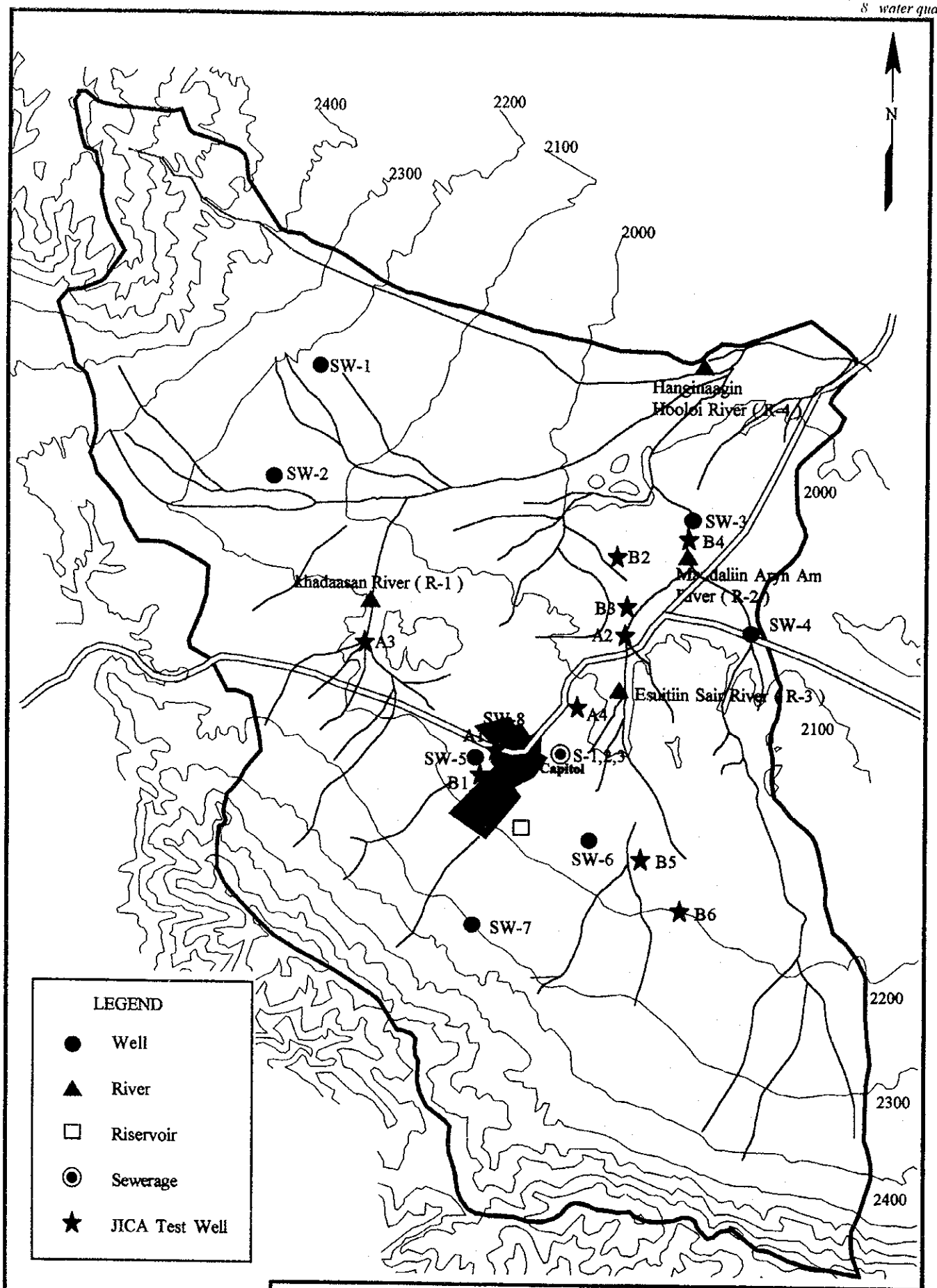

Figure 8.1(1) Sampling Points for Water Quality Analysis (Existng Well)

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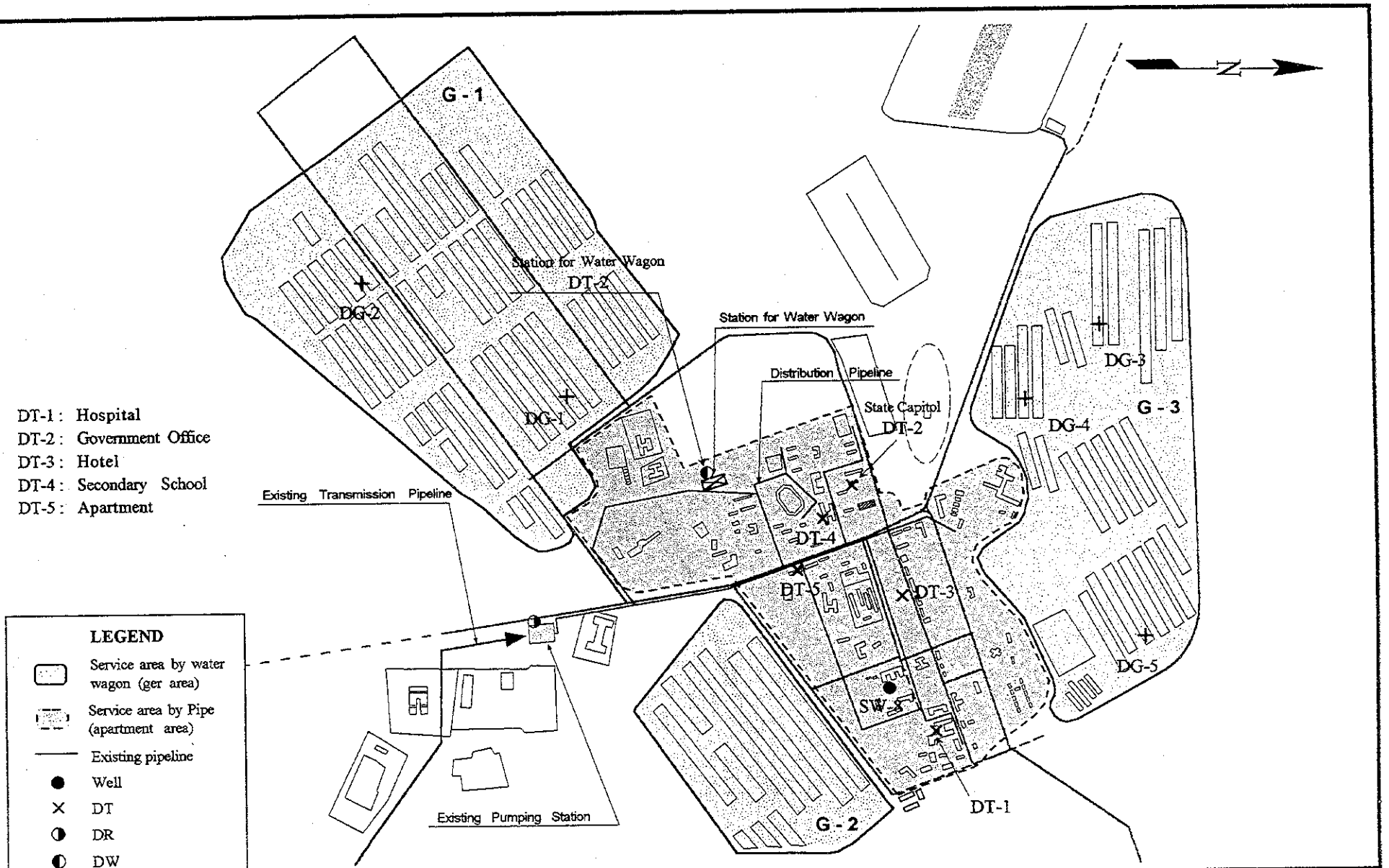

Figure 8.1(2) Sampling Points for Water Quality Analisis (Water Supply System)

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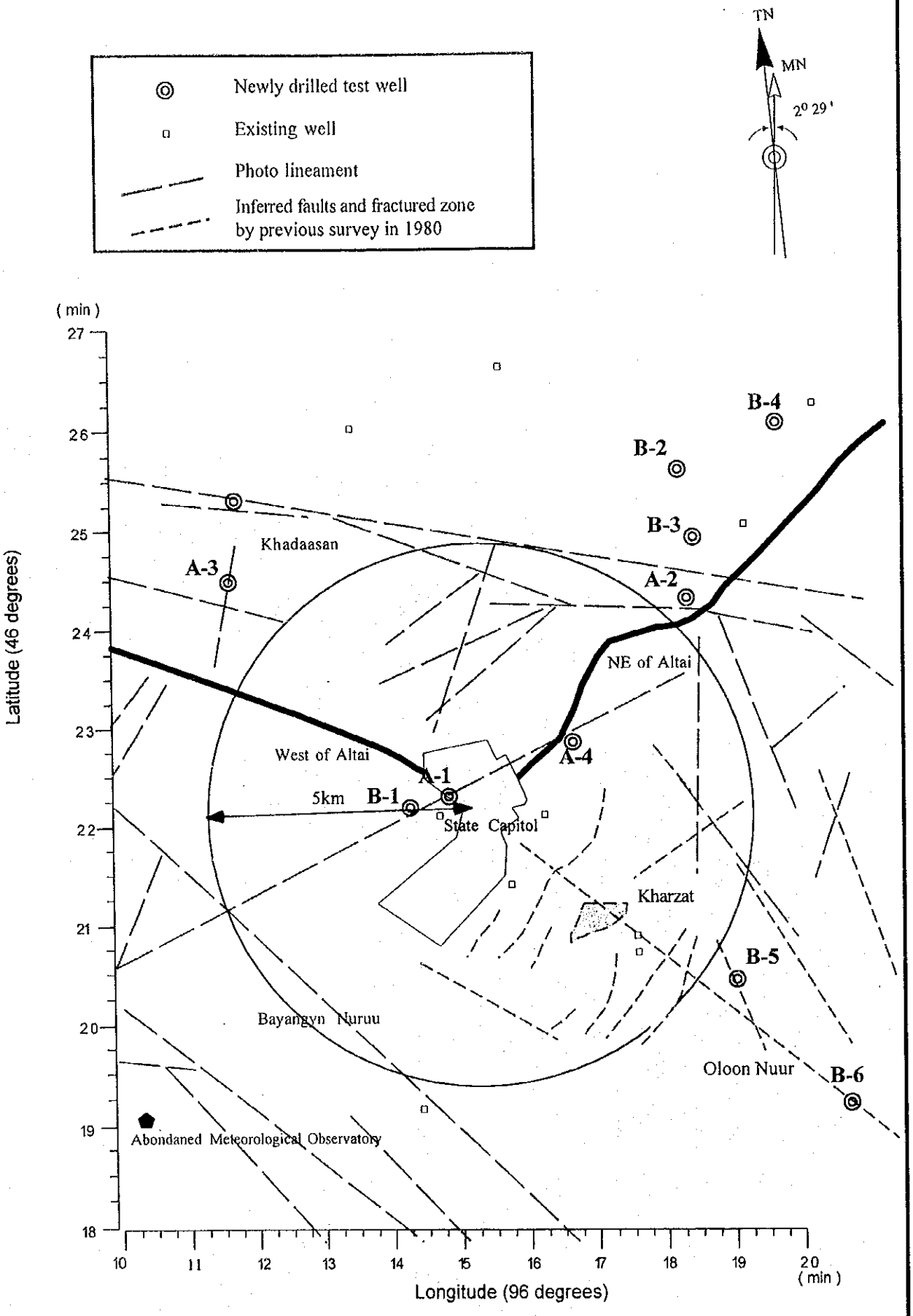

Figure 8.1 (3) Sampling Points for water Quality Analysis (New Test Wells)

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9. WATER SUPPLY FACILITY

9.1 PRESENT CONDITION OF WATER SUPPLY

9.1.1 Service Condition

(1) Service Area

The service area covered by public water supply is ascertained as shown in Figure 9.1. Potable water is supplied to the central apartment area (approximately 90 ha) by pipe network system and to ger area (approximately 224 ha) by water wagon transportation system.

(2) Population in Service Area

Population of Altai City is about 17,800 in the year of 1997. People live in apartment buildings in the central area and gers houses in the ger area around the center of the city. Population of those areas is shown in the following table

Category	Population	Number of household	Family size
Apartment Dwellers	3,245	488	6.6
Ger Dwellers	14,516	2,661	5.5
Total	17,761	3,149	5.6

9.1.2 Water Supply System

(1) Outline of the system

Public water supply system in Altai City shown in Figure 9.2. has been basically the same since the start of water supply service of Altai City. The system is operated and managed by Altai City Public Service Department (APSD) which controls water supply and sewerage works. Raw groundwater is first pumped up at the intake wells in Kharzat and is transported to the distribution pumping station through pipeline. At the pumping station, it is reserved in the storage reservoir which stands adjacent to the station. Finally it is supplied to consumers, after chlorination at the storage reservoir. Water is supplied

through pressured pipelines to apartment buildings, institutions and some of industries with individual service pipe connection.

Buildings are also supplied with hot water during the cold season from the communal heating center (CHC; eight CHC exist in the city, one of them holds public bath in addition to it's regular service) where some parts of cold water from distribution pipelines is heated. Therefore building are supplied with two types of water through dual service pipes. APSD is responsible for supplying water up to the entrance of the CHC.

In ger area, water is supplied by 4 water wagons with 4 m^3 to 4.75 m^3 of tank capacity. People in ger area have to go to buy water with water vessels (20 to 60 liters of volume) to delivery points, where water wagons come to supply water every other day (The number of water wagon is not enough to deliver water every day).

(2) Water Source

Altai City solely depends on groundwater as the source for public water supply. There are four intake wells with lift pump including one well under repair and one abandoned well in Kharzat area located at the southern part of the city.

Water is pumped up by any of two wells out of the three wells that are operated every day by turns. Then it is transmitted to the storage reservoir at the distribution pumping station. The specifications of the intake wells are outlined in Table 9.1.

(3) Condition of Water Supply Facilities

Through field survey in Altai City, present conditions of water supply facilities were clarified and are summarized as follows.

A. Intake Pump

	Item	Specification, Remarks
1	Number of Pumps	4wells: dia.8" x 25 m^3/h /unit x (80m-100m) x 4 units (CK4923;1979, CK4924;1979, CK8761;1986 under repair, CK8850;1995)
2	Daily intake quantity	25m^3/h.unit x 2 units x (18~24 hrs/d) =900~1200 m^3/d
3	Point at issue	- the pressure gauge and other accessories of pump have not functioned well. - spare parts for repair is always in short supply - some of the pumps have been deteriorating

B. Transmission Pipe

	Item	Specification, Remarks
1	Length of pipes	Dia150mm x 3.4km x 2 lines (in parallel) = 6.8 km
2	Pipe material	Steel pipe coated outside with coal tar and joined by welding
3	Depth of pipe	Thickness of soil covering: 3.6 meters
4	Point at issue	- Pipes have been deteriorating - Water transmission has been often interrupted on account of water leakage caused by corrosion of pipe - Reconstruction of the pipe was requested to GIAUS

C. Distribution facilities

	Item	Specification, Remarks
1	Storage reservoir	- 1,000m^3/unit x 2 units =2,000m^3 - Two rectangular reservoirs of the same size made of reinforced concrete.
2	Chlorinating	Liquid chlorine is added to the inlet pipe of raw water at the reservoir for thirty minutes a day when reservoir is nearly full. Dosage is not well controlled.
3	Distribution pump Number of pump	- Dia.8" x 90 m^3/h .unit x 35m x 3 Units Only one unit is usually operated. - 90 m^3/h x 1 unit x (18-24 hrs/d) = 2160 m^3/d
	Dairy quantity	- Practically the water of 800(summer)~1200 (winter) m^3/d is distributed.
4	Point at issue	- Pressure gauge on the delivery pipe of the pump indicated 4.6 kg/cm^2, which is higher than the designed pressure of 3.5 kg/cm^2 of the pump. - Pump capacity is too large for present water demand.

D. Distribution pipe

	Item	Specification, Remarks
1	Length of pipes	Dia.200mm x 5600 m (Approximately) Dia.125mm x 135 m Total 5735 m (Approximately)
2	Pipe material	Steel pipe coated outside with coal tar and joined by welding
3	Depth of pipe	Thickness of soil cover: 3.6 meters
4	Point at issue	- It is necessary for reduction of water leakage to control the water pressure of pipes by valve for low ground level area. - Pipeline network covers only the central area.

E. Water supply for ger

	Item	Specification, Remarks
1	Water wagon	4 m^3 of capacity : 3 vehicles 4.75 m^3 of capacity : 1 vehicle Total : 4 vehicles
2	Daily delivery quantity	Mean : 41.3m^3/day (based on APSD data) Maximum : 78 m^3/day (based on weekly data at the beginning of Oct.1998)
3	Point at issue	- People in ger area suffer inconvenience in getting potable water in terms of quantity and accessibility. - Carrying filled water vessels to home is a burden on women and children.

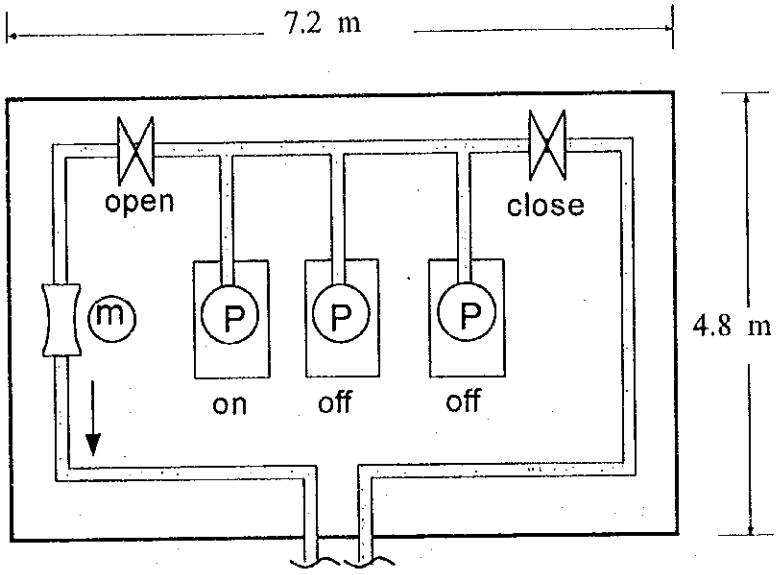
9.1.3 Water Supply Amount

(1) Flow Rate Measurement at Distribution Pump Station

With regard to water supply amount, flow rate measurements were carried out to clarify the actual water supply amount in summer season (June, July 1997) and winter season (October 1998) at distribution pumping station. It should be noted that a little higher consumption of water is expected in winter season because CHCs use water for heating.

The measuring device (ultra-sonic current meter) was installed at the delivery pipe of pump in the pumping station.

(2) Measurement Result



ⓜ ultra-sonic current meter

1) Summer Season

The measurement of distribution amount was carried out on June 26 and July 15. However the distribution pump stopped in the middle of the measuring due to electric power cut at the first measurement on June 26.

The following table shows the distribution amount at the second measurement on July 15. The measurement was done for 24 hours on thet day continuously.

Distribution Amount in Summer (1997)

Site	Start	End	Duration (hours)	Quantity of Water Supplied	Ave. Hourly Flow Rate
Distri. Pump Station	7/15, 6:00	7/16, 6:00	24	861m³	36m³/h

2) Winter Season (1998)

To clarify the distribution amount in winter, 48-hour measurement at

station was carried out twice (October 9 to 11 and October 16 to 18). The distribution amount in winter season is shown below.

Distribution Amount in Winter (Oct.1998)

Site	Start	End	Duration (hours)	Amount (m^3, (m^3/h))	
				First 24 hrs	Second 24 hrs
Distri. Pump Station (First)	9 (Fri), 6:00	11 (Sun), 6:00	48	1,067 (44.6)	1,044 (43.5)
Distri. Pump Station (Second)	16 (Fri), 6:00	18 (Sun), 6:00	48	948 (39.5)	965 (40.2)

(3) Water Supply Amount at Present

From the result of the flow rate measurements at distribution pump station, present condition of water supply amount in Altai City can be summarized as follows.

Summer season

- Supply amount to service area is about 860 m^3 /day in average.
- Even late in the night considerable amount of water (6.5m^3/hour) is distributed after pump stop caused by electric power cut.

Winter season

- Supply amount to service area is about 1,060 m^3 /day in average.
- Daily consumption on weekdays (Friday) and on weekend (Saturday) is almost the same.
- Peak-flow appears around 9:00-10:00AM on Friday and at 10:00-11.00 AM on Saturday.
- Even late in the night considerable amount of water (35 to 38 m^3/hour) is distributed.

9.1.4 Water Consumption

(1) Domestic Use

The water consumption data of domestic users is shown in the following table for 12 months until the end of September, 1998. This data was presented by

APSD and is based on the water tariff data. of APSD.

Unit: m^3

Type of Dweller	Monthly Consumption (1997-1998)												Annual Amount
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
Apartment	4950	4950	4950	5202	5202	5202	5202	5202	5202	5202	5202	5202	61,668
Ger house	940	980	988	1194	1301	1331	1108	1259	1663	1378	1213	1734	15,089

1) Apartment Dweller

According to the above data, monthly water consumption of apartment dwellers is almost constant every month in the same year. In 1997, 1650 persons of all apartment dwellers was registered at APSD as water consumers and water bills were collected from them. It seems that the water consumption (monthly 4,950m^3) of apartment dwellers was calculated on the basis of the following unit water demand and number of consumers.

- Unit water demand is set at 100l/c/d
- There are 1,650 registered consumers

There fore, the monthly consumption is calculated as follows.

Monthly consumption = 100 l/c/d x 1,650 persons x 30 days x 10^{-3}
= 4,950 m^3/month

However, this figure is too small to be real. This means that the water consumption figure derived from the accounting data may not represent the actual consumption amount.

In fact, it is difficult to estimate consumption for the apartment dwellers because there are not any water meters in apartment buildings.

Actual measurement

With an intention of obtaining more reliable data, the Study Team conducted water consumption measurement for domestic use on July 1997 and October 1998 at two apartment buildings (No 17 and No 20).

The following table shows the summary of the flow rate measurement at the apartment buildings in winter season.

Summary of the flow rate measurement

Apartment No	Supplied Amount (m^3/d)	Number of Families	Number of Dwellers	Unit Consumption (l/c/d)	Remark
17	22	27	78	282	measured about 1.0m^3/h in midnight
20	22	37	125	176	ditto

(*) Average consumption per capita: 217 l/c/d = (22 + 22) m^3/day / (78+125) person

Average unit consumption can be calculated to be 217 l/c/d for 203 persons living in 64 dwellings in two apartment buildings.
The measurement result in summer season (June, July 1997) was 28.8 m^3/d and unit consumption can be calculated to be 220 l/c/d in average for 130 persons living in 29 dwellings in No. 20 apartment building.

Ger dwellers

Ger dwellers consume 58 m^3/d in average of monthly maximum on the basis of the data from APSD. On the other hand, the consumption for ger dwellers in the winter season of 1998 was examined on the basis of the data of water delivery amount by wagons. The following table shows the weekly consumption data from October 1 to 7. These data are reliable because water quantity to wagon tank is measured by water meter set at the transfer station to ger areas since last May.

Weekly data of water delivery quantity to Ger areas (Oct. 1 – Oct. 7, 1998)

	1 (Thus)		2 (Fri)		3 (Sat)		4 (Sun)		5 (Mon.)		6 (Tue)		7 (Wed)	
Wagon No	trips	amount (m^3/d)	trips	amount (m^3/d)	trips	amount (m^3/d)	Trips	amount (m^3/d)	trips	amount (m^3/d)	trips	amount (m^3/d)	trips	amount (m^3/d)
1	5	19.8	6	22.3	6	20.5	6	22.4	6	20.3	5	19.9	4	15.4
2	4	14.9	6	23.6	5	17	7	26.3	7	27.3	-	-	-	-
3	4	15.1	5	22.9	5	23.5	6	28.3	4	20.1	4	17.7	6	25.7
4	-	-	-	-	-	-	-	-	4	10	6	22.4	4	12.1
Total	13	49.8	17	68.8	16	61	19	77	21	77.7	15	60	14	53.2

Daily average in a week : 63.9 m^3/day
Daily maximum in a week: 77.7m^3/day

According to the above data, Ger dwellers require about 80 m^3/d in daily maximum in winter season. It means that the unit water demand can be

estimated to be more than 5.5 l/c/d if all the ger dwellers are covered.

2) Institutional and Industrial use

At present there are 31 institutions and 3 industries which are supplied with water from pipeline network of APSD. The number of institutions tend to increase year by year. Monthly water consumption in institutions and industries is shown in Table 9.2 for one year (Oct. 1, 1997~ Sept. 30, 1998) and it was compiled from the data from APSD.

The water consumption of institutions and industries is 145.2 m^3/d in annual daily average. However there is agreat difference in water consumption between summer and winter as shown in the following Table.

This reflects the fact that CHCs (Communal Heating Center) need much water in cold season for heating. The following table shows the summarized water consumption of institutions and industries in the same year.

Summarized Water Consumption of Institution and Industries

Categories	Annual Average Consumption		Monthly Maximum Consumption (representing winter)		Monthly Minimum Consumption (representing summer)	
	(m^3/day)	(%)	(m^3/day)	(%)	(m^3/day)	(%)
1. Total Institution	136	93.8	229	94.2	44	86.3
CHC	(16)	(42.0)	(140)	(57.6)	(6)	(11.8)
2. Total Industries	9	6.2	14	5.8	7	13.7
Ground Total	145	100	243	100	51	100

9.1.5 Water Leakage

Water leakage volume survey for apartment and institutional buildings was conducted on June 26, 29, and 28 in 1997. The number of households investigated was 68 (8 buildings), and 10 for institutional buildings. The result is shown in Table 9.3.

Methodology

- Interviewers visit apartment and institutional building.
- They check conditions of toilet instrument and water taps.
- When leakage form water tap is perceptible they measure amount of leakage

using a beaker and watch.

- Amount of leakage water from toilet instrument is classified into four (4) ranks by their subjective point of view.

The result is summarized as follows.

Summary of Leakage Survey

Category		Rate of poor equipment	Leakage
Apartment	Tap	10.0 %	43 m^3/d
	Toilet	32.0 %	115 m^3/d
Institution	Tap	2.3 %	?
	Toilet	21.0 %	?

(1) Condition of Water Taps and Toilet Instruments of Apartment

The rate of leaking tap in apartments is 10% (14/135). The leakage volume from the taps of 68 households is 4.215 liter/min. It means that the leakage volume from the taps of one household is 62 milliliters per minute. If this figure is applicable to the other households for 24 hours, the total leakage volume from the taps of all the apartments is estimated at 39 m^3/day on the data of 441 households in apartment buildings last year (1997). However the total leakage volume was recalculated to be 43m^3/day because there are 488 households in apartment buildings at present (1998) on the revision of the data.

The rate of leaking toilet instruments is about 32% (22/68). The rate is worse than that of tap. It was difficult to actually measure the leakage volume from toilet instruments. However, according to "The Study on Water Supply System in Ulaanbaatar and Surroundings", the leakage volume from each toilet instruments ranges from 360 to 3081 liters per day. Assuming that the leakage volume from toilet instruments ranked under *small* in Table 6.3 is 360 liter per day and the leakage volume from toilet instruments ranked under *large* is 3081 liter/day, the leakage volume of toilet instruments from 68 households can be estimated to be 16.1 m^3/day. If the total leakage from toilet instruments of apartment buildings is estimated in the same manner as tap's one, 104 m^3/day is calculated, and it can be recalculated to give 115m^3/day for 488 households at present (1998).

(2) Condition of Water Taps and Toilet Instruments of Institutional buildings

The rate of leaking tap in institutional buildings is 2.3% and quite good compared with apartment's tap. The number of leaking instruments of institutional building is almost the same as that of apartment's toilet instruments.

9.1.6 Operation and Maintenance

(1) Organization of Water Supply Works.

Daily operation and maintenance has been conducted by Altai Public Service Department(APSD).

APSD is one of the departments of the municipality. It takes care of water supply and sewerage works in Altai city and is financially independent from municipality since 1996. The name of the organization was changed to Public Service Department (Company) from Water Supply Department. The organization chart of APSD is shown in Figure 9.3 with the number of employee of each division in the Department. Total number of employees of APSD is 45 at present including the director.

(2) Operation of Pump Facilities

There are three members of staff for operation of the intake pumps at the intake well sites. They operate the pumps in response to phone call from the distribution reservoir site. According to an interview to a staff member, the intake pumps could be operated automatically. However, the automatic operation system has been broken.

Distribution pumps are operated manually, the daily operation time is 24 hours in winter season and 16~18 hours in summer season. So when the distribution pump stops, water supply is suspended.

(3) Operation of Chlorination

Liquid chlorine is added to the inlet pipe of reservoir for thirty minutes a day when the reservoir is nearly full. One staff member is in charge of chlorination. The laboratory is located beside the distribution reservoir, three staff members

work in the laboratory. Judging from the appearance, equipment in the laboratory is definitely insufficient. According to the data of water quality analysis, residual chlorine in reservoir and tap water in 1996 was zero (refer to chapter 8 of this report). Reliability of chlorination should be raised to the point where a little amount of chlorine should remain in water from taps.

(4) Maintenance

Maintenance of the water supply facilities should be conducted periodically so as to keep the facilities in good condition as long as possible. At the same time, daily inspection of the facilities is required.

APSD maintenance staff is not sufficient in number. Moreover, shortage of equipment, devices, materials, and so on is the most crucial matter in performing sufficient maintenance. Existing spare parts of major equipment based on the interview to APSD, are described as follows.

-	Submersible pump for installation of a intake well:	25 m^3/h x 100m 1 set
-	Centrifugal pump for distribution:	90 m^3/h x 35m 1 set
-	Injection equipment for Chlorination:	1 set
-	Fan for exhaust gas at Chlorination room:	1 set
-	Tees for accessory of Chlorination injection:	D 25 3 pipes
-	Valve	D 25 n= 10
-	Valve	150 n= 10

9.1.7 Financial Statement of APSD and Water Tariff

(1) Profit and Loss Statement

The following table shows the profit and loss statement of APSD in these five years from 1993. The largest revenue is water tariff from consumers, accounting for 69% of the total income in 1997. On the other hand the largest spending is on electric power accounting for 48.6 % of the total expenditure in 1997.

The balance in the year of 1997 shows a profit of Tg. 11.2 million

Profit and Loss Statement of AWS D (unit :Tg 1,000)

Year	1993	1994	1995	1996	1997	1997 (%)
1. Revenue						
Tariff	22,501.8	21,636.6	17,964.4	52,198.6	72,349.1	69.0
Piping Service	8,786.2	9,487.6	6,860.6	20,659.4	25,668.6	24.5
Other Service	1,193.4	2,886.8	3,193.1	3,514.4	6,781.5	6.5
Total	32,481.4	34,011.0	28,018.1	76,372.4	104,799.2	100.0
2. Expenditure						
Raw Material	120.1	320.5	1,600.0	228.2	1,471.4	1.6
Coal/ Wood	31.3	155.1	140.0	--	98.6	--
Fuel	6,166.1	8,097.1	9,000.0	6,851.1	7,632.2	8.2
Parts	793.2	1,231.3	1,156.0	2,535.1	3,932.2	4.2
Power	9,017.5	8,396.2	9,001.0	40,692.5	45,476.3	48.6
Heating	705.4	1,120.8	1,427.5	1,796.3	2,744.9	2.9
Expendable	49.1	442.2	662.0	351.2	902.9	1.0
Communication	223.5	235.9	267.1	465.7	793.7	0.8
Repair	5,332.5	5,314.9	5,320.0	5,316.0	10,100.4	10.8
Salary	3,381.5	6,990.4	8,251.2	9,142.2	11,126.5	11.9
Tax	456.5	943.7	1,402.7	693.3	2,300	2.5
Other	585.2	1,772.0	1,347.5	3,011.3	7,004.0	7.5
Total	26,862.2	35,019.7	39.575.0	71,081.9	93,583.3	100.0
3. Balance	5,619.2	-1,008.7	-11,556.9	5,289.5	11,215.9	

(2) Water Tariff

The following table shows the present water tariff. Tariff is collected as follows:

- PWSD delivers an invoice to consumers and
- consumers receive the invoice and pay the bill at the bank.

According to APSD, about 99% of water tariff was collected.

Water Tariff set by APSD for 1997 (Tg)

Consumer	Unit	Water supply	Sewerage	Total
Industry, Enterprise	Tg/m^3	900	900	1800
Apartment	Tg/month/cap.	250	240	490
Ger	Tg/m^3	1250	-	1250

Apartment dwellers pay only a fixed amount of Tg250 per month per capita. On the other hand, ger dwellers pay Tg1,250 for coupon tickets to buy one cubic

meter of potable water.

9.2 SEWERAGE SYSTEM

9.2.1 Outline of Sewerage System

Altai City has a sewerage system managed by APSD. Only wastewater from urban area (apartment, commercial and institutional areas) is collected by the sewer. No roadside ditch and sewer for stormwater are present in the city.
In the ger areas, each ger has its own latrine. Sediments in the latrine is desludged about once a year. The sludge is conveyed to the new wastewater treatment plant site.
Collected wastewater is discharged to two wastewater treatment plants with stabilization pond and is discharged to the swamp next to the plants. The location of the plant is shown in Figure 9.4.

9.2.2 Collecting System

The collecting system by sewer covers almost all the central area of Altai City. The sewer route is shown in Figure 9.4. The diameter of the sewers range from 125 mm to 350 mm, the sewers are made of reinforced concrete.
There are two main sewers and two wastewater treatment plants. Their flow rate is roughly estimated to be 400 m^3/d~ 600 m^3/d, however some portion of the flow leaks and discharges to Esuitiin Sair River.
Manholes are located at sewer intersections, changes in alignment, changes in sewer size and also arranged with regular intervals where alignment remained unchanged.

9.2.3 Treatment System

The Old Wastewater Treatment Plant

APSD operates an old wastewater treatment plant (WWTP) and a new one, both plants are working at present. The old plant is located at the southeast of the city center. Influent flow at the old one is much bigger than that of new one. Treatment process uses a stabilization pond with four cells. However almost all

of the effluent wastewater percolates downward through the bottom and evaporates at the outlet of the plant. That means little effluent wastewater is discharged into nearby streams. The area of old plant site is about 10 ha based on GPS survey.

The New Wastewater Treatment Plant

The new WWTP is located at the east of the city center. The treatment process uses a stabilization pond with six cells. Most of the influent wastewater percolates downward through the bottom and evaporates just as it happens in the old one. That means there is little effluent water except leakage from collecting sewer. However in the coldest season, some of the treated wastewater discharges to the outside according to the interview with APSD. The area of the new WWTP site is about 12 ha based on GPS survey.

The confluence of leaked wastewater and Esuitiin Sair River is 3 km away from the old treatment plant. The leaked wastewater near the confluence looks as clear as the treated wastewater. However the quality of wastewater before the confluence point should be analyzed as effluent wastewater quality of WWTP.

9.3 SOLID WASTE MANAGEMENT

The Urban and Road Department of Altai City is responsible for solid waste management in Altai City. This department has four vehicles and five staff members for conveying solid waste.

The disposal site is located in the northeastern part of the city and the distance from the city center is approximately 6 km. Collected solid wastes are leveled by bulldozer without any soil cover.

Table 9.1 Features of Intake Wells

	Item		Unit	Intake well				
1	Well code			CK-4923	CK-4924	CK-8761	CK-2 (8850)	CK-22
2	Construction year			1979	1979	1986	1995	1986
3	Depth of Well		m	39	62	30	52	45
4	Depth of Installed Pump		m	37.5	22	29	33	42
5	Pumping Rate		l/s	7.5	9.5	6.0	7	7.6
6	Statistic Water Level		m	GL-5.0	GL-7	GL-6	GL-7	GL -8
7	Dynamic Water Level		m	GL-9.0	GL-11	GL-10	GL-13	GL -18
8	Drawdown (SWL - DWL)		m	4	4	4	6	10
9	Specification of Pump			8x25m^3/hx80m	8x25m^{3}x100	8x25m^{3}x180	8x25m^{3}x100	
10	Depth to Aquifer	Upper	m	GL-10	GL-11	GL-18	GL-14	GL-12
		Lower	m	GL-24	GL-25	GL-28	GL-47	GL-20
Comment						under repair		abandoned

Table 9.2 Water Consumption in Institutional and Industrial Facilities

unit : m^3

	Facilities		Monthly Consumption (1997 - 1998)												Anual Consumption
			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	
1	Communial Heating Center	No.1	134	118	45	74	98	87	645						1,201
		No.2	1,263	997	951	1,500	1,643	2,151	285						8,790
		No.3	257	299	325	253	217	380	536						2,267
		No.4	265	119	110	119	138	149	153						1,053
		No.5	70	188	159	239	152	128	158						1,094
		No.6	300	593	428	424	645	835	624						3,849
		No.7	125	104	84	110	131	297	272						1,123
		No.8	240	185	264	264	334	307	344	173	294		198	281	2,884
	Sub-total		2,654	2,603	2,366	2,983	3,358	4,334	3,017	173	294	-	198	281	22,261
2	Provincial Hospital		1,698	869	1,074	1,040	1,181	1,120	1,320	1,249	1,409	1,150	860	806	13,776
3	School No.1		876	876	876	876	876	876	876	310	240				6,682
4	No.3		7	7	7	10	8	8	8	8			8	8	79
5	Kindergarden No.1		57	45	13	22	11	8	27	11					194
6	No.2						5							27	32
7	No.3		5	7	6	11	11	6	4	6	18			120	194
8	No.4					8		8	4	4					24
9	Governor's office		160	160	160	417	291	190	160	160	195	190	196	190	2,469
10	Police office		25	25	25			34	32	32	77	74	47		371
11	Post office		28	28	28	28	28	28	28	28	28	20	56	56	384
12	Public Health Center		5	1	1	2	2	2	2	2	2	2	2	2	24
13	Radio Broadcasting St.					40	48	10	25	77					200
14	Earthquake St.									2					2
15	Oil Supply Company							82	4						86
16	Airport					28	39	70	33	5				23	198
17	Medical Collage Dormitory		114	110	90	150	150	200	940					555	2,309
18	Laundry		39	27	15										81
19	Hair Dresser		2	2	2	1	2	1	1	1	2	2	2	2	20
20	Baby Nursery										5			16	21
21	Chemist (Shop)									5					5
22	Nursery for Elder People						6	12	8		10	12			49
23	Agricultural Stock-exchange					48	39	96	6						189
A: Sub-total Institution (1 - 23)			5,670	4,760	4,663	5,664	6,055	7,085	6,495	2,074	2,280	1,450	1,369	2,086	49,650
1	Mandal Co.		41	103	98	93	85	64	81	31	70	100	65	39	870
2	Entum Co.		104	164	45	91	260	260	260	75	55	35	55	85	1,489
3	Tulga Altai Co.		100	100	100	100	100	100		100	100	100	100		1,000
B: Sub-total Industry (1 - 3)			245	367	243	284	445	424	341	206	225	235	220	124	3,359
Gand Total (A + B)			5,915	5,127	4,906	5,948	6,500	7,509	6,836	2,280	2,505	1,685	1,589	2,210	53,009

Table 9.3 Result of Leakage Volume Survey

	House-hold	Resi-dents	Tap Condition			Toilet Condition			
			Good	Bad	Leakage Volume (ml /min)	Good	Ranked Leakage Volume		
Apartment							small	medium	large
No. 20	10	43	16	4	190	8	2		
No. 5	5	38	10			4	1		
No. 8	7	31	13			5	1		1
No. 18	20	96	36	4	2,730	14	6		
No. 7	1	8	2			1			
No. 4	23	94	41		1,275	12	9		2
No. 21	1	9	1	1	20	1			
No. 27	1	4	2			1			
Total	68	323	121	14	4,215	46	19	0	3
Police Office			4			2			
Mongol Bank			6			6			
Kindergarten No. 1			22			16			
School No. 3			7	2	130	19			
Post Office			2			2			
School No. 1			18			7	15	3	
Dormitory of School No.1			40			10	6		
Dormitory of Medical College			20			26			
Governor's Office			5			6			2
Mandal Company			3	1	600	4			
Total			127	3	730	98	21	3	2

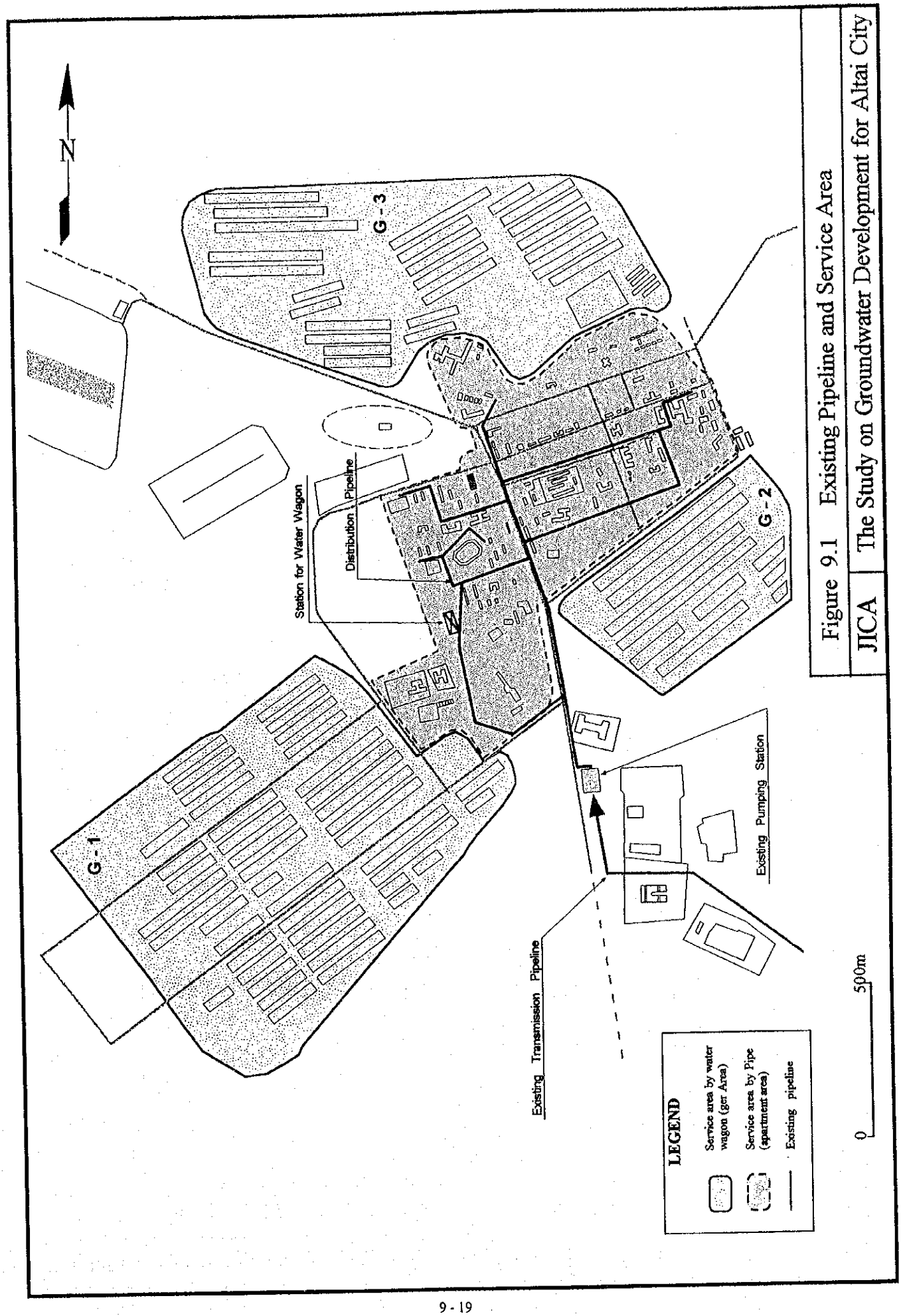


Figure 9.1 Existing Pipeline and Service Area

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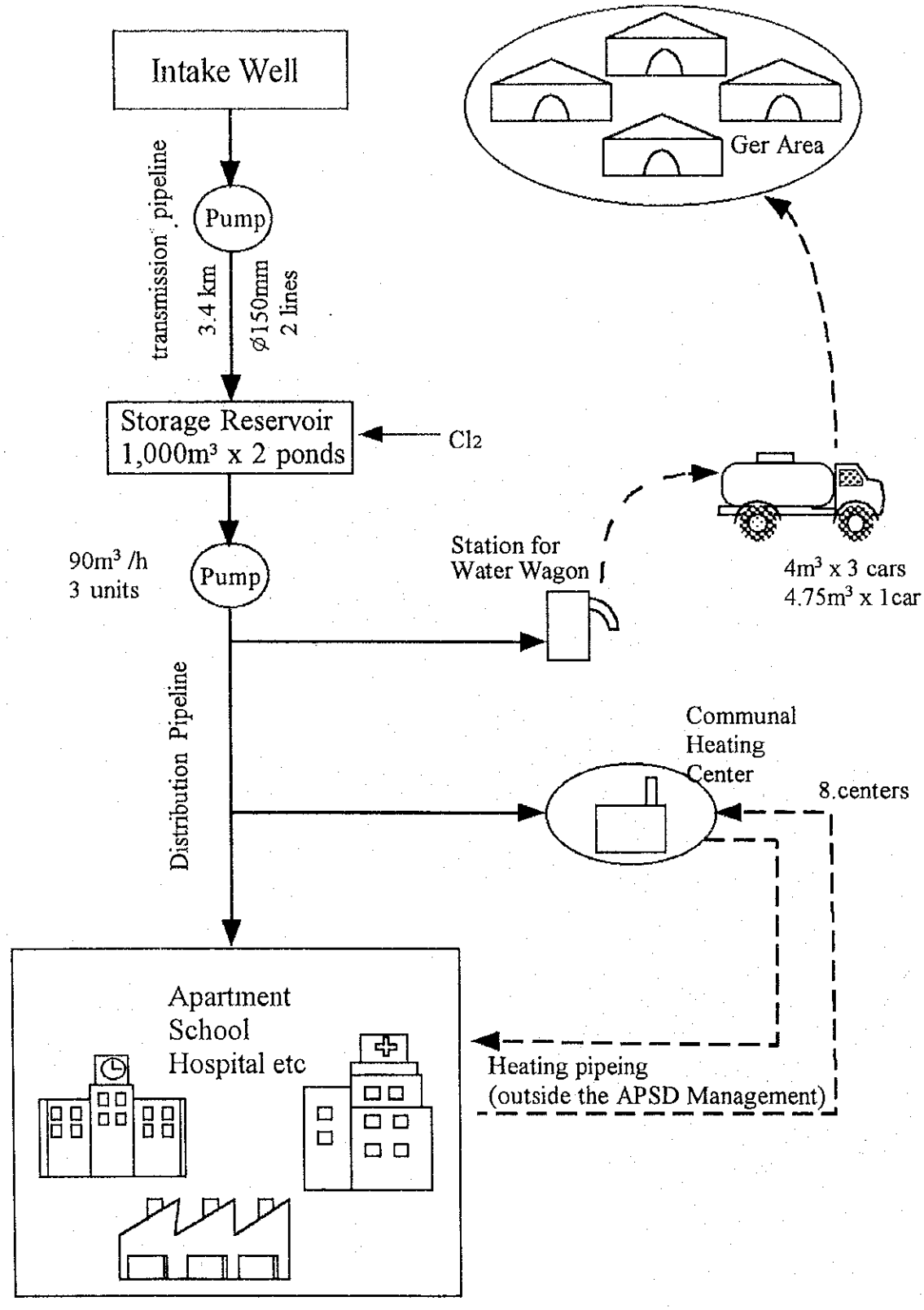

Figure 9.2 Water Supply System of Altai City

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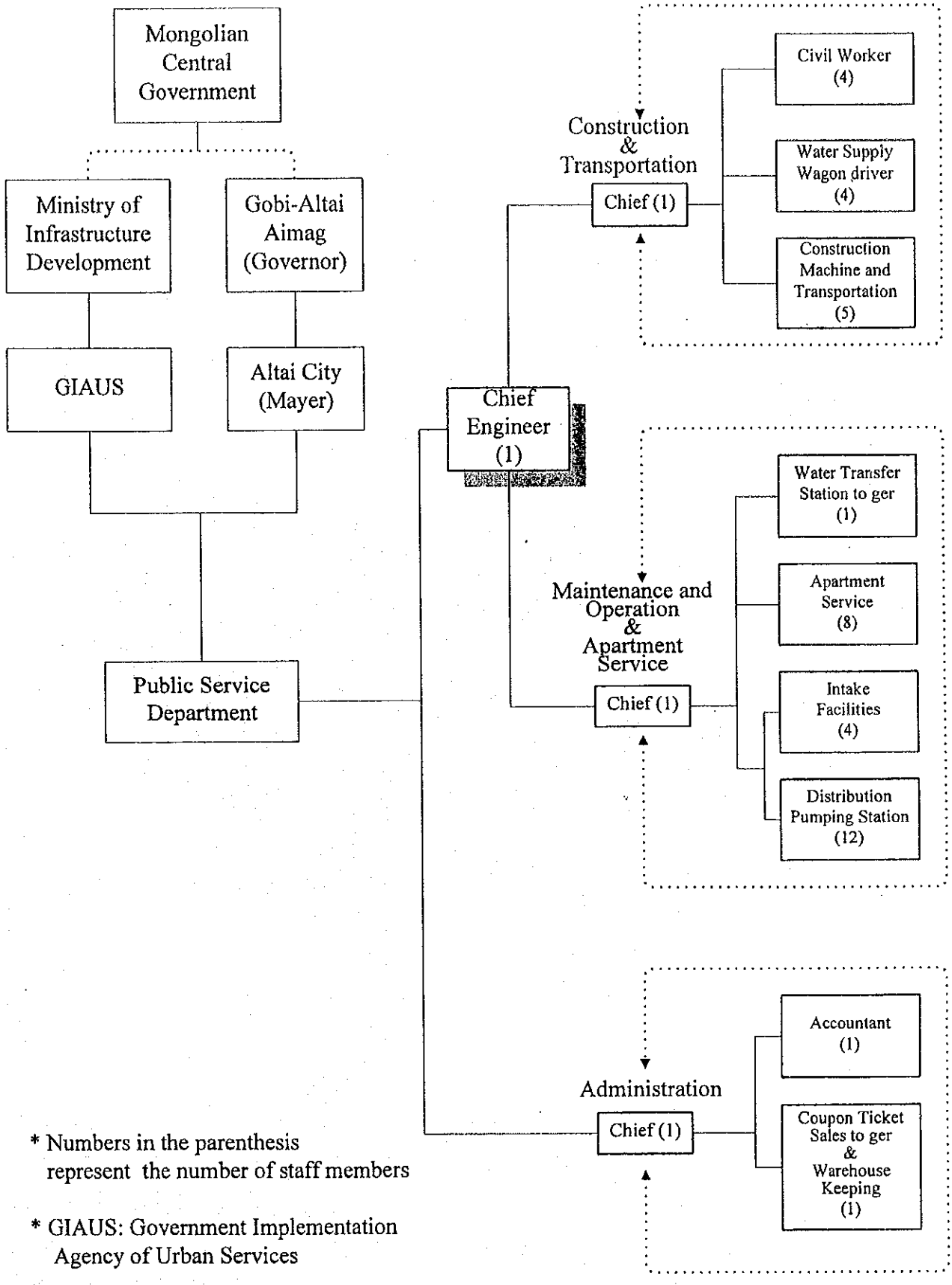

Figure 9.3 Organization Chart of Water Supply Works in Altai City

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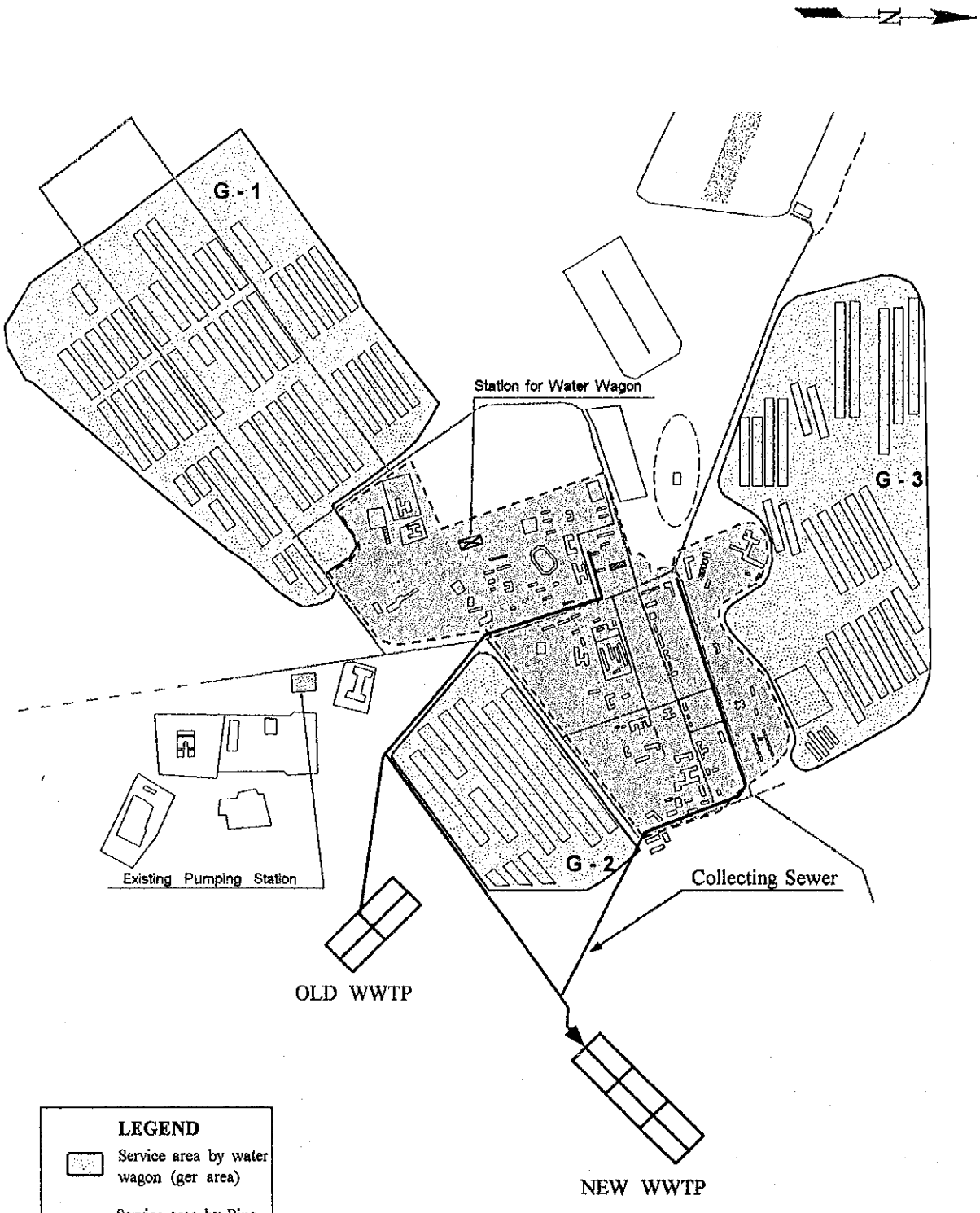

Figure 9.4 Sewerage System in Altai City

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III MASTER PLAN STUDY

III MASTER PLAN STUDY

1. BASIC CONCEPTS FOR THE MASTER PLAN

Water supply development plan shall be established on the basis of the following basic concepts.

(1) Existing Kharzat water source shall be expanded under proper of groundwater preservation scheme such as groundwater table and water quality monitoring.
(2) Water supply development for ger area district shall be given priority.
(3) Recommended unit water consumption for apartment dwellers is 150 liter / capita / day. It should be achieved step by step under the improvement work of leakage from water tap and toilet instrument.
(4) Unit water consumption for ger dwellers is recommended as 40 liter / capita / day that is the recommended volume of Ministry of Health.
(5) Water demand of institutions and industries shall be projected on the basis of economic (3-4%) and industrial growth rate (4-5%) respectively.
(6) Water loss from pipes shall be decreased step by step with the improvement work of water supply facilities.
(7) It is important to promote the people's awareness of saving water. This is equally important as developing the water source or improving the water supply facilities.
(8) Water tariff system shall be changed with the installation of water meter.
(9) The self operation system of Altai Public Service Department (APSD) shall be established on the basis of water tariff and operation and maintenance cost.

2. WATER RESOURCES

2.1 EVALUATION OF GROUNDWATER RESOURCES

Groundwater resources in and around the Altai city are listed below and their locations are shown in Figure Ⅲ-1.

Kharzat water resources shall be given priority for the water resources development from the viewpoints of the potential, water quality, and economy as follows.

Examination for Groundwater Resources

Water resources	Aquifer type	Distance* (km)	Altitude (m)	Potentia	Water quality	Hardness (mg $CaCO_3$/l)	Construction cost	Running cost	Priority
Kharzat	Alluvial	4-6	2180	big	good	225	low	low	1
Olon Nuur	Alluvial	8-9	2190	big	good	256	low	medium	2
Skhyn Hooloy	Quarter-nary	8-10	2050	small	bad	-	medium	high	-
Khadaasan	fissure	6-7	2150	small	medium	363	medium	high	-
NE of Altai	fissure	2-3	2120	medium	bad	1875	low	medium	-
Tsagaantokhoy	Alluvial	98	1890	big	medium		high	high	-
Tyshir	Alluvial	45	1700	big	(good)	-	high	high	-

* : distance from the governor's office (elevation is 2170 meters)

(1) Kharzat

Kharzat groundwater resources located near the city has been utilized for the domestic and industrial water. It has sufficient potential for the ute of water supply and its water quality is better than another water resources.

(2) Olon Nuur

It is located at the upstream of Kharzat water resources. It is expected that the groundwater potential is sufficient for the water supply of Altai City. Although its water quality is slightly worse than Kharzat water it's not so bad as the other sites.

(3) Sukhyn Khooloy

It is located to the north of Altai City and about 10 kilometers away from the city. It is reported that water quality of this water is bad due to the Quaternary aquifer condition (including Neogene aquifer) and its groundwater potential is not big comparing with Kharzat and Olon Nuur.

(4) Khadaasan

Khadaasan water resources of fissure aquifer is located at the northwest of Altai City, and about 6 to 7 kilometers far from the city with an altitude of 2150 meters. Its potential is suitable for local water supply. Water quality of this fissure water is not so bad with the hardness of about 362.5 (mg $CaCO_3$/liter), Magnesium of about 73 (mg/liter).

(5) NE of Altai

This water resources of fissure aquifer is located at the northeastern edge of Altai city, and about two kilometers far from the city with an altitude of 2120 meters. Its potential is estimated at about 1000 m^3/day. Water quality of this fissure water is not

suitable for the source of potable water with the hardness of about 1,875 (mg $CaCO_3$/liter) and Magnesium of about 402 (mg/liter).

(6) Tsagaantokhoy

This water resources of Alluvial aquifer was investigated by the Mongolian side. They found a flowing well and it proved to be a good water resource with satisfactory water quality. But, Tsagaantokhoy is located 98 kilometers far away from Altai City with an elevation 280 meters lower than Altai City. These are significant disadvantage from the viewpoints of procurement cost of materials, construction cost, and running cost of electricity and maintenance.

(7) Tayshir

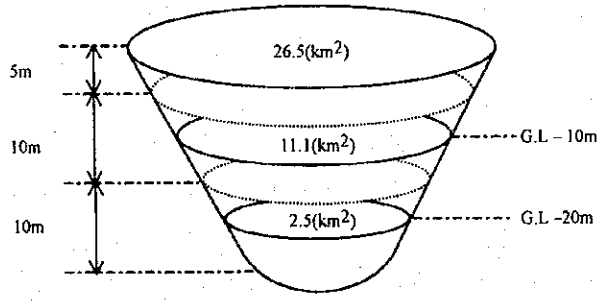
This water resources of Alluvial aquifer is supposed to be a good water resources with satisfactory water quality. But, it is also located far away from the Altai city with a distance of about 45 kilometers and its elevation is 450 meters lower than Altai City. These are significant disadvantages in the same manner of Tsagaantokhoy water resource.

2.2 GROUNDWATER POTENTIAL OF KHARZAT GROUNDWATER RESOURCES

(1) Groundwater Storage

Based on the Isopach map of the aquifer, the volume of groundwater storage can be roughly calculated as follows.

	The area of the aquifer			
A thickness	0	10	20	(meters)
The area	26.5	11.1	2.5	(km^2)



The volume of the whole aquifer is estimated by the following simplified expression;

$26.5 \times 10^6 \times 5 + (11.1+2.5) \times 10^6 \times 10 = 268.5 \times 10^6$ (m^3)

Effective porosity of the aquifer material is estimated at 0.1 to 0.15;
Then, the groundwater volume stored is ;

$268.5 \times 10^6 \times (0.1 \text{ to } 0.15) = 26.9 \times 10^6$ to 40.3×10^6 (m^3)

(2) Recharge Volume

The average annual recharge volume to an aquifer can be quantified by considering the infiltration rate of precipitation. The recharge volume to Kharzat water resources is estimated below.

Recharge Volume to Aquifer

Area	Catchment area	Precipitation	> 8mm/d in a year	Recharged precipitation	Recharged volume
Kharzat	about 70km^2	181.6 mm	34 mm	14% of total 25.4mm/year	4,870 m^3/d or 1,778,000 m^3/year

The area of Kharzat is about 70 km^2. The annual average precipitation is reported at 181.6 mm. About 64 % of precipitation concentrate during rainy season from June to August. The result of the continuous water level observation indicates that rainfall affects water level if it is over eight millimeters per day (8mm/day). It probably means that rainfall of seven millimeters or less flow out from ground surface.
In 1998, the total of rainfall that is over eight millimeters per day was 34.4 mm. The value is 25 % of the total rainfall in the rainy season (137.4mm in 1998) that has 64 % of annual precipitation in an average of about 40 years. Therefore, 16 %, or 0.64 multiplied by 0.25, of annual precipitation is the roughly estimated recharge to underground. Two percent of precipitation is considered to become interflow. Consequently, 14 % of annual precipitation, or 25.4 mm, recharge to the aquifer. The estimated total recharge volume becomes 1,778,000 m^3/year, or 4,870 m^3/day in Kharzat area.

(3) Groundwater Potential

Groundwater potential, in other words, available volume of groundwater can be utilized within the limits of storage and recharge volume under proper groundwater preservation measures of groundwater table and water quality measurement.

The following simple equation is representing flow through an aquifer;

$$\text{Total potential} = (\text{Storage volume} + \text{recharge volume}) - (\text{utilization} + \underset{\textit{discharge}}{\text{baseflow}})$$

The groundwater development potential in an area will be evaluated on the basis of the storage of the aquifer and the natural recharge to the aquifer.

In Kharzat area, the estimated recharge volume is 4,870 m^3/day. The present yield (utilized volume) from the aquifer is 960 m^3/day in average and 1,150 m^3/day in maximum.
Therefore, more than 3,000 m^3/day may be safe yield.

Potential of Groundwater Resource of Kharzat (unit: m^3/day)

Water source	Total potential	Utilized volume	Safe yield
Kharzat	4,870	1,150	> 3,000

(4) Development Program

When the development is implemented, it should be avoided that a large amount of water is pumped up from only one production well because it may cause the local reduction of water level and the deterioration of water quality. Continuous monitoring of water level and quality in the area is recommended even if a number of production wells are constructed to obtain water.

Kharzat aquifer has sufficient groundwater potential in summer season because of sufficient recharge volume from precipitation.
On the other hand, no recharge is expected in winter season from November to the middle of April. But, its aquifer has a large storage of groundwater (26,900,000 m^3), and this stored groundwater can be used in winter season without affecting the environment. Groundwater potential recovers from the middle of April every year because of the rising of groundwater table due to the melting of underground water.

2.3 OPTIMUM PUMPING YIELD OF KHARZAT WATER SOURCE

There are four production wells in Kharzat and two out of them have been operating at present. The maximum total pumping volume is about 1,150 m^3/day. The discharge rate from one well is 575 m^3/day that is close to the volume planned

originally. This seems to be an appropriate operation and pumping yield.

When considering an optimum pumping yield, the drawdown in a well ideally should be kept under six (ideally four) meters considering the aquifer thickness of 10 to 20 meters.
But, actual pumping rate and pumping water level have not been recorded at any of Kharzat production wells. So the water level monitoring is essential for the proper groundwater management.
Therefore a proper water level measurement system should be urgently established.

The optimum pumping yield for a well in Kharzat is examined with Theis non-equilibrium equation on the basis of the following assumed figures;

1) Transmissivity is 360 m^2/day that is the mean value in the area.
2) Storage coefficient of the aquifer that is 0.005 of unconfined with semi-confined

The above-assumed figures can be applied to the present condition first as follows.
When the annual average of the pumping rate of a well is 480 m^3/day, the drawdown in the cased well with the inside diameter of 0.2 m is calculated at 2.39 meter after the pumping duration of 365 days. The interference drawdown caused by another pumping well that is 100 meters away is calculated at 0.92 m for the same duration. The total drawdown in the well is the sum of the two figures; 3.31 m.
While actual water levels in the intake wells are unknown, the figure can be considered reasonable compared with the original planned figures of 4 to 6 meters. These planned figures were likely determined by the pumping test conducted when the wells were constructed in 1979, 1986, and 1995, though the detailed data were not obtained during the Study (See Table 6.4 in Chapter 6). The isopach map shows that the thickness of Kharzat aquifer is 10 to 20 meters or more. If the actual present drawdown is more than the estimated drawdown, it is possible that the well performance has been deteriorated by some factors. For example, when a pump operates continuously for a long period, the filter zone of the well may be plugged by fine particles and it causes loss of well efficiency. Almost 20 years have passed since the construction of the wells in Kharzat.

3. POPULATION AND WATER DEMAND FORECAST

3.1 SOCIO-ECONOMIC FRAMEWORK

(1) Objective

The objective of formulating a Socio-economic framework is to provide some of the basic conditions for water demand forecast. Water demand in Altai City is to be estimated for the year of 2005 and 2015 on the basis of the projected population and economic growth rates set as the Socio-economic Framework.

(2) Economic Growth

The following economic growth targets for Altai City were set during the first field survey in Mongolia in 1996.

Economic Growth Targets (%/year)

	1996-2005	2005-2015
Whole economy	3.0	4.0
Industry	4.0	5.0

The period until the year 2005 is regarded as a transitional period from a centrally planned to a market economy. The period since 2005 is characterized by a higher level of market oriented operations. The period until 2005 could be characterized also by a high level of dependence on the central government for the development activities, both public and private. As for other regions in Mongolia, Gobi-Alai would have to depend on the central government for funding various projects. A whole mechanism of development in Mongolia would be that the advanced areas in Mongolia such as Ulaanbaatar and border towns accelerate economic growth, leading to an increase in tax revenue for the central government. The central government can channel part of the collected revenue to regions in the form of subsidy or loans with favorable conditions. It is important that the fund, thus, provided be used for investment objective as much as possible rather than consumption purpose. Once initial momentum for further growth is gained, it would become easier for regions to expand development activities on their own. This would take place more in the period from 2005 to 2015 in areas like Gobi-Altai with location disadvantages and underdeveloped infrastructure.

Various efforts by the Mongolian government is aimed at accelerating economic growth through development of various hard and soft infrastructure. The mechanism such as above would likely take place with continued efforts by the government. Based on these considerations, the economic growth rates set for Atai City as presented above are to be applied as the Socio-economic framework.

3.2 POPULATION FORECAST

The population in Altai City is projected in the following two steps.

- projection of total population in Altai City for 2005 and 2015
- projection of population by district and settlement pattern, ger or apartment, for 2005 and 2015

The result is summarized as follows and presented in TableIII-1 and TableIII-2.

Projected Population in Altai City

Year	Ger	Apartment	Total
1997	14,516	3,245	17,761
2005	15,357	3,433	18,790
2015	17,131	3,830	20,961

The total population in Altai City is projected by estimating the natural growth and social change, migration of the population. First, population change by natural factor, birth and death, are estimated until 2015. Secondly, the number of labor force to be generated in Alai City is estimated. Those people becoming 16 years are all assumed to enter into the labor market in Altai City. Part of this age group that continues to higher school is assumed to be cancelled out by those entering into the labor market from the higher level schools. The number of jobs available in Altai City is estimated based on the number of jobs in 1997 and annual growth rates of 3% per year until 2005 and 4% per year between 2005 and 2015.

The balance between the number of new labor force and available jobs results in out-migration or in-migration of labor force from and into Altai City. As the summarized result in Table 3.1 shows, the labor force will keep flowing out of the city until 2009, but from 2010 labor force will start coming in from outside the city along with economic growth of Altai City. The population change by social factor is estimated by multiplying the dependency ratio by the labor force out-migrating or in-migrating. The total population in Altai City is, thus, estimated by adding the population change by the social factor to the population based on natural change. A detail of the applied

assumptions are presented in the notes attached to Table III-1.

Table III-2 shows a distribution of the total population into each district by settlement pattern, ger or apartment. The population in 1997 in each district and by settlement pattern was estimated by applying the distribution proportions of the households, for which data were collected at the Altai City Mayor's office. The distribution in 2005 and 2015 is made applying the same proportions as those in 1997. It is judged that there will be no significant investment on apartment construction at such a magnitude as to change the distribution proportion between ger and apartment dwellings.
It was found that the central government did not approve the request made by the Gobi-Altai Province government for subsidizing the apartment rehabilitation amounting to Tg. 200 million in the 1999 budget.

3.3 POPULATION SERVED AND SERVICE AREA IN 2015

The whole population of 20,961 shall be served and whole area of ger and apartment shall be covered by the water supply service in the year of 2015.

(1) Ger Area

For ger area, enough public taps or water kiosks which will deliver domestic water by pipe shall be installed. The service level to the ger area will be greatly improved and about 17,131 dwellers will be able to get more water timely.

The service ratio for the water demand projection will be raised up to 100% starting from the recent year. Unit water demand for the ger dwellers is also considered to increase up to 40 liter/c/d from the current 8.6 liter/c/d in the year of 2015. This value is recommended by Ministry of Health.

(2) Apartment Area

The coverage for the apartment dwellers should be maintained at the current level as of 100%. Whole apartment dwellers of 3,830 will have access to the tap water in the year of 2015. Unit water demand was set at 150 liter/capita/day in 2015.

(3) Service Condition for Institution and Industry

Service condition for the institution and industry should be considered on the basis of

economic growth rate of 3 % in 1998 to 2005 and 4 % in 2006 to 2015 and industrial growth rate of 4 % in 1998 to 2005 and 5 % in 2006 to 2015 respectively.

3.4 WATER DEMAND FORECAST

3.4.1 Service condition

(1) Gel Area

Ger dwellers use the water delivered by water wagon while apartment dwellers use the water from water taps in each dwelling. One of the possible way to supply more water to ger area is the construction of enough public taps or water kiosks in order to deliver potable water through pipes.

With those kinds of new facilities, the service level to the ger area will be greatly improved and the dwellers will be able to get more water timely.

Regarding the service ratio of ger area, the personnel in water supply works of Altai City consider that it is 100% because water wagons cover the whole ger area every day. On the basis of the above consideration, the service ratio of ger area for the water demand projection shall be set at 100% including recent years.

Unit water demand for the ger dwellers is also expected to increase from the current 8.6 liter/c/d to 40 liter/c/d in the year of 2015. This value is the one recommended by Ministry of Health.

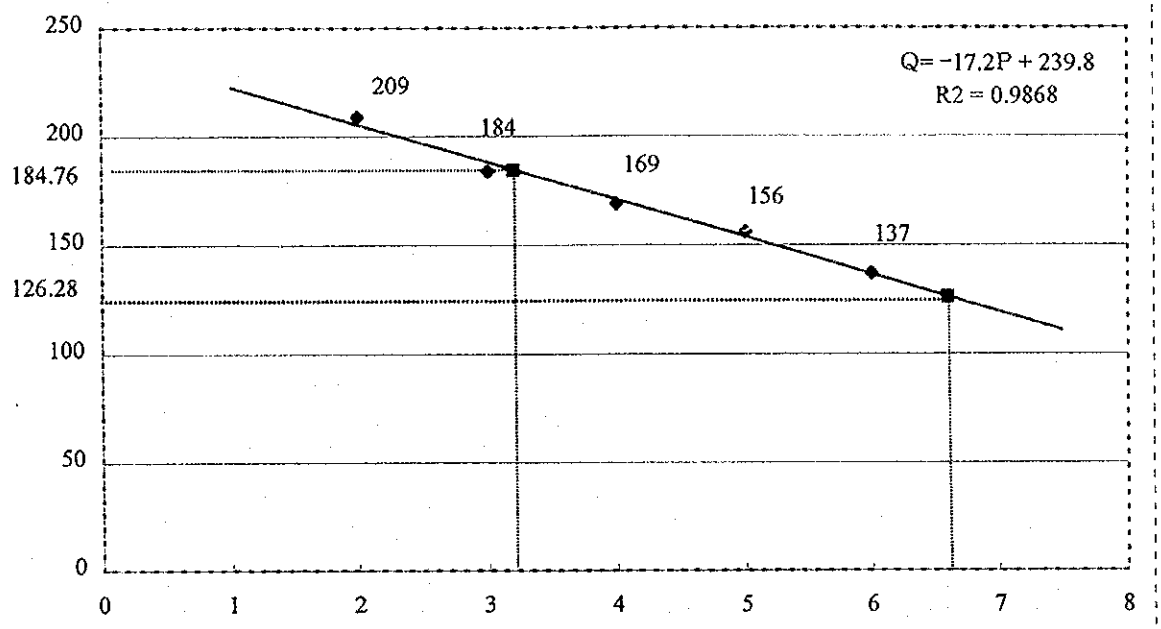
Year	1997	2005	2015
service ratio	-	100%	100%
unit water demand	8.6 liter/c/d	20 liter/c/d	40 liter/c/d

(2) Apartment Area

In the summer season of 1997 and winter season of 1998, flow rate measurement was carried out to clarify the water consumption for apartment dwellers. Unit water consumption was calculated to be 220 l/c/d. on the basis of the data analysis for the result of flow rate measurement in both seasons of summer and winter.

However family size of apartment dwellers in No.17, No.20 building is smaller than average family size (6.6 persons) of overall apartment dwellers by 3.2 persons. Generally unit water demand tends to decrease with the increase of family size as shown in the below figure.

Example: Unit Water Consumption in Each Family Size (Sapporo City, Japan, 1986)



On the basis of this tendency, unit water consumption for the apartment dwellers of Altai City can be estimated as follows.

217 (l/c/d) ×0.7=151.9 (l/c/d) → 150 (l/c/d)

The coverage for the apartment dwellers shall be maintained at the same level as the present one.

(3) Service conditions for institution and industry

Service conditions for institution and industry should be considered on the basis of economic growth rate of 3% in 1998 to 2005 and 4% in 2006 to 2015 and industrial growth rate of 4% in 1998 to 2005 and 5% in 2006 to 2015 respectively.

3.4.2 Unit Water Demand

(1) Present

Present unit water consumption and water consumption in daily maximum are summarized as follows.

Present Water Consumption

	Hearing Survey	Data from APSD	Estimation from measured data
Unit water consumption			(l/c/d)
Apartment Dweller	-	150	150
Ger Dweller	8.6	8	-
Maximum daily water consumption			(m^3/day)
Apartment Area	-	165	487
Ger Area	-	58	78
Institution	7300	229	229
Industry	(163)	14	14
Loss	-	-	342
Total		466	1150

The methodology and procedure for calculation of unit water consumption is discussed in the previous section.

(2) Forecast

Domestic unit water demand

Apartment dweller: The figure, 150 liter/c/d, is used as a basis for domestic water demand projection through the year of 1998 to 2015 because this figure is considered sufficient.

Ger dweller: The present daily consumption is 8.6 liter/c/d. However, as the survey revealed, this is too low to meet the requirement of the dwellers. The figure will be increased to 20 and further to 40 by the year of 2015.

Institutional and Industrial Water Demand

Institution: The present figure is 229 m^3/day. This figure is used as the basis for the projection. The figure will increase in proportion

to the economic growth rate (3 - 4 %).

Industry: The present figure is 14 m^3/day. This figure is used as the basis of the projection. The figure will increase in proportion to the industrial growth rate (4 - 5%)

Summarized conditions for the water demand projection

	1997	2005	2015
Service Ratio (%)			
Apartment dwellers	100	100	100
Ger dwellers	62 (100)	100	100
Unit Water Demand (liter/c/d)			
Apartment dwellers	150	150	150
Ger dwellers	8.6	20	40
Growth Rate of Water Demand (%)			
Institution	3	4	4
Industry	4	5	5

3.4.3 Water Demand (Conclusion)

Based on the assumptions discussed in the previous paragraphs, the water demand projection until the year of 2015 has been made for each category of apartment, ger, institution, and industry. The result is presented in the following table.

The current total water demand for Altai City is calculated by adding the loss volume of pipeline to the sum of the present water demands for the above four categories. The loss rate is estimated to be about 30% of daily consumption, which will be improved step-wise with the completion of water supply facility constructions in the year of 2005 and 2015. The target is set at 25% for 2005 and 20% for 2015. The yearly projected demand can be calculated in the same manner as mentioned above.

(1) Daily Water Demand

The projected water demand for Altai City for the year of 2005 is 1,140 m^3/day and 1,500 m^3/day for the year of 2015. The result is summarized in the following table to show the general trend of water demand increase.

Water Demand Forecast

	Category	Popula-tion (persons)	Served Raito (%)	Unit Demand in max (l/c/d)	Water Demand (m^3/d) mean.	max.	Remarks
1997 - 1998	Apartment	3,245	100	150	487	487	
	Ger	14,516	62 (100)	8.6 (5.2)	41	78	
	Institution	(31)	-	-	136	229	0n the basis of 1998 data
	Industry	(3)	-	-	9	14	ditto
	Loss	-	-	-	287	324	As 30% of Total
	Total	17,761			**960**	**1,150**	Actual consumption
2005	Apartment	3,433	100	150	515	515	
	Ger	15,357	100	20	163	307	mean=max x (41/78)=0.53Max
	Institution	(38)	-	-	167	282	Annual 3% in Growth Rate.
	Industry	(4)	-	-	12	19	Annual 4% in Growth Rate.
	Loss	-			283	377	As 25% of Total
	Total	18,790			**1,140**	**1,500**	
2015	Apartment	3,830	100	150	575	575	
	Ger	17,131	100	40	363	685	mean=max x (41/78)=0.53Max
	Institution	(56)			248	417	Annual 4% in Growth Rate.
	Industry	(7)			20	31	Annual 5% in Growth Rate.
	Loss	-			294	432	As 20% of Total
	Total	20,960			**1,500**	**2,140**	

(2) Hourly Maximum Water Demand

Hourly maximum water demand is necessary to decide the capacity of distribution facilities. It can be calculated by setting daily supplied hours and time coefficient of hourly consumption for each category of water users as below.

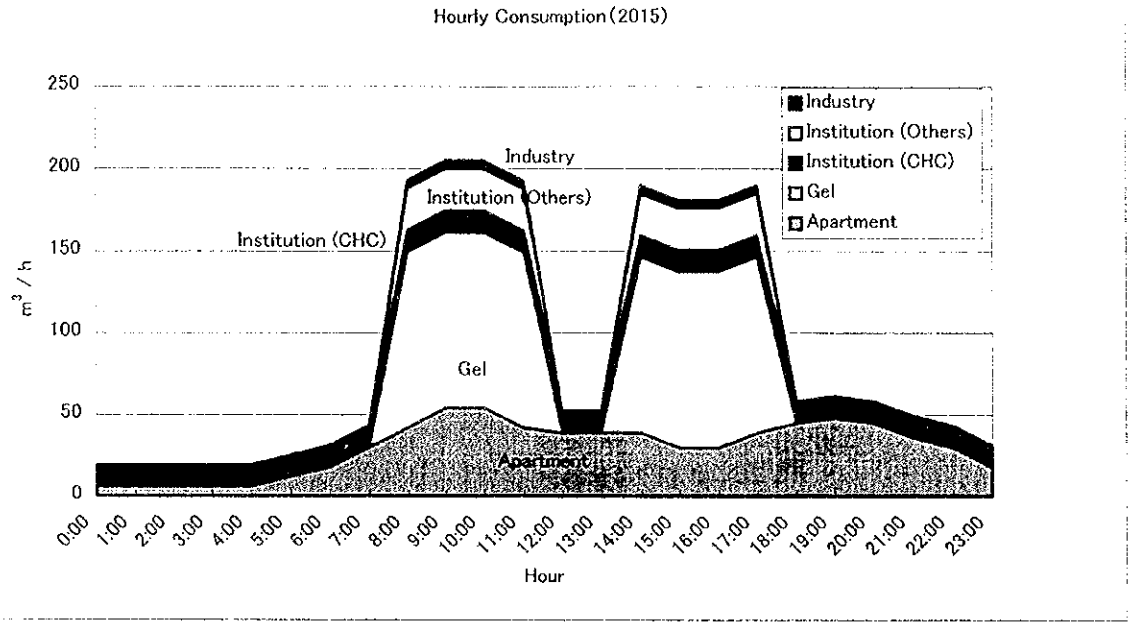
Category	Daily Supplied Hours (hrs/day)	Time Coefficient (k)	
Apartment	24	2005	2015
		1.75	1.8
Ger	8	1.0	
Institution (CHC)	24	1.0	
Institution (Others)	8	1.0	
Industry	8	1.0	

On the basis of the daily supplied hours and time coefficient of hourly water consumption, distribution amount is forecasted as shown in the following table.

Distribution Amount Forecast

Year	Category	Daily Demand (m^3/d)			Hourly Max. Demand
		Mean.	Max.	Max, including loss	(m^3/h)
Present	Apartment	487	487	693	33.9
	Ger	41	78	111	13.9
	G-1	20	38	55	6.9
	G-2, G-3	21	40	56	7.0
	Institutions	136	229	326	17.7
	CHC	61	140	199	8.3
	Others	75	89	127	9.4
	Industries	9	14	20	2.5
	Loss	287	342		
	Total	960	1,150	1,150	68.0
2005	Apartment	515	515	688	50.2
	Ger	163	307	410	51.3
	G-1	79	151	202	25.3
	G-2, G-3	84	156	208	26.0
	Institutions	167	282	377	27.9
	CHC	75	173	231	9.6
	Others	92	109	146	18.3
	Industries	12	19	25	3.1
	Loss	283	377		
	Total	1,140	1,500	1,500	132.5
2015	Apartment	575	575	721	54.1
	Ger	363	685	858	107.3
	G-1	178	338	423	52.9
	G-2, G-3	185	347	435	54.4
	Institutions	248	417	522	38.7
	CHC	111	255	319	13.3
	Others	137	162	203	25.4
	Industries	20	31	39	4.9
	Loss	294	432		
	Total	1,500	2,140	2,140	205.0

On the other hand, water utilization pattern at daily maximum demand is expected as shown in the following figure.



(3) Design Condition Recommended

Design conditions for the establishment of water supply services is recommended as follows.

4. DEVELOPMENT PLAN

4.1 DESIGN CONDITION

Design condition for master plan is set as follows.

Recommended Design Condition

Item	1997	2005 (FS)	2015 (MP)
Population	17,760	18,790	20,960
Service ratio (%)			
Apartment dwellers	100	100	100
Ger dwellers	60-100	100	100
Unit water demand (l/c/day)			
Apartment dwellers	150	150	150
Ger dwellers	8.6	20	40
Water supply method			
Apartment area	Pipeline / tap		
Ger area	Pipeline / kiosk 1000 - 1500 residents / 1 kiosk / within 250m radius /1 kiosk /		
Growth rate of water demand (%/year)		1998 - 2005	2006 - 1015
Institution	-	3	4
Industry	-	4	5
Effective distribution ratio (%)	70	75	80
Dairy maximum water demand (m^3/day)	1,150	1,500	2,140
Hourly maximum water demand (m^3/hour)	65	133	205

4.2 WATER RESOURCES DEVELOPMENT

(1) Development Capacity for Water Resources

Future maximum water demand was estimated to be 2,140 m^3/day in the year of 2015. On the other hand, the existing production capacity in 1997 is 1,150 m^3/day in maximum. Therefore, 990 m^3/day shall be developed by 2015.

Development Capacity in 2015 (Unit : m^3/day)

	Item	Production capacity
A	Future production demand in maximum	2,140
B	Existing production capacity in maximum	1,150
C	Future development capacity (=A-B)	990

Existing water source of Kharzat has sufficient capacity for the additional development to cope with the future water demand in 2015. It is located near Altai City with a

distance of about 3.4 kilometers and its remaining groundwater potential can be utilized efficiently under a proper groundwater preservation management.

(2) Development Plan for Kharzat Water Source

The four production wells in Kharzat were to pump up 600-800 m^3/day with a drawdown of 4-6 meters. According to the collected data, the specific capacity ranges from 102 to 432 m^3/day/m. Based on the relation of specific capacity to transmissivity, it is estimated that the value of transmissivity ranges from 157 to 565 m^3/day/m.

The optimum pumping yield for a well is examined with Theis non-equilibrium equation as discussed in section 2.3.

Estimated Drawdown in 2005 and 2015

	Year	1997-98	2005	2015	*1 2015 max
	Water demand (average)	960	1140	1500 (m^3/day)	*2,140 (m^3/day)*
Number of wells					
2	Pumping rate a well (m^3/day)	480x2	570x2	750x2	*1070x2*
	Drawdown (Pumping)	-2.63 m	-3.12 m	-4.11 m	*-5.87 m*
	Drawdown (Interference)	-1.17 m	-1.38 m	-1.82 m	*-2.6 m*
	Total drawdown in a well	-3.80 m	-4.50 m	-5.93 m	*-8.47 m*
3	Pumping rate a well (m^3/day)		380x3	500x3	*714x3*
	Drawdown (Pumping)		-2.08 m	-2.74 m	*-3.91 m*
	Drawdown (Interference)		-0.92x2 m	-1.21x2 m	*-1.73x2 m*
	Total drawdown in a well		-3.92 m	-5.16 m	*-7.37 m*
4	Pumping rate a well (m^3/day)			375x4	*535x4*
	Drawdown (Pumping)			-2.06 m	*-2.93 m*
	Drawdown (Interference)			-(0.91x2+0.79)m	*-(1.30x2+1.03)m*
	Total drawdown in a well			-4.67 m	*-6.56 m*
5	Pumping rate a well (m^3/day)			300x5	*428x5*
	Drawdown (Pumping)			-1.64 m	*-2.35 m*
	Drawdown (Interference)			-(0.73+0.64)x2 m	*-(1.04+0.91)x2 m*
	Total drawdown in a well			-4.38 m	*-6.25 m*

- Well location; every 100 m on a straight line
- *1 : as a reference

4.3 DEVELOPMENT PLAN OF WATER SUPPLY FACILITIES

(1) Development Alternative

There are some ways to develop the water supply facilities to cope with the water demand in 2015. The following table shows three comparative distribution methods to be selected as the most suitable development plan. The arrangement of pipelines and related facilities for each plan is shown in Figure Ⅲ-2 (1) ~Ⅲ-2 (3).

Development Alternative

Case	Summary of system	Distribution facilities
1	Dual pumping system to divide the service area into low and high ground level areas	Pump: 1.3m³/min x 35m x 18kw x 3 unites 0.9m³/min x 55m x 18kw x 2 unites Pipe: dia. 150mm~200mm x 9.3 Km Others
2	-Direct pumping system to overall service area.	Pump: 1.8m³/min x 55m x 30kw x 3 unites Pipe: dia. 150 ~ 200 x 9.4 Km Others
3	Gravity distribution system to low ground level area with water distribution to high ground level Ger area by pump	Pump: 1.5m³/min x 65m x 30kw x 2 unites Reservoir: 500m³ x 2 ponds Pipe: dia. 150mm ~ 250mm x 11.0Km Others

The primary supply target of ger area has been divided into three areas, G-1, G-2 and G-3 according to their geographycal condition.
The most suitable development plan shall be selected from the viewpoints of technical aspect, environmental impact, economic aspect, and financial aspect.

In conclusion, Case3 shall be given priority for the development of water supply facilities from the result of following examination on the basis of comparative study in initial cost and operation cost as shown in Table Ⅲ-3.

Examination of Each Case

Case	Technical	Environ-mental impact	Construc-tion cost	O/M cost	Financial	Priority
1	Medium	Small	Low	Medium	Medium	2
2	Difficult	Small	Low	High	Medium	3
3	Easy	Small	Low	Low	Low	1

(2) Optimum Development Plan

The development of water supply facilities shall be carried out in the following order.

① Reconstruction of 4 existing production wells
② Replacement of 4 submersible pumps with control system
③ 2 sets of water level meter shall be installed for the reservoir to control the withdrawing volume from intake wells.
④ Procurement of 3 water wagons for supplying water to the ger area
⑤ Procurement of water cart for ger dwellers to transport water from kiosk to their homes
⑥ Installation of distribution pipe for supplying water to ger area of G-1, G-2, and G-3
⑦ Construction of kiosks at ger area of G-1 to G3
⑧ Construction of one new well in the south east part of Kharzat
⑨ Installation of transmission pipe from new wells to existing reservoirs
⑩ Construction of new reservoirs
⑪ Installation of new pump station to transmit the domestic water to new reservoir with water distribution to Ger area of G-1

Required Facilities for the Development of Water Supply facilities in 2015

Measures	Facilities
Improvement of existing facilities	1, reconstruction of 3 wells 2, replacement of submersible motor pump with control system : 0.42m^3/min x 60m x 4 unites
Additional new facilities	1, water level indicator system for reservoir : 2sets 2, procurement of water wagon : 3 cars 3, procurement of water cart : 2792 (households) sets 4, distribution pipe for ger area G-1, G-2, G-3: dia.150mm ~ 250mm x 11.0 km lines 5, construction of kiosk : G-1; 6 places, G-2; 3 places, G-3; 5 places 6, construction of one production well 7, installation of transmission pipe : dia.200mm x 3.5km x 2lines 8, construction of new reservoir : 500m^3 x 2 ponds 9, installation of new pump station: 1.5m^3 / min x 65m x 2unit

Intake Facilities

Intake wells, submersible motor pumps, and collection pipes have sufficient capacity for the present water demand. But, two of the four production wells which were constructed in 1979 were deteriorating and they shall be reconstructed as soon as

possible. Another two wells were constructed in 1986 and 1995. These wells may become deteriorated by 2015, and they should also be reconstructed by 2015.

The existing submersible motor pumps may also be deteriorated by 2015 and they shall be replaced with new pumps.

A control system of pump is also necessary to automatically manage the withdrawing volume of groundwater in the night or in the case of low consumption of water to prevent overflow in the reservoir. The system should be a simple one to avoid mechanical trouble.
Figure Ⅲ-3 shows the existing intake capacity(considered to be reconstructed) and the timely proposed extension plan to cope with the water demand by the year of 2015.
According to the proposed extension plan, one production well shall be constructed in the southeast part of Kharzat to cope with the water demand in 2008.

Transmission Facilities

Raw water transmission pipe (made of steel) from the production well to the reservoir shall be also replaced with a new steel pipe because of the deterioration and the lack of transmission capacity for future water demand as shown in Figure Ⅲ-4.

The transmission pipe shall be also installed from production wells to existing reservoirs, and it's capacity of the two pipe lines with diameter of 200mm is enough to transmit the required raw water amount to for the future water demand as shown in Figure Ⅲ-5.

Purification Facilities

Judging from the result of water quality analysis, it is not necessary to install purification facilities.

Distribution Facilities

2 sets of water level meter with transmission cable shall be installed at the reservoirs to control the withdrawing volume from the intake wells by communicating the information of water level between the intake wells and reservoir.

There are four water wagons which transport water to ger area at present, but the number is not enough for 2005. Distribution pipe and water kiosks shall be installed for the ger area G-1, G-2 and G-3 which can be supplied with water from the existing pump station as shown in Figure Ⅲ-6. Three water wagons shall be also procured to strengthen water transportation capacity of existing wagons to ger area G-1 with no

pipeline in 2005. All the ger area will be covered by the water kiosk in 2015.
Water cart shall be procured for ger dwellers to transport water from the delivery points of water wagon or kiosk to their homes.

Distribution pipes for all ger area of G-1 to G-3 are necessary to be installed by the year of 2015 as shown in Figure III-7.

New two reservoirs as shown in Figure III-8 shall be constructed at the southwest of G-1 ger area so that water can be supplied to the lower ground level part of Altai city by gravity. It will save the distribution energy.
A New pump station shall be installed to transmit the domestic water to the new reservoir with water distribution to Ger area of G-1 instead of the distribution from existing pump station.

5. OPERATION AND MAINTENANCE PLAN

In order to make a future plan for the operation and maintenance of water supply system, Altai Public Service Department (APSD) shall comply with the basic concept of water supply development.
The self operation system should be applied to APSD, which will make APSD independent both financially and legally. It is also important to promote the people's awareness of the fact that the users of the water supply system should pay water tariff according to the amount of benefit they get.

5.1 INSTITUTIONAL STRENGTHENING

(1) Introduction of Appropriate Water Tariff

It has been made clear by JICA Study Team that people of the service area can afford a rise in the water tariff, if sufficient and safe water is supplied. Consequently, water tariff shall be determined on the basis of financial aspect of water supply operation and management.

(2) Establishment of Meter System

If water meters are to be installed to every consumer as early as possible and if meter system is to succeed, it will be necessary institutionally to obligate every user to maintain the proper functioning of the meter. On the side of APSD, it will be

necessary to inspect the meters and collect water tariff.

(3) Reduction of Leakage

The causes of leakage should be identified and proper measures should be taken toward the alleviation of leakage. People shall have the awareness of saving water to reduce leakage from taps and valves of toilet. In addition to these, APSD shall improve the superannuated distribution pipes to reduce leakage from the pipelines.

(4) Introduction of Strict Financial Management

All the above mentioned items have one common objective of improving the financial status of APSD toward self-financing. The revenue of APSD has been higher than its expenditure. However APSD still depends on central government for expansion and reconstruction of facilities. This investment cost should be paid by APSD in order to achieve the self-operation.
For strict financial management of APSD, the three-step cycle of "plan, do, see" should be introduced.

Plan
Before the start of particular financial year, the annual financial plan should be prepared and formulation of the expenditure and revenue should be done. Such a budget will be ultimately distributed over 12 months.

Do
APSD's activities such as the implementation of investment project, the production and distribution of water, and the collection of water tariff should be done based on the carefully drawn up budget.

See
APSD's actual activities should be recorded to be, monthly compared with the budget ones. Finally the annual comparison of accomplishments and budget should be done and the difference between them should be analyzed.

(5) Organization

Increase of staff for water tariff collection should be necessary if meter system starts. Also the staff in administrative section should be increased to procure and to control various equipment.

If the pipeline network expands to the ger area, wastewater generation from ger area also will increase. In this case enforcement of sewerage section may be necessary.

5.2 LEGAL STRENGTHENING

The following legal issues should be considered in order to accomplish the self operation.

(1) Establishment of standard for industrial products

If meter system is introduced, many spare parts such as taps, valves, pipes, water meters will be in need. However the market of Altai City is so small that APSD will not be able to procure the spare parts with reasonable price and quality. If the nationwide standard of spare parts is established. It may attract manufacturers which provide spare parts to many water supply agencies.

(2) Independence from Altai Municipality

The nationwide law under which a local government can approve independence of the water supply agency may be necessary.

5.3 TRAINING SYSTEM

O/M manuals for mechanical and electrical equipment should be prepared. Training of employee for O/M will also be required.

5.4 HYGIENE EDUCATION PLAN

Measures against contamination of drinking water

Other than technical improvement of water quality test, it is important to make the residents of ger area know that the responsibility of water quality lies on the residents once the water has been delivered to the ger area. It is recommended for Social Health Center to conduct often a microbiological test on stock water in ger so that they can monitor the hygienic situation in ger area. It should be noted that water analysis is done to monitor the condition of drinking water not to measure the true risk of the people. Therefore, it is encouraged to promote the understanding on the role of water analysis a swell as exchanging information between APSD and Social Health Center.
nded.

In order to increase the hygiene practice among the residents in Altai City, the following approaches are recomme

(1) Increase of awareness on hygiene practice and water consumption

Target group:	All the residents in Altai City
Media:	Local radio and TV
Expected outcome:	The all residents of Altai City apply the knowledge of hygienic practice to their daily life.
Implementation body:	Gobi-Altai Social Health Center / Governors' office

Media and communication are undertaken by the Governors' office. TV station with 10 staff members provides its local broadcasting service for three hours every Monday evening and radio broadcasting for 30 minutes every Monday morning. TV and radio sets are quite prevailed with the purchase ratio of 1/25 (one out of 25 household) for TV and 1/24 for radio respectively. Meanwhile, the Social Health Center holds the education methodology specialist in its institution. If the above all resources are utilized for common purpose, it will bring substantial impact. It is more preferable to conduct a series of broadcasting program on hygiene practice including sanitation and waste management.

(2) Proper management of stock water and water consumption

Target group:	Residents in ger area
Media / Promoter:	Health Volunteer
Expected outcome:	The risk of water-borne and water-washed disease will be lowered through the proper management and use of stock water and increase of water consumption.

Recently health volunteers were appointed as promoter of community health along with the National Community Health Program. They are also expected to identify problems to be addressed for hygiene and sanitation in their living community. With the technical support from the health promotion section of Social Health Center, the group takes a role of health promoters in front line. In the hygiene education program within the Study, they were involved in the production process of educational material and trainer's training. The Social Health Center also experienced program implementation and was capable of handling the program.

(3) Water and Health

Target group:	School children
Media:	School Class
Expected outcome:	The basic knowledge on hygiene will be put into practice in their life.

Primary and middle schools are not included as targets of health education including hygiene practice. In fact, national health education program is being prepared for schools with the joint cooperation of Ministry of Education and Ministry of Health and Social Service. However, a textbook for health education is not available yet and those textbooks / posters are usually prepared by the national health education center of Ministry of Health. The hygiene education component in this Study provided the chance of developing educational materials at local setting through encouraging participation process. Similar process and program planning can be applied to not only future program but also other relevant program.

6. MONITORING PLAN

6.1 GROUNDWATER

Groundwater shall be utilized sustainablly for the public and economic activity because of its general advantage such as the accessibility for the consumer, good water quality, and an easiness of intake comparing with surface water. The overall restriction of groundwater utilization is not appropriate without scientific investigation on its quality capacity and environmental influence.

According to the existing data, groundwater quantity may be sufficient for the future water demand in Altai city. But, groundwater, especially shallow groundwater is easy to be polluted by pollutants. For the time being, the preservation of water quality shall be mainly focused on.

(1) Institutional Strengthening

The problem is that no organization has the responsibility of synthesizing the existing data. A scientific organization for research and development shall be established to collect and analyze the existing dispersed data from the geological and hydrogeological points of view. "Department of Strategy planning, Unified policy in Ministry of Agriculture and Industry " may be the most suitable for that work.

(2) Investigation

It shall be clarified the present condition of groundwater basin structure, aquifer structure, recharge volume, groundwater quality, and groundwater utilization as follows.

- The volume of groundwater basin. This means the storage capacity of groundwater.
- The essential element of hydrogeological parameters of permeability, transmissivity, storativity, specific storage, specific yield, and so on.
- The external element of precipitation, river discharge, and so on. Those are needed to estimate the recharge volume to groundwater.
- Groundwater quality. This is important to estimate an available volume of groundwater and the cost of purification for groundwater.

(3) Making Inventory and Database

All existing data shall beexamined, and the inventory and the database should be established using data.
The inventory of production wells and monitoring observation wells has to describe coordinates of location, screen position, the result of pumping test (pumping rate, permeability, specific capacity) and water quality, geological condition and the constructed year.

(4) Preliminary Examination

JICA Study Team made an examination of the groundwater potential of the study area and established the development plan on the basis of the groundwater potential, national development plan, and regional development plan.

The following items shall be continued in order to establish the groundwater management.

(5) Monitoring

Monitoring shall be continued at the existing station, and some of the test wells of JICA as follows.

Existing meteorological stations and observation wells
B5 : Kharzat water resource of Alluvial aquifer
B6 : Olon Nool water resource of Alluvial aquifer
A3 : Khadaasan water resource of fissure aquifer
A4 : NE of Altai city water resource of fissure aquifer

The following items shall be measured and investigated.

Groundwater table

The actual storage volume of unconfined groundwater is represented by the groundwater table, which can be used for the estimation of stored or remaining volume of groundwater and to judge the safety pumping yield. If the groundwater table has a tendency to lower, its cause shall be clarified. There can be many causes such as the seasonal fluctuation or long-term fluctuation, reduction of precipitation and river discharge (decrease of recharge volume), excess utilization of groundwater, and deterioration of pumping equipment.

Hydrological and meteorological data

These data will affect the fluctuation of recharge volume. Groundwater balance study shall be worked out in consideration on the balance of utilizing volume of groundwater and recharging volume from precipitation, and surface water. The fluctuation of groundwater table shall be considered in connection with hydrological and meteorological data.

Groundwater quality

The change of groundwater quality is important to estimate the available volume of groundwater and to find the source or site of pollution.
Regarding shallow groundwater, measures shall be taken to prevent a polluted water inflow from the surface to the aquifer.

Groundwater utilization

Groundwater utilization pattern of the study area is not clear. Since there has been no measurement of groundwater levels at the intake wells. It is one of the important elements to assess the groundwater balance and remaining volume for the development.

(6) Establishment of the Groundwater Management Plan

- The water balance shall be simulated from the monitoring data of at least five (5) years.
- The groundwater potential and recharge volume shall be projected.
- The groundwater utilization plan shall be established on the basis of estimated hydrogeological condition, national development plan, and regional development plan.

(7) Opening Information

All database and information shall be opened to the public and especially to the user to improve the awareness for saving water, preservation of the environment, and sustainable development in that groundwater is limited natural resources.
Consequently, groundwater shall be managed and preserved by not only the government but also the public and its users. Otherwise, it cannot be controlled the irregular development of groundwater and pollution.

6.2 WATER SUPPLY FACILITIES

The monitoring of water supply facilities is required for the appropriate operation and maintenance as follows:

- water quality of raw water and distributed water,
- residual chlorine at the water tap of the end of pipeline,
- distributed water pressure at pumping station, and
- supplied water pressure at the end of pipelines.

7. IMPROVEMENT PLAN FOR SANITATION

For the central area it is required to improve the existing sewer and waste water treatment capacity to cope with the increase of water after water supply facilities are expanded in 2005 and 2015.

On the other hand, much more waste water from ger dwellers will be discharged to the ground after the improvement of water supply system to ger area. There is not any facilities to collect and treat the waste water, in gel area. Consequently, it is also required to install personal or community treatment facilities to prevent contamination of soil, groundwater, and the environmental in ger area until the establishment of collection sewer system in the area.

The following sanitary zones should be established to protect the sources of drinking water:

I - (100 m) strictly prohibited zone.
prohibit the setting up of any sources of possible pollution in the I-zone
II - (300 m) zone under protection.
III - (1,000 m) monitoring zone.

It should be carried out bacteriological and chemical analyses in these zones.

8. COST ESTIMATION

The total investment cost is estimated at US dollars 3,031,061 which includes the construction cost, land acquisition cost, engineering cost and physical contingency. Its break down is shown below. Out of investment cost, detailed direct construction cost is shown in Table Ⅲ-4.

Investment Cost

Unit : US Dollar

Work Item	Nos	Amount	Year	
			2000-2005	2006-2015
A. Direct Construction Cost		1,916,876	630,108	1,286,768
		1,274,733 / 642,143	382,466 / 247,642	892,267 / 394,501
(1) Intake facility				
·Reconstruction of existing well	4 Wells	263,078	197,308	65,770
		230,547 / 32,531	172,910 / 24,398	57,637 / 8,133
·New production well	1Wells	65,770		65,770
		57,637 / 8,132		57,637 / 8,133
(2) Transmission facility				
·New pipe-line (Φ200 x 2line)	3.5Km	311,500	0	311,500
		245,000 / 66,500	0 / 0	245,000 / 66,500
(3) Distribution facility				
·Water level indicator				
① Electrode	2 Sets	6,694	6,694	0
		6,586 / 108	6,586 / 108	0 / 0
② Transmit Cable	1 Lot	47,805	47,805	0
		40,659 / 7,146	40,659 / 7,146	0 / 0
·Water wagon	3 Cars	52,800	52,800	0
		50,400 / 2,400	50,400 / 2,400	0 / 0
·Water cart	2792 Sets	92,136	92,136	0
		0 / 92,136	0 / 92,136	0 / 0
·Water kiosk	14 Unit	71,484	51,060	20,424
		0 / 71,484	0 / 51,060	0 / 20,424
·Reservoir	2 Ponds	78,140	0	78,140
		0 / 78,140	0 / 0	0 / 78,140
·Pipe-line (Φ150~250)	11Km			
① G-1 Area	(3.6Km)	192,700	38,540	154,160
		128,260 / 64,440	25,652 / 12,888	102,608 / 51,552
② G-2 Area	(1.3Km)	67,500	51,975	15,525
		40,500 / 27,000	31,185 / 20,790	9,315 / 6,210
③ G-3 Area	(3.7Km)	184,500	91,790	92,710
		110,700 / 73,800	55,074 / 36,716	55,626 / 37,084
④ Central Area	(3.4Km)	186,520	0	186,520
		121,160 / 65,360	0 / 0	121,160 / 65,360
·Pump Station (Including Pump)	1 St.	206,297	0	206,297
	-	157,714 / 48,583	0 / 0	157,714 / 48,583
·Chlorinating equipment	Unit	53,250	0	53,250
		53,250 / 0	0 / 0	53,250 / 0
·Water level indicator	Set	36,702	0	36,702
		32,320 / 4,382	0 / 0	32,320 / 4,382
B. Land Acquisition Cost	-	0	0	0
C. Construction Cost (A X 1.25)	-	2,396,095	787,635	1,608,460
D. Design & Supervision (C X0.1)	-	239,610	78,764	160,846
·Detailed Design (C x 0.05)	-	119,805	39,382	80,423
·Supervision (C x 0.05)	-	119,805	39,382	80,423
E. Physical Contingency {(C+D) X 0.15)}	-	395,356	129,960	265,396
Total (C+D+E)	-	3,031,061	996,359	2,034,702

9. IMPLEMENTATION PROGRAM

The existing water supply facilities of production wells, raw water transmission pipe, and distribution pump have sufficient capacity to cope with the water demand in 2005. But, some of them are deteriorating and water supply for ger dwellers will not be enough due to the shortage of water wagons.
Naturally the present water supply facilities will not have sufficient capacity to cope with the water demand in 2015.

Therefore, this project will improve the existing water supply facilities at first and expand the water resource and the water supply facilities after that. The improvement and expansion of the water resource and water supply facilities shall proceed step by step on the basis of the implementation schedule shown in the following figure.

According to the implementation schedule, total investment cost is divided up among the years of 2000 to 2015 as shown in Table III-5.

Implementation Schedule

Work Item	Nos	Year (2000-2015)																
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
(1) Intake facility																	
·Reconstruction of existing well (Including submersible pump)	4 Wells																
·New construction of production well (Including submersible pump)	1Wells																
(2) Transmission facility																	
·New pipe-line (Φ200 x 2line)	3.5Kms																
(3) Distribution facility																	
·Water level indicator	2 Sets																
·Water wagon	3 Cars																
·Water cart	2,792 Sets																
·Water kiosk	14 Units																
①G-1 area	(6)				(2)						(4)						
②G-2 area	(3)				(3)												
③G-3 area	(5)					(5)											
·Reservoir	2 Ponds																
·Pipe-line (Φ150~250)	11Kms																
①G-1 area (Φ150~200)	(3.6)				(0.7)						(2.9)						
②G-2 area (Φ150)	(1.3)				(1.0)										(0.3)		
③G-3 area (Φ150)	(2.7)					(1.8)								(0.6)	(0.3)		
④Central area (Φ150~250)	(3.4)										(2.0)	(0.8)	(0.6)				
·Pump Station (Including Pump)	1 St.																
·Chlorination equipment	1 Unit																
·Water level indicator	1 Set																