMU Staff	11	

Source: Draft Final Report on Vientiane Water Supply Rehabilitation and Upgrading Project, March, 1992

Table 4-2 PROPOSED PIO STAFFING

Professional Staff	No.	Reports To
Project Engineers	3	PMU Manager
Administrator	1	Project Engineer
Works Supervisors	6	Project Engineer
Total Professional Staff	10	
Supporting Staff		
Clerk/Secretary	2	Administrator
Clerk/Driver	2	Administrator
Total Supporting Staff	4	
Total PIO Staff	14	
TOTAL PMU AND PIO STAFF	25	

Source: Draft Final Report on Vientiane Water Supply Rehabilitation and Upgrading Project, March, 1992

It is desirable for NPL to operate the JICA and ADB projects under as simple organization as possible since both projects closely relate each other. The above arrangement as considered appropriate for effective execution of the project is to be applied also to the current project.

Apart from NPL obligations, one consulting engineer should station at the site during all the construction period, as a project manager. The project manager must have deep insight and experiences in civil and sanitary engineering and management fields, and supervise whole construction work providing most appropriate technology and judgement at every construction stage.

An input of electrical and mechanical engineers is necessary and will continue during whole period of the electrical and mechanical works.

At the test-run stage of the facilities after the completion, a hydro-chemist will be required. He will guide/train operators for effective operation and maintenance of the facilities, demonstrating how to attain optimum chemical dosing rates by routine water testings. The supervisory services will cover followings:

- To assist NPL in tender calling, tender evaluation and award of contract
- To study and approve shop drawings prepared by contractors

- To study and approve construction schedule prepared by contractors
- To examine conformity of materials and equipment with the specification described in tender documents in terms of function, configuration, strength, etc.
- To prepare monthly progress reports
- To carry out quality control of whole works
- To assist NPL in inspecting various tests conducted by contractors and manufacturers
- To provide technical advice and guidance
- To examine completed works and prepare completion report

From the field survey on availability of construction materials and machinery, followings are locally available:

(a) Materials - Sand, gravel, brick, plywood for form-work, timber, log for timbering,

(b) Fuels - Fuels and oils for construction machinery

Materials other than stated above are imported from abroad.

Reinforcing bar will be possibly purchased from Thailand. From the field survey on availability of materials, however, it is revealed that bulk supply of reinforcing bar is quite difficult even in Thailand, because of recently increasing demand. Considering such condition, reinforcing bar to be used for the project is to be imported from Japan.

Cement produced in China and Vietnam is available although the quantity is limited. Further, cement from these countries is not necessarily reliable in its quality, and not recommendable for the facilities that require water tightness. Therefore, bulk of cement as well will be supplied from Japan. Cement cannot be preserved generally for a long period due to deterioration. An appropriate quantity must be imported at every stage of the construction.

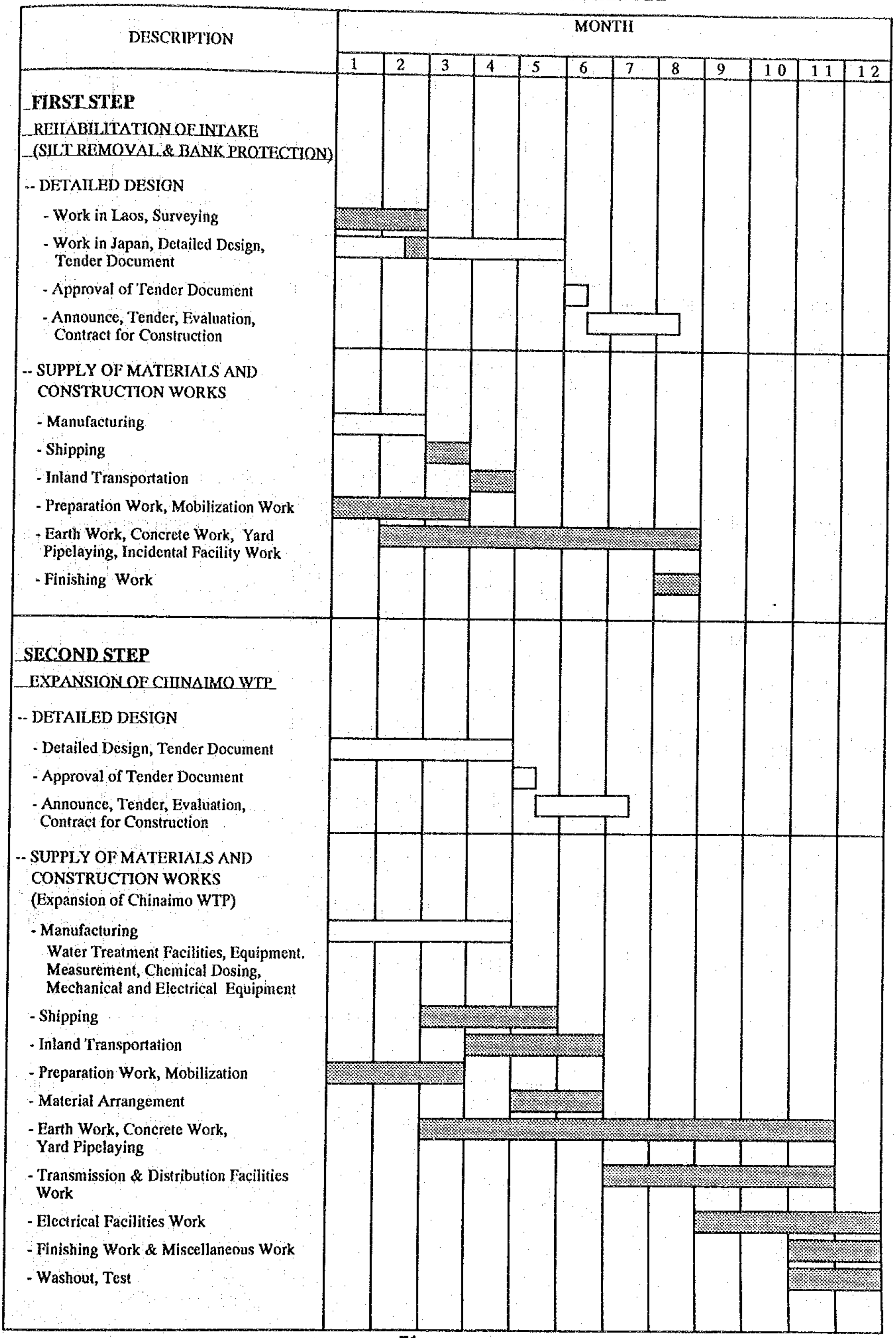
As for the facilities of treatment plant, especially electrical and mechanical equipment are to be supplied from Japan in general, taking into consideration reliability of the equipment and supply of the spare parts after project completion.

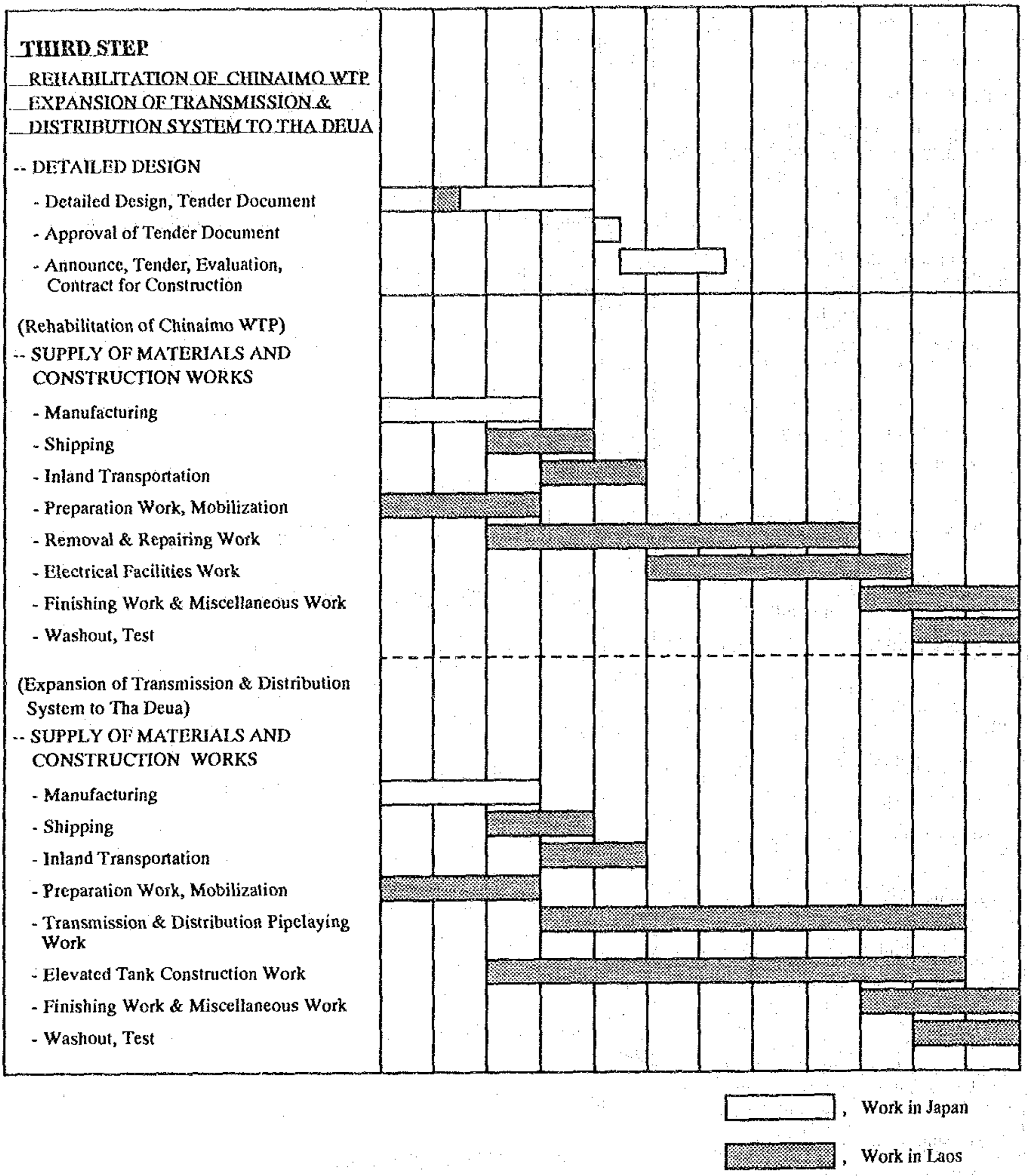
Ductile cast iron pipes are most reliable and desirable as water mains in terms of handling, installation, water tightness, strength, and ductility. The ductile cast iron pipe as well will be supplied from Japan.

4.4.2 Implementation Schedule

As stated in the previous section 4.4.1 Principle of Executing Construction, all of the facilities should be constructed as planned. Considering the construction process and period for every facility, the project is divided into three steps: in the first step the construction of the silt removal facilities will be completed, in the second step the expansion works, and in the third step the rehabilitation works of the existing treatment plant and the construction of the transmission/distribution facilities for Tha Deua area. The construction period for Steps 1, 2 and 3 are 8 months, 12 months and 12 months respectively. The detailed schedule for each step is shown in Fig 4-11.

Fig.4.11 IMPLEMENTATION SCHEDULE




THIRD STEP
REHABILITATION OF CHINAIMO WTP
EXPANSION OF TRANSMISSION &
DISTRIBUTION SYSTEM TO THA DEUA
-- DETAILED DESIGN
- Detailed Design, Tender Document
- Approval of Tender Document
- Announce, Tender, Evaluation, Contract for Construction
(Rehabilitation of Chinaimo WTP)
-- SUPPLY OF MATERIALS AND CONSTRUCTION WORKS
- Manufacturing
- Shipping
- Inland Transportation
- Preparation Work, Mobilization
- Removal & Repairing Work
- Electrical Facilities Work
- Finishing Work & Miscellaneous Work
- Washout, Test
(Expansion of Transmission & Distribution System to Tha Deua)
-- SUPPLY OF MATERIALS AND CONSTRUCTION WORKS
- Manufacturing
- Shipping
- Inland Transportation
- Preparation Work, Mobilization
- Transmission & Distribution Pipelaying Work
- Elevated Tank Construction Work
- Finishing Work & Miscellaneous Work
- Washout, Test
, Work in Japan
, Work in Laos

4.4.3 Scope of Work

The Scope of Work of the Project and the portions implemented by the Japanese side and the Lao side are shown in the following table.

Table 4-3 SCOPE OF WORK

Item	Construction Work (by Japanese Side)	Construction Work (by Lao Side)
1. Expansion of Chinaimo WTP	Treatment Plant Facilities (Design Capacity : 40,000 m^3/day) including clear water reservoir (Volume : 3,300 m^3) new intake pump installation and existing pump overhaul	Warehouse (Approx : 430 m^2)
2. Rehabilitation of Existing Chinaimo WTP	Existing Treatment Plant Facilities (Design Capacity : 40,000 m^3/day) including intake silt removal facility, and bank protection around drain shoot channel at intake site	–
3. Extension of Transmission and Distribution System to Tha Deua	Transmission Pipelaying : ø 300, DIP, L = 6.2 km Distribution Pipelaying : ø 350, DIP, L = 4.0 km; ø 300, DIP, L = 4.6 km Elevated Storage Tank 1 NO. Capacity = 1,500 m^3	Land Acquisition for Elevated Storage Tank site (Approx. 70 m x 70 m)

Estimated cost for the portion implemented by Lao side is as follows.
(Refer to Appendix-2)

1) Construction of Warehouse at Chinaimo WTP site	:	Kip 22 million
2) Land Acquisition for Elevated Storage Tank site	:	Kip 57 million
Total estimated cost born by the Lao side	:	Kip 79 million

CHAPTER 5 BENEFITS AND CONCLUSION

5.1 Benefits of the Project

The current JICA basic design deals with upgrading and rehabilitation of the Chinaimo Water Treatment Plant and pipeline extension to Tha Deua, while the ADB Project lays stress on rehabilitation of the distribution network together with extension of transmission mains from Chinaimo to the planned elevated storage tanks. The increased water production at Chinaimo Water Treatment Plant will be distributed through pipelines to be installed under the ADB's project. It is, hence, desirable that both projects should be completed on a timely manner by the end of 1995. The social and economic benefits accrued from the operation of the planned facilities are described below:

1) Water Supply Conditions

On completion of the whole projects, the existing service area presently suffering from water shortage will be eliminated and the entire population in the service area will enjoy abundant hygienic water accordingly. The completion of the project thus contributes to improvement of the water supply conditions in the service area, resulting in enhancement of people's health and welfare.

2) Enhancement of Commercial and Industrial Activities in the Area

Groundwater in the area generally contains high concentration of chloride. Commercial and industrial activities in the area, under the current water supply conditions, have been restricted to a large extent. If increased amount of clean water produced at Chinaimo Water Treatment Plant alleviates water shortage in the area then the present project may trigger economic activities in the area.

3) Expanded Service Area

Doubled water production at Chinaimo WTP may be sufficient enough to meet water consumption by the people resided within the existing service area. The excessive amount of produced water, therefore, can be supplied to the new customers who have never enjoyed hygienic piped water. If NPL could extend pipeline reticulation to such unserved area, service ratio of the Vientiane prefecture will increase significantly, from the present 42% to almost doubled 70% by 2000. A substantial increase of the people who have means of access to safe piped water will create a hygienic living environment and relieve people from such water borne diseases as cholera, typhoid, dysentery, etc.

4) Experience obtained through the Project

NPL is now expanding its responsibilities for supply of water to the major provincial towns in the country including Vientiane. Experiences obtained through the project management and coordination will be beneficial to NPL for the future work in provincial towns.

5.2 Conclusion and Recommendation

5.2.1 Suitability of the Project

Supposed that ADB portion of the project is implemented by the end of 1995 in accordance with the Memorandum dated April 5, 1992, the proposed project components for the Japanese grant aid are considered effective to improve significantly water supply conditions in the service area and increase water revenue of NPL. In addition, the project components are designed in compliance with the basic concept and design criteria applied for the existing facilities. The operation and maintenance required for the expanded facilities does not require any particular expertise.

1) Financial Capability of NPL

Besides the social and economic benefits mentioned in previous section, the treated water of 40,000m3/day in day-maximum capacity (33,000m3/day in day-average) will be supplied from the Chinaimo WTP to the service area with a substantial increase of accounted-for water resulting in increase of water sales. The favourable effects on financial standing of NPL, thus, is considered large.

2) Capability of Operation and Maintenance

The equipment and facilities of the NPL are well maintained despite shortage of tools and machinery for repair. When the repair is found beyond capability of NPL, NPL is used to entrust the repair to the local workshops which reserve large machinery of lathes, milling machines, shearing machines, drilling machines, etc. Taking these conditions into account, the tools and machinery are purchased under the present Project as referred to Table 3-4.

The above machinery and materials to be procured will be administered by NPL.The engineers and technicians engaging in operation and maintenance of the Chinaimo WTP have sufficient capability and experience. It is judged therefore that the equipment to be procured will be utilized and managed effectively by the NPL.

5.2.2 Recommendations

In the course of the basic design, followings are considered essential to an effective execution of the Project.

1) Project Coordination

It is recommended that design concept and criteria to be applied in the ADB's project should be in line with the basic design concept proposed for the current project. To this end, coordination meetings will be held periodically between agencies concerned.

2) Leakage Abatement and New Service Pipeline Extension

Since the projects do not explicitly cover works required for extension of new reticulation, more attention should be paid to how to supply water to the new service area as well as to reduce leakage in the existing service area. Even under the financial restriction, NPL should attempt to install or rehabilitate service mains and service pipelines where water shortage and leakage is eminent. Accurate data compilation through these activities will be beneficial for future extension.

3) Training and Recruitment of NPL Staff Members

The design concept and criteria proposed in the current basic design are in compliance with those practiced in Chinaimo WTP. Therefore, any particular skills for operation and maintenance are not required. The expanded production of the Chinaimo WTP, however, will require additional personnel and operators. This can be achieved through intensive training of the staff members.

4) Allocation of Necessary Budgets for Operation and Maintenance

The current Project plans to procure various spare parts and tools for repair and overhaul of mechanical and electrical equipment. To maintain the facilities under normal conditions, periodical checkup and overhaul of electrical and mechanical equipment including laboratory equipment and chemicals such as draft chambers, refrigerators, air-conditioners, numerous kinds of chemicals, and other consumable (glassware, testing kits, etc.) are essential. Priority should be placed in allocating budgets needed for such procurement and renewal to maintain the facilities under normal conditions.

5) Revision of Water Tariff Structure

As suggested in the ADB Report, present water tariff structure set up in 1990 is still within a capability of consumers. Ratio of average amount of monthly water bill to household income is considered lower as compared to 3 or 4%, upper limits widely accepted in the developing countries. Although NPL has not showed explicitly its necessity, the best opportunity for possible tariff revision may be after the project completion.

6) Effective water tariff collection

Drastic reduction of the accounts receivable may improve significantly the financial standing of NPL. Major reason for this is somewhat deferred payment by the government offices. In this connection, MCTPC is recommended to take appropriate measures for eliminating such burden to NPL at the earliest possible date.

Appendix - 1

App 1.1 Organization of the Study Team

The JICA entrusted with the execution of the study from the Government of Japan has organized the Study Team with members as follows:

1. Mr.Hiroki HASHIZUME Team Leader	Deputy Director for International Cooperation International Affairs Division Ministry of Health and Welfare
2. Mr.Hideo MIYAMOTO	First Basic Design Study Division Grant Aid & Design Department Japan International Cooperation Agency
3. Mr.Takayuki NIIKURA Survey Team Leader	Overseas Services Department Nihon Suido Consultants Co.Ltd.
4. Mr.Hiroyasu YODA Operation & Maintenance	Overseas Services Department Nihon Suido Consultants Co.Ltd.
5. Mr.Akihiro MIYAKE Treatment Plant Design	Overseas Services Department Nihon Suido Consultants Co.Ltd.
6. Mr.Yutaka ISHII Pipeline Design	Overseas Services Department Nihon Suido Consultants Co.Ltd.
7. Mr.Hitoshi OCHIAI Mechanical Design	Overseas Services Department Nihon Suido Consultants Co. Ltd.
8. Mr.Takashi UEDA Electrical Design	Overseas Services Department Nihon Suido Consultants Co. Ltd.

App 1.2 Field Activities of the Study Team

A. Field Survey for Basic Design Study (March 21 - May 15, 1992)

No.	Date(1992)	Activity
1	Mar 21(Sat)	Departure of Team members from Narita (T.Niikura, H.Yoda)
2	Mar 22(Sun)	Arrival at Vientiane
3	Mar 23(Mon)	Visit to Japanese Embassy,MCTPC,NPL
4	Mar 24(Tue)	Data collection at MCTPC,NPL
5	Mar 25(Wed)	Discussion of Inception Report at NPL
6	Mar 26(Thu)	Mr.H.Hashizume, Mr.H.Miyamoto arrived at Vientiane Field survey at Mekong Bridge construction site
7	Mar 27(Fri)	Visit to Japanese Embassy, NPL Field survey at Chinaimo, Kaolieo TP
8	Mar 28(Sat)	Discussion at NPL
9	Mar 29(Sun)	Field reconnaissance at Dongdok Hospital, city area
10	Mar 30(Mon)	Discussion among NPL, JICA team, ADB
11	Mar 31(Tue)	Discussion with ADB, Preparation of Minutes of Meeting
12	Apr 1(Wed)	Visit to Ministry of Public Health, Japanese Embassy Preparation of Minutes of Meeting
13	Apr 2(Thu)	Signing of Minutes of Meeting among JICA, ADB, MCTPC Mr.A.Miyake, Mr.Y.Ishii arrived at Vientiane
14	Apr 3(Fri)	Discussion with NPL
15	Apr 4(Sat)	Signing of Minutes of Meeting among JICA and MCTPC Field survey at Chinaimo TP
16	Apr 5(Sun)	Mr.H.Hashizume,Mr.H.Miyamoto Departed from Vientiane Inner Meeting
17	Apr 6(Mon)	Visit to Japanese Embassy, Field survey at Chinaimo TP Data collection of pipeline at NPL
18	Apr 7(Tue)	Data collection at NPL, Chinaimo TP Discussion with NPL for pressure measuring of pipeline
19	Apr 8(Wed)	Data collection at NPL, Chinaimo TP Pressure measuring of pipeline
20	Apr 9(Thu)	Mr.H.Ochiai, Mr.T.Ueda arrived at Vientiane Data collection at Chinaimo TP, ETPL Pressure measuring of pipeline
21	Apr 10(Fri)	Field survey at Chinaimo, Kaolieo TP Data collection at EDL
22	Apr 11(Sat)	Discussion with ADB
23	Apr 12(Sun)	Holiday
24	Apr 13(Mon)	Field survey at Chinaimo TP
25	Apr 14(Tue)	Field survey at Chinaimo TP
26	Apr 15(Wed)	Field reconnaissance at Nam Gum Dam
27	Apr 16(Thu)	Inner discussion for rehabilitation/expansion Field survey at pipeline route
28	Apr 17(Fri)	Field survey at Chinaimo TP, pipeline route
29	Apr 18(Sat)	Field survey at Chinaimo TP, pipeline route
30	Apr 19(Sun)	Holiday
31	Apr 20(Mon)	Field survey at Chinaimo TP Data collection for operation/maintenance, pipeline route
32	Apr 21(Tue)	Field survey at Chinaimo TP, pipeline route
33	Apr 22(Wed)	Field survey at Chinaimo TP, pipeline route
34	Apr 23(Thu)	Field survey at Chinaimo TP, pipeline route
35	Apr 24(Fri)	Inner discussion for rehabilitation/expansion Field survey at pipeline route

		Data collection for financial materials
36	Apr 25(Sat)	Field survey at Chinaimo TP, pipeline route Data collection for maintenance
37	Apr 26(Sun)	Holiday
38	Apr 27(Mon)	Data collection for operation report, water quality, pipeline Data collection at EDL,ETPL
39	Apr 28(Tue)	Inner discussion for rehabilitation/expansion Data collection at MCTPC Field survey for elevated tank construction
40	Apr 29(Wed)	Preparation of meeting materials
41	Apr 30(Thu)	Discussion with NPL Data collection for maintenance, elevated tank construction
42	May 1(Fri)	National Holiday
43	May 2(Wed)	Data collection at Chinaimo TP
44	May 3(Sun)	Holiday
45	May 4(Mon)	Data collection at Chinaimo TP Field reconnaissance at mechanical/electric factory
46	May 5(Tue)	Discussion with MCTPC,NPL at NPL Preparation of minutes of meeting
47	May 6(Wed)	Preparation of general drawing for rehabilitation/expansion, pipeline Preparation of minutes of meeting
48	May 7(Thu)	Preparation of general drawing for rehabilitation/expansion, pipeline Submission of minutes of meeting
49	May 8(Fri)	Arrangement of collected data Field reconnaissance at existing pipeline route
50	May 9(Sat)	Mr.H.Yoda departed from Vientiane Arrangement of collected data
51	May 10(Sun)	Holiday
52	May 11(Mon)	Visit to Japanese Embassy
53	May 12(Tue)	Water quality test at Chinaimo TP Arrangement of collected data
54	May 13(Wed)	Water quality test at Chinaimo TP Arrangement of collected data
55	May 14(Thu)	Team members departed from Vientiane
56	May 15(Fri)	Team members arrived at Narita

B. Explanation/Discussion of Draft Final Report (August 11 - August 20, 1992)

1	Aug 11(Tue)	Departure of Team members from Narita (T.Niikura, A.Miyake Y,Ishii)
2	Aug 12(Wed)	Arrival at Vientiane
3	Aug 13(Thu)	Visit to Japanese Embassy Explanation of Draft Final Report at NPL, MCTPC Mr.Hashizume, Mr.Miyamoto arrived at Vientiane
4	Aug 14(Fri)	Explanation of Draft Final Report at NPL
5	Aug 15(Sat)	Preparation of Minutes of Meeting Discussion with ADB mission
6	Aug 16(Sun)	Holiday
7	Aug 17(Mon)	Discussion among JICA team, NPL and ADB
8	Aug 18(Tue)	Preparation of Minutes of Meeting Signing of Minutes of Meeting among JICA, ADB, and MCTPC
9	Aug 19(Wed)	Team members departed from Vientiane
10	Aug 20(Thu)	Team members arrived at Narita

App 1.3 Main Officials Discussed with the Study Team

A. Field Survey for Basic Design Study (March 21 - May 15, 1992)

Ministry of Communication-Transport-Post and Construction	Vice Minister	Mr. Seune PHETSANGHANE
	Department of International Relations Deputy Director	Mr. Khangeum KHAMVONGSA
	Administrative Officer	Mr. Chansy NOUANMALY
	Nam Papa Lao General Manager	Mr. Boriboun SANASISANE
	Deputy General Manager	Mr. Somlith SILAPHET
	Deputy Project Manager	Mr. Pinkeo SAYCOCIE
	Technical Section	Mr. Oth KEOMANIVON
	Manager of Chinaimo WTP	Mr. Lat PABPHAN
	Vice Manager of Chinaimo WTP	Mr. Khambay VONGSAYARATH
	Dept of Habitat construction & Town Planning Director	Mr. Somphone DETHOUDON
	Acting Director	Mr. Kongfa PHOUMMASAK
	Enterprise detat des Postes et Telecommunications LAO Director	Mr. Boualay SOUK ALOUN
	Manager	Mr. Padaphet SAYAKHOT
	Electricite Du Laos Deputy Chief	Mr. Vanhdy VILAYASANE
Ministry of External Economic Relations,Lao	Deputy Director	Dr. Bountheuang MOUNLASY
City of Vientiane		Mr. Phaytoum THOUMPASEUTH
Embassy of Japan	Ambassador	Mr. Shigemi ANDOU
	Counselor	Mr. Yukuto MURATA
	First Secretary	Mr. Shinji NAGASHIMA
	Second Secretary	Mr. Kiyoshi OHMAMEUDA
Asian Development Bank	Project Engineer	Mr. Ian POWELL
	Consultant	Mr. Raymond MILES
	Consultant	Mr. Antony PEENY
UNDP Consultant		Mr. Sangarappillai SANDANAM

B. Explanation/Discussion of Draft Final Report (August 11 - August 20,1992)

Ministry of Communication-Transport - Post and	Vice Minister	Mr. Seune PHETSANGHANE
	Department of International Relations Deputy Director	Mr. Khangeum KHAMVONGSA
	Administrative	

	Officer	Mr. Chasy NOUANMALY
	Nam Papa Lao	
	General Manager	Mr. Boriboun SANASISANE
	Deputy General Manager	Mr. Somlith SILAPHET
	Deputy General Manager	Mr. Boungnon HOMSOMBAT
	Project Manager	Mr. Pinkeo SAYCOCIE
	Project Advisor	Mr. Khamsouk KHAMPHILAVANH
	Technical Section	Mr. Oth KEOMANIVON
Ministry of External Economic Relations, Lao	Deputy Director	Dr. Bountheuang MOUNLASY
City of Vientiane		Mr. Oudone VATHANAXAY
Embassy of Japan	Ambassador	Mr. Shigemi ANDOU
	Counselor	Mr. Yukuto MURATA
	First Secretary	Mr. Shinji NAGASHIMA
	Second Secretary	Mr. Kiyoshi OHMAMEUDA
Asian Development Bank	Project Engineer	Mr. Ian POWELL
	Counsel	Mr. Eveline FISCHER
	Financial Analyst	Mr. Arjun THAPAN
	Staff Consultant	Mr. Lindsay BLACK