2-2-2-3 Facility planning

(1) Composition of Planned Facilities

Major facilities planned for this project are composed of the following.

a. Intake facility:	Tubewells and intake pump stations
b. Collecting facility:	Collector mains
c. Transmission facility	Pump well, booster pump station, chlorinator and transmission main
d. Distribution facility:	Terminal reservoir and terminal pump station
e. Improvement of the existing network in the city:	Supplementary sections to the existing arterial mains
f. Electrical facility	Secondary power facilities for pump stations in the wellfield, the booster pump station and the terminal reservoir

(2) Description of Facilities

1) Intake Facility

i. Components of Intake Facility

Table 2-15 List of Intake Facilities

Classification	Facility	Quantity	Specifications		
a. Water Source Facility	Tubewell	25	Design dicharge (a)	Total 91,000m^3/day Discharge rate of one tubewelll = 200 m^3/hr (2cusec)	
			Basic Depth (b)	160m	
			Diameter (c)	Pump housing section	16"、0～45m

				Water intake section	10", 45～160m
			Screen (d)	Structure	Wire wound type
				Material	Stainless Steel
				Basic length	30m
b. Intake Facility	Intake Pump	25	Type	Vertical-motor driven, vertical shaft turbine pump	
			Pumping Rate	$200m^3/hr$	
			Total Head	70m～40m (of which, 20m is under ground)	
			Riser Pipe	200mm (@3m)	
			Motor	Vertical shaft, totally enclosed fan cooled type 50kW, 1,450 rpm, 50Hz, 400V	
	Pump station	25	Structure	Reinforced concrete structure with water-proof mortar finish for outside wall and roof)	
			Dimensions	7.000 x 6,500 ($45.4m^2$)	

Remarks: The tubewell drilled for testing during the basic design study will be used as one of permanent production wells. Accordingly 24 new tubewells will be drilled through the implementation of the project.)

ii. Particulars of tubewells

a. Design discharge

- With the total discharge from the planned wellfield targeted at $91,000m^3/day$, the unit pumping rate of one tubewell is determined at $200m^3/hr$, based upon the analysis in Section 2-2-2 Water Sources Plan.
- The duration of daily pumping is proposed to be 20 hours for the purpose of ensuring the water level recovery during the rest of the day.
- The number of tubewells necessary for ensuring the targeted discharge is therefore 23 (($91,000m^3/day$)／($200m^3/hr$ x 20 hours) =22.75).
- Two (2) standby tubewells corresponding to 10% of the calculated requirement for the number of tubewells should be added in case of shutdown or repairing of working ones. As a result, the planned tubewells totals 25.

b. Basic drilling depth

According to the results of the geophysical survey for this study, the second and third aquifers occurring from about 40m to 170m in depth below ground surface across the planned wellfield will be targeted as the zones for the intake of groundwater. The aquifer conditions and depths can vary, and during the detailed design study it is proposed to carry out the geophysical survey once more to make final confirmation of the drilling depths, after the extent of the wellfield is determined and exact drilling points of 25 tubewells are pinpointed . Since the average depth to the lower horizon of the third aquifer is assumed to be 160m, this will be set as the basic drilling depth.

c. Casing

- The structure of the tubewell is basically divided into the upper portion of a large diameter to accommodate a pump and the lower one with a smaller diameter for the intake of water where screen is installed.
- The pump capable of delivering the discharge rate of 200 m^3/hr requires more or less 16" diameter for housing, and this size is set as a standard casing diameter for the upper portion of the tubewell. Since the upper horizon of the aquifer is estimated to occur 40 meters or deeper below the surface, the 16" diameter upper casing shall end at 45 meters at the deepest. A water level measuring tube (25mm steel pipe) will be installed down to the pump section.
- The lower water intake portion where screen is installed can have a reduced diameter to cut off the cost of the structure, while the design should be based upon such factors as the discharge rate, aquifer thickness, and uphole velocity (1.5 m/sec). These factors dictate the size should be 8" or larger. Taking an additional factor into account for minimizing the drawdown, one size larger casing and screen, 10", is proposed for the lower portion of the tubewell. The upper casing will be joined with the lower one with a reducer as local practice employed for the existing tubewells in Chenab wellfield.

d. Screen

A stainless steel wire-wound type screen with a maximum water intake surface area will be adopted. A larger water intake area means a smaller inflow velocity, effectively suppressing drawdown and preventing sand incoming. The length should be determined basically according to the thickness of the aquifer, but the economic length can be calculated by selecting the appropriate length so that the velocity becomes less than 15mm/sec using the following equation.

A(water intake area) x V(incoming velocity) = Q(design pumping rate)
(V<15mm/sec)

The standard screen length designed for the existing tubewells constructed by the previous ADB project was 30m. This length gives a velocity about 8mm/sec, which is sufficiently below 15mm/sec, and this design will be employed for this project as well.

e. Layout of the wellfield

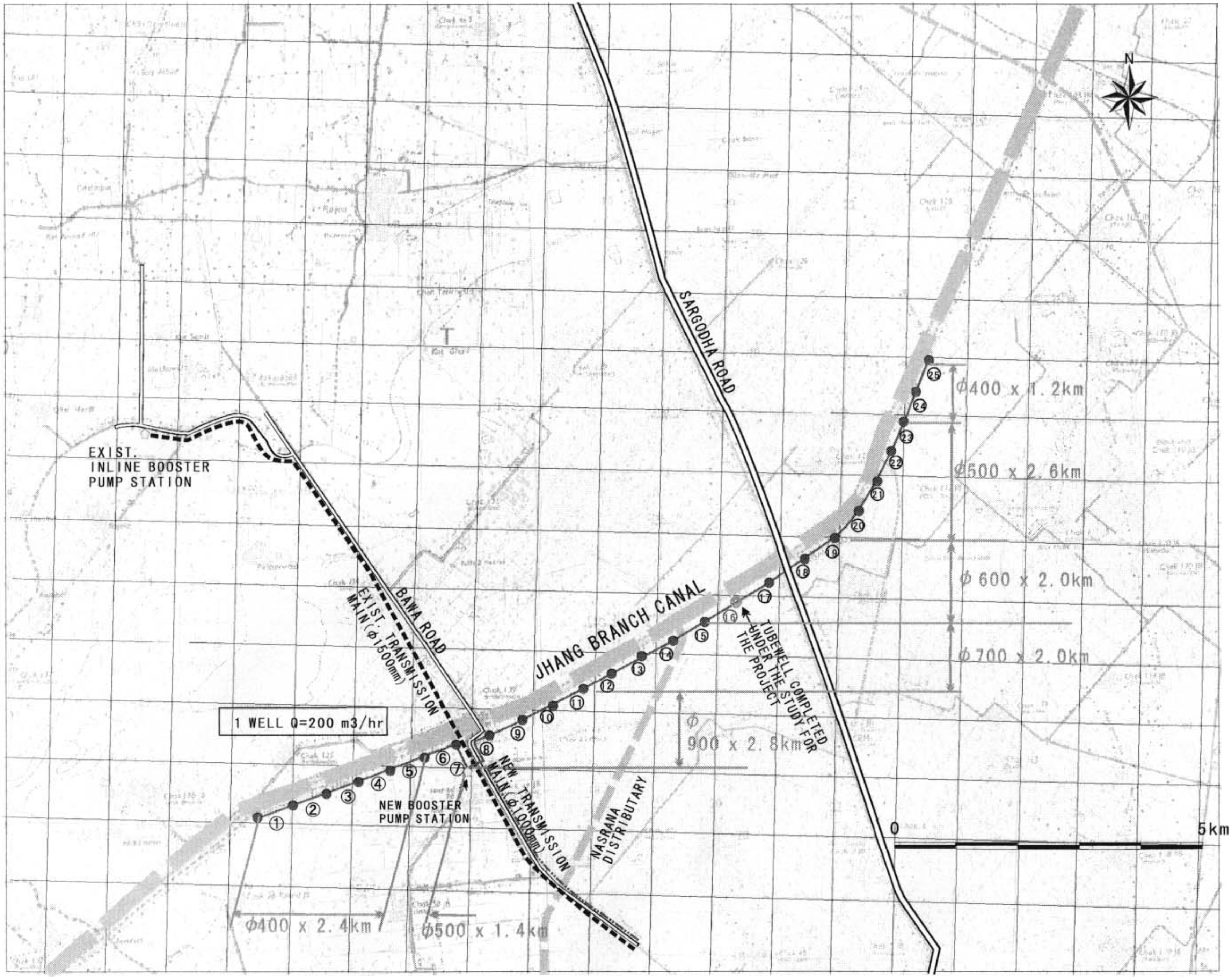
- The wellfield for this project is to be in public land of narrow strip about 20m wide along the left bank of the Jhang Branch Canal under management of the Electricity and Irrigation Department of the Punjab government. The basic design for the wellfield is to align 25 tubewells in parallel with the channel of the canal. In the existing wellfield along the Rakh Branch Canal within Faisalabad, WASA adopted a similar design for the alignment of tubewells, resulting in stable discharges with a good qualities, thanks to the constant seepage from the canal.
- For this project, the tubewells are designed to be installed at intervals of 600m, in accordance with the concept of minimizing the lowering of water level as a result of the pumping tests.
- One test well was drilled at the center of the planned wellfield during the field survey. Since its discharge and quality satisfy the design criteria, it will be used as one of the production wells for this project. Using the location of this well as the reference point, the other wells will be located at 600m intervals to the up- and downstream of this well (See Fig. 2-13).

iii. Tubewell pumps

a. Type

As intake pumps for the project, types of those submerged in tubewells are required for the longstanding stable operation of the intake system. There are

FIG. 2-13 LAYOUT OF TUBEWELLS ALONG JHANG BRANCH CANAL



two types available: one is vertical turbine pumps; and the other, submersible motor pumps. The former is of Pakistan make and was employed for the previous project. In view of advantages and merits in this equipment described hereunder, it is recommended to adopt it for this project as well:.

- A submersible motor pump is suitable for systems requiring high heads for lifting water from the tubewell having low water level. The pump operates at as high a speed as 3,000 rpm. On the contrary, tubewells in the project area are retaining high water levels close to the ground surface thanks to the constant recharge from the canal, and the range of water level lowering in the future will be limited. This situation allows to employ the vertical turbine pump operating at 1,500 rpm, 1/2 speed of the corresponding submersible pump. It goes without saying that this much lower rate of revolution is more advantageous in terms of operation and maintenance of equipment.
- Since the submersible motor pump is a combined unit consisting of a submersible pump and motor to be installed inside the tubewell, the whole unit must be raised out of it for inspection and maintenance whenever repair is needed. Repairs of motors are more frequent than pumps themselves. On the other hand, for the vertical turbine pump, only the pump is installed inside the tubewell and the drive unit is installed above ground. For both types, the units are connected by a transmission drive axis. As the drive unit, other than a motor, an engine is also used particularly in areas without electric power, although motors are more economical. The existing pumps are driven with vertical electric motors. If a motor has trouble, it can be inspected and repaired above ground without pulling the pump up, giving advantage for operation and maintenance. Also, the motor is not a special submersible type, but a normal above ground type, and this is easier to repair than the submersible type.
- WASA is familiar with operation and maintenance of this type since vertical -motor- driven, vertical turbine pumps have been working continuously for 10 years in the previous ADB project. During this period, electrical problems with motors and power distribution panels were encountered, but problems

with mechanical parts of the pump itself were not experienced.

b. Pump capacity

・The unit discharge rate is set at 200m^3/hr.

・The total head is determined as the total of the pumping water level (including projected water level lowering in the future) of the well, the losses in the effluent pipeline and valves in the pump station, friction losses in the collector mains, and height difference between the ground levels of the tubewell and the booster pump station.

－Pumping water level in a tubewell

The pumping water level is calculated from analysis of the pumping test results of the test well with certain assumptions.

= (Average static water level of the wellfield=6-9m) + (Drawdown when pumping at 200m^3/hr =2m) ＋ (further water level lowering during canal distribution shutoff periods and measure for influence on water level lowering from the existing Chenab wellfield =5m) ＝ about 14m

Moreover, as allowance for characteristics of the unconfined aquifer which is directly influenced by rainfall, a maximum pumping water level of 20m is assumed (the existing tubewells of Chenab area initially had water levels similar to that of the test well of the present study, but after 10 years, their pumping water level lowered to 25m at the maximum)

－Other losses

The 25 wells of the wellfield will be aligned alongside the approximately 14km belt of the Jhang Branch Canal and water pumped from them will pass through the collector mains to the pump well in the Jhang B. Canal booster pump station. The losses in water flow varies at the respective locations of the tubewells with about 40m at the farthest upstream of the wellfield down to less than 10m at the well field near the pump station. The ground level at the booster pump station as the delivery point is about

2 m lower than the upstream of the canal, but most of the course of collector main along the canal is nearly flat.

The calculation of required heads of the pumps for 25 tubewells involves all the above components. The maximum head is 60 m for the pumps in the upstream tubewells far from the booster pump station, and the minimum, 30 m for those close to the pump station. As a result, the pumps are classified into 4 groups differing in the head requirement.

iv. Intake pump station

The main structure of the intake pump station is of reinforced concrete, following the design for the existing pump stations. The roof will be structured with reinforced concrete and waterproof mortar finish to allow the work for lifting and lowering the pump with a heavy-duty chain block.

As ancillary facilities to the pumps, effluent pipe of the pump station, air release valve, gate valve, check valve, water meter and others will be installed for flow control and measurements.

2) Collecting facility

i. Components of Facility

The function of the collecting facility is to transport the discharges of 25 tubewells for the project to the planned booster pump station. The 25 tubewells are aligned in public green belt about 20 m wide and 14 km long along the left bank of the Jhang Branch Canal at intervals of 600m. Their discharges pass into the collector main leading to the pump well in the booster pump station. The components of the collector main are listed in the following table.

Table 2-16 List of Collecting facility

Facility Classification	Type	Quantity	Type of Pipe	Diameter	Length	
Collecting Facility	Collector Main	Total Length 15.600m	Ductile Cast Iron Pipe	400 mm	3,600m	Total 12,800m
				500 mm	4,400m	
				600 mm	2,400m	
				700 mm	2,400m	
			Steel Pipe	900 mm	2,800m	Total 2,800m

ii. Determination of piping material

- Two types of pipe are proposed for the collector main: one is ductile cast iron pipe and the other, steel pipe.
- While the construction of the entire line with the latter can reduce the cost, the sections of smaller diameter steel pipe raise technical difficulty in ensuring a rigid structure to be accomplished with on-site welding and protective coating at joints both outside and inside. Such works inside the pipe can be allowed in 800 mm and larger ones in view of safety factors. In case smaller diameter sections are replaced with 800mm steel pipe as an alternative, the cost rises higher than the case of ductile iron pipes of designed sizes. Under such consideration, the line is designed with ductile iron pipe for sections smaller than 800mm and steel pipe for 900mm diamter ones. (Refer to Section 4) Transmission Main for the detail of comparison of the 2 types.)
- The collector mains will be laid along nearly flat land on the left bank of the canal. Examining the results of the topographic survey, air release and washout valves will be placed at appropriate locations for ensuring effective performance of the line. On the route of the pipeline there are 3 sections to cross distributaries branched from the canal (Nasrana distributary about 20m wide, etc). These sections can be undercrossed during the winter season every year when the channel bed runs dry after the water delivery through the canal ceases for a period of about one month for its maintenance

and repair (The preceding ADB project successfully carried out the work in a similar manner). There is no need to employ costly technology such as trenchless construction method.

3) Transmission facility

i. Components of facility

The discharge from the 25 tubewells transported through the collector mains is temporarily received at the booster pump station. After chlorination at the station, the water is pumped out by the booster pumps through the transmission main to a planned terminal reservoir to be constructed on the premises of the existing T/R in the city. The components of transmission facility are shown in Table 2-17.

Table 2-17 List of Transmission Facility

Facility Classification	Facility or Equipment	Quantity	Specifications	
Transmission Facility	Pump Well	1 no	Structure	Reinforced Concrete Structure, Effective Depth 4m
				Flat stab, bent structure
			Capacity	4,000m^3、Single compartment
	Booster Pump Station	1 no.	Structure	Reinforced Concrete Structure
			Dimensions	26,000 x 14,000
			Ancillary equipment	Mobile crane, 5,000kg capacity
			Annex buildings	Chlorinator building: 13,000 x 600 (1 no.)
				Operation control building (1 no.)
				Operator's quarters (one in-station, one outside)
	Booster Pump	3 nos. + 1 standby	Discharge rate	91,000m^3/day (daily operating hours: 20 hours)
				@ 25.3m^3/min x 33m x 980 rpm x 190kW

			Diameter	450 mm (suction) x350mm (discharge)
			Type	Double suction volute pump
			Motor	High tension 3 phase cage type induction current
				190 kW x 6p x AC 3.3 kV x 50 Hz
			Ancillaries	450mm butterfly valve (suction side, 5 bar manual)
				Ditto (discharge side, 10 bar automatic)
				450mm swing check valve
				1,000mm ultrasonic flow meter
	Chlorination system	Automatic 2 nos manual, 1 no.	Chlorinator	Injector Type: Dosing Rate 0-5,000 g/hr
				Measurement range 20 : 1
			Chlorine cylinder	6 nos. ＋2 standbys, 1 ton volume
			Weighing scale	1 set, 0-4,000kg
			Leakage detector	1 set, 0-5ppm
			Preventive equipment	Chlorine neutralizer spray unit (3 units)
				Self-priming oxygen respirator (2 units)
			Decontamination equipment	Neutralizing tower (FRP/PVC), Neutralizer storage tank (FRP)
				Neutralization blower, pump
	Transmission main	13,000 m	Steel pipe	Dia. 1,000mm (Exterior: polyethylene coating, interior :epoxy resin paint)

ii. Determination of transmission method

The distance from the left bank of the Jhang Branch Canal to T/R is about 13km. A vast agricultural land extends from the wellfield to T/R, which is located on the northwestern fringe of the city. The route is nearly flat, although the wellfield is slightly higher than T/R in elevation. While the topographic feature allows direct transportation of discharges from the tubewells to T/R, the examination of the existing system in the preceding project dictates to install an intermediate pump station between the tubewells and T/R to control flows and pressures of discharges at the respective wells which tend to vary widely, depending upon the characteristic of the aquifer. Therefore, the booster pump station is planned as one major component of transmission facility.

iii. Booster Pump Station

a. Candidate Site for Booster Pump Station

The construction site for the booster pump station is selected at a location along a public road close to the wellfield, which allows to install a large diameter pipeline for a minimum distance without difficulty. There are two public roads extending from the Jhang Branch Canal to the city; one is Sargodha road to the east, and the other, Bawa road to the west. Along the latter, the existing 1,500mm diameter transmission main runs from the existing in-line booster pump station to T/R. Of the two, Bawa road is shorter to T/R. As a result of the survey in and around the wellfield, a site was finally determined through the negotiations between WASA and related local offices at a public land more than 3 ha along Bawa road, about 800m south of the wellfield along the Jhang Branch Canal. (Refer to Fig. 3-13.)

b. In-station Facilities

The main facilities to be constructed in the booster pump station are the following.

* Pump well (4,000 m^3)	1 unit
* Booster pump station	1 unit
* Chlorinator building	1 unit
* Operation control building	1 unit
* Quarters for operators	1 unit

c. Soil strength of construction site

To examine soil strength of land proposed for the booster pump station, the standard penetration tests down to 20m were carried at 3 points within the site during this study.

From results of the survey, at 2m and below from the surface, a layer of consolidated silty clay and fine sand is distributed and the N values are as follows.

Table 2-18 Soil Strengths of Booster Pump Station Site

Point No. 1	Point No. 2	Point No. 3
Depths 2-6m, N=20-30	Depths 2-6m, N=approx. 15	Depths 2-4m N=10-20
Depths below 6m, N=30-40	Depths 8-12m, N=approx. 30	Depths 4-11m N=20-30

Furthermore, taking the results of sample analysis into account, the foundation of the design structure is basically set at a range of 2m to 3m below ground, and the exact depths of the respective structures will be decided according to the hydraulic grade line in the system design. (The groundwater level in the site for the booster pump station was 5.2 - 5.3 m during the study carried out in the latter half of the rainy season)

iv Pump well

This structure receives water transported from the tubewells in the wellfield and temporarily stores water for pumping to the final destination of T/R. The detention time is designed at 1 hour of the daily pumping rate of 91,000(m^3/day)/24(hours)＝3,800m^3 = approx. 4,000m^3. The storage tank is of water tight, reinforced concrete, a single unit of bent flat slab structure (beams are not used and reinforced concrete slab is used as the beam). Flow regulating walls are installed at the inlet and outlet inside the tank.

v. Booster pump station

a. Booster pumps

・The water from the existing tubewells in the Chenab wellfield passes through the collector main, existing in-line booster pump station and then is transmitted to the final distribution tank (T/R) in the city. The existing booster pump station lacks storage facility and the pressure of the water passing the station is directly boosted with line pumps to reach T/R. Until 1998 the water could directly pass from the tubewell pump stations to T/R without boosting on the way, since the water head of the tubewell discharge was sufficiently large thanks to high groundwater level. In recent years, however, the progress of groundwater level lowering in the region has led to the necessity of pressure boosting on the way when the discharge rate is high in the daytime. The lesson from the experience in the existing system is that a booster pump station is required for control of transportation of the discharges from a group of tubewells for a long distance, since the performance of tubewells tends to vary as time passes, and that the station should have a temporary storage facility to ensure constantly stable flows to the destination. In this project, the booster pump station is planned with a pump well for the storage of tubewell discharges as have been explained in Paragraph iv.

・The type of booster pumps proposed for the project is double suction volute pumps suitable for a large quantity of discharge. Those employed in the existing in-line booster pump station and T/R were of the same type. One of the advantages in this type is that since the pump casing can be separated into upper and lower parts, only the upper casing needs to be removed for inspection of the pump interior without disconnecting the motor.

・The maximum discharge rate at the booster pump station is 91,000m3/day covering the maximum daily flow of tubewells (4,6000 m^3/hr for 20 running hours). This rate is delivered with simultaneous operation of 3 units of pumps (with one standby).

b. Booster pump station

An independent pump station to house 4 units of booster pumps is constructed in the site premise. The building is of reinforced concrete wall structure with outer mortar finish.

vi Chlorinator building

a. Chlorinator

- The discharge of tubewells is disinfected by liquid chlorine at the booster pump station to ensure a safe supply. The chlorinator consists of an injector and pressure control mechanism to form a vacuum, and in the vacuum state, chlorine gas is measured, controlled, mixed with pressure water inside the injector, and the chlorine solution is injected into the water for supply. (In this project, pressure water from the booster pump is branched into the injector and chlorine solution is fed into the pump well installed on the premises of the booster pump station site.)

- An injection up to an effective rate of 2 ppm for the discharge is targeted as the dosage capacity, and 2 units having 5,000 g/hr capacity per unit will be installed.

- For the existing chlorination system, WASA has a contract for a constant supply of liquid chlorine with a local chemical plant located about 40km from Faisalabad, and additional procurement can be assured through a revised contract　On the other hand, there is no domestic producer of one ton cylinder to contain liquid chlorine, and this needs to be procured through this project.

b. Safety considerations

- No serious risk has so far been experienced with the existing chlorination system installed in the in-line booster pump station. However, since chlorine gas is highly toxic, the project plans to safeguard against damage and injury to the personnel handling a planned system through safety considerations including the provision of standard safety gears as well as the installation of an emergency scrubber system. The scrubber system designed for the project is a single-pass multi-stage absorption facility, consisting of a reaction unit and chemical storage tank to neutralize the chlorine-contaminated air. When gas leakage occurs in the injection room, a blower passes the gas into the neutralization tower and it comes in contacts with a neutralizing agent (caustic soda solution) in the neutralization tank to decontaminate the gas.

c. Injector Room

- The injector room is an independent reinforced concrete structure on the premises of the booster pump station. The liquid chlorine storage room is adjacent to the injector room separated by a partition wall. The scrubber system consists of a chlorine gas blower, neutralization tower and neutralization tank, which are installed outside the injector room.

vii. Other buildings in the booster pump station

The booster pump station will have two annex buildings; one is the operation control building for management of the system in the booster pump station, and the other is the quarters for operators posted at the tubewells in the vicinity of the booster pump station. The latter is designed to have capacity to accommodate 5 persons.

Each of the existing tubewell pump stations in the ADB project has an annex for the rest and accommodation of the operator. Under this project, however, accommodation facilities for operators working in 3 shifts at the tubewells will be constructed separately, one at the booster pump station for the west side of the wellfield and one in a public land near Sargodha road for the east side, where the test well for this survey was drilled.

The capacity of the quarters is based upon the manning schedule of WASA for planned facilities along the Jhang Branch Canal as follows:

Table 2-19 Manning Schedule for Borehole and Booster Pump

.	Location	Service	Operation Hours	Operation System	Manning Schedule
1	Tubewell Pump Station	Simultaneous operation of 23 tubewells	Daily operation basically continues for 20 hrs at the respective stations..	In principle, 1 operator per well is assumed. He is responsible for pump operation, confirmation of flow rate and water level. in 3 shifts	The number of max. staff is 77 persons (Night crew 12 persons)
2	Booster Pump Station	Simultaneous operation of 3 pumps with 1 chlorinator	24-hour operation	3 shift system	Max. staff no. 14 persons (Night crew 5 persons)

The quarters for operators are basically for use by night workers with their maximum anticipated number at 28 including those for both the tubewells and the booster pump station. WASA expects that those who will be in need of lodgings are about one third of that total number, since it plans to provide a chance for employment to residents having their own home in the nearby villages. Accordingly the quarters will have a capacity to receive ten persons in total, 7 to 8 at the tubewells and 2 to 3 at the booster pump stations. The quarters are planned to be built at two locations, each having a capacity to accommodate 5 persons, with one in the booster pump station at the west side and the other in the public land near the Salgodha road for the east side.

viii. Selection of material for transmission main

a. Concept of the design for transmission main

The route of the transmission main from the Jhang Branch Canal booster pump station to T/R in the city zone for this project is planned along Bawa road, where the existing 1,500 mm diameter transmission main runs from the in-line booster station in the Chenab wellfield to T/R. The existing line was installed in the ADB project, Phase I, in which the design included considerations for future additional flows from the Chenab wellfield, leaving an extra capacity to transmit more than the design flow rate (225,000 m^3/day in design, and 200,000m^3/day at the maximum in practice). Since the Jhang Branch Canal booster pump station is planned on the way along the existing line, there is the alternative of installing a separate transmission main or passing the discharge into the existing line in this project. The alternative methods for transport of the discharge from the planned booster pump station were examined in detail during the second stage of this study. The results are as follows:

- The existing 1,500 mm diameter transmission main has the capacity to simultaneously transport the flows from both the Chenab and Jhang Branch Canal wellfields.
- It was found, however, the discharge pressure of the existing pumps in the in-line booster pump station is short of transmitting the flow in combination with an additional flow joining on the way to T/R.
- If the existing booster pumps can be replaced with those with an appropriate higher pressure, the combined transmission will become possible.

WASA had no objection against the utilization of the existing line for this project, and in response to the findings of the study team, it requested to the Japanese side to examine the economic side of the alternative methods, since it put the highest priority on a design to minimize the cost of operation and maintenance. (Refer to Annex 2: Technical Note)

The results of economic comparison of the alternative are as follows:

- The use of the existing line is more advantageous in the construction cost than the installation of a new line.
- The situation reverses in respect of the cost of operation and maintenance because of the soaring electrical cost.

・The comparison of the total costs of the project in both cases during its life indicates that the separate pipeline system eventually gains an advantage over the combined system.

As a result of economic comparison of the alternative, this project chooses the plan to install an independent transmission main which is more economical in the operation and maintenance for a long term.

b. Determination of piping material

As a result of the consideration in Section 1), since the plan for construction of a new supply pipeline is selected for this project, the main pipe materials for this project including the already explained transmission pipe will be considered.

The existing pipelines transporting the discharges of the existing tubewells in the Chenab wellfiled via the in-line booster pump station to T/R in the city consist of the collector mains of 300 mm to 1,000 mm diameters about 10 km long and the 1,500 mm diameter transmission main about 18km long. These pipelines are all ductile cast iron pipes (ISO standard) of Japanese make procured through the international tender by ADB. Time since then has proven the quality of this type of pipe and it is one of the best choices for this project. Meanwhile Pakistan has developed spiral steel pipe, especially for high-pressure gas pipeline works, with domestic manufacturers now competing to produce high quality ones with protective coating. It has lately been employed in water projects financed by international agencies such as the World Bank as the alternative of ductile cast iron pipe. The comparison of the two types is shown in the table below.

Table 2-20 Comparison of Ductile Cast Iron Pipe and Steel Pipe

	Ductile Cast Iron Pipe	Steel Pipe
Durability	While the two types of pipes has a similar range of physical strength, the ductile cast iron	Its official service life was 25 years in Japan, but was recently revised to as long a life as that of ductile

	pipe features long durability and reliability due to its higher anti-corrosive quality of material than the latter. A life of 40 years is officially employed in the Japanese standards. Further longer life is reported in practice around the world.	cast iron pipe, namely 40 years.
Workability	Easily joined by rubber ring joint or slide ring. The joint structure and ring efficiency determines the quality. (Faulty products tend to have leaks through joints.)	Joined by welding. For large diameters, inspection of welded joints by X-ray testing is officially required. (1 X-ray test for every 10 welded joints). Also anti-corrosion coating is required for the exterior and interior of welded portions. Such requirements prolong the work schedule for the installation of steel pipes in comparison to cast iron pipe.
Lining/ Coating	Internal lining: : Mortar lining External coating: Epoxy resin coating for water supply	Internal lining: : Epoxy resin air spraying External coating: Plastic (epoxy and polyethylene) coating. Japan has been switching the conventional method of coating with asphalt enamel to plastic coating.
Cost	Costly compared to other types of pipes.	Less expensive than ductile cast iron pipe. Moreover since local products of this type are available in the home market, they can be procured without the high cost of overseas transportation necessary for import of ductile cast iron pipe. (Remark: since local plants do not have facilities for manufacture of fittings, their procurement amounting to 10 to 20% of the pipe price relies upon overseas supply.)

According to the comparison in the foregoing table, the ductile cast iron pipe has an advantage in workability over the steel pipe as well as in durability, although there is little difference on the overall basis. On the other hand, the steel pipe is considerably lower in cost and can contribute to the reduction of the project cost.

As one of essential factors for the selection of pipe type, the conditions of the site where the pipeline is to be installed were examined. The collector and transmission mains for the project are designed to pass an extensive flat terrain consisting mainly of farmland where the pipe-laying works technically pose little difficulty except for limited portions along the route where congested marketplaces for villages run. In such working condition, the steel pipe is preferred due to its high merits in the economy of the project.

Assuming thus to basically employ the steel pipe for the project, at least for the collector and transmission mains, this type of pipe is required to be joined by on-site welding both outside and inside. Further, these joints need to be protected with the application of anti-corrosive coating both outside and inside after welding in order to ensure a durable structure. This requirement excludes the employment of steel pipe for sections of smaller diameters, partly for physical difficulty of working inside the smaller diameter pipe and partly for safety considerations. Reference to the Japanese safety regulations dictates that the diameters of pipes allowing the interior works should be 800 mm and larger. Based upon such practical considerations for the field work, this project determines to employ the steel pipe for the works requiring large diameters of 800 mm and larger and the cast iron pipes for those of the smaller diameters.

As will be described later in this section, the project includes another important undertaking mainly consisting of the installation of pipelines in the traffic-congested streets of the city center, which requires a high level of workmanship in skill and speed. For this part of the works, the cast iron pipe is preferred from technical considerations even for sections of 800 mm and more.

c. Determination of pipe diameters

The maximum supply rate from the booster pump station on the basis of the design discharge rate of the tubewells is (91,000 m^3/day)/20 hr=4,550 m^3/hr. The economic diameter for this supply rate is either 1,000mm or 900mm.

The technical factors of these diameters are listed in the following table, including friction losses, based upon the Hazen-Williams equation.

Table 2-21 Comparison between Pipe Diameters

Diameter	900mm	1,000mm
Maximum Flow Rate	4,550 m^3/hr	Same as left
Flow Velocity	2.00m/sec	1.62m/sec
Friction Loss in the Pipe (C=120, distance 13 km)	50. 9m	30.5 m

Economic comparison of both types shows that in terms of the construction cost, there is no big difference between the two sizes. While the 900 mm diameter pipeline is less expensive than the 1,000 mm line in the cost of material and installation, the former entails the higher cost in the pumping facilities including the pumps and electrical and control facilities, since the friction loss along the former is by far higher than the latter. On the other hand, for the operation and maintenance cost, power consumption for the 1,000mm pipe is much lower. The overall evaluation indicates that the economic diameter for the transmission main in the project is 1,000mm. Since WASA places high emphasis on the saving of energy cost, the selection of the 1,000mm pipe is appropriate.

d. Determination of the pipeline route

The transmission main for the project is planned to take the route about 13 km long along BAWA road between the booster pump station and T/R where the existing 1,500mm transmission main runs. The road is a privately-operated bus route connecting the villages around the Jhang Branch Canal to the city. The road is blacktopped and traffic is jammed in the morning and evening time for commuting. The initial section about 3 km long from the booster pump station passes through market areas for surrounding villages where small shops line both sides of the road. To accomplish the works along this section smoothly, lots of activities for public relations with the related villages are required in the pre-construction stage. Public meetings will be necessary to obtain overall consensus of the villages for the work. Most of the sections along the route run through vast farmlands apparently posing little difficulty on the works. However, since laying large diameter pipes along the roadside may require from place to place to pass through private lands, detailed survey of land use along the route is indispensable and consent from the concerned landowners should be ensured. Since the revenue department of the district office is in charge of land use in the area, cooperation of this department is needed during the construction stage as well as the detailed design stage and the situation must be sufficiently studied. With the existing 1,500mm pipeline is laid on the right side of the road towards the city, the planned 1,000mm diameter transmission main will take the left side of the road.

The elevation of the starting point, the booster pump station, and the that of T/R are both at the same level of 185.4m, and the route in-between is nearly flat. The cavitation analysis of the pipeline along the route assures no risk without surge tanks and other measures taken for the existing transmission main, but air release valves and washout valves will be installed wherever necessary.

The planned route has a section to cross the canal (the Nasrana Distributary) in the middle of the village Chak No. 50, which is the downstream of the canal to be crossed by the collector main. The construction method is by an open-cut method when there is no flow there in winter, in the same manner as for the collector main.

4) Distribution Facility

i. Concept of the design for the terminal reservoir in the project

The discharge of the existing Chenab system flows into the existing reservoir in T/R located in the outskirts of the northern part of the city and from the distribution pump station on the premises, the water is supplied to the city through the arterial mains of 1,600m to 500mm in diameter having a total length of about 49km. Those existing facilities for distribution were completed in 1992 by Phase I of the ADB project. The additional discharge from the Jhang Branch Canal is planned to be received by new facilities on the premises of T/R, from which the water will be distributed to the city through the existing arterial mains to supply water to the city, simultaneously with the flow from Chenab system.

The present study found that the existing reservoir and pumps have been malfunctioning, as is later explained in subsections (iii) and (iv), and this project plans to provide some measures to improve the condition so that the water service through the single distribution main could go on as well as possible, including the reinforcement of the existing arterial mains for the same purpose in response to the request from WASA (refer to Technical Note in Annex), which will be examined in detail in Section 5.

ii. Major components of distribution facility

The components of the new distribution facility are as follows

Table 2-22 Main Components of Distribution Facility

Classification	Facility or Equipment	Quantity	Specifications	
Distribution Facility	Terminal reservoir	1 no.	Structure	Semi underground reinforced concrete structure, effective depth 6 m
				Flat slab, bent structure
			Reservoir capacity	36,000m^3
	Terminal pump station	1 no.	Structure	Reinforced concrete
			Ancillary equipment	Mobile crane facility 7,500 kg
			Dimensions	36,500 x 15,000
	Distribution pumps	3 nos. + 1 no standby (Total 4 nos.)	Discharge rate	Total: ;5,700m^3/hr @31.6m^3/min x 45m x 980 rpm x 330kW (Hourly maximum supply rate =17,000 m^3/hr)
			Diameter	500mm(suction side) x 350mm (discharge side)
			Type	Double suction volute pump
			Motor	High tension 3 phase wound induction motor
				330 kW, 6P, 3.3 kV, 50 Hz
				Liquid resistor
			Valves	500 mm butterfly valve (suction side, 5 bar, manual)
				500 mm butterfly valve (discharge side, 10 bar, manual)
				500 mm swing check valve (10 bar)
				500 mm cone valve (discharge side 10 bar, electrically operated)
				1,200 mm ultrasonic flow meter

iii. Terminal reservoir

The capacity of the planned terminal reservoir is designed at 23,000 m^3 corresponding to the amount of 6 hours of the maximum supply rate as a minimum standard for continuous supply. However, since the operation of T/R for distribution involves not only the supply from the planned system but also that of the existing Chenab system, which are to be operated in parallel. Therefore, considerations must be given for effective distribution by both systems.

The existing terminal reservoir receiving the discharge of the Chenab system has the design capacity of 46,000 m^3 with an effective water depth of 6 m. However, its lower half, 3 m, has been left unusable since its commissioning, seemingly due to a combination of various design defects such as the installation height of the pumps, characteristics of the pumps and suction header. Consequently its effective capacity has been limited to 23,000 m^3.

If the discharge is increased by this project, the total amount of water flowing into T/R will be 271,000 m^3 (ongoing 180,000m^3 of the Chenab system plus 91,000m^3 of the Jhang Branch Canal system). Against this volume of discharge, the effective storage capacity of T/R totals 46,000 m^3(23,000 m^3 of the existing reservoir plus 23,000 m^3 of the design capacity of the planned one). The planned capacity covers only about 4 hours of the total water supply from T/R. Since this rate of storage capacity is insufficient for an appropriate operation of T/R for distribution, this project plans to improve it through the following measures:

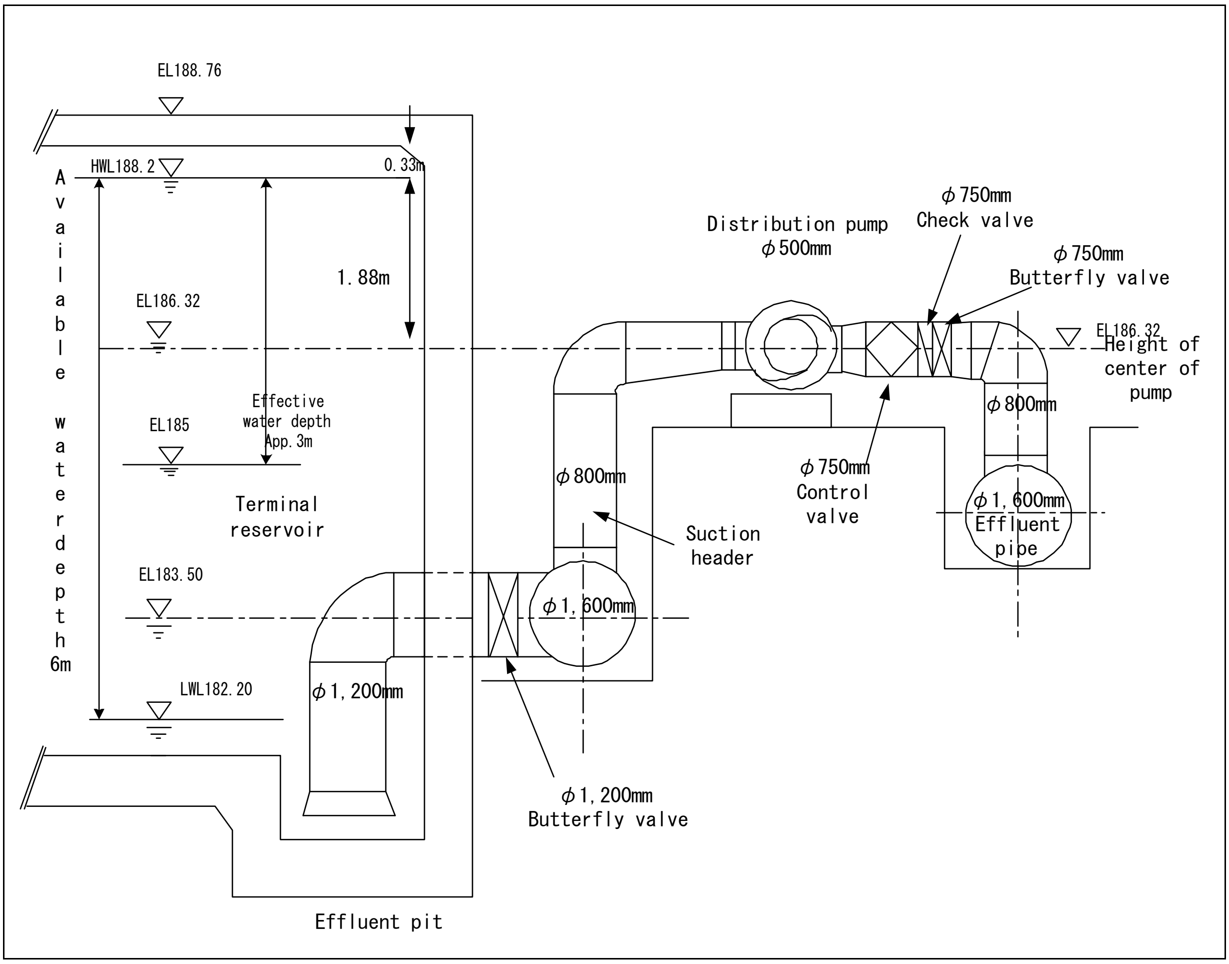
・The planned reservoir at T/R will be designed, taking into account the dimensions of available land on the premises of T/R for the purpose of augmenting its capacity. Its maximum possible capacity is 36,000 m^3, based upon the existing facilities layout on the premises. Then the total effective capacity will become 59,000 m^3 corresponding to about 5.2 hours of the maximum water supply rate.

・In addition, the project plans to tap the lower part of the existing reservoir in order to increase the storage capacity at T/R, even if partially. For this purpose, the suction pipe of the new distribution pumps is designed to be connected to the existing pump suction header. Since the new pumps are to be installed on the underground floor in the planned pump station, such arrangements make it possible for the new pumps to have access to the unused portion of the existing reservoir constructed on the ground level. Theoretically its total volume could be added to the storage capacity.

Notwithstanding the actual effective capacity cannot be determined precisely at this stage since the consumption pattern after the water is augmented remains yet to be seen and that will affect the high and low water levels of the two reservoirs at T/R for a combined operation of the existing and new pumps. This measure, however, is anticipated to result in the increase of the effective capacity close to the standard of 6 hours of the maximum water supply rate. The targeted storage capacity is assumed at 65,000 m^3, increase by about 10% of the design capacity.

- The alignment of the existing pumps in relation to the existing reservoir is shown in Fig. 2-14 for reference.

Fig. 2-14 Section of the Existing Reservoir and Pumps



iv. Selection of distribution pumps

a. Type of the pumps

The capacity of the new distribution pumps is designed to discharge the peak hour rate of the maximum discharge rate of 91,000 m^3 /day augmented through the project

(91,000 m^3/day) x (peak hour ratio=1.5)/24 hours = 5,700 m^3/hr

The conventional double suction volute pump is the appropriate type for the new pumps as well. WASA has been using this type of pumps at T/R for 10 years and they are well acquainted with operation and maintenance methods of this type. In comparison to other large capacity pumps (such as the vertical inclined flow pump), this type is cost wise preferred.

The new pumps are run in parallel with the existing large-scale distribution pumps during peak hours. Since the pumps with different capacities are operated simultaneously, the present performance of the existing pumps is examined in detail in the next section.

b. Performance of the existing pumps at T/R

As shown in Fig. 2-14, the existing distribution pumps are connected to the suction header specially designed for their parallel operation. The design pump suction lift is 6 m, but in actual operation, the increase of friction loss in the suction pipe due to its design and alignment is suspected to restrict the suction lift to about 3 m, resulting in the cut-off of the effective capacity of the existing reservoir, as explained in Section 3. This situation could have been prevented if the pumps could have been installed at levels lower than the suction piping. (Under this consideration, the new pumps are designed to align on the underground floor of the planned pump station.

The existing pumping system consists of 6 identical units of pumps and 1 standby with the supply rate controlled with the number of the running units The pumps are run 3 times a day, each 2 hours at the maximumu, due to the shortage of water and limited storage of the reservoir at T/R. Under such service conditions, as consumers in the city open their taps simultaneously whenever the pump starts, the hourly consumption soars and the pump discharge becomes enormous to reduce the pump pressure. Although the rated pressure of the existing pumps was designed at 4kg/cm^2, the current simultaneous operation of 6 pumps cannot raise the pressure and 3kg/cm^2 is the maximum. It drops off to as low as 0.5kg/cm^2 downstream of the arterial mains in the east side of the city, resulting in persistent poor water service across that area.

This unbalanced demand and supply is creating what's called a "cavitation" phenomenon even to the pumps themselves. Originally the pumps were designed so that the flow rate is controlled through pump number adjustments in response to demand, but when one to three pumps are running, a drastic pressure drop occurs due to increased flow from a high demand, and the pump function reduces because of cavitation, leading to difficulties in continuous operation. One of typical examples of influences from cavitations in the past is the damage to the main shut-off valves on the delivery side of pumps. The 5 of them out of 7 in total had been directly attacked, their casings penetrated through with a couple of cm holes due to heavy corrosion.

Faced with this situation, WASA took practice to start the operation with 3 pumps, controlling the flow with the other shut-off valves of butterfly type, and after gradually raising the pressure, the operation was changed over to normal operation using 5 or 6 pumps. In the ongoing operation, the pressure of the initial stage is 10 m for 3 pumps, and when it is stabilized in about 30 minutes, other 2 to 3 pumps join for full operation.

c. Pump operation plan for the project

The following are the basic typical example of pump operation upon completion of this project. It may be adjusted due to actual demand and consumption pattern.

・The peak hour rate is designed as 1.5 times of the daily maximum supply rate 271,000 m^3 /day. There are 3 peak times a day, each in the morning, noon and evening, each for 2 hours at the maximum. The present peak times will be referred to for time setting.

(271,000m^3/day x 1.5)/24 hours = 406,500/24 = approx. 17,000m^3/hr

・At peak times it is assumed to operate the existing 6 pumps and the 3 new pumps in parallel. The characteristic curve of the performance of the simultaneous operation of these 9 pumps is as shown in Fig. 2-15, with the performance of the existing 6 pumps estimated from the condition of the ongoing operation. Based upon this curve, the pump discharge pressure can rise to the rated 40 m, while the flow rate, unless properly controlled, is expected to increase to 20,000 m^3/hr, surpassing the design peak hour rate with a ratio of 1.9. In this case, whether to reduce the pump number of either the existing or new pump group will be determined by observing the demand trend during the actual test runs and adjustment period.

・The normal operation during non-peak hours will be handled by controlling the new pumps only, since the control of the existing larger pumps is difficult and is likely to cause excessive discharges during normal hours. If all the 3 new pumps are run simultaneously, the flow rate will be excessive in the same manner as that of the existing pumps. The anticipated flow rate is estimated to reach about 9,000 m^3/hr with the pressure at nearly the same range of 30 m as currently experienced. In case the pump discharge pressure is the same as the present one, the supply pressure at the east side will remain the same, resulting in the same poor level of supply. A countermeasure against such a risk is planned for this project, as later explained in Section (5) Plan for the Improvement of Distribution System. The expected supply rate of 9,000 m^3/hr with the new pumps is about 20% less than the daily maximum supply rate, but it is close to the daily average supply rate.

・The storage capacity at T/R of 65,000 m^3 as examined in Section 3) can manage simultaneous operation of both the new and existing pumps at peak times and continuous operation of the 3 new pumps at ordinary time. Therefore, the supply service to the citizens can be greatly improved as compared to the present one.

・However, the aforementioned plan is formulated from the possible supply rate of the supply side, and the uncontrolled consumption of the citizens is most likely to surpass the design rate. As measures to deal with this case, some kind of flow rate control and cavitation prevention device are necessary, since pump number control alone cannot handle the situation, as has been experienced in the ongoing operation of the existing pumps. The existing pumps have difficulties in arranging such measures, and the following ones are planned for the new pumps only.

－For the main control valve, the cone valve having cavitation prevention effect will be adopted.

－To cope with this kind of flow rate fluctuations, pump velocity control is most appropriate, but full automatic operation would be highly difficult from an operation and maintenance viewpoint, and hence difficult to adopt. On the other hand, velocity control by a resistor attached to the motor is being used at the existing in-line booster pump station. The employed one is a metal resistor which manually changes velocity step-wise (the existing one with 3 steps). WASA has already experience in this type of device.

For this project a liquid resistor capable of continuous velocity control is preferred. Since the liquid resistor is a manual dial type to regulate velocity, the operation is simple and maintenance is technically without difficulties. This resistor is capable of velocity regulation of the motor within the range from 100% to 60%, ensuring lower flow rates. The expected effects are shown in the characteristic curves of Figure 2-15

The type of the drive which can use the resistor is the wound induction motor. (Remark: The motors for the new booster pumps are the cage type. Flow control like one at T/R is unnecessary there.) In practice, the effect of this device is anticipated most at peak times when the discharge rate tends to exceed the design hourly maximum supply rate of 17,000 m^3/hr. While the existing pumps cannot be controlled, the new pumps can do to contribute to reducing the excessive flows.

When the improved supply service becomes common in the city through the implementation of the project, WASA can shift to the metered system of tariff collection now under planning. The new system has an effect to reduce uncontrolled consumption, and under such a situation velocity control may frequently be required. Thus this method will become one of necessities in future supply services.

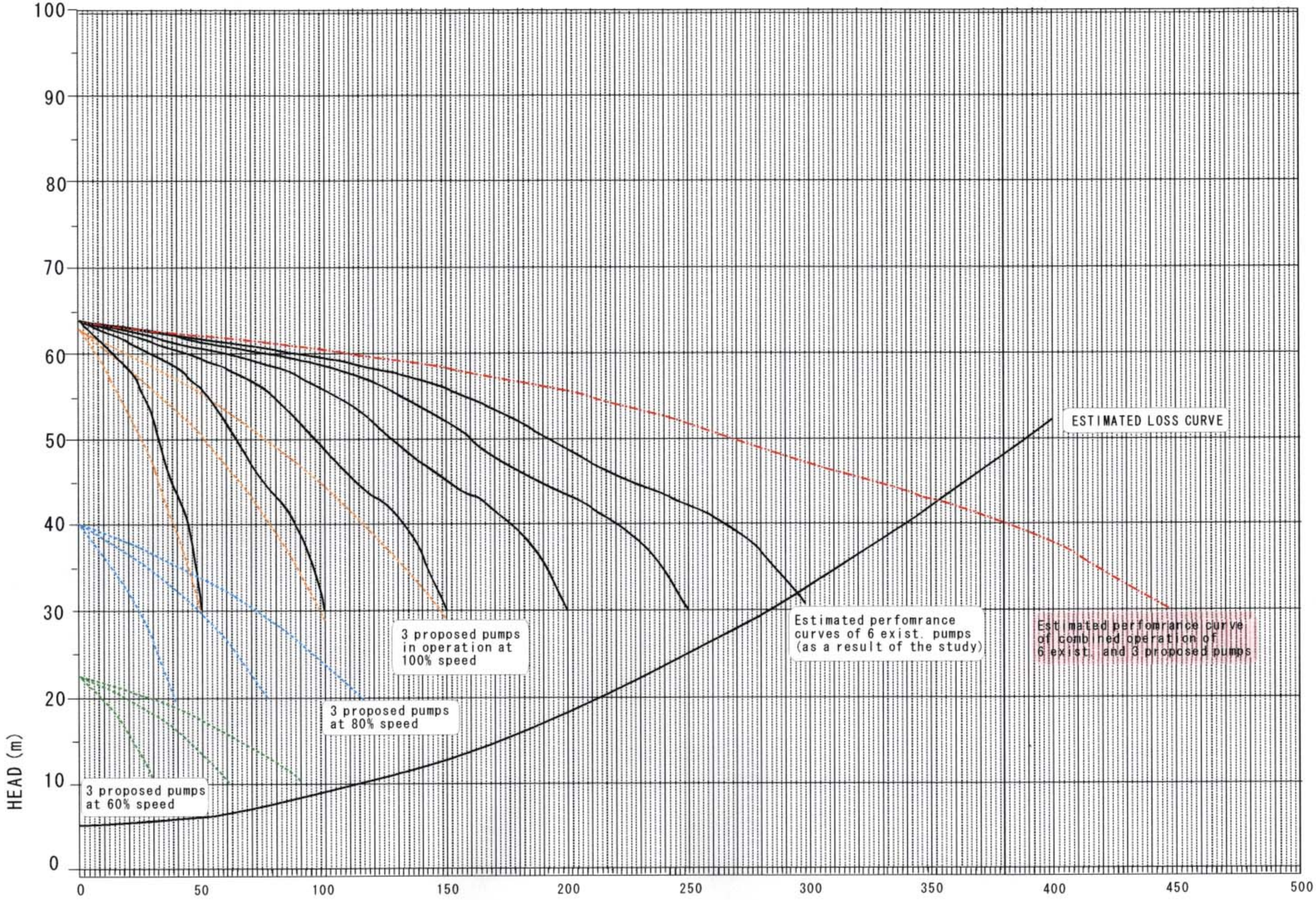


FIG. 2-15 ESTIMATED PERFORMANCE CURVES OF EXIST. AND PROPOSED PUMPS AT TERMINAL RESERVOIR

- The method to handle the demand trend of the citizens in relation to facilities and equipment of the T/R is as explained above. However, since demand after increasing the supply rate is unsure until the supply service actually starts, there may occur unpredictable troubles in the operation like cavitation encountered with the existing distribution pumps. Therefore, the optimum operation method will be established through test operation for about one month.

- For reference the change of water levels in the respective pump stations from the tubewell stations to the terminal reservoir is shown in Fig. 2-16.

5) Plan for Improvement of Distribution System in the City

i. Concept of improvement of the existing distribution system

The ongoing water supply system for the city was completed in 1992 under Phase I with ADB's financial assistance. Since facility improvement needed to handle population increase is delayed, the present municipal supply is in a drastically unbalanced state. The project can have an effect to alleviate acute shortages of water supply, but it is feared that the project effect cannot be realized, unless the present distribution system properly function, and therefore, measures for appropriate scope will be considered (refer to Chapter 1, Section 1-2).

ii. Consideration of WASA Proposals

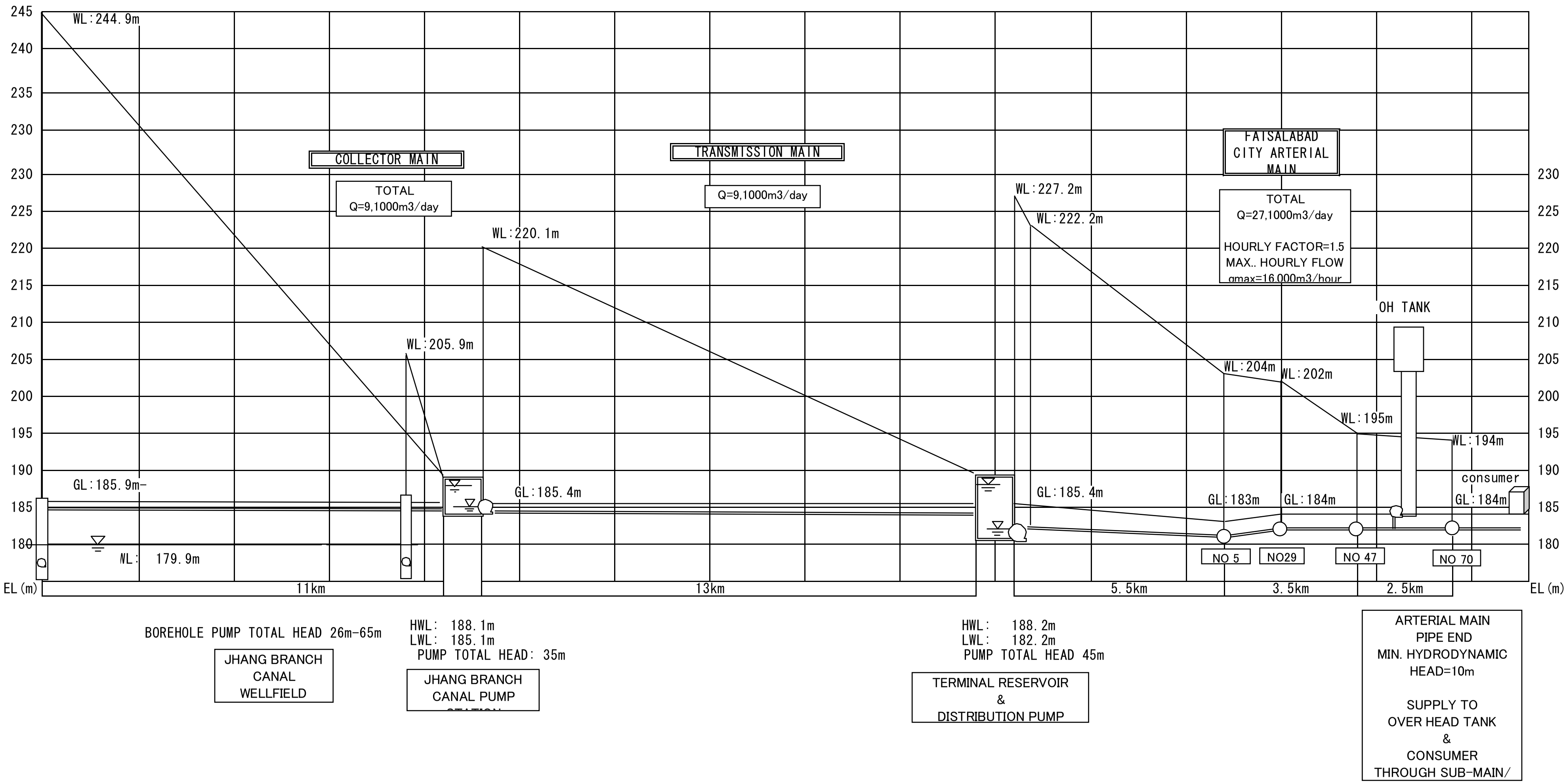
WASA examined themselves the measures for the improvement of the existing network, and during the second stage of the study, it proposed several plans to the study team. (Refer to Annex 4-2 Technical Note.) As a result of examination of its plans, the routes having effects for improvement of the main target of the east side of the city are as follows: (Details are shown in Annex 5-14.)

a. WASA's proposal No. 1 route (route from Junction No. 5 and Jhal Khanuana Head Water Work Junction No. 46, 3.5km in length)

b. Extension of No. 1 route (No. 4 route, from Junction Nos. 46 to Junction No. 70, 2.5km in length)

In case the reinforcement of the foregoing 2 routes is implemented, supply pressures of 1.2 kg/cm^2 - 1.5 kg/cm^2 can be assured in the arterial mains in the easternmost area.

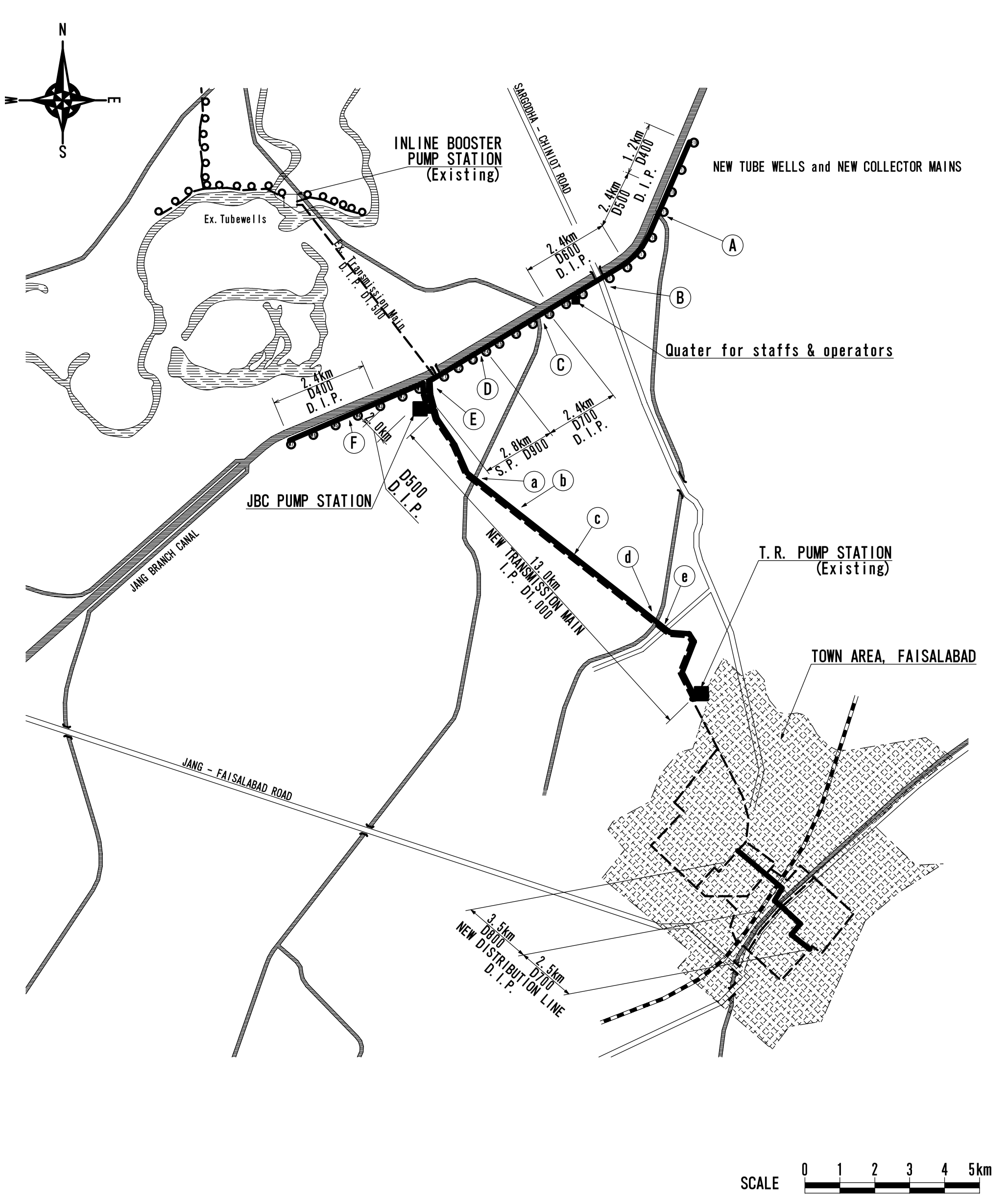
Fig2-16
HYDRAULIC PROFILE OF JHANG BRANCH
CANAL WATER SYSTEM TO FAISARABAD CITY

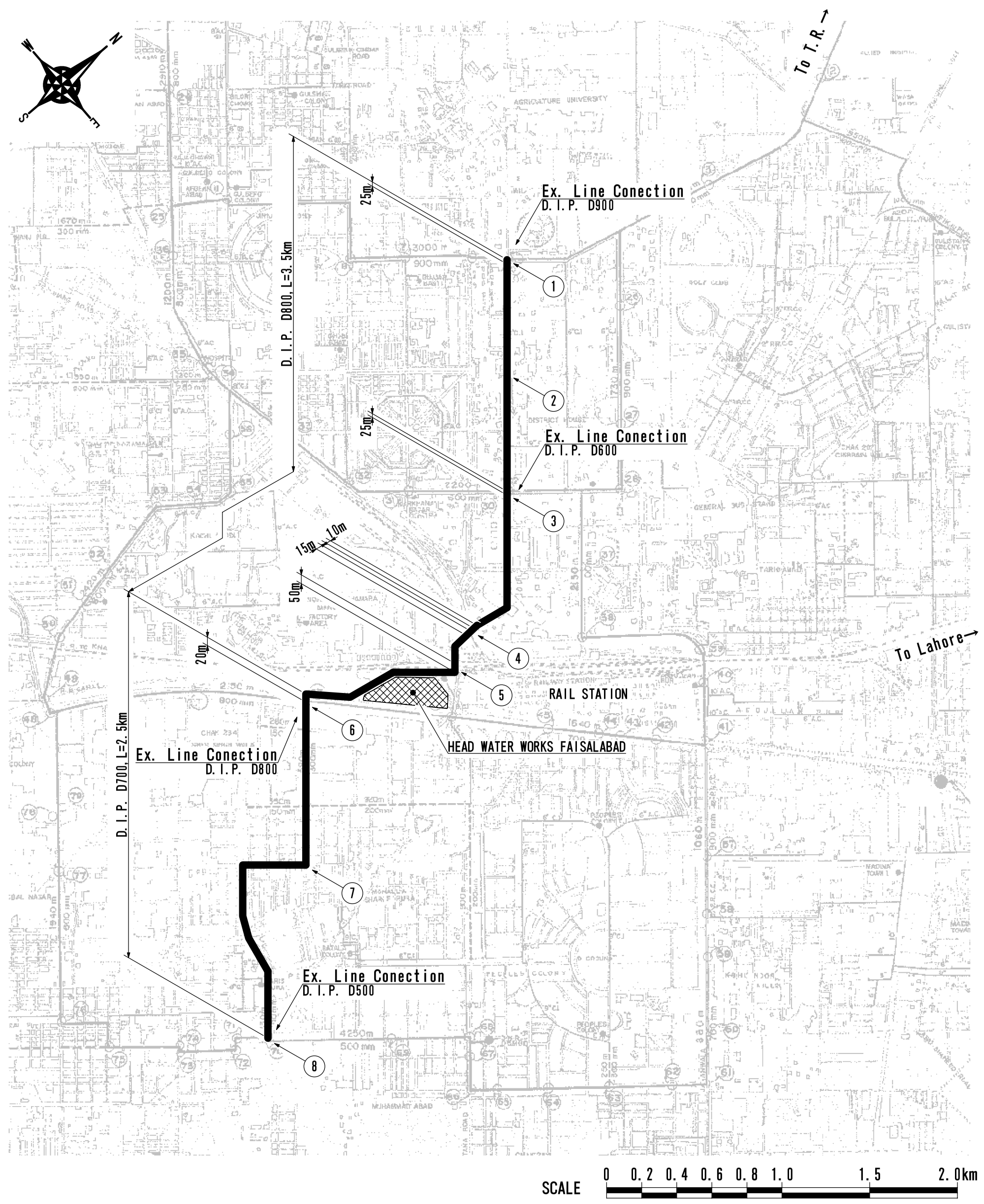


2-2-3 Basic Design Drawing

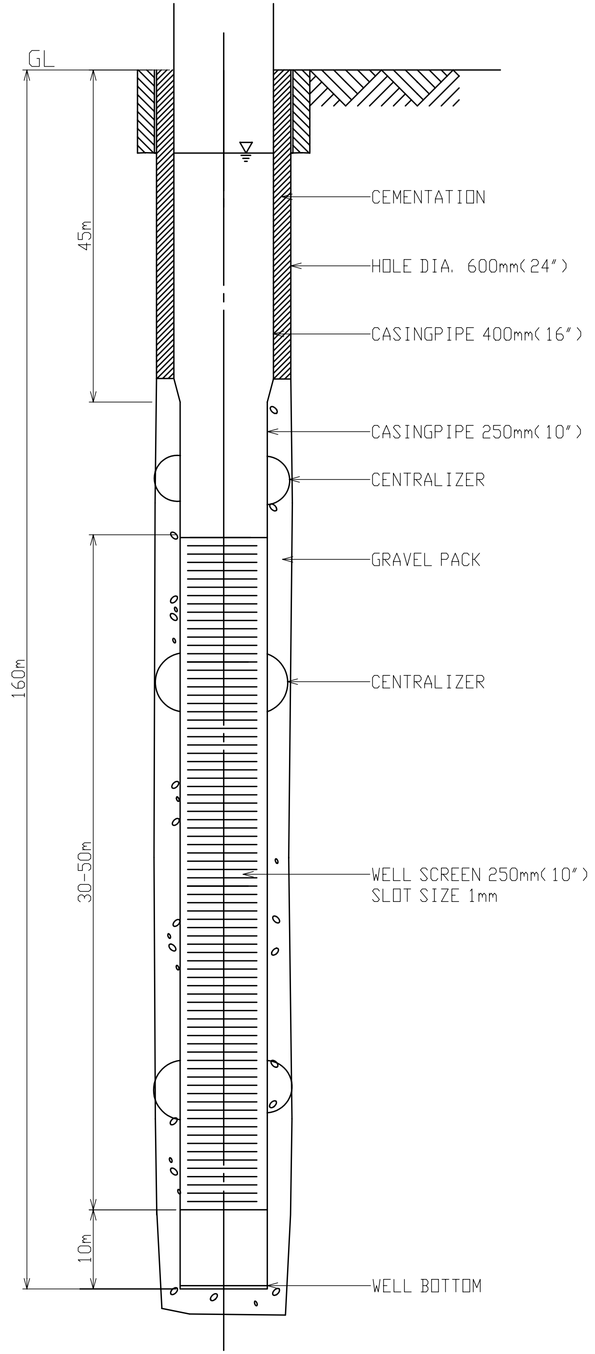
The basic design drawings are shown in the following.

BASIC DESIGN DRAWING





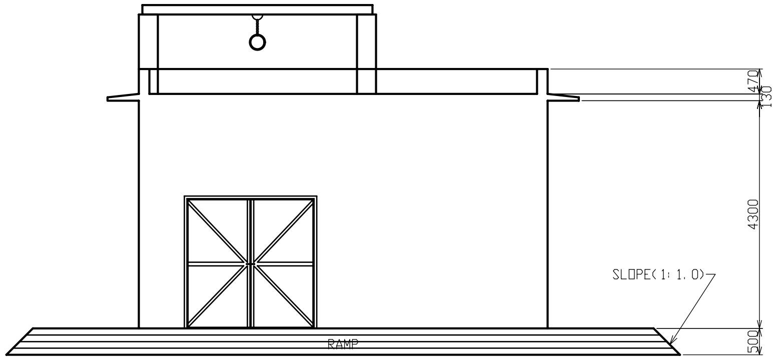
A:Canal Crossing	a:Canal Crossing	1:Conection to Ex. D.I.P.D900	WATER AND SANITATION AGENCY(WASA) FDA, FAISALABAD
B:Road Crossing	b:Air Valve	2:Butterfly Valve	THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY IN FAISALABAD
C:Canal Crossing	c:Draining Facilitiy	3:Conection to Ex. D.I.P.D600	
D:Canal Crossing	d:Canal Crossing	4:Canal and Railway Crossing by Jacking Method,	VIEW OF THE PROJECT
E:Air Valve	e:Road Crossing	5:Railway Crossing by Jacking Method	PLAN
F:Air Valve		6:Canal and Railway Crossing by Jacking Method, Conection to Ex. D.I.P.D800	
		7:Butterfly Valve	
*1)Canal Crossing is Inverted Siphon, includes 2 Air Valves and 1 Draining Facilitiy. *2)Road Crossing includes 1 Air Valve.		8:Canal Crossing, Conection to Ex. D.I.P.D500	JICA JAPAN TECHNO



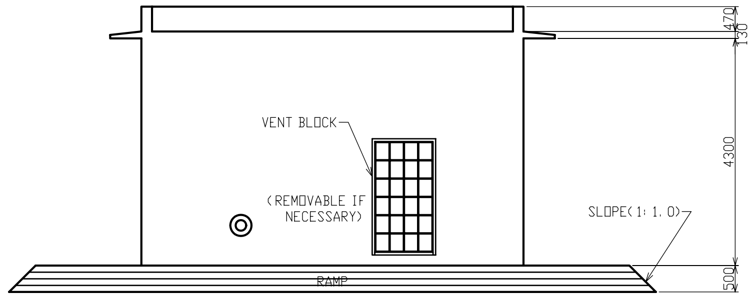
WATER AND SANITATION AGENCY(WASA)
FDA,FAISALABAD
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
IN FAISALABAD

TUBEWELL PUMP STATION
TUBEWELL
WELL STRUCTURE

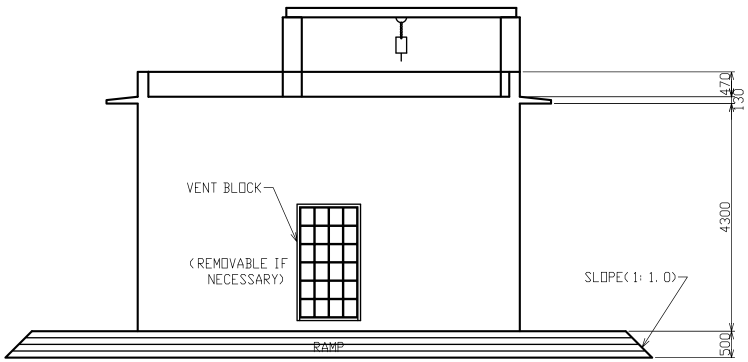
JAPAN TECHNO



PUMPHOUSE
(ELEVATION-1)



PUMPHOSE
(ELEVATION-2)

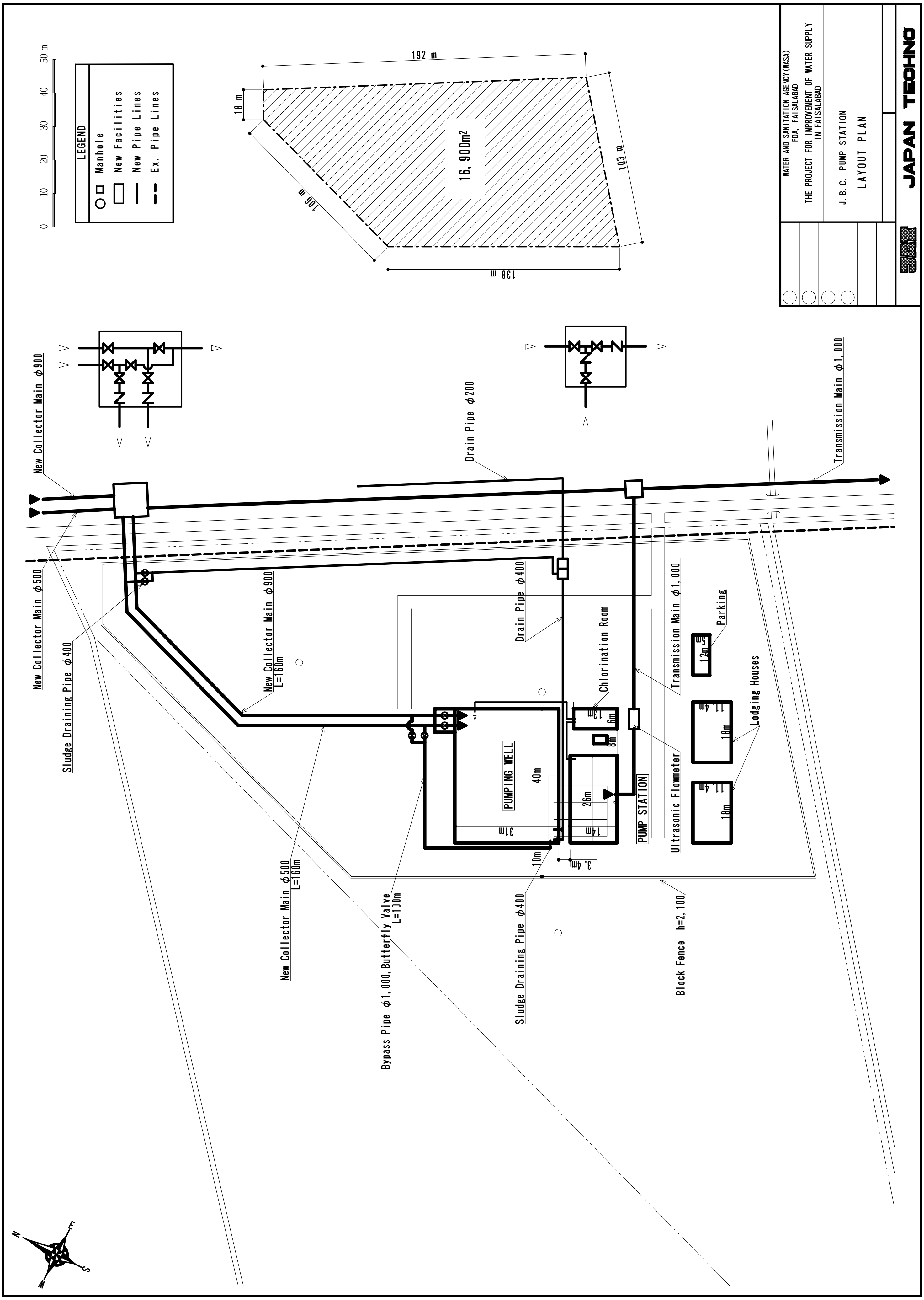


PUMPHOUSE
(ELEVATION-3)

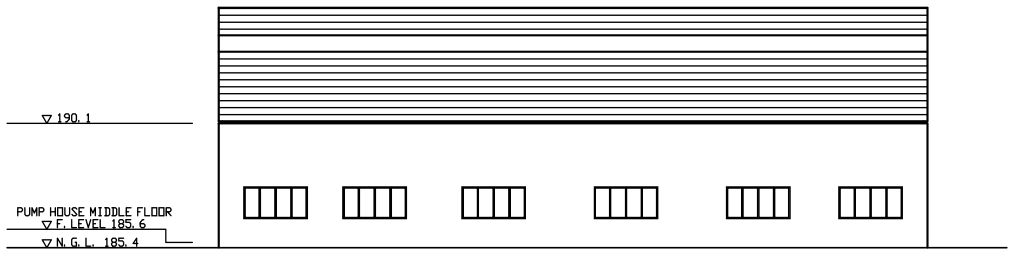
WATER AND SANITATION AGENCY (WASA)
FDA, FAISALABAD
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY IN FAISALABAD

TUBEWELL PUMP STATION
PUMPHOUSE
ELEVATION

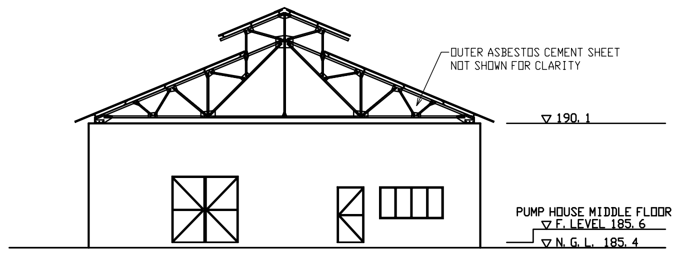
JAPAN TECHNO



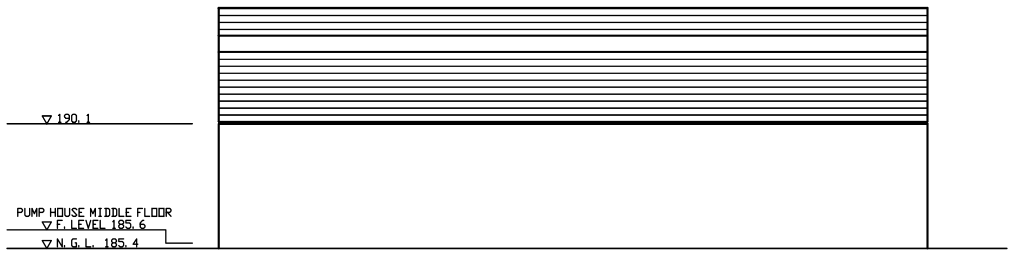
WATER AND SANITATION AGENCY(WASA) FDA, FAISALABAD
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY IN FAISALABAD
J.B.C. PUMP STATION
LAYOUT PLAN
JAPAN TECHNO
LEGEND
Manhole
New Facilities
New Pipe Lines
Ex. Pipe Lines
0 10 20 30 40 50 m
192 m
18 m
103 m
106 m
138 m
16,900m2
New Collector Main φ900
New Collector Main φ500
Sludge Draining Pipe φ400
New Collector Main φ900 L=160m
New Collector Main φ500 L=160m
Bypass Pipe φ1,000,Butterfly Valve L=100m
Drain Pipe φ200
Drain Pipe φ400
Transmission Main φ1,000
Chlorination Room
PUMPING WELL
PUMP STATION
Ultrasonic Flowmeter
Parking
Lodging Houses
Sludge Draining Pipe φ400
Block Fence h=2,100
40m
31m
26m
14m
13m
6m
8m
10m
3.4m
12m
11.4m
18m



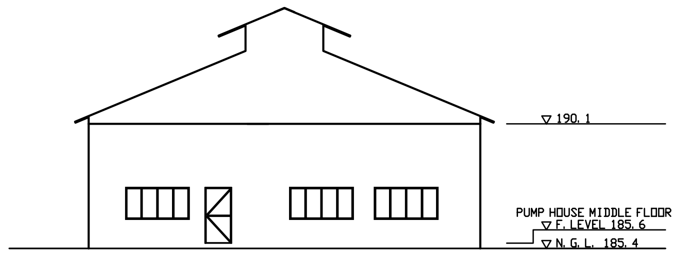
ELEVATION-1



ELEVATION-2



ELEVATION-3

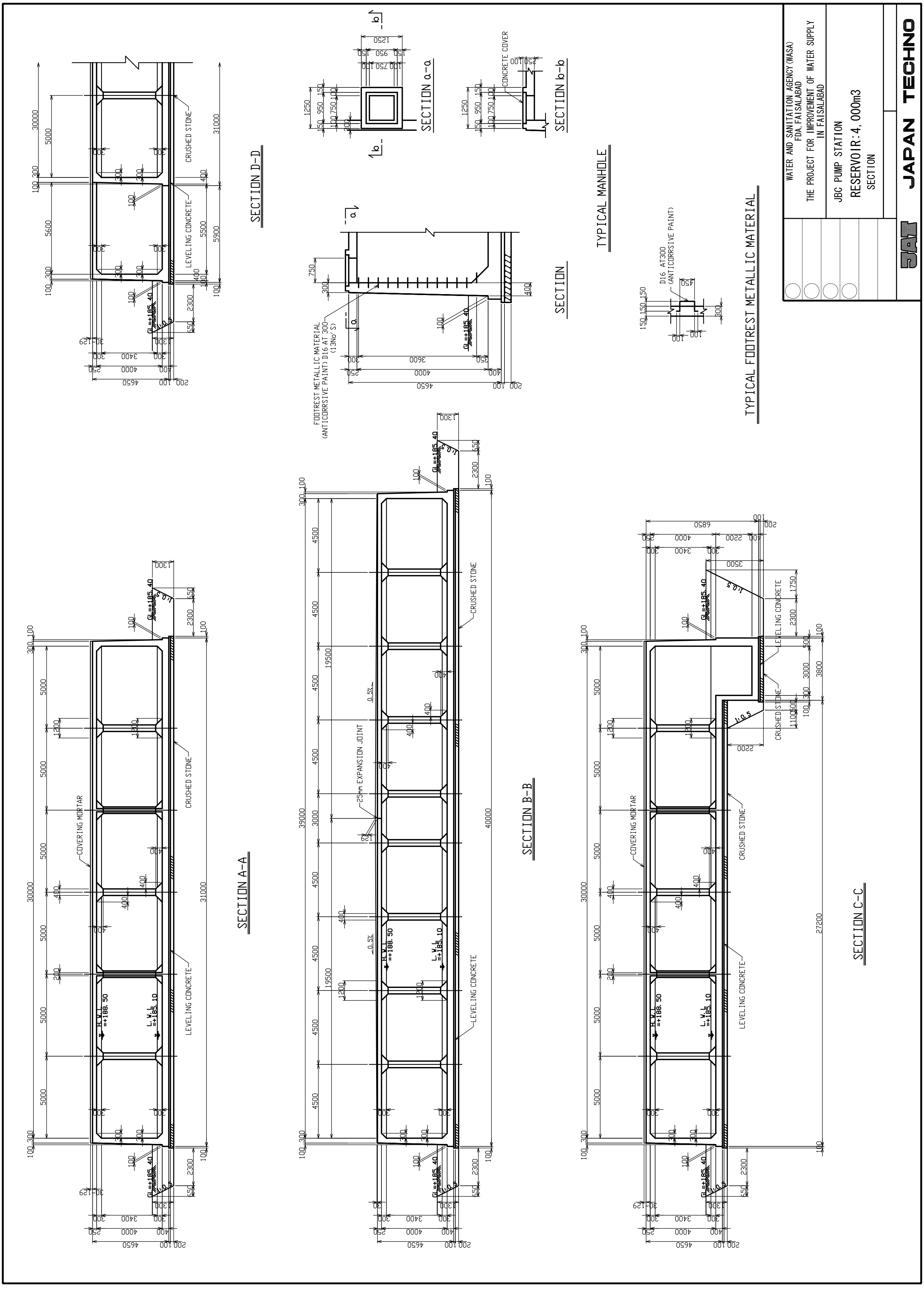


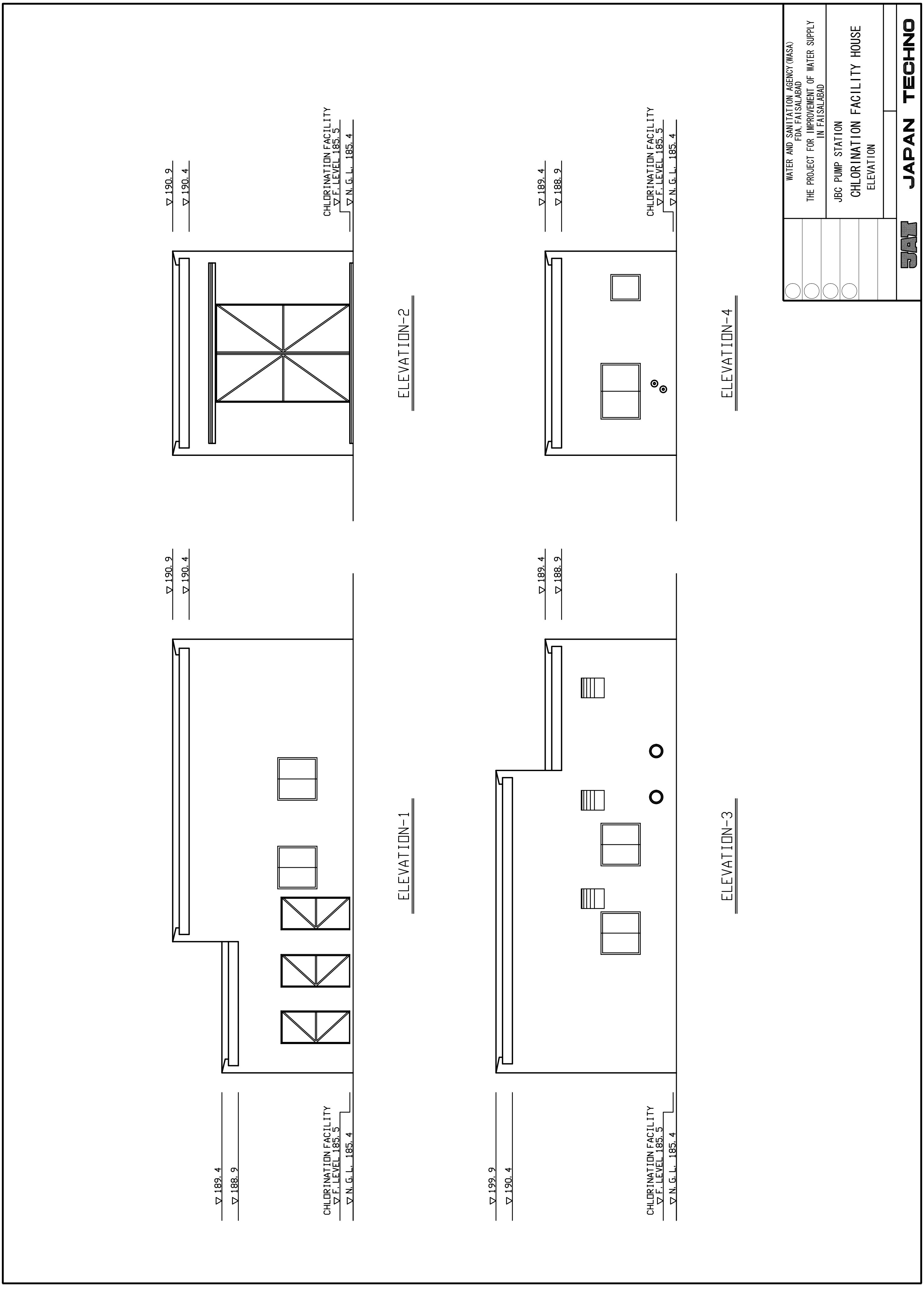
ELEVATION-4

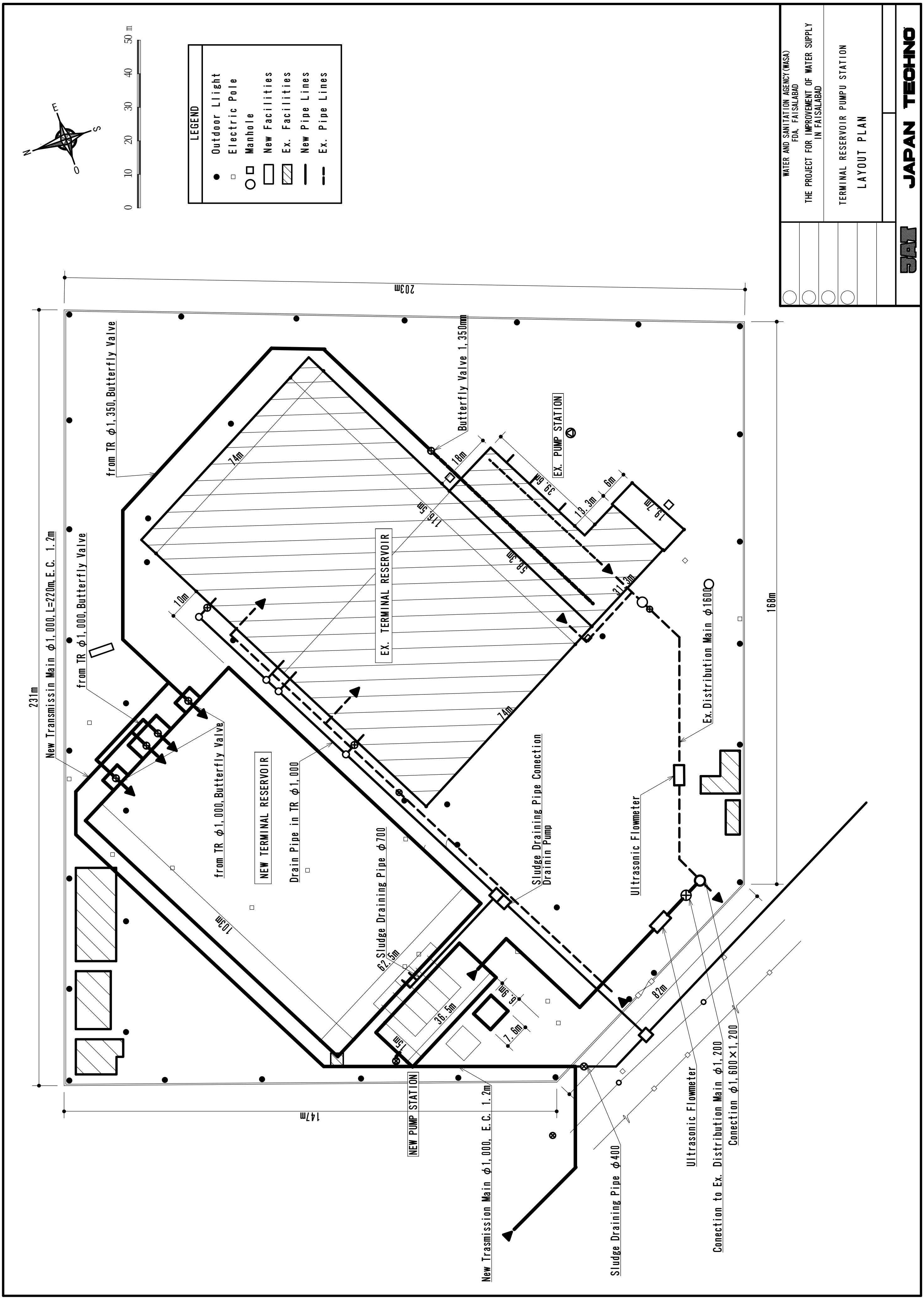
WATER AND SANITATION AGENCY (WASA)
FDA, FAISALABAD
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
IN FAISALABAD

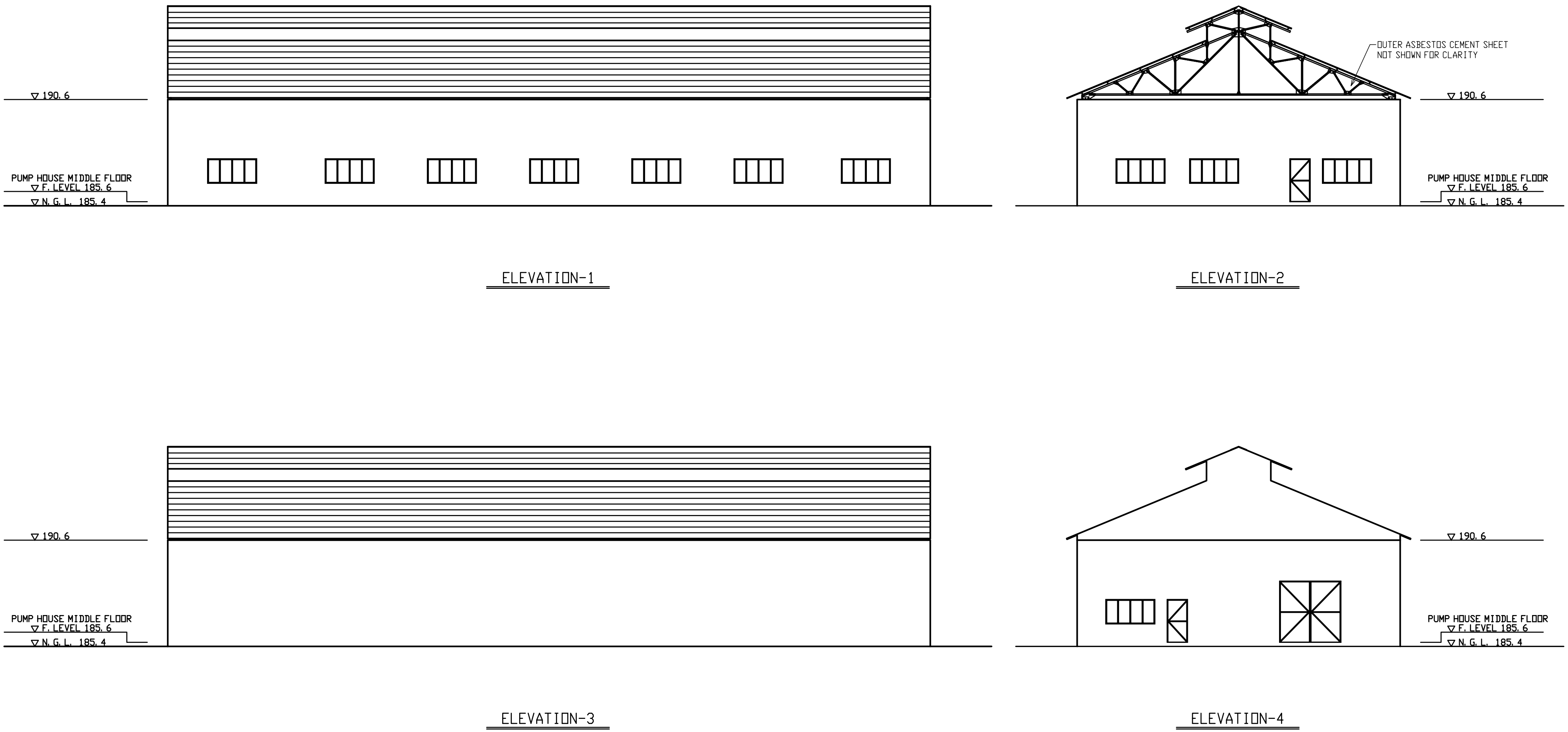
JBC PUMP STATION
PUMPHOUSE
ELEVATION

JAPAN TECHNO


WATER AND SANITATION AGENCY (WASA)
FDA, FAISALABAD
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
IN FAISALABAD
JBC PUMP STATION
RESERVOIR:4,000m3
SECTION
JAPAN TECHNO
SECTION D-D
SECTION a-a
SECTION b-b
CONCRETE COVER
TYPICAL MANHOLE
SECTION
FOOTREST METALLIC MATERIAL
(ANTICORRSIVE PAINT) D16 AT 300
(13No's)
TYPICAL FOOTREST METALLIC MATERIAL
D16 AT300
(ANTICORRSIVE PAINT)
SECTION A-A
SECTION B-B
SECTION C-C
CRUSHED STONE
LEVELING CONCRETE
COVERING MORTAR
25mm EXPANSION JOINT
H.W.L =+188.50
L.W.L =+185.10
GL=+185.40


WATER AND SANITATION AGENCY (WASA)
FDA, FAISALABAD
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
IN FAISALABAD
JBC PUMP STATION
CHLORINATION FACILITY HOUSE
ELEVATION
JAPAN TECHNO
ELEVATION-1
ELEVATION-2
ELEVATION-3
ELEVATION-4
CHLORINATION FACILITY
▽F. LEVEL 185.5
▽N. G. L. 185.4
▽190.9
▽190.4
▽189.4
▽188.9
▽199.9

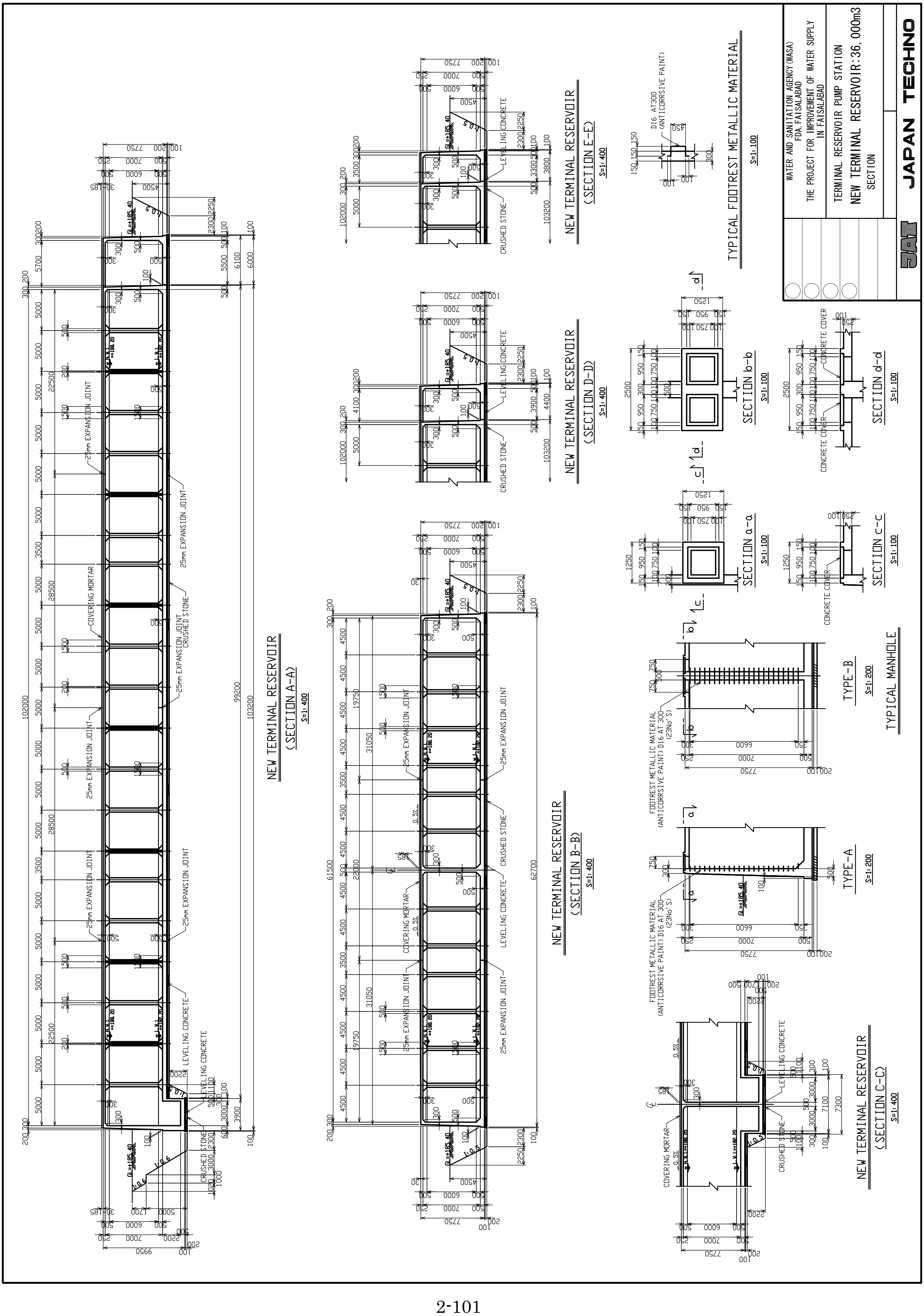

WATER AND SANITATION AGENCY(WASA) FDA, FAISALABAD
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY IN FAISALABAD
TERMINAL RESERVOIR PUMPU STATION
LAYOUT PLAN
JAPAN TECHNO
LEGEND
Outdoor Llight
Electric Pole
Manhole
New Facilities
Ex. Facilities
New Pipe Lines
Ex. Pipe Lines
0 10 20 30 40 50 m
E
S
O
N
203m
231m
168m
147m
from TR φ1,350,Butterfly Valve
Butterfly Valve 1,350mm
EX. PUMP STATION
EX. TERMINAL RESERVOIR
NEW TERMINAL RESERVOIR
New Transmissin Main φ1,000,L=220m,E.C. 1.2m
from TR φ1,000,Butterfly Valve
from TR φ1,000,Butterfly Valve
Drain Pipe in TR φ1,000
Sludge Draining Pipe φ700
Sludge Draining Pipe Conection Drainin Pump
Ultrasonic Flowmeter
Ex.Distribution Main φ1600
NEW PUMP STATION
New Trasmission Main φ1,000, E.C. 1.2m
Sludge Draining Pipe φ400
Ultrasonic Flowmeter
Conection to Ex. Distribution Main φ1,200
Conection φ1,600×1,200
74m
74m
116.5m
58.3m
39.6m
18m
13.3m
6m
19.7m
31.3m
10m
103m
62.5m
36.5m
6.9m
7.6m
5m
82m



WATER AND SANITATION AGENCY (WASA)
FDA, FAISALABAD
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
IN FAISALABAD

TERMINAL RESERVOIR PUMP STATION
NEW PUMPHOUSE
ELEVATION

JAPAN TECHNO



WATER AND SANITATION AGENCY (WASA)
FDA, FAISALABAD
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
IN FAISALABAD
TERMINAL RESERVOIR PUMP STATION
NEW TERMINAL RESERVOIR:36,000m3
SECTION
JAPAN TECHNO
NEW TERMINAL RESERVOIR
(SECTION A-A)
S=1:400
NEW TERMINAL RESERVOIR
(SECTION B-B)
S=1:400
NEW TERMINAL RESERVOIR
(SECTION C-C)
S=1:400
NEW TERMINAL RESERVOIR
(SECTION D-D)
S=1:400
NEW TERMINAL RESERVOIR
(SECTION E-E)
S=1:400
TYPICAL FOOTREST METALLIC MATERIAL
S=1:100
D16 AT300
(ANTICORRSIVE PAINT)
TYPE-A
S=1:200
TYPE-B
S=1:200
TYPICAL MANHOLE
SECTION a-a
S=1:100
SECTION b-b
S=1:100
SECTION c-c
S=1:100
SECTION d-d
S=1:100
FOOTREST METALLIC MATERIAL
(ANTICORRSIVE PAINT) D16 AT 300
(23No's)
CONCRETE COVER
25mm EXPANSION JOINT
COVERING MORTAR
CRUSHED STONE
LEVELING CONCRETE

2-2-4 Procurement Plan of Equipment for Operation and Maintenance

(1) Examination of the requested contents and the procurement plan

The request from the WASA for the project includes the procurement of the operation and maintenance equipment necessary for proper management of the facilities by the WASA after the completion of the project. The results of the examination of the types and the specifications of the equipment requested by the WASA during the second stage of the study are shown below.

1) Water level meter

As previously described, the villages surrounding the planned wellfield are in fear of likely lowering of groundwater level at their irrigation wells as a result of continuous pumping at the project tubewells. It is necessary, therefore, for WASA to carry out a properly planned monitoring programme of the levels at the project tubewells as well as observation wells laid out around the wellfield. To support WASA's efforts in this programme, it is planned to procure handy water level meters with calibration for measuring levels. The planned number of meters is one for each of two tubewells, totaling 12 units (23 daily operating tubewells x 1/2)..

2) Water quality analysis equipment

The planned wellfield is now located closer than the initially proposed ones to the city where groundwater quality is degraded due to artificial contamination as well as natural conditions. It is necessary to carry out the periodical analysis of groundwater quality in and around the wellfield. WASA has an official laboratory for water analysis belonging to the Water Resources Division. The existing equipment in the laboratory is not adequate in quantity and quality for the required monitoring programme. As a minimum requirement, a unit of equipment with higher accuracy is planned to be procured for the laboratory. An appropriate model is of a photo-spectral type which the present staff is capable of handling through their experience. In addition, potable analysis equipment for field testing on basic items such as EC, pH and TDS is required.

3) Monitoring equipment for distribution system

This project plans to contribute to the improvement of the existing network through the installation of additional sections to it. Upon completion of the project, nine pumps are to be operated simultaneously for effective distribution of increased water supply. To ensure a maximum effect for distribution by such operation, regular monitoring of water pressures and flows through the existing arterial mains is of vital importance. To assist such works, this project plans to procure a potable type of gauges, a ultra-sonic flow gauges and two units of automatic pressure recorders. For leakage detection, a simple sounding bar type is selected.

4) Voice communication system for operation control

Upon completion of the project, WASA's water service will be carried out through a combined operation of the existing and new facilities, which are scattered in a vast area of 30 km north to south and 15 km east to west. Since the operation is controlled through directions from the WASA headquarters in the city, a suitable communication system is essentially required. For this purpose, the project plans to procure a voice communication system of a similar type as currently employed by WASA for the existing system, instead of a sophisticated telemeter system capable of transmitting data.

As a result of the examination of WASA's request, the procurement plan of this procurement plan is listed as follows:

Table 2-23 List of Equipment Procured under the Project

<table>
<tr><th></th><th>Equipment</th><th>Q'ty</th><th>Specifications</th><th>Purpose</th></tr>
<tr><td>1</td><td>Water level meter</td><td>12</td><td>Battery driven, potable type
Measurement depth: 50m</td><td>For monitoring plan of groundwater level</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Water analysis equipment</td><td>1</td><td>a. Photo-spectral type including reagents for analysis</td><td>For testing use by WASA's laboratory</td></tr>
<tr><td>2</td><td>b. Potable TDS meter</td><td>For monitoring of quality</td></tr>
<tr><td>2</td><td>c. Potable EC/pH meter</td><td>For monitoring of quality</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Equipment to monitor distribution</td><td>1</td><td>a. Ultra-sonic flow meter</td><td rowspan="2">For monitoring distribution system</td></tr>
<tr><td>2</td><td>b. Automatic pressure recorder</td></tr>
<tr><td>2</td><td>c. Leakage sound detector</td><td>For detecting leakage</td></tr>
<tr><td>4</td><td>Voice communi-cation system</td><td>1</td><td>Frequency zone VHF
Effective distance5～30km
Power source: commercial power
Locations for installation
a. WASA headquarters
fixed type x 1 unit
b. Terminal reservoir</td><td>For communication between the respective facilities and the headquarters and for directions from head-quarters</td></tr>
</table>

			fixed type x 1 unit c. Jhang B. Canal booster pump station: fixed type x 1 unit d. Tubewell Operators: potable type x 15 nos. e. Existing inline booster pump station: fixed type x 1 unit Distance between units a→b about 5km b→c about 13km c→d 3km to 12km d→e about5km	

(2) Operation and maintenance of procured equipment

1) Water analysis equipment

WASA's water laboratory has been engaging in periodical water analysis of its existing tubewells of about 50 in number in both the Chenab wellfield and the Rakh wellfield since 1978. Besides it responds to the requests of citizens for analyses of their waters. It is operated by three qualified specialists. Since equipment it owns, however, is outdated one that the manufacturer already stopped manufacturing, this project plans to procure an upgraded photo-spectral type to meet the requirement in monitoring. The specialists have experience and knowledge of this type of equipment. Reagents for analysis are available in the local market. Pakistan does not manufacture this type of equipment, but inspection and minor repair is locally possible through dealers of equipment.

2) Monitoring equipment for distribution system

During the study for the project, the study team employed an automatic pressure recorder and an ultra-sonic flow meter to examine the conditions of the existing arterial mains, working with counterparts from WASA. After completion of the project, the daily operation of facilities needs to be overseen through regular inspection of the system. For such purpose, the same type of potable gauges as employed in the study is recommended. WASA's counterparts has already acquired experience and knowledge of this type of equipment through the study for the project. During the implementation of the project, the consultant works again with them for control of distribution system, utilizing procured equipment. In particular, equipment will be effectively used during the work for the improvement of the existing network under the project.

Since Pakistan does not produce this type of equipment, those of Japanese or the third country make will be procured. Damage on it will not occur, if handled carefully. In case necessity for repair arises, major components electronically activated will have to be replaced by the manufacturers. As consumed materials, only papers and pens for automatic pressure recorders are required to be supplemented. However, their procurement is not difficult. Data of the flow meter can be output into computers.

2-2-5 Implementation Plan

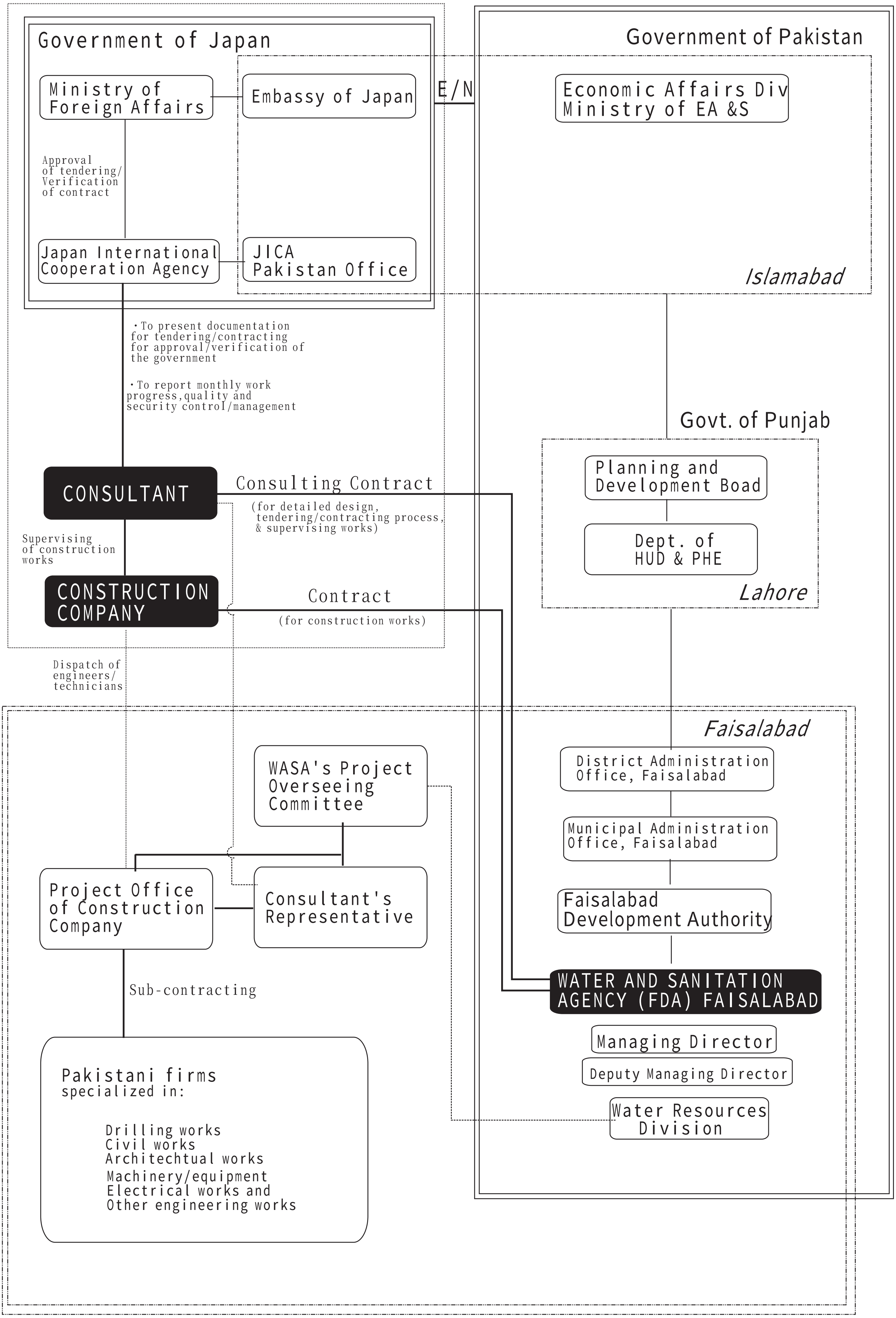
2-2-5-1 Implementation Policy

This project is aimed at constructing the water supply system with Japan's grant aid for Faisalabad city in the Punjab province of Pakistan. The construction work for the project will be carried out with the establishment of an appropriate implementation system in which the work schedule, quality control, safety and environmental considerations will satisfactorily be realized to achieve the objectives of the projects and the given project effects. Fig.2-17 shows the setup of the project implementation system planned in this project.

Under Japan's grant aid scheme, the construction work will be undertaken by a Japanese firm(s) as prime contractor under supervision of a Japanese consultant. The preceding project Phase I with ADB's assistance followed the procurement procedure to recruit international firms for tendering with the entire project divided into two large parts, equipment procurement and construction work, each part further subdivided into components of major facilities for the respective international tendering. On the other hand, this project will be divided into two parts, the main portion for the augmentation of water supply and the other smaller in scale for the improvement of the existing distribution system. The two components thus divided is subject to tendering respectively as a package including both equipment procurement and construction work on a turn-key basis. This method of construction has an advantage to ensure the works with uniformity and integrity.

In the ADB project, main equipment and materials such as piping materials and pumps were procured from Japan through tenders, while the construction work was undertaken by the leading contractors in Pakistan. Some contractors that participated in the ADB project still exist within Faisalabad. Furthermore there are many contractors specialized in large-scale construction works in the provincial capital of Lahore to which access from Faisalabad is now about 1.5 hours through the expressway completed in October 2003. The new road also links the city directly to the metropolitan area of Islamabad-Rawalpindi where enterprises abound.

Fig. 2-17 STRUCTURE FOR PROJECT IMPLEMENTATION



It is highly encouraged, therefore, that the Japanese prime contractor will employ these leading local companies to take advantage of their expertise and experiences for satisfactory execution of the works.

The construction work for the project is composed of (a) the construction work of the intake facility along the Jhang Branch Canal flowing through about 13 km northwest of Faisalabad, together with a booster pump station beside the canal, (b) installation of the 1,000 mm diameter transmission main about 13 km long along Bawa road from the booster pump station to the terminal reservoir in the city, (c) construction of a new terminal reservoir and a terminal pumping station on the premises of the existing terminal reservoir(T/R) and (d) the reinforcement of the existing network within the city. Equipment and facilities in these works are all in large scale, requiring qualified technical capability and skills in their handling. In order to satisfy such technical requirements, prospective Japanese contractors who intend to participate in tendering for the project will be listed for the examination of qualification in the pre-tendering stage. One of the qualification requirements is that the contractor shall have an official license for the construction of water facilities of similar type and scale in Japan. The tender will be authorized solely to the companies qualified in this procedure.

The successful contractor in the tender will be required to prepare the detailed plans for his work describing the method of construction of each facility and its quality control together with temporary works, including considerations for safety and environmental protection, for the review and approval of the consultant.

The executing agency for the project, WASA, plans to organize a project supervising committee consisting of the staff of the Water Resources Directorate in charge of the existing water facilities, senior officials and technical experts from other related directorates. The Water Resources Division is headed by a director who, together with other senior officers in the division, was engaged in supervision of the construction work for Phase I of the ADB project, and after commissioning has been taking care of completed facilities. His staff includes technical experts in hydrogeology as well as water supply engineering, and they are expected to impart professional advice and practical response for quality and progress control for the project through their experience and expertise.

The Japanese consultant assigned to the project will play a principal role in effectively promoting the supervision of the construction work through the coordination between WASA and the Japanese contractor.

2-2-5-2 Particulars of the Construction Work

1) Drilling work

The drilling work will employ a number of local professional companies in Faisalabad and/or its neighboring cities such as Lahore, Rawalpindi and Islamabad as subcontractors. The structure of tubewells in this project is designed to meet the hydrogeological features predominant all over the Indus Plain including the project site. Lahore, the provincial capital, has more than 200 tubewells for its municipal water supply system along the Ravi river running through the area, and local professional companies have a wealth of experience and expertise in similar drilling works with machines locally produced.

Apart from the present study, the features of hydrogeological conditions of the project area around Faisalabad were investigated in detail from time to time in the past. The results of these studies all agree that the site has an adequate potential of groundwater for development. The key to its proper development is the structure of the tubewell, particularly the design of screen. As one of important procedures in the construction of tubewells, the borehole geophysical survey is required after completion of drilling to determine the exact setting position(s) of the screen. On the other hand, in this area it is a common practice to determine the screen design only based upon the geological features of the strata that are drilled through. Since logging of the geophysical survey can provide data to supplement drilling results, the project plans to include it in the drilling work as one of its basic components to determine the optimum screen position resulting in a higher efficiency of wells.

Since the beginning of the study for the project, the impact of the WASA's tubewells on those for irrigation in the neighborhood has been a social problem since villagers had fears that the withdrawal of groundwater by WASA might result in lowering of the regional groundwater level likely to result in the depletion of resources. This situation urged to arrange the design considerations to minimize such risks.

However, since these considerations are based on various assumptions, their actual effects remain yet to be seen. Taking such a situation into account, the simultaneous pumping test is planned at 23 tubewells out of 25 during their test run in order to collect detailed data and information for forecasting the movement of groundwater level more precisely.

2) Pipe installation work

i. Canal crossing

The large-sized collector and transmission mains in this project cross the Nasurana distributary branched from the Jhang Branch Canal, upstream and downstream respectively. The existing transmission main in the preceding ADB Phase I project crossed both the Jhang Branch Canal and the Nasurana distributary, taking advantage of the period of closure of water courses for their maintenance and repair, which is yearly carried out for about one month in the winter season by the Department of Power and Irrigation of the Punjab government. After the flow in the channels ceased, the sections to cross were excavated for undercrossing of pipelines. As the canal closure is an official routine in compliance with the regulations, the same method of pipeline installation can be applied to those in this project as well. For the period and method of crossing work, the contractor is required to submit his plan to the authorities for its approval. The restoration work of the crossed sections of the canal shall be executed in strict compliance with the instructions of the authorities.

ii. Pipe installation through market areas on the roadsides

This project plans to lay the 1,000 mm diameter transmission main along Bawa road where the existing transmission main was previously installed by the ADB project. The route runs from the planned booster pump station beside the left bank of the Jhang Branch Canal through the market area of the village Chak No. 49 congested with a variety of small shops and then pass another market of Chak No. 50. (The market streets run about 3 km.) The installation of large-sized transmission main through those traffic zones necessitates the consent of related municipalities and villagers in the pre-construction stage through the actions for public relations including public meetings where information on the details of the construction method, procedures and measures to minimize the inconvenience and troubles to villagers is presented to the concerned parties to ensure their understanding.

Bawa road is a bus route connecting Faisalabad to villages along the Jhang Branch Canal, and traffic on the route is particularly high in the morning and in the evening with villagers commuting to their workplaces in the city. In addition, the road is busy with villagers from the aged to the children. Thus, the measures against any danger is likely to occur in the excavation and pipe burying works should carefully be taken..

iii. Work for improvement of the existing network in the city

The work for the improvement of the existing network in the city is planned for the downtown area of the city, with the installation of 800 to 700mm diameter pipes for a distance of approximately 6 km with connections to 3 junction nodes along the existing arterial mains. The planned pipeline will cross not only street intersections but also the railway track at 2 sections, which divides the city area into the east and west sides. The work in such areas entails risks and difficulties. The detailed work plan will be formulated at the time of the detailed study through the inspection of sites and close discussions with the related authorities/agencies. Attention is particularly focused on the following points.

a. Survey of buried utilities

As various utilities such as electric cables, telephone lines, water and sewage pipes and city gas pipelines are expected to be laid along the planned pipeline route, the maps showing the locations of various facilities will be prepared based on data and information available from the related agencies as well as the surveys by the consultant during the detailed design and by the contractor in the preparation period for the work. For those getting in the way of the planned route of pipe, measures to deal with them will be concluded through the discussions with the agencies in their charge.

b. Layout of stores, houses and parking lots along the route

Influence of the work to entrance to properties will be examined along the route.

c. Sidewalks and drains

The actual conditions of sidewalks and drainage systems such as ground surface drains will be surveyed to examine the necessity of temporary alternatives during the construction and restoration works.

d. Connections to the existing junction nodes

For connecting new sections of pipes to the existing ones for the reinforcement of the network undertaken in the project, flows to the targeted junction nodes are planned to be temporarily closed by the existing gate valves along the arterial mains, and the connecting work will be done after the water in that section is drained. For such a type of connections, the underpressure connecting method is preferred since the connection can be performed without closing flows through the targeted section of the line. However, since special precision tools and equipment for underpressure connection of ductile cast iron pipes is not available in Pakistan, the project adopts the conventional method. In order not to affect the limited daytime supply currently in practice, the overnight work is planned for these sections. The inspection of some of the existing valves during this study found their conditions sound. In the detailed study by the consultant, the junction nodes most suitable for connections will be determined and the conditions of valves for closing the targeted sections will be examined.

e. Crossing of the railway track

The city is divided into two parts by the railway track and the planned route crosses over it at two sections, one of which is located in the subtrack that will not be used with frequency, but the other is located on the train service track. To avoid interfering with regular train operation, it is necessary to adopt the trenchless pipe installation method in which segments of pipes to cross are directly driven through beneath the targeted section by jacking.. According to the market survey, there are contractors who have experience in jacking in concrete pipe, but those who can work for ductile cast iron pipe are not available, since the latter requires special equipment for this method. Consequently the former will be employed for this work. After the concrete pipe is driven through the targeted section underground, the segments of ductile cast iron pipe are installed through the inside of the predecessor.

3) Concrete works

Although the main facilities in the project are planned to be built with reinforced concrete, there is no ready-mixed concrete plant within the city as well as its surrounding areas. The contractor is required to install a temporary concrete batch plant for the required works. The concrete work in the preceding ADB project conformed with the UK's BS standards, but through the inspection of the existing structures this project plans to employ the requirements of the JIS standards for strict quality control

Since the temperature in the daytime during the summer season in Faisalabad reportedly exceeds 48°C, appropriate measures such as shortened concrete placing time, water spraying and preparation of a protective cover, etc. are required to ensure quality of concrete structure..

2-2-5-3 Undertakings by the Respective Countries

For the construction work of the project, Japan will undertake the construction of major water facilities planned by the study under its grant aid scheme, while the Pakistani side will be responsible for the provision of primary electrical system and other appurtenant facilities. The major undertakings by the respective parties are listed in the following table:

Table 2-24 Major Undertakings by the Respective Countries

	Japan	Pakistan
(1) Water source /intake facilities	Tubewells/pump stations x 25 units	a. Land acquisition b. Site preparation c. Primary power supply system including 400V transformer system, to an integrating wattmeter.) x 25 units d. Access/connecting roads (metalled road 5m x approx. 15km) e. Fence work for pump stations
(2) Collecting facility	Collecting main 400 to 900mm x 14.4km	a. Land acquisition b. Site preparation
(3) Transmission facility	a. Booster pump station * 1 booster pump station building (pumping units	a. Land acquisition b. Site preparation c. Primary high-voltage

	and secondary power and control system) * 1 chlorinator building (Chlorination system) * 1 Reservoir for booster pumps * 1 operation control building and 1 building for operators' quarters b. Transmission mains 1,000mm diameter x 13km	power supply system (11kV, main watt-hour meter, etc. including primary power supply to temporary facilities for construction work) d. Road on the premises e. Site fences f. Furniture and fixtures for the pump station and other buildings
(4) Distribution facility	a. Terminal reservoir: 1 no. b. Terminal pump station: 1 no. (pumping units and secondary power and control system)	a. Primary high-voltage power supply system (11kV high- voltage feed to main watt- hour meter.) b. Provision of land for contractor's temporary facilities such as the construction office, yard, etc., together with temporary utilities.
(5) Improvement of existing network	Supplementary sections to existing arterial mains, 700 to 800 mm diameter x 6 km	Provision of land for contractor's temporary facilities with temporary connections to utilities
(6) Procurement of equipment for O/M	Water analysis equipment, Pipeline monitoring equipment Voice communication system and water level meters	
(7) Project management and construction supervision	Provision of consulting services for the detailed design and supervision of construction work	

Concerning land acquisition for the construction work by the Japanese side, the Pakistani side plans to secure patches of public land along the Jhang Branch Canal for the planned 25 tubewells and booster pumping station, while the terminal reservoir facilities will be installed on the premises of the existing T/R. While the T/R site requires no cost for its acquisition, other sites along the canal will be transferred from the authorities in charge to WASA through negotiations and appropriate official procedures.

For the road for access to the 25 tubewells, WASA plans to purchase part of the privately owned land adjacent to the public land along the canal and construct 5m-wide metalled road.

The 1,000 mm diameter transmission main is planned along the public road from the booster pump station to the existing T/R. All the route is assumed to be on the public property, but necessity may arise to pass strips of privately-owned land, with the most likely ones being farmland alongside the road, particularly for appurtenant facilities to the pipeline such as air release and drain valve boxes
.

For the primary power supply system for the tubewells, the Pakistani side is requested to provide the 11 kV high-voltage power supply and step-down transformers from 11 kV to 400 V to each of 25 tubewells, as was the case with the existing tubewells in the Chenab wellfield. The Japanese side will undertake to install the secondary power system including the pump starting and control panel and connections to pumping equipment in each pump house. Another high-voltage 11 kV power supplies are required at the two planned pump stations. The design power consumption of electrical equipment including pump motors at the respective stations requires a step-down transformer with a rated capacity of more than 1,000 kVA at 3.3 kV. Since the WAPDA, the authority responsible for national power supply system in Pakistan, can respond only to the requirements for transformers of 500 kVA and less, those for the two pump stations are to be provided in the construction work by the Japanese side. WASA plans to get the respective power supplies from the independent grid stations, namely from the one in Faisalabad to the terminal reservoir and from another one in Chiniot city about 15 km north of Jhang Branch Canal to the booster pump station, through the negotiation with FESCO (Faisalabad Electric Supply Company) established by the WAPDA (national authority for power supply). Such arrangements will ensure the constant supply to each station, and the extension works are less expensive.

2-2-5-4 Consulting Services

This project will be implemented as grant aid program of Japan and a Japanese company as the consultant for the Project will undertake the detailed design and supervision of the construction works. The consultant's main activities are as follows:

(1)	Pre-construction stage:	Detailed design Preparation of tender documents Assistance in tendering Evaluation of tender results Assistance in contracting
(2)	Construction stage:	Construction supervision Inspection service Training service in operation of facilities Reporting (to WASA and JICA)

After the official agreement for implementation of the project are signed and exchanged by both the governments of Pakistan and Japan, the Japanese consultant will enter into the consulting agreement with WASA to undertake the detailed design and the construction supervision for the Project.

The consultant will dispatch expert engineers specialized in groundwater development, water supply and civil engineering and electric works to make the supervision of quality and work processes of the construction works by the contractor, coordinating between WASA and the contractor, the related provincial and city agencies and the related organizations in Pakistan.

In order to ensure satisfactory progress of the large-scale construction work for the planned water system in this project, the consultant will appoint experts in water works engineering as resident engineers, who will be supported by other specialists assigned for a short time. In addition it is necessary to employ a local consultant assisting the Japanese in order to promote the effective supervision of the work in an extensive area for the project from the city to the left side of the Jhang Branch Canal. The participation of the local consultant will demonstrate its effects especially in works requiring contacts with the local administration and the residents in the city and villages where "Punjabi" is commonly spoken as an official language..

2-2-5-5 Procurement Plan

1) Equipment and materials for drilling work

The water service in the provincial capital city of Lahore relies on tubewells of about 200 in number developed in the floodplain of the Rabi River, one of the main tributaries of the Indus. Groundwater development, therefore, has ever been active and a large number of enterprises specialized in drilling have emerged there. Tubewells in this area are commonly drilled by the reverse rotary method fitted to the hydrogeological features of aquifers consisting of recent sediments of the Indus system, employing equipment and materials locally developed and manufactured. In this Project, this conventional drilling method is adopted, together with the procurement of local equipment and materials except for the stainless steel screens.

The list of main equipment and materials to be procured is shown in Table 2-25.

Table 2-25 List of Materials/equipment Procured for Drilling Work

Equipment	Country of origin			Remarks
	Pakistan	Japan	Other	
Casing	○			Spiral steel pipe of domestic make
Screen		○	○	Stainless steel, wire –wound type
Packing gravel	○			
Pumps for tubewell	○			Vertical turbine pumps

The selected type of pump for the tubewell in the project is a vertical turbine pump, which is popular not only in Faisalabad but also all over Indus plain, since its mechanism and structure are fit well to the performance of aquifers in this region, although internationally the submersible motor pump is more preferred. The selected pump is one of the main products of domestic pump manufacturers.

For the planned tubewells the stainless steel wire-wound screen is adopted, as it previously was for the existing ones in the Chenab wellfield, since this type of screen has the largest open area of all, which can assure the least drawdown at a given discharge, providing the effect of controlling the water level lowering. The leading local product is the brass-made vertical-grooved slit type screen that is available at a low cost, but its smaller open area is a disadvantage. In recent years, the domestic-make glass-fiber casing and screen have widely been used, but it is slit-processed and has the same level of open area as the brass-made screen. the spiral steel casing pipe of domestic make will be adopted in this Project. On the other hand the spiral steel casing pipe of domestic make is adopted for the project. The features of this product will be described in the next paragraph.

2) Piping materials

As a result of examination of pipes in terms of quality, price and construction, the two types of pipes, ductile cast iron pipe and spiral steel pipe, are selected for the project. The former imported from any other country. The highest class of cast iron pipe is manufactured in Japan and France. In the preceding ADB project Phase I, the ductile cast iron pipes (ISO standard-compatible product) were adopted for the collector and transmission mains as well as the arterial mains. The results of the survey of a part of the arterial mains installed in 1992 showed that these pipes have been preserved in good condition..

In recent years various kinds of pipes from Asian countries such as China, Taiwan and Korea are penetrating in the international market. Among them, Korea has a large share in the steel pipe supply, but keeps a low profile for the ductile cast iron pipe. Instead China is aggressively selling the latter, with more than 10 plants popping up in the country. These products that got into the market late are available in Pakistan at lower prices than Japanese products, but there are reportedly cases in which some of them are inferior in quality control for water tightness of the rubber ring joints and structure of fittings. Since this project regards the cost as one of the important factors for procurement, it will not limit the origin of pipes to Japanese products only, but the strict evaluation of quality will be made through the examination of the capability of manufacturers in fabricating large diameter pipe in compliance with ISO standards for assuring rigid structure of pipelines during and after installation work.

In Pakistan, the domestic production of spiral steel pipes began 30 years ago to meet demand for gas transportation and distribution from the domestic gas industry and the supply performance improved for many years has stabilized the pipe quality. In recent years, the Karachi water works project with the assistance of the World Bank adopted this type of pipe and it is gaining competitiveness in the water supply, sewage and irrigation projects. According to the results of survey, there are three large manufacturers in the country and the steel plate coils as the pipe materials are not only domestically manufactured but also imported from Japan and Korea. Their products conform to the international standards such as ISO, API and AWWA in their steel pipe processing and quality control. Therefore, their products have no problem in mechanical quality such as material strength.

On the other hand, as one of essential conditions for the selection of pipe in this project, the corrosion-resistant coating of the interior and exterior of a pipe and the secondary coating of on-site welded joints is significantly important. Table 2-26 shows the comparison of Pakistan-made steel pipes with corrosion-resistant coating as a result of the survey of local manufacturers.

Table 2-26 Comparison of Pakistan-made steel pipes with corrosion-resistant coating

	Factory Product	Secondary coating of on-site welded part	Applicable Standard
Interior	a. Epoxy paint air-spray coating, average 500 micron thick	a. Coating with epoxy paint by brush, trowel or roller	AWWA
	b. Mortar lining, minimum 19mm thick.	b. On-site finishing	AWWA, BS
Exterior	a. 3-layer polyethylene coating, minimum 3mm	a. Same as left	AWWA, DIN
	b. Fiber glass resin cover	b. Same as left	AWWA
	c. Asphalt coating, minimum 5mm thick.	c. Same as left	AWWA

In Japan, the steel pipe with exterior asphalt coating had once been predominant, but it has lately been replaced with the one coated with plastic material such as polyethylene, and the epoxy coating has widely been used for the interior. In this project, a product specified for corrosion-resistant treatment that is compatible with the Japanese standards will be selected out of the products as shown in the above table.

The domestic manufacturers produce only standard lengths of pipes, and fittings must be imported from foreign countries including Japan. The latter is required to be coated with the anti-corrosive paint of the same or equivalent quality as for pipes.

As a result of the examination in the study, the list of pipes to be procured for the project is shown as follows:

Table 2-27 List of Piping Materials

Pipe Type	Country of origin			Remarks
	Pakistan	Japan	Third countries	
Spiral steel pipe	○			Interior: Epoxy coating Exterior: Plastic cover
Ductile cast iron pipe		○	○	
Pipe fittings		○	○	For steel pipe/cast iron pipe

3) Materials for civil work

The main materials for civil work such as cement, aggregates, reinforcing steel bars and forms are all procured in Pakistan. As there is no ready-mixed concrete plant in Faisalabad, a batch plant facility is needed at each site to place concrete for large structures such as the terminal reservoir. In the ADB project, the local contractors built similar temporary plants for large-scale facilities. The standard concrete strength in this project will not conform to the BS standards for the preceding project, but to the JIS standard as the result of survey on the existing facilities. The Japanese standard has been adopted in other projects with Japanese assistance in this country and it is deemed to be appropriate for the strict strength required for the main structures to be built in this Project.

4 to 5 brands of cement are domestically produced, but those meeting the quality

standards including strength are reportedly limited to half of those. It is necessary to select brands that can satisfy the quality requirements through testing to be made at each site. Faisalabad is an industrial city where the market for industrial products is thriving, assuring constant stable supply of materials.

Aggregates are available from the large-scale river bed site below the Chinito Bridge on the bank of the Chenab river about 30 km north of the city. The right to collect sand there is renewed by tendering every year. There are many aggregate suppliers within the city and in its surroundings and any required quantity of quality materials is available from them.

The raw materials for reinforcing steel bars are imported and processed by domestic manufacturers to meet demand. In this project, the domestic products will be used. Forms for concrete structure will be of steel type. They can be fabricated by processing the materials that are domestically available.

Table 2-28 List of Main Materials for Civil Works

Item	Country of origin			Remarks
	Pakistan	Japan	Third countries	
Cement	○			
Aggregate	○			
Reinforcing steel bars	○			
Steel form	○			

4) Building materials

All the building materials for the structures including steel and wooden trusses and bricks and for fixtures such as doors and windows at two pumping stations will be procured in the local market. It has been confirmed in the market survey that the quantities is sufficient.

5) Pumps

The pumps for the tubewells can be selected among the domestic and foreign products as described in the paragraph 1) above. However, the double-suction centrifugal pumps for the booster pump station and the terminal reservoir are not manufactured in Pakistan. This type of pumps needs to be procured from Japan or any third country in Europe. In the preceding ADB project, the Japan-made pumps of this type were installed, and WASA has been running them for more than 10 years. WASA's staff now has sufficient experience and expertise about this type of pumps. Therefore, it will be appropriate to adopt foreign-made pumps.

6) Electric equipment/materials

The electric power is supplied by the state-owned Water and Power Development Authority (WAPDA) in Pakistan and the electric products are available from the manufacturer operating under the license of an international company based in Germany, keeping a market share of 90% or more in Pakistan. In this project, the primary power of 11kV will be supplied from WAPDA, so that it is desirable to adopt domestic electric products. The results of survey made on the availability of electric equipment including transformers, electric motors, generators, power distribution boards and instruments that are required for this project will be described below.

The electric products in Pakistan comply with the standards of "International Electrotechnical Commission (IEC) having slightly different criteria for cable sizes and testing methods from those of the Japanese standard JIS, although there is little problem in compatibility.

Of the electric products required in this project, both the high- and low-voltage transformers are locally manufactured so that it is appropriate to procure them. However, there are no high-voltage electric motors of Pakistani make. Only the low-voltage products up to 400 V are available. The generators are limited to the low-voltage type as well. Instruments are all imported. Therefore, it is appropriate to adopt the pumps with which the pump manufacturer will procure together with the power control panels and instruments as accessories. Based on the above survey results, the plan of procurement of electric products is shown in Table 2-29 below.

Table 2-29 List of Equipment/materials for Electrical Works

Item	Country of Origin			Remarks
	Pakistan	Japan	Third countries	
Transformer	○			

Electric motor (high-voltage)		○	○	
Electric motor (low-voltage)	○	○	○	
Generator (high-voltage)		○	○	
Power distribution/control panels and instruments		○	○	

7) Construction machinery and vehicles

The construction industry in Pakistan has been keeping up with international standards in various fields as typically shown in the construction of highways in recent years. The construction machines required for the work in this project can fully be procured domestically in types and quantity. There are many construction machines available from Asian countries including Japan, China and Korea. Trucks and passenger cars of Japanese models are locally produced and they have a high share in the market of Pakistan. The Japanese contractor is expected to procure or lease these machines for its construction work.

2-2-5-6 Implementation Schedule

The implementation procedure of a grant aid project is normally taken as follows:

- Step 1 Exchange of Notes by both Governments
- Step 2 Consulting agreement between the executing agency and the Japanese consultant
- Step 3 Detailed design study by the consultant
- Step 4 Preparation of tender documents
- Step 5 Pre-qualification and tendering of Japanese contractors
- Step 6 Construction work by the contractor under supervision of the consultant
- Step 7 Completion

A grant aid project is completed in compliance with the above procedure for a period of a single fiscal year. Under this scheme the net construction period will be more or less 6 months. On the other hand, the implementation schedule of this project involving large-scale construction works will be determined, based upon various factors including Japan's grant aid scheme, components of the project and their design and scale as follows:

a. Despite a basic rule to complete the project within a single year, those requiring a longer period for completion are implemented in phases extending for several years, each for a single-year period. As a condition for dividing a grant aid project in phases, each phase is required upon completion to demonstrate independent effects of its own.

b. All the components of this project are of large scale and respectively require a long period for completion. Each of them alone cannot demonstrate the effects of the project, which can be achieved only when all of them are integrated. Accordingly it is difficult to divide the entire project into phases in the same way as in the implementation procedure of general grant aid projects. This project needs to be implemented as a package extending for a couple of years.

c. The approval of such package projects takes a longer process than the one for general grant aid projects. Taking the urgent nature of the project, it is planned to select the facilities that can be completed for a single-year period in order to ensure earlier commencement of the project to be followed by the main components.

d. As a result of examination of the components of this project, the work for the improvement of the existing network can be separated from the main facilities, This component has its own objective to contribute to the improvement of the existing system, and can show its effects after completion. Other facilities cannot demonstrate their effects individually.

e. As a measure to promote the earlier commencement of implementation, therefore, it is planned to divide the entire Project into two phases as follows:

Phase I Work for the improvement of the existing network
Phase II Detailed design for main works of the project
Construction work of main project
(construction of tubewells, piping, pumping stations, reservoirs, etc.)

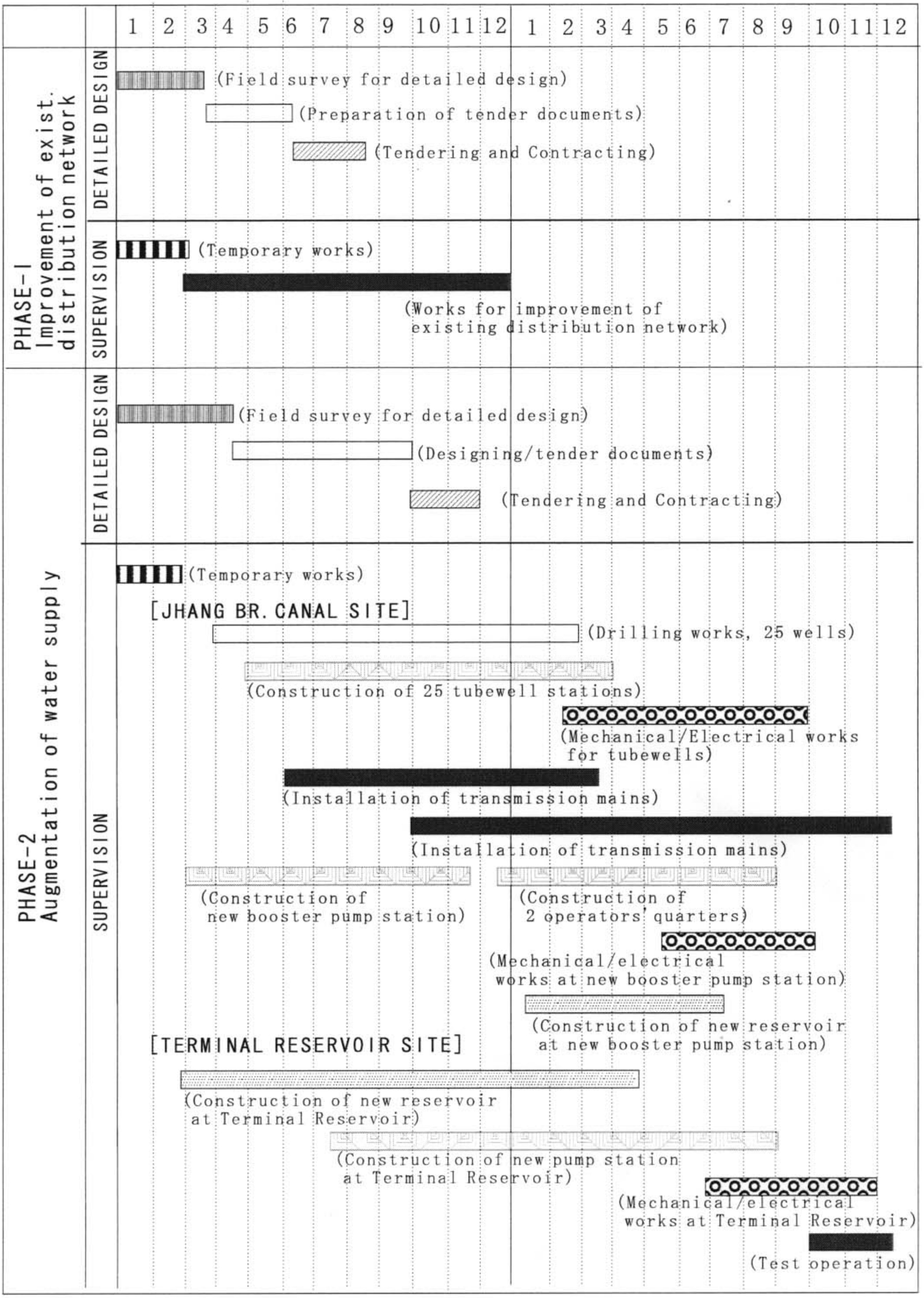
f. For Phase I thus divided, the implementation procedure described for the general type of grant aid projects will be applied, but the main components of the project for Phase II will be implemented in a different way as follows:

Stage I:
* E/N (for the processes up to the detailed design and tender by consultant)
* Consulting agreement between the executing agency and the Japanese consultant
* Detailed design study
* Preparation of tender documents

Stage II:
* E/N (for the main construction works)
* Consulting agreement for construction supervision between the executing agency and the consultant
* Tendering
* Contracting between the executing agency and the Japanese contractor
* Construction works
* Completion

h. The implementation periods for Phase I and Phase II will be about one year and 3 years respectively. The completion of the entire Project is estimated to take 44 months, as shown in the chart in Fig. 2-18.

Fig. 2-18 Project Implementation Schedule



2-3 Obligations of Recipient Country

The government of Japan will provide assistance with grant aid for the following works and activities in the project.

- Construction of tubewells & intake facility
- Construction of transmission facility including the booster pump station and transmission main
- Construction of distribution facility including the terminal reservoir with pump station
- Improvement of distribution network in Faisalabad city
- Detailed design and supervision of the above construction

On the other hand, the government of Pakistan must confirm undertaking the following responsibilities.

- To secure land necessary to construct the water supply facilities, and clear, level and reclaim the land prior to commencement of the construction work.
- To provide facilities for the supply of primary electric power to the constructed facilities, and other incidental facilities in and around the project sites, as necessary.
- To extend assistance in prompt execution of unloading, customs clearance at the port of disembarkation and internal transportation of the products imported for the execution of the project with grant aid, in case products are imported.
- To exempt Japanese nationals of customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the verified contracts.
- To accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the verified contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.
- To assure the safety of the said Japanese nationals and provide full-time police accompaniment at sites where security is highly suspicious .
- To operate and maintain the facilities constructed and equipment procured through the implementation of the project properly and effectively, and to appoint necessary staff for this operation and maintenance.

- To bear the advising commission for an Authorization to Pay (A/P) and the payment commissions to the Japanese foreign exchange bank for the banking services based upon on the banking arrangement (B/A).
- To bear all the expenses other than those covered by the grant aid.

Table 2-30 List of Major Undertakings by the Pakistani Side Concerning Construction Work

	Description of undertakings	Estimated cost (x 10^6 Rs)	(Equivalent in yen) (x 10^6 yen)	Remarks
1.	Installation of primary power supply system	35.83	78.47	* Installation of high voltage primary power supply system of 11 kV capacity with step-down transformers to 400V for 25 units of tubewell pump stations * Installation of high voltage primary power supply system of 11kV for the booster pump station and the terminal reservoir.
2	Land acquisition	10.94	23.96	* Procurement of private properties is required for the wellfield and connecting road along the Jhang Branch Canal in addition to public land where the 25 tubewels are planned. Further, along the route of the planned transmission main on Bawa road, patches of private land will have to be purchase..
3	Site clearance and ground leveling	0.90	1.97	Required for the wellfield and booster pump station.

4	Road construction	101.69	222.70	Road for access to the tubewells along the Jhang Branch Canal about 20 km in total length.
5	Installation of enclosures for the pump stations.	6.12	23.40	Fences and gates for the 25 tubewell pump stations and the booster pump station in the Jhang Branch Canal area
6.	Procurement of furniture, fixtures, office equipment and others	11.44	25.05	Required for the booster pump station and the terminal reservoir
7	Site preparation cost for premises of the booster pump station	6.12	13.40	Required for the construction of the road on the premises, gardening, lighting, security measures and others for the booster pump station along the Jhang Branch Canal
8	Project supervision cost	48.00	105.12	Required for management and supervision of the construction work by WASA
9.	Procurement of vehicles for supervision	5.50	22.80	Required for management and supervision of the project by WASA
10.	Construction of residence	21.46	47.00	Housing for new staff for new water supply facilities
11	Public relations expenses	2.50	5.45	Expenses for public relation activities for the urban and rural residents
	Total	250.50	548.32	

As shown in the above table, the cost to be borne by the Pakistani side is estimated at about 250 million Pakistan rupees, which is equivalent to about 550 million yen. The Punjab government considers to secure the budget from the Public Sector Development Programme with the approval of the cabinet in the first fiscal year after the implementation of this Project is approved by both the governments of Japan and Pakistan.

2-4 Operation and Maintenance Plan

The planned water supply system and its components are similar to those of the existing Chenab system constructed under Phase I of the ADB project, which have been run by WASA for more than 10 years as the main facilities for its water service. Therefore, the operation and maintenance of the planned facilities are expected to be run effectively and efficiently with its past experiences and expertise. No special arrangements will be necessary for its operation and maintenance, since the technical level of the facilities are in the same range as that of the existing ones.

Since the planned system is independent of the existing one with the respective scales of its facilities in a similar range, its operation and maintenance plan needs to be appropriately formulated, focusing on the major elements such as staff requirements and power consumption.

The sound financial management of water service after the completion of the project definitely depends upon the acquisition of new clients. Since the tariff of WASA is a flat rate system according to the size of the consumer's property, the increased water supply to the current consumers will not contribute to increasing WASA's income. On the other hand, WASA will have to pay a huge additional amount for power consumption required in the operation of additional facilities. In order to plan a cost recovery, therefore, an early shift of the flat rate system to the metered system now under planning is essentially necessary.

The main elements for the operation and maintenance of the planned system are examined as follows.

(1) Personnel plan

The WASA is considering the following personnel plan for new facilities.

1) Basic standards for employment

i. Daily working hours: 8 hours (WASA regulation based on the labor standard of Pakistan)
ii. Number of working days in a week: 6 days (same as above)
iii. Working system: 3-shift system for the 24-hour operation of tubewells, booster pump station and the terminal reservoir

2) Personnel plan

Table 2-31 Personnel plan for the new facilities

	Job type	23 tubewells	1 booster pumping station	1 terminal reservoir
		23 wells are in full-time operation daily	3 booster pumps 2 chlorinators in full-time operation	3 pumps for distribution in full-time operation
1	Technical manager	1	1	Manager of the existing T/R
2	Work supervisor (in charge of electricity and machines)	1	1	Staff in charge of the existing facility at T/R
3	Chlorinator manager	-	1	ditto
4.	Electric engineer	1	1	ditto
5	Machine engineer	1	1	ditto
6	Pluming engineer	1	1	ditto
7	Driver	1	1	ditto
8	Warehouse worker	-	1	ditto
9	Operator	77	14	11
10	Security guard	5	4	Staff working at the existing facility at T/R
11	Watchman	-	4	4
12	Radio communication staff	4	4	4
13	Other miscellaneous worker	-	6	5

In WASA's personnel plan, the number of the operators working at the tubewell pump station is especially large because they are assigned to each of 23 stations.. (69 for the 3-shift system including the reserve staff).

WASA plans to recruit them as follows:

・Previously more than 50 tubewells were in operation in the wellfield along the Rakh Branch Canal running through the city, but after completion of the Chenab system, they were reduced to about 20 in recent years through the rehabilitation by WASA. As a result, the staff who used to work at the tubewells and the pump stations was drastically reduced. Most of those who left the jobs still live in the city. Since they are skilled operators of water facilities with long-term experience, a part of them could be considered for the posts in this project.

・Most of the staff now working at the 28 tubewells in the existing Chenab wellfield are the residents of the nearby villages under consideration to give employment opportunities to local residents. As for the basics operation of pumping system, a short-term training was given to them and the opportunities to learn the technique are given to them through the daily inspection of the tubewells by WASA's supervisors. The same measures are considered for the Project.

In addition to such employment of operators, recruiting of senior staff is easy by advertising in newspapers and so on. It is possible to acquire competent and capable experts since Faisalabad is close to Lahore, the capital of the province.

(2) Operation and Maintenance of Facilities

1) Power Supply Facilities

At each site of the tubewell pump stations, booster pump station and terminal reservoir, a high-tension 11 kV supply will be extended under the responsibility of the Pakistani side.. Similar extensions were made in Phase 1 project with difficulty in securing a supply base for the Chenab wellfield as well as the terminal reservoir. The situation for power supply has changed since then, and it is now provided with a choice of grid stations around Faisalabad, one station in the city itself and another in Chiniot city to which the Jhang Branch Canal is close. Each station is connected with national grid to greatly improve the power supply environment more than before.

Power supply is provided by the state-owned WAPDA (Water and Power Development Authority), and operation and maintenance is handled by the power service company under WAPDA. Since Faisalabad is a key industrial city, WAPDA established a service company called FESCO (Faisalabad Electric Supply Company) for stable supply to large consumers as well as ordinary citizens.

WASA plans to station permanent electricians at each of the 3 facilities to continue create a normal operation and maintenance system.

The following table summarizes the power supply installations and allocation of responsibilities.

Table 2-32 Classification of Required Power Facilities

	Facility name	Loads of main equipment	To be borne by the Pakistan side	To be borne by the Japanese side
1	25 tubewell pump stations	25 tubewelll pumps Details 380 V x 80 HP at 6 stations 380 V x 60 HP at 7 stations 380 V x 50 HP at 10 stations 380 V x 30 HP at 2 stations	11 kV power lead-in at the primary side, transformers for step down to 400V, and the watt hour meters inside the pump stations	Secondary power feed including the power switch boards inside the pump stations
2	Booster pump station	1) 3 nos of booster pumps,: 3.3 kV x 190 kW 2) Equipment at 400 V (Chlorinator and crane: 400 V x approximately 25 kW) 3) Single phase equipment such as illumination : 230 V x approximately 6 kW in total	11 kV power lead-in at the primary side to	11 kV incoming panel, 11kV/3.3kV transformers 3.3 kV and 400 V switch boards inside the pump station.

3	Terminal reservoir	1) 3 nos. of distribution pumps: 3.3 kV x 330 kW 2) Ancillary equipment: 400 V x approximately 12 kW 3) Single phase equipment for lighting, etc.: 230 V x approximately 6 kW	11 kV power lead-in at the primary side	11 kV high tension incoming panel, 11 kV/3.3 kV transformers and 3.3 kV and 400 V switch boards inside the pump station.

2) Equipment

Major equipment for the project includes tubewell pumps, booster pumps and distribution pumps and chlorinators. Similar models with which WASA has experience through the ongoing operation of the existing facilities were selected, and their operation and maintenance can be carried out without difficulty. Having been run for more than 10 years without serious troubles and damages, their conditions are found good in general. The most vulnerable components seem to be electrical equipment, particularly power starting and control panels locally manufactured, where minor damages and malfunctions in switches and controls are reported. These troubles used to be dealt with by their manufacturers, and WASA trusts them, as they turned out technically reliable with their products guaranteed with licenses from leading EU engineering companies

A stable supply of liquid chlorine gas for chlorinators is available through a contract with a chemical plant located about 30 km away from the city.

2) Other Facilities

After the completion of the construction work, the Water Resources Division of WASA will be in charge of the operation and maintenance of the newly-installed facilities of this project, with support of the Operation and Maintenance Division which owns heavy equipment and machinery for maintenance and repair works of facilities. In addition, special works required for tubewells, pipeline and equipment can be handled by contractors available in the city. Although special equipment for repairing facilities is not included in the project, WASA can continuously operate the system without any difficulty.

(2) Financial status

The balance sheet of WASA to date shows that its revenue has continuously been less than the cost for water service. In an effort to remedy this trend, WASA raised the tariff by 40% in the beginning of 2004. (Refer to Appendix 5-18 for WASA's new tariff).

WASA's water tariff is not a metered system, but a flat rate one based on the dimensions of consumer' property, as has been widely employed in most cities in the country. According to a survey by ADB (1998), the water tariff of Pakistan cities was remarkably low among major Asian cities. The flat rate system has been a principal cause for lower incomes and degraded management of water agencies including WASA. The deficits are usually covered by government subsidies from shares of property tax.

With its latest tariff revision, the increase in income from the collection of water fees may cover the cost of service with the existing facilities. Yet if the new facilities are added, the power cost will dramatically increase, and there is a risk to return to imbalance of the income and cost under the current flat rate system, unless WASA makes had efforts in acquiring new clients large in number. The only effective measure to ensure sound finance will be the changeover to the metered tariff system.

WASA has been considering the changeover to the metered system, and has already received approval from the overseeing department of the provincial government. The implementation of this project can provide an opportunity for the start of such a shift. One of the practical measures will be to start it with prospective new clients as their obligation.

Due to the persistent shortage of water, part of the city has been left under an extremely poor service condition. As a result, illegal actions by a part of citizens unsatisfied with the ongoing service are widespread, partly rejecting payments or daring illegal connections to the service pipes or withdrawing the water forcibly with pumps. The increased water supply through the implementation of the project is anticipated to reduce such illicit behaviors. For the improvement of WASA's financial status, WASA is requested to continue its efforts in extending appropriate service to all the consumers as well as collecting fees by the metered system along with the establishment of legal regulations to contain illicit practices of a part of consumers.

2-5 Project Cost Estimation

2-5-1 Project Cost Estimation

The grand total cost required for implementation of the project is estimated at 4,603 million yen. The cost estimates to be borne respectively by Japan and Pakistan are presented in paragraphs (1) and (2), based upon the conditions for the estimate described in paragraph (3). However, this cost estimate is provisional and would be subject to further examination of the government of Japan for its approval.

2-5-1-1 Cost to be borne by the Japanese side

<u>Total Project Cost Estimate</u> <u>Approx. 4,053 million Yen</u>

25 Tubewells, Collector main 15.6 km, Booster pump station, Transmission main 13 km, Terminal reservoir, Water distribution within city 6km

Item			Cost Estimate (million Yen)	
	Water sources development	Construction of tubewells and pump stations	438	
	Collector main	Ductile cast iron pipe Steel pipe	530	
Construction Work	Booster pump station	Pump well, pump station, chlorination system, piping and buildings for the staff and operators	570	3,663
	Transmission main	Steel pipe	481	
	Terminal Reservoir	Terminal reservoir, pump station and Piping	932	
	Water distribution within city	Ductile cast iron pipe	522	
Detailed Design and Construction Supervision				385

Cost Estimate (Sub-Total)　　　Approx. 4,048 million Yen

Procurement of Equipment and Materials:

Item		Cost Estimate (million Yen)
Water level meter	12 units	5
Water analysis equipment (Photo-spectral type)	1 set	
PH/EC meter	2 set	
TDS meter	2 set	
Voice communication (fixed type)	4 set	
Voice communication (potable type)	15 set	
Automatic pressure recorder	2 set	
Ultra-sonic flow meter	1 set	
Leakage sound detector	2 set	
Reagent for water analysis equipment	1 set	

Cost Estimate (Sub-Total)　　　Approx. 5 million Yen

2-5-1-2 Cost to be borne by the Pakistani side

1) Power extension : 35.83million Rs (Approx. ¥78.47million)
2) Land acquisition: 10.94million Rs (Approx. ¥23.96 million)
3) Land clearance: 0.90million Rs (Approx. ¥1.97 million)
4) Road construction: 101.69million Rs (Approx. ¥222.70 million)
5) Fence construction: 6.12million Rs (Approx. ¥13.40 million)
6) Equipment in pumping station:
11.44million Rs (Approx. ¥25.05 million)
7) Preparation of premises for the booster pump station:
6.12million Rs (Approx. ¥13.40 million)
8) Supervision of the project: 48.00million Rs (Approx. ¥105.12 million)
9) Vehicles for supervision: 5.50million Rs (Approx. ¥22.80 million)
10) Construction of residence 21.46million Rs (Approx. ¥47.00 million)
11) Expenses for public relations 2.50 million Rs (Approx. ¥5.45 million)

Total: 250.50million Rs(Approx. ¥548.32 million)

2-5-1-3 Conditions for Estimation

a. Estimation Base	November 2003
b. Exchange Rate	1 US$ = 117.08 Yen
	1 Rs = 2.19 Yen
c. Period of Construction and Procurement	Implemented in two (2) phases according to schedule shown in previous section.
d. Others	This project is to be implemented in accordance with the guidelines for grant assistance of the Japanese government.

2-5-2 Operation and Maintenance Cost

In accordance with the policy for the operation and maintenance for the project explained in Section 3-4, the required costs are presented below.

(1) Personnel Cost

The total number of personnel required for this project is 162 persons. The posts of the staff will be similar to those allocated to the present facilities of WASA. The basic remunerations are as follows.

a. Chief technical manager	Rs 144,000/yr (=¥325,000/yr)
b. Supervisor (electrical-mechanical)	Rs 136,000/yr (=¥298,000/yr)
c. Operator	Rs 50,000-30,000/yr (=¥110,000-66,000/yr)

The total remuneration of the project personnel=Rs 7,920,000/yr (=¥17,344,000/yr)

(2) Power Supply Cost

The power consumption rate for intake, transmission and distribution of the daily maximum water supply rate of 91,000 m^3 for this project is about 1.4 million kWh/month according to calculations based on the design capacities of electrical facilities for the respective pump stations listed in Table 2-32.

The electricity rate for WASA is based on a preferential rate including a 15% consumption tax, and the present unit cost is Rs 5.727/kWh.
According to this rate, the power supply cost for WASA is calculated as follows.

Annual power cost = Rs 5.727 (/kWh) × 1,405,400 kWh/mon × 12 mon
= Rs 96,583,107 (about ¥210 million)

Along with the increase in water supply, wastewater will also increase, resulting in the boost in the power cost charge for WASA due to its operation of sewerage works. The cost estimation of increase in sewerage-related power costs will be based on the following assumptions.

- For the present water supply rate, the respective power costs for water and sewerage sectors are reportedly in the same level, namely each amounting to about 1/2 of the total annual electrical cost.
- The ratio of increased water supply from the new facilities is about 40% of the present rate.
- The sewerage rate is much greater than the WASA water supply rate since most of the factories in the city use groundwater because they cannot receive WASA water supply. (The World Bank survey results showed that in 1992, WASA water supply for industrial use was only 5%, and since then, there is no actual increase.) The World Bank master plan estimated that about 30% of sewerage rate derived from groundwater.
- From the above assumptions, the increase in sewerage related power cost is calculated as follows.
  Sewerage related power cost = Rs 66,600,000/yr (1/2 of total power cost for 2001/02-02/03)
  Increase in sewerage = (Present sewerage rate) × (1.4 × 0.7)
  Therefore, Increase in power cost = Rs 66,600,000 × (0.4 × 0.7)
  = Rs 17,648,000

The sewerage operation expenses are added to the assumed sewerage power cost.
Annual power cost total = Rs 96.6 million + 17.7 million = Rs 114.3 million (= about ¥250 million)

(3) Other Expenses

Other expenses are the following.

a. Chlorination cost

Assuming an average of about 1 ppm of dosage for 91,000 m^3/day water supply, the daily chlorine consumption rate is about 100 kg. The liquid chlorine used for dosage costs Rs 8,300 for a 1 ton container, and with a consumption of 3 containers per month, the cost is about Rs 25,000.

b. Facilities maintenance and repair cost

The repair cost is an indispensable cost item for operation and maintenance of the facilities, and therefore, this should be listed separately with careful consideration. Presently, small repairs are made within the operating cost, and the annual budget for this item in the water supply is about Rs 7 million. Upon commencement in operation of the new facilities, the expenses for the first few years are predicted to be not so large, but a minimum budget similar to the present amount is necessary for annual small maintenance and repair costs.

c. Facilities management cost

Vehicle related costs including repair and fuel costs, as well as office expenses and other incidental costs need to be accounted for. Taking the present actual expenses as maximum, the annual cost is Rs 2 million.

(4) Operation and Maintenance Cost

As a result of the above considerations, the annual operation and maintenance cost is estimated as follows.

a.	Personnel cost	Rs 8,000,000
b.	Power cost	Rs 115,000,000
d.	Chlorine and water quality analyses chemicals	Rs 1,000,000
e.	Maintenance and repair cost	Rs 7,000,000
f.	Management cost	Rs 2,000,000
	Total	Rs 133,000,000
		(=¥290 million/yr)

(5) Current balance

Through the review of WASA's performance in financial management up to the present, a current balance after the implementation of the project is examined as follows.

1) The balances between the ordinary revenues and expenditures for the past 3 years show that the expenses mainly consisting of personnel and power costs continued to surpass the income from tariffs by about 30%. The deficit was subsidized by fixed property tax allocations to WASA each year.

2) Since a flat rate system based on the property is presently adopted for water fee collection, the exact cost per unit rate for consumption is unknown. From the balance sheet of 2002/2003, the average cost of unit supply rate of 1 m^3 is estimated as follows.

a. Annual income from water fees Rs 233 million

b. Annual production rate Daily average 210,000 $m^3 \times$ 365 days = 76,650,000 m^3

c. Unit water cost = a/b = Rs 3.04/m^3

d. Unit cost after adjustment of unaccounted-for-water

Since leakage rate estimate is 30%, the unit cost for actual paying supply rate is:

= c/0.7 = Rs 4.34 (= about¥9.5)/m^3

3) The water tariff was raised about 1.4 times in January 2004, Since the above calculation is based on the rate before revision, the unit cost will become (d)$\times$1.4 = Rs 6.1 with revised rate. With this revised cost, the current expense, which is a direct production cost, can be recovered by the calculated income from revised water fees as shown in the following calculation.

a. Annual ordinary expenditure (2002/2003) Rs 270.7 million

b. Assumed income due to cost increase = Production rate (76,650,000 m^3 $\times$0.7)$\times$revised cost (Rs 6.01/ m^3) = <u>Rs 322.5 million</u>

4) After the water supply rate is increased due to this project, the operation

method and supply rate of the existing facilities is assumed to remain in the same level as before, with the direct cost for production kept at the same level as well. On the other hand, the annual total cost of the additional facilities is assumed at Rs. 133 million as estimated in section 1), with only the direct cost accounted for and other expenses covered by those for the existing facilities, since this is not an independent facility. The unit cost for this new system, therefore is calculated as follows.

a. Annual production rate — 91,000 $m^3 \times$ 365 days = 33,215,000 m^3

b. Actual water supply rate — 25% UFW rate expected in the year 2008 when the operation is anticipated to commence
= 33,215,000 $m^3 \times 0.75$ = 24,911,250 m^3

c. Direct production cost per m^3
Estimated direct cost/(b) = Rs 133.2 mil/25 mil m^3
= Rs 5.3

This estimated unit cost is less than WASA's revised cost, and therefore, if a metered system is introduced, then income from tariffs can recover the management expenses without any problem. In the case of the present flat rate system, assuming a monthly rate of Rs 500-1,000 per household, this would correspond to 20,000 clients as the maximum and 10,000 as the minimum.

5) In the above calculation, although direct contribution to the improvement of the current balance from the increase in water supply in this project is not apparent, the following benefits can be anticipated due to the water augmentation.

a. Convenience of the city water supply will increase for the presently registered consumers.
b. Due to the increase in contracts for supply, the current balance of WASA will be stabilized through setting of appropriate tariff levels, and eventually the changeover to the metered system will become easier.

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CHAPTER 3

PROJECT EVALUATION AND RECOMMENDATIONS

Chapter 3 Project Evaluation and Recommendations

3-1 Project Effects

This project is aimed at augmenting water supply to improve the worsening service in Faisalabad with the third largest population of 2 million in the country. The ongoing municipal water supply depends mainly on the facilities completed in 1992. Despite a steadily increasing population at a high rate of 3.7% since then, substantially effective expansion of facilities remains yet to be seen, currently resulting in (a) low service coverage, (b) decrease in a per capital daily average and (c) unbalanced water distribution within the city. There is no other way for citizens suffering from water shortages than relying on contaminated groundwater sources. As a result, illegal and unlawful acts such as rejection of payments, unregistered connections, forced water withdrawal from supply pipes with pumps, etc. are widespread in the city. The financial status of WASA, the executing agency of the project, is in a dire predicament.

Under such circumstances, the augmentation of water supply through the execution of this project is anticipated to have effects as follows:

(1) Direct effects

a. The study for the project revealed that presently the water service coverage in Faisalabad is at a level of 55% with a served population of 1,272 thousand among an estimated population of 2,300 thousand, with a per capita daily average supply rate at 100 liters. After an additional water supply of 91,000m^3/day is secured through the implementation of the project in 2008, the coverage will increase to 60% with a served population of 1,564 thousand in the estimated 2,600 thousand with a per capita daily average enhanced to 130 liters.
b. Ongoing supply hours of 6 hours at the maximum can be switched to a continuous daily operation.
c. Extremely poor water service in the east side of the city with one third of the entire population can be improved with water pressure in the arterial mains in that area increased from current 0.5 kg/cm^2 at the maximum to 1.0 to 1.5 kg/cm^2.

(2) Indirect effects
a. The significant increase of safe and stable water supply can contribute to alleviating water-borne diseases such as hepatitis, diarrhea, etc., and to improving health environment for citizens.
b. The improved water service can have effects to raise revenues as it may decrease arrears and

rejection of payments of water fees, illegal connections, forced withdrawals with consumers' own pumps, etc. The implementation of the project will offer WASA the best chance to shift to a metered water tariff.

Table 3-1 shows the extent of these effects and the method of evaluation of indicators after the completion of the project.

Table 3-1 Effects and Improvements due to Project Implementation

Current status	Measures by the project	Anticipated results	Evaluation of indicators
(1)Water coverage in the city is hovering around 55% (estimated in 2003)	Augmentation of water supply in an amount of 91,000m³/day through the development of a new wellfield	Water coverage rises to 60% in 2008.	a. Water can be served to additional 30 thousand new consumers in the year of the completion of the project. Population estimate in the study is as follows: ・Average yearly growth rate: 2.4% (Refer to the Appendix 5-1). Year Total population Served 2003 2.3 million 1.275 million 2008 2.6 million 1.53 million b. The study for the project estimated the current water service rate at 55%, based upon WASA's proposal to employ the proportion of the size of the currently served area with piped water to that of the whole city. (The sizes of served areas in the city were based upon WASA's calculation.) Since the served areas are concentrated in population-congested area, extra 10% allowance was added to the calculated result of 50%. c. For the evaluation of the indicator after the completion of the project, the following data and information shall be taken into account: ・Population census ・WASA's working record for additional pipelines in the city after 2003. ・WASA's record of new consumer contracts ・ Household survey carried out with the population census which includes a survey for water supply condition. An alternative method, if any at the time of evaluation, may be employed to ensure a more accurate estimate.

(2)An average per capita daily supply is low, about 100 litters to the complaint of citizens.	Augmentation of water supply in an amount of 91,000m³/day through the development of a new wellfield	It can be increased to 130 liters on average.	a. For the estimate of this rate, the study employed WASA's daily records as follows: ・Water supply record ・Estimated rate of leakage = 30%, based upon the master plan report ・Supply records of bulk consumers(a part of them are metered). b. WASA keeps the foregoing records available for the evaluation after the completion of the project.
(3)The east side of the city accounting 1/3 of the whole city suffers from extremely poor water service, with low pressure of 0.5 kg/cm² in the trunk mains at the time of pumped distribution and 0 at the time of gravity distribution.	The project provides supplementary sections to the trunk mains, focusing on the east side of the city.	The water pressure can be improved to 1.0 to 1.5 kg/cm² at the time of pumped distribution. Furthermore, continuous pump operation is planned, based upon increased water supply to maintain improved water pressure in the area in question.	a. Flows and pressures in the existing trunk mains were measured during the study for the project. For network analysis, WASA's daily supply record was referred to. b. Based upon this analysis, a relevant design for increasing pressure in the east area was worked out. c. For the evaluation of the indicator after the completion of the project, it is possible to use equipment for testing flows and pressures, which is planned to be procured under the project.
(4)Water supply hours with pumps are restricted at 3 times a day, each for 1 to 2 hours.	The effective and efficient pump operation combining the new and existing ones is planned. New pumps are equipped with a simple type of speed control for dealing with changing demand.	With increased water supply, continuous operation of pumps will basically be achieved. Demand variation will be controlled with new pumps with speed control.	a. The existing pumps cannot handle variation of demand, resulting in malfunctioning with damages on pump accessories.。 b. Actual demand and trend in consumption of citizens remain yet to be seen. The control of pump operation is, therefore, will closely be examined during the test operation, and propose the most appropriate method of operation for ensuring the maximum effect. c. For the evaluation of the indicator, reference shall be made to WASA's pump operation record.
(5)WASA's yearly financial balance shows a continued loss. Current water supply cannot improve its financial situation.	Indirect effect by means of increased supply	The revenue can be increased, as outstanding payments and rejection of payment decrease, owing to increased supply.	a.The evaluation can utilize the following data: ・WASA's annual financial report ・ WASA's bill collecting record (computerized data) ・WASA's record for promotion of arrears reduction programme b. Check the situation of WASA's planning for the shift to metered tariff system.

(6)Citizens suffering from shortages of water supply depend upon contaminated groundwater as alternative, resulting in frequent occurrence of waterborne diseases.	Increase of water supply coverage rate and a per-capita daily average supply rate	Dependence on groundwater decreases.	The additional water targeted by the project corresponds to nearly 40 % of the ongoing supply. Although it cannot cover the whole population, such significant increase of safe and stable water can contribute to improvement of health of citizens. The city has good medical facilities and their records of diseases can be accessed at the health department of the district office.

3-2 Recommendations

a. For the development of groundwater under the project, the provincial government and WASA agreed to promote measures for risk management against likely groundwater level lowering in the surrounding wellfield. WASA is expected to formulate concrete measures including compensations in case of a real threat of the expansion of influence due to pumping at the project tubewells and to open relevant data and information to stakeholders through public meetings and dialogues. It is of vital importance for WASA to ensure their agreement to the implementation of the project through such steps as soon as practicable.

b. WASA is recommended to organize its own plan for continuously monitoring groundwater level in the region, based upon the policy described in this report. Data obtained through the monitoring program will provide an accurate basis for predicting the influence of pumping at its tubewells to the surrounding areas and to establish practical measures for dealing with adverse effects. In respect of water quality, the result of the study indicates that good quality to meet the requirement of the standards can be maintained thanks to the constant recharge from infiltration of the canal. However, its monitoring is necessary as well, since the survey found in the region a trend of quality worsening apparently due to the expansion of contamination by domestic waste waters.

c. The augmentation of water supply as the target of this project depends upon the potential of groundwater resource along the Jhang Branch Canal. It has been confirmed by this study that the main source of its recharge is infiltration from the canal. Accordingly stable flows through the canal are one of the essential conditions for the sustained operation and maintenance of the project.

The Jhang Branch Canal is one of the secondary mains of the Lower Chenab Canal, which is the largest in scale in the existing irrigation network of the Indus system. Since the Lower Chenab Canal system including its intake headwork has now been overage due to its oldest construction, the provincial government of Punjab plans a large-scale rehabilitation work as well extensive lining of the existing channels for the purpose of enhancing discharges. This study was informed, however, that the lining is planned for the distributaries and smaller downstream channels, with the trunk mains remaining intact. The flow through the Jhang branch Canal is likely to increase by the implementation of such a plan. This situation seems to guarantee the soundness of water sources for the project for a foreseeable future. Notwithstanding WASA is requested to pay close attention to the operation of the canal, collecting data and information from the authorities, particularly during the period of its closure, for its proper management of water sources.

d. Although the augmentation of water supply by the project can satisfy urgent need of the city, it is not in a level to meet a long term demand, and WASA is required to continue its efforts to acquire additional water sources. However, as the development of urban water facilities requires a huge investment as well as a long term for realization, it is necessary to make efforts to minimize water loss in the of distribution system. One of the main targets is to reduce leakage from trunk mains, branches and house connections. The actual range of leakage of the existing system in Faisalabad remains unidentified, since the level of the exact consumption is unknown due to the lack of meters. According to the inspection of existing pipelines during the study, the ductile cast iron lines composing arterial mains, which were completed in 1992, showed little signs of leaks as yet, while leaks in asbestos cement lines mainly used for secondary mains and branches were witnessed in some places. There remain within a city lots of aged sections deteriorated, particularly among those of smaller sizes, which are vulnerable to damages leading to leaks. As the total length of the existing lines in the city now reaches nearly 1,000 km, the eradication of leaks is not an easy task. As a first step, a pilot project for examining the real situation of existing pipelines in a couple of selected colonies in the city should be planned. It is recommended to work out practical measures for the remedy of leaks, based upon data and information obtained through the project and put them into practice in stages.

e. The plan in the project for the reinforcement of arterial mains targets the area at the end of arterial mains in the east side of the city suffering the poorest condition of water supply. Meanwhile WASA has been continuously carrying out the plans to expand and reinforce the existing network proposed by the revised master plan in 1993. To assist its efforts, this project plans to procure equipment for monitoring flow and pressure of pipelines. It is recommended such equipment be effectively utilized in their planning for the improvement of the network.

f. WASA's current tariff system is based upon the sizes of properties of consumers, regardless of consumed water quantities. Under this fixed tariff system, citizens are anxious to withdraw as much water as possible during the restricted supply hours. In this competition, those in the west side of the city close to the terminal reservoir have a clear advantage over those in the east side away from it. Under the ongoing unbalanced water supply, the latter is inclined to reject payments for water fee

WASA already finished its examination of the shift to the metered system. In order to improve its finance, it is recommended to establish the practical strategies to switch to it as earlier as possible along with the implementation of the project.

g. The implementation of the project is shared between both parties, with the Pakistani side undertaking the installation of primary high-tension power supply facility, land acquisition and preparation for the construction work, public relations, etc. The fund for its undertakings is secured after the approval of PC-I for the project by the related organizations of the provincial and state governments. For this project, the Pakistani side expressed its intention to ensure the anticipatory approval of ECNEC as the highest authority by the end of June 2004 during the mission for the explanation of the draft final report. For the smooth implementation of the project, the undertakings by the Pakistani side are required to be carried out in tune with those by the Japanese side, and the positive cooperation on the Pakistani side is requested in every stage of its implementation to promote it in a satisfactory manner.

3-3 Project feasibility

The following points can provide a basis to verify feasibility for the implementation of this project with Japan's grant aid:

a. Those who can receive benefits through the implementation of the project are ordinary citizens in Faisalabad. According to the household survey in 1993 by the revised master plan financed by the World Bank, nearly 40% of the whole citizens were estimated at a level of the poor, and this composition is generally believed to be still persisting.

The supply to be increased through the project corresponds to approximately 40% of the ongoing one. Nevertheless its greater part will have to be served to the ordinary citizens acutely in need of basic supply.

b. The citizens suffering from extremely poor water service have also been relying upon progressively deteriorated groundwater. The household survey in the master plan showed nearly 80% of the entire households in the city have their own tubewells or those for common use. According to the past studies, within the city is unfit for drinking, since the deeper one has a high concentration of salts, while the shallower one is artificially contaminated. The social survey under this study has shown that more than 20% of the respondents see there are "frequent" risks of waterborne diseases such as hepatitis, diarrhea, etc., with the ongoing water practice. The augmentation of safe and stable water supply by this project can contribute to the improvement of health and sanitation environment of citizens.

c. The project is managed by WASA, the municipal water authority, with a newly recruited staff of about 160 along with the ongoing manpower of about 1,500. The new system added to the current one is composed of similar facilities as the ongoing ones with their technical grades at similar levels. It is operated and maintained by WASA consistently with the existing one with which WASA has acquired expertise and experience through the past operation.

WASA's financial management so far, however, has been facing difficulties with its yearly deficit in the operation cost supplemented by the government subsidies. The deficit derives from the insufficient revenue due to the low and fixed tariff system common in the large cities of the country. In its efforts to improve the situation, WASA lately revised its tariff, and moreover is now planning to shift to a metered tariff system, encouraged by the government policy. The remedy of its financial situation will be able to have a significant effect, once WASA switches its tariff to a metered system. The implementation of the project will offer a good chance for such a fundamental shift of management policy WASA has long been thinking about.

d. Since the development of groundwater in the project is likely to have a risk of affecting the agricultural groundwater use in the region, the opposition of surrounding community devoted to agriculture broke out while the study for the project was underway. The rural population had a profound anxiety since it had encountered an adverse effect of WASA's groundwater withdrawal in the preceding project for Phase I. This project, therefore, adopted a design policy to minimize such a risk. In addition, both sides have agreed to work out measures to alleviate the fear of the stakeholders around the wellfield, including appropriate compensations in case of real danger as a prerequisite for the implementation of the project. Such steps have never been taken for WASA's preceding projects, and open up a new way for WASA to go through in launching a project in the future, since it evidently needs further expansion of its water system to keep up with the development of the city.

3-4 Conclusion

This project is aimed at urgently improving public water service targeting the increased water supply and per capita supply rate for citizens including large numbers of the poor in a significantly big city of the country. It will contribute to improvement of their BHN and health environment. All these characteristics of the project, together with effects enumerated as follows, are deemed adequate for verifying feasibility of extending Japan's grant aid to the implementation of the project.

Finally it is requested to WASA to take the following measures into account to enhance the effects of the project:

(1) Risk management
As a result of the study there is a risk of groundwater level lowering in the surroundings of the planned wellfield on the medium to long-term basis. It is necessary to work out relevant measures for alleviating the adverse effect including possible compensations to the concerned villages. Prior to the implementation of the project, the Pakistani side is required to secure agreement of all the stakeholders to the implementation of the project through public meetings as well as intimate dialogues with them, providing all relevant information, as was agreed during the basic design draft explanation mission in March 2004.

(2) Efficient water supply by means of reduction of leakage and improvement of distribution
In order to minimize loss of valued water, WASA is required to take aggressive actions to reduce leakage of pipelines which reportedly stands at a level of 30%, though the real situation is unknown since house connections have no meters. It is recommended to select pilot areas as a first step to know the situation and work out a relevant plan for eradicating water loss. Furthermore, as the project plans to undertake a partial remedy of the existing distribution network, WASA is requested to continue its own efforts for the improvement of distribution system such as the reinforcement of secondary network and branches. Equipment procured under the project for testing flows and pressures of pipelines are requested to be effectively utilized in such undertakings for realizing balanced water service through the city.

(3) Employment of metered tariff system
Augmentation of water supply can have its maximum financial effect under the metered tariff system. The shift of all the current consumers of about 100 thousand is estimated to take more than three years. Since its preparation seems likely to take time, at least WASA should start it with new consumers from now on. Earlier realization of the plan is strongly desired.

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