WATER FACILITIES EXPLOITATION DEPARTMENT
ULAANBAATAR CITY
MONGOLIA

BASIC DESIGN STUDY REPORT ON THE EMERGENCY REHABILITATION OF WATER SUPPLY FACILITIES IN ULAANBAATAR CITY IN MONGOLIA

FEBRUARY 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON JOGESUIDO SEKKEI CO., LTD.

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PREFACE

In response to a request from the Government of Mongolia, the Government of Japan decided to conduct a basic design study on the Emergency Rehabilitation of Water Supply Facilities in Ulaanbaatar City in Mongolia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Mongolia a study team from September 12, 1995 to October 6, 1995.

The team held discussion with the officials concerned of the Government of Mongolia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Mongolia in order to discuss a draft basic design, 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 Mongolia for their close cooperation extended to the teams.

February, 1996

Kimio Fujita
President
Japan International Cooperation Agency

February, 1996

LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Emergency Rehabilitation of Water Supply Facilities in Ulaanbaatar City in Mongolia.

This study was conducted by the Nippon Jogesuido Sekkei Co., Ltd., under a contract to JICA during the period from September 4, 1995 to March 15, 1996. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Mongolia 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,

Kenji Takayanagi
Project Manager,
Basic design study team on
the Emergency Rehabilitation
of Water Supply Facilities in Mongolia
Nippon Jogesuido Sekkei Co., Ltd.

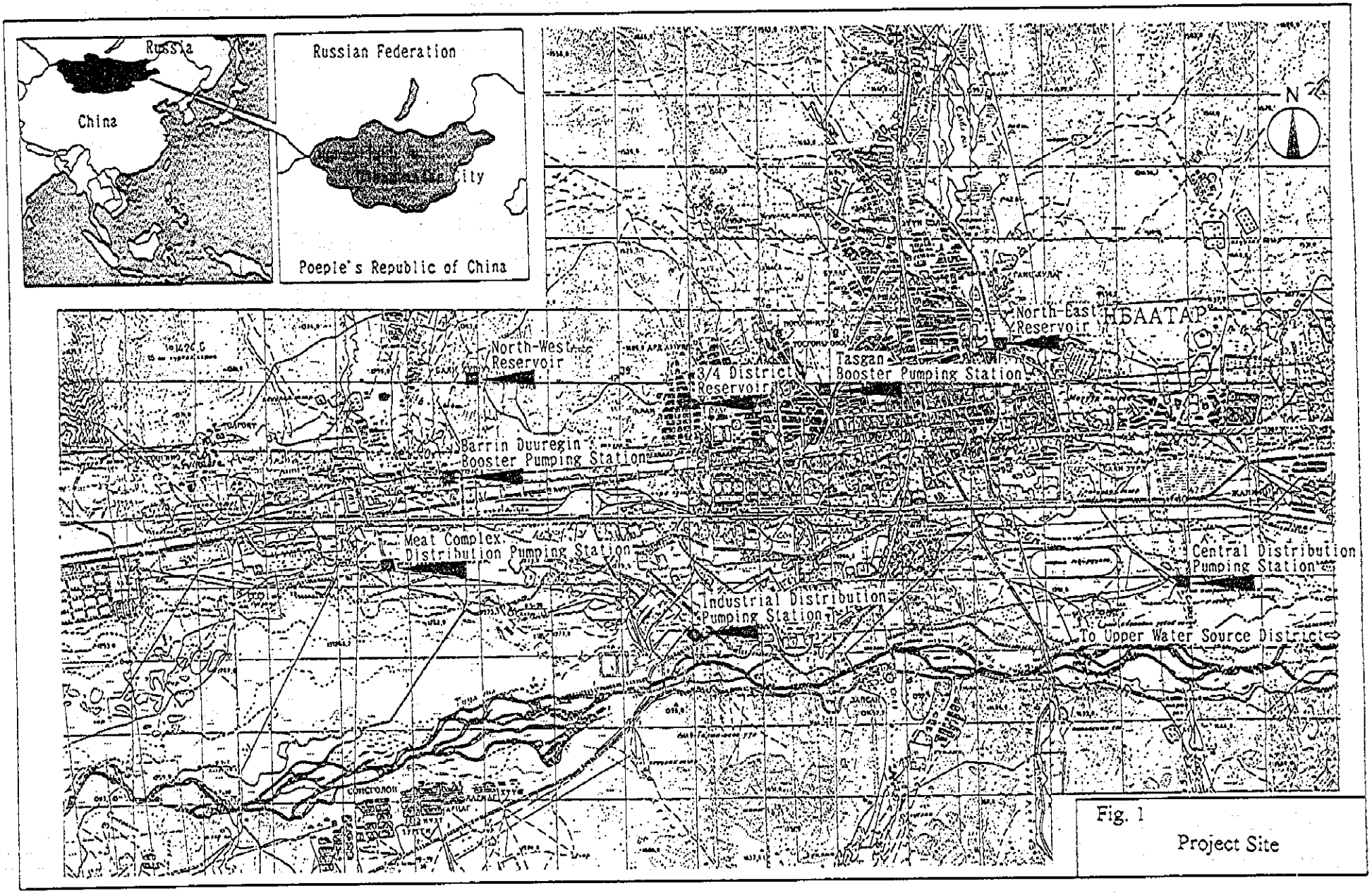


Fig. 1

Project Site

LIST OF ACRONYMS AND ABBREVIATIONS

The following abbreviations have been adopted in this report

Implementation Agency :

USAG	: Water Facilitie Exploitation Department Ulaanbaatar City (Ulaanbaatar City Water Supply Bureau)

Country :

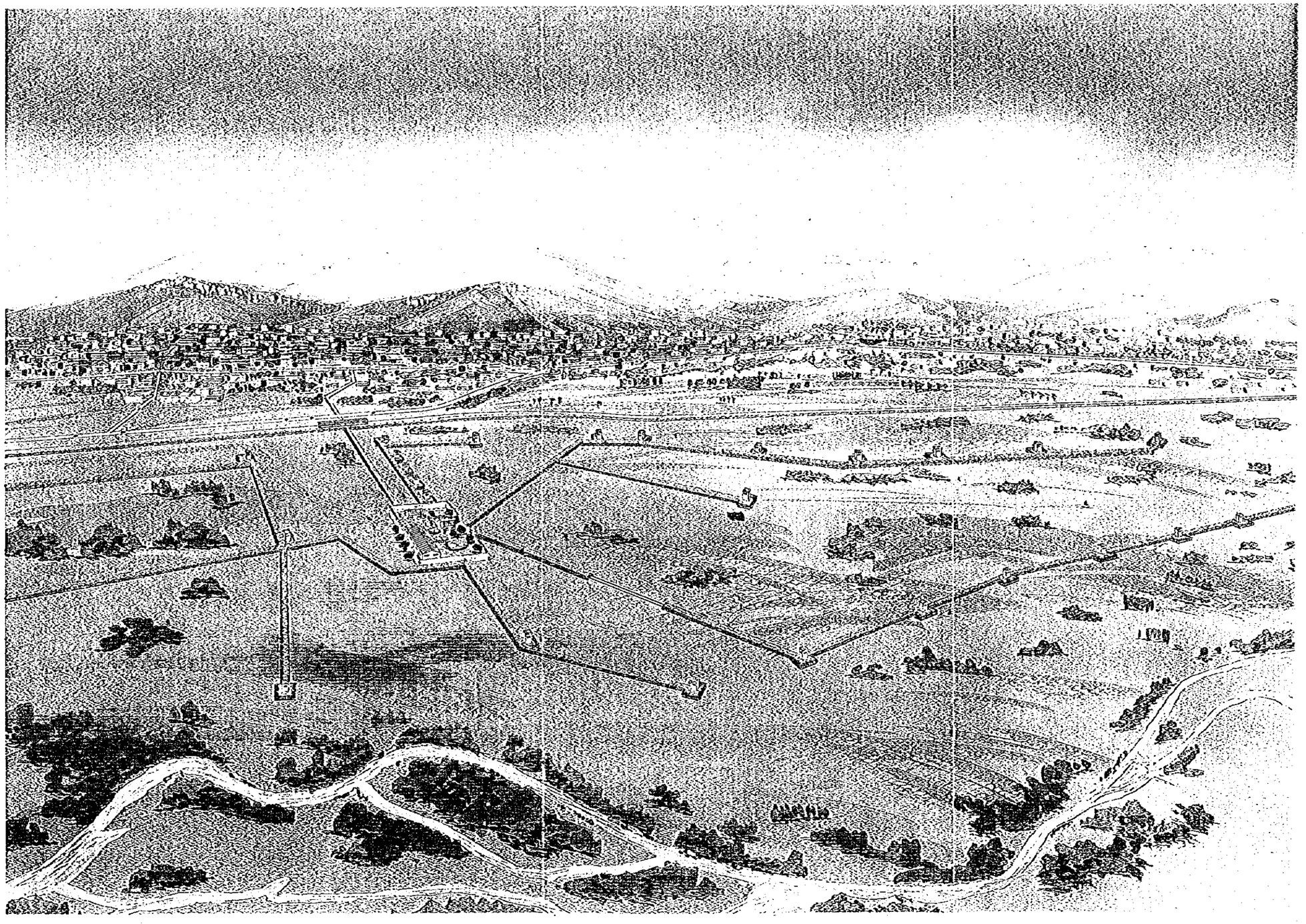
China	: People's Republic of China
USSR	: Union of Soviet Socialist Republics

Others :

ADB	: Asian Development Bank
City	: Ulaanbaatar City
CTP	: Community Heating Center
GOJ	: Government of Japan
GOM	: Government of Mongolia
JICA	: Japan International Cooperation Agency
JOCV	: Japan Overseas Cooperation Volunteers
MEDS	: Mongolia Economical Development Strategy
Project	: The Emergency Rehabiltation of Water Supply Facilities in Ulaanbaatar City in Mongolia (Basic Design Study)
Social Development Project	: The Study on Water Supply System in Ulaanbaatar and Surroundings conducted from 1993 to 1995.

Units of Measurement :

%	: percent
"	: inch (2.54 cm)
km	: kilometer
lpcd or l/c.d	: litter per capita per day
MHz	: mega hertz
m	: meter
mm	: millimeter
m^3/day	: cubic meter per day
PVC	: polyvinyl chloride
Tg	: tugrik (Mongolian currency unit)



Overview of Intake Wells and Distribution
Pumping Station of the Central Water Source

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CHAPTER 1 BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

Ulaanbaatar City, the capital of Mongolia, has been developed as the governmental, economical, and cultural center of Mongolia and is located in the northeast portion of the country. It has a population of 650,000 according to the 1995 census. This is one fourth of the country's total population of 2,250,000.

The city's water supply system was constructed with economical cooperation of the former Union of Soviet Socialist Republics (USSR) from the 1950's to the 1960's using USSR-built equipment. Due to the difficulty of the procurement of spare parts after the USSR's political revolution in 1990 and to the inadequacy of the Water Facilities Exploitation Department, Ulaanbaatar City (USAG) maintenance budget in the face of large electric expenditures resulting from the ineffective operation of the system, the system deteriorated. The system is now not in good condition and cannot deliver a sufficient amount of water to meet the increasing water demand.

The city's water supply system is managed by the USAG (city's water supply bureau) and supplies water to the apartment complexes and also to the Ger areas (areas containing private residential tents developed during Mongolia's nomadic past and still used today). The system consists of wells taking riverbed water of the Tuul River and distribution pumping stations with its associated distribution pipeline networks. The supply capacity of existing system is not large, and shortages are anticipated in the future. It is estimated that the shortages amounted to 5,800 m^3/day in 1993 and will reach about 25,000 m^3/day in the year 2000. Also, the waterworks management and organization requires strengthening in order to cope with the shift to a market economy system.

Recently, the water demand increased significantly. This increase is blamed on the influx from the rural areas, the change of life style, and industrial promotion efforts associated with the shift toward a market economy. Accordingly, the water supply volume cannot meet the water demand, especially at the end of the dry season (from April to May), which often results in the suspension of water supply in the city.

Based on the background mentioned the above, the GOM requested assistance for a social development survey from the GOJ.

In response of the request of the GOM, the GOJ decided to conduct a social development survey relating to the water supply in Ulaanbaatar City and JICA dispatched a preparatory study team (S/W mission) from March 1st, 1993 to March 16th, prior to the dispatch of the study team.

Based on the preparatory study's results, JICA conducted "the Study on Water Supply System in Ulaanbaatar and Surroundings" from August 1993 to March 1995. The study established a master plan (M/P) with a target year of 2010 and a feasibility study (F/S) for development of new water sources. As a result of survey, water demand in the year 2010 will increase to 285,000 m^3/day. The city needs the development of a new water source of 106,000 m^3/day because the present water source capacity is smaller than that of the future demand, amounting to some 179,000 m^3/day. The future development of water sources shall be examined by the combination of the existing water sources of (1) the Upper Water Source, (2) the Central Water Source, and (3) the lower part of Nalaih in the new target area. The study proposed that the expansion plans for the water supply systems be performed in three stages to cope with the increase in water demand. As a precondition of the implementation of the M/P, the study proposed to conduct an emergency rehabilitation program to recover the design supply capacity of the system in the three years, starting from 1996.

Based on the proposal for the emergency rehabilitation program planned in the above study, the GOM requested the GOJ to conduct the program by Grant Aid. The contents of request is shown in Table 1-1.

Table 1-1 Contents of Original Request

Items		Contents of Original Request	
		Quantity	Remarks
Renewal of Intake Pumps (installation)	Central W.S.	23 units	including major pipes in the pump house, flow-rate measurement device, electric-motor valve and check valve in the delivery pipe, electric control panel, room heater, lamps, and manual hoist.
	Industry W.S.	7 units	
	Meat Complex W.S.	5 units	
	Total	35 units	
Standby Pumps	(procurement only)	11 units	about 30 % of the number of new pumps
Renewal of Distribution Pumps	Central W.S.	5 units	
	Tasgan Pumping Station	1 unit	
	Industry W.S.	2 units	
	Upper W. S.	2 units	
	Total	10 units	
Procurement of Well Construction Materials	Well Drilling Rig	1 unit	Truck-mounted percussion type drilling rig, Capacity: diameter max. 500 mm, drilling depth max. 100 m
	Screen and Casing	20 units	Well depth: 33 m, Casing diameter: 300 mm Screen: round-wire type, 300 mm diameter
CTP Flow Meter		40 units	Diameter: 150 mm
Remote Control System (C.W.S)	New Intake Pumps	1 unit	Enable operators to operate existing intake pumps at the control centers in the distribution pumping stations.
	Existing Intake Pumps	1 unit	
Development of Upper Water Source		L.S.	

CHAPTER 2 CONTENTS OF THE PROJECT

Chapter 2. Contents of the Project

2.1 Objectives of the Project

The Mongolia National Economic Development Policy, published in 1994, indicates that social infrastructure development is indispensable as a prime measure for national economic growth and puts a high priority on the development of water supply facilities. The Study on Water Supply System in Ulaanbaatar and Surroundings, conducted by JICA between 1993 and 1995 prior to this Project, established a water supply plan with a target year of 2010 and proposed not only a three-stage implementation schedule as a long-term expansion plan but also the emergent rehabilitation of the deteriorated existing facilities starting from 1996 to 1998.

The USAG charges a water tariff in proportion to the consumed water flow measured by meter only in the industrial area, while households in the apartment complex area, which account for 55% of total population of the city have no flow meters and it is unknown how much water is consumed by each household. The water tariff , therefore, is charged using a per-capita basis, assuming that one person consumes 150 liter/day. This means that the actual water consumption is not reflected in the tariff revenue. Due to the deterioration of the facilities, a great deal of the supplied water is wasted through leakage and other defects.

As to the operating costs, the existing facilities have not been maintained properly since the necessary budget for the spare parts and depreciation costs is compromised by the excessive electricity costs induced by the inefficient operation of the facilities. These conditions hinder not only the stable and continuous operation of the facilities but also make it difficult to conduct sound and independent waterworks management.

The objectives of this project are 1) to establish stable water supply by the rehabilitation and renovation of the deteriorated existing facilities, improving the operating efficiency of the facilities and 2) to improve waterworks management by reducing electricity expenditures and the unaccounted for water volume--thereby increasing water revenue.

It is strongly suggested that the USAG makes and implements a strategic plan to reduce the unaccounted for water volume and to increase its tariff revenues to promote stable waterworks management so as to keep pace with this Project (refer to APPENDIX A-7 STRATEGIC PLAN).

2.2 Basic Concept of the Project

The request by the Mongolian side has been modified slightly considering the efficient and integrated operation of the existing total system and the results of the detailed survey of the facilities.

The matrix of the basic concepts of the Project is described in Table 2-1. Utilizing this matrix, a number of alternative plans for each concept item are subsequently enumerated and compared. As a result, a combination of selected alternatives is chosen to produce an optimized plan.

Table 2-1 Basic Concept Matrix

Item	(1) Objectives of the Project	(2) Target Year and Rehabilitation Subject	(3) Unit Consumption Rate and its Reduction	(4) Preservation of Water Source Quality	(5) Three Water Sources	(6) Upper Stream Water Source	(7) Well Reconstruction	(8) Replacement of Intake Pump	(9) Replacement of Distribution Pump	(10) Remote Control of Intake Pump
Alternatives	1-1 Rehabilitation of existing facilities to restore original design capacity	2-1 Target year: 1995 Subject:deteriorated facilities	3-1 As requested	4-1 USAG takes anti-dumping measures and removes the existing wastes to control water quality	5-1 As requested new construction consists of : Central 8 Industry 7 Meat Complex 5 Total 20	6-1 As requested	7-1 Select existing wells with low well efficiency in Industry, Meat Complex and Central Water Source based on the result of pumping test	8-1 All the existing pumps in the three water sources are checked on their conditions and deteriorated ones are selected	9-1 All the existing pumps in the three water sources are checked on their conditions and deteriorated ones are selected	10-1 All the existing pumps in the three water sources are checked on their conditions and centralized remote control is installed
	1-2 Total renovation including improvement and rehabilitation of existing facilities to reduce electricity expenditures, non-revenue water through the efficient operation of the water supply system	2-2 Target year: 1999 Subject: facilities which have already deteriorated as well as those anticipated to be deteriorated before target year	3-2 Consumption rate for the residents in the apartment area will be reduced gradually so that the original design capacity could cover the increased water demand due to population growth	4-2 Problems still remain even after USAG takes anti-dumping measures and removes the existing wastes	5-2 Existing intake capacity for Industry and Meat Complex. Up to full capacity for Central Water Source (without expansion)	6-2 Out of the scope of this Project	7-2 Industry and Meat Complex wells are out of the Project's scope due to their water quality and no space for construction sites resulting in well interference. Only Central Water Source system is planned for the Project	8-2 Industry and Meat Complex wells are out of the Project's scope due to the possibility of the occurrence of groundwater pollution in the future. Only Central Water Source system is planned for the Project.	9-2 Industry and Meat Complex wells are out of the Project's scope due to the possibility of the occurrence of groundwater pollution in the future. Only Central Water Source system is planned for the Project.	10-2 Industry and Meat Complex wells are out of the Project's scope due to the possibility of the occurrence of groundwater pollution in the future. Only Central Water Source system is planned for the Project.
			3-3 In addition to the implementation plan as mentioned in 3-2, consumption rate for the residents in the apartment area will be further reduced so that saved electricity expenditure could offset appropriate O&M cost		5-3 Up to full capacity for Central Water Source, Industry and Meat Complex (without expansion)					
					5-4 Existing intake capacity for Industry and Meat Complex. Up to full capacity for Central Water Source (with additional 8 wells constructed)					

Explanation of Further Details of Basic Concept Matrix

(1) Objectives of the Project

Reason of selection (1-2)

The deterioration of the facilities was caused by an inadequate maintenance budget, mainly due to excessive electricity expenditures incurred by inefficient operation, unaccounted for water, and also due to the limited amount of revenue gained under the existing tariff system. If the facilities were rehabilitated without resolving these fundamental problems, the current situations is bound to repeat itself within a few years. Since one of the goals of this project is to improve the waterworks' management conditions, a resolution of the above-mentioned problems should be attempted, together with the rehabilitation of the facilities themselves.

Responsibility of USAG

It is requested that the USAG recognize the reasons for the system's deterioration and to make and implement a strategic plan to solve the problems.

(2) Target year and subject of rehabilitation

Reason of selection(2-2)

The target year is 1999, the final year of the Project's implementation scheme.

Responsibility of USAG

- The maintenance budget should be increased through the improvement of the waterworks budget after the completion of the Project
- The USAG's maintenance system shall be strengthened before the completion of the Project

(3) Unit consumption rate and its reduction

Reason of selection (3-3)

Unit consumption volume is now projected at 430 lpcd for the apartment residents in the city. This seems too large, judging from the citizens' living conditions. Since the development of water sources in the future is not limitless, it is necessary to reduce the consumption volume. Thus, the reduction target of the unit consumption volume is set as the level necessary to meet operation and maintenance cost, combined with the reduction in electrical expenditures.

Responsibility of USAG

- Countermeasures to reduce water consumption should be made in advance of the implementation of this plan
- Countermeasures with definite targets and time frames should be established
- Countermeasures should be put into practice soon after the flow meters of the CTPs are installed

(4) Preservation of water source quality

Reason of selection(4-2)

Wastes are being dumped in the well fields of the Industry and the Meat Complex Water Sources. There is the possibility that groundwater pollution may be caused during the rainy season when the groundwater table is high. Although both water sources are important to the city's waterworks, the study team cannot neglect this water quality problem. It is recommended that the Mongolian side take protective countermeasures for the preservation of the water quality.

Responsibility of USAG

- Fencing water source area

- Regular patrol around the site and punishment of illegal dumping in cooperation with the police

- Survey on groundwater pollution caused by the disposal of charcoal wastes from the power plant

(5) Three water sources

Reason of selection (5-4)

The Industry and the Meat Complex Water Sources are out of the scope of this Project for the following reasons:

1) It is difficult to maintain the necessary distance (about 400 m) between neighboring wells to prevent well interference due to the existing space constraints.

2) Water source quality to meet the drinking standard cannot guaranteed by the possibility of the occurrence of groundwater pollution in the future.

In addition to the restoration of the deteriorated water supply facilities in the Central Water Source, the construction of new wells is planned for the Project in order to cope with the projected water demand in the comparatively wide area by the target year 1999.

Responsibility of USAG

- Groundwater quality should be checked regularly (the water sampling frequency shall be increased during the rainy season when groundwater pollution is more likely to occur) and water intake should be halted in case the pollution is found

(6) Development of Upper Water Source

Reason of selection (6-2)

The development of the Upper Water Source is out of the scope of this project for the following reasons:

1) The Upper Water Source is located about 35 km from the supply area. This will require high pressure pumps in order to transmit the water through the long pipelines, resulting in high electricity expenditures in relation to each unit of water.

2) Measures to provide for the reduction of high pressure levels in the Zavsariin Reservoir have not been taken. The reservoir has overflowed in the past due to this situation.

3) The distribution pipelines in the service area connected to the transmission pipelines from the Upper Distribution Pumping Station have not been improved. The distribution pipelines cannot be used unless they are improved.

Responsibility of USAG

- Research of the distribution network system and subsequent improvement of them is necessary to increase the water volume conveyed from the Upper Water Source
- Development of new water sources necessary to meet increased water demand should be conducted by the Mongolian side

(7) Well reconstruction

Reason of selection (7-2)

Only the well reconstruction in the Central Water Source is planned for the Project; the other two sources are out of the scope of this Project.

Responsibility of USAG

- At present a well supervisor (monitor: resident in the neighborhood) is assigned to monitor the operation of the submersible pumps of four wells every two hours per day and report to the engineer working at the distribution pump stations. Since the supervisor is not an engineer, but a civilian, it is difficult for them to report the precise and detailed condition of the pumps. As a result, the patrol monitoring system by the USAG personnel shall be strengthened.

(8) Replacement of intake pump

Reason of selection (8-2)

Same as (5). The intake pumps at the Central Water Source, whose operation efficiency is either low or which are anticipated to be torn out before target year, are selected for replacement. The existing pumps at the other two sources are out of the scope of this Project. Thus, the limited water supply capacity of the pumps shall be offset by the reduction in water demand conducted through the review of the unit consumption rate

Responsibility of USAG

- Beefing up of monitoring system by the USAG personnel

(9) Replacement of distribution pump

Reason of selection (9-2)

Same as (5). The intake pumps at the Central Water Source, whose operation efficiency is either low or which are anticipated to be torn out before target year, are selected for replacement. The existing pumps at the other two sources are out of the scope of this Project.

Responsibility of USAG

- This project includes the installation of water level meters in the storage tanks at the distribution pumping station and in the reservoirs. The correlation between water level fluctuations and the pumping operation schedule should be monitored in order to promote efficient pump operation.

(10) Remote control of intake pump

Reason of selection (10-2)

Same as (5). The installation of the remote control system at the Industry and the Meat Complex Water Sources are out of the scope of this Project due to the future anxiety regarding groundwater pollution.

Responsibility of USAG

- Continuous monitoring of the operating conditions of the intake pump should be conducted and recorded. The USAG should establish an emergency repair system to cope with a possible breakdown of the pumping system.

2.3 Basic Design

2.3.1 Basic Concept

(1) Concept on natural conditions

The winter season starts in November and lasts until March in Ulaanbaatar City and the average temperature during this season is -17.7° C, making field work difficult if not impossible. Thus, the transportation and the installation works of equipment in the local area shall be done from April to October. The water supply system shall be equipped with heating or anti-freeze systems so that it can function during the winter season.

It is windy throughout the year, with a monthly average wind velocity 5m/s to 6.9m/s and in addition, lightning often occurs from August to September. As the signal cable lines for the remote control system are laid on the electrical poles used for the existing intake pump, careful attention should be paid to the effects of strong winds and lightning.

(2) Concept of construction conditions

The Project includes the reconstruction of water source wells, the installation of restored facilities, and the installation of a remote control system. The reconstruction of the water source wells consists of well construction, the installation of transmission pipelines, and the construction of pump houses.

Construction companies in Mongolia are generally lacking in their organizational set-up and they do not have adequate levels of construction equipment, technical expertise, personnel or financial resources. Workers are employed on a short-term basis in based on the work volume contracted. Therefore, Japanese experts will be expected to give technical assistance to the local companies when facilities are constructed. The formation of a consortium should be considered in order to share the responsibility of the construction work due to the probability that one company cannot fulfill the total construction by itself.

Moreover, their drilling equipment is obsolete and they cannot drill the wells as designed. Equipment fitting the design specifications cannot be procured in China, so the drilling equipment will be procured from Japan. However, these machines will not be turned over to the Mongolian

side, but will only be leased during the construction period. This is because the USAG has no drilling section to keep such equipment in good condition and the construction period is limited due to the weather conditions in the area.

On the other hand, the restoration of water supply facilities consists of the installation of intake pumps, distribution pumps, flow meters for the intake and distribution mains, and a chlorinator. The installation of rehabilitated equipment is also beyond the capabilities of the local contractors because they have many of the difficulties previously mentioned above with regard to their equipment, etc. The installation of the rehabilitated equipment will be done along the same implementation styles as those of the well construction.

The local materials to be procured are limited to basic construction materials like cement, sand, bricks, steel bar, timber, acetylene gas and others. The remaining material or equipment will all come from abroad. Based on the comparison of cost, quality, and market condition, etc. of the materials to be procured, the best available from either Japan or China will be procured depending on the respective requirements. A stock pile of the necessary local procurement material is to be confirmed by the Contractor prior to construction to prevent needless delays during the implementation stage.

(3) Concept of the operation and maintenance capability of the implementation agency

The Consultant will dispatch a water supply engineer and an electric engineer to train local operators in order to operate facility efficiently after the completion of the construction work. The Contractor will conduct the training of concrete operation and repair methods of installed equipment. The technical transfer will cover the following subjects:

- Efficient operation of intake and distribution pumps (including training of pump operator)
- Training of workshop personnel (including training on the operation of procured equipment)
- Guidance relating to the operation of other related equipment

(4) Concept on the frame of the project and its grade

This project aims to bring about the rehabilitation of the existing water supply system and to restore the system's water supply capacity. Thus, the Project will target only the restoration of deteriorated facilities. The rehabilitation of the distribution pipe networks and the development of new water sources are left for future projects.

The cold climate is the main determinate regarding the procurement specifications, as it is important that the equipment function properly during the winter season. A heating system will be included, if necessary, in the Project. Also, the Project will include sufficient spare parts in order to keep the procured equipment well-maintained for at least two years, as shown in APPENDIX A-11.

2.3.2 Basic Design

(1) Water Demand

The most important factors relating to the city's waterworks' management are supply area, supply population, and unit consumption rate. However, underlying all these factors is the water demand of the city's inhabitants. The investigation of the water demand of Ulaanbaatar City is shown below.

In the city, the residential areas and non-residential areas are clearly separated in accordance with the city's planning scheme. People in Ulaanbaatar City live in either the apartment areas or the Ger areas. Since the whole of the city is covered by water supply service, the city's population is nearly equal to the service population. The water supply capacity of the existing facilities versus water demand is examined in Table 2-2, which shows the supply capacity of each water source and the effects of water demand reduction. In this table, the planned service population is estimated by considering the rate of past population increases calculated from the government static data of 1993.

Considering the present condition of water consumption, the unit consumption rate for the apartment is set at 430 lpcd and that of Ger area is 10 lpcd. The actual unit consumption rate is 420 lpcd in the apartment areas and 7.4 lpcd in the Ger area. This is set up according to the rate values mentioned in the Social Development Project (1993-1995) "The Study on Water Supply System in Ulaanbaatar and Surrounding".

Invalid water means leaked water in the supply system and it accounts for 10 % of the total water demand, as estimated in the above-mentioned Social Development Project. In the estimation of water demand in this Project, a leakage ratio of 10 % in the city's system is adopted.

In the investigation of the planned service population, the estimated water demand is based on the planned unit water consumption, the existing water source capacity, and the water supply capacity of each source expected to be available through the implementation of this Project. Also included is the effect of the reduction in water demand. These effects are shown in Table 2-2.

In Table 2-2, the total water demand is indicated as total water demand (F). In case the plan for water demand reduction is not carried out, the water demand shall exceed the intake capacity of the water source for the foreseeable future.

Table 2-2 Effects of Reduction of Water Demand

Year		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Reduction rate(%)						3	6	11	16	21	26	32	38	44	50
Central Area															
Population	(x10^3)	413	433	449	461	473	485	497	509	522	535	548	561	574	588
A. Apartment Area Water Demand	(m^3/d)	97,675	102,405	106,189	109,027	111,865	114,703	117,541	120,379	123,453	126,528	129,602	132,677	135,751	139,062
B. Gel Area Water Demand	(m^3/d)	1,859	1,949	2,021	2,075	2,129	2,183	2,237	2,291	2,349	2,408	2,466	2,525	2,583	2,646
C. Industrial Water Demand	(m^3/d)	5,726	5,972	6,229	6,497	6,776	7,067	7,371	7,688	8,019	8,364	8,724	9,099	9,490	9,898
D. Other Water Demand	(m^3/d)	5,378	5,496	5,617	5,741	5,867	6,125	6,260	6,398	6,539	6,539	6,683	6,830	6,980	7,134
E. Invalid Water	(m^3/d)	10,876	11,344	11,809	12,128	12,455	12,804	13,124	13,465	13,855	14,174	14,543	14,907	15,280	15,677
F. Total Water Demand	(m^3/d)	121,514	122,166	131,865	135,468	139,092	142,882	146,533	150,221	154,215	158,013	162,018	166,038	170,084	174,417
G. Water Demand with Reduction Plan	(m^3/d)					135,362	135,232	132,160	128,806	125,380	121,430	115,892	109,956	103,630	97,048
H. Existing Water Source Capacity	(m^3/d)	122,760	122,760	122,760	122,760	122,760	122,760	134,280	134,280	134,280	134,280	134,280	134,280	134,280	134,280
I. H - F	(m^3/d)	1,246	-4,406	-9,105	-12,708	-16,332	-20,122	-12,253	-15,941	-19,935	-23,733	-27,738	-31,758	-35,804	-40,137
J. H - G	(m^3/d)					-12,602	-12,472	2,120	5,474	8,900	12,850	18,388	24,324	30,650	37,232
Industrial Area															
Population	(x10^3)	120	125	130	134	137	141	144	148	152	156	160	164	168	172
A. Apartment Area Water Demand	(m^3/d)	28,380	29,563	30,745	31,691	32,401	33,347	34,056	35,002	35,948	36,894	37,840	38,786	39,732	40,678
B. Gel Area Water Demand	(m^3/d)	540	563	585	603	617	635	648	666	684	702	720	738	756	774
C. Industrial Water Demand	(m^3/d)	2,863	2,986	3,114	3,248	3,388	3,534	3,686	3,844	4,009	4,181	4,361	4,549	4,745	4,949
D. Other Water Demand	(m^3/d)	1,628	1,664	1,701	1,738	1,776	1,854	1,895	1,937	1,980	1,980	2,024	2,069	2,115	2,162
E. Invalid Water	(m^3/d)	3,292	3,434	3,575	3,672	3,771	3,877	3,974	4,077	4,195	4,291	4,403	4,513	4,626	4,746
F. Total Water Demand	(m^3/d)	36,703	38,210	39,720	40,952	41,953	43,247	44,259	45,526	46,816	48,048	49,348	50,655	51,974	53,309
G. Water Demand with Reduction Plan	(m^3/d)					40,868	41,014	40,076	39,273	38,386	37,340	35,830	34,201	32,456	30,597
H. Existing Water Source Capacity	(m^3/d)	37,992	37,992	37,992	37,992	37,992	37,992	37,992	37,992	37,992	37,992	37,992	37,992	37,992	37,992
I. H - F	(m^3/d)	1,289	-218	-1,728	-2,960	-3,961	-5,255	-6,267	-7,534	-8,824	-10,056	-11,356	-12,663	-13,982	-15,317
J. H - G	(m^3/d)					-2,876	-3,022	-2,084	-1,281	-394	652	2,162	3,791	5,536	7,395
Meat Complex Area															
Population	(x10^3)	66	67	71	73	75	77	79	81	83	85	87	89	91	93
A. Apartment Area Water Demand	(m^3/d)	15,609	15,846	16,792	17,265	17,738	18,211	18,684	19,157	19,630	20,103	20,576	21,049	21,522	21,995
B. Gel Area Water Demand	(m^3/d)	297	302	320	329	338	347	356	365	374	383	392	401	410	419
C. Industrial Water Demand	(m^3/d)	2,863	2,986	3,114	3,248	3,388	3,534	3,686	3,844	4,009	4,181	4,361	4,549	4,745	4,949
D. Other Water Demand	(m^3/d)	1,094	1,118	1,143	1,168	1,194	1,247	1,274	1,302	1,331	1,331	1,360	1,390	1,421	1,452
E. Invalid Water	(m^3/d)	2,211	2,306	2,401	2,466	2,533	2,604	2,669	2,738	2,817	2,882	2,957	3,031	3,107	3,188
F. Total Water Demand	(m^3/d)	22,074	22,558	23,770	24,476	25,191	25,943	26,669	27,406	28,161	28,880	29,646	30,420	31,205	32,003
G. Water Demand with Reduction Plan	(m^3/d)					24,583	24,694	24,320	23,903	23,447	22,904	22,115	21,270	20,368	19,412
H. Existing Water Source Capacity	(m^3/d)	25,416	25,416	25,416	25,416	25,416	25,416	25,416	25,416	25,416	25,416	25,416	25,416	25,416	25,416
I. H - F	(m^3/d)	3,342	2,858	1,646	940	225	-527	-1,253	-1,990	-2,745	-3,464	-4,230	-5,004	-5,789	-6,587
J. H - G	(m^3/d)					833	722	1,096	1,513	1,969	2,512	3,301	4,146	5,048	6,004
Total Area															
Population	(x10^3)	599	625	650	668	685	703	720	738	757	776	795	814	833	853
A. Apartment Area Water Demand	(m^3/d)	141,664	147,814	153,726	157,983	162,004	166,261	170,281	174,538	179,031	183,525	188,018	192,512	197,005	201,735
B. Gel Area Water Demand	(m^3/d)	2,696	2,814	2,926	3,007	3,084	3,165	3,241	3,322	3,407	3,493	3,578	3,664	3,749	3,839
C. Industrial Water Demand	(m^3/d)	11,452	11,944	12,457	12,993	13,552	14,135	14,743	15,376	16,037	16,726	17,446	18,197	18,980	19,796
D. Other Water Demand	(m^3/d)	8,100	8,278	8,461	8,647	8,837	9,226	9,429	9,637	9,850	9,850	10,067	10,289	10,516	10,748
E. Invalid Water	(m^3/d)	16,379	17,084	17,785	18,266	18,759	19,285	19,767	20,280	20,867	21,347	21,903	22,451	23,013	23,611
F. Total Water Demand	(m^3/d)	180,291	187,934	195,355	200,896	206,236	212,072	217,461	223,153	229,192	234,941	241,012	247,113	253,263	259,729
G. Water Demand with Reduction Plan	(m^3/d)					200,813	200,939	196,556	191,982	187,213	181,674	173,837	165,427	156,455	147,056
H. Existing Water Source Capacity	(m^3/d)	186,168	186,168	186,168	186,168	186,168	186,168	197,688	197,688	197,688	197,688	197,688	197,688	197,688	197,688
I. H - F	(m^3/d)	5,877	-1,766	-9,187	-14,728	-20,068	-25,904	-19,773	-25,465	-31,504	-37,253	-43,324	-49,425	-55,575	-62,041
J. H - G	(m^3/d)					-14,645	-14,771	1,132	5,706	10,475	16,014	23,851	32,261	41,233	50,632

*1. Population ratio in Apartment area is 55% of total population and Gel area is 45%.
*2. Unit consumption rate for the Apartment resident is 430 liters per capita per day(lpcd) and that of Gel area is 10 lpcd
*3. Water demand is computed by multiplying the area population based on the population ratio by the unit consumption rate

In order to meet the water demand of the target year with the existing system's capacity, the water consumption rate of the residents in the apartment area should be reduced. The balance between the water demand and the intake capacity of the existing water sources by respective source is summarized as follows:

1) The balance between the total water demand and the intake capacity of the existing water sources

   Without a reduction in water consumption, the water demand in total city area exceeds the intake capacity of the existing water sources all the period from 1994 to the target year 1999 and the water demand should be reduced.

2) The balance of water demand and intake capacity at the respective water sources and the effect of the reduction of water consumption.

   As shown in Table 2-2, the reduction of the unit consumption rate is anticipated to begin in 1997 when the flow meters will be installed at the CTPs and it is intended to reduce the present consumption by half by 2006. This reduction target was set up based on the agreement made between the Study Team and the USAG.

The water demand will have to be reduced by more than 11% after the year of 1999, in order to have a measurable impact on the intake capacity of the existing water sources. Before 1998, the reduction effect will be too small and the water demand will still exceed the intake capacity.

Considering the possible reduction effect, the supply capacity of the Central Water Source will exceed the reduced water demand after the year of 1999 and that of the Industrial Water Source will do so after the year of 2000. The water demand of the Meat Complex Water Source will always exceed the water demand. However, the effect of the reduction of water consumption will be reflected immediately in this area because the service population is small.

As mentioned the above, a reduction of the water demand is necessary for the long-term utilization of the existing water sources, considering that the volume of wasted water raises the existing consumption rate up to 430 lpcd--almost twice the Japanese norm. The reduction of wasted water significantly contribute to the reduction of electrical expenditures that now equal 66% of the USAG's total expenses.

(2) Renewal Plan of Water Source Wells

1) Number of Reconstruction and Rehabilitation Wells

The number of the wells to be reconstructed or rehabilitated for the Project is mainly determined on the basis of the results of the pumping test of the existing wells conducted by the study team during the site survey, and also includes the wells that are no longer operational due to the collapse of their riser pipes and pumps into the wells.

The pumping test was carried out during the site survey by the selection of the existing wells with small specific capacities in the pumping test at construction time and of the requested renewal wells. The step drawdown test was carried out in five steps with a pumping duration of one hour. The analysis results of the pumping test are indicated in Table 2-3.

Based on the results of the pumping test, the inflow per unit opening area in the screens was calculated by dividing the average specific capacity of each well into the opening area of the screens. In case that the inflow was very small in comparison with the average value, the wells were selected as reconstruction wells, and in the case that the inflow was 15% smaller than average, the wells were planned to be rehabilitated.

Considering the large quantity of sand inflow into the screens, most wells will be need to be reconstructed. As a result of the previously mentioned pumping test, the following reconstruction wells are selected: 10 wells in the Central Water Source, four wells in the Industry Water Source, and three wells in the Meat Industry Water Source. The rehabilitation wells are as follows: one well in the Central Water Source, two wells in the Industry Water Source, and one well in the Meat Industry Water Source.

However, as mentioned in 2-1 Basic Concept of the Project, the Industry and the Meat Complex Water Source have the possibility of groundwater pollution and are therefore not included in the Project. Thus, the following (as a result of the pumping tests) are planned for the Project: the reconstruction of 10 wells in the Central Water Source, and the rehabilitation of one well in the Central Water Source.

In addition, the Project includes the reconstruction of one well in the Central Water Source (No. 31 well), whose riser pipes collapsed and the construction of eight new wells in order to cope with the projected water demand in the target year in the Central Water Source.

In total, the Project plans to involve a total of 20 wells, including the reconstruction of 19 wells, the rehabilitation of one well, and the construction of eight new wells in the Central Water Source.

2) Specification of Reconstruction Well

The planned drilling depths shall either have a 30% increase over the existing wells, including the surplus for the sand trap of the casing, or as the same depth as the existing wells.

In the case that a new submersible pump is insert (renewal of the pumps), the casing diameter is determined as 12" (300 mm) according to the insert diameter of the submersible pumps. In the case that the existing pumps are used, the casing diameter is planned to be the same diameter as the existing wells if the diameter is larger than that of 12" due to the different specification of the existing pumps and to be 12" if the diameter is smaller than the planned 12" ones.

Materials of casing and screens shall be the steel pipes because there is no special water quality. PVC pipes are not planned due their lack of durability in freezing conditions.

The specification of the reconstruction wells are summarized in Table 2-4.

Table 2-3 RESULT OF PUMPING TEST

Central Water Source

Well No	Specific Capacity						S. C. /m2 (Sreen Area)	Evaluation
	Step 1 (m^3/H/m)	Step 2 (m^3/H/m)	Step 3 (m^3/H/m)	Step 4 (m^3/H/m)	Step 5 (m^3/H/m)	Average (m^3/H/m)		
2	82.13	82.19	80.65	83.21		82.05	43.28	Reconst
5	45.82	48.21	51.13	51.33		49.12	36.60	Reconst
9	112.5	118.29	132.54	128.87	172.80	133.00	39.65	Reconst
13	255.83	249.74	216.00	216.00	200.93	235.5	55.81	Rehabili
36	132.37	123.2	110.46	110.78	115.71	118.50	69.87	Good
37	144.24	146.44	142.94	148.00	166.15	149.94	94.72	Good
42	63.00			64.14		64.14	25.22	Reconst
44	63.96	58.94	48.91	44.77	42.26	51.77	23.79	Reconst
47	90.00	83.48	74.44	74.18	75.27	76.84	28.62	Reconst
51	413.33	336.92	268.42	214.62	174.86	281.63	117.25	Good
54	126.67	118.33	106.55	105.43	103.50	114.25	34.85	Reconst
56	22.77	29.24	37.37	38.44	40.40	31.96	19.50	Reconst
59	158.57	155.45	151.3	153.91	156.52	155.15	148.33	Good
60	177.11	170.56	168.11		127.89	160.92	94.88	Good
63	59.72	56.71	53.20	51.24	50.29	54.49	50.74	Reconst
69	152.00	111.06	114.32	112.17	92.73	107.57	63.43	Good
72	5.5	11.00	12.13	12.87	13.95	11.11	9.83	Reconst
Average							60.02	

Note: Good >60.02, 60.02>Rehabilitation>51.02(=Averagex0.85), Reconstruction<51.02

Industrial Water Source

Well No	Specific Capacity						S. C. /m2 (Sreen Area)	Evaluation
	Step 1 (m^3/H/m)	Step 2 (m^3/H/m)	Step 3 (m^3/H/m)	Step 4 (m^3/H/m)	Step 5 (m^3/H/m)	Average (m^3/H/m)		
1	71.20	79.83		85.33	87.33	84.16	97.07	Reconst
2	77.14	76.67	93.33	96.67	97.89	88.34	75.63	Reconst
3	102.56	85.03	99.95	116.67	127.14	106.27	82.57	Reconst
4	127.14	129.71	115.69	124.58	149.49	129.32	110.15	Rehabili
5	142.60	126.06	133.64	145.79	181.98	151.28	110.02	Rehabili
6	264.60	312.97	321.56	334.00	378.55	337.69	277.02	Good
7	121.74	108.56	105.73	106.96	106.49	109.90	89.50	Reconst
Average							125.41	

Note: Good >125.41, 125.41>Rehabilitation>106.60(=Averagex0.85),
Reconstruction<106.60

Meat Complex Water Source

Well No	Specific Capacity						S. C. /m2 (Sreen Area)	Evaluation
	Step 1 (m^3/H/m)	Step 2 (m^3/H/m)	Step 3 (m^3/H/m)	Step 4 (m^3/H/m)	Step 5 (m^3/H/m)	Average (m^3/H/m)		
1	217.24	193.71	197.84	192.63	211.58	202.60	299.37	Good
2	221.05	206.47	124.14	140.00	160.00	183.89	62.32	Reconst
3	83.58	65.92	72.45	72.22	73.89	73.61	128.21	Rehabili
4	70.59	66.67	66.57	67.45	77.52	69.80	83.02	Reconst
5	212.5	200.47	189.47	189.80	193.94	197.20	77.36	Reconst
Average							130.06	

Note: Good >130.06, 130.06>Rehabilitation>110.55(=Averagex0.85),
Reconstruction<110.55

Table 2-4 PROPOSED SPECIFICATION OF RECONSTRUCTION WELL

Central Water Source							
Well No	Well Depth (m)	Casing Diameter (m)	Screen Length (m) *	Casing Length (m) *	Pump Replacement	Screen Length (m) **	Casing Length (m) **
2	30	300	12	18	×	11	19
5	30	300	12	18	×	11	19
9	35	300	14	21	○	16.5	18.5
31†	45	300	18	27	○	16.5	28.5
42	40	300	16	24	×	16.5	23.5
44	40	300	16	24	○	16.5	23.5
47	35	300	14	21	×	16.5	18.5
54	45	300	18	27	×	16.5	28.5
56	30	300	12	18	×	11	19
63	30	300	12	18	○	11	19
72	35	300	12	21	○	16.5	18.5
N-1	35	300	14	21	○	16.5	18.5
N-2	35	300	14	21	○	16.5	18.5
N-3	40	300	16	24	○	16.5	23.5
N-4	40	300	16	24	○	16.5	23.5
N-5	35	300	14	21	○	16.5	18.5
N-6	35	300	14	21	○	16.5	18.5
N-7	35	300	14	21	○	16.5	18.5
N-8	30	300	12	18	○	11	19
Total	680		270	408		286	394

Note: Well No. 31† (the drop of pump, motor, and conductor pipes)
* : Planned screen length (40% of total well depth)
** : Length of actual screens and casings counted as 5.5m/pipe

(3) Renewal of Intake Pump

1) Number of Renewal Intake Pumps

The renewal intake pumps are given priority on the basis of their respective data from the non-operating period (from January to September, 1995) and from the data on the pump damage for each pump. The criteria for pump renewal is limited to those with non-operating periods of more than 30 days and to the wells held to be heavily damaged. The non-operating period and the reasons for the pump damage are indicated in Table 2-5 and 2-6.

As mentioned in 2-2 Basic Concept of the Project, the intake wells distributed in the Industry and the Meat Complex Water Source may be influenced by groundwater pollution due to the presence of a deposit area for trash and coal cinders from a thermal power plant near the water source areas, thus, the intake pumps in these sources will not included for the Project.

Because of the reasons mentioned the above, only the intake pumps located in the Central Water Source are planned to be renewed. The number of the renewal pumps is planned at 18 units. Moreover, the existing wells often have intake pumps with a very small capacity, such as 25 m^3/hr, due to the shortage of optimized capacity pumps. According to the analysis of the existing data of pumping tests, the optimum safety pumping rate is estimated to be 60 m^3/hr. Thus, the pumps with small capacities shall be changed to resume the optimum intake amount in the wells with pumps of 60 m^3/hr capacity. The number of small capacity pumps with a capacity of 60 m^3/hr will number nine units.

In addition, the new construction of 8 wells is planned in order to cope with the water demand at the target year (1999) and to increase the intake amount. Thus, the number of renewal pumps in this Project is planned to be 35 units. The renewal of these intake pumps includes the installation work.

Meanwhile, the facilities predicted to be damaged until the target year are also need to be included in the Project in order to maintain the function of all the system as indicated in Table 2-1 (2) Target Year and Rehabilitation Subject. It is considered that the existing intake pumps have a life of about 12 years based on the examination of the operating condition of the existing pumps.

Table 2-5 NON-OPERATIONAL PERIOD OF INTAKE PUMPS

(Unit: days)

Central Water Source											
Well No	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total	Remark
2	15									15	
3	31	28	31	30	31	30	31	31	25	268	No pump & motor
8	31	20	31	30	31	30	31	31	25	268	No pump & motor
9								17	13	30	
10						18	31	31	25	105	Burned motor
12								16	25	41	No electrical cable
13	16				28	30	31	31	22	158	Burned motor
15	31	28	31	30	31	30	31	31	25	268	Burned motor
18								25	25	50	Burned motor
20							16	3		19	Non-operational pump, pump broken
29						2			2	4	Damage of electrical line
31	31	28	31	30	31	30	31	31	25	268	Drop of pump & motor inside the well
35							16			16	
37	31	28	31	30	31	30	31	31	25	268	Drop of pump & motor inside the well
39								10	25	35	
40								17		17	
42							3			3	
43					17	30	24			71	
44	7									7	
45	22	5	22		17	16	31	31	25	169	No pump & motor
50	31	28	31	30	31	30	31	31	25	268	
51	20									20	
52	31	28	31	30	17		7	15		159	
54					2	18				20	
57	11						13			24	
58	4									4	
62				30	31	30	31	31	25	178	
64	20	8		4						32	
67			11	30	3					44	
69	31	28	31	30	31	30	31	31	25	268	
71									16	16	
72									3	3	

Table 2-6 NON-OPERATIONAL PERIOD OF INTAKE PUMPS

(Unit: days)

INDUSTRIAL WATER SOURCE											
Well No	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total	Remark
3				3	31	30	20			84	
4			6							6	
6				14				10		24	
8									20	20	
11		24	31	30	31	30	31	31	25	233	No pump & motor
14	7			19	31	30	31	31	25	174	No pump & motor
15	31	28	31	30	31	30	31	31	25	268	No pump & motor
16	31	28	31	30	31	30	20			201	No pump & motor

(Unit: days)

MEAT COMPLEX WATER SOURCE											
Well No	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total	Remark
1	23			7						30	
2	31	11								44	
4							2	26	25	53	
5			25							15	
7						24				24	
9								10	5	15	
10					3	23				26	

Thus, the pumps operating beyond their life expectancy are also provided in the Project. The total number of pumps will be 14 units. These pumps shall be installed by the Mongolian side. The relationship between the operating conditions and operating years of the pumps in the Central Water Source is shown in Table 2-7.

Table 2-7 Operating Years of Intake Pumps

Operating Years		Numbers of Operating Pumps
Basic Design Stage (1995)	Target Year (1999)	
1	5	0
2	6	2
3	7	5
4	8	0
5	9	3
6	10	5
7	11	8
8	12	9 (32)*
9	13	4
10	14	8
11	15	2 (14)**
Total		50

Note: * Total life expectancy is 12 years or less at the target year (1999)
** Total life expectancy is more then 12 years at the target year (1999)

In the survey stage (1995), there are no pumps held to have a life expectancy of more than 12 years due to the lack of operating pumps. Thus, the life expectancy of the existing pumps is estimated at 12 years. Based on the reasons mentioned above, 14 existing pumps with life expectancies of more than 12 years are planned to be rehabilitated.

The number of the renewal pumps, and the total pumping rates are shown in Table 2-8 and 2-9.

2) Specification of Intake Pump

Number of renewal pumps	35 units (installed under the Project) 14 units (only supplied, not installed)
Pump type:	submersible pumps
Pump diameter:	100 mm
Pump capacity:	60 m^3/hr
Pump head:	65 m
Control Unit:	auto cut-off of using a limit switch

Table 2-8 TOTAL PUMPING RATE IN REPLACEMENT OF INTAKE PUMPS

Central Water Source					
Well No	Existing Pump		Replacement Pump		
	Capacity (m3/hr)	Head (m)	Replace-ment	Capacity (m3/hr)	Head (m)
1	40	60		40	60
2	40	60		40	60
3	25	100	○	60	65
4	63	65		63	65
5	63	65		63	65
6	63	65		63	65
7	63	65		63	65
8	63	65	○	60	65
9	63	65	○	60	65
10	63	65	○	60	65
11	Abandon Well				
12	63	65	○	60	65
13	63	65	○	60	65
14	63	65	△	63	65
15	63	65	○	60	65
16	120	65		120	65
17	63	65	△	63	65
18	63	65	○	60	65
19	63	65	△	63	65
20	63	65		63	65
21	120	65		120	65
22	63	65		63	65
23	63	65	△	63	65
24	63	65	△	63	65
25	120	65	△	120	65
26	63	65	△	63	65
27	63	65	△	63	65
28	63	65	△	63	65
29	63	150		63	150
30	63	65		63	65
31	63	65	○	60	65
32	63	65		63	65
33	63	65		63	65
34	63	65		63	65
35	63	65		63	65
36	63	65		63	65
37	63	65	○	60	65
38	63	65		63	65
39	63	65	○	60	65
40	63	150		63	150
41	63	65		63	65
42	63	65		63	65
43	63	65	○	60	65
44	25	100	◎	60	65

(Note)
○ Replacement due to the pump damage
◎ Replacement due to the appropriate pumping rate
△ Replacement due to the pasted pump life

Table 2-9 TOTAL PUMPING RATE IN REPLACEMENT OF INTAKE PUMPS

Central Water Source					
Well No	Existing Pump		Replacement Pump		
	Capacity (m3/hr)	Head (m)	Replace-ment	Capacity (m3/hr)	Head (m)
45	25	100	◎	60	65
46	63	65		63	65
47	63	65		63	65
48	63	65		63	65
49	63	65		63	65
50	63	65	○	60	65
51	63	65		63	65
52	120	60	○	60	65
53	63	65	△	63	65
54	63	65		63	65
55	63	65	△	63	65
56	63	65	△	63	65
57	25	100	◎	60	65
58	40	60		40	60
59	63	65	△	63	65
60	63	65		63	65
61	63	65		63	65
62	40	60	○	60	65
63	25	100	◎	60	65
64	40	60	○	60	65
65	25	100	◎	60	65
66	25	100	◎	60	65
67	25	100	○	60	65
68	25	100	◎	60	65
69	10	60	○	60	65
70	63	65	△	63	65
71	25	100	◎	60	65
72	25	100	◎	60	65
N-1			○	60	65
N-2			○	60	65
N-3			○	60	65
N-4			○	60	65
N-5			○	60	65
N-6			○	60	65
N-7			○	60	65
N-8			○	60	65
Total	4, 115	(m^3/h)		4, 974	(m^3/h)
	98, 760	(m^3/d)		119, 376	(m^3/d)

(Note)
○ Replacement due to the pump damage
◎ Replacement due to the appropriate pumping rate
△ Replacement due to the pasted pump life

(4) Equipment and Materials Plan for Well Construction

The two well drilling machines and other equipment for the well construction are planned to be transported from Japan to Mongolia by hire because the existing equipment in Mongolia is inadequate, and the private sector lacks the required drilling techniques, equipment, etc. These factors are also influenced by the need to complete the work within a short time frame. The main specification of the well drilling machines is determined based on the conditions regarding well construction for the Project and is as follows:

1) Bit Specification

The renewal wells are distributed in the riverbed of the Tuul River. According to the existing data, the geology for this area is mainly composed of sand and gravel layers, together with a thin clay layer in the comparably deeper portion near the bed rock. Also, the size of gravel ranges from granule to cobble.

Considering the specification of the reconstruction wells (casing diameter 300 mm), the bit size of 24" (600 mm) is planned for the drilling of the guide casing, and 18" (450 mm) for the borehole drilling considering that annular space for gravel packing is selected. Bits with weights ranging from one ton to two tons are used. The two ton bit is used for the drilling of the guide casing or for drilling in pebble or cobble (these formations make drilling difficult). Considering the geological conditions and drilling speed efficiency, a two ton bit is planned for the Project.

2) Drilling Machine

A drilling machine is used to drill the gravel layers of the riverbed. The most optimum machine is of the percussion type. The drilling capacity should have a 100 m maximum depth with a drilling hole diameter of 24". Also, engine output shall have a capacity capable to safely and effectively move the two ton bit.

3) Equipment Relating to Well Drilling

The equipment relating to well drilling is planned to include the pumping test equipment, electric logging equipment, and well bending test equipment.

4) Rehabilitation Equipment

The existing wells were constructed quite some time ago. As the results of the pumping test indicate, some wells have small specific capacities and need to be rehabilitated. Also, well screens with iron scaling were observed in the survey. The specifications for the rehabilitation equipment are planned to include a brushing apparatus to remove the scales in the screens.

5) Casing and Screen

Casings and screens for the 19 reconstruction wells in the Central Water Source are planned. The casing diameter is planned to be 12" (300 mm) based on the insert diameter of the planned submersible pumps and the inflow velocity into the screens. The screen type is planned to be the continuous V slot wire wound type. The screen length is planned to be about 40% of the depth of proposed reconstruction wells. The length of screens and casings is planned as follows:

Table 2-10 Planned Casing and Screen Length

Well No.	Screen Length (m)	Casing Length (m)
2	11	19
5	11	19
9	16.5	18.5
31	16.5	28.5
42	16.5	23.5
44	16.5	23.5
47	16.5	18.5
54	16.5	28.5
56	11	19
63	11	19
72	16.5	18.5
N1	16.5	23.5
N2	16.5	23.5
N3	16.5	23.5
N4	16.5	23.5
N5	16.5	23.5
N6	16.5	23.5
N7	16.5	23.5
N8	11	19
Total	286.0	419.0

Planned screen length: 286 m
Planned casing length: 419.0 x 1.1 = 461 m

The total length of casings is planned to include a 10% surplus considering the standing portion above the ground for the casing pipes and deeper drilling. The flowing velocity into a well through

screens in the reconstruction wells is calculated based on the opening ratio of screens and planned pumping rate. As result of the calculation, the flowing velocity is V = 15 mm/s or less of the laminar flow velocity when the planned pumping rate (Q = 60 m^3/h) is pumped up. Thus, it is confirmed by the calculation that if the planned length of screens is 40%, planned pumping rate is possible to be pumped up.

Casing Specification

Number of casings: 99 units
Materials : Steel pipes for distribution water supply
Casing Diameter : 300 mm
Length : 5.5 m / unit

Screen Specification

Number of casings: 48 units
Materials : Galvanized wire wound type V slot type
Casing Diameter : 300 mm
Length : 5.5 m / unit

Bottom Plate Specification

Number of Plate : 19 units
Materials : Steel plate
Casing Diameter : 300 mm

6) Transmission Pipeline

The transmission pipelines from the reconstruction wells to the existing intake mains are planned to be included for the Project so that the planned facilities will effectively operate. The transmission pipeline is planned to be of 150 mm diameter steel pipes. The total length of steel pipe is estimated as follows:

Table 2-11 Planned Length of Transmission Pipelines

Reconstruction Well No.	Planned Distance of Transmission Pipeline (m)
2	183
5	102
9	500
31	370
44	50
47	50
54	50
56	50
63	50
72	50
N1	410
N2	430
N3	340
N4	400
N5	400
N6	400
N7	400
N8	400
Total	4,985 m

Planned length of transmission pipelines: 4,985 m x 1.2 = 5,982 m

The distance of the transmission pipelines is planned to include a 20% surplus allowance for the uneven conditions of the topography.

Specification of transmission pipelines

Number : 534 units
Materials : Coated steel pipes for water transmission
Casing Diameter : 150 mm
Length : 5.5 m / unit

(5) Renewal of Distribution Pump

In the planning of the renewal of the distribution pumps, the sum of the distribution water amount of the existing and renewal pumps is constrained by the existing intake pump capacity and the distribution capacity of the existing pipelines. Thus, a hydraulic analysis for the distribution system was conducted to determine the discharge amount and the head of the pumps based on the projected water supply conditions in the target year. Overall renewal plan, including the necessary numbers

and specifications of pumps is then determined while taking into consideration such allowances as the standby units.

1) Standby Unit

The existing distribution pump is designed based on the USSR Standard. According to this standard, the necessary numbers of standby pump units are regulated as shown below. At least two units of standby pumps are necessary even if only one unit is regularly operated.

Numbers of duty pump	Necessary numbers of standby unit
1 ~ 6	2
7 ~ 9	3
10 and above	4

The total number of the existing pump unit in the study area is seven, including four units in the old pump room and three units in the new pump room of the Central Distribution Station. According to the above standard, the number of duty pumps is two units and given that one unit is a standby, totaling three units in the existing pump room and the new pump rooms, respectively. However, the actual pump operation record in recent years shows that one pump in the old pump room and two pumps in the new pump room, were operated regularly. It is not profitable for too many standby units to be provided.

Therefore, one standby each for the old and new pump rooms, totaling two units will be provided as is usually applied in the Japanese design standard, in addition to the five duty pumps, including three for the old pump room and two for the new pump room.

The pumps in the old pump room should be provided with a 90 m lifting head, while the lifting head of the pumps in the new pump room should be increased to 100 m to prevent any inefficiency caused by parallel pump operation.

2) Specification of Pumps to be Replaced

Description	Pump No. 1, 2, 3, 4	Pump No. 6
Nos.	4 units	1 unit
Type	Horizontal	
Nominal size	ϕ300 x 250 mm	ϕ450 x 250 mm
Capacity	630 m^3/h	2,000 m^3/h
Lifting head	90 m	100 m
Output	220 kW	750 kW

(6) Remote Control System

The existing remote control system, as mentioned above, uses an individual control line by means of the arbitrary signal wire line in the Central Water Source and it is currently out of order. Usually, a remote control system is not recommended for a water supply system due to its complicated operation and maintenance. In the Central Water Source, however, it is absolutely critical to ensure the operation of the 71 well water sources scattered over a 15 km long by 2 km wide area in a proper manner during the long and severe winter season. The installation of the remote control system will enable the water supply system to be effective and to be efficiently operated as an integrated system by the linkage among the operation of the intake pumps and the amount stored in the storage tanks of the distribution pumping station. As a result, electric expenditures, which account for a large part of the waterworks' budget, will be reduced.

According to the estimated benefits resulting from the installation of the remote control system (refer to APPENDIX A-6), the system cost will be recovered within a year or so after the completion of the Project. In addition, the installation of the remote control system will also result in not only the reduction of electric expenditures but also in the extension of pump life.

Therefore, introduction of a remote control system using an individual control line will be employed for the Project.

The schematic diagram of the control system is shown in Fig. 2-1. The control items, transmission circuit methods, and system specifications are shown below as follows:

1) The information items sent from the slave station to the master station

Indication items : status of on-off and fault by indicator lamps

Control items : status of on-off for the intake pumps

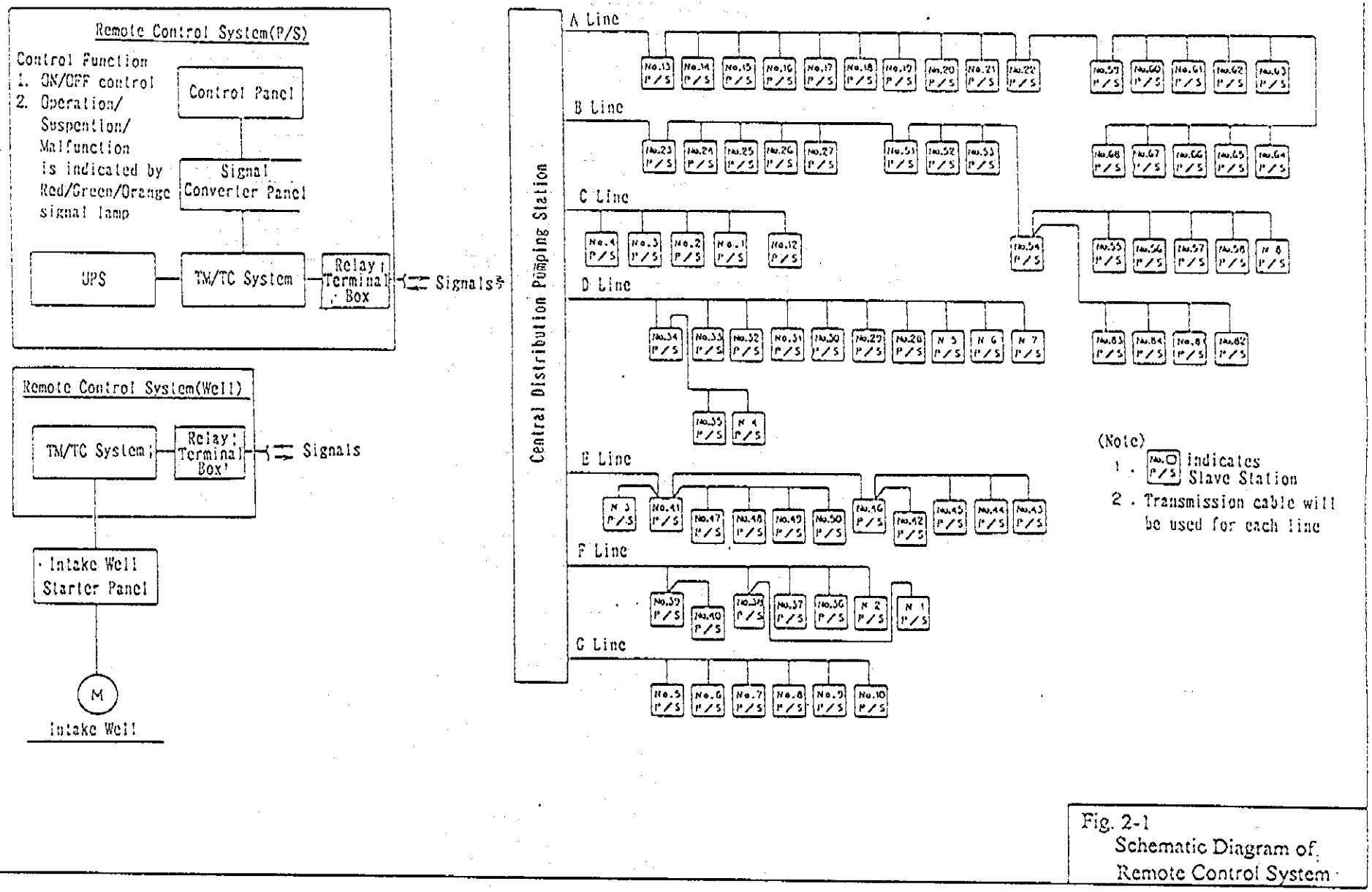


Fig. 2-1
Schematic Diagram of Remote Control System

2) Transmission Circuits

In the transmission circuits between the slave stations and the master stations, there are two systems: 1) the radio control system and 2) the wire control system. The radio control system consists of a simplex radio circuit (70 MHz or 400 MHz). The wired control system consists of a private wire line owned by the USAG. The wired control system is more advantageous than the radio control system as shown below. Thus, the wired control system is employed in the Project.

- Price: the radio control system is more costly because the system needs complicated equipment such as radio equipment, antenna, antenna tower, and numerous adjustments. The relay equipment and the power supply device are especially costly if a relay station is necessary. On the other hand, the price of the wired control system is reasonable because the transmission circuits can be installed using the distribution line poles.

- Reliability: the radio control system is low in reliability due to noise, fading, and interference. The wired control system is more reliable when compared with the radio control system and is not constrained by signal transmission speed.

- Operation and Maintenance: The radio control system is more complicated than the wired control system.

3) Control System

A communication system (1:N) with a telemeter control system between one master station and many slave stations will be employed.

- Merit: The equipment in the master station is compact and easy to operate and maintain due to the compatibility of equipment. The cost is reasonable in that the master station can connect with many slave stations (four or more). It is easily expanded with the addition of more slave stations without addition of the master stations.

4) Specification of Remote Control system

Transmission Circuit:	private wire lines (multi-channel transmission circuit sing CPEV-S cable)
Enclosure Construction:	master station -- self-standing enclosure type; slave station -- wall mounted type
Connection Method:	unit connection method
Function:	control and indication
Transmission Method:	cyclic digital time division method
Numbers:	master station (distribution pump station)

System Equipment: Master Station (Distribution Pumping Station) 1 unit

- TM/TC System for Master Station	1 unit
- Remote Supervisory Control Panel	1 unit
- Uninterruptable Power Supply (UPS)	1 unit
- Signal Converter Panel	1 unit
- Relay Terminal Box	1 unit
- Slave Station (Intake Pump)	79 units
- TM/TC System for slave station	79 units
- Relay Terminal Box	79 units
- Pump Station Panel	79 units

5) Maintenance of Signal Cable Line for Remote Control System

In the Project area, lightning often occurs from August to September. The existing system was severely damaged by lightning in the past and now cannot be used. In addition, the signal cable lines for the remote control system are mostly installed using the existing electrical poles for the intake pumps and the Central Pumping Station.

In this Project, lightning cables on the electrical poles with arrestors shall be installed as a preventative countermeasures against lightning, together with the installation of arrestors every 300 m, connecting to the electrical lines. Moreover, lightning cables with arrestors shall also be installed on the Central Pumping Station building's roof to protect the equipment from damage. Also, as the existing system was burned by a fallen electric line and as damage was also caused by contact between the signal cable lines and the electric line because these wires were uninsulated, the signal cables installed in this Project will be insulated.

In case that a well that is currently connected to the remote control system is abandoned and another well is constructed nearby as its replacement, it will be a simple matter of using the old well's signal cable to connect the new well to the remote control system.

The Project area often has strong winds, with a monthly average of 5 m/s to 6.9 m/s. To cope with the strong winds, the new signal cable lines shall be installed on poles placed at the same intervals as the existing electrical poles; the existing installation has proven durability in the windy conditions.

(7) Chlorination

1) Selection of Type of Chlorinator

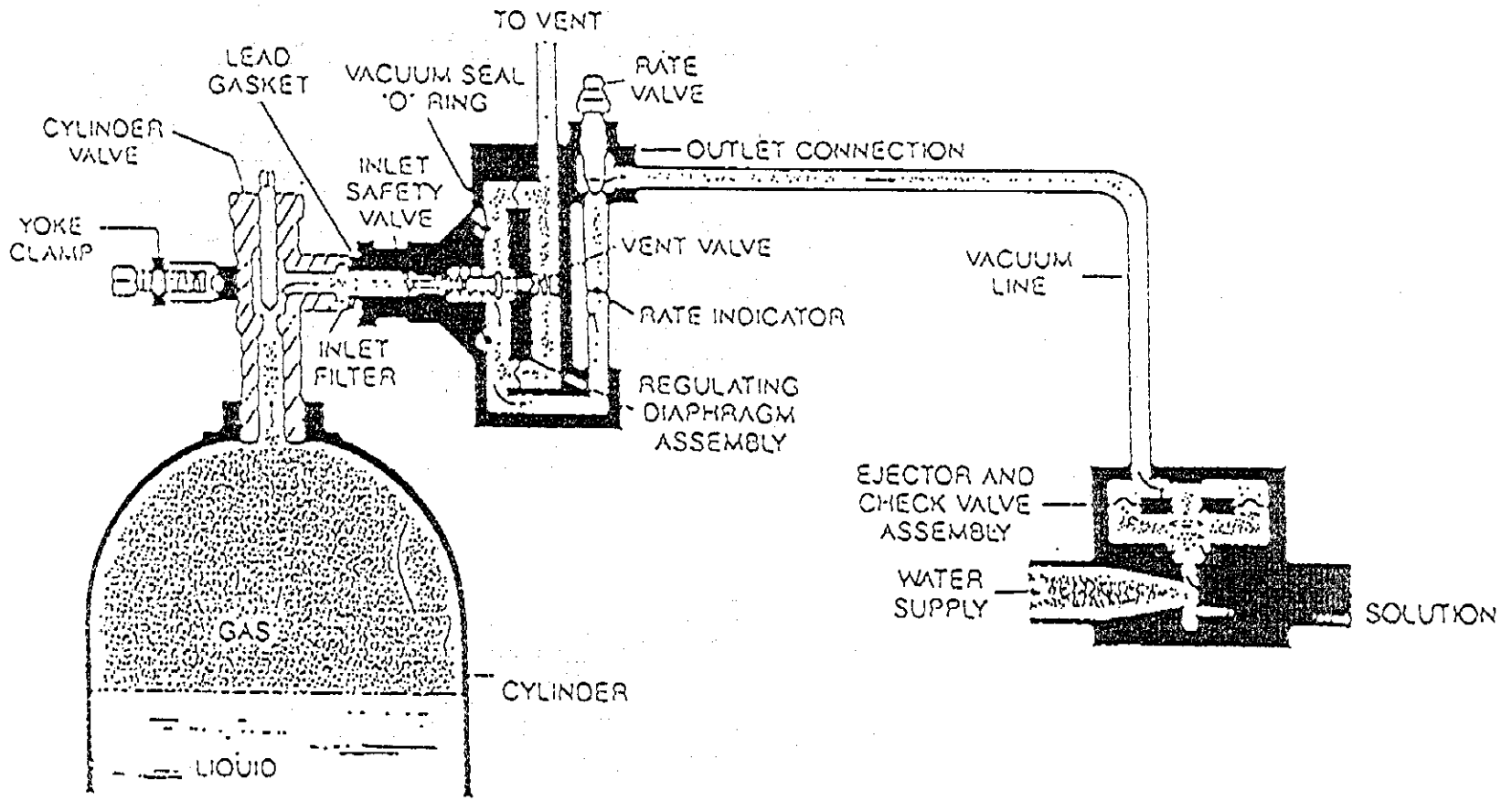
There is leakage in the chlorination facilities due to corrosion and improper workmanship in the piping between the chlorine cylinders and ejectors. It is caused by the positive pressure system of the existing chlorinators. To prevent this, a vacuum gas chlorinator will be employed in this Project.

The chlorinator is actuated by a vacuum created by water flowing through the remote ejector, an assembly consisting of a vacuum-producing venturi and a spring-loaded, diaphragm-type check valve, which isolates gas from water upon shut down. The outline of the planned chlorinator is shown in Fig. 2-2.

Once opened, the ejector check valve permits the vacuum to travel back through vacuum tubing to the system regular mounted on the gas valve of a cylinder. This causes the inlet safety valve to open, initiating gas flow. A filter located in the regular removes any foreign material from the gas. A spring-opposed diaphragm regulates the vacuum at this point. Gas passes through the flow meter, the rate control valve, and the system tubing to the ejector check valve assembly. Here the gas is thoroughly mixed with water and applied as a solution at the application point. Direct mount type of chlorinator can further prevent accident caused through pipelines. Feeding is done manually in accordance with the inflow from the storage tank.

2) Feeding Points

The existing chlorinator system is shown in Figure 2-3. At present, chlorine is fed at the inflow pipe in the valve pits, wherein no cover is provided. Power failure, often occurring in the winter season, causes an interruption of water supply and the pipes thereupon freeze. Chlorination fails due to not only power failure but also to the complicated piping connection. Moreover, in case



Flow Diagram

Fig. 2-2
Conceptual Diagram of Planned Chlorinator

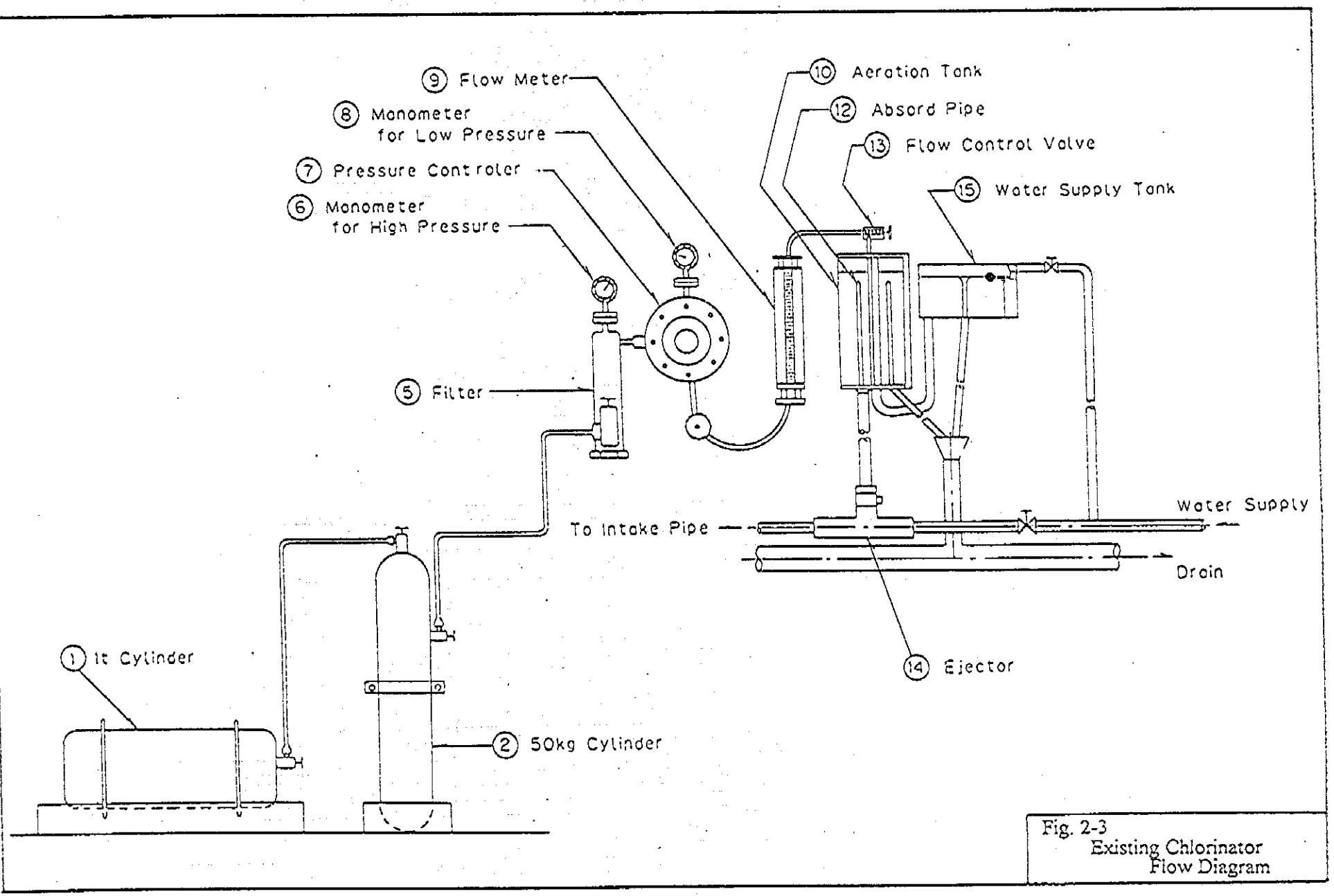


Fig. 2-3
Existing Chlorinator
Flow Diagram

several storage tanks are used simultaneously, some distribution pipe lines are possibly not chlorinated.

To secure the chlorination, a chlorine solution will be fed to each raw water storage tank. A chlorine feeding pipe will be installed in a concrete protection trough to be constructed underground. The trough will be heated and provided with thermal insulation material as a cold protection measure.

3) Adjustment of dosage to each point

The Central Pumping Station has four feeding points and adjustment of chlorine dosage to each point should be carefully checked so that all the distribution pipes are chlorinated. This adjustment should be done before the chlorine gas is combined with the pressurized water because a failure of the heating system may freeze into liquefied chlorine.

4) Chlorine Dosage

Based on the current feeding rate and chlorine demand, the chlorine dosage is determined. The chlorine demand is computed as a total of the following:

- Chlorine consumed by inorganic and organic compounds
- Chlorine to be consumed during passing through the supply facilities
- Chlorine retained at the end of distribution pipe

The current dosage at the Central Pump Station is shown in Table 2-12. This dosage seems reasonable because it is similar to the dosage computed from chlorine demand.

Table 2-12 Chlorine Dosage

Pump Station	Current Dosage	Chlorine Demand	Planned Dosage
Central	0.35 ~ 0.45 mg/l	0.36 mg/l	1 mg/l

Chlorination facilities to be replaced are summarized in Table 2-13.

Table 2-13 Chlorination Facilities to be Replaced

Description	Central Distribution Pump Station
Vacuum regulator	2 sets
Automatic switch over device	1 set
Flow meter	1 set
Compound meter	5 sets
Check valve	5 sets
Ejector	5 sets
Piping	L.S

(8) Flow Meter

1) Intake Flow Meters

Presently, intake flow is not measured due to the deterioration of the flow meter in the various facilities. Intake flow meters will be installed to ensure the following benefits:

- Measurement of intake flow
- Optimization of pump operation
- Decision of chlorine feeding rate
- Saving of electric power for pump operation
- Data collection for future water demand projection

Under the Project, one flow meter for each raw water storage tank, totaling four flow meters, will be installed. The equipment for the Industry and the Meat Complex Water Source will be excluded from replacement. The details for the Central Distribution Pumping Station are referred to Table 2-14 and The installation places are shown in Figure 2-4.

The ultrasonic type does not require a water interruption during installation. Therefore this type will be employed for the 600 and 700 mm intake pipe lines. This is because any stoppage of these main pipelines during the construction involved in the Project will heavily affect the entire intake system. The orifice type requires a water interruption during its installation and will be employed

for the 400 and 500 mm intake pipe lines. A summary of the intake flow meters to be installed is listed in Table 2-14.

Table 2-14 Intake Flow Meter

Distribution Pump Station	Nominal size	Nos.	Remarks
Central Water Source	ϕ700 mm	1	Ultrasonic
	ϕ600 mm	1	ditto
	ϕ500 mm	2	Orifice
	ϕ400 mm	3	ditto
Total		7	

Flow meters will be installed in the flow meter pits to be constructed in this Project. A distance equaling ten times the diameter of the flow meter on the upstream side and five times on the downstream side must be maintained from each flow meter installation point to ensure the accuracy of the flow measurement. The flow will be indicated, integrated, and recorded at the administration room of the Central Distribution Station. The necessary pipes for detection of the orifice pressure will be heated using the small generators provided for the chlorinators.

2) Distribution Flow Meter

Distribution flow is currently not measured due to the deterioration of the flow measurement equipment. There is no way to confirm the existing pump performance as to whether it is operated as designed or not. Measurement of distribution flow is important for the optimized pump operation. To recover this situation, flow meters will be installed in this Project as shown in Table 2-15. The types of the flow meter and installation conditions are determined in the same manner as the intake flow meter and the ultrasonic type is used for the pipe with diameter more than 600 mm.

Table 2-15 Distribution Flow Meter

Dist. Pump Station	Nom. Size	Nos.	Remarks
Central Water Source	ϕ800 mm	1	Ultra sonic
	ϕ600 mm	1	Ultrasonic
	ϕ400 mm	1	Orifice
Total		3	

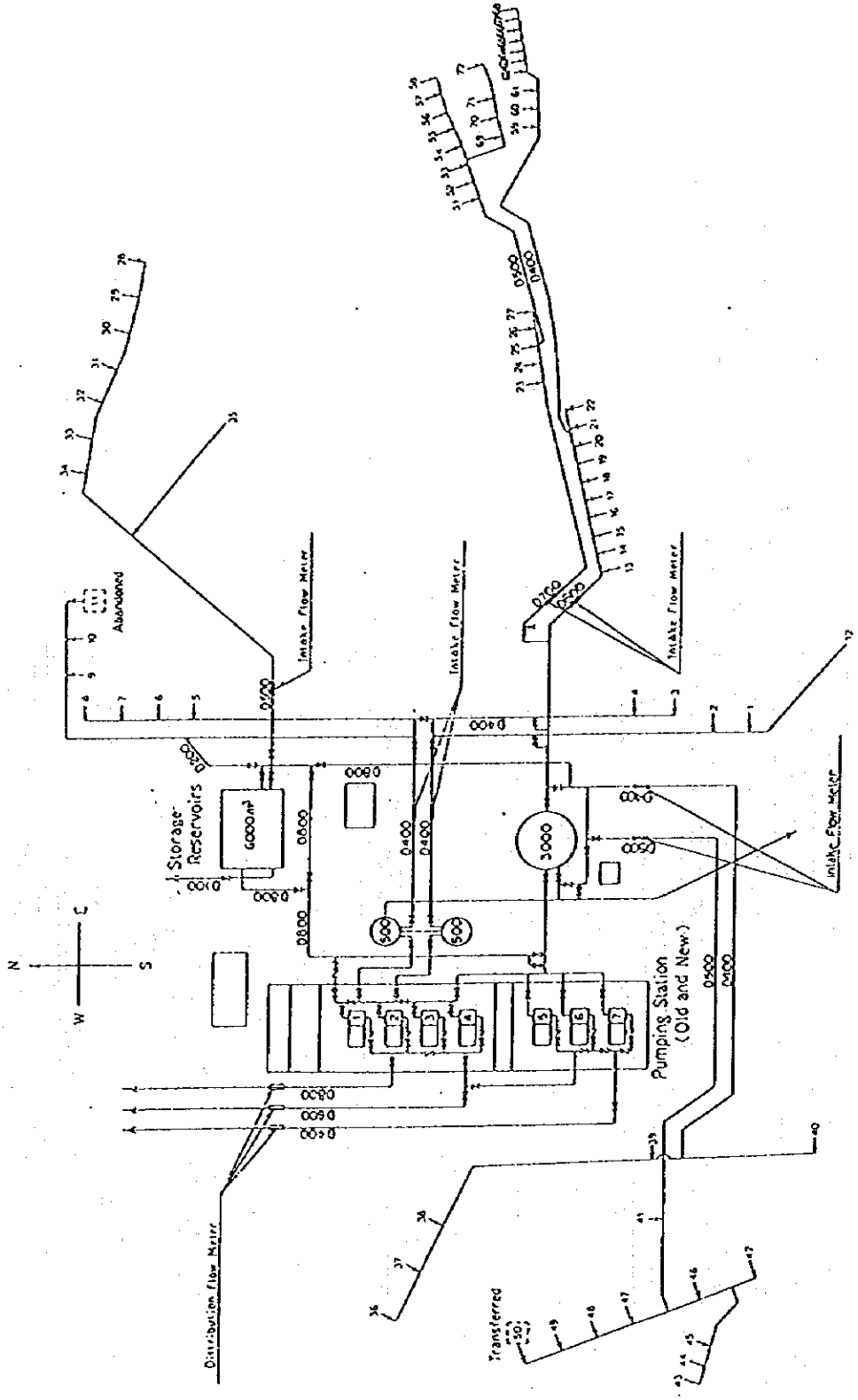


Fig. 2-4
Location Map of Flow Meter in Central Distribution Pumping Station

3) CTP

The corporate mission of public water supply is to provide water at an affordable rate and in an equitable manner to the people. It is then essential that the water tariff structure be properly set on a full cost recovery basis. Therefore, an individual water meter should be installed for every consumer and the tariff system should be based on meter reading. This can reduce the amount of the wasted water and help the USAG manage a more financially sound waterworks.

The current state of Mongolia, however, is quite different from an ideal situation. It is very hard to install individual water meters due to the existing complicated service pipe installation. For example, the service pipe is connected to not only one home at a time, but involves multiple connections. There is a water service line and a hot water service line. Under these circumstances, a constant water rate is applied, which results in lack of incentive to save water and a lack of awareness regarding the importance of water leakage control.

To improve this situation, 54 units of flow meter, with indicator and a nominal size ranging from 50 mm to 200 mm, will be installed as shown in Table 2-16. The installation of CTP flow meters will enable the USAG to record the water consumption of each apartment group and will allow the USAG to allot a water rate according to the water consumption rate of the respective apartment groups. The planned number of flow meters includes the number of damaged, uninstalled, and operating meters, as these meters can be guaranteed to operate by the target year of 1999.

Table 2-16 CTP Flow Meter List

Apartment No.	CTP No.	Diameter(mm)	Existing Condition	Replacement	Remarks
I	I	ϕ 80	Broken	O	
	II	100	Broken	O	
	III	100	Removed	O	
	I-40,000	50	Removed	O	
II	I	100	Broken	O	
	II	80	Removed	O	
	III	50	Removed	O	
III	I	80	Removed	O	
IV	120,000	80	Broken	O	
	X IX	50	Removed	O	
Y	I	150	Broken	O	
	II	150	Broken	O	
	III	100	Removed	O	
	IV	100	Removed	O	
VI	I	150	Operational		
	II	150	Operational		
	III	150	Broken	O	
VII	I	200	Broken	O	
	II	200	Broken	O	
	III	200	Broken	O	
	X I	150	Broken	O	
	X II	150	Broken	O	
	X III	150	Broken	O	
	X IV	150	Broken	O	
YIII	VIII	200	Broken	O	
	IX	200	Broken	O	
	X	150	Broken	O	
IX	I	150	Broken	O	
	II	200	Broken	O	
	III	150	Broken	O	
X	I	150	Operational		
	II	150	Unmeasurable	O	
	III	150	Unmeasurable	O	
	IV	150	Unmeasurable	O	
X I	V	150	Operational		
	VI	150	Operational		
X II	I	100	Unmeasurable	O	
	X IX	80	Unmeasurable	O	
X III	I	150	Broken	O	
	II	150	Broken	O	
	III	150	Broken	O	
	IV	100	Broken	O	
	V	100	Removed	O	
X IV	X III	150	Broken	O	
	X IV	150	Broken	O	
X V	IV	100	Broken	O	
	V	100	Broken	O	
	VI	100	Broken	O	
	VII	100	Broken	O	
X VI	I	100	Broken	O	
X VII	I	150	Removed	O	
	II	150	Removed	O	
X VIII	I	100	Unmeasurable	O	
	II	80	Removed	O	

Table 2-16 CTP Flow Meter List (continued)

Apartment No.	CTP No.	Diameter(mm)	Existing Condition		Replacement		Remarks
Replacement		ϕ50	ϕ80	ϕ100	ϕ150	ϕ200	Total
	Unmeasurable		1	2	3		6
	Broken		2	8	15	6	31
	Removed	3	3	4	2		12
	Total	3	6	14	20	6	49
Operational					5		5
Total		3	6	14	25	6	54

(9) Water Level Meter

1) Water Level Meter for Storage Tank

All the flow meters excepting for the Central Distribution Station, are inoperable due to their deterioration. To secure a stable water supply, the intake pumps should be operated effectively and the distribution pumps should be controlled precisely according to the fluctuation of water level of the storage tanks which reflects balance between distribution and intake volume

Therefore, a water level meter will be installed in each storage tank so as to operate each storage tank as necessary. The total number of flow meters to be installed is four. Ultrasonic flow meters will be employed considering the potential of freezing water.

2) Reservoir

All of the existing water level meters are abandoned due to deterioration.

To realize a stable water supply, the water level of the distribution tank should be continuously monitored. This will allow the essential continuous monitoring of the water level in the reservoirs.

Therefore, water level meters will be installed in the Tasgan Reservoir and the No. 3 and No. 4 District Reservoirs as shown in Table 2-17. As in the storage tanks, ultrasonic flow meters will also be employed in consideration of the potential water freezing difficulties.

Table 2-17 Water Level Meter to be Installed

Description	Necessary set to be installed
Tasugam Reservoir	3
No. 3 and No. 4 Reservoir	2
Total	5

(10) USAG Workshop

Table 2-18 shows the list of equipment of the USAG. Based on the operating conditions of each equipment, replacement priority is determined.

Table 2-18 Workshop Equipment

Item No.	Description	Year of Procurement	Operating	Priority
1	Lathe (large) ϕ650 x L3,000	1957	operable but deteriorated	I
2	Shaper	1957	out of order	I
3	Lathe(small) ϕ620 x L1,500	1969	operable	III
4	Crane	1969	out of order	II
5	Boring machine	1958	out of order	I
6	Grinder	1980	operable	III
7	Grinder	1959	operable but deteriorated	II
8	Electric sawing machine (wood)	1980	operable	III
9	Lathe (large) ϕ650 x L3,000	1978	out of order	II
10	Screw maker	1987	out of order	II
11	Lathe (large) ϕ620 x L1,500	1980	out of order	I
12	Boring machine	1953	out of order	I
13	Electric sawing machine (wood)	1959	operable but deteriorated	II
14	Electric Plane (wood)	1980	operable but deteriorated	II

Notes: Priority I means currently out of order

Priority II means currently operational but damaged/deteriorated

Priority III means operational

Only priority I will be replaced under this Project due to the emergency nature of the Project. In addition to the above equipment, the following equipment will be provided in this Project to assure proper operation and maintenance work

Lathe:	(large type), ϕ 630 to 750 mm, length 2,850 to 3,000 mm	L.S.
Shaper:	(stroke: 550 to 650 mm)	L.S.
Boring Machine:	(stroke: 1,300 to 1,500 mm)	L.S.
Lathe:	(small type), ϕ 625 to 650 mm, length 1,500 mm	L.S.
Bench Drill:	(drill: ϕ 23 mm)	L.S.
Welding equipment with generator	(with gas cylinder, gas regulator, etc.):	L.S
Disk grinder	(ϕ 100 mm, whetstone):	L.S
Portable drilling machine	(max. ϕ13 mm, set of drill)	L.S
Portable water level detector	(200 m)	L.S
Chain pipe tongs	(for 2"-8" pipes and 4"-12" pipes):	2 sets each
Pipe wrench	(450 mm, 600 mm, 900 mm):	2 sets each

(11) Radio Telecommunication System

This project aims at the establishment of an integrated operation and maintenance system for the whole water supply system. The water level of the storage tank of the Central Pumping station and the reservoirs should be monitored continuously so that pumps can be operated effectively. Currently, no communication system is provided between the Tasgan Booster Pumping Station and the 3/4 Area Reservoir.

As it will take more than a year to install a telephone line, a radio communication system will be employed. The communication system will be installed at the Tasgan Booster Pumping Station, the 3/4 Area Reservoir, and the Central Distribution Pump Station. The type of the communication system will be an indoor type FM radio control system .

In addition, five portable transceiver sets will be procured. One is for the field work of the USAG personnel, four sets are in case of the failure of the central source remote control system and for patrol of the intake pump site. The radios to be procured are summarized below.

1. Indoor type FM radio control system Communication range: 10 Km Number: 3 sets
2. Portable transceiver Communication range: 10 Km Number: 5 sets

CHAPTER 3 IMPLEMENTATION

Lathe:	(large type), ϕ 630 to 750 mm, length 2,850 to 3,000 mm	L.S.
Shaper:	(stroke: 550 to 650 mm)	L.S.
Boring Machine:	(stroke: 1,300 to 1,500 mm)	L.S.
Lathe:	(small type), ϕ 625 to 650 mm, length 1,500 mm	L.S.
Bench Drill:	(drill: ϕ 23 mm)	L.S.
Welding equipment with generator	(with gas cylinder, gas regulator, etc.):	L.S
Disk grinder	(ϕ 100 mm, whetstone):	L.S
Portable drilling machine	(max. ϕ13 mm, set of drill)	L.S
Portable water level detector	(200 m)	L.S
Chain pipe tongs	(for 2"-8" pipes and 4"-12" pipes):	2 sets each
Pipe wrench	(450 mm, 600 mm, 900 mm):	2 sets each

(11) Radio Telecommunication System

This project aims at the establishment of an integrated operation and maintenance system for the whole water supply system. The water level of the storage tank of the Central Pumping station and the reservoirs should be monitored continuously so that pumps can be operated effectively. Currently, no communication system is provided between the Tasgan Booster Pumping Station and the 3/4 Area Reservoir.

As it will take more than a year to install a telephone line, a radio communication system will be employed. The communication system will be installed at the Tasgan Booster Pumping Station, the 3/4 Area Reservoir, and the Central Distribution Pump Station. The type of the communication system will be an indoor type FM radio control system .

In addition, five portable transceiver sets will be procured. One is for the field work of the USAG personnel, four sets are in case of the failure of the central source remote control system and for patrol of the intake pump site. The radios to be procured are summarized below.

1. Indoor type FM radio control system Communication range: 10 Km Number: 3 sets
2. Portable transceiver Communication range: 10 Km Number: 5 sets

CHAPTER 3 IMPLEMENTATION

CHAPTER 3 IMPLEMENTATION PLAN

3.1 Implementation Plan

3.1.1 Implementation Concept

The construction for the Project is divided into three categories: (1) reconstruction of the existing wells, (2) rehabilitation work for the water supply system, and (3) installation work of the remote control system.

The Japanese Consultant will carry out the detailed design, tender, construction supervision in order to efficiently carry out the Project. Until the planned completion date, the consultant will supervise the construction work by always staying with the supervisor at the construction sites as a substitute of the USAG.

In the installation of equipment and the construction work, the Japanese Contractor's engineers will supervise the work by always staying on the site and implementing the installation work of the electric equipment and machinery (pumps, valves, panels, and meters, etc.) and will conduct the arrangement of the trial operation. Moreover, the training for the technology transfer at delivery time is planned as a part of the construction work.

Meanwhile, the USAG has to shoulder the following roles as the implementation agency:

- to arrange and contact other relevant city offices.
- to arrange and contact with other ministries and agencies.
- to conduct the detailed design and the tendering with the Consultant.
- to cooperate with the Japanese engineers who will assist and lead the construction work.
- to install the CTP water flow meter.
- to provide water and electricity for the construction work.
- to make the manuals for efficient operation of intake and distribution pumps with Japanese engineers and to conduct efficient operation.

The Ministry of Trade and Industry arranges the international and foreign assistance for Mongolia and issues the Banking Arrangement (B/A) and the Authorization to Pay (A/P). Also the Ministry of Infrastructure Development supervises the USAG and establishes the policy for water supply. Thus, these agencies shall be kept in close contact via the USAG to ensure smooth project implementation.

3.1.2 Implementation Conditions

The winter season in Mongolia is from November to March. The harsh conditions of the season make it very difficult to do construction work because the surface soils often freeze to a depth of 3 m. Thus, this season is excluded from the construction period. In the planning of the construction terms, the construction work will be determined to be completed early before the deadline month, considering the public holidays (January 1st, New Year; January 13th, Constitutional Day; February 4th, Lunar Calendar's New Year; March 8th, Womens' Day; May 1st, Labor Day; and July 11th, Revolution Day)

The equipment and materials procured from Japan will be unloaded at Tianjin Port after a marine transportation time of about one week and will arrive at the Ulaanbaatar Railway Station via rail with a transport time of about one month via Erenhot Station in China and Dzamin Uud in Mongolia (located on the national boundary). After one week, the equipment and materials will be transported from Ulaanbaatar Station to the USAG warehouse. During the railway transport phase, the equipment and materials have to be transshipped between Erenhot Station and Dzamin Uud because of the rail lines are of different widths, together with the arrangement of customs clearance. The customs arrangement is predicted to necessitate a long time. Thus, the transportation period needs to be sufficiently planned to allow sufficient time for all the required activities to be performed on schedule. Also, the equipment and materials have to be packed tidily.

The packaged materials will be inspected at their arrival at the warehouse or stockyard of the USAG in the presence of USAG officials and the Consultant. In addition, the Project will be deemed to have been completed at the end of the installation work of the equipment and materials.

During the construction stage, the following items shall be carefully dealt with:

(1) Operation of existing water supply system

The objective to the Project is to rehabilitate and reconstruct the existing water supply system. Effort will be taken to minimize the influence of the work on the system. Moreover, the safety of the work shall be a priority because the system to be rehabilitated is in operating condition.

(2) Suspension Planning of Water Supply

During the rehabilitation work for the water supply equipment, the suspension of water supply in some areas may occur due to the stoppage of pumps, open and shut-off of valves, on-off of electric power, and the connection between the existing and the new transmission pipelines. Thus, the USAG shall explain to get the understandings of the users in advance. If the USAG considers another supply method during the suspension time of water supply, the USAG must take care not to incur unnecessary problems.

(3) USAG's Cooperation for Rehabilitation Works

The rehabilitation work for the water supply system is of a large-scale and includes many kinds of equipment, and it has to be conducted in the limited period from May to October due to the cold winter season. In order to effectively and orderly conduct the construction work, together with the minimization of inconvenience caused by the construction work to the users, a detailed and optimized plan for construction work shall be established, and also it shall be explained to the USAG in detail in order to facilitate good cooperation.

(4) Arrangement of Remote Control System

After the existing remote control system was damaged by lightning, the system was left unrepaired. In the Project, the Japanese side will conduct the installation, arrangement, and trial operation, etc. of the new system. In this stage, the Japanese side needs to conduct a technology transfer to whose in charge of the operation of the remote control system, using Manuals. This will facilitate the system's maintenance after the completion of the Project.

3.1.3 Scope of Works

In the implementation of the Project, the outline of the work shared between the Mongolian and the Japanese sides will be determined, considering the field conditions and the contents of the Project.

(1) The Japanese portion

- Japanese Contractor with Japanese nationals shall conduct the procurement of the equipment and materials. The rehabilitation works of water supply facilities will be conducted under the supervision of the Japanese Consultant with Japanese nationals.
- A technical transfer for the operation and management of water supply system shall be conducted by the Consultant.
- Construction works will be conducted under the supervision of Japanese dispatched engineers.

The contents of the construction is shown in Table 3-1.

Table 3-1 Contents of the Construction

* Reconstruction of 19 wells
* Installation of intake pumps and transmission pipelines, and the construction of pump houses
* Installation of a remote control system
* Installation of water flow meters in intake and distribution mains
* Installation of water level meters in storage tanks of distribution pumping station and reservoirs
* Installation of renewal distribution pumps (including panel)
* Installation of machines tools in the USAG workshop

(2) Mongolian side

As the implementation agency of Mongolian side, the USAG shall cooperate regarding the following items:

- to provide a liaison office in the water supply bureau for the Consultant.
- to install a telephone in the liaison office with a separate line.
- to make the USAG officials' technical teams and make effort for the effective operation and maintenance of completed system.
- to acquire the land area necessary for the Project and to prepare the site (it must be level).
- to get the permission necessary for the electrical work and the use of the radio frequency from the ministries and agencies who in charge.
- to permit the land use of the construction sites.
- to provide the yards or warehouses for temporary storage of equipment and materials with security guards.
- to provide vehicles, such as trucks and cranes, if such equipment is needed for the construction work of the Project.
- to supply water and electricity to the construction sites and to install a drainage system.
- to assist in the arrangement for the customs clearance, transportation, and tax exemption of equipment and materials procured in overseas for the Project.
- to assist in the acquisition of the necessary visas for the stay of Japanese nationals' engineers.

3.1.4 Consultant Supervision

The Project's schedule will not allow a delay in the construction term because the construction period is short due to the severe weather conditions during the winter season. Considering these conditions, the Consultant's supervision should be conducted in the following manner:

(1) Checking shop drawings and working drawings submitted by the Contractor who concluded the Contract for the construction works of the Project, and to approve these documents on behalf of the USAG. Also, to conduct the delivery inspection of equipment and materials from the factories, and to advise for the USAG and Contractor by holding a meeting before the implementation of the construction work.

(2) Supervision will be conducted based on the close discussions with the USAG and related organizations of the Mongolian and Japanese Contractor(s). Moreover, the suspension of water supply during the construction work is probable, and this suspension will greatly inconvenience the citizens of Ulaanbaatar City. Thus, the inconvenience will need to be minimized through the cooperation between the USAG and the related agencies.

(3) The Project includes many kinds of work, such as the installation and reconstruction of wells, transmission pipelines, electric equipment, and workshop machinery. Therefore, a detailed work schedule, combining the time schedules for every task, shall be established in order to perform the work in the planned construction term. If delay of the construction work occurs, urgent countermeasures must be taken.

(4) If the suspension of water supply occurs, the period of the suspension should be minimized, and urgent countermeasures, such as the water supply for industries and hospitals, shall be taken into account in discussions with the USAG.

(5) The Consultant will submit a monthly report for the construction work to the USAG. The Consultant will hold a meeting with the USAG when troubles arise, and submit the documents on the agreements.

As mentioned above, the Project includes significant rehabilitation works. Thus, on-the-spot supervision is considered difficult to perform for all the works. Supervision shall be conducted by a resident supervisor. The Consultant will dispatch one resident supervisor for all construction terms (15.5 man-months total). Other engineers will have to be dispatched for the mechanical and the electric fields not able to be covered by the resident supervisor. Thus, the Consultant will dispatch an electric engineer and a mechanical engineer for on-the-spot supervision (2 man-months total).

In addition, the Consultant will dispatch two engineers to perform a technology transfer regarding operation and maintenance as shown in the following table.

Specialty	Description	Period of Assignment
Water Supply Engineer	To prepare operation and maintenance manual and perform instruction regarding operation and maintenance for the intake and distribution pumps.	3 months in the Third Term
Electrical Engineer	To perform instruction regarding operation and maintenance of the remote control system.	1 month in the Third Term

3.1.5 Procurement Plan

The equipment and materials necessary for the Project are planned to be procured in Mongolia as much as it possible. However, the equipment and materials unable to be procured in Mongolia, inappropriate ones in specifications and material quality, or with no stable supply in terms of selling cost and quantity of production will be procured from Japan or third countries in order to efficiently conduct the construction work. The market for materials in Ulaanbaatar City (as surveyed by the B/D study) are indicated on the following pages.

(1) Cement

Mongolian products are sold in the market and the availability is good. Thus, Mongolian products will be used.

(2) Sand and Gravel

The materials are produced in Mongolia. Thus, Mongolian products are planned to be used.

(3) Reinforcement Bar

Mongolian products produced by an iron manufacturer located in Darhan are sold. Thus, Mongolian products are planned to be used.

(4) Concrete Block and Brick

Mongolian products of sufficient quantity are sold in the market. Thus, these products are planned to be used.

(5) Steel Pipe and Another Distribution Pipe

These materials are not produced in Mongolia. Chinese products that meet the quality criteria are planned to be used.

(6) Pump

Intake pumps (submersible pumps) and distribution pumps (volute type) will be procured. The most probable countries for procurement are (1) Japan and (2) China. Thus, the products of both countries were examined and compared, as shown in Table 3-2. As a result of this comprehensive evaluation, the Japanese products were judged superior. Thus, Japanese products will be procured.

(7) Well Construction Materials (Casings and Screens)

The screens of the existing wells are of a very simple type consisting of wound steel wires on round frames. This simple structure causes the suction of sand and small gravel into screens during pumping and the deposit of such materials into the well bottom. The

effective area of the screens decreases during a short time, and well efficiency is adversely affected. This suction also causes friction in the pump impellers and reduces pump life.

The Project scope includes technical education through the transfer and introduction of advanced technology. Thus, the screens procured for the Project are the wire-wound type with a V slot, which are generally used world-wide and are superior collector apparatuses due to their high opening ratio and lack of clogging. The casings will use strong steel pipes. Products of Japan and China were selected for the procurement of casings and screens. Chinese products, however, are not found in steady quantity in the market and the quality of their materials and the time of delivery is also lacking. Thus, Japanese products are planned to be used.

(8) Water Flow Meter (for CTP and for intake and distribution mains)

The prospective procurement countries for the meters will be China or Japan. However the meters are planned to be procured from Japan considering their reliability and material quality.

(9) Remote Control System

In China, this system is not being manufactured. In order to complete the system, the integration of system design between the pump makers and the remote control system maker is necessary. Thus, both systems need to be manufactured in the same country. The system is planned to be procured from Japan.

(10) Machine Tool for USAG Workshop

All existing machine tools are USSR-built. These tools are difficult to import from the Russian Federation. Tools from China and Japan were considered. However, China has no equipment that meets with the specifications. Thus, Japanese products are selected for the Project.

Table 3-2 Comparison of Pump Products Between China and Japan

Compared Items	Chinese Products		Japanese Products	
	Compared Contents	Evaluation	Compared Contents	Evaluation
Price	Compared with the same capacity's model (1$=Y103.00) (1) Submersible pump Y492,000 (63m3/hr x 60 m x 18.5 kw x 380 V, efficiency 67.5%) (2) Centrifugal pump Y3,850,000 (2,000 m3/hr x 98.5 m x 800 kw x 6,000 V, efficiency 79.5%)	○ ○	Compared with the same capacity's model (1) Submersible pump Y2,712,000 (63m3/hr x 60 m x 18.5 kw x 380 V, efficiency 70%) (2) Centrifugal pump Y47,080,000 (2,000 m3/hr x 98.5 m x 800 kw x 6,000 V, efficiency 84%)	△ △
Quality	* Dispersion of quality (insufficient quality contorl) * Rough finish in general view	△	* Good quality (under quality control) * Good finish (under quality control)	○
Capability	* Pump efficiency is fairy lower than that of Japanese products. Considering the bad electrical condition and the large electrical budgeted cost in USAG budget, the efficiency can not be ignored.	△	* High pump efficiency	○
Technical Support System	* Chinese manufactures have no support system including manufacturing, piping system, installation of relavant equipment, and trial operation. * The manufactures have no good system to cope with the modification of the specification.	△	* Good technical support system * Japanese manufactures smoothly can cope with the modification of the specification.	○
Manufacturing and Delivery Date	* Chinese manufactures are producting based on the yearly production plans. Thus, they are difficult to cope with the spot order. Moreover, the spot order from overseas sometimes leaves them postpone. Thus, the manufactures are often difficult to keep delivery date.	△	* The manufactures have the production system based on the contract award, so called spot order. Delivery date is surely guaranteed.	○
Electrical Cost	Yearly operating hours are supposed: 365 day x 24 h = 8,760 hr. (1) Submersible pump (63m3/hr x 60 m x 18.5 kw x 380 V, efficiency 67.5%) 8,760 hr x 18.5 kw /0.675 x 14.6 Tg/kw = 3,505,298 Tg (2) Centrifugal pump (2,000 m3/hr x 98.5 m x 800 kw x 6,000 V, efficiency 79.5%) 8,760 hr x 800 kw / 0.795 x 14.6 Tg/kw = 128,700,377Tg	△	Yearly operating hours are supposed: 365 day x 24 h = 8,760 hr. (1) Submersible pump (63m3/hr x 60 m x 18.5 kw x 380 V, efficiency 70%) 8,760 hr x 18.5 kw /0.70 x 14.6 Tg/kw = 3,380,109 Tg (possible to save about 120,000 Tg) (2) Centrifugal pump (2,000 m3/hr x 98.5 m x 800 kw x 6,000 V, efficiency 79.5%) 8,760 hr x 800 kw / 0.795 x 14.6 Tg/kw = 128,700,377Tg (possible to save about 14,500,000 Tg)	○
Comprehensive Evaluation	△		○	

(11) Radio Telecommunication System

The system is installed to communicate among (1) the Tasgan Booster Pumping Station and (2) the 3/4 Areas Reservoir which have no telephone lines in the USAG's water supply system, and (3) the Central Pumping Station. The selected system is three units of the interior type of FM wireless telephone. In addition, a hand-held type of radio telecommunication system consisting of (1) three units for the communication in the field use when remote control system is damaged, and for patrols during operating inspections of the intake pumps and (2) two units for field work by the USAG, are planned to be procured.

(12) Chlorinator

The equipment is not reliable and may prove dangerous due to leakage of chlorine gas. Thus, a chlorinator of Japanese manufacture will be selected for the Project.

(13) Water Level Meter (for storage tanks and reservoirs)

Most equipment is inoperable. The observation of the water level in the storage tanks of the Central Distribution Pumping Station and the reservoirs are indispensable for the effective operation of the intake pumps and the distribution pumps. The equipment shall be the durable type capable of long-term use with easy-to-read values. Thus, Japanese products with a high level of reliability will be selected for the Project.

The countries from which equipment and materials will be procured are shown in Table 3-3.

Table 3-3 Breakdown of Equipment & Materials by Country of Procurement

No.	Items	Mongolia	China	Japan
(1)	Cement	x		
(2)	Sand and Gravel	x		
(3)	Reinforcing Bar	x		
(4)	Concrete Block, Bricks	x		
(5)	Steel Pipe and Others		x	
(6)	Pump			x
(7)	Well Construction Materials			x
(8)	Water Flow Meter			x
(9)	Remote Control System			x
(10)	Machine Tools for USAG Workshop			x
(11)	Radio Telecommunication System			x
(12)	Chlorinator			x
(13)	Water Level Meter			x

In the event of a breakdown of the rehabilitated facilities, agents of the manufacturers will deal with such matters.

3.1.6 Implementation Schedule

Considerting the arrival date of the equipment and materials in Ulaanbaatar City, the total number of renewed facilities, their locations, the weather conditions, and the Mongolian private sector's ability to carry out construction, the implementation schedule for the Project is projected as shown below.

Table 3-4 Implementation Schedule

		1996年	1997年	1998年
Procurement of Equipment and Materials (small scale grant aid)				
Long Term Project	Detail Design			
	First Stage - Procurement of Euipment and Materials Installation and Construction			
	Second Stage - Procurement of Euipment and Materials Installation and Construction			

3.1.7 Obligations of Recipient Country

The obligations of the recipient country are indicated in the Minutes of Meeting concluded between Mongolia and Japan during the Study. The obligations of the recipient country and Japan are allotted as shown in Table 3-5.

3.2 Operation and Maintenance Plan

3.2.1 Operation and Maintenance Plan

In order to operate and maintain the rehabilitated facilities, sufficient budgetary resources are necessary. The present budget for waterworks management is not sufficient due to excessive outlays for electricity costs caused by inefficient pump operation. Thus, the budget for the operation and maintenance shall be secured by the implementation of (1) the reduction of non-revenue water and (2) the efficient operation of the system. In addition, the following operation and maintenance plans are appealed in order to effective operate and maintain the completed system over the long-term:

(1) to train thoroughly the field operators by operation manuals on the operation method of the completed system and the repair workers on the repair menthods. This training, will be carried out by the Japanese dispatched engineers when the construction works is finished. After the completion of the training, the trained water supply engineers of the USAG will educate the field workers.

(2) the USAG shall always prepare the spare-parts in order to the long term maintenance of the existing and the completed system. Necessary spare parts shall be listed and be controlled to be always held in the warehouse, and also shall be added.

(3) the introducing of new technology and the education of professional technology is indispensable in order to develop the waterworks management. Thus, the USAG shall plan the improvement of the technology of the USAG officials conducting training programs.

Table 3-5 Allotment of Obligation between Mongolia and Japan

	Allotment Items	Mongolia	Japan
1.	To secure land	x	
2.	To clear, level and reclaim the site when needed	x	
3.	To construct gates and fences in and around the site	x	
4.	To construct roads within the site		x
5.	To construct roads out the site	x	
6.	To provide facilities for the distribution of electricity		
	* distributing line to the site	x	
	* drop wiring and internal wiring within the site		x
	* main circuit breaker and transformer		x
7.	To provide facilities for the water supply		
	* city water distribution main to the site	x	
	* supply system within the site		x
8.	To provide facilities for drainage		
	* city drainage main to the site	x	
	* drainage system within the site		x
9.	To provide facilities for telephone		
	* telephone trunk line to the site	x	
10.	To provide facilities for general furniture	x	
11.	To provide facilities for Project equipment		x
12.	To issue Authorization to Pay (A/P) and to bear commissions to the Japanese foreign exchange bank	x	
13.	To transport the equipment and materials (from Japan to Recipient Country)		x
14.	To exempt the custom duties, internal taxes and other fiscal levies	x	
15.	To bear all the expenses, other than those to be borne by the grant	x	
16.	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant	x	

(4) at the time that the waterworks management become stable and sufficient budget for operation and maintenance is ensured, a flow meter for each apartment and/or each household is planned to be installed.

(5) to monitor quality of raw water in order to preserve the water source.

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATION

(4) at the time that the waterworks management become stable and sufficient budget for operation and maintenance is ensured, a flow meter for each apartment and/or each household is planned to be installed.

(5) to monitor quality of raw water in order to preserve the water source.

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATION

Chapter 4. Project Evaluation and Recommendation

4.1 Project Effect

(1) Effect Anticipated

1) Stable water supply is possible.
2) Safe and potable water supply brought about by the installation of chlorinator is possible.
3) The efficient operation of water supply facilities shall be conducted, resulting from the measurement of the water flow of the intake and the distribution mains, as well as the basic data collection for the future expansion plan.
4) A part of the water consumption of the apartment complexes is lost because of the deterioration of the water supply system. The reduction of the water consumption and the efficient operation of the pumps due to the installation of remote control system will result in the reduction of the electric expenditures in waterworks budget. The plan to reduce the electric expenditures is shown in APPENDIX A-6. The electric expenditure ratio is 66 % of the waterworks outlet budget outlay, amounting to 1.25 million Tg (Yen 0.27million).
5) Sound management of waterworks shall give increase of operation and maintenance cost which presently has small ratio of 2 % in waterworks outlet budget. The increase shall enable the USAG to easily purchase the spare parts and to maintain the system.
6) Sound budget base for waterworks management, based on a self-sustaining system for the USAG shall be established after the completion of the Project.
7) The maintenance capability of the USAG shall be enhanced by the renewal of workshop machine tools.
8) The implementation of the Project shall be in line with the long-term expansion program (M/P), with the year 2010 as its target year, proposed by the social development plan (1993-1995).

(2) Benefit

1) The project covers 300,000 citizens living in the central supply area of Ulaanbaatar City. Mongolian per capita GNP is US$400, as of 1995, and categorized as a Least Developing

Country and most of the beneficiaries belong to the low-income class. This situation can also be attributed to the still present influence of socialism.

2) This Project is an emergent water supply system rehabilitation project for Ulaanbaatar, capital city of Mongolia. Water supply is one of the basic requirements of the city's residents and this project helps to establish a safe and stable water supply system.

(3) Appropriateness as a Japanese Grant Aid Project

1) The Project complies with the Mongolian national development policy, which includes a national policy on urban and rural water supply. This national policy includes a) acquisition of water source, b) rehabilitation and expansion of required facilities and c) appropriate tariff system based on the flow measurement.
2) This is a Grant Aid project intended to rehabilitate a public water supply and its purpose is not for making profit.
3) Construction under this Project has to be implemented with careful consideration on environment.

Considering the conditions mentioned above, the Project is recommended to be implemented because implementation of the Project can be evalutaed as appropriate and feasible.

4.2 Recommendation

This project is very useful from the point of benefits provided by its implementation and also from the point of its contribution to basic human needs. During and after the implementation of this Project, however, the following issues remain to be solved in order to ensure optimum conditions for the Project.

(1) The USAG shall carry out the Strategic Plan in order to reduce the water consumption of the apartment residents and shall establish an implementation committee in the office.
(2) The USAG shall request cooperation from the supervisory agency, the Ministry of Infrastructure Development and the water rate collection agency, the City apartment management office in order to carry out the Strategic Plan.

(3) After the completion of the Project, the USAG shall examine the strategy and carry out the countermeasure on their own in order to reduce water consumption and to efficiently operate their pumps.

(4) USAG shall collect the basic data concerning operating condition of the system as well as the water supply amount in order to establish sound waterworks management methods.

(5) In case the electric expenditures can be reduced, the cost savings shall be put towards operation and maintenance costs. Moreover, the USAG shall establish an operation and maintenance system including the requisite organization capabilities.

(6) The USAG shall reduce of its electrical expenses and improve the revenue/expense balance of the waterworks

(7) In order to upgrade the technical level of the field operators, who in charge of the operation and maintenance of the completed system, the USAG shall make a training program and carry out the associated training. In addition, the USAG shall prepare a library to stock the necessary books, documents etc.

(8) The USAG shall constantly maintain sufficient spare-parts and/or parts in case of emergent damage.

The USAG shall implement continuous monitoring of water quality of water source wells.

APPENDICES

APPENDIX A-1 MEMBER LIST OF STUDY TEAM

Appendix A-1 Member List of Study Team

Field Survey Team (Period: September 12 to October 6, 1995)

Assignment	Name	Position
1. Team Leader	Mr. Haruo IWAHORI	Expert, JICA
2. Grant Aid Planner	Ms. Kae YANAGISAWA	Deputy Director, Study Review & Coordination Division, Grant Aid Study and Design Department, JICA
3. Project Coordinator	Mr. Shokichi SAKATA	First Basic Design Study Division, Grant Aid Study and Design Department, JICA
4. Hydrogeologist	Dr. Kenji TAKAYANAGI	Deputy Manager, Engineering Division, Overseas Department, Nippon Jogesuido Sekkei Co., Ltd.
5. Water Supply Facilities Planner	Mr. Shigeo SAWAI	Senior Civil Engineer, Engineering Division, Overseas Department, Nippon Jogesuido Sekkei Co., Ltd.
6. Equipment Planner Operation and Maintenance Planner	Mr. Takashi WATANABE	Chief Civil Engineer, Engineering Division, Overseas Department, Nippon Jogesuido Sekkei Co., Ltd.
7. Interpreter	Ms. Atsuko TAKEHARA	Engineering Division, Overseas Department, Nippon Jogesuido Sekkei Co., Ltd.

Draft Basic Design Report Explanation Team (Period: January 9 to January 18, 1996)

Assignment	Name	Position
1. Team Leader	Mr. Haruo IWAHORI	Expert, JICA
2. Hydrogeologist	Dr. Kenji TAKAYANAGI	Deputy Manager, Engineering Division, Overseas Department, Nippon Jogesuido Sekkei Co., Ltd.
3. Water Supply Facilities Planner	Mr. Shigeo SAWAI	Senior Civil Engineer, Engineering Division, Overseas Department, Nippon Jogesuido Sekkei Co., Ltd.
4. Interpreter	Mr. Junichiro HATTORI	Engineering Division, Overseas Department, Nippon Jogesuido Sekkei Co., Ltd.