社会開発調査部報告書

No. 2

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF INFRASTRUCTURE DEVELOPMENT (MID)
THE GOVERNMENT OF MONGOLIA

THE STUDY ON GROUNDWATER DEVELOPMENT FOR ALTAI CITY IN MONGOLIA

FINAL REPORT

EXECUTIVE SUMMARY

MARCH 1999

PACIFIC CONSULTANTS INTERNATIONAL
MITSUI MINERAL DEVELOPMENT ENGINEERING CO., LTD.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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In this report, project costs are estimated based on December 1998 prices with an exchange rate of US$ 1 = Mongolian Tugrug 890 (US$ 1 = Yen 117.5).

PREFACE

In response to a request from the Government of Mongolia, the Government of Japan decided to conduct the master plan and feasibility study on Groundwater Development for Altai City in Mongolia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Mongolia a study team headed by Mr. Teruo TAHARA, Pacific Consultants International (PCI) and composed of staff members of PCI and Mitsui Mineral Development Engineering Co., Ltd., four (4) times between September 1996 and March 1999.

The team held discussions with the officials concerned of the Government of Mongolia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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 team.

March 1999

Kimio Fujita
President
Japan International Cooperation Agency

THE STUDY ON GROUNDWATER DEVELOPMENT FOR ALTAI CITY

March 1999

Mr. Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

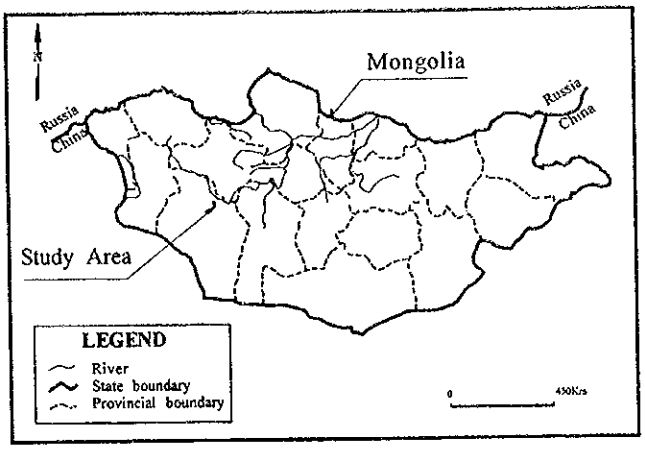
We are pleased to submit the final report entitled "The Study on Groundwater Development for Altai City". This report has been prepared by the Study Team in accordance with the contract signed between Japan International Cooperation Agency and Pacific Consultants International in association with Mitsui Mineral Development Engineering Co.,Ltd.

The report consists of Mongolian Summary, Executive Summary, Main Report, Supporting Report, and Data Book. Executive Summary summarizes the results of the Study. Main Report presents the results of the whole study including Master Plan for the development of water resources and water supply, Feasibility Study on the groundwater development for a high priority project selected from the Master Plan Study. Supporting Report describes the technical details of the Study. Data book has been prepared and submitted herewith.

All members of the Study Team wish to express grateful acknowledgments to the personel of your Agency, Advisory Committee, the Ministry of Foreign Affairs, the Embassy of Japan in Mongolia, Mongolia Office of Japan International Cooperation Agency, and also to the officials and individuals of the Government of Mongolia for their assistance extended to the Study Team. The Study team sincerely hopes that the result of the Study will contribute to the improvement of the water supply condition and social and economic development in Altai City.

Yours Faithfully,

Teruo TAHARA
Team Leader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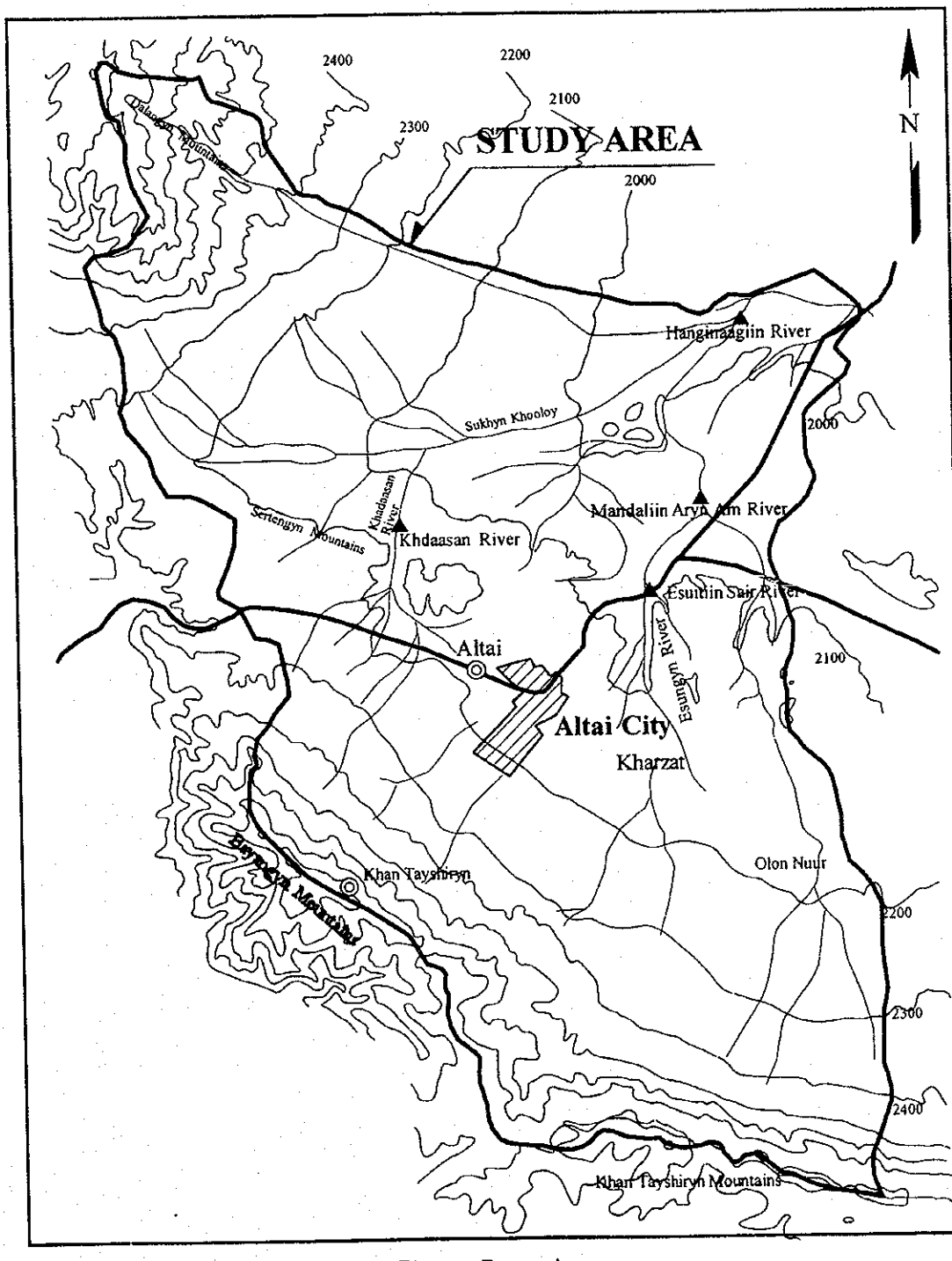
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Sukhyn Khooloy
Khdaasan River
Khdaasan River
Sertengyn Mountains
Mandaliin Aryn Am River
Esuntiin Sair River
Esungyn River
Altai
Altai City
Kharzat
Olon Nuur
Khan Tayshiryn
Khan Tayshiryn Mountains

Study Area

THE STUDY ON GROUNDWATER DEVELOPMENT FOR ALTAI CITY

ABSTRACT

1. DESIGN CONDITION

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

Design Condition

Item	1997	2005 (FS)	2015 (MP)
Population	17,761	18,790	20,961
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 - 2015
Institution	-	3	4
Industry	-	4	5
Effective water 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

2. DEVELOPMENT PLAN

Water Sources: expansion of Kharzat water source

Development Capacity (Unit: m^3/day)

	Item	Production capacity	
		2005 (FS)	2015 (MP)
A	Future production demand in maximum	1,500	2,140
B	Existing production capacity in maximum	1,150	1,150
C	Future development capacity (=A-B)	350	990

Water Supply Facilities

Required Facilities for the Development of Water Supply Services in 2015

Measures	Facilities
Improvement of existing facilities	1, reconstruction of 4 wells (including one spare well) 2, replacement of submersible motor pump with control system : 0.42m^3/min x 65m x 4 unites (including one spare pump)
Additional new facilities	1, water level indicator system for reservoir : 2 sets 2, procurement of water wagon : 3 cars 3, procurement of water cart : 2792 (households) sets 4, installation of main distribution pipe for ger area G-1,G-2,G-3 : dia. 150-250mm x 11.0km 5, construction of water kiosk in ger district : G-1; 6 places, G-2; 3 places, G-3; 5 places 6, construction of one production well : keeping 100m from existing wells 7, installation of transmission pipe : dia.200mm x 3.5km x 2 lines 8, construction of new reservoir : 500m^3 x 2 ponds 9, construction of new pump station: 1.5m^3/min x 65m x 2units

3. PROJECT COST

Investment Cost (unit: US Dollar)

Item	2000-2005 (FS)	2006-2015(MP)	Total
a. Direct construction cost	787,635	1,608,460	2,396,095
b. Land acquisition cost	0	0	0
c. Design, supervision cost (a x 10%)	78,764	160,846	239,610
d. Physical contingency ((a+c) x 15%)	129,960	265,396	395,536
Total	996,359	2,034,702	3,031,061

Exchange rate: US$ 1.0 = yen117.5 = Tg.890

4. OPERATION AND MAINTENANCE COST

Annual Operation and Maintenance Cost (unit: US Dollar)

Item	2000 – 2005	US$/year
a. Electric power cost	202,160	33,693
b. Chemical cost	5,847	975
c. Personnel cost	73,335	12,223
d. Repairing cost	20,235	3,372
Total	301,577	50,263 $/year

Replacement Cost (unit: US Dollar)

Facilities	2000 – 2005	Every 10 years	Every 15 years	Every 25 years	Every 40 years
a. Intake	246,635	0	220,788	15,783	10,065
b. Distribution	541,000	66,000	183,294	227,881	63,825
Total	787,635	66,000	404,081	243,664	73,890

5. PROJECT EVALUATION

Economic Evaluation

- EIRR for Master Plan in 2015: 14.5 %
- EIRR for the priority project in 2005: 16.3 %

Financial Evaluation

- FIRR for Master Plan Study in 2015: negative %;

  It is recommended that the government shall subsidize the cost for implementing the master plan.

- FIRR for the priority project in 2005: 4.6 %

  FIRR is estimated under the following proposed water charge.

Water charge (unit: Tg/m^3)

Item	Existing	2005	2015
Ger dwellers	1250	566	283
Apartment dwellers	56	64	86
Industry/institution	900	900	900

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THE STUDY ON GROUNDWATER DEVELOPMENT FOR ALTAI CITY

SUMMARY

1. INTRODUCTION

The Government of Mongolia established "the Regional Development Plan of Western Five Province" including Gobi-Altai province in 1993. The Government of Mongolia also adopted the Decree 119 of some measures on development of Gobi-Altai province in July 5, 1995. It is reported in the development plans that the shortage of water quantity and bad water quality had restricted the development of western part of Mongolia and Gobi-Altai Province. Consequently, the improvement of those of Altai City, which is the capital and center of Gobi-Altai province, shall be given priority to promote the development.

Recently, Altai City has frequently encountered the suspension of water supply due to the superannuated water supply facilities.

Altai City requested to improve the water supply facilities to the Ministry of Infrastructure Development. But, central government could not cope with the improvement of water supply facilities in Altai City due to the shortage of budget and manpower. Accordingly, the Government of Mongolia requested the technical assistance from Japanese Government in the formulation of a master plan for the water resources development and a feasibility study on the high priority project for Altai City.

The Study was conducted by the Study Team of Japan International Cooperation Agency (JICA) in cooperation with the Ministry of Infrastructure Development (MOID) and other related agencies from September 1996 to March 1999.

The objectives of the Study are :

① to formulate a master plan on water resources development (focusing on groundwater) and improvement of water supply system for Altai City for the target year of 2015,
② to conduct a feasibility study for the priority project identified in the master plan for the target year of 2005, and
③ to pursue the technology transfer to the counterpart personnel in the course of the Study.

The Study area covers an area of about 600 km^2 . The detailed groundwater development study covered the area of "Kharzat" and "Sukhyn Hooly" . Tsagaantokhoy and Taishyr along the Zavkhan River were also investigated as for alternative water sources by reviewing previous studies. Figure 1 shows the Study area.

2. PRESENT CONDITION

2.1 SOCIAL SECTOR AND HYGIENE EDUCATION

(1) Social Characteristics

The City is culturally and ethnically homogeneous and there is no major social disparity among the people. Social services such as media, education, and social security were well developed during the former social regime. However, it is getting more difficult to maintain the current social services due to the shortage of public fund.

Other Information from Household Survey

- Median of total annual income : Tg. 299,940 (monthly : Tg.24,995)
- Median of total monthly expenditure : Tg. 44,500 (ger) to Tg.58,810 (apartment)
- Water tariff rate out of income : apartment dwellers; 1%, ger dwellers; 2%
- Distance to water delivery point of ger dwellers : within 200m for 70%
- Ger dwellers hope to get water whenever they want and to reduce the water tariff
- the people are looking forward to having a method and device to remove higher minerals from drinking water.

(2) Water Quality and Health

One of the people's concerns in Altai City is the quality of drinking water. Around 60% of the people perceive that the quality of drinking water is not good. They think that hardness of water brings about diseases. In addition, some authorities believe that higher magnesium and calcium ratio increases the morbidity.

The water quality analysis of the Study Team revealed that the most of chemical substances including hardness in Altai City's water are almost within the range of Mongolian standard.

Only the concentration of magnesium is slightly higher than the Mongolian standard However, Japan and most countries do not have such a ceiling level of magnesium as

shown in the following table. Furthermore, the Study Team could not find any information to prove the relationship between magnesium (or ratio of magnesium and calcium as the social health center describes) and health status through possible worldwide sources.

Water Quality Standards and Guidelines for Hardness, Calcium, and Magnesium

Standard / Guideline	Total Hardness	Calcium	Magnesium
Study result(water supply)	199 mg $CaCO_3$/l	28 mg/ l	31 mg /l
Mongolian Standard	350 mg $CaCO_3$/l (7 m eq/l)	100 mg /l	30 mg /l
EU (1995)	-	-	-
WHO health	-	-	-
WHO complaint	500 mg $CaCO_3$/l	-	-
Japanese standard	300 mg $CaCO_3$/l	-	-
US standard	-	-	-
Bulgarian standard	600 mg $CaCO_3$/l	150 mg/l	80 mg/l

- : no ceiling value

At this point, it is difficult and inappropriate to conclude the direct causality between the water quality and non-infectious disease, in particular chronic disease, since there are many risk factors to non-infectious disease such as smoking, drinking, gene, age, sex, eating habit, and so on.

(3) Hygiene Education

Gobi-Altai Province social health center conducted seven times of trainer's training for schoolteachers and health volunteers and six times of hygiene education for children and mothers using the textbook prepared by the Study Team. In total 909 people participated in the program. The Province social health center also plans to implement hygiene education continuously.

Distribution of Hygiene Education Materials through Trainers Training

Target	Number of Materials
Schools	143
Health Volunteer	100
Medical Doctors and Other Health Professional	183
Total	426

(4) Social Analysis

Benefit (+) and Disadvantage (-)

- While the higher income group of ger dwellers approved 161% of increase, the lower income group of them approved 80% of increase to the current tariff level. Exemption system of water charge for lower income group should be introduced.
+ Installation of kiosk will improve the availability of water in terms of time and distance. It is also expected to reduce the habit of storing water and bring about less opportunity of contamination.
- However, 20% of ger dwellers will not gain water within 250m radius. Therefore supply of water carts for them is recommended.

Water Tariff

A disparity of unit water price between ger dwellers and apartment dwellers should be revised. Opening this fact to the public will be the initial step to minimize the gap on the proportion of water fee to income.

2.2 ECONOMY OF ALTAI CITY

(1) Population

The population of Altai City numbered 17,761 in 1997 with the following detail.

Total :	17,761
by settlement pattern	
Apartment Area:	3,245 (18%)
Ger Area:	14,516 (82%)

(2) Economy of Altai City

Altai City is the center of manufacturing activities and the nodal point and logistic center for agriculture production and distribution in Gobi-Altai Province. Most of the manufacturing activities in Gobi Altai Province are found in Altai City. In terms of industrial output, those of Altai City have been accounting for a range of 80% to 96% of all the industrial output in the province since 1991. Altai City plays a minor role in agriculture production in Gobi Altai Province with agriculture labor force accounting only for 5% of the total labor force of the city. Its role is found more in the processing, trading, and consumption of agriculture products. Traditional large industries experienced a drastic fall in production level between 1990 and 1992 and have tended to

be stagnant since then. Small scale production and commercial activities, on the contrary, are gradually expanding. The overall economy of Altai City seems to be expanding little by little, supported by agriculture related activities and small scale and new production and commercial activities.

2.3 METEOROLOGY AND HYDROLOGY

(1) Observatory

Meteorological and hydrological stations are listed below and shown in Figure 2.

Meteorological Stations

Station	Year of Establishment	Altitude (m)	Observation Item
Altai City (Airport)	1954	2,180.7	temperature, precipitation, humidity, air pressure, wind, evaporation
Khan Tayshiryn (Mountain)	1978	2,890.0	temperature, precipitation, humidity, air pressure, wind

Hydrological Station

Station	River System	Year of Establishment	Catchment Area (km^2)	Observation Item
Guulin	Zavhan River	1971	12,200	water level / discharge
Durveljin	Zavhan River	1977	--	water level / discharge

(2) Meteorological Characteristics

Precipitation

Altai basin is characterized by the rainy season from June to August, whose precipitation account for about 64% of the annual precipitation.

Station	Average Monthly Precipitation (mm)												Total
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	(mm)
Altai	1.1	2.1	5.8	10.5	13.2	29.2	48.2	41.8	17.1	7.3	3.1	2.2	181.6
Khan Tayshiryn	1.1	2.3	7.3	10.8	13.8	31.5	39.1	55.4	22.4	11.1	4.0	1.6	200.4

Note : Altai City ; data from 1955 to Aug. 1996; Khan Tayshiryn data from 1978 to 1989

JICA Investigation

The results of evaporation and rainfall measurements conducted by the Study Team are shown below.

Monthly Evaporation and Rainfall in mm

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Evaporation												
1997	-	-	-	-	-	-	238.7	179.2	136.2	-	-	-
1998	-	-	-	-	182.2	217.0	166.5	146.5	136.1	68.1	-	-
Rainfall												
1997	-	-	-	-	-	-	83.7	1.2	11.6	-	-	-
1998	-	-	-	-	15.9	10.6	113.7	13.1	7.1	-	-	-

In 1997 and 1998, rainfall was exceptionally high in July.

(3) Hydrological Characteristics

Seasonal Variation of River Discharge

Average monthly discharges of Zavkhan River are calculated based on those data as tabulated below.

Station	Average Monthly Discharge (m^3/s)												Ave.
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec	(m^3/s)
Guulin	-	0.01	0.22	7.27	16.11	13.82	24.08	21.38	18.62	9.61	2.52	0.21	9.49
Durvelji	1.09	0.95	2.44	13.66	16.75	23.23	32.48	28.52	29.30	15.23	4.81	1.62	14.17

[1]Note: Guulin data from 1971 to 1981; Durveljin data from 1977 to 1986 (missing: 1981, 1985)

Annual average runoff volumes at Guulin and Durveljin stations are calculated to be about 299 and 447 million m^3 respectively. About 52% of annual runoff in average concentrate during rainy season from June to August.

River Discharge of Small River in the Study Area

JICA Study Team measured the river discharge in the Study Area for four (4) rivers of Khadaasangyn Am River, Mandaliin Aryn Am River, Esuitiin Sair River, and Hanginaagiin Khooloy River.

These rivers do not have flow normally. Only during or after heavy rainfall, flow can be seen in some rivers.

2.4 TOPOGRAPHY AND GEOLOGY

Altai City is located at the northern side of mountain foot of Altai mountain range with an altitude of 2,040 to 2,180 meters.

Quaternary fan deposits are distributed in the south of Altai City and unconfined aquifer in these deposits is utilized as the water sources for water supply.

Clayey lake deposits of Neogene period underlie the Quaternary fan deposits in the Study area. These deposits are aquiclude.

The basement rocks are mainly composed of Precambrian ultra-basic rocks of peridotite, serpentine in the Altai mountain range and Precambrian gneiss, quartzite, and schists in the vicinity to north of Altai City as shown in Figure 3 and 4.

The structural faults and fractured zones are distributed in the basement rock in the direction of east-west and northwest–southeast, and a part of fractured zone bear the fissured water.

2.5 HYDROGEOLOGY

(1) General

Groundwater investigation started from 1956 in and around Altai City, and 99 exploration wells were constructed.

JICA Study Team constructed 10 test wells for Quaternary aquifer and fissured aquifer and made a groundwater evaluation. The results of test wells are summarized in Table 1.

(2) Groundwater Table

Groundwater levels of the observation wells were measured periodically from June 1997 to October 1998 as shown in Figure 5.

The observation wells were divided into three groups of "A" (deep wells), "B" (shallow wells), "C". (shallow wells in Sukhyn Khooloy).

The water levels of Group "B" and "C" start going down soon after the end of rainy season, which was July in 1997 and 1998. Meanwhile the water levels of Group "A" continue to rise until the end of October. From the beginning of February the groundwater levels of Group "B" wells commence to increase, though the water levels of Group "A" keep decreasing until the middle of April.

(3) Hydrogeological Characteristics

The results are summarized in Figure 6.

Quaternary Aquifer

Hydrogeological characteristics are summarized as the following table.

Water resources	Specific capacity Sc (m^3/day/m)	Hydraulic conductivity K (m/day)	Transmissivity*1 T (m^3/day/m)	Pumping yield Q (liter/sec.)
Kharzat	1-864	0.07–9.4	157-565 (av.360)	0.01–12.4 (av.3.15)
Olon Nuur	1-93	0.1-16.3	—	1.2-7.1 (av.2.51)
Sukhyn Khooloy*2	187max	4.57-8.3max	—	0.18-10.6 (av.3.59)

*1 : estimate from specific capacity
*2 : Value is from local area. Generally, this area is not fit for water resources with bad water quality and small quantity of water.

JICA test well B-6 located in Olon Nuur has a transmissivity of more than 1,000 m^3/day/m with a hardness of 257.5 mg$CaCO_3$/l. This is considered to be excellent aquifer for water supply. B-5 well located in the border of Kharzat and Olon Nuur has intermediate potential for water supply with a transmissivity of 39 m^3/day/m and a hardness of 225 mg$CaCO_3$/l.

Transmissivity of B-1 to B-4 well located in northeast of Altai City are 1.3 to 5.1 m^3/day/m with a hardness of 845 to 1950 mg$CaCO_3$/l. Water of these wells is not suitable for water supply.

Neogene Aquifer

This aquifer undelies quaternary aquifer of Kharzat, Olon Nuur, and Sukhyn Khooloy. It is distributed widely in Sukhyn Khooloy.
It is reported that the pumping yield is 0.2 to 0.4 liter / second and the Neogene aquifer is not suitable water resources for water supply.

Fissured Aquifer

It is reported by the previous investigation that pumping yield was 1.6 to 14.4 liter/second.

JICA test well of A-4 located northeast of Altai City has recorded a pumping yield of about 16 liter/second with a transmissivity of about 200 m^3/day/m. This is considered to be a good aquifer but a hardness of this fissured water is 1875mg $CaCO_3$/l.
Transmissivity of other wells are 1.3 m^3/day/m (hardness; 1,000 mg$CaCO_3$/l) in A-1 well, 10.4 m^3/day/m (hardness; 372.5 mg$CaCO_3$/l) in A-2 well, and 7.4 m^3/day/m (hardness; 362.5 mg$CaCO_3$/l)in A-3 well.

(4) Groundwater Resources

The following water resources are listed in the Study Area and shown in Figure 1.

① Kharzat water source : available to expand
② Olon Nuur : available to develop
③ Sukhyn Khooly : bad water quality
④ Khadaasan River : low to medium quantity,
⑤ Northeast of Altai : fissured aquifer : sufficient quantity, but bad water quality (hardness ; 1876mg$CaCO_3$/l)
⑥ Tsagaantoghoy : sufficient water quantity, but too far (98 km) and too low (280m lower than Altai), 3 to 5 booster pumps are required.
⑦ Zavkhan Riverbed at Taishyr : sufficient water quantity, but too far (45km) and too low (470m lower than Altai), 5 to 6 booster pumps are required

Among all these, Kharzat water resources shall be given priority for the development.

(5) Groundwater Storage Volume of Kharzat Water Source

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

	The area of the aquifer			
Thickness	0	10	20	(meters)
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 ;

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

Groundwater volume is estimated to be from 26.9 $x10^6$ m^3 in minimum and 40.3 $\times$ 10^6 m^3 in a maximum depending on the estimation for the storativity (effective porosity) of 0.1 to 0.15.

(6) Groundwater Balance

Water balance and groundwater potential are formulated as follows.

- Precipitation = Evapotranspiration + Overflow + Infiltration
  (Infiltration = Interflow + Recharge volume + Baseflow)
- Groundwater potenlial = Recharge volume – (Utiligation volume + Baseflow)
  (Baseflow = almost 0)

Recharge Volume

The recharge volume of Kharzat aquifer is estimated below.

Recharged Volume to Aquifer

Area	Catchment area	Annual Precipitation	> 8mm/d in a year	Recharged precipitation	Recharged volume
Kharzat	about 70km^2	181.6 mm	34.4 mm	25.4mm/year (14% of total)	4,870 m^3/d, or 1,778,000 m^3/year

The result of the continuous water level observation indicates that rainfall affects the water table 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 (137.4 mm in 1998) that has 64 % of annual precipitation in an average of about 40 years. Therefore, 16 %, of annual precipitation

(0.64 multiplied by 0.25) may be the infiltration rate 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.
No recharge is expected in winter season of November to middle of April.

Groundwater Utilization

At present the total yield of Kharzat production wells is 960 m^3/day in average and 1,150 m^3/day in maximum.

2.6 ECOLOGY AND ENVIRONMENT

(1) Outline

No countries can be compared with Mongolia on the size, diversity, and the health of its natural ecosystems in the temperate zones of the Northern Hemisphere. Mongolia is located at the northern edge of Central Asian deserts and the southern edge of vast Siberian taiga. Its wide range of transitional ecosystems is reflected in the diversity of wild species. But these ecosystems are recently being affected by some environmental factors, such as overgrazing and deforestation.

(2) Ecology in Altai City

Fauna

The development of Altai City has reduced the distribution of the large mammals near the city, however some animals are still observed in the survey area. Common mammal species in the Study Area are Brandt's Vole, Tolai Hare, Siberian Marmot, Red Fox and Corsac Fox, and common bird species are Northern Wheatear, Arctic Warblar, Tree sparrow, White Wagtail, Horned Lark, Northern Raven and Rock Pigeon. Around Khadaasan River, a variety of birds of prey were seen. In wet season (spring and summer), some waterfowls visit temporary wet lands. Common insects are arid steppe locusts and grasshoppers.

Flora

A great part of the land near Altai City is used as pasture land. Overgrazing near the city and the present chaotic sprawl of roads have caused damage to the soil and vegetation.
The vegetation cover near Altai City can be divided into two types of "Arid desert vegetation" and "Desert steppe vegetation".

(3) Law and Regulation

Mongolia has more than 20 environmental laws and regulations. Mongolia has also ratified the international conventions and treaty related to the environment.

(4) Executing Agency

Ministry of Nature and Environment (MNE) has the responsibility for investigation, monitoring, conservation, and protection of the natural and social environment.

(5) Initial Environment Examination (IEE)

In Mongolia, IEE is regarded as the General Environmental Screening Process in conformity with the Mongolian Law on Environmental Impact Assessment approved by the Parliament of Mongolia on January 22, 1998. For this project, it was carried out on May 22, 1998 by State Senior Inspector in Policy and Coordination Department of the Ministry of Nature and Environment.

(6) Mongolian Environmental Impact Assessment

The following laws stipulate the Environmental Impact Assessment (EIA).

a) Mongolian Law on Environmental Impact Assessment (date effective; February/20/1998)
b) Annex of the Mongolian Law on Environmental Impact Assessment
c) Annex of decree No. 66 of 1998 of the Minister of Nature and Environment
d) Annex 1 of decree No. 66 of 1998 of the Minister of Nature and Environment
e) Annex 2 of decree No. 66 of 1998 of the Minister of Nature and Environment

MNE and the local government will conduct the screening and choose the required level of EIA study out of the following.

- No further study of EIA is required
- Item-wise EIA study is required
- Full scale study of EIA is required

If it is required, a licensed environment impact assessment company will conduct the EIA study for the project under the supervision of the government. The results of EIA study are made open to the public. The government makes a decision whether to implement the project or not on the basis of the results.

2.7 WATER QUALITY

Sampling

Existing well : SW-6 and SW-8 on May 30th 1998.

Water supply system : DR-1, DR-2, DT-1, DT-2, DT-3, DT-4, DT-5, DW-1, and DW-2

New Test Well : A1, A2, A3, A4, B1, B2, B3, B4, B5, and B6

Water Quality of Well

All the existing wells except SW-6 are not good for drinking because of the high concentration of hardness, magnesium and sulfate.

JICA test wells except B-5 and B-6 are not good for drinking, because of the high concentration of hardness, magnesium, and sulfate.

Water Quality of Water Supply System

The concentrations of magnesium is slightly higher than the Mongolian standard. Total coliforms exceed the standard in water of reservoir, tap water, water of water wagon, and stored water in ger. Other items are within the standard (refer to Table 2).

2.8 WATER SUPPLY SYSTEM

(1) Condition of Water Supply Service

Service Area

The service area covered by public water supply is shown in Figure 10. The potable water is supplied to the central area (apartment area : approximately 90 ha) by pipe network system and to whole ger area (approximately 224 ha)by water wagon transportation system.

Population in Service Area

Population of Altai City is about 17,800 in the year of 1997. People live in the apartment buildings in the central area and ger houses in the ger area on the periphery 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

(2) Present Water Supply System

The system is operated and managed by Altai City Public Service Department (APSD). APSD is responsible for supplying water up to eight CHC (the Communal Heating Center; that supply hot water during the cold season to the central area). In ger area, water is supplied every day by four (4) water wagons with a tank capacity of 4 m^3 to 4.75 m^3. The system is summarized in Figure 7.

Water Supply Facilities

Water Supply Facilities and Capacity (October 1998)

Production well	1,200 m^3/day	25 m^3/hr x 24hrs x 4 units (1979, 1986, 1995), two of them are utilized, 1 is spare, 1 is under repairing
Transmission pipe	-	Dia.150mm x 2 lines, 3.4km x 2 = 6.8km
Reservoir	2,000 m^3	1,000 m^3 x 2 ponds
Distribution pump	180 m^3/hr	90 m^3/hr x 24hrs x 3 units (1 is spare)
Distribution pipe	-	Dia.200mm x 5600m + dia.125mm x 135m, iron pipes
Water wagon	Max. 78m^3/day	4cars (4m^3 x 3cars + 4.75m^3 x 1car)

(3) Actual Water Supply Amount

The water supply amount in the winter season is higher than that of summer season by about 20%. It suggests that additional water is used for CHC in winter season.

season	Amount (m^3/d)	Remarks
summer	860	Late night: 6.5 m^3/hour (leakage?)
winter	1,060	Late night: 35-38 m^3/hour (leakage?) Peak flow: 9-10AM (Friday), 10-11AM (Saturday) Daily supply amount : week day = weekend

Summer season: middle of May to September
Winter season: October to middle of May

(4) Water Consumption

Domestic Use

(unit: m^3)

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

Apartment : daily mean : 169.0 m^3 , daily max. 185.3 m^3
Ger : daily mean : 41.3 m^3 , daily max. 57.8 m^3

Institutional Use

Category	Annual Average Consumption (m^3/day)		Monthly Maximum Consumption (m^3/day)	
1. Total Institution	136	93.8%	229	94.2 %
CHC	(16)	(11.0)%	(140)	(57.6)%
2. Total Industry	9	6.2%	14	5.8%
Ground Total	145	100%	243	100%

3. MASTER PLAN STUDY

3.1 BASIC CONCEPTS FOR THE MASTER PLAN

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

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

3.2 WATER RESOURCES

(1) Evaluation of Groundwater Resources

Water resources in and around the Altai City are listed below and shown in Figure 1.

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

Examination for Groundwater Resources

Water source	Aquifer type	Dis-tance* (km)	Altitude (m)	Potential	Water quality	Hardness ($mgCaCo_3/l$)	Const-ruction cost	Run-ning cost	Priority
Kharzat	Alluvial	4-6	2,180	big	good	225	low	Low	1
Olon Nuur	Alluvial	8-9	2,190	big	good	256	low	Medium	2
Skhyn Khooloy	Quarter-nary	8-10	2050	medium	bad		medium	High	-
Khadaasan	fissured	6-7	2,150	small	medium	363	medium	High	-
NE of Altai	fissured	2-3	2,120	medium	bad	1,875	low	medium	-
Tsagaantoghoy	Alluvial	98	1,890	big	good	406	high	high	-
Tyshir	Alluvial	45	1,700	big	good	-	high	high	-

* : distance from the governor's office (elevation is 2,170 meters)

Booster pumps will be required to transmit water from some of the sites to Altai City as follows.

Skhyn Khooloy : 2 booster pumps
Khadaasan : 1 booster pump
Tsagaantghoy : 3 booster pumps
Tyshir : 5 booster pumps

(2) Groundwater Potential of Kharzat Groundwater Resource

Groundwater can be utilized within the limit of storage of aquifer and natural recharge volume.

The following simple equation represents flow through an aquifer;

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

More than 3,000 m^3/day may be used as safe yield.

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

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

Stored groundwater (26,900,000m^3) shall be utilized with the monitoring of water table and water quality in a drought year. The groundwater table recovers every May in normal, and no serious impact is expected for the groundwater resource.

3.3 POPULATION AND WATER DEMAND FORECAST

(1) Socio-economic Framework

The following economic growth targets for Altai City were set.

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 after 2005 is characterized by a higher level of market oriented operations as shown in Figure 8.

(2) Population Forecast

The result is summarized as follows.

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 was projected by estimating the natural growth and social change: migration of the population.

A distribution of the population in the ger and apartment areas was made applying the same proportions of apartment and ger dwellers as in 1997 on the basis 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.

(3) Water Demand Forecast

The current total water demand for Altai City was calculated by adding the loss volume to the actual consumption. 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 was set at 25% in 2005 and 20% in 2015.

The yearly projected demand was calculated on the basis of population forecast, served ratio, and unit water demand. The projected water demand for Altai City in the year of 2005 is 1,140 m^3/day and 1,500 m^3/day in the year of 2015.

The result is presented in the following table.

Water Demand Forecast

	Category	Population (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	on the basis of 1998
	Industry	(3)	-	-	9	14	on the basis of 1998
	Loss	-	-	-	287	324	As 30% of Total
	Total	17,761			960	1,150	Actual measurement data
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	
	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	20,961			1,500	2,140	

3.4 DEVELOPMENT PLAN

(1) Design Condition

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

Design Condition

Item	1997	2005 (FS)	2015 (MP)
Population	17,761	18,790	20,961
Service ratio (%)			
Apartment dwellers	100	100	100
Ger dwellers	60-100	100	100
Unit water demand (l/c/day)			
Apartment dwellers (including leakage)	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 - 2015
Institution	-	3	4
Industry	-	4	5
Effective distribution ratio (%)	70	75	80
Daily maximum water demand (m^3)	1,150	1,500	2,140
Hourly maximum water demand (m^3)	65	133	205

* Distribution area will be divided into four : Central area, ger area G-1, G-2, G-3 shown in Figure 9.

(2) Water Resources Development

Development Capacity for Kharzat Water Sources

Future maximum water demand is estimated to be 2,140 m^3/day in 2015. On the other hand, the existing production capacity in 1997 is 1,150 m^3/day in maximum. Therefore the difference of 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 a maximum	2,140
B	Existing production capacity in a maximum	1,150
C	Future development capacity (=A-B)	990

Existing water source of Kharzat has the sufficient capacity for an 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 can be utilized efficiently under groundwater preservation management.

Development Plan for Kharzat Water Source

The four production wells in Kharzat were planned to pump up 600-800 m^3/day with a drawdown of 4-6 meters.

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

- transmissivity is 360 m^3/day/m in an average (157 to 565 m^3/day/m estimated from specific capacity ranges from 104 to 432 m^3/day/m)
- storage coefficient of 0.005 is adopted because of semi-confined aquifer in deeper part
- pumping duration is 10 years or 3650 days

In 2015, if the pumping wells are operated attentively with a water level monitoring, four wells will be adequate for the water demand. But, these four existing wells are deteriorating. Consequently, these wells shall be reconstructed before 2015 and it is recommended that a spare well should be newly constructed. It shall be located 100 meters away from the existing wells.

Estimated Drawdown in 2005 and 2015

	Year	1997-98	2005	2015	*2015 max*1*
	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

(3) Development Plan of Water Supply Facilities

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 select as a suitable development plan.

Development Alternative

Case	Summary of System	Distribution facilities
1	Dual pumping system to divide the service area into low and high altitude area.	pump: 1.3m^3/min x 35m x 18kw x 3 units 0.9m^3/min x 55m x 18kw x 2 units pipe: dia.150-200mm x 9.3km others
2	Direct pumping system to whole service area	pump: 1.8m^3/min x 55m x 30kw x 3 units pipe: dia.150-200 x 9.4km others
3	Gravity distribution system to low altitude area with distribution to high altitude area by pump	pump: 1.5m^3/min x 65m x 30kw x 2 units reservoir: 500m^3 x 2 ponds pipe: dia.150-250 x 11.0km others

Case 3 shall be given priority for the development of water supply facilities from the technical, environmental, economic and financial viewpoints as summarized below.

Examination of Each Case

Case	Technical	Environ-mental	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

Optimum Development Plan

The outline of development of water supply facilities is as follows.

Required Facilities for the Development of Water Supply facilities in 2015

Measures	Facilities
Improvement of existing facilities	1, reconstruction of 4 wells (including one spare well) 2, replacement of submersible motor pump with control system : 0.42m^3/min x 60m x 4 units (including one spare pump)
Construction of new facilities	1, water level indicator system for reservoir : 2sets 2, procurement of water wagon : 5m^3/car x 3 cars 3, procurement of water cart : 2,792 (households) sets 4, installation of main distribution pipe for ger area G-1,G-2,G-3 : dia. 150-250mm x 11.0km 5, construction of water kiosk in ger district : G-1; 6 sites, G-2; 3 sites, G-3; 5 sites 6, construction of one production well : keeping 100m from existing wells 7, installation of transmission pipe : dia.200mm x 3.5km x 2 lines 8, construction of new reservoir : 500m^3 x 2 ponds 9, installation of new pump station: 1.5m^3/min x 65m x 2 units

Intake wells, submersible motor pumps, and collection pipes have the sufficient capacity for the present water demand. But, these facilities may become deteriorated in 2015, and it is recommended to reconstruct in 2015.

One production well shall be constructed in the southeastern part of Kharzat water sources to cope with the water demand in 2015.

2 sets of water level meter shall be installed for the reservoir to automatically control the withdrawing volume from intake wells.

There are four water wagons but the number is not enough for 2005. Three water wagons have to be procured in 2005. All 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 (up to 2005) and kiosk (after 2015).

3.5 OPERATION AND MAINTENANCE PLAN

(1) Institutional Strengthening

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.

Establishment of Meter System

It will be necessary to install water meters in apartments and supply facilities. APSD has to establish the inspection system of meter and the collection system of water tariff.

Reduction of Leakage

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

Introduction of Strict Financial Management

APSD still depends on the central government in the case of expansion and reconstruction of facilities. This investment cost should be paid by APSD in order to achieve the self-operation.

Organization

Increase of staff who does 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.

(2) Legal Strengthening

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

① Establishment of standard for industrial products
② Independence from Altai Municipality

(3) Training System

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

(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 as well as exchanging information between APSD and Social Health Center.

In order to promote the hygiene practice among the residents in Altai City, the following approaches are recommended.

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

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.

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.

3.6 MONITORING PLAN

(1) Groundwater

Groundwater shall be utilized sustainably for the public and the economic activity under proper management plan.

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

Existing meteorological stations and observation wells
B5 : Kharzat water resources of Alluvial aquifer
B6 : Olon Nuur water resources of Alluvial aquifer
A3 : Khadaasan water resources of fissured aquifer
A4 : NE of Altai City water resources of fissured aquifer

The following items shall be measured and investigated.

① Groundwater table
② Hydrological and meteorological data
③ Groundwater quality
④ Groundwater utilization
⑤ Making inventory and database
⑥ Establishment of groundwater management plan

All database and information shall be opened to the public and other users to improve the awareness for saving water, preservation of the environment, and sustainable development in order to get across the idea that groundwater is limited natural resources.

Groundwater shall be managed and preserved not only by the government but also by the public and other users. Otherwise, the irregular development of groundwater and pollution cannot be controlled.

(2) Water Supply Facilities

It is also required that the monitoring of water supply facilities for proper 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.

3.7 COST ESTIMATION

The total investment cost is estimated to be 2,034,702 US dollars which includes the construction cost, land acquisition cost, engineering cost and physical contingency as shown below.

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

Note 1) Exchange Rate : US$ 1.00 = Yen 117.5 US$ 1.00= Tg 890

2) ① Total ② Foreign Portion ③ Local Portion

3.8 IMPLEMENTATION PROGRAM

The improvement and expansion of water resources and water supply facilities shall be proceeded step by step on the basis of implementation schedule shown in the following figure.

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)	(3.7)					(1.8) ■■■								(1.2) ■■■	(0.7) ■■■		
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										■■■						

■■■■■■ :breakdown

3.9 IMPROVEMENT PLAN FOR SANITATION

The following sanitary measures should be taken to protect the sources of domestic water after the expansion of water supply facilities in 2005 and 2015.

- Central apartment area: improvement of sewer and waste water treatment capacity
- Ger area: installation of personal or community treatment facilities

In addition, the following sanitary zones should be established to protect the sources of domestic water.

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

Bacteriological and chemical analyses should be carried out in these zones.

3.10 EVALUATION FOR MASTER PLAN

(1) Economic Analysis

The following table summarizes the result.

Result of Economic Evaluation of Mater Plan

Case	EIRR (%)	B/C	NPV (10^3)
Standard	14.5	1.23	591
Cost 10% up	12.4	1.12	339
Benefit 10% down	12.2	1.11	280
Cost 10% up plus benefit 10% Down	10.3	1.01	29

EIRR: economic internal rate of return,
B/C: benefit-cost ratio,
NPV: net present value

The EIRR for the standard case is derived at 14.5% indicating high economic return of the master plan, compared with an opportunity cost of capital or cut-off EIRR at 10%.

The economic evaluation was carried out based on the following assumptions.

1) An assumed life of the pipelines at 25 years.

2) The estimated costs are as follows.

Investment cost :	$ 3,031 thousand in total
Operation and maintenance cost:	$ 82 thousand per year in 2015 and thereafter
Replacement cost :	$ 1,593 thousand in total

3) Economic benefit by domestic water supply is estimated based on the prevailing water charges and the surveyed willingness-to-pay of the consumers.

Economic Benefit by Domestic Water Supply

Item	Unit	Minimum requirement	Commercial commodity
Value of water	Tg/m^3 $/$m^3$	1,875 2.11	67 0.08
Net water use in 2015 Apartment Ger	 l/c/d l/c/d	 20 20	 130 1.2
Population in 2015 Apartment Ger	 No. No.	 3,830 17,131	
Economic benefit in 2015 and thereafter	10^3 $/year	322	14

4) Economic benefit of industrial and institutional water supply was estimated based on the present revenue by water sale, surveyed willingness-to-pay for water of the industries and institutions, and annual growth rates at 3.5 % per year until 2005 and 4.5% per year between 2005 and 2015. The following economic benefits were derived.

2005 :	$ 112 thousand per year
2015 and thereafter :	$ 174 thousand per year

(2) Financial Analysis

The objectives of a financial analysis are :

- to derive appropriate water charges, and
- to assess financial viability of the master plan for APSD by deriving a financial internal rate of return (FIRR) based on the derived water charges.

An analysis was made to derive fair water charges for ger and apartment dwellers from the perspectives of **cost recovery** and **affordability**. It was found that an appropriate target for cost recovery would be the one where operation and maintenance cost is covered by water sale revenue. A target beyond this level would pose a difficulty in terms of affordability for residents. It is assumed that the present tariff for industries and institutions remain unchanged. The following table compares the existing water charges and the proposed water charges for 2005 and 2015.

Proposed Water Charges for Domestic Water

(Unit : Tg/m^3)

	Existing	2005	2015
Ger	1,250	566	283
Apartment	56	64	86
Industry/institute	900	900	900

Under these water charges, the proportion of the expenditure on water to monthly income stays within 5% for the population with a per capita income of less than Tg 10,000 per month. The population of this category accounts for 80% of ger dwellers and 40% of apartment dwellers.

The financial internal rate of return (FIRR) of the master plan under these proposed water charges is negative. It would be necessary for the government to subsidize the investment cost and replacement cost for implementing the project. Financial autonomy of APSD would be achieved for operation and maintenance portion.

(3) Social Evaluation

Proposed project on water supply system mainly focused on the improvement of water supply in the ger area increasing chances of water availability. Although the residents of ger area cited yard connection as a preferable choice, it is not technically feasible. As mentioned in social analysis, no negative impact on the proposed project is recognized in terms of religion and social custom, acquisition of land for the project, and water seller.

(4) Analysis for the Beneficiaries

While the higher income group of non-piped households approved 161% of increase, the lower income group of non-piped households approved 80% of increase to the current tariff level. As indicated in the result of the household survey, the lower income group of non-piped household consume less volume of water per day per person than the higher income group. Since the value used by the higher income group is still insufficient, it

is recommended that exemption system of water charge for lower income group such as unemployed and single female headed households should be revised periodically in corresponding local poverty assessment.

The proposed program for water supply system, which plans the installation of kiosk-type water delivery points in the ger area, will improve the availability of water in terms of time. This also will lead to the increase in the water consumption for non-piped households. The frequent supply of water will reduce the habit of stock water and bring about less opportunity of contamination.

However, 20% of non-piped households will not gain the very benefit of kiosk type of water supply since a fixed single kiosk is designed to cover a radius of 250m. It is recommended that the water supply department promote use of water cart.

(5) Initial Environmental Examination (IEE)

General

"General Environmental Screening Process" for this project was carried out in conformity with the Mongolian Law on Environmental Impact Assessment approved by the Parliament of Mongolia, dated January 22, 1998.

As a result of this screening, "Scope of Actions" was drawn up. It is briefed in the following paragraphs.

Scope of Actions

The main points of scope of actions are as follows.

a) The following items should be investigated and concluded by a specialized organizations.

- Water
- Soil
- Flora and Fauna
- Historical and Cultural Monuments

b) It shall be worked out an environmental plan of action and environmental monitoring program.

c) The detailed environmental impact assessment (EIA) statement should be submitted to the Ministry of Nature and Environment on the basis of the Law on Environmental Impact Assessment. It was submitted in September 1998.

3.11 SELECTION OF THE PRIORITY PROJECT FOR THE FEASIBILITY STUDY

Considering the so-far- mentioned criteria such as groundwater potential, water demand, and economy, the priority project of the water supply development has been selected. It recommends to improve existing water supply facilities of production wells, transmission pipes, distribution pump. It also recommends the procurement of the water wagon and water cart and construction the main distribution pipe and kiosk for some ger area. These shall be examined in an implementation design in the feasibility study.

4. FEASIBILITY STUDY

4.1 DESIGN CONDITION

Design condition for the feasibility study on the priority project is summarized below.

(1) Target year : 2005
(2) Future population in 2005 : 18,790
(3) Population served : 18,790 (apartment; 3,433, ger; 15,357)
(4) Service area : whole apartment and ger area shown in Figure 10.
(5) Future water demand in 2005 : 1,500 m^3/day in a maximum
(6) Additional development capacity : 350 m^3/day in a maximum
(7) Water source and its potential : Kharzat, more than 3,000 m^3/day

4.2 DEVELOPMENT PLAN

(1) Facilities

The outline of development of water supply facilities is as follows and it is also shown in Figure 10.

Required facilities to increase the capacity of water supply

Measures	Facilities
Improvement of existing facilities	1, reconstruction of 3 wells (total 4 wells; one is spare) 2, replacement of submersible motor pump with control system : 0.42m^3/min x 60m x 3 units (total 4 pumps; one is spare)
Construction of new facilities	1, water level indicator system for reservoir : 2sets 2, procurement of water wagon ; 5m^3 x 3 cars 3, procurement of water cart : 2792 (households) sets 4, distribution pipe for ger area G-2, G-3, and a part of G-1 : dia.150-200mm x 3.9km 5, construction of water kiosk : 2 in G-1, 3 in G-2, 5 in G-3

Water Source

In Kharzat water source, there are four production wells and two of them have been utilized for supplying water about 960 m^3/day in average and 1,150 m^3/day in maximum on October 1998. This water source can be expanded to about 1,500 m^3/day in maximum in 2005.

Intake Facilities

Among the four production wells, two wells constructed in 1979 are deteriorated and another well constructed in 1986 is damaged. They shall be reconstructed. The well constructed in 1995 is not necessary to be replaced in this stage.

Submersible motor pumps may also deteriorate by 2005 and they shall be replaced with new pumps. The control system of pump is also necessary to manage the withdrawing volume of groundwater in the night or in the case of low consumption of water.

Distribution Facilities

Two sets of water level meter shall be installed for the reservoir to automatically control the withdrawing volume from intake wells.

Water wagon is required until water Kiosks are constructed in G-1 area in 2015.

Location of proposed extension pipeline and water kiosks for ger areas for the year 2005 is shown in Figure 10.

(2) Land Acquisition

Some area of public owned land will be required for the construction of the facilities without monetary compensation.

4.3 OPERATION AND MAINTENANCE PLAN

(1) Institutional Strengthening

Daily operation and maintenance of water supply facilities have been conducted by APSD. The expanded and developed water supply facilities shall be also managed by strengthened organization and institution of APSD. The following are necessary items to strengthen maintenance and operation system of APSD.

- Introduction of appropriate water tariff
- Implementation of meter measuring system
- Reduction of water leakage
- Introduction of strict financial management
- Establishment of functional organization

(2) Establishment of Related Law for the water Supply Service

Design and operation criteria shall be established to ensure the structural and hygienic safety of the water supply facilities.
Regulation on water supply service shall be also established to provide, rational service for consumers.

(3) Improvement of Data Arrangement

Daily or monthly operation record of water consumption, electric power consumption, chemical dosage and other necessary data shall be arranged systematically and checked well under the strengthened organization. These data is available to maintain water supply facilities in good condition and to make a future development plan of water supply facilities.

(4) Training System

There are 45 employees including director in APSD. They have been working for long period in the same section, and have been learning skills of operation and maintenance only through their daily work.
It means that they do not have so much experience with skilled work in other sections.
Therefore, appropriate training system is necessary to make them master the comprehensive operation and maintenance technique.

(5) Hygiene Education Plan

Measure 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 is noted that water analysis is conducted to monitor the condition of drinking water not to measure true risk of the people. Therefore, it is encouraged to promote the understanding on the role of water analysis as well as exchanging information between APSD and Social Health Center.

In order to promote the hygiene practice among the residents in Altai City, the following approaches are recommended.

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

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.

Water and health

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

4.4 MONITORING PLAN

Monitoring of water sources and water supply facilities shall be conducted continuously and the following items should be measured, checked and recorded.

For water sources

- groundwater level,
- hydrological and meteorological data,
- groundwater quality, and
- groundwater utilization.

For water supply facilities

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

4.5 COST ESTIMATION

The total investment cost by the year of 2005 amounts to 996,359 US dollars which includes the direct construction cost, overhead cost, land acquisition cost, engineering (design & supervision) cost, and physical contingency. Its break down is shown below.

Investment Cost until the Year of 2005 (Unit : US Dollar)

Work Item	Nos	Total Cost (2000~2005)	
A. Direct Construction Cost	-	630,108	
		382,466	247,642
(1) Intake facility		197,308	
·Reconstruction of existing well	3 Wells	197,308	
		172,910	24,398
(2) Distribution facility		432,800	
·Water level indicator			
① Electrode	2 Sets	6,694	
		6,586	108
② Transmit Cable	1 Lot	47,805	
		40,659	7,146
·Water wagon	3 Cars	52,800	
		50,400	2,400
·Water cart	2792 Sets	92,136	
		0	92,136
·Water kiosk	10 Unit	51,060	
		0	51,060
·Pipe-line (Φ150~250)	3.9 Km		
① G-1 Area	(1.0Km)	38,540	
		25,652	12,888
② G-2 Area	(1.0Km)	51,975	
		31,185	20,790
③ G-3 Area	(1.9Km)	91,790	
		55,074	36,716
B. Land Acquisition Cost	-	0	
C. Construction Cost (A X 1.25)	-	787,635	
D. Design & Supervision (C X0.1)	-	78,764	
·Detailed Design (C x 0.05)	-	39,382	
·Supervision (C x 0.05)	-	39,382	
E. Physical Contingency {(C+D) X 0.1	-	129,960	
Total (C+D+E)	-	996,359	

Note 1) Exchange Rate : US$ 1.00 = Yen 117.5 US$ 1.00= Tg 890

2) ① ② ③ ① Total ② Foreign Portion ③ Local Portion

4.6 IMPLEMENTATION SCHEDULE

Implementation schedule on priori h ty project is proposed as shown below.

Implementation Schedule

Work Item	Nos	Year (2000–2005)					
		2000	2001	2002	2003	2004	2005
(1) Intake facility							
・Reconstruction of existing well (Including submersible pump)	3 Wells			■■■	■■■		
(2) Distribution facility							
・Water level indicator	2 Sets			■■■			
・Water wagon	3 Cars		■■■				
・Water cart	2,792 Sets		■■■				
・Water kiosk	10 Units				■■■	■■■	
①G-1 area	(2)				(2) ■■■		
②G-2 area	(3)				(3) ■■■		
③G-3 area	(5)					(5) ■■■	
・Pipe-line (Φ150～250)	3.9 Kms				■■■	■■■	
①G-1 area (Φ150～200)	(1.0)				(1.0) ■■■		
②G-2 area (Φ150)	(1.0)				(1.0) ■■■		
③G-3 area (Φ150)	(1.9)					(1.9) ■■■	

4.7 DISBURSEMENT PLAN

The proposed disbursement of the project is shown below.

Disbursment Plan

(Unit : US Dollar)

Work Item	Nos	Year 2000 - 2005						Total Cost (2000~2005)
		2000	2001	2002	2003	2004	2005	
A. Direct Construction Cost	-		144,936	186,038	181,815	117,320		630,108
			50,400 | 94,536	162,519 | 23,520	114,474 | 67,341	55,074 | 62,246	0 | 0	382,466 | 247,642
(1) Intake facility								197,308
·Reconstruction of existing well	3 Wells			131,539	65,770			197,308
				115,274 | 16,266	57,637 | 8,133			172,910 | 24,398
(2) Distribution facility								432,800
·Water level indicator								
① Electrode	2 Sets			6,694				6,694
				6,586 | 108				6,586 | 108
② Transmit Cable	1 Lot			47,805				47,805
				40,659 | 7,146				40,659 | 7,146
·Water wagon	3 Cars		52,800					52,800
			50,400 | 2,400					50,400 | 2,400
·Water cart	2792 Sets		92,136					92,136
			0 | 92,136					0 | 92,136
·Water kiosk	10 Unit				25,530	25,530		51,060
					0 | 25,530	0 | 25,530		0 | 51,060
·Reservoir	2 Ponds							0
								0 | 0
·Pipe-line (Φ150~250)	3.9 Km							
① G-1 Area	(1.0Km)				38,540			38,540
					25,652 | 12,888			25,652 | 12,888
② G-2 Area	(1.0Km)				51,975			51,975
					31,185 | 20,790			31,185 | 20,790
③ G-3 Area	(1.9Km)					91,790		91,790
						55,074 | 36,716		55,074 | 36,716
B. Land Acquisition Cost	-	0	0	0	0	0	0	0
C. Construction Cost (A X 1.25)	-	0	181,170	232,547	227,268	146,650	0	787,635
D. Design & Supervision (C X0.1)	-	9,059	20,686	22,991	18,696	7,333	0	78,764
·Detailed Design (C x 0.05)	-	9,059	11,627	11,363	7,333	0	0	39,382
·Surpervision (C x 0.05)	-		9,059	11,627	11,363	7,333	0	39,382
E. Physical Contingency {(C+D) X 0.15)}	-	1,359	30,278	38,331	36,895	23,097	0	129,960
Total (C+D+E)	-	10,418	232,134	293,869	282,859	177,080	0	996,359

Note 1) Exchange Rate : US$ 1.00 = Yen 117.5 US$ 1.00= Tg 890

2) ① Total ② Foreign Portion ③ Local Portion

4.8 OPERATION AND MAINTENANCE COST

Operation and Maintenance Cost

The annual average O/M costs after the completion of each construction works without replacement cost (as of 1998) are estimated below.

Annual Operation and Maintenance Cost

Item	Unit	Year (2000-2005)						Total
		2000	2001	2002	2003	2004	2005	
Daily Mean Demand	m3/day	1,011	1,037	1,063	1,089	1,114	1,140	
Hourly Maximum Demand	m3/h	86.4	95.6	104.9	114.1	123.3	132.5	
1. Electric Power Cost (US$0.126/KwH)	US$/Year	32,600	37,173	37,699	31,213	31,558	31,917	202,160
·Electric Consumption	KwH/Year	258,727	295,022	299,198	247,726	250,463	253,310	
①Intake Pump (Existing)	KwH/Year	162,367	166,542	170,718				
②Intake Pump (Reconst. & New)	KwH/Year				119,246	121,983	124,830	
③Distribution Pump (Existing)	KwH/Year	96,360	128,480	128,480	128,480	128,480	128,480	
④Distribution Pump (New)	KwH/Year							
2. Chemical Cost (US$0.34/Kg)	US$/Year	916	939	963	987	1,009	1,033	5,847
·Chemical (Cl_2) Consumption	Kg/Year	2,693.81	2,763.09	2,832.36	2,901.64	2,968.25	3,037.53	
3. Personnel Cost	US$/Year	10,598	10,598	11,771	11,771	13,456	15,141	73,335
4. Repair Cost (1% of Const.-Cost)	Lot	0	0	1,812	4,137	6,410	7,876	20,235
Total Annual M & O Cost	US$/Year	44,113	48,710	52,245	48,108	52,433	55,967	301,576

The equipment shall be periodically replaced at the end of its life span. The detail replacement cost is shown in the following table.

Replacement Cost

Unit : US Dollar

No	Work Item	Unit	Life Span	Year (2000-2005)						Total
				2000	2001	2002	2003	2004	2005	
1	Intake facility (Exist. & New)					164,423	82,212			246,635
	·Well	Year	15			30,660	15,330			45,990
	·Pump house	Year	40			6,710	3,355			10,065
	·Intake pump	Year	15			116,531	58,266			174,798
	·Collection pipe	Year	25			10,522	5,261			15,783
2	Distribution facility	Year			181,170	68,124	145,056	146,650		541,000
	·Water level indicator	Year	15			68,124				68,124
	·Water wagon	Year	10		66,000					66,000
	·Water cart	Year	15		115,170					115,170
	·Water kiosk	Year	40				31,913	31,913		63,826
	·Pipe-line (Φ150~250)	Year	25				113,143	114,738		227,881
3	Total of Replacement Cost	-	-		181,170	232,547	227,268	146,650		787,635
	Every 10 Years				66,000					66,000
	Every 15 Years				115,170	215,315	73,596			404,081
	Every 25 Years					10,522	118,404	114,738		243,664
	Every 40 Years					6,710	35,268	31,913		73,890

Note 1) Exchange Rate : US$ 1.00 = Yen 117.5 US$ 1.00= Tg 890

4.9 IMPROVEMENT PLAN FOR SANITATION

(1) The following sanitary measures should be taken to protect the sources of domestic water since water supply facilities are expanded in 2005 and 2015.

- Central apartment area: improvement of sewer and waste water treatment capacity
- Ger area: installation of personal or community treatment facilities

(2) The following sanitary zones should be established to protect the sources of domestic water.

I - (100m) strictly prohibited zone.

prohibit setting up of any sources of possible pollution in the I-zone

II -(300m) zone under protection.

III-(1,000m) monitoring zone.

Bacteriological and chemical analyses should be carried out in these zones.

4.10 PROJECT EVALUATION OF PRIORITY PROJECT

(1) Economic Analysis

The following table summarizes the result.

Result of Economic Evaluation of Priority Project

Case	EIRR (%)	B/C	NPV (10^3)
Standard	16.3	1.38	532
Cost 10% up	14.3	1.25	391
Benefit 10% down	14.1	1.24	337
Cost 10% up plus benefit 10% Down	12.3	1.13	196

EIRR: economic internal rate of return,
B/C: benefit-cost ratio,
NPV: net present value

The EIRR for the standard case is derived at 16.3 % indicating high economic return of the priority project, compared with an opportunity cost of capital or cut-off EIRR at 10%. The assumptions for the analysis on the master plan are also employed. The following are the used values and the estimated economic benefit.

Economic Benefit in 2005

Item	Unit	Minimum requirement	Commercial Commodity
Value of water	Tg/m^3	1,875	67
	\$/m^3	2.11	0.08
Net water use in 2005			
Apartment	l/c/d	10.6	139.4
Ger	l/c/d	10.6	0.0
Population in 2005			
Apartment	No.	3,433	
Ger	No.	15,357	
Economic benefit in 2005 and thereafter			
Domestic water	10^3 \$/year	153	13
Industrial and institutional water	10^3 \$/year	112	

(2) Financial Analysis

The FIRR for the priority project is derived at 4.6% based on the derived water charges in 2005 indicating the possibility that the fund for implementing the priority project could be procured from the sources with an interest of less than 4.6% per year.

Proposed Water charge (unit:Tg/m^3)

Item	Existing	2005	2015
Ger dwellers	1250	566	283
Apartment dwellers	56	64	86
Industry/institution	900	900	900

(3) Social Evaluation

Proposed project on water supply system mainly focuses on the improvement of water supply in the ger area by increasing chances of water availability. Although the resident of ger area cited yard connection as a preferable choice, it is not technically feasible. As mentioned in social analysis, no negative impact on the proposed project is recognized in terms of religion and social custom, acquisition of land for the project, and water seller

(4) Analysis for the Beneficiaries

While the higher income group of non-piped households approved 161% of increase, the lower income group of non-piped households approved 80% of increase to the current

tariff level. As indicated in the result of the household survey, the lower income group of non-piped household consume less volume of water per day per person than the higher income group. Since the water used by the lower income group is still insufficient, it is recommended that exemption system of water charge for lower income group - unemployed and single female headed households should be revised periodically in corresponding local poverty assessment.

The proposed program for water supply system, which plans the installation of kiosk-type water delivery points in the ger area, will improve the availability of water in terms of time. This also will lead to the increase in the water consumption for non-piped households. The frequent supply of water is expected to reduce the habit of stock water and bring about less opportunity of contamination.

However, 20% of non-piped households will not gain the very benefit of kiosk type of water supply since a fixed single kiosk is designed to cover a radius of 250m. It is recommended that the water supply department promote use of water cart.

(5) Environmental Impact Assessment (EIA)

EIA was conducted for the priority project site of Kharzat water source and new water supply facilities.

Screening

"General Environmental Screening Process" was carried out on May 22, 1998 by State Senior Inspector of Policy and Coordination Department of the Ministry of Nature and Environment. It was concluded that detailed environmental assessment should be conducted for the planned facilities.

1) Expected Environmental Impacts

The result of EIA is summarized in the following two tables.

Construction of Water Supply Facilities

Item	Judgement
Drilling noise for human being (including livestock) and fauna (especially in breeding season)	small negative impact
Degradation of vegetation / subsoil by drilling work, (10-30 m^2)	small negative impact
Degradation of vegetation / subsoil by constructing distribution pipeline (30 m x 3.9 km: affected area 12ha)	large negative impact
Employment	small positive impact
if construction workers are locally employed,	impact is positive.
if construction workers are employed from other places,	impact is negative.

Operation of Water Supply Facilities

Item	Judgement
Stable water supply, especially for Ger areas	large positive impact
Degradation of groundwater, wetland, vegetation and subsoil if overusing the groundwater	large negative impact
Employment (changing types of job)	small impact

2) Mitigation of Impacts

Some protection measures have been proposed as a result of EIA. They are;

- Informing the construction detail before the commencement,
- Preventing the degradation of vegetation and subsoil from the construction work, and
- Preventing the degradation of groundwater from overusing.
- The following sanitary scheme should be established to protect the sources of drinking water:

  I -(100m) strictly prohibited zone,

  Prohibit setting up of any sources of possible pollution in the I zone.

  II -(300m) zone under protection, and

  III -(1,000m) monitoring zone.

Bacteriological and chemical analysis should be carried out in these zones.

3) Monitoring and Management

Construction Phase

After the construction of a facility, vegetation and subsoil in the affected area should be monitored, and if necessary, some measure should be taken.

Operation Phase

Water level and quality of groundwater, vegetation, and subsoil should be monitored, and if necessary, some measures should be taken.

5. CONCLUSION AND RECOMMENDATION

(1) Conclusion

The project evaluation revealed that both the master plan and priority project were feasible, therefore worth promoting to the implementation stage. The project would contribute to the improvement of the living standard of Altai people and support economic development in the city. An appropriate financial arrangement would be needed considering the low financial return of the project. No adverse impacts are envisaged in the environmental and social aspects.

(2) Recommendation

1) Ger dwellers have great disadvantage in that water wagons deliver water a couple of times in a day for them, while apartment dwellers get water by taps any time. They cannot get water whenever they want. Therefore, improvement of water supply service for ger dwellers shall be given priority.
2) Disparity of water tariff between apartment dwellers and ger dwellers shall be revised. To start with, the fact should be opened to the public.
3) People have to change the awareness for water quality that high mineral concentrations in water affect their health. Actually, the chemical contents are below the Mongolian standard except magnesium. The problem is the total coliform in water, especially in the stored water in ger. Water in Altai City is not as bad as they claim, considering the water quality analysis result and especially when it is compared with water quality and standard of some other countries. Hygiene education for the public shall be conducted through radio, television, by the public health center and school with following objectives:
   - increase of awareness on hygiene practice and water consumption,
   - proper management of stock water and water consumption, and
   - water and health.
4) Epidemiological survey, that started from 1998, shall be continued to clarify the cause of chronic diseases.
5) The drawdown in operation of wells should be kept around four to six meters to conserve the limited natural resources of groundwater.
6) The loss ratio of leakage should be improved step-wise. Water meters shall be installed at the pumping station, apartment buildings, public buildings, and in each apartment. APSD has to inspect meters and find the point of leakage in order to

improve the water supply facilities. Inspection staff in APSD should be strengthened.

7) All information shall be opened to the public to improve the people's awareness for saving water, preservation of the environment to spread the idea that groundwater is limited natural resources.