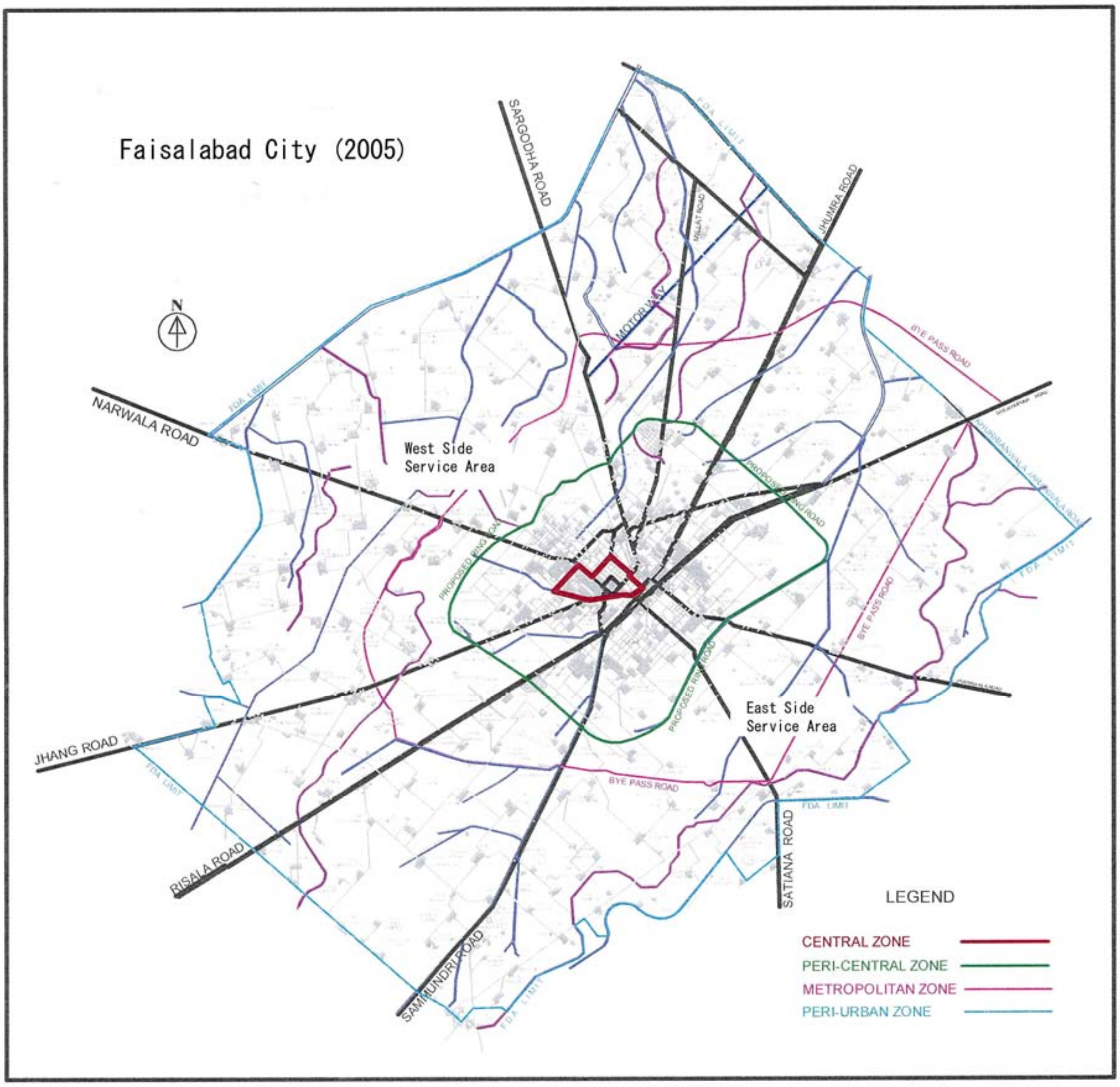
2-2-2-2 Water supply planning

1) Service area of the project

Faisalabad city in Punjab Province is the third largest city (approximately 130km^2) in the country with an estimated population of 2.6 million in 2007. In the past it served as a regional agricultural center of Punjab, but in recent years textile industry has flourished and it has now grown to be one of major industrial and commercial cities in Pakistan.

In June 2005 the District of Faisalabad with the city serving as its center was promoted to the City District with all its administrative area divided into 8 Towns. As a result the former municipal zone of the capital now consists of 4 Towns.

Fig 2-8 Administrative Area of Faisalabad City (2005)



The ongoing service area of WASA is limited to the peri-center area indicated in Fig.2-8. After the announcement of the City District, however, it has been expanded to the Metropolitan Area in the same map. Accordingly the area between the boundary of the peri-center and the proposed bypass road will become the target of future development by WASA.

The peri-center area where WASA water service has been extended to date has long been suffering from the acute shortages of water supply. The main source of the existing water system for the city is the tubewells installed in the Chenab wellfield about 20km northwest of the city, and the water pumped there is transmitted via a booster pumping station to the Terminal Reservoir Pumping Station (hereinafter called as T/R), situated in the northwestern suburbs of the city. The water is then supplied to the service areas in the city, largely divided into two zones in the east and the west, through arterial mains extending toward the east to southeast side of the city. The network remains yet to cover the whole area, particularly at the end of existing trunk main in the east side, where the shortage of water supply has long been acute due to lower pressure. During the preceding process of implementation under the project, the construction work for reinforcing the existing network was executed as the first phase for the purpose of improving water supply in this area. The effect of this work will be verified as water increases upon completion of the second phase planned for the construction of main water facilities in the future.

2) Population

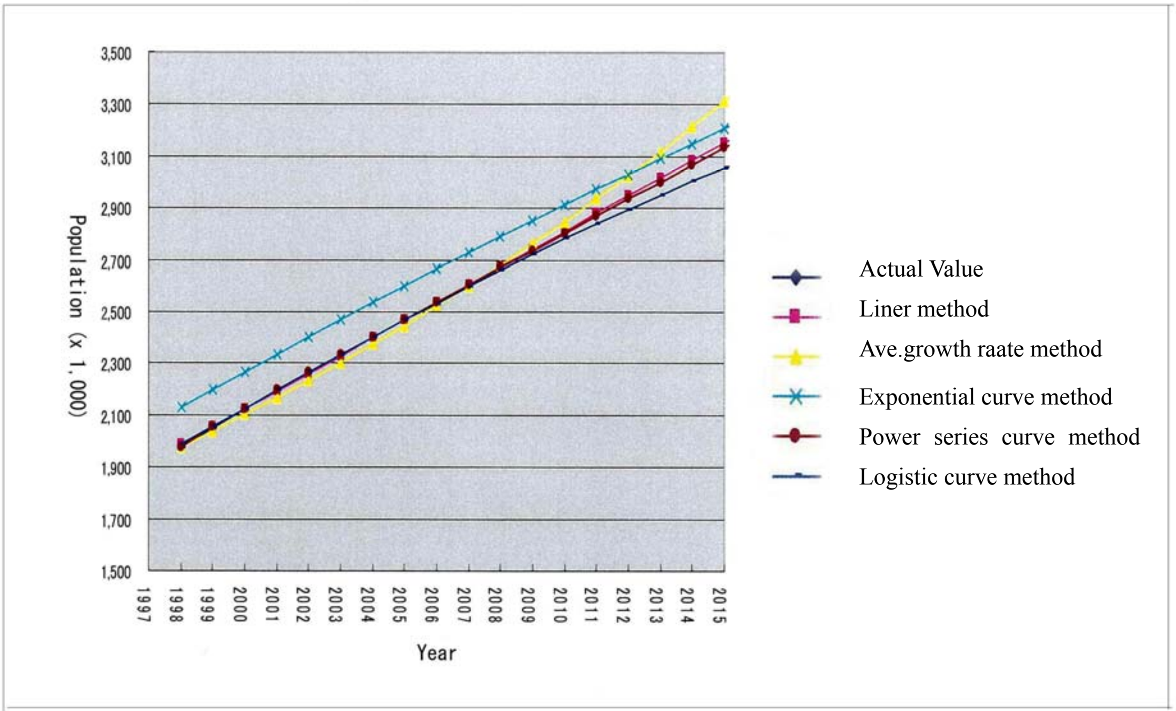
The population of the city is now estimated at 2.6 million based upon the national census in 1998. It was 2.2 million in 2001. The growth rate ranged from 2.6 to 3.6 %. Comparing it with the statistical data in 1981, the present population increased by about 2.5 times in 25 years.

Based on the past statistical data, the future population of Faisalabad was projected for the study using four estimation formulas. The results of four estimates are plotted in Fig.2-9 for graphical comparison. Among them, the values calculated with the "mean increase number method" (linear method) show an intermediate range, and is considered to provide a suitable basis for the study. Assuming this forecast, the population of the city is estimated to reach 2.8million in 2010, when this project is to be completed.

Table 2-9 Change of the Population of Faisalabad (x 1,000 people)

year	Actual						Estimated		
	1981 (census)	1991 (census)	1995	1998 (census)	2000	2001	2007	2010	2015
Projected Population	1,104	1,583	1,875	1,997	2,020	2,200	2,600	2,811	3,154
Data	WB	WB	Statis-tics	Census	WASA	WASA	WASA		

Fig. 2-9 Projection of the Population of the City (thousands)



3) Examination of basic elements for supply planning

(1) Water sources

According to the preceding basic design study for the project in 2003, WASA depended mainly upon tubewells in two major wellfields as water sources for supply, supplemented with supply from slow sand filtration systems. This implementing review study in 2007 confirmed the composition of sources for WASA system had no substantial change.

The present state of the discharges of the existing water sources is reported as follows:

i. Tubewells

a. Chenab Wellfield

In the ADB project, completed in 1992, 25 tubewells were installed in the Chenab wellfield as the main source of water supply for the city. In 2000, WASA added four in their own effort to increase supply.

The design discharge rate from this wellfield was initially 225,000m^3/day. The basic design study in 2003 saw that the actual production rate in those days had ranged from an average rage of 160,000m^3/day to the maximum of 180,000m^3/day, although the record marked a few cases of a maximum production of 200,000m^3/day in the first quarter of 2001, when the number of operating wells had increased to 29.

The present study for the implementing review in 2007 examined the record from the first month of the year to the end of July. Its results showed that a daily average in the winter season was in the range of 160,000m^3/day, while that in the summer tended to rise to 180,000m^3/day marking a daily maximum production of 200,000m^3/day on a couple of days. The highest production was ensured by continued pumping from 25 wells out of 28 tubewells in service in the wellfield.

The review of WASA's records of pumping from the tubewells and daily log of distribution under this study indicated that the current practice of production from the Chenab wellfield was continuously aggravating the fall of groundwater level in and around the wellfiled. The tubewells in Chenab wellfield are mostly 120 m deep with a 14 " pump casing installed to a depth of 40 to 45 m from ground level. If the local water level keeps falling in an average rate of 0.6 m per year as used to be since the start of operation in 1992, a part of the tubewells are likely to have difficulty in continuous pumping before not so long. In order to contain such a trend, it is necessary to reduce the dischcarge from the wellfield.

For planning for the future supply in which the new project is to contribute to enhancing supply, the existing wellfiled is desired to maintain the discharge rates which have been ensured throughout the continued operation to date. Based upon the review of the past records, the study employs a rate of 180,000 m^3/day as the daily maximum. WASA is requested to undertake necessary measures for maintenance of tubewells and pumps to ensure this level of production from the Chenab wellfiled.

b. Rakh Branch Canal wellfield

Until the completion of the Chenab wellfield, the entire water supply for the city used to rely on the tubewells installed alongside the Rakh Branch Canal running across the east side of the city. In the early 1990s the number of wells alongside totaled more than 50. Tubewells used to be concentrated in this zone since the quality of groundwater along the narrow strips on the both sides of the canal was acceptable, contrary to the ones in other areas within the city where TDS was well over 2,000mg/lit, unacceptable for drinking mainly due to salinity. The wellfield located downtown had thus been overly developed, and resulted in many of the tubewells to be closed due to lowering of groundwater level and degradation of water quality.

The World Bank’s master plan suggested to limit the total discharge in this strip to a range of the seepage amount from the canal to preserve proper quality and quantity. In compliance with this recommendation, WASA rehabilitated the existing tubewells by 2002. As a result, old and new tubewells of 18 in total are presently in operation along the canal side. The design discharge of this source is 1 cusec (=102m^3/hour) for each tubewell. The respective tubewells serve independently to their surrounding areas, and their operation hours vary, depending upon the demand of targeted areas. On the average, the total discharge from this wellfield is now around 50% of the quantity developable estimated by the World Bank's study.

The present study team happily came across WASA's announcement of a new project of groundwater development along this canal. PC-1 for installation of 10 tubewells was approved by the provincial government and fund for the project was allocated for this fisical year. This project plans to install 10 new tubewells in the upper-stream area of the currently existing 18 tubewells. The main objective is to provide approximately 10,000m^3/day additional water supply for the surrounding new residential area, independently from the trunk line water supply, but it will certainly contribute to the improvement of the overall water supply.

ii. Surface water treatment facilities

a. Jhal Khanuana water treatment plant

The Jhal Khanuana water treatment plant, situated in the central part downtown, on the left bank of the Rakh Branch Canal, used to withdraw the canal water, and to feed it to the arterial mains after processing it through slow filtration. Although the design capacity was 17,000m^3/day, it continuously decreased to about one-third 5,000m^3/daydue to deterioration of facilities during the basic design study in 2003.

The present study confirmed the final shutdown of the filtration plant due to deterioration. WASA has no plan to restore it due to the difficulty in canal water quality, always too muddy for slow filtration.

b. Millat Town water treatment plant

The treatment method is slow filtration just like Jhal Khanuwana plant, and withdraws surface water from one of the distributaries of Jhan Branch Canal located away from the city. It produces about 5,000m^3/day. This treatment plant independently supplies water to the new residential area of Millat Town.

The total production from the existing water sources was about 230,000m^3/day by the previous basic design study in 2003. Summing up their examination under this study, the anticipated supply rate in the future is estimated in the following table 2-10:

Table 2-10 Maximum Production Capacity of Water Sources

Water source	Production rate(m^3/d)				New Plan	Remarks
Year	1993 (WB:MP)	1998 (JICA:B/D)	2001 (JICA:B/D)	2007	2010	

Chenab wellfield	225,071	204,750	200,000	200,000	(180,000)	Total 29 wells @400 m^3/hour/well
Rakh Branch Canal wellfield	83,178	20,200	20,000	20,000	(20,000) + 10,000	Total 18 wells 100m^3/hour/well commenced 2002
Jhang Branch Canal wellfield					91,000	This project Total 25 wells 200m^3/hour/well
Jhal Kanuana water treatment plant	17,125	6,825	5,000	Aban-doned		
Milat town treatment plant (independent supply unit)	—		—	4,550	4,550	
Total Production	325,374	231,775	232,000	234,550	305,550	

(2) Water service rate and served population

WASA charges for its service on a fixed tariff system based on the sizes of the properties in a similar manner to those in other major cities of the country. Most of all the households in the city are without water meters. Accurate water consumption, therefore, remains unknown. Furthermore accurate data for served population is not available. In 1992 the World Bank conducted a household survey of 5,400 for its task of revising the master plan for the city's water service, and estimated the water coverage at 60%. On the other hand, the consumer survey conducted about the same time by FDA for 16,000 households reported it was about 50%.

To examine the coverage rate during the basic design study in 2003, WASA recommended to estimate it by calculating the extent of its service area where secondary distribution lines and house connections had already been installed. The calculated service area based upon the data provided by WASA turned out to account for about 50% of the city's entire administrative area. Since pipelines were installed mainly in the populous area, the ratio of the citizens living in the service area to the entire population of the city was likely to be more than the ratio of the two areas thus compared. This study assumed 10% for a rate of additional population, taking into account various factors affecting the estimate such as the ongoing daily water supply rate, average per capita daily consumption, etc. Consequently the estimated coverage of WASA's water service was proposed to be at a rate of 55%.

The same service rate employed by the basic design study is proposed for this study in 2007, since there was no substantial increase in the number of new contracts for supply during the period between the two studies, mainly due to shortages of water. Since the estimated population of Faisalabad is now 2.6million (2007), the current served population is 1.43 million, taking a rate thus estimated. In future the prospect of enhanced water supply through this project is likely to invite more new customers than in the past at a rate of approximately 1 % annually. According to this assumption, at the time of completion of this project in 2010, the water coverage rate could rise to 60%, with the served population increasing to 1.69 million among the total projected population of 2.81 million.

According to the results of 1998 national census, the number of households in the city was 279 thousand with the average number of family members at 7.1. On the other hand the number of the households connected to the water service in 2002 was 98 thousand, indicating the water service coverage by connections accounted for only 35% of the total households. The reasons for the difference are not clear, but one of guesses is that more than one household are illegally connected to single service lines. Connections of this type are reportedly widespread, since unregistered households need not pay the fixed rate of water tariff to be charged upon their property sizes. Although the number of house connections can provide useful information for estimating the water coverage rate, the current figure of registered connections cannot tell the real situation in Faisalabad. It is strongly recommended to WASA, therefore, to survey the conditions of current service connections for collecting the exact data on the actual situation of its water service. When WASA moves to shift its fixed water tariff to the metered one, such data is indispensable for planning an effective method for execution.

The number of water supply connections is shown as a reference in the table 2-11:

Table 2-11 Number of connections (July 2007)

<table>
<tr><td colspan="2">Type</td><td colspan="2">Number of connections</td></tr>
<tr><td colspan="2">Year</td><td>2003</td><td>2007</td></tr>
<tr><td colspan="2">Households</td><td>98,000</td><td>+ 1,300</td></tr>
<tr><td rowspan="2">Industrial</td><td>Industrial</td><td>90</td><td rowspan="2">+ 20</td></tr>
<tr><td>Commercial</td><td>1,700</td></tr>
<tr><td colspan="2">Total</td><td>100,000</td><td>101,320</td></tr>
</table>

WASA classifies the categories of consumer’s usage into (a) Household use, (b) Industrial use and (c) Commercial use. The industrial use is the one by large consumers such as factories, public institutions, banks, hospitals and schools. The number of consumers in this category was 78 in December 2002. The commercial use is for consumers with 1/4" diameter pipes (same as households), and the number of connections was about 850 during the same period. WASA estimates that the consumption of these two categories accounts for about 15 % of the total. The confirmation was made in 2003 during the basic design study to examine the actual situation, based upon WASA’s computerized billing log as follows:

a. Industrial use

According to the billing record of December 2002, the monthly consumption of this type was estimated at 250,000m^3/month. The number of connections was 78, all of them large consumers such as top textile plants, public institutions, banks, hospitals and hotels. The 21 users among them were paying the bills for metered volumes, which accounted for a greater part of charges in this category. The remaining users were charged on the assumed volumes of consumption determined by WASA in its tariff system, depending upon the diameters of their connections. They were paying for the consumed amounts of water, but the rates of consumption are fixed.

b. Commercial use

All the users in this category are served with unmetered connections of the same diameter, 1/4"as domestic users, but their tariff rate is about 4 times higher than that for the latter, since they are assumed to consume more. There are 850 users in this category, but without meters, the amount of consumption remained only a guess. Assuming the daily consumption of one connection to be 2 m^3, the monthly consumption from 850 connections was 51,000 m^3 in total.

According to this study, the total consumption in the two categories amounted to 310,000 m^3 per month, indicating that their average daily consumptions are around 10,000 m^3. The estimated consumption rate corresponded to around 6% of the total water supply rate, but this share needed some adjustment because the data based for this estimation was of December 2002, namely the increase on demand in summer time and data correction. Thus it was assumed that about 10% of the total effective water supply was consumed for the industrial and commercial usage.

As WASA gives priority to the general public in its inadequate supply condition, most of the industrial users installed their own tubewells on their premises to secure necessary water. (The World Bank estimated in the Master Plan report, 1992, that 95% of industrial users had their own sources). However, the withdrawal of groundwater even from their own sources is not free. It is charged by WASA as "Aquifer Charges" set in its tariff system, and it has been one of important sources of income for WASA (although increasingly uncollected). Although WASA has been anxious to respond to the increasing demand in the industry as it could contribute to WASA's revenue with a tariff rate 3 times higher than that for domestic use, it has been highly difficult to increase the share of this sector under the current level of water supply. As for the commercial use, since a great majority of users in this category are engaged in family business of small scale, the average consumption rate is supposed to be in a similar level as that of domestic usage, both categories using the same connection size of 1/4". Accordingly the consumers in the commercial use may be treated together with ordinary domestic users in respect of demand.

As far as the present water supply continues, the increase of supply for the industrial sector will be frozen. Even after the supply rate increases in 2010, much cannot be expected for the sector if the public demand is prioritized. Under the circumstances, dependency on private tubewells will have to be maintained.

(3) Examination of the supply rate

a. Ongoing daily supply rate

The present study examined the latest records of WASA operation for supply. The following table 2-12 shows the supply log from the Chenab source, which produces about 90% of total supply rate for the city. As shown in the table, the maximum and the average daily supplies from this source were respectively 200,000 and 174,800m^3/day.

Accordingly, the maximum daily supply for the city is currently estimated as follows:

* Chenab source		200,000m^3/day
* Rakh Branch Canal source		20,000m^3/day
* Millat Town treatment plant		5,000 m^3/day
	Total	225,000m^3/day

This average daily supply is more than that identified at the time of Basic Design (160,000m^3/day, June 2002), indicating the efforts made by WASA to respond to the ever growing demand. However, there is a possibility that such increase is causing the continuous lowering of water level due to excessive withdrawal. Therefore, it will be appropriate to set the maximum daily supply at 180,000m^3/day, as it had been before. The Chenab Source Supply Record in 2007 (January to July) is shown as a reference in the table 2-12:

Table 2-12 2007 Jan- Jul WASA Chenab Source Supply Record

Date	Jan	Feb	Mar	Apr	May	Jun	Jul
1	172,000	172,500	165,500	168,800	182,000	194,000	179,600
2	172,000	172,500	163,000	161,200	183,000	188,500	193,300
3	172,000	172,500	164,500	162,500	181,500	193,200	190,200
4	170,500	173,000	167,500	166,800	182,000	188,800	187,600
5	171,500	173,500	161,000	166,500	183,500	190,500	198,000
6	171,500	172,500	168,700	166,000	182,700	194,000	192,900
7	171,000	169,800	168,500	166,000	182,300	182,700	184,000
8	172,000	173,700	172,400	166,000	179,400	188,300	185,900
9	171,300	172,000	163,400	163,500	179,900	183,600	188,700
10	152,800	140,000	152,000	165,000	174,800	175,500	192,200
11	165,500	153,200	159,000	169,800	189,600	163,500	180,600
12	168,000	160,300	164,000	166,700	189,500	153,500	177,000
13	168,500	154,500	163,000	176,000	189,200	184,500	179,600
14	167,500	155,700	162,000	173,700	182,000	164,800	142,600
15	133,000	162,300	164,000	179,300	185,000	175,100	184,400
16	167,000	164,000	167,800	179,000	189,400	190,900	201,700

17	164,800	166,000	166,200	176,000	157,100	194,100	185,100
18	168,200	170,000	163,000	180,500	138,000	193,800	186,700
19	169,500	126,000	164,000	183,000	187,500	184,100	178,500
20	171,000	165,000	164,200	183,500	193,500	200,000	193,600
21	170,500	144,200	159,800	180,500	193,000	182,200	188,800
22	172,000	167,600	148,500	183,500	182,500	195,500	188,000
23	170,000	166,500	165,000	180,500	190,000	188,500	189,300
24	168,500	169,500	163,500	183,500	186,400	191,000	189,900
25	171,500	165,500	167,000	181,500	186,100	187,400	191,000
26	171,000	163,000	162,500	180,300	192,599	192,100	193,400
27	174,000	165,500	162,000	162,000	191,000	194,200	182,900
28	170,000	165,500	139,700	180,000	194,500	190,000	178,000
29	167,000		169,300	156,800	192,000	186,200	188,500
30	173,500		166,500	182,000	192,500	192,500	
31	169,000		168,200		190,500		
Total	5,216,600	4,576,300	5,055,700	5,190,400	5,702,999	5,583,000	5,392,000
Daily Ave.	168,277	163,439	163,087	173,013	183,968	186,100	185,931

b. Unaccounted-for water

The past studies such as the World Bank's Master Plan estimated that there was about 30% loss of water supply in the system due to leakage, and based upon this estimate, WASA currently assumes the effective rate of water supply at 75%. The inspection of the existing pipelines within the city during the previous studies under the project tells that leakage rarely occurs in the arterial mains thanks to their relatively young age and good quality in material as well as workmanship and to utilize the ductile cast iron pipe manufactured in Japan. However, the distribution pipes made from asbestos from the secondary mains to service lines, which are a combination of recent and older installations, seemed to be leaky. Interviews to citizens in the east side of the city during the social survey for the previous basic design study revealed that they had experiences with drinking water contaminated with sewage. In May 2005 a case of a large scale contamination incident took casualties of 11 citizens, mostly infants. In an aftermath of this incident, the provincial government intervened and directed WASA to replace old connections, not only the affected area but also other parts of the city. The replacement work has since been in progress, and this situation is likely to have good effects in improving unaccounted-for water ratio due to leaks. This project expects the work now in progress could contribute to the improvement of leaks by 5% in 2010 when the operation of the new facilities under the project will be commenced.

c. Daily maximum supply rate

The water supply to the city has been restricted to 3 cycles of pump operation a day totaling 6 hours at the maximum so that the actual demand of consumers remains unknown. This situation makes it difficult to determine various factors for planning including a ratio for determining the daily maximum supply rate. As a measure to address the task, this study takes the present consumption pattern for reference, since the target of the project is now to urgently alleviate the current shortage of water in the city rather than undertake a plan targeted by the World Bank's master plan.

Assuming this policy, the load factor, which is the ratio of the daily maximum supply to the daily average supply, is obtained, based upon the recent performance in supply from T/R, based upon the record shown in table 2-13.

The calculation is presented as follows:

(Daily maximum supply rate =200,000m^3/day)

/ (Daily average supply rate=174,800 m^3/day) = 1.144

d. Peak hour factor

The peak hour factor determines the design hourly maximum supply rate. It is again difficult to obtain the reliable range of this value as is the case with the daily maximum supply rate. Although the World Bank employed a ratio of 1.9 to the daily maximum supply rate, based upon the demand projection, this project prefers a ratio of 1.6, which is the standard level for cities of the same size as Faisalabad.

e. Actual per capita daily average supply rate

The actual average daily supply rate per capita including industrial and commercial uses is calculated as follows, using the current actual supply, served population and the effective ratio described in the foregoing sections.

(Daily maximum water supply x effective ratio) / (current population x water coverage ratio)

= Per capita daily maximum water supply rate

(224,550m^3/day x 0.75) / (2.6 million x 0.55)) = <u>117 lit/capita/day</u>

Subtracting the estimated 10% of the industrial and commercial use and dividing by maximum load factor (=1.14) results in a per capita daily average supply rate for household, as follows:

［(224,550 m^3/day x 0.75) x0.9)］ / (1.15) / (2.3 million x 0.55)) = <u>92 lit/capita/day</u>

The calculation indicates the current per capita average supply is in the level of less than 100 liters per capita per day. The estimated level is quite low among the standards of other cities in Pakistan, which is 30gal (=135 liters) and more. This situation shows the acute shortage of water in the city.

f. Design per capita average water supply rate

In the early stage of water supply planning for the city, the ADB's master plan in 1970s determined on 135 lit/capita/day as the average water supply rate in 2000 and the World Bank's master plan, based on a consumption pattern survey conducted as part of the household survey, set the rate by income levels and proposed 135, 180, 320 lit/capita/day for low, middle and high income families respectively. The average rate across different income levels is 170 lit/capita/day. For the third largest city in the country, the supply standard given by the World Bank may be preferable. However, the real situation in supply is that only demand has been soaring with constantly increasing population as the future plan to augment water for the year 2000, proposed by the World Bank's master plan, was not realized. As a result, the shortage of water is now so acute that even the amount of supply augmented through the implementation of this project cannot meet the rates formerly proposed by the World Bank.

Table 2-13 shows the result of the projection of the water supply after the completion of this project, based upon the factors previously examined. According to this forecast, the per capita daily average supply rate will be 130 lit. in 2010, provided the industrial and commercial demand is kept at the present level, and presuming the water coverage rate will increase from the present 55% to 60%, Furthermore, in order to maintain this level as the population grows after 2010, possible measures to increase the supply such as the decrease of leakage, rehabilitation of the Jhal Khanuana Head Water Works, more effective use of the existing tubewells in the Rakh Branch Canal wellfield, etc. will have to be taken. For reference the projection of water supply in Table 2-12 includes the results of the calculation assuming such contributions as the decreased leakage and increased supply from the tubewells along the Rakh Branch Canal.

Table 2-13 Water supply projection

FY	1.Estimated population	Daily maximum supply rate (m^3/day)				Daily ave. supply(m^3/d)	7. Coverage rate	8.served population	Per capita daily supply (lcpd)	
		2.intake rate	3.effective water	4.industrial /commercial	5.household	6.household			9.Ave.	10. Max.
2007	2,600,000	224,550	168,340	16,830	151,510	128,230	0.550	1,430,000	92	106
2008	2,674,000	224,550	170,660	16,830	153,830	128,230	0.560	1,497,440	87	103
2009	2,742,000	224,550	175,150	16,930	158,320	128,230	0.580	1,590,000	87	92
2010	2,811,000	305,550	244,440	16,830	229,140	128,230	0.600	1,687,000	114	136
2011	2,880,000	305,550	250,550	16,830	233,720	128,230	0.620	1,785,600	114	131
2012	2,948,000	315,550	265,000	16,830	248,170	200,580	0.640	1,886,720	114	132
		Supply increased by this project in 2010 and increase of water supply from Rakh Canal source in 2010 & after	The present leakage at a rate of 25% is improved to 20% by 2010, and an improvement of 2% per year after 2010.	4. =10% of 3. Assumed to keep the same level after 2007	5. =3.-4.	6.=5./1.15 (load factor for max. supply).		8. =1.x7.	6. / 8.	5. / 8.

2-2-2-3 Facility planning

1) Components of Planned Facilities

Major facilities planned for this project under the responsibility of the Japanese side are composed of the following.

a. Intake facility: Tubewells and tubewll stations
b. Collecting facility: Collector mains
c. Transmission facility Pump well, booster pumping station, chlorinator and transmission main
d. Distribution facility: Terminal reservoir pumping station
e. Improvement of the existing network in the city:
Supplementary pipeline to the existing arterial mains Phase 1 (2005-2006) completed
f. Electrical facility Secondary power facilities for pump stations in the wellfield, the booster pumping station and the terminal reservoir pumping station

2) Description of Facilities

(1) Intake Facility

i. Components of Intake Facility

Table 2-14 Lists of Intake Facilities

Classification	Facility	Quantity	Specifications		
a. Water Source Facility	Tubewell	25	Design discharge (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 30～80HP, 1,450 rpm, 50Hz, 400V
	Tubewell 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 while the pump is idle.
- 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.

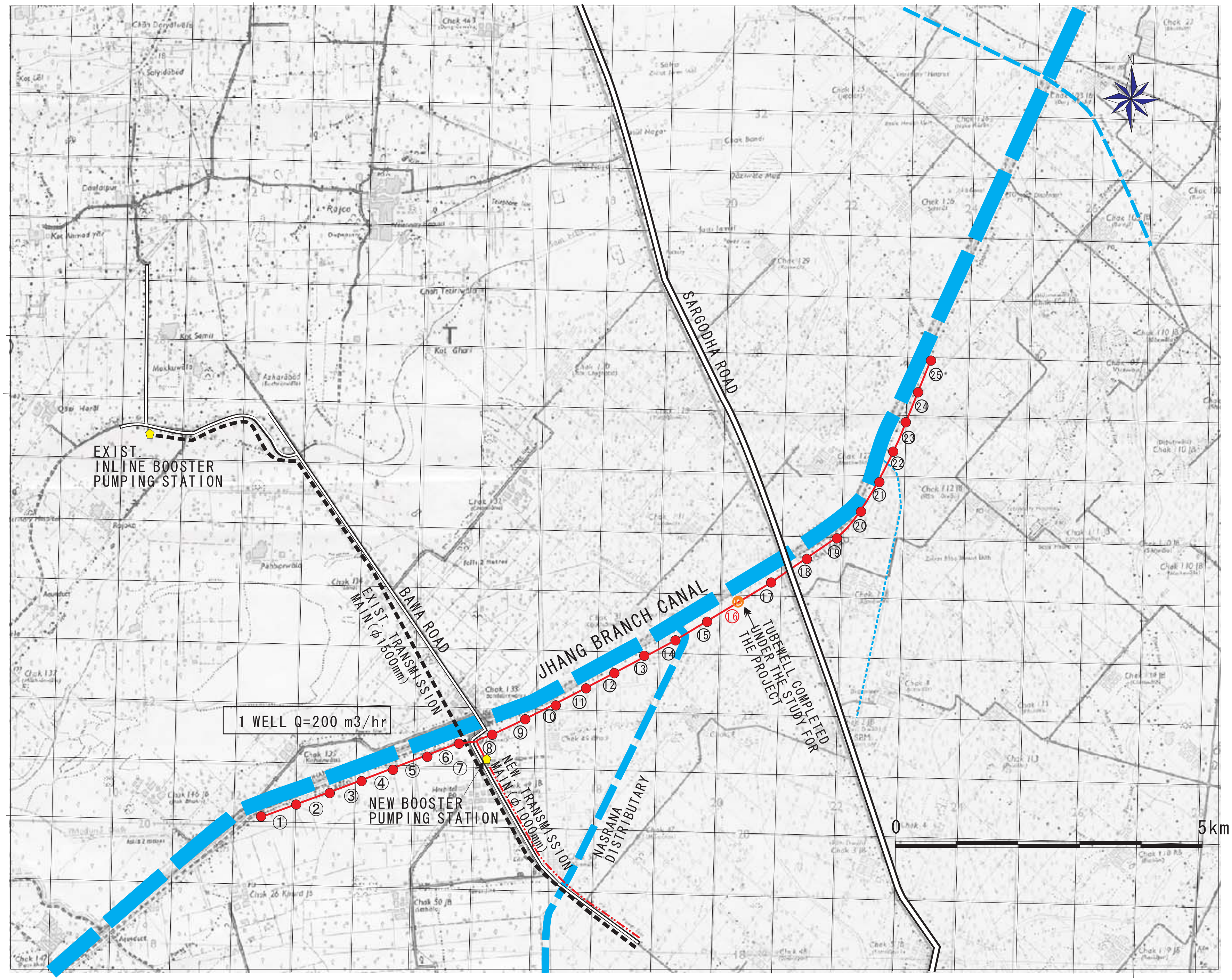
A (water intake area) x V (incoming velocity) = Q (design pumping rate) ($V<15$mm/sec)

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 quality, 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.2-10).

FIG. 2-10 LAYOUT OF TUBEWELLS ALONG JHANG BRANCH CANAL



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 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 runs 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 needs troubleshooting, 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 tubewell station, friction losses in the collector mains, and height difference between the ground levels of the tubewell and the booster pumping 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 Brunch Canal booster pumping station. The loss 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 pumping station. The ground level at the booster pumping 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 pumping station, and the minimum, 30 m for those close to the pumping station. As a result, the pumps are classified into 4 groups differing in the head requirement.

iv. Tubewell station

The main structure of the tubewell station is of reinforced concrete, following the design for the existing tubewell 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 tubewell 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 pumping 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 pumping station. The components of the collector main are listed in the following table 2-15.

Table 2-15 List of Collecting facility

Facility Classification	Type	Quantity	Type of Pipe	Diameter	Length	
Collecting Facility	Collector Main	Total Length 14,620.4m	Ductile Cast Iron Pipe	400 mm	3,704.2m	Total 11,431.0m
				500 mm	3,396.3m	
				600 mm	2,515.9m	
				700 mm	1,814.6m	
			Steel Pipe	900 mm	3,189.4m	Total 3,189.4m

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 diameter 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 pumping station. After chlorination at the station, the water is pumped out by the booster pumps through the transmission main to a planned T/R to be constructed on the premises of the existing T/R in the city. The components of transmission facility are shown in table 2-16.

Table 2-16 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
	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 6000 (1 no.)
				Operation control building and Operator's quarters *to be constructed by the Pakistani side
	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)
				As above (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 0-6,000 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
			Protective 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
	Transmis-sion 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 pumping 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 pumping station is planned as one major component of transmission facility.

iii. Booster Pumping Station

a. Candidate Site for Booster Pumping Station

The construction site for the booster pumping 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 pumping 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. 2-10.)

b. In-station Facilities

The main facilities to be constructed in the premises for the booster pumping station are the following.

* Pump well (4,000 m^3)	1 unit
* Pump station	1 unit
* Chlorinator building	1 unit
* Operation control building	1 unit (Undertaken by the Pakistani side)
* Quarters for operators	2 unit (Undertaken by the Pakistani side)

c. Soil strength of construction site

To examine soil strength of land proposed for the booster pumping station, the standard penetration tests down to 20m were carried at 3 points within the site during the previous 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 shown in table 2-17.

Table 2-17 Soil Strengths of Booster Pumping 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 pumping 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. Pump Station

a. Booster pumps

・The water from the existing tubewells in the Chenab wellfield passes through the collector main, existing in-line booster pumping station and then is transmitted to the final distribution tank (T/R) in the city. The existing booster pumping 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 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 pumping 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 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 pumping 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 pumping station is 91,000m3/day covering the maximum daily flow of tubewells (46,000 m^3/hr for 20 running hours). This rate is delivered with simultaneous operation of 3 units of pumps (with one standby).

b. 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 pumping 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 pumping station site.)
- An injection up to an effective rate of 2.5 ppm for the discharge is targeted as the dosage capacity, and 2 units having 6,000 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 measures

- No serious risk has so far been experienced with the existing chlorination system installed in the in-line booster pumping 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 pumping 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. 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 pumping 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 pumping station in the Chenab wellfield to T/R. The existing line was installed in the ADB's project, 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 pumping 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 pumping station were examined in detail during the previous 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 pumping 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.

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 due to increase of motor output.
・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 pumping 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 two 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 2-18 Comparison between Ductile Pipe and Steel Pipe

		Ductile Pipe	Pakistani Manufactured Steel Pipe
1.Standard		ISO 2531	API, AWWA, DIN, others
2.Size	(1)Thickness(mm)	(1) 13.5	(1) 4-22

	(2)Length (mm)	(2) 6,000/9,000	(2) 12,000
3.Pressure Resistance	(1)Internal Pressure (2)External Pressure	(1)High bending strength to withstand heavy loads (2)Can withstand high pressures over 32bar (straight pipe)	(1)Higher ductility than ductile pipe (straight pipe) (2)Can withstand high pressures over 25bar (straight pipe)
4.Joints	(1)Type (2)Anti-water intrusion (3)Elasticity (4)Detach-proof (5)Applicability to weak foundation	(1) T, K, NS types, all push-on type (2)Water intrusion can be prevented due to sealing with rubber ring (3)Due to elasticity of joint, unreasonable force is not applied to pipe (4)Since T-type pipes are not detach-proof, detach preventive measures for joints are needed where pressures are not uniform. (5)Since joint has elasticity, unreasonable force is not applied. If subsidence is high, quake-proof joint will be used.	(1)Outer V end, inner V end, X end (2)High anti-water intrusion can be obtained if completely welded (3)Since welded joints have no elasticity, elastic bending pipes need to be used (4)Welded joints are highly detach-proof (5)Since joints have no elasticity, unreasonable force is applied. If subsidence is high, elastic pipes need to be installed.
5. Workability	(1)Trenching (2)Hanging Installation (3)Pipe Jointing (4)Backfilling	(1)Hand digging is necessary at points where joints are located. (2)Unit meter weight of pipe is heavier than steel pipe, but since the length is half of Pakistani-made steel pipes, no difference in workability (3)T-shaped pipes can be jointed in short time by using lever blocks and wire ropes Will not be influenced by small amounts of subsurface water and weather conditions (4)Backfilling is basically possible using trenched soil Since backfilling can be done soon after jointing, influence to the surrounding is minimal	(1)Since welding is required, trenching cross section must be larger than that for ductile pipe (2)Same as left (3)Workability is very poor compared to ductile pipes since welding is required, and X-ray inspection is needed. Easily influenced by weather conditions due to welding Since man cannot enter inside pipes of inner diameter less than 800mm, interior welding cannot be made. (4)If trenching soil is not of good quality, outside soil backfilling must be made Since time is required for welding, painting and drying of jointing

			works, backfilling has to be delayed and so, this has great influence to surroundings.
6. Durability	(1)Corrosion resistance (2)Interior anticorrosion (3)Exterior anticorrosion (4)Anticorrosion from stray current	(1) Highly corrosion resistant due to scientific characteristics (2)Since mortar lining or epoxy painting is carried out at the manufacturer's plant, quality is consistent and anticorrosion is applied to joints along with the pipes themselves. (3)Tar epoxy or asphalt vinylon cloth painting is conducted at the plant If necessary, polyethylene sleeve is wrapped (4)Protected from stray current corrosion because joints are electrically insulated by rubber rings.	(1) Highly corrosion resistant if completely welded and painted (2)Same as left, but from a viewpoint of safety, anticorrosion work for joints of inner diameters less than 800mm cannot be done at the site. (3) Tar epoxy or asphalt vinylon cloth painting is conducted at the plant (4)Since joints are welded, pipes are electrically uniform to easily cause stray current corrosion

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 since local products are available in the home market and they can be procured without the high cost of overseas transportation necessary for import of ductile cast iron pipe.

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, over 800mm steel pipe is preferred due to its high merits in the economy and safety 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 700 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 700 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 were required a high level of workmanship in skill and speed. For this part of the works, the cast iron pipe was preferred from technical considerations even for sections of 800 mm and more.

c. Determination of pipe diameters

The maximum supply rate from the booster pumping 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 2-19 Comparison between Pipe Diameters

Nominal 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.

d. Determination of the pipeline route

The transmission main for the project is planned to take the route about 11 km long along Bawa road between the booster pumping 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 pumping 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 pumping station, and 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

a. Concept of the design for the terminal reservoir (T/R) in the project

The discharge from the existing Chenab source flows via the existing booster pumping station into the existing reservoir in T/R located in the outskirts of the northern part of the city and finally water is supplied from the distribution pump station on the premises of T/R to the city through the arterial mains of 1,600m to 500mm in diameter having a total length of 49km. Those existing facilities for distribution were constructed in 1992 under the ADB’s project.

This project plans to transport the discharge of new tubewells in the Jhang Branch Canal wellfield via a new booster pumping station beside the wellfield to a reservoir newly constructed within the same premises of T/R, from which the water will be distributed to the city through the existing arterial mains, combined with the flow from Chenab source.

As a result of the former studies by JICA, the operation of the existing distribution facilities is known to have been under the operation problem of the influence of initial design defects. (The details are described later in (c) and (d) of this section. Since new facilities for distribution are to work jointly with them, measures will be taken to alleviate the influence of such design defects in the existing facilities. One measure was the installation of 600 m long bypass line of 700 to 800 mm diameter ductile iron pipe to the existing arterial main for the purpose of increasing supply pressure in the service area located at the end of trunk main (arterial main). The work was already completed in 2006 during the previous implementation period of the project, and the effect of this line will eventually be confirmed when water supply increases after the completion of this project.

a. Major components of distribution facility

The components of the new distribution facility are shown in table 2-20

Table 2-20 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
	Pump station	1 no.	Structure	Reinforced concrete
			Ancillary equipment	Mobile crane facility 7,500 kg
			Dimensions	36,500 x 15,000
	Distribution pumps, Type (1)	2 nos.	Discharge rate	@31.6m^3/min x 45m x 980 rpm x 330kW
			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
	Distribution pumps Type (2)	3 nos.	Discharge rate	@63.2^3/min x 45m x 980 rpm x 620kW
			Diameter	600mm (suction side) x450mm (discharge side)
			Motor	620 kW, 6P, 3.3 kV, 50 Hz
			Valves for 5 pumps	500/600 mm butterfly valve (suction side, 5 bar, manual)
				500/600 mm swing check valve (10 bar)
				500 mm cone valve (discharge side 10 bar, electrically operated)
				1,200 mm ultrasonic flow meter

c. Terminal reservoir

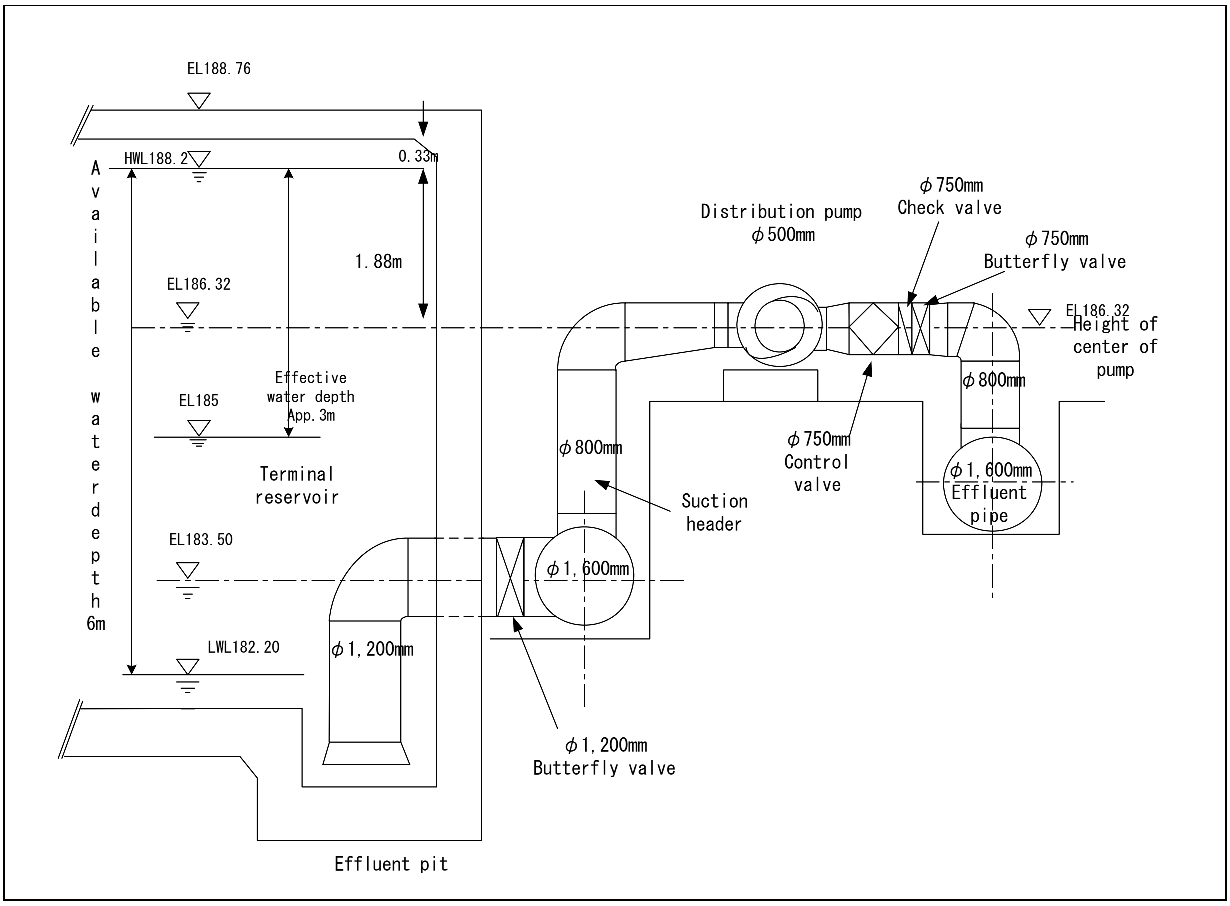
i. Plan by the basic design study in 2003

* Capacity of reservoir

The capacity of the new T/R is designed to have a capacity of 23,000 m^3 to allow storage of a minimum amount of 6 hours of the maximum supply rate for continuous supply. However, since the new and existing facilities at T/R are run in combination, the design requires consideration for the effective operation of both systems.

The existing terminal reservoir receiving the discharge of the Chenab source was designed and constructed for a capacity of 46,000 m^3 with an effective water depth of 6 m. However, as the existing pumps could not pump out its lower half of 3 m, it has been left dead since its commissioning. This malfunctioning derived from the defects in design for pump layout; (1) alignment of pump setting in the station was too high; (2) suction header connecting 7 pumps for parallel operation was too long and complex, resulting in increase of suction head loss. Consequently its effective capacity has been limited to 23,000 m^3. This is the reason the ongoing pump operation for supply has been limited to two hours at maximum. (Refer to Fig. 2-11 for the relation of the levels of the reservoir, suction header and the pumps.)

Fig. 2-11 Relation of Levels of Existing Reservoir and Pumps



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 new 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 to supplement insufficient storage there. 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 5.4 hours of the maximum water supply rate.

* Arrangements for connection of two reservoirs
  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. This measure is anticipated to result in the increase of the effective capacity close to the standard of 6 hours of the maximum water supply rate.

ii. Examination of design by the Implementing Review Study

* Review of design by WASA
  WASA reviewed the design for the new reservoir proposed as a result of the basic design study in 2003, and requested the following modifications.

  --As the capacity of new pumps is small, they will only be used jointly with the existing pumps. (At present, WASA arranges to discharge water in the reservoir by gravity into the arterial mains while the pumps are idle. Although the pressure of gravity flow is limited to 2 to 3 m only, its flow rate amounts to about 4,000 m^3 to 5,000 m^3/hr. Since the capacity of new pumps is 5,700 m^3/hr with 3 units, WASA considered the operation of new pumps only would result in loss of electric power.)

  -- Since the existing pumps will play a main role for distribution even upon completion of the new project, the level of the new reservoir shall be raised so that the existing pumps could pump out of it.

* Conclusion of the study

WASA's request was closely examined under this study. The conclusion was as follows;

- To raise the new reservoir for pumping with the existing pumps is likely to cause the following trouble in operation:
  - ・The connection pipe of two reservoirs functioning as suction pipe for the pumps will become extraordinarily long – about 200 m, generally 50m. It is feared the suction pipe is likely to entrap air leading to pump shutdown.
  - ・There will be great difficulty in controlling water levels of two reservoirs during the operation.

- Due to the technical problems likely to be caused by the different alignments of two reservoirs, WASA's proposal is difficult to employ for the project. Instead the new pumps will be replaced with those having larger capacity to meet WASA's requirement, as examined in detail in the following section.

d. Examination of distribution pumps

i. Plan by the basic design study

* Pump capacity

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

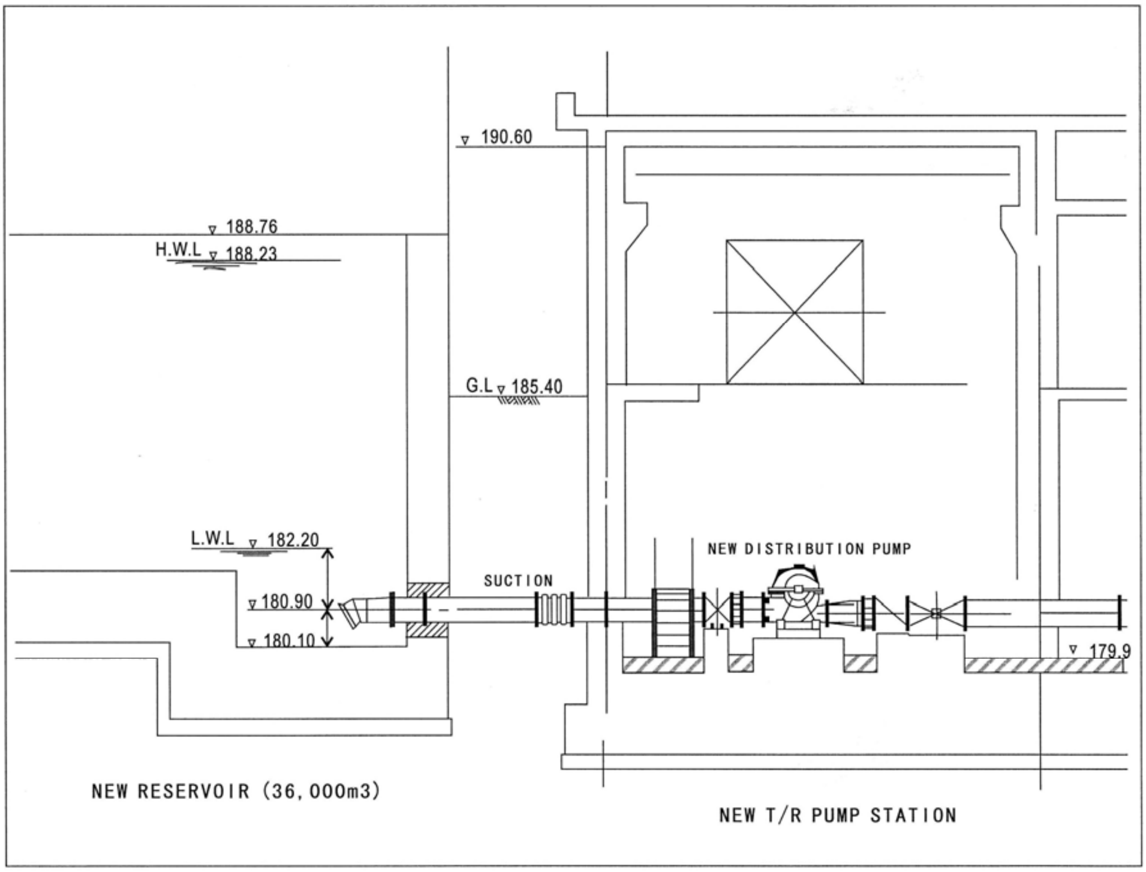
* Type of pumps

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 15 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.

* Alignment of pumps

The alignment of new pumps will be designed to ensure positive suction head by means of installing equipment at a lower level than the low water level of the new reservoir, as illustrated in the typical diagram of Fig. 2-12.

Fig. 2-12 Typical Alignment of New Distribution Pumps



ii. Examination of this study

* Change of pump capacity

According to WASA's request for continuous operation, the capacity of new pumps was modified as follows:

-- Conditions for the determination of pump capacity

- The independent operation of the new pumps can supply the peak hour rate of a minimum 17,000 m^3/hr (peak hour ratio = 1.5).
- The number of units shall be 5 at maximum, since the design of the new pump station has a space for 5 units at maximum (currently 4 including 1 back-up).
- During the Detailed Design Study in 2005, WASA dismantled one of the 7 pumps for inspection, after 15 years of operation since 1992. Internal corrosion due to cavitations was found. At the time of this Implementing Review Study, it was confirmed that WASA had started the repairs of the pumps (1 unit so far). Sufficient capacity for the new pumps should be considered, in case of shutdown of the existing pumps due to deterioration.
- Two types, large and small, shall be selected for the operation of supply rates less than peak hour flows.

As a result of the examination in view of the conditions for the selection, the following two types of pumps are proposed for the new pump station:

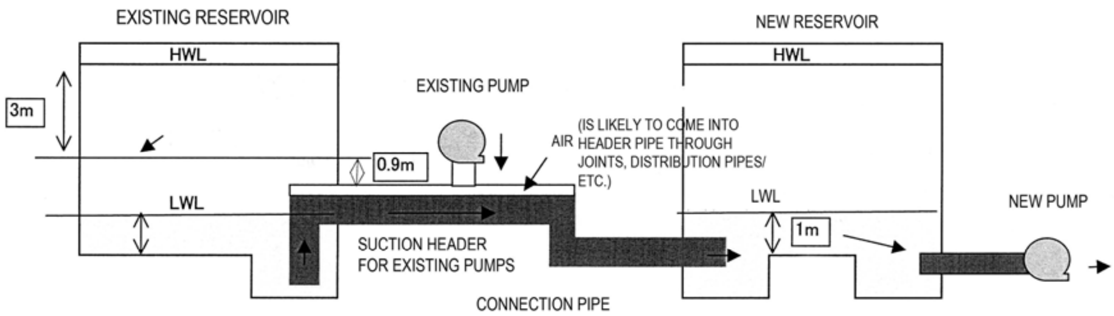
Table 2-21 Condition of New Pumps

	Class	Discharge	Head	No. of units	Remarks
1	Large	63.2 m^3/min (3,792m^3/hr)	45m	3	Double capacity of a small type
2	Small	31.6m^3/min (1,896m^3/hr)	45m	2	Same pump selected by the basic design study

* Examination of connection pipe

The connection pipe of two reservoirs was examined in detail under this study, together with cooperation of WASA. This examination led to a finding that there will be a risk of air entrapment in this pipe when the water level was lowered below the low water level for ongoing operation of the existing pumps (lower than 182.5m in Fig.2-11), as illustrated in the diagram in Fig.2-13. As a result, the connection pipe will not be able to be used as suction pipe, but as a simple connection pipe for water level control.

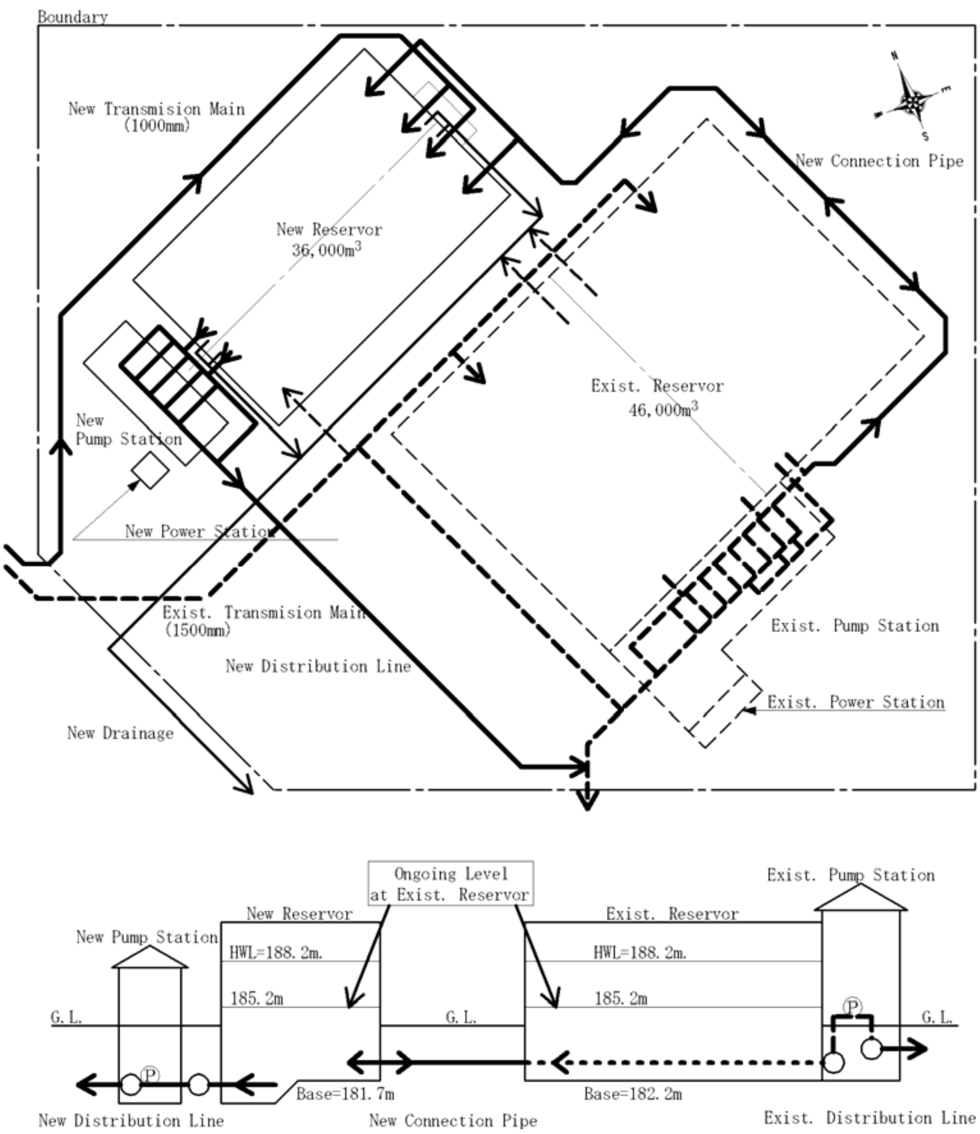
Fig. 2-13 Air Entrapment Risk in Connector Pipe



However, the lower half of the new reservoir will be able to be pumped with the new pumps by closing the connector pipe with a motorized control valve without difficulty

The alignment of facilities at T/R thus determined under this study is illustrated in Fig.2-14.

Fig. 2-14 This study's Designs for the Alignments of Facilities at T/R



iii. Pump operation plan for the project

Upon completion of the project, the operation of pumps for water supplying to the city is planned as follows:

-- Peak hour flow

It is empirically known that the peak hour flow ranges from 1.5 to 2 times of the hourly average of the daily maximum. In case of WASA's operation, the present study came across a record peak flow of 18,000 m^3/hr corresponding to the peak factor of 2.16. Such a high rate of peak factor indicates the concentration of consumption when the intermittent supply was resumed. Since the trend of citizen's consumption pattern is yet unknown under the ongoing practice of restricted time supply, this study assumes the largest consumption experienced in actual supply, 180,000 m^3/hr as an indicator for the future supply, which corresponds to a peak factor of 1.6 against the daily maximum of 271,000 m^3/day.

-- Water supply simulation for assumed consumption patterns

This study presents the results of simulation of pump operation, assuming several consumption patterns as follows:

Case (1) Assumptions:

- The peak time comes three times a day.
- The peak time continues from 2 to 3 hours each time.
- The peak supply rate is 18,000m^3/hr in the average.
- Between the peak times, a lower rate of supply continues (average 11,000 m^3/hr)

Case (2) Assumptions

- A large consumption continues during the daytime.
- The supply responds to such a demand pattern with the continuous feed of the peak flow of 18,000 m^3/hr in average, unless the water level drops down at the LWL. of the reservoirs.

The results of simulation of these two cases are plotted in the graphs in Fig.2-15. The characteristic features of the two cases are described as follows:

* Case (1) is one of the typical continued supply patterns in which the pump operation responds to the peak times of the day. If large demands in a range similar to those at the peak times continue for a greater part of the day, however, this pattern will not be able to be applied.
* In Case (1), the ongoing practice of providing gravity flow may be employed during a low-demand time zone at midnight in line with WASA's policy to save energy cost.
* Case (2) shows the operation of continued supply of peak hour flows at the average rate of 18,000 m^3/hr. Due to the constraints of the water level problem at the existing reservoir and the limit of discharges from the sources, it is difficult to continue such operation for the whole day. According to the simulation, the total service hours at this rate will become 14 hours a day (double of the ongoing practice), but the operation must be interrupted during its course twice a day to restore the water level in the reservoirs.

-- Necessary arrangements

* The peak hour flows will be supplied with 6 existing pumps and two to three new pumps. The optimum selection of numbers of units and models will be confirmed during the test operation of pumps in the final stage of the construction work.
* During the rest of time of the day when demand is relatively low, the new pumps will be

run as they are equipped with valves controlling occurrence of cavaitation.

* Regarding supply pressure, there is a low pressure zone in the east side service area located at the end of long arterial mains where residents have long been suffering from the shortages of water. Since the difficulty was unlikely be alleviated even after the completion of this project due to the problem in the initial design of trunk mains, a bypass line to reinforce the arterial mains was planned during the basic design study in 2003 and was installed by March 2006 during the previous implementation period for Phase 1.

  WASA estimated a necessary supply pressure through the trunk main in this zone at about 10m at minimum. According to the results of the study, the delivery pressure of pumps at T/R was required to be in the range of 40 m to meet WASA's requirement. It is difficult, however, to predict it precisely in the future, since it will always change in tune with fluctuation of actual consumption with time. The optimum method for supply with pumps will, therefore, be determined during the test operation in the final stage of the construction, taking supply pressure into due consideration.

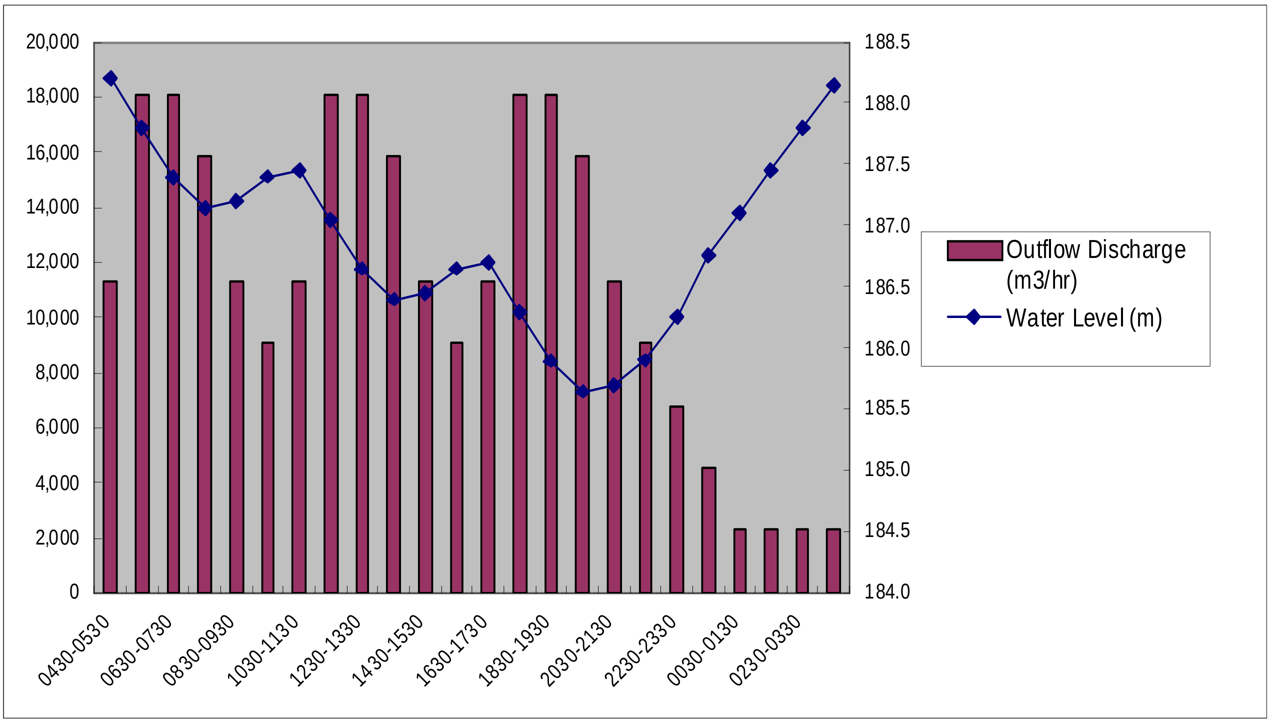
* The distribution plans introduced so far are all based upon the supply side conditions. As a matter of fact, demand of citizens is most likely to exceed the range of available water. The operation to meet such a larger demand than planned may result in damage in pumps/valves/pipelines due to cavitation, as experienced by the existing facilities. In order to protect the pumps at least, special corn type control valves will be equipped with the new pumps.

* Measures for improving the distribution practice under this project include:

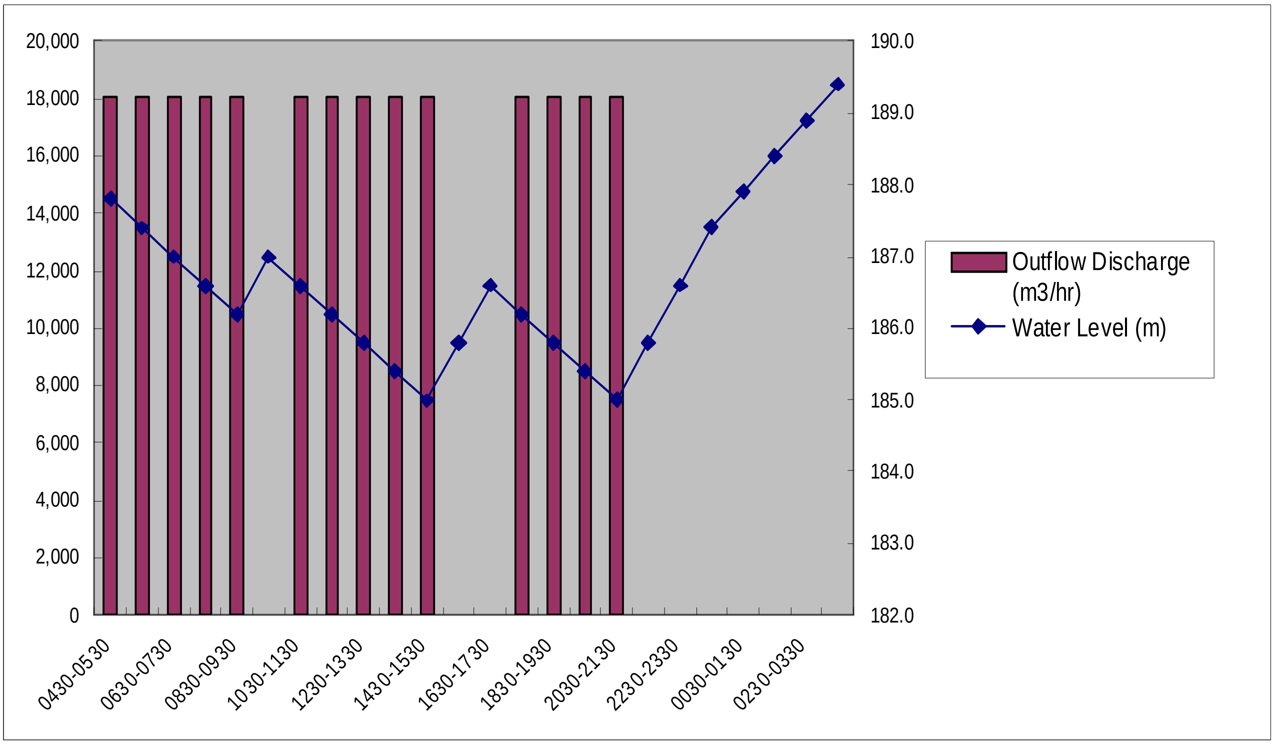
  - increase of storage capacity at T/R
  - provision of connection pipe of new/existing reservoirs
  - selection of new pumps suitable for joint operation with the existing ones
  - protection of new pumps against cavitation
  - installation of a bypass line to existing arterial mains

Fig.2-15 Result of Water supply simulation

Case (1) Typical ordinary consumption patter with peak supply 3 times a day



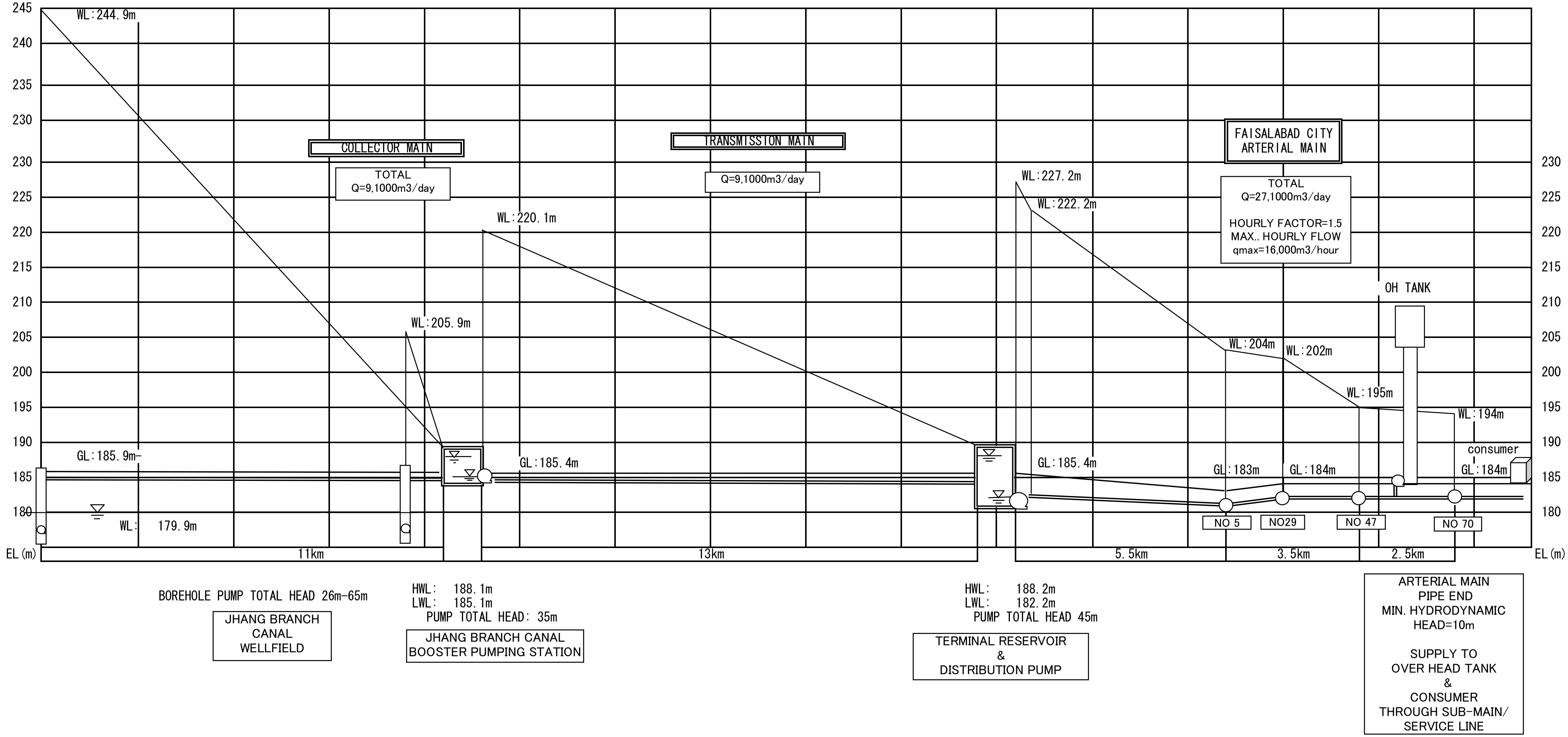
Case (2) Supply with constant peak flow rate at 18,000m^3/hr in average



Despite such measures, the actual operation depends largely upon the trend in citizen's trend in consumption. The optimum operation, therefore, will be concluded during the test operation which is planned to continue at least for one month.

For reference in the planning of water facilities in this project, the hydraulic grade line from the water sources to T/R is illustrated in Fig.2-16.

Fig.2-16
HYDRAULIC PROFILE OF JHANG BRANCH CANAL
WATER SYSTEM TO FAISARABAD CITY



2-2-2-4 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 included 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 contents of the request for the procurement were examined through the discussions with WASA during the preceding basic design study. Based upon the conclusion of the study, the equipment was supplied to WASA in the previous implementation period of Phase 1.

Further the conditions of equipment thus procured were confirmed through the follow-up inspection of the completed works after one year from the date of completion (April, 2007). The inspection team reported all the procured equipment and materials were being effectively utilized by WASA.

The procured equipment and materials are listed in the following table 2-22:

Table2-22 List of Equipment Procured under the Project

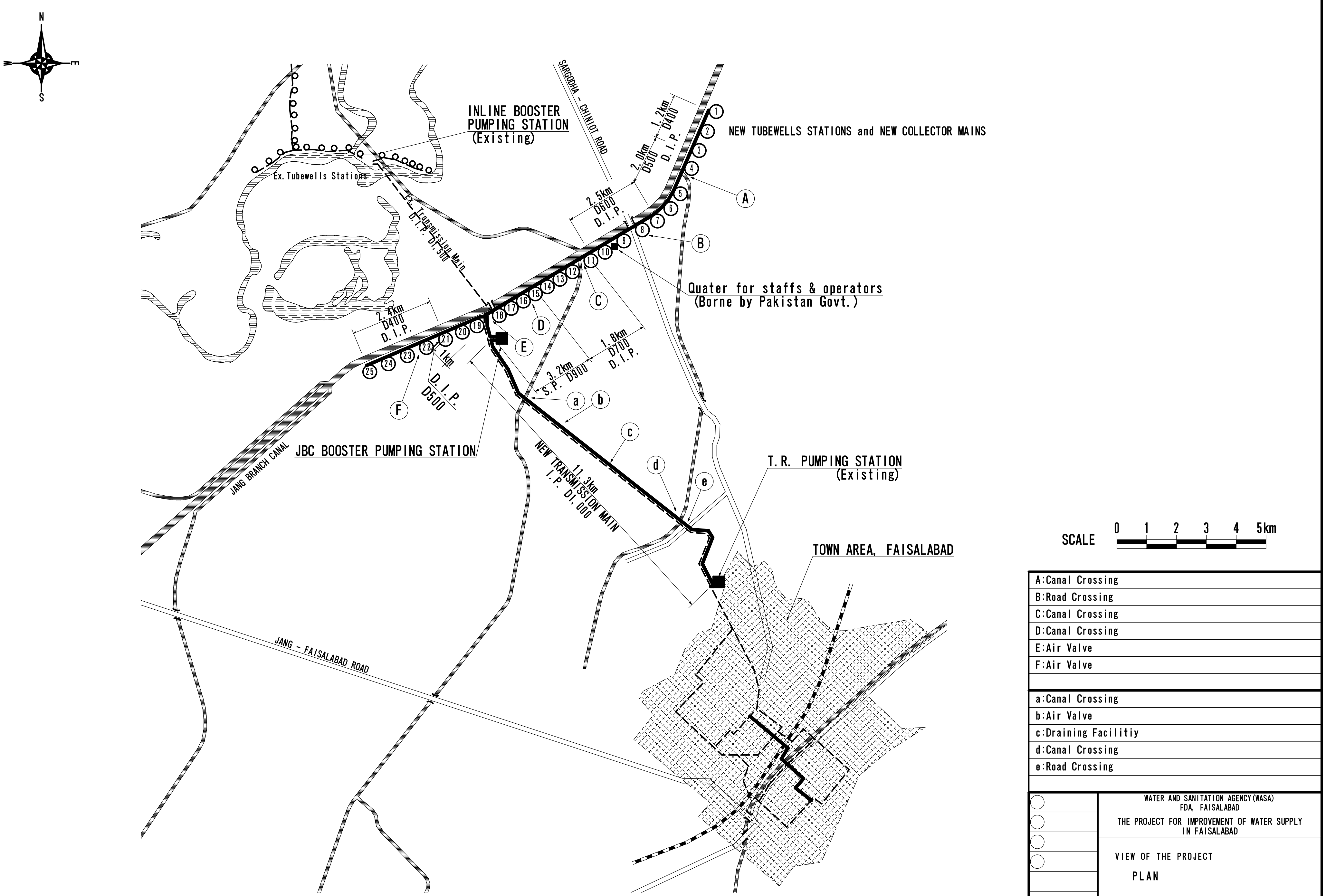
	Equipment	Q'ty	Specifications	Purpose
1	Water level meter	12	Battery driven, potable type Measurement depth: 50m	For monitoring plan of groundwater level
2	Water analysis equipment	1	a. Photo-spectral type including reagents for analysis	For testing use by WASA's laboratory
		2	b. Potable TDS meter	For monitoring of quality
		2	c. Potable EC/pH meter	For monitoring of quality
3	Equipment to monitor distribution	1	a. Ultra-sonic flow meter	For monitoring distribution system
		2	b. Automatic pressure recorder	
		2	c. Leakage sound detector	For detecting leakage
4	Voice communi-cation system	1	Frequency zone VHF Effective distance 5～30km Power source: commercial power Locations for installation a. WASA headquarters: fixed type x 1 unit b. Terminal reservoir: fixed type x 1 unit c. Jhang B. Canal booster pumping station: fixed type x 1 unit d. Tubewell Operators: potable type x 15 nos. e. Existing inline booster pumping station: fixed type x 1 unit	For communication between the respective facilities and the headquarters and for directions from headquarters

			Distance between units a→b about 5km b→c about 13km c→d 3km to 12km d→e about 5km	

2-2-3 Basic Design Drawing

The basic design drawings are shown in the following pages.

BASIC DESIGN DRAWING



A:Canal Crossing
B:Road Crossing
C:Canal Crossing
D:Canal Crossing
E:Air Valve
F:Air Valve

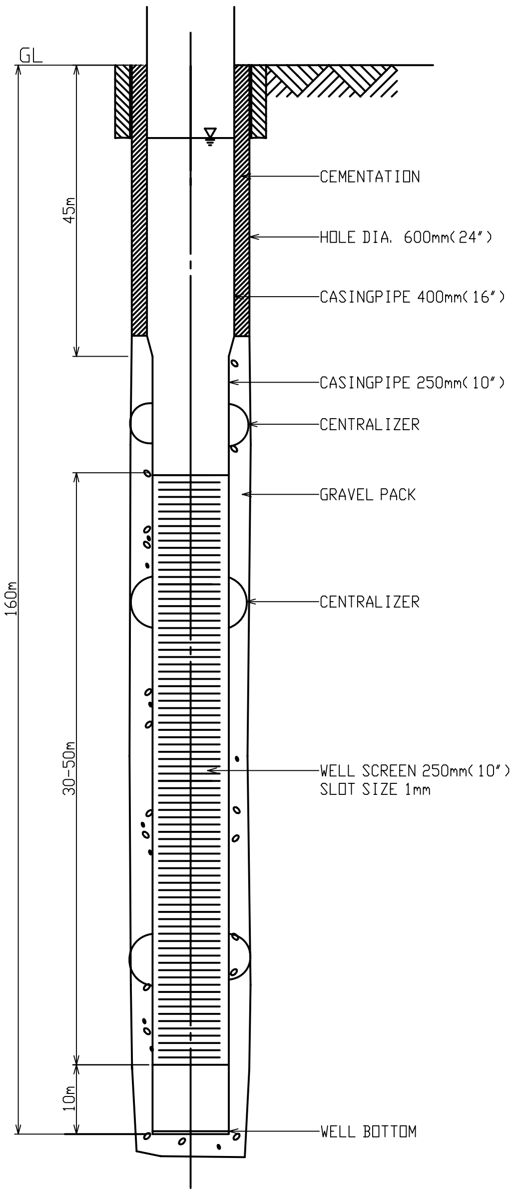
a:Canal Crossing
b:Air Valve
c:Draining Facilitiy
d:Canal Crossing
e:Road Crossing

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

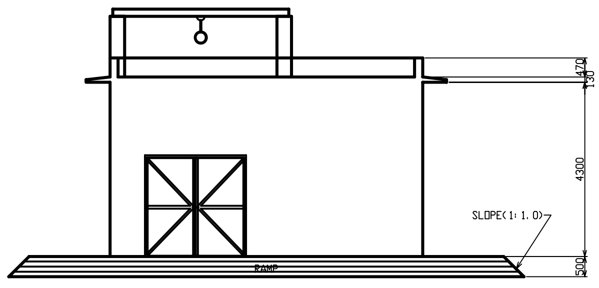
VIEW OF THE PROJECT
PLAN

JAT JAPAN TECHNO

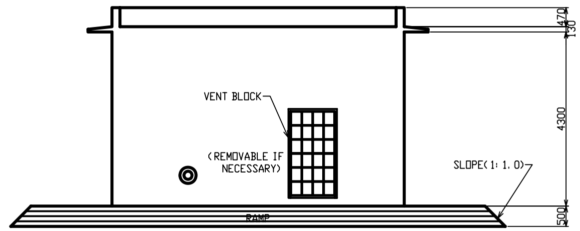
TUBEWELL



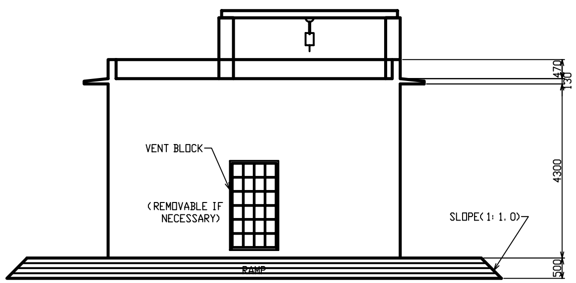
PUMPHOUSE



PUMPHOUSE
(ELEVATION-1)



PUMPHOUSE
(ELEVATION-2)

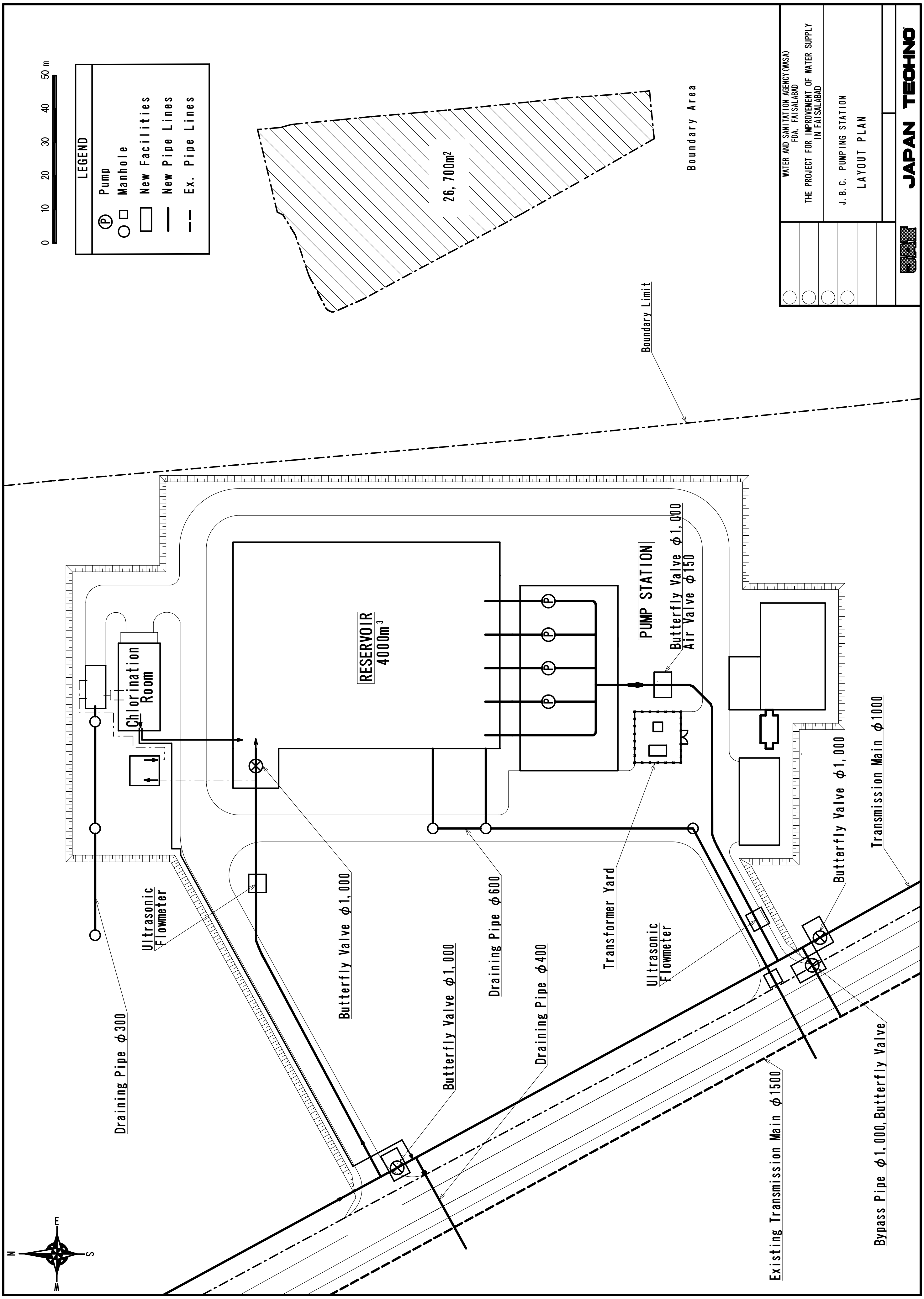


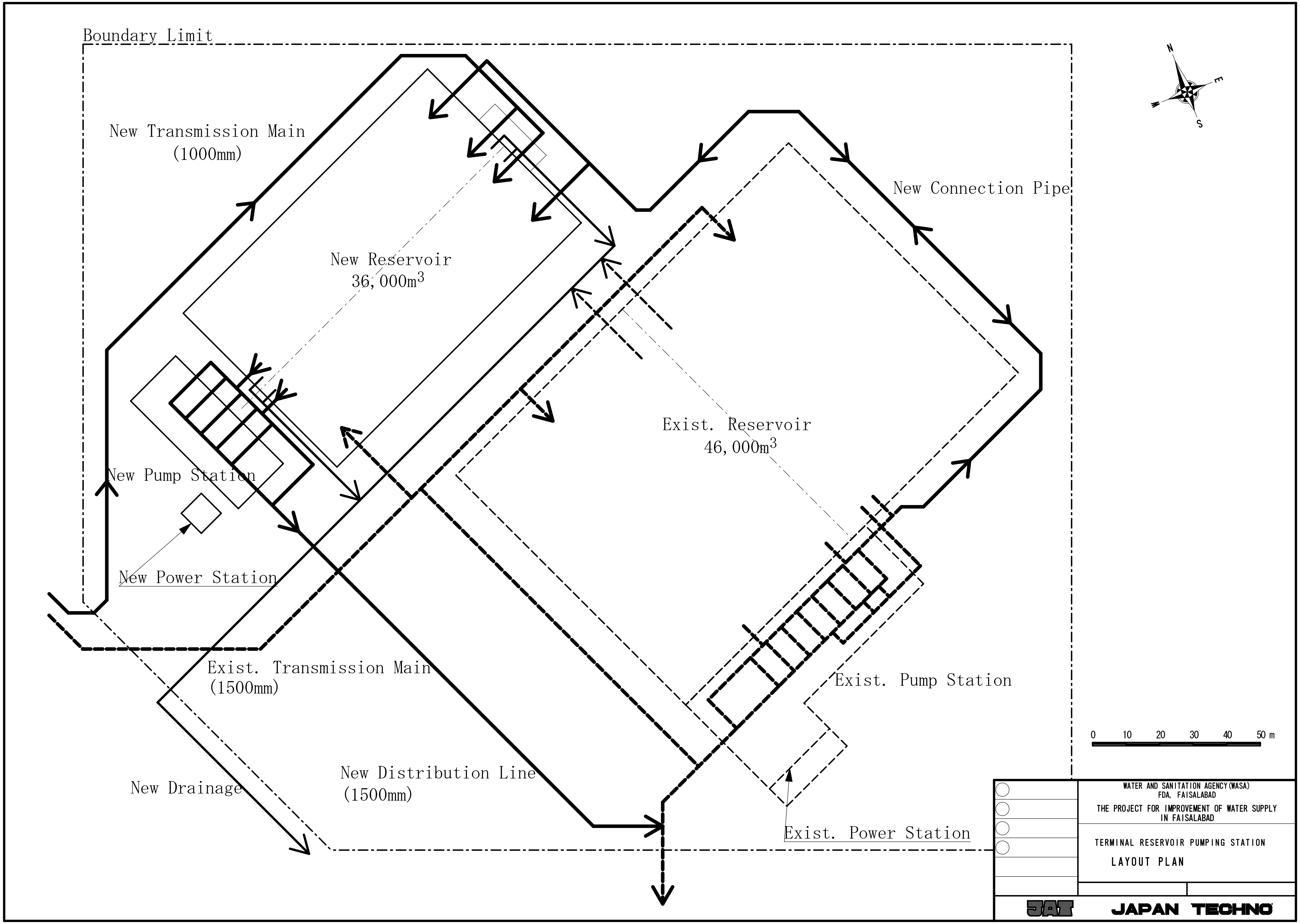
PUMPHOUSE
(ELEVATION-3)

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

TUBEWELL STATION
TUBEWELL / PUMPHOUSE
ELEVATION

JAPAN TECHNO


WATER AND SANITATION AGENCY(WASA) FDA, FAISALABAD
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY IN FAISALABAD
J.B.C. PUMPING STATION
LAYOUT PLAN
JAPAN TECHNO
LEGEND
Pump
Manhole
New Facilities
New Pipe Lines
Ex. Pipe Lines
0 10 20 30 40 50 m
26,700m²
Boundary Area
Boundary Limit
RESERVOIR 4000m³
PUMP STATION
Chlorination Room
Butterfly Valve φ1,000
Air Valve φ150
Transmission Main φ1000
Butterfly Valve φ1,000
Ultrasonic Flowmeter
Transformer Yard
Draining Pipe φ400
Draining Pipe φ600
Butterfly Valve φ1,000
Butterfly Valve φ1,000
Ultrasonic Flowmeter
Draining Pipe φ300
Existing Transmission Main φ1500
Bypass Pipe φ1,000, Butterfly Valve
E
N
S
W


Boundary Limit
New Transmission Main
(1000mm)
New Reservoir
36,000m³
New Connection Pipe
Exist. Reservoir
46,000m³
New Pump Station
New Power Station
Exist. Transmission Main
(1500mm)
New Distribution Line
(1500mm)
New Drainage
Exist. Pump Station
Exist. Power Station
N
E
S
W
0 10 20 30 40 50 m
WATER AND SANITATION AGENCY(WASA)
FDA, FAISALABAD
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
IN FAISALABAD
TERMINAL RESERVOIR PUMPING STATION
LAYOUT PLAN
JAPAN TECHNO

2-2-4 Implementation Plan

2-2-4-1 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.

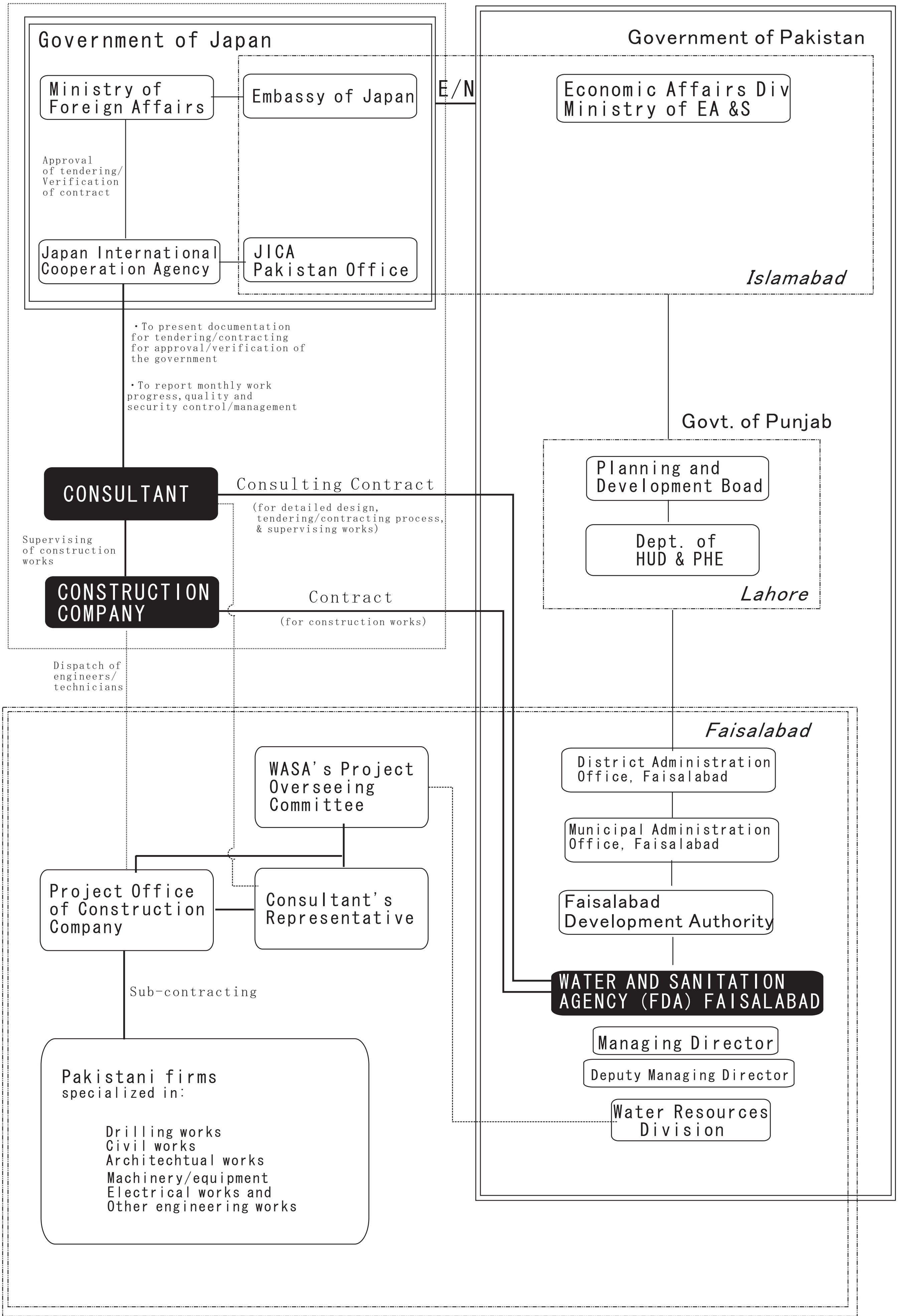
Under Japan's grant aid scheme, the construction work will be undertaken by a Japanese firm(s) as prime contractor under supervision of a Japanese consultant. This project will be divided into two parts, the main portion for the augmentation of water supply and the other smaller in scale for the improvement 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.

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 pumping station beside the canal, (b) installation of the 1,000 mm diameter transmission main about 11.3 km long along Bawa road from the booster pumping station to the terminal reservoir in the city and (c) construction of a new terminal reservoir and a pumping station on the premises of the existing terminal reservoir(T/R). 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

Fig. 2-17 STRUCTURE FOR PROJECT IMPLEMENTATION



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 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.

2-2-4-2 Implementation Condition

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.

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

(1) 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 1 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.

(2) 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 pumping 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 likely to occur in the excavation and pipe burying works should carefully be taken.

3) Connection with the existing pipes

In this project, connection with large diameter pipes will be needed at the T/R. In order to avoid working during the peak water supply hours, the connection works must be done during night-time, which is normally the time when water supply is stopped. The functioning of some of the existing valves was tested during this study and it was confirmed they opened and closed smoothly. The best positions for connections, the opening and closing of the valves and drainage method need to be confirmed during the construction works.

4) 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.

2-2-4-3 Scope of Works

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 2-23:

Table2-23 Major Undertakings by the Respective Countries

	Japan	Pakistan
(1) Water source /intake facilities	Tubewells/Tubewell 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 f. 1 operation quarter
(2) Collecting facility	Collecting main 400 to 900mm x 14.6km	a. Land acquisition b. Site preparation
(3) Transmission facility	a. Booster pumping station * 1 Pump station building (pumping units 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 11.3km	a. Land acquisition b. Site preparation c. Primary high-voltage 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 g. 1 operation quarter
(4) Distribution facility	a. Terminal reservoir: 1 no. b. Terminal pump station: 1 no. (pumping units and secondary power and control system, generator)	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. c. 1 operation quarter
(5) Improvement of existing network	Supplementary sections to existing arterial mains, 700 to 800 mm diameter x 6 km (Completed in Phase 1 of preceding Project)	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	(Completed in Phase 1 of preceding Project)
(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, 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, and appropriate budget allocation will be needed.

For the road for access to the 25 tubewells, it has been decided on metal paving of public roads, and WASA has already started the construction of more than 15km.

The 1,000 mm diameter transmission main is planned along the public road from the booster pumping 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 pumping stations which will be under the responsibility of the Pakistani side. 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 Water and Power Development Authority (hereinafter called as 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 pumping 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 pumping station, through the negotiation with FESCO (Faisalabad Electric Supply Company) established by the WAPDA. Such arrangements will ensure the constant supply to each station, and the extension works are less expensive.

2-2-4-4 Consultant Supervision

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: 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. Normally the first stage will be to make an implementation design, but since the detailed design has already been prepared in the preceding project, this process will be omitted in this Project. Any modification to be made on the specification will be incorporated as part of the preparation of tender documents.

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.

2-2-4-5 Quality Control Plan

At the beginning stage of construction, the locally employed supervisors will be trained to establish a quality control system. Throughout the construction period, quality control is carried out with the local supervisors trained under the guidance of the Japanese full-time supervisor. Also, as records of work progress and quality control, photos shall be taken and compiled. Photos shall be taken for all work divisions and especially, for important work portions which cannot be observed after completion of works, additional photos from various angles will be taken.
See Table 2-24 for a summary of methods for quality control of each work.

Table 2-24 Quality Control Method

Inspection Items		Method	Frequency
1) Earthwork			
For Reservoir	Bearing stratum	Loading test	1 pt/structure
	Ground elevation	Level measurement	4 pt/structure
For Building structure	Ground elevation	Level measurement	4 pt/structure
Trench excavation	Dimension	Scale measurement	Per 100m
Backfilling	Depth of cover Compaction	Visual check Scale measurement	Per 100m
2) Tubewell drilling work			
Drilling	Diameter of drilling bit Drilling depth Vertical alignment	Scale measurement	Each tubewell
Casing installation	Screen depth Verticality Quality of connection	Scale measurement Plumb bob mesurement Visual check	All joint
Gravel packing	Quantity	Quantity measurement	Each tubewell
Pumping test	Water discharge	Orifice meter or triangular weir	Each tubewell
Water quarity test	24 items	Official laboratory	Each tubewell
3) Mechanical and Electrical work			
Tubewell pump installation	Setting depth of pump Wiring connection status Riserpipe jointing status	Scale measurement Visual check	Each tubewell
Pumping equipment	Operating condition	Extensive testing for all operation	
Wiring and lighting	Wiring status Electrical panels setting status Lighting status	Scale measurement Visual check	Each building
	Power distribution status	Cable size Connection strength Switch on / off	Each building
	Insulation resistance	by 500V Megatester	Each building
4)Pipeline installation			
Installation	Laying Jointing Welding (steel pipe) Painting (steel pipe)	Visual check X-ray inspections at welding condition	As needed Min. 10 % of all welding joints
Pressure test	Leacage	Specified pressure, 2.0 / 1.6 / 1.2 / 0.9 MPa in 1hour	300 to 500 m each
5) Concrete Work			
Reinforcement	Quantity Assembly accuracy Fixation Position/Jointting process Spacer setting status	Millsheet Tensile strength test Scale measurement Visual check	Before casting
Formwork	Reference level Width Hight Length Displacement of centerline Span length Timbering setting Tightening status	Photogrammetric instruments Visual check	Before casting

Inspection Items		Method	Frequency
Mixing	Slump Air content Mixing ratio of WCSG Temperature of concrete Chloride quantity	Visual check Various test (by tnstruments)	Trial mixing Each concrete batch
Casting/Curing	Casting method Placing joint Tamping Curing method	Visual check Casting duration Palpate test	Before casting As needed while casting
Finishing	Member position Workmanship	Visual check Photogrammetric instruments	Formwork removal timing
	Compressive strength	Compressive strength test	7 and 28 days after casting
Structure	Reference level Thickness Width Hight Length Displacement of centerline Span length	Photogrammetric instruments	Each structure
6) Building work			
Masonry	Workmanship	Visual check	Each Building
Plastering	Workmanship	Visual check	Each Building
Painting	Workmanship	Visual check	Each Building
Roofing	Workmanship	Visual check	Each Building
Joiner's work	Workmanship	Visual check	Each Building

2-2-4-6 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 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.

The stainless steel wire-wound screen will be procured from Japan or any third country. 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, 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. The features of this product will be described in the next paragraph.

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

Table2-25 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

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 is imported from abroad. The highest class of cast iron pipe is manufactured in Japan and France. In the preceding ADB project Phase 1, the ductile cast iron pipes of Japanese make (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. 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 the procurement of pipe fittings can be unreliable. 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. Table2-26 shows the comparison of Pakistan-made steel pipes with corrosion-resistant coating as a result of the survey of local manufacturers.

Table2-26 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 in table 2-27:

Table2-27 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 and pumping station. 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 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.

Table2-28 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 as 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 pumping 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 the type of foreign-made pumps.

6) Electric equipment/materials

The electric power is supplied by the state-owned 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 is 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 Table2-29 below.

Table2-29 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 Europe, Japan 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.

2-2-4-7 Initial Operation Guidance Plan

Since the technical level for the operation of the new facilities is the same as that for the existing facilities, the operation can be managed with the present technical level of WASA. However, since the tendency of water consumption after the increase in the supply rate is unknown until service actually starts, the optimum operation settings can be determined during the test operation period of about 1 month. During the test operation period, by giving guidance on operation, the optimum operation conditions will be finally decided.

2-2-4-8 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 contract between the executing agency and the Japanese contractor
Step 7 Construction work by the contractor under supervision of the consultant
Step 8 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. (The preceding implementation of this project was divided into two phases, and Phase 1 for construction of reinforcement of the existing network was executed under this scheme.)

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 three year, with one year period set as "Term".

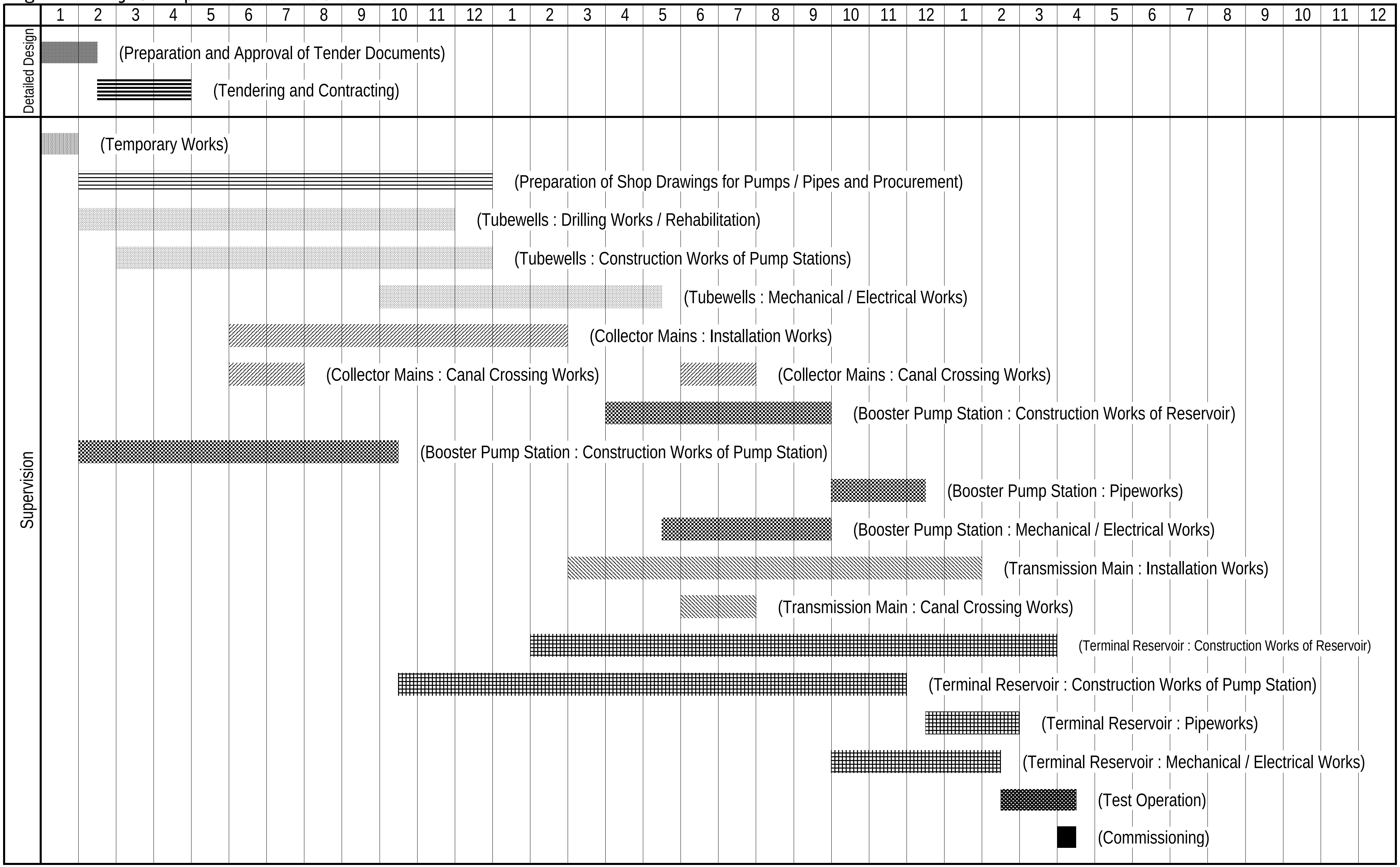
c. As a result of the examination of implementation method, therefore, it is planned to divide the entire Project into three terms (3 fiscal years of Japan).

* E/N (for the entire period of implementation)
* Consulting agreement between the executing agency and the Japanese consultant
* (Detailed design study)
* Preparation of tender documents
* Tendering
* Contracting between the executing agency and the Japanese contractor
* Commencement of construction works
* Completion

As the detailed design has been completed in the preceding project, an on-site study will not be conducted for this project. The modifications will be included in the preparation of the tender documents.

d. The implementation period will be 3 years to complete the entire works for this project.
The diagram of the work schedule is shown in Fig.2-18.

Fig.2-18 Project Implementation Schdule



2-3 Obligations of Recipient Country

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.

The project will be completed in 3 years. The government of Japan will provide assistance with grant aid for construction works, and the government of Pakistan must implement the works shown in the following table 2-30.

Table2-30 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	80.00	172.00	* Installation of high voltage primary power supply system of 11 kV capacity with step-down transformers to 400V for 25 units of tubewell stations * Installation of high voltage primary power supply system of 11kV for the booster pumping station and the terminal reservoir.

2	Land acquisition	10.94	23.52	* 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 purchased.
3	Site clearance and ground leveling	0.90	1.94	Required for the wellfield and booster pumping station.
4	Road construction	80.00	172.00	Connecting road for access to the tubewells and booster pumping station about 20 km in total length, and rehabilitation of part of public road along the Jhang Branch Canal
5	Installation of enclosures (fences and gates	8.00	17.20	Required for the 25 tubewell stations and the booster pumping station in the Jhang Branch Canal area
6	Procurement of furniture, fixtures, office equipment and others	8.00	17.20	Required for the booster pumping station and the terminal reservoir
7	Site preparation cost for premises of the booster pumping station	6.00	12.90	Required for the construction of the road on the premises, gardening, lighting, security measures and others for the booster pumping station along the Jhang Branch Canal
8	Project supervision cost	48.00	103.20	Required for project management and supervision committee established by WASA
9	Procurement of vehicles for supervision	6.00	12.90	Required for WASA's supervisors of the project
10	Construction of residence	30.00	64.50	Housing for new WASA's staff for new water supply facilities
11	Public relations expenses	2.50	5.38	Expenses for public relation activities for the urban and rural residents
12	Compensation for rural residents	60.00	129.00	Required with environmental improvement of drainage, road and others in return for water sources development
13	Banking commission on payment of foreign currency	36.47	78.41	Includes commission of the domestic banks, as well as the Japanese banks
14	Others	15.00	32.25	
15	Operation quarters	12.22	26.27	Required for the tubewell stations, the booster pumping station and the terminal reservoir pumping station(total 3 units)
	Total	404.03	868.67	

As shown in the above table, the cost to be borne by the Pakistani side is estimated at about 404.03 million Pakistan rupees, which is equivalent to about 868.67 million yen, of which the costs for installation of primary power supply system, road construction and compensation package for rural residents account for a large share. The Punjab government will secure the budget from the Annual Development Programme, a part of which have already been disbursed since 2005 when the preceding implementation for Phase started. The Pakistani side considers the initial approval of PC-1 by ECNEC are still effective since the prior project started, so the budget applied by WASA will be approved by the provincial parliament and be secured in the first fiscal year, after signing of the Exchange of Notes. On the other hand, the procedure for the revision of PC-1 due to the budget increase, will be processed by the Pakistani side if it is necessary.

2-4 Project Operation Plan

The planned water supply system and its components are similar to those of the existing Chenab system constructed under 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 pumping station and the terminal reservoir

(2) Personnel plan

Table2-31 Personnel plan for the new facilities

	Job type	25 tubewells	1 booster pumping station	1 terminal reservoir pumping station(T/R)
		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	Chief Technical manager	-	1	Manager of the existing T/R
2	Technical manager	-	1	-
3	Work supervisor (in charge of electricity and machines)	1	1	Staff in charge of the existing facility at T/R
4.	Chlorinator manager	-	1	ditto
5	Electrician	1	1	ditto
6	Mechanic	1	1	ditto
7	Plumber	1	1	ditto
8	Driver	1	1	ditto
9	Warehouse worker	-	2	ditto
10	Operator	90	14	11
11	Security guard	3	3	Staff working at the existing facility at T/R
12	Watchman	-	4	4
13	Radio communication staff	1	2	Staff working at the existing facility at T/R

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

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 tubewell 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 basic 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 stations, booster pumping 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 the ADB 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, 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 a normal operation and maintenance system.

The following table 2-32 summarizes the power supply installations and allocation of responsibilities.

Table2-32 Classification of Required Power Facilities

	Facility name	Loads of main equipment	To be borne by the Pakistani side	To be borne by the Japanese side
1	25 tubewell 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 tubewell stations	Secondary power feed including the power switch boards inside the tubewell stations
2	Booster pumping 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 for lighting, etc : 230 V x approximately 6 kW in total	11 kV power lead-in at the primary side	11 kV high-voltage incoming panel, 11kV/3.3kV transformers and 3.3 kV and 400 V switch boards inside the pump station
3	Terminal reservoir pumping station	1) 3 nos. of distribution pumps: 3.3 kV x 630 kW and 2 nos. of distribution pumps: 3.3 kV x 330kW 2) Ancillary equipment: 400 V x approximately 12 kW 3) Single phase equipment for lighting, etc.: 230 V x approximately 6 kW in total	11 kV power lead-in at the primary side	11 kV high-voltage 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.

(3) 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.

3) 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.

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 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.

The changeover to the metered system has been considered by WASA under the strong direction of the provincial government under the NDWP, and actually the metered system was adopted in a model service area in 2006. With endorsement of the FDA as a overseeing organization, WASA decided to expand stepwise adoption of the metered system for other areas, and 2 areas were selected as candidates. In 2007, water meterss for commercial and domestic use were procured with the budget of approximately Rs 3 million (JP6 million) as a measure to promote this policy. Therefore, the implementation of the project will provide a good momentum to trigger the changeover to the metered system, and WASA will enforce a policy to obligate prospective new clients to install a water meter.

On the other hand, 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. Under the direction the of P&D of the provincial government, the following measures are recently being taken by WASA.

(1) Private sector participation (PSP)

In order to improve an inefficient official collection system, the collection service by the private sector is under plan. As a matter of fact, WASA held a briefing for candidates shortlisted from interested companies which are recruited by press advertising in 2007. A conclusion has not yet been reached, but the future move of this effort must be closely watched.

(2) Mandatory disconnection

As a sanction against nonpayment clients, “Disconnection Campaign” was established and is in practice, which is to cut off service pipe and disconnect it, and as a result, 473 cases against vicious clients were confirmed from February to June of 2007. This policy is now supported by the city of Faisalabad.

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 Cost to be borne by the Pakistani side

Table2-33 Cost to be borne by the Pakistani side

	Description	Basic Design Study		Implementing Review Study	
		Million Rs	Million ¥ (approx.) 1Rs=JY2.19	Million Rs	Million ¥ (approx.) 1Rs=JY2.15
1.	Primary power supply	35.83	78.47	80.00	172.00
2.	Land acquisition	10.94	23.96	10.94	23.52
3.	Site clearance	0.90	1.97	0.90	1.94
4.	Road construction	101.69	222.70	80.00	172.00
5.	Installation of Enclosures	6.12	13.40	8.00	17.20
6.	Procurement of Equipment in pump station	11.44	25.05	8.00	17.20
7.	Site Preparation of premises for the booster pumping station	6.12	13.40	6.00	12.90
8.	Project Supervision	48.00	105.12	48.00	103.20
9.	Vehicles for supervision	5.50	12.05	6.00	12.90
10.	Construction of residence	21.46	47.00	30.00	64.50
11.	Public relations	2.50	5.45	2.50	5.38
12.	Compensation for residence	—	—	60.00	129.00
13.	Banking commission	—	—	36.47	78.41
14.	Others	—	—	15.00	32.25
15.	Construction of three (3) Operator's Quarters, etc.	—	—	12.22	26.27
	Total	250.50	548.57	404.03	868.67
	Balance			+153.53	+320.10

The Cost to be borne by the Pakistani side increased about 153 million Rs (320 million JY) from Cost to be borne by the Pakistani side in Basic Design Study.

2-5-2 Conditions for Estimation

a. Estimation Base	August 2007
b. Exchange Rate	1 US$ = 121.32 Yen
	1 Rs = 2.15 Yen
c. Period of Construction and Procurement	Implemented in three (3) terms 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.

2-5-3 Operation and Maintenance Cost

In accordance with the policy for the operation and maintenance for the project explained in 2-3, 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 420,000/yr (=JP903,000/yr)
b. Technical manager	Rs 300,000/yr (=JP645,000/yr)
c. Supervisor (electrical-mechanical)	Rs 180,000/yr (=JP387,000/yr)
d. Operator	Rs 72,000-96,000/yr (=JP154,800-206,400/yr)
The total remuneration of the project personnel	Rs 12,530,000/yr (=JP26,939,500/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 67,800 kWh/day according to calculations based on the design capacities of electrical facilities for the respective pump stations listed in Table 2-31 and to increase in power consumption accompanied by 14 hours continuous running of existing pumps at terminal reservoir.

The electricity rate for WASA is based on a preferential rate including a 15% consumption tax, and the present unit cost is Rs 6.50/kWh.
According to this rate, the power supply cost for WASA is calculated as follows.
Annual power cost = Rs 6.5 (/kWh) x 67,800 kWh/day x 365 days
= Rs 160,855,000 (about JP346 million)
(The power consumption will result in drastic increase, as evidenced by the power cost of WASA for the past 3 years being Rs 180 million including cost for sewerage facilities.)

3) Other Expenses

Other expenses are the following.

a. Chlorination cost

Assuming an average of about 2 ppm of dosage for 91,000 m^3/day water supply, the daily chlorine consumption rate is about 200 kg. The liquid chlorine used for dosage costs Rs 12,000 for a 1 ton container, and with a consumption of 6 containers per month, the cost is about Rs 72,000/month.

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	12,528,000
b. Power cost	Rs	160,855,000
c. Chlorine and water quality analyses chemicals	Rs	2,000,000
d. Maintenance and repair cost	Rs	7,000,000
e. Management cost	Rs	2,000,000
Total	Rs	184,383,000 (=JP400 million/yr)

5) The issue of 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 prospected as follows.

(1) The financial management of WASA is divided into urban water and sewerage services and

development projects including facilities construction. Recently, total cost has increased and reaches Rs 1,300-1,600 million for the past 2 years since a number of sewerage projects has been implemented with the annual provincial budget. However, new contracts with consumers are few due to shortage of water supply, so the scale of financial management including sewerage is within Rs 500 million.

The annual cost for electricity accounts for a large share of the ordinary expenditures, which presses the financial management of WASA. Results of the income from services and the cost for electricity for the past 3 years are shown in the following table2-34.

Table2-34 Results of the income from services and the cost for electricity

Year	Income from services		Cost for electricity	
	Rs (x 10^3)	JP (x 10^3)	Rs (x 10^3)	JP (x 10^3)
2004-2005	318,520	684,818	178,515	383,807
2005-2006	320,000	688,000	196,000	421,400
2006-2007	310,000	666,500	197,828	425,330

In consideration of the scale of financial management, countermeasures for the actual cost for operation must be examined and taken circumstantially from this moment since improvement of operation by the project may accompany the almost same cost as ever for electricity.

(2)The ordinary expenditures continue to surpass the income from tariffs of water and sewerage services by 30-40%, the deficit was subsidized by fixed property tax allocations to WASA each year. NDWP published in 2005 targets independent financial management of urban water supply, but there is no alternative but to subsidy the financial management as a temporary measure due to current conditions such as that the metered system is unfamiliar nationally and cities are troubled by nonpayment, which is expected to be phased out. Therefore, the positive response of provincial governments is highly required for prompt improvement of the financial management system of city organizations in charge. In response to this requirement, P&D of the Punjab government directs Faisalabad WASA to adopt private consignment of collection and promotes the changeover to the metered system. In this regards, however, rapid improvement is difficult in major cities, and the improvement of WASA has just been prefaced finally.

(3)The water tariff fixed in 2004 was raised about 15% in January 2007. This tariff revision was approved by the Punjab government officials in consideration of water sources of Faisalabad locating further away compared to other big cities in Punjab province and of the consequent cost increase for electricity.

The unit cost by this new water tariff with metered system is fixed at approximately Rs 10.0

(JP20.0) per 1 m^3. According to simple calculation, the income by the tariff excluding sewerage charge is Rs 270 million as an increase and can meet the total cost of Rs 180 million. (Total balance will be comparable size to this.) The detail is shown in table 2-35.

Table2-35 Balance concerning water supply facilities constructed by the project

Operation & maintenance	Expenditure (thousand Rp)	Remarks
a. Personnel cost	12,528	
b. Power cost	160,855	
c. Chlorine and water quality analyses chemicals	2,000	
d. Maintenance & repair cost	7,000	
e. Management cost	2,000	
Total	184,383	
Income	Income (thousand Rp)	
Income from water service	*265,720	Water supply/day: 91,000m^3 Revenue ratio: 80% Operation day: 365days Water tariff: 10Rp
Balance	81,337	

*Income from water service : Water supply/day(91,000m^3)×Revenue Ratio(0.8) x Operation days(365days) x Water tariff (10Rp)

(2) Under the direction of the provincial government, WASA is making efforts for the improvement of their financial management at the moment, and the changeover to the metered system is one of priority measures. To execute these measures and attain the independent financial management are pressing duties of WASA. 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 the changeover to the metered system will become easier, and eventually the sound financial management will be realized.

2-6 Issues for Consideration on Project Implementation

(1) Revised PC-1

With respect to implementation of this project, ancillary facilities works such as high-tension primary power line extension to the pumping station and construction of access road to the water source, as well as land purchasing and supervisory costs including compensations to surrounding villages due to water source development are the responsibilities of the Pakistani side. At the beginning of the first phase, the PC-1 for this project was approved by the Executive Committee of National Economic Council (ECNEC), the highest examination organization of the central government, and partial funding is already provided from 2005. However, since the cost to be borne by the Pakistani side has increased from the budget secured by the previous PC-1, WASA is planning to acquire the additional cost by resubmission of a revised PC-1. During discussions on Explanation of the Draft Final Report for the Implementing Review Study in November 2007, the Pakistani side promised to receive approval of ECNEC by the end of February 2008. In order to implement this project quickly and smoothly, promotion of the responsibilities of the Pakistani side to be executed in line with the construction schedule of this project is essential. In order to implement the project smoothly and without delay, therefore it is essential that the Pakistani side will execute its responsibilities in line with the construction schedule. To ensure it, close tie and cooperation between WASA and the Japanese side will have to be firmly held.

(2) Management Improvement of WASA

After completion of this project, when water supply service starts, the operation and maintenance costs will put pressure on the management of WASA. Although WASA has gone through various management improvements through instructions from the provincial government, including changeover to the metered system, it is necessary to constantly encourage WASA to put such measures firmly in place by the time the construction work in completed and the operation of the new system starts in order to improve financial management.

(2) Information Sharing to Residents

To ensure consent of stakeholders and residents of villages in the project site on implementation of this project, WASA will make a series of talks and give compensations. Subsequently, a liaison committee will be formed by WASA, representatives of municipalities and concerned parties in order to mutually share information. Furthermore, meetings and discussion sessions need to be held to receive understanding by residents.

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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 2.6 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 which jeopardizes the health conditions of the population. 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 for improvement 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 1,430 thousand among an estimated population of 2,600 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 2010, the coverage will increase to 60% with a served population of 1,687 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 3 times/day 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 city 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 1.0kg/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, typhoid, 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.

c. The project will be implemented under the condition that the agreement with the farmers of the region has satisfactorily been obtained. Careful consideration were necessary in the previous stage of this project not only in the technical aspects such as limiting the lowering of groundwater level to a minimum, but also in social aspects such as the realization of compensation measures. Such a process to ensure consent of all stakeholders in the project could be referred to us a model for WASA's undertaking in the future.

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 2007)	Augmentation of water supply in an amount of 91,000m^3/day through the development of a new wellfield	Water coverage rises to 60% in 2010.	a. Water can be served to additional 25 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 2007 2.6 million 1.435 million 2010 2.81 million 1.68 million b. The basic design 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 2007. ・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 91,000m^3/day through the development of a new wellfield	It can be increased to 130 liters.	a. For the estimate of this rate, the study employed WASA's daily records as follows: ・Water supply record ・Estimated rate of leakage = 25%, ・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 for 1/3 of the whole city suffers from extremely poor water service, with low pressure of 0.5 kg/cm^2 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 kg/cm^2 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 BD 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 was procured in this 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 control valve specially designed for prevention of cavitation.	With increased water supply, continuous operation of pumps will basically be achieved. Demand variation will be controlled with selection of combination of pump units and their numbers..	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, therefore, will closely be examined during the test operation, and proposed 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 from private wells 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 practical measures including compensations in case of a real threat of the expansion of influence due to pumping at the project tubewells and to release 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.

b. WASA is recommended to organize its own plan for continuously monitoring groundwater level in the region, based upon the approach/method 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 formulate 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 in the region found a trend of quality worsening, apparently due to the expansion of contamination by domestic waste waters in the surrounding villages.

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 as 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 unchanged. The flow through the Jhang Branch Canal is not likely to decrease significantly 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 promote a more effective water supply. 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 household meters. According to the inspection of existing pipelines during the study in 2003, the ductile cast iron lines composing arterial mains, which were completed in 1992, showed little signs of leaks as yet, while asbestos cement lines mainly used for secondary mains and branches seemed to tend to leak. There remain within a city lot of deteriorating sections, particularly among household connections, which are vulnerable to damages resulting in 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 for the reinforcement of arterial mains targets the area at the end of arterial mains in the east side of the city which is suffering the poorest service. 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 of tariff.

   The changeover to the metered system has already been studied by WASA under the reinforced government instruction, and the metered system has been adopted in some areas in 2006. The areas adopting metered system are planned to be expanded, but complete shift will still require some time. 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. According to the Punjab Province Urban Environment Survey conducted by the World Bank in

2005, the groundwater of Faisalabad is not suitable for drinking and intake from distant wellfiellds is necessary. Transferring large quantity of water from the source requires huge amount of electricity cost and is putting pressure on the financial status of WASA. Continuous water supply will require further increase in the energy-related cost.

Other cities in the province are suffering from similar difficulties of water supply, pricing and fees collection systems, and their operation and management costs have been supported by property tax. This situation has been a concern of the NDWP, and although the difficulty to abolish such subsidy is recognized, a gradual shift to self-supportive management is strongly being advised. Based on this policy, the provincial government is strengthening WASA's management and the adoption of meter system and consignment of water fee collection to private companies are two of the measures being considered. WASA is requested to improve its services, review its operation, and make efforts towards healthier financial management.

h. Earlier acquisition of revised PC-1

For the implementation of the project, WASA pledged its share of undertakings such as installation of high-tension primary power connections for the tubewell stations, pumping stations, access construction across the wellfield, execution of a compensation package project, land acquisition cost, etc. The fund for these responsibilities on the Pakistani side is granted to WASA by the government, based upon its application called PC-1 which is to be approved through the official channel of the provincial and federal governments. At the onset of the preceding implementation stage, PC-1 was already ensured. However, the newly revised project cost requires the review of the plan and budget through the same process. Since the Japanese side needs the approval of PC-1 for its final approval by the end of February 2008, the Pakistani side is requested to follow the process with close attention to meet the required deadline.

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 structure is generally believed to be still persisting.

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 90% of the entire households in the city have their own tubewells or those for common use. According to the past studies, groundwater 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, typhoid, etc., under 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 1,700. 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 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 communities 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 ADB project. 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 another 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 Conclusions

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. This operation and management of the project will be implemented under the condition that WASA will be able to study and act upon the problems of staffing, finance, and social environment.

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

(1) Conservation of the well field through execution of relevant monitoring system

The augmentation of water supply in this project entirely depends upon groundwater resource along the course of the Jhang Branch Canal. As a result of the survey, groundwater in this wellfiled has proven to satisfy the targeted quantity and quality thanks to the ample recharge from the canal. However, there seems risk of occurrence of potential damage to the current advantages by the influence of external elements. As the most effective measure to protect the quantity and quality of the wellfield, the establishment of pertinent monitoring system is essential. The essential monitoring approach is introduced in this report. Testing equipment such as tubewell level meters and potable water analysis devices have been delivered under the previous implementation stage. WASA is strongly advised to formulate the most pertinent monitoring system and utilize the collected data effectively for the protection of the wellfield.

The conceivable external elements are as follows:

a. Possibility of decline of groundwater level during the rehabilitation season of the canal for one month in a year when the authorities ceases to discharge the canal flow.

b. Possibility of change in water quality due to the expansion of contaminated groundwater flow from the surrounding villages where waste water is not dealt with properly.

(2) Necessity of information release and risk management

As a result of the Basic Design Study in 2003 it was revealed there might be a risk of groundwater level lowering in the surroundings of the planned wellfield on the medium to long term basis. WASA, therefore, made close contacts with stakeholders in the area and launched a compensation package project for the concerned villages. Due to such efforts friction from them have been subsided for the moment. When WASA starts the operation of new tubewells there upon completion of the construction work, however, old hostility may revive among them as the study team encountered during the Basic Design Study in 2002～03. As a measure to prevent such a situation, constant contacts with stakeholders will be required through the organization of a liaison office involving representatives of city officials and stakeholders where information and data obtained through monitoring is to be openly provided to ensure understanding of stakeholders. Occasional public meeting and hearing with villagers in general will also have effects. The environmental impact assessment report prepared for the project by WASA is of a similar opinion.

(3) Efficient water supply by means of reduction of leakage and improvement of distribution

In order to minimize loss of water, WASA is required to take aggressive actions to reduce leakage of pipelines which is reportedly at a level of 30%, although the real situation is unknown since house connections have no meters. WASA was forced in 2006 to renew house connections in a colony where a tragic incident happened resulting in 11 casualties of infants due to contamination of water pipes by sewers. After this incident, WASA is poised to replace deteriorated pipelines in other service areas. Since this measure is especially effective for reducing leaks, WASA is strongly recommended to realize it gradually, based upon a practical plan.

Another effort should be turned to reinforcing the existing network for distribution. As a model case, this project carried out the installation of bypass line intended for the improvement of water pressure in the east area of the city. In addition, various kinds of monitoring and testing equipment for pipeline were provided to WASA. To remedy or rehabilitate the existing network, these devices will be essentially helpful, telling actual pressures and flows in the field. WASA is recommended to use these equipments effectively and realize efficient distribution for the respective service areas.

(4) Shift to metering system

Augmentation of water supply can have its maximum financial effect under the metered tariff system, which WASA undertook for the colony hit by the incident cited in the foregoing clause in combination with the renewal of house connections. WASA is said to have a policy to practice it in other areas where pipe renewals are being planned. 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 with new consumers from now on. Earlier realization of the plan is strongly recommended.

(5) Necessity of improvement of financial management

According to the calculation in this implementing review study, the combined operation of distribution pumps for longer service hours after the commencement of operation of a new system is likely to cause WASA a huge amount of expenditure for operation and maintenance, particularly energy cost. Since WASA has lately been under strict control and advice from the provincial government for the improved financial management including the shift to the metering tariff, WASA is required to aggressively address challenges to its financial management and establish a balanced financial base for reliable service.

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