Water and Sanitation Agency
FDA, Faisalabad
Islamic Republic of Pakistan

IMPLEMENTING REVIEW STUDY REPORT ON THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY SYSTEM IN FAISALABAD IN ISLAMIC REPUBLIC OF PAKISTAN

DECEMBER 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

JAPAN TECHNO CO., LTD.

PREFACE

In response to a request from the Government of the Islamic Republic of Pakistan, the Government of Japan decided to conduct an implementing review study on the Project for Improvement of Water Supply System in Faisalabad and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Pakistan a study team from 17^{th} July 2007 to 7^{th} August 2007.

The team held discussions with the officials concerned of the Government of the Islamic Republic of Pakistan, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, after discussion about a draft implementing review and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Islamic Republic of Pakistan for their close cooperation extended to the teams.

December 2007

Masafumi Kuroki
Vice-President
Japan International Cooperation Agency

December 2007

LETTER OF TRANSMITTAL

We are pleased to submit to you the implementing review study report on the Project for Improvement of Water Supply in Faisalabad in the Islamic Republic of Pakistan.

This study was conducted by Japan Techno Co., Ltd, under a contract to JICA, during the period from July 2007 to December 2007. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of the Islamic Republic of Pakistan and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Tetsuji Niwano
Project Manager
Implementing Review Study Team
The Project for Improvement of Water Supply in Faisalabad
in the Islamic Republic of Pakistan
Japan Techno Co., Ltd.

SUMMARY

Summary

The Islamic Republic of Pakistan (hereafter called "Pakistan") lies in the southwestern Asia, bordering on India to the east, on Iran and Afghanistan to the west and facing the Arabian Sea to the south, occupying a total area of 796 thousand km^2. Its estimated population in 2006 was close to 160 million (World Bank), about 2/3 of which is the rural population as agriculture is still one of the main stays of the country's economy. Faisalabad, city targeted by this project, is located in the central area of Punjab province developing a national granary thanks to the dense canal network from the Indus river and its tributaries. According to the latest census in 1998, its population reached the third largest level in the country only behind Karachi and Lahore, and in 2007 is estimated at 2,600 thousand. At its birth in 1960s, the place was intended to serve as a distributing center of agricultural products in neighborhoods. It was not long before the city saw the textile industry settled in the town, eventually developing as one of the country's largest industrial cities. GDP of Pakistan was 135,653,280,000 US dollars (JETRO) in 2006.

Its GDP in the recent years has dramatically been picked up, driven by the strong influence of dynamic neighboring Asian countries, especially China and India. It is now proud of its GNP growth sustaining a high rate of as much as 7% on average for nearly 5 years. Such an economic growth has been produced mainly due to contribution from industrial manufacturing and services. At the turn of the century when the economic situation looked dire, the nation's poverty headcount was estimated at 32.1%, and the Pakistan government issued its poverty reduction strategy papers in 2003 for sustainable development of economy and poverty reduction focused on the improvement in rural areas. Although the recent robust economy raised individual income, resulting in the improvement of MDG's(Millennium Development Goals) indicators, poverty still seems persisting at 35% as before, according to the estimate of the World Bank (2006). Many of those in rural areas fled to large cities such as Karachi (now with a population of about 10 million), Lahore (6 million) and Faisalabad (2.5 million), most of them living in shanty towns there. Now about 50% of the urban population reportedly crowds the country's 7 largest cities with one third of them living under the poverty line. As a result, a large influx of immigrants has inevitably squeezed fragile infrastructure of cities, leaving their social services deteriorated.

Rapid growth of Faisalabad required the improvement of infrastructure, and ADB undertook a project for installing water and sewerage system for the city in 1970s, starting with preparation of a master plan. The planned facilities for water and sewerage service (Phase 1) were finally completed in 1992. 25 tubewells were constructed along the Chenab River, a tributary flowing in the southeastern direction from the Indus River, approximately 30km northeast from the city. The project established a comprehensive water supply system, including the tubewell construction, installation of transmission pipelines to transfer the water from the site to the city, the terminal reservoir and the city distribution network of 45km in total length. Immediately after its completion, however, the city authorities felt necessity to extend them as the city had increasingly become larger during the lapse of time, and a

request for assistance for the improvement of water facilities was submitted to Japan in 1995. Cooperation by Japan was interrupted on the way of the basic design study due to the economic sanctions after Pakistan enforced nuclear testing in 1998. Its renewed request after the lift of sanctions finally resulted in the implementation of the 2-phased project in 2004 for which the Exchange of Notes were signed. However, Phase 2 construction had not been implemented due to bidding problem. The implementing review study this time was thus planned to realize the objective of the project.

The components of existing water facilities for Faisalabad remain nearly the same as they were completed in 1992 through the implementation of the preceding ADB project. Consequently the ongoing service has extremely been degraded due to the acute shortage of water corresponding to increased demand. Moreover the city's unsatisfactory sewerage system tends to cause damage to environment, in an extreme case resulting in contamination of drinking water through leaking pipe sections. As citizens have thus been exposed to incessant risk in the daily necessities, their concern has been mounting.

Degraded service in the water sector has not been limited to Faisalabad. It is widespread across the main cities of the province. As the situation had been worsened, the provincial government carried out in 2005 the investigation of urban environment in the province by the team from the World Bank. The survey team found that the average rates of connections to municipal water and sewerage services in 9 largest cities in the province were 55% and 57% respectively. It carried out in-depth study through the household survey, which revealed those who had no connections to the water service relied upon their own private water wells. Even 90% of those having connections were found to depend upon their own water wells together with the municipal service or as their main sources, since the service had been unreliable. In Faisalabad groundwater sources within the city area are not suitable for drinking purpose since they naturally contain more salt than the other 8 cities and are contaminated with waste waters from industry or defective sewers. A great number of citizens, therefore, protect their health buying water for drinking purpose. Under these circumstances, hearing from citizens under this project reported that they were afraid of rampant water borne diseases such as hepatitis, diarrhea, etc.

Meanwhile the federal government had been serious about the degrading urban environment, and publicized its expression of apprehension as "National Drinking Water Policy" (hereafter NDWP) which is yet to be approved by the national assembly, followed by "National Sanitation Policy" in 2006. The former is a guideline defining the framework of responsibilities for the water sector development, in which the respective provincial government plays a main role for the establishment of administrative and legal procedures and for the provision of financial arrangements. In addition the national drinking water criteria and the procedures to ensure compliance were established, in order to protect the health of the population. In Punjab province, the provincial government has launched to provide guidance to WASAs (Water and Sanitation Agencies) in 6 major cities, including Faisalabad, and other authorities of towns and other administrative units in compliance with the provisions of NDWP. For the urban water sector, it issued a policy named "Roadmap for Improving Water and

Sanitation Service", in which the investment required for rehabilitation of urban facilities was estimated to amount to 750 million US dollars for 5 years. The improvement in Faisalabad was given higher priority in this policy for earlier realization.

With the background as described in the preceding sections, this project is aimed at improving the water supply system in Faisalabad, thereby alleviating the acute shortage of water for the citizens. The outline of the scope of the project is (a) to install 25 tubewells in the wellfield about 13 km north of the city, as the water quality of groundwater within the city is not fit for drinking, and (b) to transmit discharge of 91,000 m^3/day in amount from the tubewells via a booster pumping station to the terminal reservoir in the city. As new facilities for distribution, a new reservoir of 36,000 m^3 capacity and a pumping station is to be provided. Furthermore, the installation of bypass line of 6 km in length to the existing trunk main is carried out in order to alleviate imbalance of distribution among the service areas. One component is to cover a procurement program of monitoring and testing equipment of tubewells and pipeline as well as water analysis equipment. This framework for the project was formulated by the basic design study in 2003 and agreed by both parties in 2004. This implementing review study took a step to confirm the previous scope. As a result there was no fundamental alteration of the scope.

The implementation period was divided into two phases, with the first stage assigned for the installation of bypass distribution line and for the procurement of equipment through Grant Aid and the second one implemented with Government Bond covering the major construction works of the new water facilities. The first phase was already executed in 2006 in the previous stage. The main construction works, however, remain yet to be completed.

Since 1995 when the initial request for assistance was issued, the Japanese side has been responding for the realization of the project as follows:

1) 1997 Preliminary study
2) 1998 Basic Design Study (First stage) (During the course of the study, Pakistan launched nuclear testing against international objections, which eventually resulted in economic sanctions by major countries and the study for the project was also cancelled.)
3) 2002 Basic Design Study after the lift of economic sanctions (Second stage, phase 1) in which residents in the area surrounding the candidate for the wellfield developed intensified protest against the project, resulting in the cancellation of this study.
4) 2003 Basic Design Study as the Pakistani side determined an alternative wellfield site (Second stage, phase 2). The study was successfully completed.
5) 2004 Basic Design Study Draft Report Explanation (The framework of the project was agreed by both sides. In October of the same year, the exchange of notes for Phase 1 of the Grant Aid project was concluded, followed by the Detailed Design Study.)

6) 2005 *Commencement of construction work for Phase 1 (The tender was held in July.)
*Exchange of notes was concluded in April for Phase 2 of the Government Bond Project followed by the Detailed Design Study.
7) 2006 *In March end, the construction work for Phase 1 was completed.
*Tender for Phase 2 was held first in March, followed by another two tenders within the same year which ended in failure as well
8) 2007 In March, the implementation for Phase 2 was terminated with agreement by both parties on the termination of the consulting agreement, as it was impossible to complete the construction work for Phase 2 within the effective date of the exchange of notes.

The causes of failures in tender in 2006 were as follows:
(1) After the completion of estimate of the project cost in 2003, based upon the results of the basic design study, global price hike emerged and dramatically raised the cost of local steel pipes, one of main materials in the project. The steel price has since been remaining in the higher level.
(2) Extraordinary price hike of crude oil started in 2003, affecting cost of not only materials but also most of the components of the project. The price has since been continuing to rise to date.
(3) By 2006, the economy of Pakistan turned into robust rise, resulting in continued increase of prices of materials and labor.
(4) In an aftermath of a big earthquake in the north in 2005, the necessity of restoration there affected construction cost.
All of these events contributed to increasing the project cost in materials and labor.

The implementation of the project was once terminated in March 2007. However as the priority of the project remained high in the government plan, the Pakistani side made a request to resume it to Japan. In response to it, JICA dispatched an implementing review study team headed by Mr. Tsutomu Shimizu, Deputy Resident Representative of JICA Pakistan Office from July 18, 2007 to August 3, 2007 to examine mainly the trend of price hike in the local market as well as confirm the initial design by the Basic Design Study in 2003. For the realization of the project, the team particularly requested the Pakistani side to take steps for the approval of the revised PC-1 due to increased project cost and also to carry out the environmental impact assessment of the project for the approval by the authorities. The team later prepared a draft report on the result of the study, and JICA dispatched a draft report explanation team headed by Mr. Shimizu from October 19 to 20, 2007. The team had talks with the representatives of the Punjab government and WASA. The Pakistani side agreed on the proposal from the Japanese side, and both sides signed the minutes of the meeting. The major items agreed were as follows:
(1) Among the components of the project for the construction, the Pakistani side agreed to undertake the construction of three (3) units of operators' quarters. In case there arises later a need to request additional undertakings due to the internal arrangements of the Japanese side, it will officially inform the Pakistani side to the effect by the end of December 2007. The Pakistani side will

respond to such a request, if any.

(2) As a result of the implementing review study, the design of the pumps at the new terminal reservoir was modified from that of the Basic Design Study in 2003. The Pakistani side understood the necessity of this modification.

(3) The project cost was renewed, reflecting the results of the study on local prices. Since the increase of the new project cost is considered to require the renewal of PC-1 approval, the Pakistani side is requested to acquire the approval of the concerned authorities (ECNEC) by the end of February 2008, in order to ensure the final procedure of the approval on the Japanese side.

(4) The Pakistani side is also requested to ensure the approval of the environmental impact assessment report by the concerned authorities by the end of December 2007. In case the Pakistani side fails to complete the task (3) and (4) by the deadline, the project might be postponed or cancelled.

The scope of the project thus agreed is summarized in the following table:

Table 1 Project Scope

Group	Facilities/Equipment	Specifications
(1)Water Sources /Intake facility	①Tubewells 25 Nos.(standby 2)	Basic depth 160m
	②Tubewell station	
	a. Pump stations 25 Nos.	Floor area 45.4m^2/station
	b. Tubewell pumps 25 Nos.	Type: Motorized vertical-shaft turbine pump Capacity: 200 m^3/hr
(2)Collection facility	①Collection mains dia. 400～900mm x 14.6 km	Ductile cast iron and plastic coating/lining steel pipes
(3)Transmission facility	① Booster pumping station	
	a. Pump station 1 No.	Floor area 415.8m^2
	b. Booster pumps 4 Nos.	Type: Double suction horizontal Capacity: 25.3m^3/min, 3.3kV, 190 kW/unit
	c. Chlorination equipment 1 set.	Chlorinator chlorine cylinder, decontamination equipment.
	d. Secondary power supply and control equipment/materials	11kV～3.3kV～400V, and 240V single phase
	②Intermediate reservoir 1 No.	Storage capacity: 4,000m^3
	③Transmission mains(dia.1,000mmx11.3km)	Plastic coating/lining steel pipe
(4)Distribution facility	①Terminal reservoir pumping station 1 No.	Storage capacity：36,000m^3
	②Pump station	Floor area 545.8m^2
	a. Distribution pumps 2 Nos	31.6m^3/min、3.3kV、330kW
	Ditto 3 Nos.	63.2m^3/min、3.3kV、 660kW
	b. Secondary power supply and control equipment/materials	11kV～3.3kV～400V, and single phase 240V
(5)Reinforcement of exist-network	Bypass line to exist. network dia. 700～800mm x 6 km	Ductile cast iron pipe

(6)Procurement of O/M equipment	①Tubewell level meter x 12 Nos	Potable type
	②Water analysis equipment x 1 No.	Photo-spectral type
	③pH/EC meter x 2 Nos.	Potable type for field use
	④TDS meter x 2 Nos.	Potable type for field use
	⑤Ultra sonic flow meter x 1 No.	Potable for field flow monitoring and recording
	⑥Automatic pressure recorder x 2Nos.	Potalbe for field monitoring
	⑦Leakage sound detector x 2Nos.	Potable for field monitoring
	⑧Voice communication system x 1No.	VHF type (communication capacity, max .30km)

Remarks: In Table (1), the components, Items No. (5) and (6) were completed by March 2006, and the follow up inspection was carried out in April 2007.

This project is made up of components of huge capacities from the water sources to distribution facilities, each of which cannot be divided into separate groups to target the intended effects. For this reason, the project will be planned to be completed over several years, differing from the ordinary single year scheme of grant aid projects. As the detailed design has already been completed in the previous implementation stage, the tender will be able to be called in not so long a time after the conclusion of the exchange of notes for the project. The total implementation period, therefore, is estimated to be in the range of 44 months for completion of all construction works.

This project is implemented with Water and Sanitation Agency, FDA, Faisalabad (WASA) as the executing agency. WASA is an independent wing of Faisalabad Development Authority (FDA). The overseeing organization includes the Department of Housing and Urban Development/Public Health Engineering (HUD/PHE) and Planning and Development Board (P&D) of the Punjab government. WASA is headed by Managing Director, including 8 departments for administration and technical service for water and sewerage, with approximately 2,000 employees in 2007. The management of WASA depends upon tariff revenue for services, based upon the fixed rate system for property size common in all the cities of the country. Without meters at most of households and due to low tariff collection rate resulting to inferior service, the revenues have been subsidized from urban property tax to cover huge energy cost. However, it has recently launched a new policy under strict control of the provincial government for the improvement of financial management, including raising tariff and gradual shift to metering system.

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.

(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 3times/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., improving health environment for citizens.

b. The improved water service and awareness building of payment to the stakeholders 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.

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

(1) Conservation of the wellfield with monitoring

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 flow through the canal is one of the essential condition to secure sustainable groundwater withdrawal.

The Jhang Branch Canal is one of the secondary mains of the Lower Chenab Canal, which is the largest in scale in the existing irrigation network of the Indus system. Since the Lower Chenab Canal system including its intake headwork has now been overage due to its oldest construction, the provincial government of Punjab plans a large-scale rehabilitation work as well extensive lining of the existing channels for the purpose of enhancing discharges. This study was informed, however, that the lining is planned for the distributaries and smaller downstream channels, with the trunk mains remaining untouched. 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, in order to ensure stable supply of water.

As the most effective measure to protect the quantity and quality of the wellfield, the establishment of periodical 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 will be procured and WASA is strongly requested to formulate the most pertinent monitoring system and utilize the collected data on water volume, quality and change of water level effectively for the protection of the wellfield.

(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 be revived 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 WASA, city officials and stakeholders where information and data obtained through monitoring is to be openly provided to acquire their understanding. 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 valued 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 implementation review study, the combined operation of distribution pumps for longer 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.

(6) Revision of PC-1

For the implementation of the project, WASA pledged its share of undertakings such as instattion of high-tension primary power connections for the tubewell stations, booster pumping station and terminal pumping station, 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.

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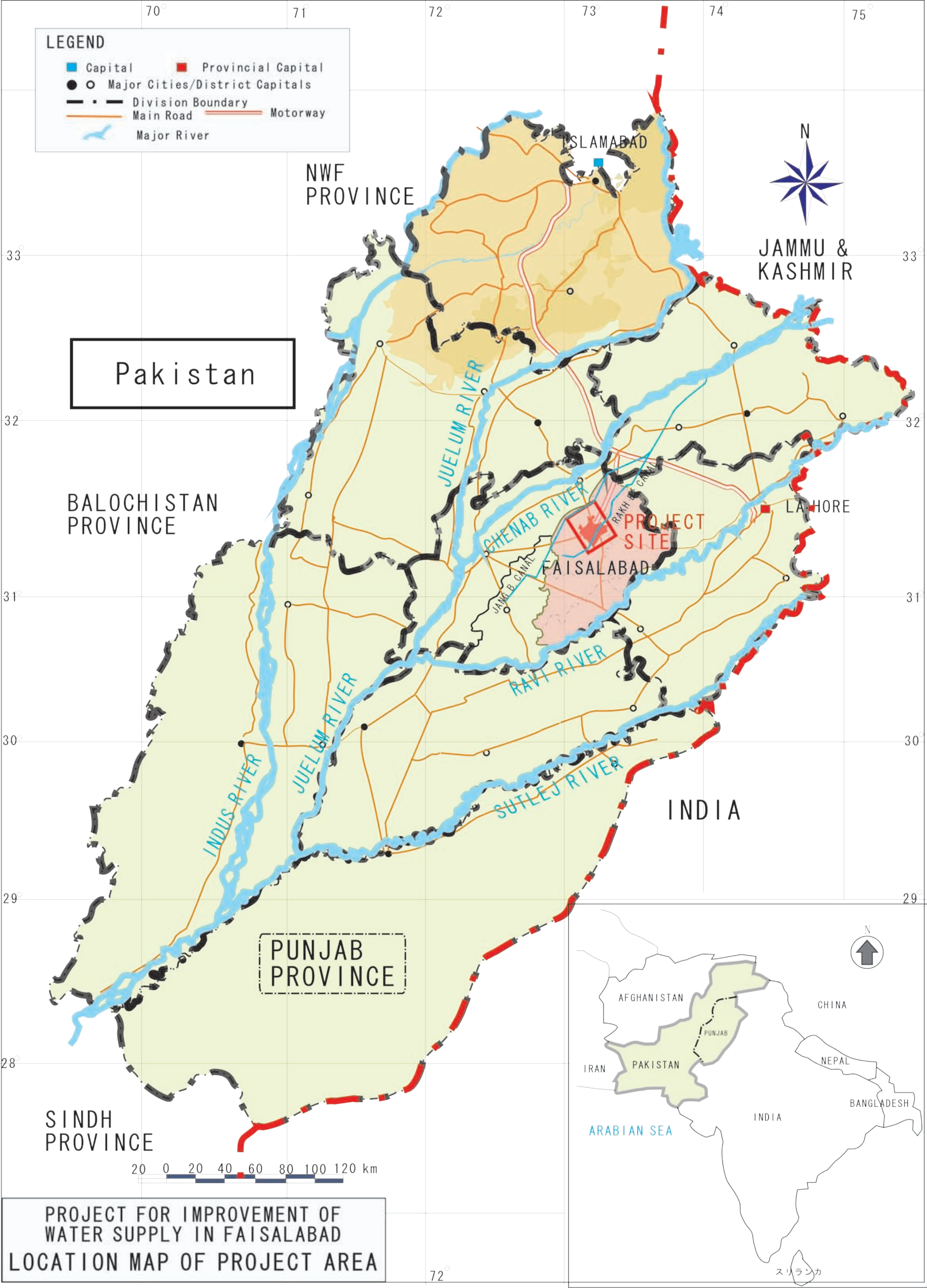
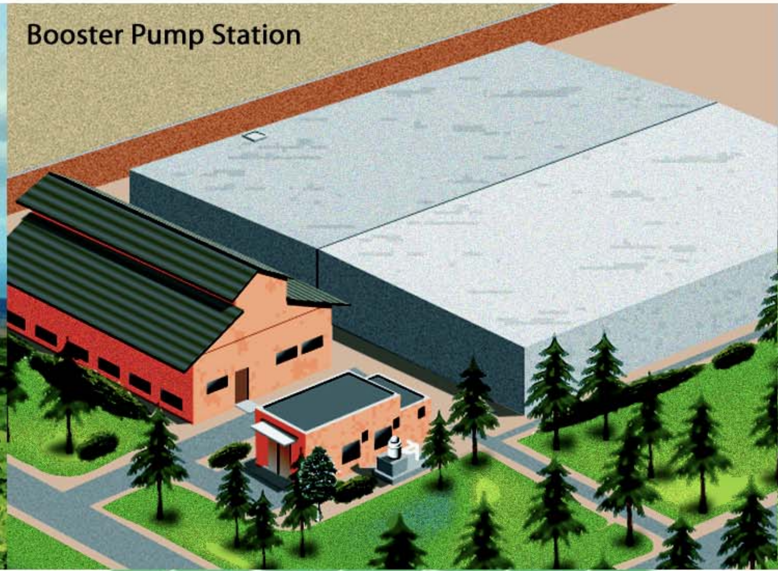
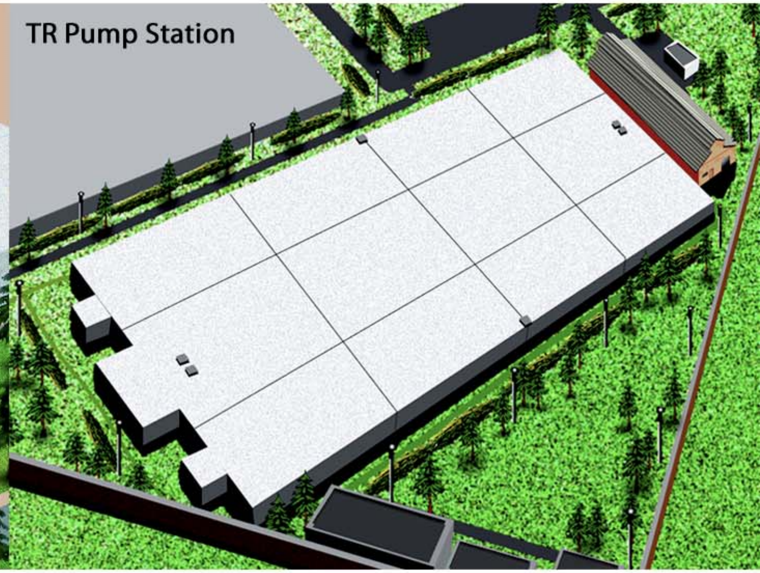
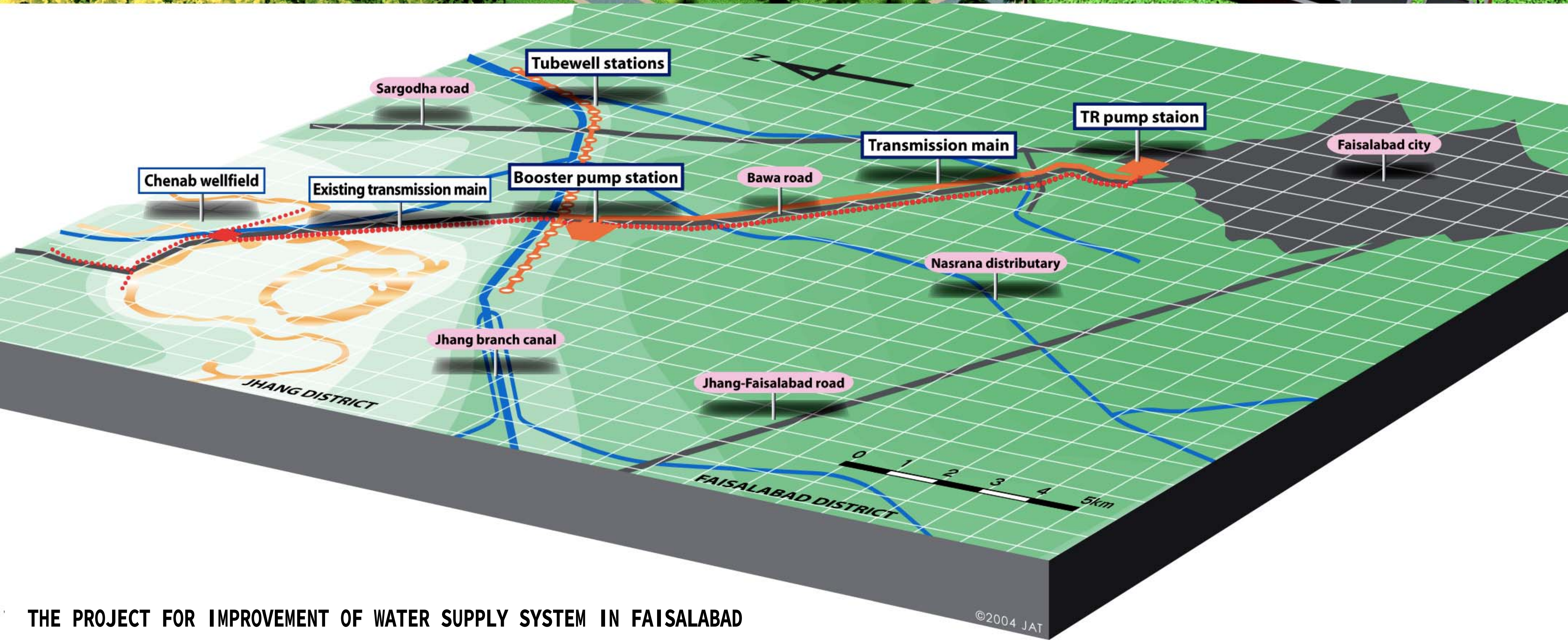


PROJECT FOR IMPROVEMENT OF WATER SUPPLY IN FAISALABAD

LOCATION MAP OF PROJECT AREA







THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY SYSTEM IN FAISALABAD

LIST OF FIGURES AND TABLES

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ABBREVIATIONS

ACP	Asbestos Concrete Pipe
ADB	Asian Development Bank
A/P	Authorization to Pay
API	American Petroleum Institute
AWWA	American Water Works Association
B/A	Banking Arrangement
BS	British Standards
DfID	Department for International Development
DIN	Deutsches Institut für Normung e. V.
ECNEC	Executive Committee of National Economic Council
E/N	Exchange of Notes
FDA	Faisalabad Development Authority
GL	Ground Level
HUD/PH	Ministry of Housing, Urban Development and Primary Health
HWL	High Water Level
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
LCC	Lower Chenab Canal
LWL	Low Water Level
PC-1	Planning Commission Document-1
PKR	Pakistan Rupees
PVC	Polyvinyl Chloride
REC	Republican Engineering Co.
TDS	Total Desolved Solids
T/R	Terminal Reservoir
WAPDA	Water and Power Development Authority
WASA	Water and Sanitation Agency
WHO	World Health Organization

CHAPTER 1
BACKGROUND OF THE PROJECT

Chapter 1 Background of the Project

This Project was initially aimed at contributing to a target of the master plan for the water and sewerage of Faisalabad city revised by the World Bank to achieve a coverage of 70% of citizens in its phase 2 from the year 1993 to 2000. For the realization of this purpose, the government of Japan has provided continued assistance to date to the project as listed in the following table:

Table1-1 Contribution of Japan to the Project to Date

	Date	Description of Assistance	Explanation
1	1998	1st Basic Design Study	Cancelled on the way due to the economic sanction imposed on Pakistan due to its enforcement of nuclear testing.
2	Dec. 2002 to Feb. 2003	2nd Basic Design Study (1)	Cancelled as well due to intensified objection of inhabitants to the selected site of the wellfield for the project
3	Aug. 2003 to Sep. 2003	2nd Basic Design Study (2)	The study (2) was satisfactorily completed after an alternative wellfield was proposed by the Pakistani side.
4	Mar. 2004	Basic design draft explanation mission	The results of the basic design study were agreed between the mission and the Pakistani side and the implementation of the study was divided into two phases (phase 1 and phase 2).
5	Jan. 2005	Commencement of the implementation of the project with the detailed design study for Phase 1 after ECNEC's approval in Oct. 2006 and the subsequent conclusion of Exchange of Notes between the both governments	The works for Phase 1 of the project consisted of the works for improving the existing distribution network of the city.
6	Jun. 2005 to Dec. 2005	Detailed design study for Phase 2	Phase 2 consisted of construction of main water facilities for augmentation of water supply.
7	Jul. 2005 to Mar. 2006	Construction works for Phase 1	The works for Phase 1 was successfully completed by March end, 2006.
8	Mar., Jul. and Oct., 2006	Tenders for Phase 2	All the three sessions of tendering for Phase 2 resulted in failure. Finally in March 2007, the implementation was forced to be closed due to shortage of time for the works within the valid date of the exchange of notes.
9	Jul. 2007	Implementing review study mission	In response to the request for resuming the project by the Pakistani side, the mission carried out the study for realization of the project implementation.

This study for the review of the project implementation was realized as a response to the aggressive request by the Pakistani side after the previous stage of the project was closed with agreement of both sides, since its needs and priority have invariably been high.

The basic design study by JICA in 2003 saw the water supply by WASA to the citizens of 2.3 million in Faisalabad had been degraded to a far lower level than that programmed by the master plan revised in 1993. The supply rate then was hovering at about 55%, while the population has constantly been increasing since then and now reached a level of 2.6 million. Meanwhile, WASA has been independently developing facilities to increase the water supply. Even now, it has its own concrete plan, other than this Project. However, the present volume of water supply has not increased since the completion of Phase 1 in 1992. In fact, the degeneration of the existing facilities is resulting in the decrease of water supply, and the level of water supply services continues to deteriorate.

Faisalabad typically represents the recent trend of urban areas in Pakistan where environmental infrastructure has progressively been worsening due to accelerated influx of population. Reports about citizens' sufferings here and there are abound in daily news. With concerns of citizens increasingly mounting, the federal government issued in 2005 a national guideline - National Drinking Water Policy (=NDWP) - to improve the situation together with National Sanitation Policy. The NDWP explicitly defined the assistance policy, legal/administrative/financial framework for the provision of water supply services, in order to ensure safe and reliable water supply to the population. It also underscored the necessity of water quality improvement and maintenance for the protection of the citizens' health.

The major strategies of the NDWP are as follows:

1) While the overall goal is to ensure safe drinking water to the entire population, the target is set at providing the same to 93% of the population by 2015 thereby raising the current coverage by almost 30%, in line with the Medium-Term Development Frame and Millennium Development Goals.

2) The minimum supply per capita per day is 20 liters for rural households and 40 liters for urban areas.

3) While the federal government will be responsible for establishing overall guiding policy and legislative frameworks for the sector, the provincial government will be responsible for directly addressing the challenges in providing safe drinking water under the provisions of the Local Government Ordinance 2001. The planning and development department of the provincial government will be expected to take a leading role for the execution of the policy for the sector.

4) All provincial governments and area governments will identify the resource allocation required for

achieving the target.

5) The Pakistan Drinking Water Quality Standards will be developed by the Ministry of Health using the WHO's drinking water quality guidelines. It will be approved by the Cabinet and enforced through an act of Parliament before 2007. Immediately after its enforcement, the provincial government will establish a monitoring and surveillance framework covering both urban and rural areas, and appropriate action will be undertaken to ensure compliance by all those concerned: from WASA responsible for urban water supply to ordinary vendors. The law will impose a fine on violators.

6) At the provincial level, the local government department will be responsible for monitoring the coverage of drinking water supply in rural areas and the WASAs will be responsible for the urban areas. The overall coordinating responsibility will be given to the provincial planning and development department.

7) There will be a regular review and updating of the drinking water policy after every five years by a committee constituted specially for the purpose.

The NDWP was publicly announced in 2005 by the nation's president through media, reflecting the social conditions at the time. Responses to the announcement were positive in general, although its targets included items that might be open to skepticism, such as the provision of water treatment plants in all urban cities by 2010. As a matter of fact, the team for the Phase 2 implementing review study witnessed this year at WASA Faisalabad how the NDWP had been working through the Punjab provincial government. WASA had received and was going to receive handsome packages of financial assistance from the planning and development of the provincial government for the improvement of its water and sanitation system, and had been receiving guidance on the operation and management, including the method of water fee collection and the shift to metered water tariff policy.

The planning and development department of the Punjab provincial government prepared in 2006 a paper entitled "Road Map for Improving the Water and Sanitation Service in Urban Areas", in which it estimated the necessary investment to be made in the sector, for the next 5 and 10 years, and announced the guideline for the implementation of the policy. For 8 large cities including Faisalabad, it predicted the needs for fund by Rs 45 billion for the coming 10 years, although a part of it was expected to have assistance from ADB and Japan.
Among the proposals of the NDWP, "Drinking Water Act" and "Pakistan Drinking Water Standards" are yet to come. However, this study confirmed that the policy had aggressively been wielding its influence over the water sector of the province. Regarding this project, the study team confirmed during the joint meetings in July 2007 attended with the representatives of the Punjab government comprised of high-ranking officials from the planning and development department and HUD/PHE department together with WASA that the project had been given a high priority in the sectoral

strategies of the government. This project will, therefore, be executed to contribute to an overall goal of the government policy prescribed in the NDWP.

As a conclusion of this study reflecting the results of the preceding basic design study, the objective of the project is set at alleviating the difficulties of citizens of Faisalabad with water supply from the ongoing system by means of the provision of urgently needed additional water of 91,000 m^3/day. The proposed amount of additional water corresponds to that previously agreed by both parties, while the population has constantly been increasing. However, it is the maximum quantity allowed to develop in the wellfield with various constraints, and can assure citizens to enjoy far better service than they do now. It will increase the present supply by 40%. Upon completion of the project, by 2010, about 60% of the population can be served with a rate of 130 lit/capita/day, compared with 100 lit/capita/day by the current supply.

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CHAPTER 2
CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

For achieving the project purpose as set forth in the previous section, Japan undertakes the construction works for new water sources to the distribution facilities in the city including reinforcement of the existing arterial mains, while the Pakistani side is in charge of installation of primary electric power and the construction of roads for access to the completed facilities. While the implementation of the project is underway, WASA will be required to expand new connections and to acquire new consumers. WASA will be in charge of operation and maintenance of completed facilities with newly organized teams, and is responsible for offering improved water service to citizens through the combined operation of the existing and new facilities. The following table summarizes the input and activities necessary for the successful implementation of the project, together with its anticipated effects.

Table 2-1 Logical Framework of the Project (Project Design Matrix:PDM)

Name of the Project：Project for Improvement of Water Supply in Faisalabad
Project Site：Faisalabad city
Ver. 2
Period：From May 2008
Target Group：Faisalabad citizens （About 1,687 thousand）
Prepared： in October 2007

Project Summary	Indicators	Means of verification	Important Assumptions
Overall Goal ☐ Water service rate in Faisalabad is improved.	☐ (The coverage rises to 60% in 2010.)	☐ Consumers log Record of installation of house connections/additional network sections	
Project Purpose ☐ Water supply in Faisalabad is improved.	☐ Served population reach 1,687 thousand in 2010. ☐ Water service rate rises to 60% in 2010. ☐ An average per capita daily supply rate is not less than 130 lit/capita/day in 2010. ☐ The operation for daily supply continues through 24 hours in 2010. ☐ One third of the population in the East Side of the city can enjoy improved distribution of water supply. ☐ The tubewells under this project provides an additional water production of 91,000m^3／day at maximum.	☐ WASA's daily pumping records at existing and new tubewells. ☐ WASA's daily record for supply at the existing flow meter and the one from the new pumping stations (the booster pump station and the terminal reservoir pumping station.). ☐ WASA's operation record at the Terminal Reservoir. ☐ Census of population and consumer survey report ☐	☐ WASA secure well-organized operation and maintenance system. ☐ WASA continues its efforts to expand facilities for effective and efficient water supply (based upon the master plan)
Output 1. Additional water sources are installed. 2. Facilities for effective distribution of increased water are installed. 3. The existing distribution system is improved with reinforcement under this project. 4. House connections increase. 5. A new team for operation and	1-1 25 pumping stations with tubewells are installed by 2008. 1-2 An additional water production of 91,000m^3/day is pumped at these pumping stations. 1-3 Collector mains (11.3km), transmission facilities consisting of a booster pumping station and transmission mains 14.4 km long and distribution facilities of a terminal reservoir and pumping station is constructed by 2010. 3-1 Supplementary sections (6km) to arterial mains are installed by 2006.	1-1 Project completion report 1-2 Record of (test) operation of facilities constructed under the project 1-3 Project completion report 2-1 Record of (test) operation of facilities constructed under the project	☐ There is no drastic change in the population of the city. ☐ The environment of the wellfield remains intact.(No industrialization and resulting pollution of environment) ☐ There is no large scale disaster to affect natural environment of the wellfield. ☐ The canals continue recharge to groundwater in the same level as they currently do. ☐ Political, social, economic conditions of the country stay stable.

maintenance is organized.	4-1 Collection of water fees is improved. 5-1 A new team is staffed by 2010	3-1 Project completion report 4-1 WASA's annual budgetary report 5-1 Record of (test) operation of facilities constructed under the project	☐ WASA can ensure financial assistance of The government in case its financial balance worsens.
Activities 1. Construction of facilities/procurement of equipment 1-1 To construct water sources/pumping stations. 1-2 To construct collector mains, transmission and distribution facilities. 1-3 To reinforce and expand the distribution network in the city (including works undertaken by WASA). 1-4 To procure equipment for operation and maintenance of facilities. 1-5 To train engineers/operators for new facilities on their operation and maintenance. 2. Understakings of the Pakistani side 2-1 To provide primary power connections to facilities. 2-2 To acquire land for the construction of facilities 2-3 To level and grade land for construction of facilities 2-4 To construct access roads to facilities 2-5 To undertake expansion of network. 2-6 To undertake sustainable operation and maintenance of facilities 2-7 To acquire new contracts and install house connections		**Input** 【Japanese side】 Manpower： Basic design study team, detailed design team, resident engineers of the consultant、expert for O/M Contractor Materials and equipment： Those for construction of facilities Those for operation and maintenance Fund： Grant aid 【Pakistani side】 Manpower： WASA's couterpart engineers Operation and maintenance team Materials and equipment： For expansion of network/house connections Fund： Public Sector Development Programme (PSDP)	**Precondition** ☐ Agreement is concluded with villages in the vicinity of the wellfield for their cooperation in the implementation of the project.

Remarks for the indicators in the above table are as follows:

1) This study estimated the current coverage of water service, based upon the dimensions of areas where WASA had installed pipelines for distribution, as detailed later in Section 2-2-2-2. Although the rate is normally estimated by the registered number of households having connections, it is actually in an incredibly low level, probably due to widespread illegal connections. To evaluate the coverage in the future, it will be necessary to review all the related factors such as WASA's performance in the extension of the network, installation of house connections with consumers log, etc.

2) Regarding the daily continuous service to the city, the details shall be referred to Section 2-2-2-3.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic policy

1) Extent of assistance

As the basic policy of Japanese assistance, the target of groundwater discharge for the project is set at 91,000m^3/day, which was agreed in 1997 between WASA and JICA's preliminary study team. This target has since then been in WASA's plan for its repeated requests to Japan.

The initial stage of this basic design study in 2002, therefore, targeted the same amount. Finally it was confirmed and agreed between WASA and the study team during the second stage in August 2003. That discharge is now far less than the target of the World Bank's master plan in 1993 due to lapse of time. However, environment has since been changed dramatically, with increasing pressure from the regional communities devoted to agriculture consuming large quantities of groundwater to supplement shortages of canal water. Increase of discharge now demands a great deal of social and environmental consideration. In view of such a background, the project is aimed at developing new sources for the project in the site which has already been agreed among the diverse stakeholders.

As a result of the preceding basic design study in the second stage in 2003, the scope of assistance by the Japanese side is proposed to include facilities from those for water source development, collector mains, a booster pumping station, transmission main, to the terminal reservoir. They are to be combined with the existing facilities for effective water service. The components are basically the same as those planned during the first stage in 2002～2003, although a part of them include some modifications as a result of the study, as listed in the following table 2-2 (Refer to Fig.2-1 for their planned locations.), for which agreement has been reached.

As shown in Table 2-2, the work for the reinforcement of the existing network was executed in August 2005 during Phase 1 in the previous implementation stage. By March end of 2006, a new 600m long bypass line of 700mm to 800 mm in diameter was installed. During the follow-up inspection of this work in March 2007, the pressure of the new line was examined with the testing equipment supplied to WASA during the same phase, showing partly improved results in supply pressure. It will finally be confirmed after water is increased upon completion of this project.

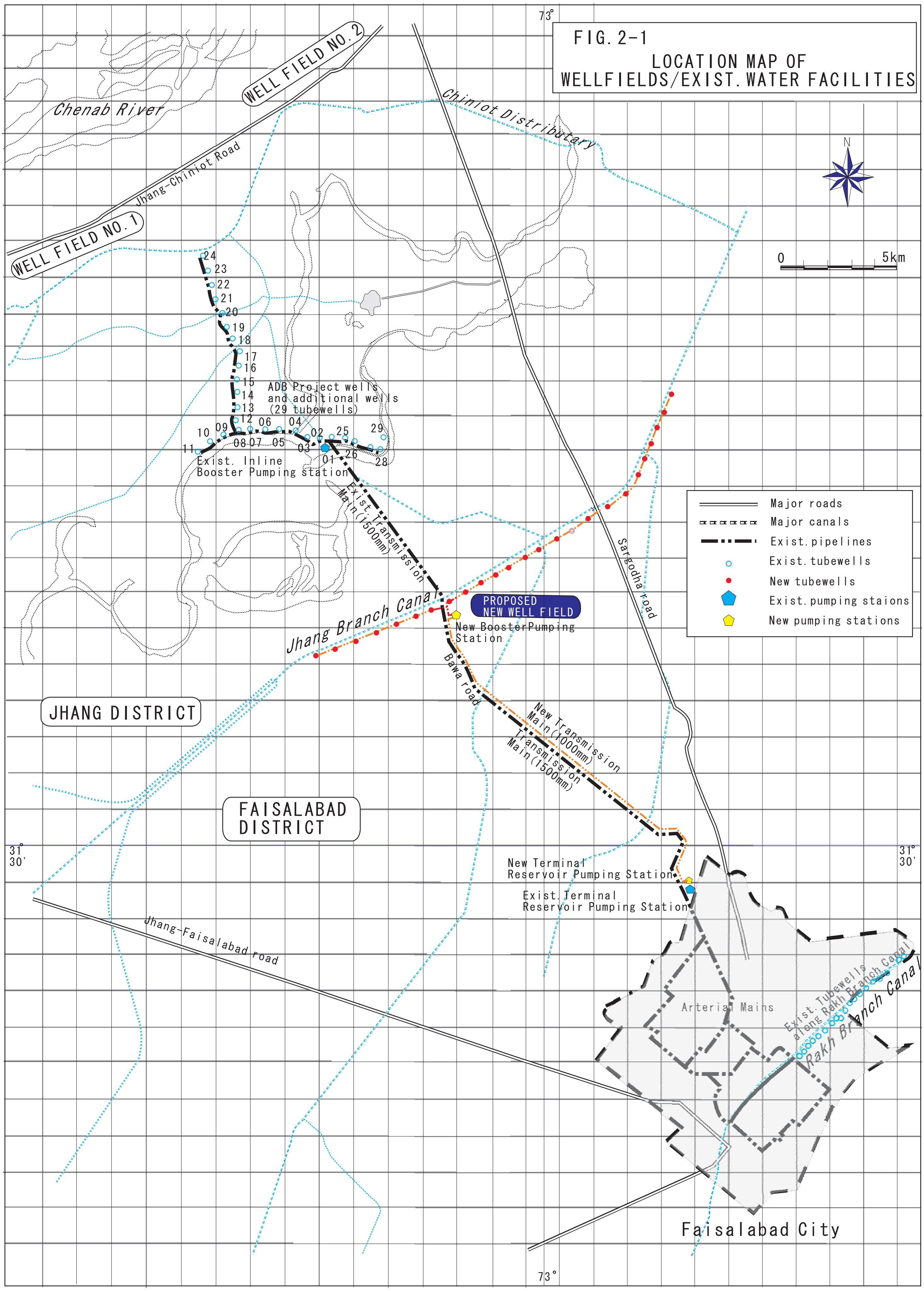
FIG. 2-1
LOCATION MAP OF
WELLFIELDS/EXIST. WATER FACILITIES
73°
WELL FIELD NO. 2
WELL FIELD NO. 1
Chenab River
Jhang-Chiniot Road
Chiniot Distributary
N
0
5km
ADB Project wells
and additional wells
(29 tubewells)
Exist. Inline
Booster Pumping station
Exist. Transmission
Main (1500mm)
Sargodha road
Jhang Branch Canal
PROPOSED
NEW WELL FIELD
New BoosterPumping
Station
Bawa road
New Transmission
Main (1000mm)
Transmission
Main (1500mm)
Major roads
Major canals
Exist. pipelines
Exist. tubewells
New tubewells
Exist. pumping staions
New pumping staions
JHANG DISTRICT
FAISALABAD
DISTRICT
31°
30'
New Terminal
Reservoir Pumping Station
Exist. Terminal
Reservoir Pumping Station
Jhang-Faisalabad road
Arterial Mains
Exist. Tubewells
along Rakh Branch Canal
Rakh Branch Canal
Faisalabad City

Table2-2 Comparison of Major Components
of the Studies for Basic Design (2003) and Implementing Review (2007)

	Basic Design Study (BD) (2003)		Implementing Review Study (2007)	
	Facility Name	Specifications	Facility name	Specifications
(1)Water source/Intake	①Water sources (Tubewells)	25 nos. (2 nos. for standby), Basic depth 160m	①Water sources (Tubewells)	Same as in BD
	② Intake facilities		②Intake facilities	
	a. Tubewell stations	25 nos. @45.4 m^2	a. Tubewell stations	Same as in BD
	b. Tubewell pumps /electrical works	Capacity:25 nos.@200 m^3/hr Vertical line-shaft type	b. Tubewell pumps /electrical works	Same as in BD
	③Operation quarters	1 no. 170.0m^2	③Operation quarters	(Borne by Pakistan Govt.)
(2)Collection	①Collection mains	Dia. 400～900mm x 15.6 km long Ductile cast iron/ plastic-lined steel pipes	①Collection mains	Same as in BD except total length:14.6km
(3)Transmission	①Booster pumping station		①Booster pumping station	
	a. Pump station	1 no. x 415.8m^2	a. Pump station	Same as in BD
	b. Booster pumps	@25.3m^3/min x 4nos. (one for standby)	b. Booster pumps	Same as in BD
	c. Chlorinator	1 unit（chlorinator & appurtenant facilities)	c. Chlorinator	Same as in BD
	d. Secondary power supply/connection	3p, 11kV～3.3kV～400V, 1p, 240V	d. Secondary power supply/connection	Same as in BD
	②Reservoir	1 no. x 4,000m^3	②Reservoir	Same as in BD
	③Operation quarters	1 no. x 170.0m^2	③Operation quarters	(Borne by Pakistan Govt.)
	④Transmission mains	Dia. 1,000mm x13 km long, Plastic-lining steel pipe	④ Transmission mains	Same as in BD except total length, 11.3 km
(4)Distribution	①Terminal reservoir	1 no. x 36,000m^3	①Terminal reservoir	Same as in BD
	②Terminal pumping station		②Terminal pumping station	
	a. Pump station	545.8 m^2	a. Pump station	545.8 m^2
	b.Distribution pumps	31.6m^3/min x 4 nos. (1 no. for standby)	b. Distribution pumps	31.6m^3/min x 2 nos. 63.2 m^3/min x 3nos.
	c. Secondary power supply	3p, 11kV～3.3kV～400V, 1 p, 240V	c. Secondary power supply	Same as in BD except increase of power supply to pumps
	d. Operation quarters	1 no. x 170.0m^2	d. Operation quarters	(Borne by Pakistan Govt.)
	③Reinforcement of Exist. network	Dia. 700～800 mm x 6km long, Ductile cast iron pipe	③Reinforcement of Exist. network	(Completed by March 2006 in the preceding implementation during Phase 1.)

2) Wellfield Site

The initially proposed site for the wellfield for the project was located along the Chenab river as in the World Bank's Master Plan about 30 km northwest of Faisalabad city in the neighborhood of the existing Chenab wellfield developed by ADB. Potential of groundwater in this area had been verified by the existing wellfield installed in the preceding project for Phase 1. However, continuous pumping of large quantitie of water from 25 tubewells there resulted in the fall of regional groundwater level affecting the surrounding agricultural wells.

Faced with persistent opposition by villages in the planned wellfield during this study, the candidate for the project was shifted to an area along the left side of the Jhang Branch Canal about 13 km west of the city. As a result of the second stage of the study, the new site has turned out to have as high a potential of groundwater of good quality and capacity as the previous site does. Thanks to ample recharge from the canal, planned tubewells there are anticipated to maintain the estimated production capacity and good quality.

The Jhang Branch Canal is a secondary main of the Lower Chenab Canal (hereafter called "LLC") withdrawing the flow of the Chenab at the Khanki Head Works, the oldest weir of the country, about 150 km upstream the project area. The authorities now plan to rehabilitate the head works and channels of this system to increase and ensure its sustainable supply, since it has now been aged. One of the measures in planning is to carry out the lining of existing channels to reduce leakage. It was confirmed, however, such works exclude the Jhang Branch Canal and are intended for smaller channels of distributaries and their downstream. In the future, therefore, the canal is expected to be able to feed more water to farms, while groundwater is likely to receive constant recharge along the main channels of the canal including the Jhang Branch Canal. This situation indicates the planned wellfield along the canal can ensure sustainable development of groundwater for the city's water system.

Meanwhile, in view of environmental conditions in and around the site hostile to groundwater withdrawal by WASA, proper measures should be taken to contain influences to a minimum level both in technical design and public relations. (Refer to item 2-2-1-3 "Policy for environmental and social arrangements")

3) Design policy for facilities

(1) Transmission Main

Since Faisalabad has the third largest population in the county, each of water facilities requires a larger size and capacity. Among them, the transmission main from the wellfield at a long distance from the city to the terminal reservoir in the suburbs of the city (hereafter called "T/R") requires special attention, technically and financially.

The existing tubewells in the Chenab wellfield developed in ADB project are further away from the city, extending 10 km north of the Jhang Branch Canal. The existing transmission main with a diameter of 1,500mm lies along Bawa road from the inline booster pumping station across the Jhang Branch Canal to the T/R (Refer to the map in Fig. 2-1)

The course of the transmission main for this project from the Jhang Branch Canal is conceived to be laid in parallel to the existing line along Bawa road as the shortest route from the canal area. Apart from installing a new line, a possibility to utilize the existing 1,500mm line was examined since the route is the same. As a result of the study, it was revealed that the existing line has an allowance to combine discharges from the Chenab wellfield and the Jhang Branch Canal wellfield. As a result of the consultation with WASA, It agreed to consider the utilization of the existing line, if there will be no major increase in their operation and maintenance costs or the electrical cost for pump operation. The results of the comparison are shown in the following table 2-3:

Table 2-3 Comparison of Methods of Transmission

	Plan A: Combined transmission	Plan B: Separate transmission
Technical examination	Pressure of the existing pumps at the inline booster station is insufficient for conveying through discharge of tubewells in Chenab to the T/R, in case discharge from the Jhang Branch Canal wellfield joins the former in the existing transmission main on the way. 3 pumps should be replaced by large capacity pumps.	No particular change required in the existing facilities.
Composition of facilities	a. Pump station *Inline booster pumping station (replacement of 3 units of existing pumps plus one standby) *Jhang Branch Canal pumping station (3 units of new pumps plus one standby) b. Transmission main *Existing transmission main (1,500mm dia. x 18km) *New transmission main (Short connection line to the existing transmission main)	a. Pump station *Inline booster pumping station (No change with 3 units of existing pumps plus one standby) *Jhang Branch Canal pumping station (3 units of new pumps plus one standby) b, Transmission main *Existing transmission main (No change) *New transmission main (1,000mm dia. x 13 km)
Economic comparison	a. Construction cost Less than Plan “B” (plus – replacement of exist. pumps minus- new transmission main) b. O/M cost Larger than Plan “B” (plus – Increase of electrical cost due to high power of replaced pumps at the inline booster pumping station. Electrical cost of new pumps in Jhang Branch Canal pumping station is the same as Plan “B”.)	a. Construction cost Higher than Plan “A” (plus- installation of new trans-mission main 1,000mm x 11.3 km) b. O/M cost Considerably less than Plan “B” (Yearly difference in costs of Plans “A” and “B” amounts to about Rs 10 million.

If the project life is assumed to be 40 years, Plan “B” becomes more economical than Plan “A” due to the difference in the electrical costs. As a conclusion, the study proposes transmission by separate lines. Plan “B” will have the effect of minimizing the annual O/M cost of WASA.

(2) Distribution system

Although the initial plan was focused on the increase of water quantity for supply with the construction of new facilities, the former basic design study revealed the necessity to improve a part of the existing distribution system for enhancing the effects of the project. The improvement is targeted at the east side of the city where water pressure has been limited to an extremely low level, leading to the difficulty in obtaining supply. As a result, this plan was incorporated into the project, and was already executed with Japanese assistance.

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(3) Improvement of Storage Capacity at T/R

Findings as a result of the 2003 basic design study included the lack of storage capacity at T/R due to the defective layout of facilities, although the design capacity of the existing reservoir was 46,000 m^3. The existing pumps cannot draw water from the lower half of the reservoir, reducing its available storage capacity to about 23,000 m^3. To address the resultant shortage of storage, the new reservoir to be constructed in the same premises under this project will be designed to have a capacity to supplement it. According to the results of the study, the capacity of the new reservoir will be 36,000 m^3 at maximum. Combined with the actual capacity of the existing reservoir, the new layout at T/R can ensure the storage capacity of about 6 hours, enabling continuous operation for supply to the city.

2-2-1-2 Policy for natural condition

Water supply in this project for Faisalabad with a population of about 2 million utilizes mainly groundwater as its water source like provincial capital, Lahore, with a population of 6 million. For the city this source is rich in quantity and good in quality, and has an advantage over any other types of sources in that it can be served only with chlorination, making the cost by far less. This ample source is mainly produced through recharge of artificial canals as one of specific features in a vast tract of Indus plain where agriculture is thriving thanks to widespread network of canals.

The policy for design for the layout of planned tubewells, therefore, pays respect to the recharge of the canal. Major elements, such the numbers of tubewells to ensure the targeted discharge, their spacing are decided, based upon the test results of the canal infiltration, which have been made available through the efforts by WASA.

Since these factors are closely related to groundwater level, which has been a focus among concerned villages, a unit discharge rate from one tubewell is to be decided within an allowable range of recharge from the canal to keep the fall of groundwater level to a minimum level.

2-2-1-3 Policy for environmental and socio-economic arrangements

The project site where groundwater development is planned is one of typical agricultural areas in the Punjab province, which took shape through colonization after the networks of canals from the Indus system were installed during the British reign in the latter part of the 19th century. Although agriculture in Indus plain has mainly been relying upon canals, canal water distribution is reportedly inadequate. For such a reason, the combined use of canal water and groundwater from tubewells has lately gained force. In fact irrigation tubewells abound in the project site. According to the survey by WASA, there is a private tubewell per 1 km^2 of the area surrounding the wellfield on average. The development of groundwater in an area crowded with existing tubewells entails due consideration to regional agriculture.

This project proposes a design for groundwater development which will limit influence to private tubewells to a minimum level, based upon the analysis of the test results of the canal infiltration. Nevertheless the detailed hydrogeological analysis of the study alarms a risk of probable fall of regional groundwater level on a medium to long term basis. Therefore, WASA is recommended to take the following actions:

a. WASA shall establish an appropriate monitoring programme of groundwater level and quality in the region from the onset of the operation of its tubewells to examine any change in these factors for assessment of influence(including the range and the level of impact).
b. WASA will work out appropriate measures including compensation for management of real risk of occurrence of influence against to which villages in the surroundings have been alarmed. (WASA considers a critical range of fall of level is 3 m, more or less.)
c. WASA will hold public meetings involving all the stakeholders around the wellfield to provide them with necessary information and ensure their agreement through discussions.

(Discussions were held with the Pakistani side during this study, and it was decided that the Punjab Provincial Government, being the overseeing organization of the Project, will take the leading role in the implementation of these measures.)

Regarding the social arrangements, this implementation review study in July 2007 confirmed that WASA already undertook a compensation package program agreed between the government side and the local stakeholders. This programme consists of 38 small to medium size of sub-projects mainly targeting environmental improvement in concerned villages around the wellfield. WASA has completed 34 projects to date, and will complete them soon with satisfactory results.

2-2-1-4 Policy for local contractors/products

This project will be implemented, employing locally produced basic materials for civil and architectural works such as cement. Moreover, since the country now produces high-quality industrial products that can be employed for the project such as pumps and piping materials as a result of efforts for industrialization promoted by the government policy, suitable materials and equipment are expected to be selected from the local market.

The preceding ADB project, Phase 1, was accomplished by local contractors selected as a result of the international tenders. With Faisalabad located close to the provincial capital, Lahore, the market in this economic zone is poised to provide qualified and capable contractors for drilling, civil and architectural works. For successful implementation of the project, the employment of local contractors is highly recommended.

2-2-1-5 Policy for grade of facilities and equipment

All the facilities and equipment comprising the planned water supply system in this project are of similar types and grades to those installed under the preceding project by ADB, which have satisfactorily been operated and maintained by WASA since 1992. This policy will ensure consistency of the combined operation of the existing and the new systems by WASA.

The study found all the existing pumps for tubewells and pump stations properly functioning for intended operation. (The existing tubewell pumps are of vertical shaft type locally manufactured with license of a European maker, while those for the pump stations are of double-suction volute type of Japanese make.) Similar types of pumps are proposed for this project as well.

The existing and the newly completed systems can be operated independently until T/R, to which all water from the existing and the new wellfields is transmitted and then pumped out to the arterial mains for distribution to the city with the existing and the new pumps simultaneously working. Parallel operation of pumps transforms the performance of the pumps into a combined one. Difficulty arises here in adapting pump operation to extreme concentration of consumption during supply hours, which is currently limited to approximately 6 hours per day. The pumps become over-burdened, resulting in low pressure, which is one of the causes of cavitations. It is feared that the simultaneous operation of the existing and new pumps may risk a similar malfunctioning since the trend in city's consumption is unknown and appears difficult to control. In order to minimize such a risk, the pumps to be installed under the project are to be equipped with protective measures as follows:

a. The new pumps are designed to be installed at a lower level than the low water level of the new reservoir so that the suction pressure could become positive.
b. Control valves specially intended to avoid cavitation will be equipped with new pumps

manual speed control of the electric motors.

Although a computerized speed-control system of motors is the most suitable arrangements for adapting operation to the demand fluctuation, WASA has no experience in this sophisticated equipment, and may pose difficulty in operation and maintenance. Instead the proposed measures are taken to contain malfunctioning of the pumps to a minimum level.

2-2-2 Basic Plan

2-2-2-1 Water source planning

This project was formulated based on the Basic Design Study which was conducted in 2003. Some of the details were confirmed during the Detailed Design Study in 2005(e.g. electrical prospecting data of the tubewell construction sites etc). Since it was confirmed during this Implementing Review Study, that no major changes had occurred in the natural environment of the project wellfield, it was considered appropriate to adopt the plan of Basic Design Study for this Project.

1) Hydrogeological study for the project

(1) Objectives
A broad study for groundwater development for this project was performed during the 2003 basic design study, for collecting relevant information and data on the following elements for water sources planning:

①Optimum rate of discharge from one tubewell
②Drawdown at a design rate of discharge
③Extent of influence of pumping at group tubewells to the surrounding area
④Layout of group tubewells
⑤Drawdown at simultaneous discharge of group tubewells
⑥Prospect on regional groundwater level lowering
⑦Groundwater quality at the planned tubewells
⑧Situation of Jhang Branch Canal water flow

(2) Components of the Study
The groundwater development study consisted of the following components:

Table 2-4 Lists of Components of the Study for Groundwater Development

	Components	Study period	Contents
1	Hydrogeological study	1st & 2nd stages	Includes inspection of more than 100 existing tubewells
2	Geophysical survey	2nd stage	Surface electrical resistivity survey at 24 points along the canal
3.	Test drilling	2nd stage	Test well (150 m x 1 No.) Observation wells (120m x 2 Nos.)
4.	Aquifer test	2nd stage	A series of pumping tests were undertaken at the test well and 2 observation wells plus 3 observation wells provided by WASA
5	Water analysis	1st & 2nd stages	Field test by the study team and analysis by WASA Laboratory

WASA and the study team agreed that the results of the former studies in the area should be referred to. The studies included the following:

a. Study by WAPDA in 1960s
b. Study by Binnie and Partners in 1975
c. Study by Republican Engineering Co. (hereafter called "REC") in 1981

Further it was agreed between both sides that the results of seepage test undertaken by WASA in 2003 for the project tested by Irrigation Research Institute of the Irrigation Department of the Punjab province should closely be examined, as an important source of information of recharge quantity in the project area.

(3) Outline of the study results

a. Geophysical survey

* The survey was made at 24 stations to a depth of 200m in the planned wellfield along the left side of the Jhang Branch Canal. According to the analysis of the survey results, the subsurface geological section to a depth of 200m is largely divided into 3 groups, among which the second section appears the main aquifer of the area.
* The survey results tell that a basic drilling depth in the well field is 160m on average. The exact depths of the respective tubewells should be confirmed during the detailed design stage by the geophysical study at the very points decided for drilling. (The detailed design study was carried out in 2006 in the preceding stage of the project.)

b. Test drilling

* The locations of the test well with observation wells are shown in Fig. 2-2
* The geological section and the structure of the test well installed under the study are shown in

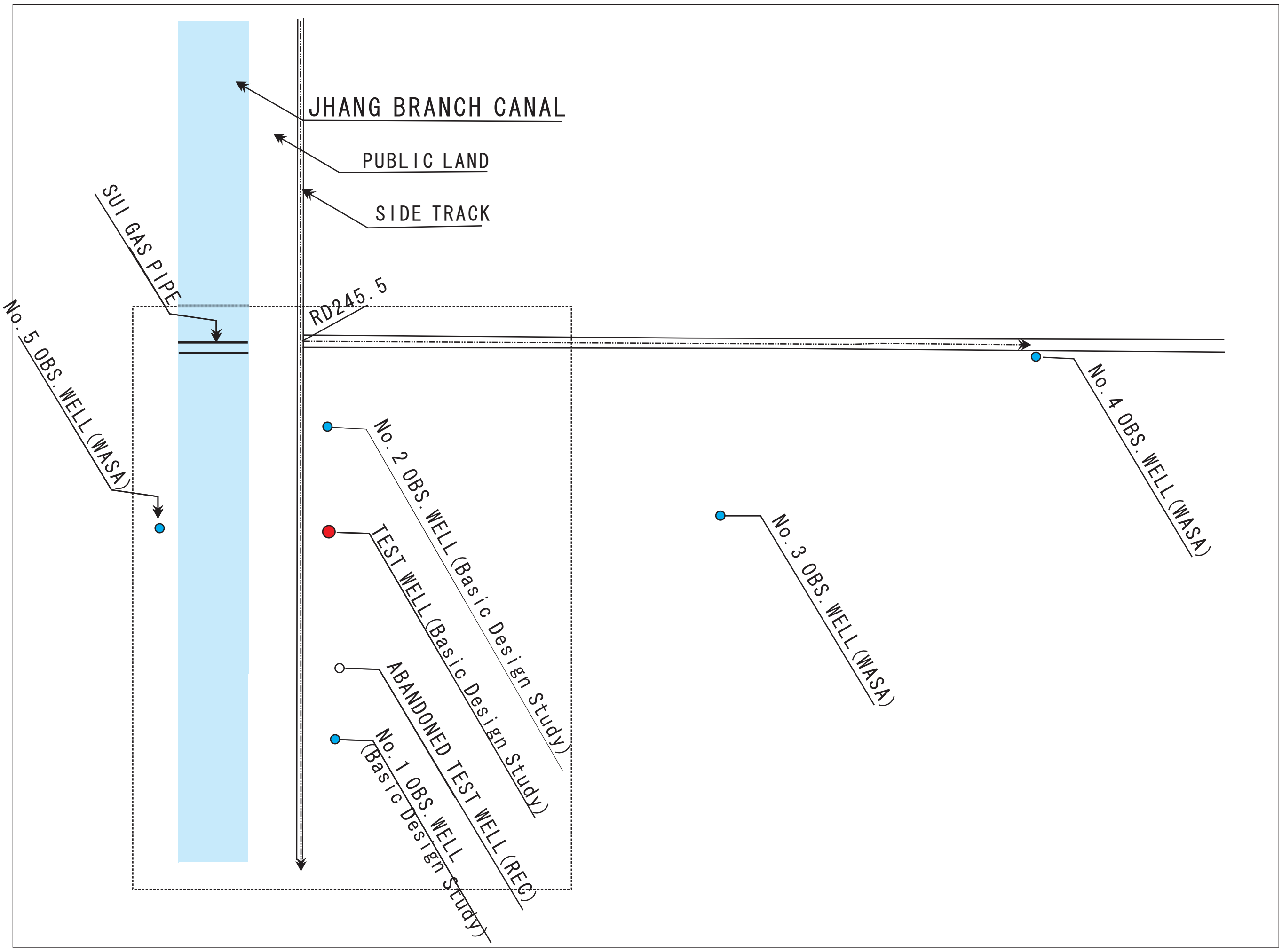
Fig. 2-6.

c. Aquifer test

* The water levels at the test well and observation wells were stabilized in about 360 minutes ater pumping started during testing due to apparently forced recharge from the Jhang Branch Canal.
* The analysis of the test results indicates that pumping at the planned tubewells would hardly affect groundwater level in the surroundings thanks to constant recharge from the canal, provided that an appropriate unit discharge rate is employed, with adequate spacing set between tubewells. During the closure of the canal in winter season when no recharge occurs, however, the level tends to gradually fall down, and eventually is likely to affect the surroundings on the medium to long term basis.

d. The test results are described in detail in the following section 2-2-2-1-2).

FIG. 2-2 TEST DRILLING SITE ALONG JHANG BRANCH CANAL



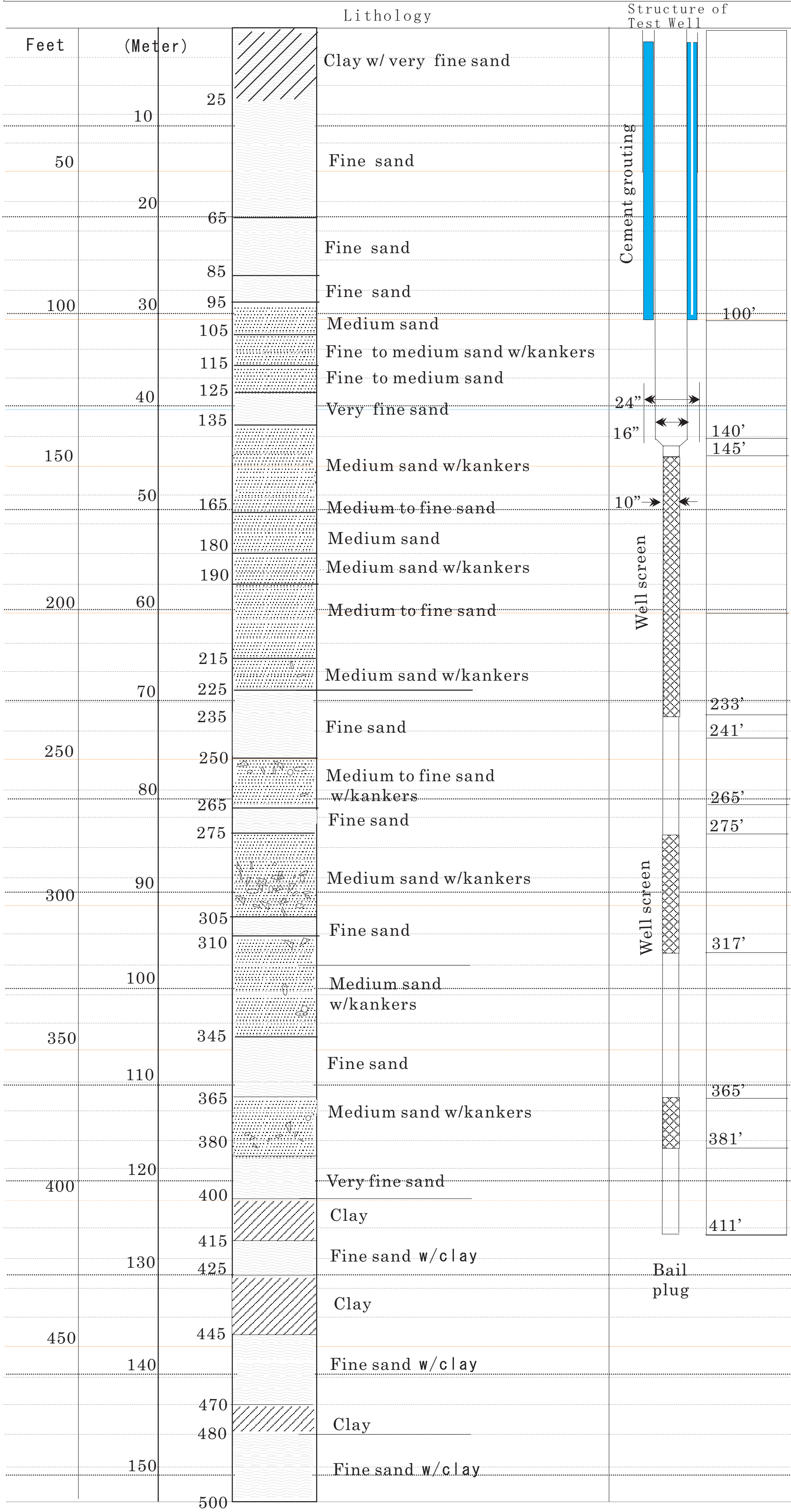
DRILLING SITE FOR BASIC DESIGN STUDY

Drilling machine is working for test well drilling. The tripod behind is for observation well No. 2.

The green belt on the left is the left bank of the canal.

Fig. 2-3 STRUCTURE OF THE TEST WELL FOR B/D STUDY

Well No. 22	Construction Date: 4 - 09 - 03	～	07 - 09 - 03
S. W. L.= 5.74 m(1988)	Q . = 3.75cusec	(375 m3/hr)	



Characteristics of Test well

Main aquifer is sand divided into 3 sections by interbeds of clay. The drilling point of the test well had a thick sand layer correspon-ing to the second group, but lacks the third group. Accordingly although drilling reached a depth of 153m, casing and screen were installed to 125m, with the lower part left untapped.

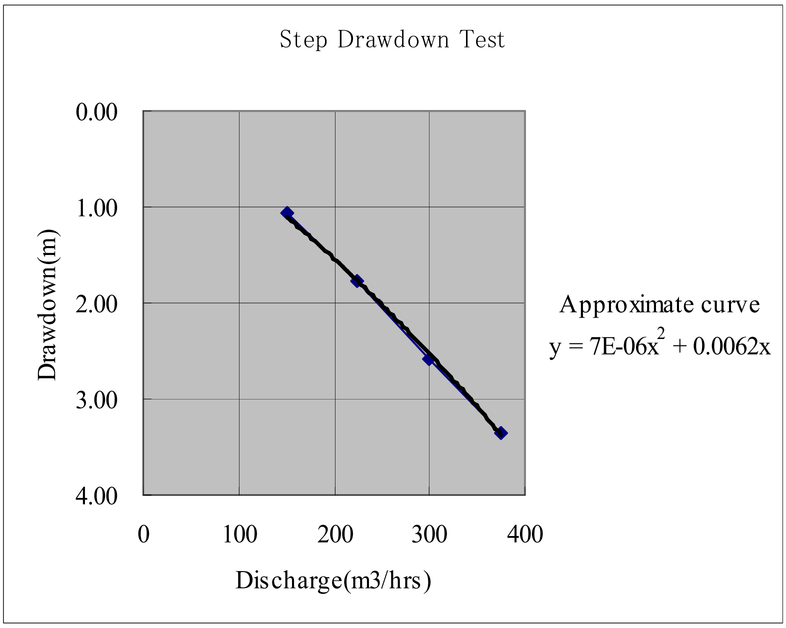
Each drilling point is planned to be confirmed for the depth by geophysical survey during the detailed design.

2) Water sources planning

(1) Discharge

REC, the local consultant, which conducted an extensive survey for groundwater development from the Jhang Branch Canal to the city, recommended a discharge of one tubewell to be within a range of 2 to 4 cusec. During the step drawdown test in this study, 4 incremental discharges within the said range were employed to examine an optimum rate. The results indicating the respective discharge rates versus drawdown are plotted in the following graph (Fig.2-4):

Fig. 2-4 Step drawdown graph



A plotted curve on log-log graph is almost straight without any abrupt change in its gradient, indicating that the ratio of drawdown to discharge is nearly proportional to each other. While any discharge keeps such a proportional relation with drawdown, it is defined as “safe yield”, and can be pumped without risking eventual depletion of the source. The results of the step drawdown test justifies REC’s former estimate of a unit discharge rate, ranging from 2 cusec to 4 cusec.

For the determination of a unit rate of discharge per well, the following conditions were taken into account:

a. The pumping water level at a tubewell gradually recovers to its initial static water level after pumping is stopped, depending upon the condition of recharge to the aquifer. In this study, it took about 6 hours for the test well pumped at a constant rate of 3 cusec to restore its initial level. It is not economical to idle 20 or more wells for 6 hours a day.

b. The existing tubewells in the Chenab wellfield discharge as much as 4 cusec from one well. As their daily idling hours are limited to 4 hours, the water levels at them do not return to their initial state by the time pumping re-starts, and the continuous operation of group wells in the wellfield has resulted in ever-increasing fall of groundwater level in and around the wellfield.

c. From such experiences at the site, the unit pumping rate for the project is proposed to be limited to less than 3 cusec to ensure water level recovery in an idling period as short as practicable, which will be 4 hours at maximum, as ongoing practice of WASA. An economic pumping rate to meet such requirements is 2 cusec (approximately 200m^3/hr). At this rate, the water levels of wells can be restored in about 4 hours after the pump stopped.

(2) Number of tubewells

a. Calculation of the number of tubewells

The factors to determine the required number of tubewells are as follows:

* Targeted total discharge	91,000m^3/day
* Unit rate of discharge from one well	200 m^3/hr/well (approx. 2 cusec)
* Duration of pumping a day	20 hours/well (4-hour idling)

Based upon these factors, the required number of tubewells is:

91,000 (m^3/day) / ［200 (m^3/hr) x 20 (hrs)］ = 22.75 (say 23) wells

In addition, standby tubewells are required for maintenance and repair. If 10% of the total number is assumed, it is 2 wells. As a result, the required number of tubewells totals “25”.

(3) Distance between adjacent tubewells

i. Estimate of seepage

The tubewells for the project are to be installed in a belt-like wellfield along the left side of the Jhang Branch Canal where artificial recharge from seepage of the canal can be anticipated. If their total discharge is less than an amount of estimated seepage, their water level can recover to the initial one during a proper idling period after it once lowered during pumping. A cycle of pumping and idling can maintain the regional groundwater level.

For the project WASA examined a range of seepage to the proposed wellfield along the canal in November 2003. The past study by REC for the area also included this type of test. The results are shown in the following table 2-5:

Table 2-5 Results of Seepage Tests along the Jhang Branch Canal

	Client	Tested by:	Year	Estimated seepage rate
1	FDA/REC	Irrigation Research Institute	1981	633 m^3/hr/km (of channel) =15,192 m^3/day/km
2	WASA		2003	437m^3/hr/km (of channel) =10,488 m^3/day/km
			Average	535m^3/hr/km (of channel) =12,840 m^3/day/km

Seepage tests are likely to result in a wide range of differences in the estimated rates, depending upon methodologies employed, physical properties of tested channels, etc., therefore, it should only be treated as an estimate. Nevertheless, it will still be needed as a reference to prevent excessive withdrawal from the canal, since the tubewells in this project will be constructed along the canal and will be recharged directly from it. Therefore, an average rate of the two tests is employed for this project. The rate can function as an index for the discharge of groundwater along the canal.

ii. Discharge of tubewells for irrigation

The existing tubewells for irrigation in and around the wellfield have been utilizing groundwater deriving from seepage. The amount of their discharge is estimated as follows:

a. According to the field survey by WASA for the project, there are 108 tubewells existing in an area about 20 km long and 3 km wide along the canal including the site for the proposed wellfield.
b. An average discharge from a tubewell is estimated as 1 cusec (100m^3/hr), based upon the practice of drilling for irrigation wells and capacities of pumps.
c. Their running hours are normally 10 hours daily. In addition, during two months in the rainy season every year, most of them are closed. This practice leads to an average operating ratio of 40%.
d. An approximate total discharge of 108 tubewells are estimated as follows:
   - Daily discharge along a section of 1 km of the canal
   = ［(108 wells) x (100 m^3/hr/well) x 24 hours x 0.4］ / (20km) =5,184 m^3/day/km

The total estimated discharge of irrigation tubewells accounts for about 40% of an average seepage rate of 12,840 m^3/day/km.

iii. Distances of proposed tubewells

Based upon the results of the foregoing estimate, the spacing between 2 tubewells for 23 regularly in operation is calculated as follows:

a. Total amount of seepage a day available for groundwater discharge in the area
   (It is assumed 90% of the estimated seepage can be utilized for the purpose.)

= 12,840 x 0.9 =11,556 m^3/day/km

b. Total amount of seepage a day allowable for groundwater discharge by the proposed tubewells
   = (a) - (discharge by irrigation wells) = 11,556 - 5,184 = 6,372 m^3/day/km

c. Daily discharge rate of one tubewell for the project
   = 200 m^3/hr x 20 hrs/day = 4,000 m^3/day

d. Length of the canal that can recharge the discharge rate (c)
   = (c) / (d) = 627m

As a result of this estimate, a distance between two wells should be 600 m as a minimum requirement. The total distance of the wellfield with 25 tubewells along the canal is, therefore,

(25 - 1) x 0.6km ≒ 14.5 km.

The major parameters for planning water sources for the project, defined in the foregoing estimates, are summarized in the following table 2-6.

Table 2-6 Major Parameters for Water Source Planning

	Parameters	Target
1.	Planned daily maximum discharge	91,000 m^3/day
2.	Planned daily discharge / one well	200 m^3/hr =4,000 m^3/day
3.	Total number of tubewells	23 + 2 as standby
4.	Daily running hours	20 hrs/day
5.	Distance between 2 wells in the well-field along the canal	600 m

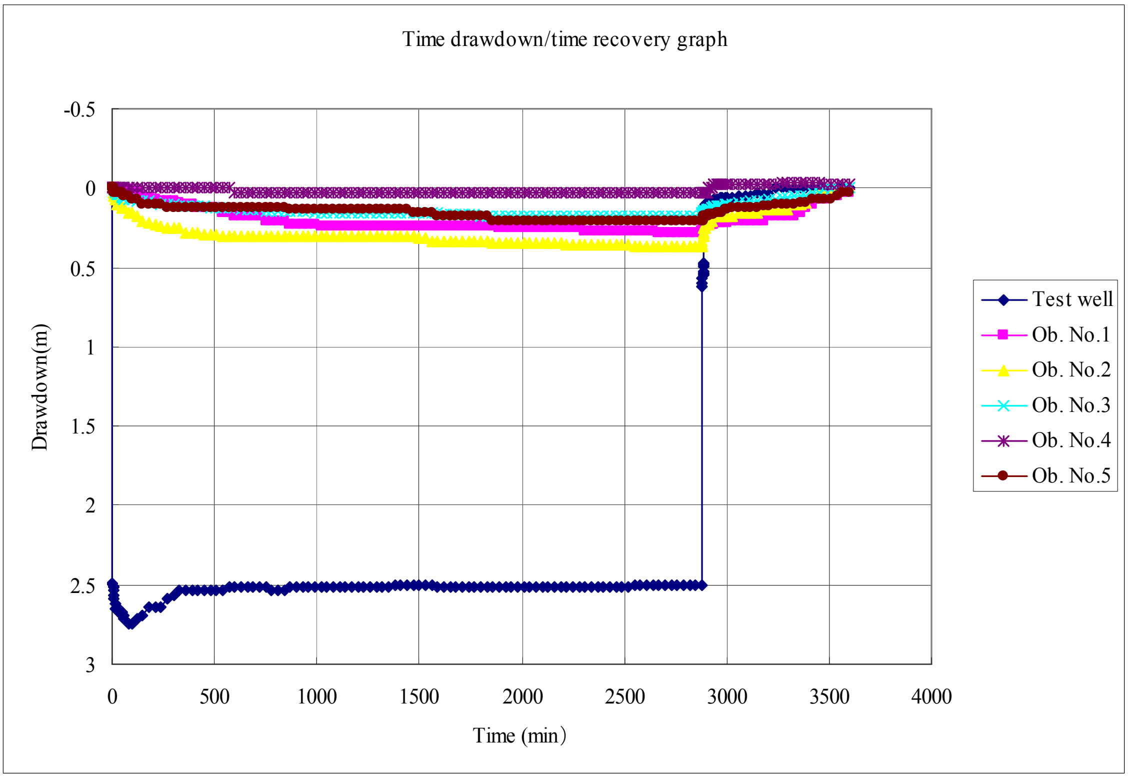
(4) Examination of Level Lowering and Extent of Influence

An extensive farming area spreads south of the Jhang Branch Canal, growing mainly sugar cane with delivery of canal water, together with groundwater discharge from private tubewells for irrigation. Since the operation of proposed tubewells on completion of the project has been feared by the local communities to affect their tubewells, lowering regional groundwater level, the extent of their influence is examined as follows:

i. Results of the time drawdown test

Drawdown at tubewells by pumping and its influence on their vicinity can be estimated by hydraulic calculation and graphical analyses, employing the values of “T” and “S” produced through the analysis of the results of time drawdown test, plotted in Fig.2-5.

Fig. 2-5 Time drawdown/time recovery graph



The time drawdown test for this study was carried out at a constant discharge rate of 3 cusec (about 300m^3/hr) for successive 48 hours, and was followed by the time recovery test after pumping stopped to confirm the recovery of levels. The members for the test consisted of one test well and five observation wells where the changes of water levels were measured simultaneously at predetermined intervals of time. The plotted graph shows specific features of the test as follows:

a. The static water level at the test well was 5.334m before starting pumping. In about 360 minutes after pumping started, the level stabilized at 7.83m, without any further drawdown until the end of pumping in 2,880 minutes. The thus stabilized level indicates the occurrence of direct recharge from the nearby canal, in this case the Jhang Branch Canal.

b. The water levels at 5 observation wells lowered little by little as pumping proceeded. All of them reached stabilization in 300 minutes after pumping at the test well started.

c. The drawdown at No. 4 observation well at a maximum distance of 359m from the test well was recorded as 20mm at the end of 48-hour successive pumping at the test well. The location of this well seemed to undergo no substantial influence by pumping at the test well.

d. The recovery of the level at the test well to the static water level took 6 hours after pumping stopped, while those at 5 observation wells, more or less 10 to 12 hours.

ii. Calculation of Coefficients of Aquifer

As described in the foregoing section, the test well seems to have received recharge from the canal during a greater part of its pumping period. The data consisting of stabilized level for most part offers no significant information on the features of aquifer function. The analysis, therefore, mainly depended upon the data before substantial recharge occurred, using the relation of drawdown to time and distances of the test well and 5 observation wells. The process of calculation for the coefficients of the aquifer "T" and "S" are referred to Appendix. The results are summarized in the following table 2-7, together with reference to the data obtained through the past studies covering the same area and its vicinity.

Table 2-7 Lists of Coefficients of Aquifer in the Study Area

Test wells	Method for calculation	Coefficient of Transmissibility, "T" (m^2/day)	Coefficient of Storage "S" (non dimensional)
This study (one test well & 5 observation wells)	*Distance-drawdown analysis(1) of 5 observation wells	15,686	3.22E−0.2
	*Distance-drawdown analysis(2) of one test well/5 observation wells	2,840	3.88E−0.2
	*Recovery method (No. 2 well)	13,071	8.47E−0.3
	*Recovery method (No. 3 well)	24,674	1.40E−0.2
Study by REC	*Recovery method (RTW1 well)	5,312	2.50E−0.2
	*Recovery method (RTW2 well)	7,080	1.27E−0.2
ADB tubewells in the Chenab	*Pumping test (No. 18 well)	11,094	
	*Recovery method (No. 18 well)	9,861	

Note: The data for the ADB tubewells is from the report of completion of drilling works. The coefficient of storage is not calculated. The report shows that an average value of "T" from the pumping tests at 23 tubewells was 12,000m^3 /day.

The calculated values of T and S in this study differ widely, probably due to intensive influence of direct recharge from the canal. However, in comparison to those in the previous studies, they are interpreted to fall within an acceptable range.

iii. Prediction of extent of influence

Using the values of "T" and "S" thus obtained and the relation of distance from the test well to the observation wells with drawdown, the extent of influence of pumping at the proposed tubewells was examined. The detailed process of calculation is shown in Appendix. For this project, the unit rate of discharge from one well is to be 200m^3/hour at successive pumping of 20 hours/day, with the idling time of 4 hours. The summary of the analysis is described as follows:

a. The tubebwells are to be installed at intervals of 600m along the canal. Interference among the tubewells occur in case the influence of pumping at one well extends beyond a radius of 300m. The hydraulic analysis predicts that the radius of influence remains within a radius of that limit during 20 hours of daily pumping at a well, thanks to constant recharge from the canal which equals discharge. Accordingly pumping at the proposed tubewells will not exert any adverse influence on surrounding tubewells for irrigation.

b. All canals of the Jhang Branch Canal are closed every year for about one month for their maintenance and repairing works. During this period, they have no delivery from the headwork, and there is no recharge from them. As a result, water level at pumping wells continues to lower with a larger rate of drawdown than during the normal period. The influence of pumping can extend beyond the radius of 300m. At the end of closure in about one month, the radius of influence is likely to extend to 2.5 km at the minimum from pumping wells and as far as 5 km in the worst case, depending upon the values of T and S. Influence of a middle range between the minimum and the maximum is likely to occur in the actual scene.

c. The amounts of lowering of level are predicted, based upon the assumption described in the foregoing section as follows:

* In case of the minimum influence:
  The radius of influence reaches 2.5 km from pumping wells.
  Groundwater level at a distance of 730m from wells is calculated to lower by 0.25m after 30 days of canal closure.

* In the worst case
  The radius of influence will enlarge to a distance of 5km from pumping wells.
  Groundwater level at a distance of 1,900m from wells is to lower by 0.25m after 30 days of canal closure.

d. To make the matter worse, lowering of level is likely to be almost doubled due to interference between two adjacent pumping wells, since the influence from each well extends beyond the limit of 300m.
If influence of a middle range of two extremes is assumed, such effect of influence will result in lowering of groundwater level by 0.5m at a distance of 1.3 km from the wells.

e. Once groundwater level is thus lowered, it will not be able to return to the former one even after the canals restart delivery, since it was assumed to utilize seepage to its full extent for discharge of existing tubewells for irrigation as well as for the project. The lowered level will probably persist, and the closure of canals each year will further deepen the level. This assumption leads to a prediction that within 5 years after the tubewells for the project starts the operation, groundwater level at a distance of 1 km from them will be 1 m deeper than the initial one.

f. The discharge of this project relies on the recharge of the canals, and the lowering of the groundwater level also depends on the extent of recharge from the canals. Although the level of recharge has been clarified to a certain extent by the data of WASA seepage tests, the influence from the wider area is still uncertain. In the worst case scenario, the lowering of groundwater level will gradually progress during the closure of the canals.

g. There is another risk of influence from 28 tubewells in the Chenab wellfield, where groundwater level has continuously been lowering for the past 10 years. This study included the estimate of their influence to the wellfield along the Jhang Branch Canal. The analysis indicates the influence soon reaches this area and that within 10 years will lower the level in this area by 2 to 3 meters.

iv. Groundwater Monitoring Program

The hydraulic analysis indicates regional groundwater level will probably be affected by the operation of the tubewells for the project, and within about 5 years after the commencement of operation a part of tubewells for irrigation located near the project wells may face difficulty in pumping.

However, since the prediction of this study is based upon the results of aquifer test at a single tubewell, it goes without saying its accuracy is in a limited extent. It is recommended, therefore, that WASA establish a properly constructed monitoring system and launch measurements of level at its own tubewells as well as at monitoring stations with reference to the following remarks.

a. Monitoring wells should comply with WASA's standard design.

b. Monitoring wells should be installed along three lines, one at a distance of 500m from the canal, the other at 1,000m, and another 3000m. Each line should have 5 monitoring wells at the minimum.

c. The tubewells for the project should be subject to daily measurements of static water level and the dynamic water level at the respective wells just before pumps are stopped. Discharges should also be recorded by flow meters installed in the respective stations.

d. Measurements of levels at the monitoring wells should be undertaken by the responsible operators at the nearby tubewell stations. During one month after pumping from the tubewells starts, levels at the monitoring wells along a line of 500 m distance should be measured in particular as frequently as practicable, at the intervals of 30 minutes to 1 hour or the like. If influence tends to expand more than expected, such measurements should be extended to those along a line of 1,000m. After one month, measurements at monitoring wells may be taken at a less frequency, say several times a day.

If laborious monitoring is continued for one year after commissioning, the data for predicting precisely the extent and size of influence of pumping wells could be collected, at least for the period when canals continues to deliver water.
During the period of canal closure, the extent of measurements at monitoring wells may expand to a line of 3,000m.

It is further recommended that WASA should develop friendly relations with local communities for risk management concerning the security of regional groundwater through the establishment of a liaison committee consisting of representatives of stakeholders in the area including those from WASA and local administration. Representatives from concerned villages should be responsible for preparing the inventory of tubewells in their areas and regularly reporting their conditions. The committee should constantly be aware of the general opinion and the movements of the society, and intervene actively and practically when problems arise.

(5) Water Quality

Water quality in the study area extending about 30 km long from the left bank of the Chenab to Faisalabad was examined in detail by the previous studies. Its features are reported to be as follows:

a. Groundwater quality is good in the area along the Chenab where fresh deposits continues to the bedrock at a depth of about 200m, with its content of TDS ranging from 500 to 1,000 mg/lit.

b. Discharge from WASA's existing tubewells in the Chenab wellfield has maintained good quality with its TDS at a level of more or less 500 mg/lit since their commissioning in 1992. The Chenab wellfield is located where one of old channels of the Chenab runs with fresh deposits continuing towards the present course of the stream.

c. On the contrary, quality tends to get deteriorated in the direction towards the city, where older deposits with an increasing content of salt become predominant. Moreover shallow groundwater there has entirely been contaminated artificially.

d. The city keeps one exceptional wellfield along the Rakh Branch Canal where groundwater with good quality can be secured. Fresh water with its TDS ranging from 500 to 1,000 mg/lit occurs in lenses in a belt-like zone along both sides of the canal, thanks to seepage of the canal. WASA presently operates about 20 tubewells in this wellfield. There were 50 wells in the past and excessive pumping had resulted in degradation of water quality and lowering of water level. Based on the evaluation of seepage volume conducted for the formulation of World Bank’s 1992 Master Plan, the number and the distribution of wells were reorganized to the current state in

2001. WASA continues to conduct water quality tests for Rakh well field.

e. The isograms of TDS in the study area as the results of the previous study are shown in Fig.2-6 for reference.

During the first and the second stages of this study, water quality of existing tubewells was extensively examined. A part of samples were analyzed by WASA Laboratory. Appendix shows the results of water analysis on the field as well as by the laboratory of tubewells for irrigation, together with data for WASA's Chenab tubewells.

To examine water quality at the tubewells for the project, samples were taken from the test well at the end of time drawdown test during the second stage of the study. The results analyzed by WASA labolatory is shown in Table 2-8, together with data of tubewells for irrigation existing within a distance of 100m from the wellfield. All the data indicates the occurrence of groundwater with good quality in the proposed wellfield.

Good quality can be guaranteed through ample seepage from the canal as is the case with the city's wellfield along the Rakh Branch Canal. The area around the Jhang Branch Canal is considered to have been a periphery zone of the old river course of the Chenab, where fresh deposits prevails, leading to good quality of groundwater occurring in them. This geological feature of this wellfield differs from that along the Rakh Branch Canal where old deposits with deteriorated quality of groundwater dominates. However, in order to maintain good quality, periodical monitoring will be required for quality as well as groundwater level.

WASA has been taking TDS as the standard indicator of water quality, with 500mg/lit as the target value. In the preceding project implemented in Chenab wellfield(approximately 5km to 10km north of this Project’s target wellfield), this value had been maintained. However, since the target area in this Project is near the area of poor water quality, WASA considers 1,000mg/lit (WHO recommendation) to be within an acceptable level.

Fig. 2-7 shows the isograms of TDS in the study area, based upon the results of water analysis on site and by WASA laboratory through the first and second stages of the study. Compared to the previous maps in 1970s and 1980s shown in Fig.2-6, the deterioration of groundwater quality is now in progress.

The World Bank's Master Plan anticipated good quality could be preserved in the reach of the Chenab, and assigned the area for another wellfield under the assumption that the degradation of water quality in the urban area will not spread further, with the Jhang Branch Canal acting as a buffer zone. However, the result of this current study suggests a progression of artificial pollution in the lower region of the Chenab River beyond Chiniot City (population 250,000), in the north-western part of the project wellfield. Degradation of water quality in villages near the canal is becoming apparent, probably due to raw sewage from the city being discharged into the streams along the Chenab River.

To the south of the proposed wellfield are many villages of large scale, each with a population close to 10,000. Daily life and active farming in these villages have resulted in artificial contamination of shallow groundwater in the surrounding areas through discharge of large quantities of waste water.
Particularly all domestic sewage and waste water flow into lower land within villages, creating a large pond of waste storage. Such a situation seems to highly contribute to the progressive deterioration of groundwater quality, with its TDS rising to an extraordinary higher range than that in the surrounding area. (In Fig.2-7, tubewells No. 2, No.3, No. 34 and No. 112 are typical examples.)

Being an agricultural area, there was a concern of agrochemical contamination. However, from the studies conducted in 1998 and in the first Basic Design Study, the influence of agrochemicals was not detected. This may be due to the fact that the majority of the farmers are poor and the absolute quantity of fertilizers used tends to be extremely low. Recently there is a move towards establishing an agrochemical testing system in the City, in collaboration with WASA Water Quality Laboratory. A development of a comprehensive water quality monitoring system which integrates testing in agrochemical contamination will be recommended.

Although a progressive artificial pollution in the surrounding areas may be predicted, it can be concluded, based on the past experience with the tubewells around the Rakh Branch Canal, that the possibility of the Jhang Branch Canal Project wellfield being affected is minimal as long as the intake is balanced with the recharge from the Canal.

Meanwhile, the increasing contamination of groundwater from the shallower level, utilized by the villagers as domestic water, is a source of concern for the villagers and appropriate measures for environmental protection is urgently needed. Positive efforts are required from the Administration at this stage.