BASIC DESIGN STUDY

ON

THE PROJECT FOR

RURAL COMMUNITIES WATER SUPPLY

IN

THE REPUBLIC OF KAZAKHSTAN

JULY 2003

JAPAN INTERNATIONAL COOPERATION AGENCY

PACIFIC CONSULTANTS INTERNATIONAL

PREFACE

In response to a request from the Government of the Republic of Kazakhstan, the Government of Japan decided to conduct a basic design study on the Project for Rural Communities Water Supply in the Republic of Kazakhstan and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Kazakhstan a study team from September 22 to November 1, 2002 and from June 10 to June 23, 2003

The team held discussions with the officials concerned of the Government of Kazakhstan, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Kazakhstan in order to discuss a draft basic design, and as this result, the present report was finalized.

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

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

川上隆朗

Takao Kawakami
President
Japan International Cooperation Agency

July 2003

LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the project for Rural Communities Water Supply in the Republic of Kazakhstan.

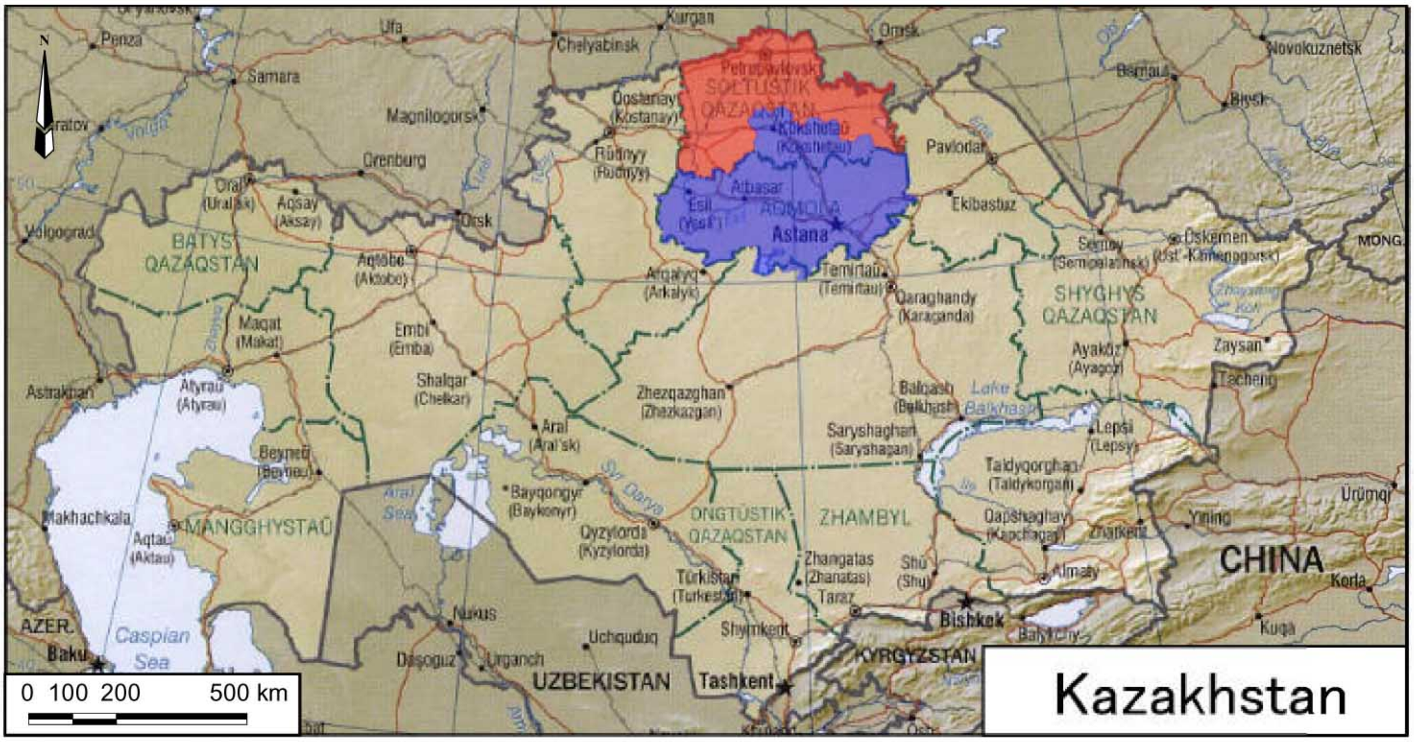
This study was conducted by Pacific Consultants International, under a contract to JICA, during the period from September, 2002 to July, 2003. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Kazakhstan and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

Very truly yours,

Y. Yamasaki

Yasumasa Yamasaki
Project Manager,
Basic Design Study Team on
The Project for Rural Communities
Water Supply in the Republic of Kazakhstan
Pacific Consultants International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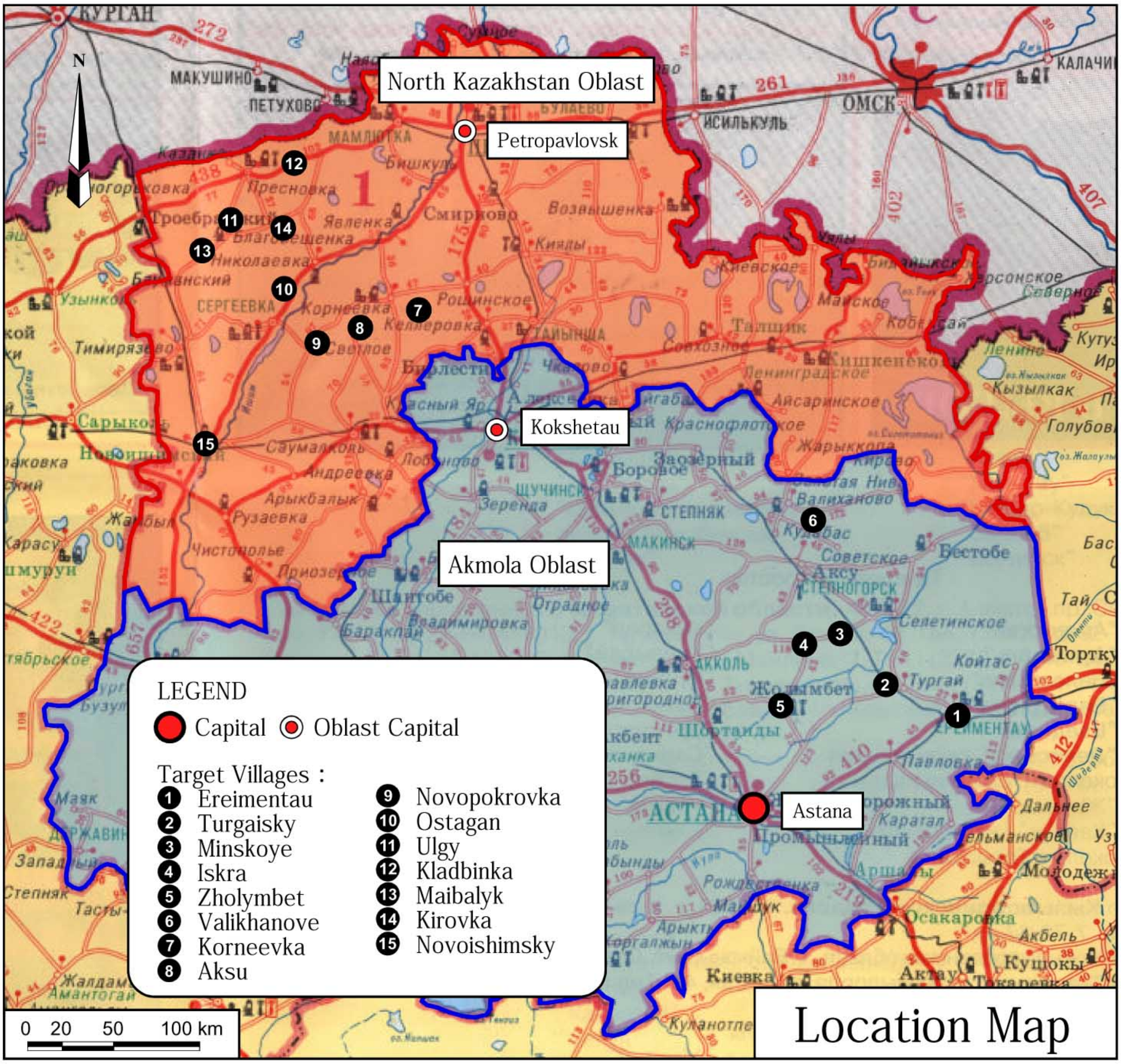
Location Map
North Kazakhstan Oblast
Petropavlovsk
Kokshetau
Akmola Oblast
Astana
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LEGEND
Capital
Oblast Capital
Target Villages :
1 Ereimentau
2 Turgaisky
3 Minskoye
4 Iskra
5 Zholymbet
6 Valikhanove
7 Korneevka
8 Aksu
9 Novopokrovka
10 Ostagan
11 Ulgy
12 Kladbinka
13 Maibalyk
14 Kirovka
15 Novoishimsky

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Abbreviations

ADB	Asian Development Bank
BHN	Basic Human Needs
BS	British Standard
CIP	Cast Iron Pipe
DTH	Down The Hole Hammer
E/N	Exchange of Notes
G.V.W	Gross Vehicle Weight
GOCT	National Standards (of the former Soviet Union)
GPS	Global Positioning System
JICA	Japan International Cooperation Agency
KT	Kazakhstan Tenge
LWL	Low Water Level
M/D	Minutes of Discussion
NGO	Non Government Organization
OJT	On the Job Training
P.T.O	Power Take Off
PE	Polyethylene
PVC	Polyvinyl Chloride
RSE	Republic State Enterprise
SP	Steel Pipe
WB	World Bank

Exchange Rate

1US$ = 119.29 Yen

1US$ = 152.94 KT

1KT = 0.78 Yen

SUMMARY

SUMMARY

The republic of Kazakhstan is located in the central Asia and land-locked country with boundary of Russia, Mongolia, China, Kirghizia, Uzbekistan, Turkmenistan and Caspian Sea. The area of national land is 2.7 million km^2 and population is 16.7 million. The climate of Kazakhstan is characterized as a continental climate and temperature difference between daytime and nighttime and also summer season and winter season is remarkable. January is the coldest through the year. The average temperature of Astana city in the Akmola Oblast during past 10 years is -14.2°C. During winter season from November to March, average temperatures reaches below freezing point. Average annual precipitation during past 10 years in the North Kazakhstan Oblast is only 315 mm, which is larger than the average precipitation of 250 mm of Kazakhstan. The most of land of North Kazakhstan and Akmola Oblasts is plain and low-lying. The altitudes of Astana, Kokshetau in Akmola and Petropavlovsk in North Kazakhstan are 600 m, 400 m and 150 m, respectively. The altitude is gently becoming smaller from southern area to northern area.

The Akmola and North Kazakhstan Oblasts, which are studied area in this project, are mainly producing cereal and No 1 and No 2 of cereal production in the Republic of Kazakhstan (hereinafter referred to as "Kazakhstan"). This is as a result of that the system of sovkhoz was established and it was continued from 1960 to 1970 under controlled by the old USSR. During the USSR era, construction of infrastructures such as road, electricity, telephone and water supply were executed at the same time of establishment of sovkhoz and transmigration of residents. For the water supply system, regional water works (group water works) was established in order to supply water for drinking and irrigation to the each village in the Akmola and North Kazakhstan Oblasts. Large scale of water transmission pipeline was constructed. The total length of pipeline in the North Kazakhstan is 6,500 km.

In 1991, system of sovkhoz was bankrupted because of collapse of USSR and Russian and German people went back to their own countries, therefore, population of the Akmola and North Kazakhstan Oblasts was reduced eminently. Moreover, jobless workers, mainly sovkhoz workers went out to the city from the villages and excessively declining population of the villages was accelerated. In recent time population drain of villages becomes calm and the population shows signs of leveling.

The group water works, which has over capability of supply water compared with the real required water demand because of the sovkhoz bankrupt and reduction of the population, didn't receive the grant from the government and couldn't maintain to supply water to the consumer. Starting 1997, many group water works were bankrupt and closed. The people

who received clean and sufficient water from the group water works should devise a countermeasure instructing by the district.

There are a few villages to manage water works systematically in the studied area in this project and people are getting water from the shallow wells. Even though they have a good organization of water supply system, water is supplied only intermittently because of the shortage of water quantity from the water source. Both of quality and quantity of supplied water are not sufficient and condition of sanitary environment is becoming worse compared with the USSR era.

In order to keep people’s life safety and stop the population drain from the villages, the government of Kazakhstan made a decision to move ahead on the program of education, medical care and water supply for the villages. For the water supply, the government of Kazakhstan advocated the program of supply clean water for the village people in 2000 and made a decision to continue a large scale of village water supply assistance program until 2005 taking into consideration not only approach to the international assistance agency but also increase of the subsidy for water supply every year. The project is getting rolling considered by the getting the budget for provision of the water supply pipeline at 2003.

In 1998, this project was made a request for Japanese Grant initially by Kazakhstan. In 2000, the Department of Natural Resource and Environment Protection revised the former request and made a request concerning the project that included construction of pipeline from the well site to the reservoir and procurement of drilling rigs and related equipments for 15 villages in both oblasts of North Kazakhstan and Akmola. Finally, Japan International Cooperation Agency (hereinafter referred to as “JICA”) carried out the project identification survey in 2000. As a result of this survey, it was identified that the water supply system was very serious problem after the group water works collapse and the water supply project was decided for an urgent project to save the people welfare.

Preliminary survey was conducted in 2001. The components of request were concluded taking into consideration the result of the preliminary survey and Japanese requirement.

- The target areas are 9 villages in North Kazakhstan and 6 villages in Akmola.
- The requests are construction of well and raw water transmission, rehabilitation of existing facilities for elevated tank, pumping stations and reservoirs and procurement of drilling rigs, survey equipment and pipe materials. However, only procurement of drilling rigs, survey equipment and pipe materials is adopted in order to require their own effort and keep their technologies.

JICA sent a study team to Kazakhstan September 2002 based on the above basic contents.

After the formulation of oblast water supply master plan, development of rural water supply was executed rapidly. The state water enterprises (Astana Su in Akmola and Esyl Su in North Kazakhstan), which are responsible for the development of water supply project, built up both of organization and maintenance. As a result, it was identified that there was not necessary for the procurement in the requested equipment as stated as bellow table. And quantity of request was changed. In order to execute their plans for Astana Su and Esyl Su, 2 drilling rigs were requested instead of 1 drilling rig.

As the result of discussion mentioned above, both sides confirmed that the Project should have following components: (1) procurement of equipment for groundwater development and construction materials for borehole facilities, (2) provision of technical assistance through "soft component". It is noted that the Kazakhstan side should be responsible for the construction works.

	Item	Contents and Quantity
1	Drilling Equipment	Drilling rig (2 units), Drilling tools and Accessories (2 sets), Truck with air compressor (2 sets)
2	Assistant Vehicle	Truck with crane (2 sets), Truck with water tank (2 sets)
3	Survey Equipment	GPS (2 sets)
4	O & M Equipment	Hydraulic jack (2 sets), Air-compressor (2 sets), Engine welder (2 sets), Battery charger (2 sets), Mechanical tools (2 sets)
5	Borehole construction material (38 boreholes)	Submersible motor and pump (including power cable, panel, discharge pipe), Casing and screen pipe, Centralizer, Raw water transmission pipe (including polyethylene pipe, joint of pipe, bend pipe, reducer, valve and so on)

The "Soft Component" of the Project consists of the following two components:

- Technical assistance for the project execution (Construction planning, Construction management and Quality control)

- Technical assistance for the maintenance of equipment (Technical assistance for the well drilling, Countermeasure against the construction troubles and storage management)

In case of execution of this project, 2.5 months for the detailed design, 8 months for procurement of equipment and material, 1.5 months for the "Soft Component" and 18 months which include 5 months of not workable period during the winter for the construction of water supply facilities for Kazakhstan side will be required. Total execution period for this project is 30 months. Required approximate total project cost estimated 962 million yen (525 million yen for Japanese side and 437 million yen for Kazakhstan side).

Expected direct and indirect effects are summarized as the following table:

	Current Status/Problems	Input by the Project	Effect by the Project
Direct Effects			
1	Most people in target communities depend on the shallow wells for the drinking water which quality and quantity are not sufficient.	Procurement of the intake facilities (38 deep wells) and the pipes for transmission of water and their installation	- Provide safe and sufficient drinking water to 37,589 people covered under the project. - Service hour will be improved from 8 hours to 24 hours in two villages. - Current water supply rate of 0 % in the 13 villages will be improved to 100 % upon completion of the Project.
2	Due to the old age of well drilling equipment owned by the contractor, duration of the construction of the well is long. The construction cost of the well is very high due to monopolization of the construction of the well.	- Procurement of two drilling rigs and support materials. - Guidance for operation and maintenance for the drilling rigs by Japanese consultant.	Shortening of the construction of the well and reduction of the budget for the well drilling will be expected.
3	People have to fetch and carry water from distant water sources and are forced to spend considerable time and effort to obtain water.	Public tap or house connection for the rural water supply system	- Reduce workload for obtaining water
Indirect Effects			
1	Oblast water supply planning will not be able to accomplish due to the long period of well construction.	Procurement of the most appropriate drilling rigs for the well drilling.	After completion of 15 villages water supply system, drilling rigs will be used for the new well construction and will cause the completion of 2005 water supply program
2	People are suffering from the waterborne infectious diseases.	Supply good quality of water	Number of people suffered from the waterborne infectious diseases is reduced.

In order to properly execute the maintenance of equipment and facilities procured under the Project and to execute the project that safe and sufficient water will be supplied to the 15 villages, it is indispensable to consider the following aspects.

(1) Water resources committee and republic state enterprise shall secure the necessary budget for the water supply project included the construction of water intake, water transmission pipeline and repair/renewal of these facilities and execute.

(2) Republic state enterprise shall keep the technology to be taught under the guidance of Japanese consultant about operation and maintenance for the drilling rig and supporting materials.

(3) Republic state enterprises, countries and villages shall retain the organization of operation and maintenance for the water supply facilities. They shall also aim to establishment of the sustainable collection system for the water fee and improvement of the operation and maintenance by themselves.

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CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1　BACKGROUND OF THE PROJECT

In the northern area of the Republic of Kazakhstan (hereinafter referred to as "Kazakhstan"), most of the population has not been supplied until now that both of the quality and the quantity of drinking water is sufficient from the existing shallow wells. And also they were suffering from that the construction cost of the drilling well is high and duration of the construction of the drilling well is long since the contractor is private and their drilling equipments are too old. Kazakhstan decided that cooperation from Japan was essential in order to improve the situation of water supply and sanitation in the northern area in Kazakhstan.

In 1998, Kazakhstan made a request for Japanese Grant Aid concerning the project that included procurement of drilling rigs, etc. for this area. In 2000, Kazakhstan revised the former request and made new requests for Japanese Grant Aid for 1 project that included the procurement of drilling facilities and related equipments in 15 villages in 2 oblasts (namely, North Kazakhstan Oblast and Akmola Oblast).

Finally, Japan decided to carry out the basic design study for Japanese Grant Aid in North Kazakhstan and Akmola Oblasts, taking into consideration the reduction of the carrying water and the supply of good quality and the quantity of drinking water.

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Basic Concept of the Project

(1) Overall Goal and Project Purpose

The government of Kazakhstan formulated "National Development Strategy 2030" as the national plan. Based on the national plan, Water Resource Committee (WRC) elaborated following water supply programs for Akmola Oblast and North Kazakhstan Oblast respectively, both of which are aiming to provide rural communities with water supply facilities.

Akmola Oblast	:	"Program of Clean Water Supply in Akmola Oblast (Saplu-Su) 2001-2003", formulated in 2001
North Kazakhstan Oblast	:	"Program of Water Supply in North Kazakhstan Oblast 2000-2005", formulated in 2000

The project purpose is to promote the progress of the above oblast programs. As the overall goal of the project, it is also expected that achievement of the oblast program will contribute to improvement of sanitary conditions, which is the one of objectives of the national plan.

Activity of the project is to procure equipment and materials necessary for groundwater development and construction of water supply facilities. The project will bring about the following outputs.

① Provision of safe water with enough quantity to 13 non-supplied communities.
② Provision of 24 hours supply in 2 communities (Ereimentau and Zholymbet), where water supply service is limited to 8 hours.
③ Promotion of the oblast water supply program (improvement of capability in drilling works).
④ Decrease in infant mortality and water-borne disease.

(2) Background of the Basic Policy

In 1998, the government of Kazakhstan requested of the government of Japan the grant aid project for 10 communities in 5 oblasts. On the occasion of the project formulation study in 2000, Ministry of Natural Resources and Environment Protection reviewed and altered the contents of the request. The newly requested contents were construction of water supply facilities from intake to distribution reservoirs and procurement of equipment and materials for well drilling. Target communities also changed to 15 communities in 2 oblasts, Akmola Oblast and North Kazakhstan Oblast.

Through the preparatory study in 2001, it was discussed whether the scope of Japan should cover both the construction and procurement. As the consequence of the study, the government of Japan determined that the scope of Japan be procurement of equipment and materials, taking into account of technical capability of Kazakhstan and in light of promotion of self-help efforts.

In 2002, the basic design study team was dispatched. Both Japan side and Kazakhstan side agreed that the scope of the project borne by Japan be procurement of equipment and materials and the scope of Kazakhstan be construction of facilities.

(3) Basic Concept of the Project

1) Contents of the request

The following table shows the contents of the equipment and materials Kazakhstan requested in 2000 for 10 communities in North Kazakhstan Oblast and 5 communities in Akmola Oblast.

Table 2-1 Content of the Request

I. Well Drilling Rig

No.	Request	Quantity
(1)	Water well drilling rig for 100 to 200 m depth (inclusive of rotary head, draw-works, mast, pull down, mud pump, carrier truck)	1 units
(2)	Drilling tools and accessories for 150 m depth	
a)	Standard accessories	1 set
b)	Drilling tools for mud rotary	1 set
c)	Drilling tools for DTH hammer	1 set
d)	Casing handling tools	1 set
e)	Fishing tools	1 set
f)	Air lifting tools	1 set
(3)	4 x 4 truck mounted air compressor	1 unit
(4)	Spare parts	
a)	Spare parts for drilling rig	1 lot
b)	Spare parts for air compressor	1 lot

II. Supporting Vehicles for Drilling

No.	Request	Quantity
(1)	Cargo truck, 6 x 6, G.V.W. of 26,000 kg, long body type, with 6-ton cab back crane, for drilling tools and heavy equipment	1 unit
(2)	Cargo truck, 4 x 4, G.V.W. of 15,000 kg, with 3-ton cab back crane, for drilling tools and other equipment	1 unit
(3)	Water tanker, 4 x 4, tank capacity of 8 3 m^3	1 unit
(4)	Pick-up type light vehicle, 4 x 4	1 unit
(5)	Spare parts	1 unit

III. Borehole Test Equipment

No.	Request	Quantity
(1)	Borehole logging equipment	1 set
(2)	Borehole testing equipment	1 lot
(3)	Water analysis equipment	1 lot
(4)	Spare parts	1 lot

IV. Geophysical Test Equipment

No.	Request	Quantity
(1)	Electrical prospecting equipment, mounted on 4 x 4 station wagon	1 set
(2)	Electromagnetic prospecting equipment	1 set
(3)	Global positioning system	1 set
(4)	Spare parts	1 lot

V. Workshop Equipment

No.	Request	Quantity
(1)	Equipment and tools for workshop	1 set
(2)	Spare parts	1 lot

VI. Equipment and Materials for Wells

No.	Request	Quantity
(1)	Submersible motor pump, 150 l/min	36 units
(2)	Transformer, power panel, power cable	36 sets
(3)	Well casing and screens for 100 meter depth	36 sets
(4)	Pipes for connection of water supply point	36 sets

2) Necessity of Equipment

① Procured equipment

Since water supply programs for Akmola Oblast and North Kazakhstan Oblast were formulated, waterworks have been improved gradually at rural communities. Executing organizations of water supply, Republic State Enterprise (RSE) Astana

Su for Akmola Oblast and RSE Esyl Su for North Kazakhstan Oblast, have enhanced their capacity and capability. As the result of their efforts, some of equipment they requested in 2000 became unwanted. Following alterations have been confirmed.

a. Geophysical test equipment

Former Soviet Union had investigated underground resources all over the land of Kazakhstan from 1970 to 1980. As for groundwater, geophysical survey as well as test drilling was conducted and hydro-geological maps were drawn. Based on the survey and maps, drilling site for deep well has been already planned at each target community. Hence, it is unnecessary to procure geophysical test equipment by the project.

b. Borehole test equipment

RSEs and private companies possess borehole logging and testing equipment. So, it became unwanted to procure it.

They also possess water analysis equipment for daily testing. As for heavy metals, they entrust the analysis to research institutes. Current analyzing system works enough to monitor drinking water quality.

c. Vehicles

RSEs have vehicles for conveyance of drilling tools. It is unnecessary to procure 6 x 6 truck and 4 x 4 pick-up truck.

d. Drilling rig

Two drilling rigs are requested by Kazakhstan, however they requested one rig in 2000. Target communities are scattered throughout two oblasts, which have too extensive area to cover by one drilling rig. It takes considerable time to move a drilling rig from community to community or from oblast to oblast. Furthermore, each RSE implement its own construction schedule. In accordance with their schedules, construction of 38 deep wells should be completed by 2005. It is difficult to comply with their schedules only by one rig for two oblasts.

The maximum drilling depth is designed at 120 m, corresponding with the maximum depth of existing well at target communities.

3) Basic Concept of the Project

The project inputs drilling equipment and construction materials for deep wells, materials for water transmission pipelines, technology transfer on project management (construction management and quality assurance) and technology transfer on operation and maintenance of drilling rigs. The following outputs are expected.

① Deep wells and water transmission pipeline are constructed at target communities.
② Necessary equipment for drilling works is equipped at RSEs
③ Effective construction works are executed and construction cost is reduced.
④ Operation and maintenance capability of RSEs is strengthened.

Basic concept of the project and its impact expected is shown in the Project Design Matrix (Table 2-2).

Table 2-2 Project Design Matrix (PDM)

Narrative Summary	Indicator	Means of Verification	Important Assumption
<u>Overall Goal</u> Water supply conditions are improved in Akmola Oblast and North Kazakhstan Oblast	① Progress of oblast's water supply program (number of communities done) ② Infant mortality ③ Morbidity of water-borne disease	① Construction record of RSEs ② data of district health center ③ ditto	• There is no change in the national development policy and oblast's water supply program. • Understanding and participation of residents are obtained.
<u>Project Purpose</u> Safe and enough volume of water is supplied	① Construction record of rehabilitation of distribution facilities ② Population served by deep well ③ Service hour	① Construction record of RSEs ② Data of RSEs and district offices ③ ditto	• Construction works are extended to other communities. • O&M is continued.
<u>Output</u> 1. Deep wells and water transmission facilities are constructed. 2. Equipment for drilling (rigs, supporting vehicles, etc.,) is equipped. 3. Effective construction works are executed.	① Number of constructed deep wells ② Length of embedded transmission pipes ③ Period of drilling works ④ Drilling cost ⑤ Number of trainee for O&M of drilling rigs	① Well passports ② Construction record of RSEs (work amount performed, schedule, budget sheets) ③ ditto ④ ditto ⑤ Training record (soft component)	• Rehabilitation of distribution facilities is implemented. • O&M of drilling equipment is regularly executed.
<u>Activity</u> 1. to construct 38 deep wells and water transmission facilities at 15 rural communities. 2. to procure drilling equipment and construction materials. 3. to instruct O&M technique of drilling rigs.	<u>Input</u> *Japan Side* [Equipment] Drilling equipment (drilling rigs, supporting vehicles etc.,) Construction materials and equipment for deep wells and water transmission facilities [Personnel] Specialist. Trainer [Cost] Procurement cost Training cost (soft component)	*Kazakhstan Side* [Equipment] Heavy equipment, construction materials [Personnel] Specialist, engineer, labor [Cost] Construction cost Procurement cost Operation and management cost	• Drilling department is established in RSEs. • Budget for construction of intake and distribution facilities is allocated. <u>Precondition</u> • E/N is concluded. • Construction budget is secured.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy

Scope of the Japan’s assistance consists of 2 components; (a) procurement of equipment and materials for drilling works, and (b) transfer technology regarding operation and maintenance of drilling rigs.

Kazakhstan side will undertake the construction of deep wells and water transmission facilities. Kazakhstan side will also rehabilitate distribution facilities (reservoirs, elevated tanks, distribution pipeline) and will complete the waterworks at target rural communities.

Target rural communities are 15 communities located in 2 oblasts as shown in the table below.

Table 2-3 Target Communities

No.	Oblast	Community	District	District capital	Population
1	Akmola	Ereimentau	Ereimentau	Ereimentau	15,000
2		Turgaisky	Ereimentau	Ereimentau	1,810
3		Minskoye	Akkol	Akkol	796
4		Iskra	Akkol	Akkol	1,042
5		Zholymbet	Shortandinsk	Shortandui	4,952
6		Valikhanovo	Enbekshildersk	Stepnyak	500
Subtotal					24,100
7	North Kazakhstan	Korneevka	Esiljskij	Yavlenka	2,829
8		Aksu	Shalakina	Sergeevka	311
9		Novopokrovka	Shalakina	Sergeevka	1,387
10		Ostagan	Shalakina	Sergeevka	335
11		Ulgy	Jamb*i*ljskij	Presnobka	363
12		Kladbinka	Jamb*i*ljskij	Presnobka	854
13		Maibalyk	Jamb*i*ljskij	Presnobka	423
14		Kirovka	Jamb*i*ljskij	Presnobka	478
15		Novoishimsky	Tselinnuj	Novoishimsky	6,509
Subtotal					13,489
Total					**37,589**

(2) Policy on Natural Conditions

The climate of Kazakhstan is characterized as a continental climate. Average annual precipitation during past 10 years is only 315 mm at target area, so that rainfall does not seem to affect the construction schedule. A change of temperature is quite remarkable at target area. During winter season (from November to March), average temperatures reaches below freezing point. In the coldest month, January, the temperature recorded minus 40 degrees Centigrade in North Kazakhstan Oblast. Due to this severe climate, normally, construction works such as drilling or laying pipes are never carried out during winter. In accordance with the local construction custom, winter season is not recognized as the construction period.

Two types of aquifer are observed in the project area. The one is unconsolidated or consolidated sedimentary formation in the Neogene and the Quatenary. The other is granite rocks in Mesozoic and Palaeozoic era. In those granite rocks, the weathered zone and fractured zone are expected to be an aquifer. The specifications of equipment will be properly designed in consideration of such geological and hydrogeological features.

(3) Policy on Social Conditions

The Republic of Kazakhstan used to be a part of the Soviet Union. Russian products are still widespread in the republic. As for selection of equipment and materials to be procured, availability of the spare parts and compatibility of the specifications should be confirmed, giving due consideration to the future maintenance works.

(4) Policy on Construction Situation, Local Contractor and Use of Local Materials

Since the restructuring of administrative organizations in 1996, private companies implement groundwater investigation and well construction works. Their equipment is remarkably deteriorated, which affects efficiency and cost of the construction. In accordance with oblast water supply programs, RSEs need to improve their organization structure and equipment so as to complete the programs effectively and economically up to 2005.

Specifications of drilling rigs shall be determined based on structure of wells and drilling method suitable for the soil condition of the sites. As for other equipment such as vehicles, manufacturer should provide high availability of spare parts.

Construction materials of wells shall be in conformity with GOCT, which is applied throughout countries of former Soviet Union.

(5) Policy on Operation & Maintenance Works

RSEs have enough capability for operation and maintenance works by means of recruiting water supply engineer of former restructured RSEs and drilling experts from private companies.

(6) Policy on Type of Equipment

In the target villages, geological formations from Pre-cambrian to Quaternary are distributed. Therefore, the drilling method should be rotary type to drill un-consolidated to consolidated formations. In addition, the drilling rig should be top drive type to be applicable for both the mud circulation rotary method and the down-the-hole-hammer (DTH) method. The drilling rig should be truck-mounted type in consideration of access and mobility to the site.

All wheel drive type vehicle will be employed to the drilling rig mounted vehicle, supporting vehicle with crane and water tanker in consideration of the road condition to sites in rainy season.

Submersible motor pumps will be the Russian products because of its availability in the Kazakhstan. Water transmission pipes shall be Kazakhstan's products that RSEs are familiar with.

(7) Policy on Construction Method, Procurement Method and Construction Period

Drilling method should be either mud circulation rotary method or DTH method. Based on the soil condition, both the methods should be properly adopted together.

2-2-2 Basic Plan (Equipment Plan)

(1) General Plan

1) Water Demand

Water demand for domestic use and other use are respectively estimated. It is noted that demand of industry and stock farming is not included to the plan.

① Domestic use

According to the design criteria of Ministry of Health, the norms of water supply are respectively prescribed to three types of the service as follows.

Hand pump or public tap	:	30～50 l/c/d
Piped water (without bath tab)	:	125～160 l/c/d
Piped water (with bath tab)	:	160～230 l/c/d

Living conditions and service level of water supply are considerably different between neighboring communities of the capital Astana or major big cities and rural communities of collapsed sovkhoz. Ereimentau and Zholymbet are located in the suburb of Astana and are comparatively urbanized, where drinking water is supplied through individual house connection. Novoishimsky is one of major rural towns and also has distribution reticulation with individual house connections although it is out of operation. If drinking wells were developed and water intake volume was raised up, the distribution reticulation of Novoishimsky would be operated again. As for other communities, people used to obtain water from public taps transmitted by Group Waterworks.

Water demand depends on living conditions and service levels. Based on the result of site survey and discussion with RSEs, the unit water demand was estimated as follows.

Public tap	:	50 l/c/d (suburb of Ereimentau and Zholymbet)
Public tap	:	30 l/c/d (other communities)
House connection	:	60 l/c/d (Novoishimsky)
House connection	:	125 l/c/d (Ereimentau and Zholymbet)

② Other water use

Water demand for other water use such as school, hospital, commercial and public office is estimated from past practice. Demands for other water use are estimated at 20 % of water demand as to urbanized communities, namely, Ereimentau, Zholymbet and Novoishimsky, which have shops, restaurants, hospitals and so on. Demands in other 12 communities are estimated at 10 % of water demand in consideration of a few public facilities. Detail of water demand is shown below.

Table 2-4 Water Demand

No.	Community	Population	Domestic use [m^3/d]	Other use [m^3/d]	Water demand [m^3/d]
1	Ereimentau	15,000	1,200	300	1,500
2-1	Turgaisky	1,650	50	6	56
2-2	Nigini Turgaisky	160	5	1	6
3	Minskoye	796	24	3	27
4	Iskra	1,042	31	3	34
5	Zholymbet	4,952	396	99	495
6	Valikhanove	500	15	2	17
7	Korneevka	2,829	85	9	94
8	Aksu	311	9	1	10
9	Novopokrovka	1,387	42	5	47
10	Ostagan	335	10	1	11
11	Ulgy	363	11	1	12
12	Kladbinka	854	26	3	29
13	Maibalyk	423	13	1	14
14	Kirovka	478	14	2	16
15	Novoishimsky	6,509	273	68	341

2) Design Volume

① Daily maximum factor

According to the design criteria of Kazakhstan, the daily maximum factor is from 1.2 to 1.3. In the project area, people without using bath tab or water heater are more than that with bath tab. The change in temperature between summer and winter is quite remarkable. It is supposed that seasonal fluctuation of water demand is considerable. Hence, the maximum value of 1.3 is employed as the daily maximum factor.

② Leakage

RSEs are planning to rehabilitate existing distribution reticulation after the project and to reduce the leak to 20 %. In this design, although GORVODKANAL is applying the improvement plan of distribution facilities in Ereimentau, the present leakage rate of 43 % is applied assuming that it would not change until 2005.

From the water demand, the daily maximum factor and the leakage rate, design volume is calculated as follows.

Table 2-5 Design Volume

[unit: m^3/d]

No.	Community	Water demand	Daily maximum	Leakage	Design volume
1	Ereimentau	1,500	1,950	1,471	3,421
2-1	Turgaisky	56	73	18	90
2-2	Nigini Turgaisky	6	8	2	10
3	Minskoye	27	35	9	44
4	Iskra	34	44	11	55
5	Zholymbet	495	644	161	805
6	Valikhanove	17	22	6	28
7	Korneevka	94	122	31	153
8	Aksu	10	13	3	16
9	Novopokrovka	47	61	15	76
10	Ostagan	11	14	4	18
11	Ulgy	12	16	4	20
12	Kladbinka	29	38	10	48
13	Maibalyk	14	18	5	23
14	Kirovka	16	21	5	26
15	Novoishimsky	341	443	111	554

3) Water Quality

Drinking water resource is groundwater from deep wells. Water quality of deep wells is better than that of shallow wells that are contaminated by coliform and bacteria. In 1970s and 1980s of Soviet era, groundwater investigation was conducted on a large scale and drilling points for new deep wells were determined. In the course of this study, we conducted test drilling at Kladbinka, one of the target communities in North Kazakhstan Oblast so as to check the groundwater quality at the drilling point fixed (by the Soviet’s investigation) again.

Table 2-6 Drinking Water Quality Standard and the Result of Test Drilling (Kladbinka)

Item	Kazakhstan Standard [mg/l]	WHO Guideline [mg/l]	Kladbinka
Odor	2	-	Not offensive
Turbidity	1.5	5 NTU	-
Color	20.0 TCU	15 TCU	No color
Total hardness	7 – 10 mmol/l	-	5.5
PH	6.5 – 8.5	-	8.1
NH_3-N	2.0	(1.5)	0
Fe	0.3	(0.3)	0

Item	Kazakhstan Standard [mg/l]	WHO Guideline [mg/l]	Kladbinka
Mg	20.0	-	44
Mn	0.1	P 0.5 (0.1)	0
NO_3-N	45.0	50*	0
NO_2-N	3.3	P 3*	0
SO_4^{2-}	500.0	-	86
Total residue	1000.0	(1000)	677
Fluoride	1.5	1.5	-
Chloride	350.0	(250)	22
Total coliform	0 / 100 ml	0 / 100 ml	Not detective
Thermo-resistant coliform	Not detective	-	Not detective

Note) P: provisional
(figure): Levels likely to give rise to consumer complaints
*: The sum of the ratio of the concentration of each to its respective value should not exceed 1. i.e.$[NO_3^-]/50+[NO_2^-]/3 \leqq 1$

In 1970 (of the Soviet era), test drilling had been already conducted at Kladbinka. As the result of test drilling in 1970, groundwater quality of the drilling point at Kladbinka was qualified. It is confirmed that the result of this study corresponds to that of Soviet's except for magnesium value. Magnesium is regulated in neither WHO guideline nor Japan's standard. Japan's standard regulate total hardness including magnesium and calcium at 200 mg/l instead of regulating magnesium alone. As shown in the above table, total hardness is below the standard value. Groundwater of the Kladbinka is not supposed to affect human health.

It is confirmed that the results of groundwater investigation in Soviet era are still valid and water quality at drilling point would be fine.

4) Number of deep wells

Necessary number of deep wells is determined from the design volume, existing well capacity and expected safe yield per well. In accordance with SNiP 2.04.02.84 "Public Water Supply System and Structures", one stand-by well will be designed for every 12 working deep wells. Depth of deep wells is based on the result of the investigation in Soviet era.

Necessary number of deep wells is shown in Table 2-7.

Table 2-7 Number of Deep Wells (by community)

No.	Community	Design water volume	Existing well capacity	Required development	Expected safe yield per well	Depth of well	Number of well	
		[m^3/d]	[m^3/d]	[m^3/d]	[m^3/d]	[m]	Op.	
1	Ereimentau (east)		1,500		864	80	2	1
	Ereimentau (south)				562	60	1	1
					302	60	1	-
					199	60	1	-
	Subtotal	3,421	1,500	1,921	2,791	-	5	2
2	Turgaisky	90		90	130.0	60	1	1
	Nigini Turgaisky	10		10	130.0	60	1	1
	Subtotal	100		100	260.0	-	2	2
3	Minskoye	44		44	345.6	60	1	1
4	Iskra	55		55	172.8	60	1	1
5	Zholymbet	805		805	345.6	50	3	1
6	Valikhanove	28	96	0	-	70	-	1
7	Korneevka	153		153	527.0	70	1	1
8	Aksu	16		16	345.6	70	1	1
9	Novopokrovka	76		76	-	70	1	-
10	Ostagan	18		18	432.0	40	1	1
11	Ulgy	20		20	432.0	40	1	1
12	Kladbinka	48		48	259.2	70	1	1
13	Maibalyk	23		23	172.8	50	1	1
14	Kirovka	26		26	259.2	45	1	1
15	Novoishimsky	554		554	397.4	70	2	1
	Total						**22**	**16**

Table 2-8 Number of Deep Wells (by oblast)

	Akmola Oblast	North Kazakhstan Oblast	Total
Duty	12	10	22
Stand-by	8	8	16
Total	**20**	**18**	**38**

5) Specification of deep well

Specification of deep wells is designed on the basis of the structure of existing wells and of the investigation of 1970s. The presumed geological columns were made as the consequence of geophysical survey and test drilling.

The casing diameter of the wells is six inches (6") or eight inches (8") based on the yield. The existing wells in the project area are normally designed without casings and screens in the basement rocks. This may cause the problems of decrease of pumping rate due to collapsing of well. Therefore, casing and screen pipes shall be installed in all boreholes.

The drilling method adopted in this plan is as follows,

- Pilot hole with a diameter of 133mm or 150mm should be drilled.
- After checking water quality and quantity the drilling should be resumed.
- In the well where 6” casing is required, a diameter of more than 190mm will be used and, for the well where 8” casing is required, a diameter of more than 244mm will be used. If the installation of the conductor pipes is needed, the well should be drilled up to required depth with a diameter of more than 244mm.

Average drilling depth of wells is 60m and the maximum drilling depth is 120m based on the average existing well depth and the existing well data.

Materials of casing and screen pipes are steel pipes. The gravel packs are used for protection of clogging of screen. Annular space between drilling wall and screen in upper part of borehole is sealed by grout to prevent water pollution.

(2) Equipment Plan

1) Equipment and Materials

Equipment and materials to be procured are composed of; (a) drilling equipment (drilling rigs, tools, air compressor, etc.,), (b) supporting vehicles for drilling, (c) test equipment (GPS), (d) workshop equipment and (e) equipment and material for well construction (submersible pumps, pipes, etc.,).

Equipment and materials are planned in accordance with purpose of usage, quantity required and specification and quantity of existing equipment. Flowchart for selecting equipment is shown in the table below.

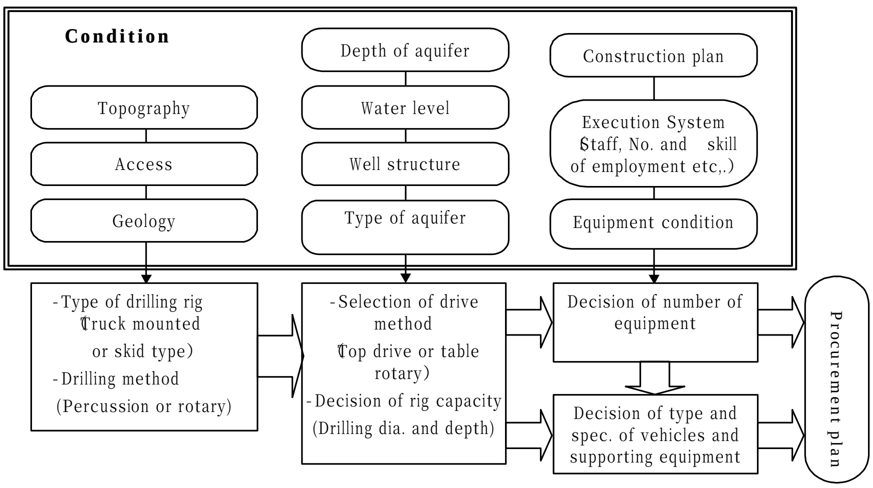

Figure 2-1 Flow Chart for Selecting Equipment

Table 2-9 Procured Equipment and Materials

No.	Equipment & Materials	Main Specification and Component	Quantity	Unit
I	Water Well Drilling Rig			
1	Truck mounted drilling rig	Type: Truck mounted Drilling method: Both D.T.H. and Mud rotary drilling Drive: Top head drive Max. drilling depth in plan: 120m Max. drilling diameter: 133mm～350mm Geology: Medium～Hard formation Truck: 4x4(P.T.O.)	2	units
2	Standard operating accessories for rig and drilling tools		2	lots
3	Truck mounted high pressure air compressor	High pressure air compressor Air delivery: ≧25.0m^3/min Pressure: ≧1.96MPa (20.0kgf/cm^2) Carrier truck Water cooled diesel engine, Max. payload: ≧7 ton, All wheels drive	2	units
4	Spare parts for above	Operating periods: 2 years	2	lots
II	Supporting vehicles			
1	Cargo truck with 3 ton crane	Engine: Water cooled diesel engine Max. payload: 5.5 t, Crane capacity: 2.9 t All wheels drive	2	units
2	Water tank truck	Engine: Water cooled diesel engine Tank capacity: ≧3,000 litter All wheels drive	2	units
3	Spare parts for above	Operating periods: 2 years	2	lots
III	Survey equipment			
1	GPS	Measuring items: Latitude, Longitude, Alutitude, Tolerance 15RMS	2	units
IV	Workshop equipment & tools		2	lots
1	Engine welder	Welding current: 30~280A(50Hz), Auxiliary power: AC10kVA, 380V	2	sets
2	Air compressor	Air delivery: ≧245 Liters/min Pressure: ≧7 kgf/cm^2	2	sets
3	Battery charger	AC input: 230V DC output: 6-12V, 18-24V	2	sets
4	Hydraulic garage jack	Capacity ≧10 ton	2	sets
5	Maintenance tools for vehicle	tire maintenance tool, electric tools, general tools, etc.,	2	sets
6	Spare parts for above	Operating periods: 2 years	2	sets
V	Equipment & materials for Well Construction(38 wells)			
1	Submersible motor pump	Total head: 75～125m Discharge rate: 70～420 Liters/min Frequency: 50Hz、Voltage: 3 phase, 380V Applicable for 6" & 8" casing Including power cable, control panel, riser pipes and standard accessories	38	sites
2	Casing and screen pipes	Casing pipe Steel pipe and threads and coupling Dia.: 6-5/8", 8-5/8"	38	sites

No.	Equipment & Materials	Main Specification and Component	Quantity	Unit
		Screen pipe Steel pipe and threads and coupling Dia.: 6-5/8”, 8-5/8” Open ratio: ≧5 % Centralizer Material: steel Applicable for 6” & 8” casing Conductor pipe Steel pipe and plane ends Dia.: 8-5/8”, 10”		
3	Transmission pipe (from well to elevated water tank or reservoir)	Material: Polyethylene pipe (PE) Max. pressure: ≧10kgf/cm^2(0.98Mpa) Including sluice valves, air release valves and fittings	38	sites

2) Necessity and basis of quantity of equipment and materials

① Equipment for drilling works

Drilling Rig

Purpose: well drilling

【Urgency】

Akmola Oblast and North Kazakhstan Oblast formulated their own water supply program under the national plan “National Development Strategy 2030”. Both the oblast water supply programs set the target year 2005 counting on the budget for Stage-I of the national plan (cf. Table 1-1). It is afraid that the completion of the project might be delayed if only one drilling rig would be procured for two oblasts to implement their programs. Hence, Water Resource Committee (WRC) strongly requested two drilling rigs so as to complete the oblast water supply programs.

【Necessity】

RSEs, executing organizations, possess no drilling rig and entrust drilling works to private drilling companies. The drilling equipment of the companies was purchased 20 years ago and was deteriorated so that the drilling schedule is prone to delay. There are a few drilling companies in an oblast, which mostly monopolize the market in the oblast. Consequently, the drilling cost is high. RSEs plan to establish the drilling department in order to shorten the drilling schedule and reduce the drilling cost.

It is noted that RSEs will continue to expand the waterworks to other rural communities after the completion of the project. There are 540 rural communities to be improved in North Kazakhstan Oblast as well as in Akmola Oblast. Drilling equipment is in high demand for future development.

【Disposition】

WRC is the administrative organization without the executing department capable to maintain the equipment and materials. Accordingly, the drilling equipment should be disposed to executing organizations in oblasts, namely RSE Esyl Su in North Kazakhstan Oblast and RSE Astana Su in Akmola Oblast. Each oblast has quite extensive area (North Kazakhstan Oblast: 98,000 km^2, Akmola Oblast: 146,000 km^2). If WRC would be equipped with a drilling rig, it would be neither effective nor economical for one organization to exercise jurisdiction over both two oblasts in aspect of the mobilization of a rig and the implementation period.

【Storage and Maintenance】

RSEs possess qualified mechanical engineers, workshops and stockyards for vehicles, construction machines, equipment for water supply, etc., enough to store and maintain the procured equipment.

As the results of the abovementioned, it is concluded that two drilling rigs are necessary in order to complete the oblast water supply program up to 2005.

Allocation : One rig for each RSE (two rigs in total)

<u>Drilling Tools and Accessories</u>

Purpose of use : Drilling works
Quantity : One set of drilling tools and accessories are necessary to each drilling rig. Two sets of tools and accessories shall be procured.

<u>Air Compressor</u>

Purpose of use : Supply of compressed air to DTH hummer, exclusion of slime, well development
Quantity : 2 compressors shall be procured because it is necessary to have one per rig.

② Vehicles

Cargo Truck with Crane

Purpose of use : Cargo Truck with Crane is for transportation of tools and materials such as tools for drilling and casing pipe.

Quantity : Two vehicles are needed because one drilling team needs at least one cargo truck for drilling works.

Water Tank Truck

Purpose of use : The water tank truck is for supply of water for drilling works such as mud circulation drilling, air drilling, DTH hammer drilling, etc.

Quantity : Two vehicles are needed because one drilling team needs at least one water tank truck for drilling works. It is possible to easily get water from nearby rivers.

③ Survey Equipment

GPS

Purpose of use : The GPS shall be used for measuring and recording the latitude, longitude and altitude of borehole points.

Quantity : 2 units shall be procured because there are 2 drilling teams.

④ Workshop Equipment and Tools

These equipment and tools shall be used for maintenance and repairing of drilling rigs. RSEs do not have these kinds of equipment and tools. Therefore, two sets of following equipment and tools shall be procured (one for each RSE).

Engine Welder

Purpose of use : Welding for repair of rigs and vehicles and also as a power supply for electric tools.

Air compressor

Purpose of use : This equipment shall be used for checking tire pressure, fixing flat tires, cleaning up engines or air elements, etc..

Hydraulic Garage Jacks

Purpose of use : This equipment shall be used for lifting up of cars, trucks for maintenance.

Battery Charger

Purpose of use : This equipment shall be used for charging car batteries such as drilling rigs and supporting vehicles.

Maintenance Tools for vehicles

Purpose of use : These tools including tire maintenance tool, electric tools, general tools etc., shall be mainly used for repair vehicles.

⑤ Equipment & materials for Well Construction

The equipment and materials shall be used for construction of 38 boreholes. Materials, purpose of use and quantity are shown in Table.

Table 2-10 Construction Materials for Deep Wells

No.	Material	Purpose of use	Quantity
V-1	Submersible motor pump including power cables, control panel, riser pipes and standard accessories	Intake of groundwater	for 38 wells
V-2	Casing pipe Screen pipes Centralizer Conductor pipe	Construction of deep well	for 38 wells
V-3	Transmission pipe including bend pipes, valves, fittings	Transmission of water from well to reservoir or elevated tank	for 38 wells

3) Specification of Main Equipment and Materials

In general a specification of drilling rig shall be decided based on geology, well structure (a diameter of casing and a drilling depth) and condition of access to the site.

Specification of water well and drilling method

A type of well structure is divided into three types as follows, in accordance with hydro-geological unit. The standard well structures of each type are shown in Figure 2-2.

Table 2-11 Types of Deep Well

Type	Dia. of casing pipe (mm)	Drilling depth (m)	Max. drilling depth (m)	Hydro-geological unit
Type A	219	70	120	Tertiary～Quaternary Unconsolidated sediments Semi-consolidated sediments
Type B	168	50～60	120	Mesozoic～Pre-Cambrian Consolidated sediments, Plutonic rocks
Type C	219	80	120	Mesozoic～Pre-Cambrian Consolidated sediments

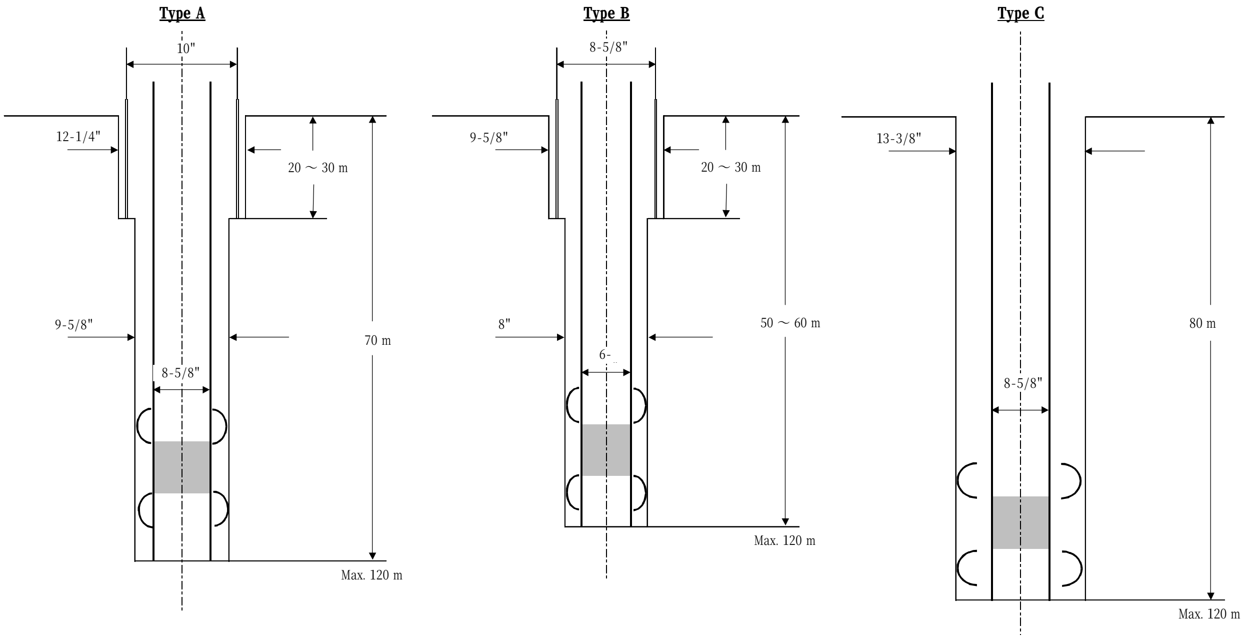

Figure 2-2 Typical Structure of Deep Well

The drilling methods and drilling procedure for these three types of water well are shown in Table 2-12.

Table 2-12 Drilling Method

	Type A	Type B	Type C
Drilling method	Mud circulation method	Down-the-Hole-Hammer method	Mud circulation method
Drilling procedure	1st step: Drill a pilot borehole up to a designated depth with a drilling dia. of 5-1/8”(130.2mm) or 5-7/8”(149.2mm) by using water instead of bentonite. Then the electrical logging will be carried out for temporary casing and screen. After installation screen pipes a pumping test by air lifting and water quality analysis will be carried out to confirm water quality and yield of aquifer. If no problem, proceed next step.	1st step: Drill a pilot borehole up to a designated depth with a drilling dia. of 6”(152mm). Then the electrical logging will be carried out for temporary casing and screen. After installation screen pipes a pumping test by air lifting and water quality analysis will be carried out to confirm water quality and yield of aquifer. If no problem, proceed next step.	1st step: Drill a pilot borehole up to a designated depth with a drilling dia. of 5-1/8”(130.2mm) by using water instead of bentonite. Then the electrical logging will be carried out for temporary casing and screen. After installation screen pipes a pumping test by air lifting and water quality analysis will be carried out to confirm water quality and yield of aquifer. If no problem, proceed next step.
	2nd step Ream the borehole up to a planned depth with a tri-cone bit of a dia. of 9-5/8”(244.5mm) by using mud circulation method.	2nd step Ream the borehole up to a designated depth with a hammer button bit of a dia. of 8”(203mm) by using mud circulation method.	2nd step Ream the borehole up to a designated depth with a tri-cone bit of a dia. of 7-5/8” (193.7mm) by using mud circulation method.
	3rd step Ream the borehole up to a depth of 20 – 30m from the surface with a tri-cone bit, a dia. of 12-1/4”(311.2mm) for installation of conductor pipes. After installation of conductor pipes installation of casing & screen pipes, gravel packing, grouting, and development works will be carried out for completion of the production well.	3rd step Ream the borehole up to a depth of 20 – 30m from the surface with a tri-cone bit, a dia. of 9-5/8”(244.5mm) for installation of conductor pipes. After installation of conductor pipes installation of casing & screen pipes, gravel packing, grouting, and development works will be carried out for completion of the production well.	3rd step Ream the borehole up to a designated depth with a tri-cone bit of a dia. of 13-3/8” (350.0mm). After reaming installation of casing & screen pipes, gravel packing, grouting, and development works will be carried out for completion of the production well.

① Drilling rig

Type of drilling rig

Taking account into topographical condition of the objective area and access road to the objective community, a type of drilling rig shall be a whole wheel drive truck mounted which has advantage in the mobilization and demobilization.

Drilling method (Cable tool percussion or rotary)

The drilling method will be divided into two major methods. The one is a cable tool percussion method which drills a well by up and down of a bit and its weight. The other is a rotary method which drills a borehole by rotation of a bit. In this plan the rotary method shall be adopted because the rotary method will be able to apply for both sediments and rocks.

Drive type (top-drive type and rotary table type)

The drive type will be divided into a top-head drive type and a rotary table type. The top-head drive type rotates a bit by power swivel. The rotary table type drives a bit through kelly rods. In this plan the top-head drive method shall be adopted because this method will be most applicable for drilling of the planned well in the area. The comparison between a top-head drive and a rotary table is shown in Table 2-13.

Table 2-13 Types of Drilling Rig (top-drive type and rotary table type)

	Item	Top-head drive type	Rotary table type
1.	Power transmission	Hydraulic	Mechanical
2.	Drive method	Power swivel	Kelly rods
3.	Control	Easy to control	Skill is needed.
4.	Install and remove of drill pipes	Easy with torque control and up-down of power swivel	Take time due to removing of kelly rods
5.	Bit rotation	Possible to get appropriate rotation for each geology by hydraulic system	Difficult to get appropriate rotation for each geology due to mechanical system
6.	Working condition at a well pit	Easy to work by up-down of power swivel	Working space is not enough to work due to a nearby rotary table
7.	Pull-down	Possible effective and speedy drilling because of pull-down by hydraulic system	In case a drilling depth is shallow drilling efficiency is low due to no pull-down
8.	Torque control	Easy to get smooth drilling and to change drill pipes by hydraulic system	Not possible to control torque due to mechanical system. In case of accident in the well restoration woks will be difficult.
9.	Down-the-hole hammer drilling(DTH)	More applicable for DTH because of easy control both bit rotation and thrust power by hydraulic system	Not applicable for DTH because of difficult control both bit rotation and thrust power by mechanical system
10.	General characteristics	Applicable for drilling of medium size of diameter and of medium depth of boreholes	More applicable for drilling of large size of diameter and of big depth of boreholes
11.	Applicable drilling method	Applicable for both mud circulation drilling and DTH drilling	More applicable for mud circulation drilling than DTH

② Truck mounted air compressor

A capacity of air compressor will be generally decided by necessary air pressure for crush rocks and by necessary air volume for smooth discharging of slime. These necessary air pressure and necessary air volume will be calculated as follows;

<u>Calculation of necessary air pressure</u>

Necessary pressure of the air compressor is calculated by the lowest operation pressure of a hammer and water head in the borehole.

A standard of the lowest operation pressure is 10.5kgf/cm^2 in the high pressure hammer with a diameter of upto 8” which are produced by European, American and Japanese manufacturers. Adding a water head pressure of 10.3kgf/cm^2 （a maximum drilling depth of 120m minus an average water level of 17 m equal to 103 m） to this lowest operation pressure necessary pressure of the air compressor comes 20.8kgf/cm^2.

On the other hand manufacturer who produces the high pressure air compressor with a capacity of more than 20kgf/cm^2 is very limited. And it is practical to carry out drilling works by using a high pressure air compressor with a capacity of 20kgf/cm^2. Therefore in this plan the necessary pressure of the air compressor shall be 20kgf/cm^2.

<u>Calculation of necessary air volume</u>

Necessary air volume of the air compressor is calculated by the following formula.

$$Q = A \cdot V$$
$$A = 1/4 \times \pi \times (D^2 - d^2)$$

Q : Necessary air volume (m^3/min)
A : Annular space area between the drill pipe and the wall of the borehole (m^2)
D : Borehole diameter (m)
d : Outer diameter of drill pipe (m)
V : Flow velocity in the space between the drill pipe and the wall of the borehole. It is generally from 1,200 to 1,500m/min.

In case borehole diameter = 0.203m(8"), outer diameter of drill pipe = 0.12m (4-3/4"), V = 1,200m/min, necessary air volume is as follows:

$$Q = 1/4 \times \pi \times (0.203^2 - 0.12^2) \times 1{,}200 = 25.25\ m^3/min$$

Therefore, the capacity of the air compressor procured in this plan shall be necessary air pressure of more than 20kgf/cm^2 and be necessary air volume of more than 25 m^3/min.

<u>Carrier truck</u>

All air compressor equipment weighs about 6.5 tons. Since it is necessary to load about two (about 500 kg) drums of fuels, therefore, the amount of loading in the carrier truck for the air compressor will be 7 tons. The truck will be a whole wheel-drive type as it is necessary to run on unpaved roads to the site.

③ Cargo truck with crane

<u>Driving form</u>

Driving form of the vehicle procured for this project will be a whole wheel-drive type in consideration of access road condition to the community and running in winter season.

<u>Load capacity</u>

The loading capacity is decided contingent on transporting the main equipment necessary to drill boreholes with average depth of 60 m (Max. 120 m) scheduled in this project. The weight of the main equipment necessary for constructing the borehole such as drill pipes, drilling bits etc., is about 9 tons in total. (Details of equipment and tools are shown in Appendix.)

The weight will become about 10 tons or more because it is necessary to transport fishing tools, welding materials, wires, tools etc., besides the main equipment to the site at the same time. There is a cargo truck which has a capacity to transport these equipment and materials at once. But the truck size is too large to carry for drilling works.

Actually, it is possible to transport separately these equipment and materials, divided into two portions. Therefore, the loading capacity in the truck with the crane procured for this project will be 5 tons.

Crane capacity

The heaviest one of the above-mentioned equipment is a 8" drill collar, weight 1,348 kg. It is important that the crane has the ability to safely load and unload that equipment weight at the limited working space. Moreover, it is necessary to consider the size of the truck with the crane. The size of the crane procured for this project will be 2.9 ton or more from the above-mentioned view points.

④ Water Tanker

Driving form

Driving form of the vehicle procured for this project will be a whole wheel-drive type in consideration of access road condition to the community and running in winter season. The eigine type shall be a water cooled diesel engine.

Tank capacity

The necessary tank capacity of the water tank truck shall be more than 3.0 m^3 because the volume of mud pit necessary to drill a borehole of Type C with the largest drilling diameter by mud circulation is calculated at about 2.2 m^3.

⑤ Submersible Pump

Material

Shuft : Stainless steel
Impellor : Reinforced phenol plastic
Casing : Stainless steel

Diameter

Submersible pumps should be set up in the casing pipes of 6" or 8".

Motor

Motor output (β)is calculated by the formula below.

$$\beta = (0.163x(Q \times H)/\ \eta) \times 1.15$$

β : Motor output (kW)
Q : Discharge volume (equal to design water volume of the communities)

H : Head
(Head is equal to the difference between L.W.L. of well to H.W.L. of elevated tanks plus friction loss of water transmission pipeline.)
η : Efficiency (80 %)
1.15: Generator efficiency

Specification of pump for each target community is shown in Table 2-14.

Control Pannel and Cable

The pumps can be operated by manual control at the site. However, the system should be equipped which will stop automatically, when water level reaches at L.W.L.

Control pannel shall be wall-mounted steel pannel. Cables shall have the length between a pomp motor and a control pannel with proper diameter to motor output and shall be in conformity with the standard "GOCT".

Table 2-14 Specification of Pumps

No.	Village	Pump Planning				Total Head	Pump Capacity	Motor
		Capacity./unit		Number of pump				
		[m^3/h]	[m^3/d]	Duty	Standby	[m]	[m^3/h]	kW
1	Ereimentau (east)	20	480	2	1	76.2	20	8
	Ereimentau (south)	25	600	1	1	93.6	25	11
		16	384	1	-	93.6	16	8
		10	240	1	-	93.6	10	8
	Total	51	1,224	3	2	-	-	-
2	Turgaisky	4	96	1	1	51.3	4	2.8
	Nigini Turgaisky	4	96	1	1	68.1	4	2.8
	Total	8	192	2	2	-	-	-
3	Minskoye	4	96	1	1	51.4	4	2.8
4	Iskra	4	96	1	1	84.5	4	2.8
5	Zholymbet	16	384	3	1	70.1	16	5.5
6	Valikhanove	4	96	-	1	69.0	4	2.8
7	Korneevka	6.3	151	1	1	92.2	6.3	2.8
8	Aksu	4	96	1	1	69.7	4	2.8
9	Novopokrovka	4	96	1	-	68.7	4	2.8
10	Ostagan	4	96	1	1	95.0	4	2.8
11	Ulgy	4	96	1	1	77.5	4	2.8
12	Kladbinka	4	96	1	1	61.6	4	2.8
13	Maibalyk	4	96	1	1	57.7	4	2.8
14	Kirovka	4	96	1	1	58.7	4	2.8
15	Novoishimsky	16	384	2	1	92.2	16	8.0

⑥ Water Transmission Pipe

Pipes shall be procured for water transmission pipeline from a well to a elavated tank or a reservoir. Necessary fittings such as bend pipes, sluice valves, etc., shall be included.

Material of pipes shall be polyethylene (PE). Sluice valve shall be made of cast iron. Fittings to connect PE pipes and cast iron valve will be included.

Hazen-Williams formula is adopted to design the diameter of pipe. The results of calculation is shown in Table 2-15.

Table 2-15 Diameter and Length of Transmission Pipe

No.	Village	Flow (Q)	Design Diameter	Coefficient of Flow	Pipe Length	Hydraulic gradient (I)	Velocity	Friction loss
		[m^3/sec]	[mm]		[m]	(1/1000)	[m/sec]	[m]
1	Ereimentau (east)	0.01111	160	110	3139.2	8.6719	0.8	27.2
	Ereimentau (south)	0.01416	225	110	3321.6	8.5620	0.5	8.6
2	Turgaisky	0.00111	63	110	200	11.5580	0.5	2.3
	Nigini Turgaisky	0.00111	63	110	442.8	11.5580	0.5	5.1
3	Minskoye	0.00111	63	110	2730	11.5580	0.5	31.6
4	Iskra	0.00111	110	110	2460	0.7553	0.2	1.9
5	Zholymbet	0.01333	225	110	5589.6	2.3051	0.5	12.9
6	Valikhanove	0.00111	90	110	3540	1.6988	0.2	6.0
7	Korneevka	0.00175	90	110	11220	3.9439	0.4	44.3
8	Aksu	0.00111	63	110	1860	11.5580	0.5	21.5
9	Novopokrovka	0.00111	90	110	10440	1.6988	0.2	17.7
10	Ostagan	0.00111	63	110	4050	11.5580	0.5	46.8
11	Ulgy	0.00111	63	110	2400	11.5580	0.5	27.7
12	Kladbinka	0.00111	90	110	5070	1.6988	0.2	8.6
13	Maibalyk	0.00111	90	110	6990	1.6988	0.2	11.9
14	Kirovka	0.00111	90	110	5730	1.6988	0.2	9.7
15	Novoishimsky	0.00889	225	110	6600	1.0895	0.3	7.2

(3) Procurement Source of Main Equipment and Materials

The main equipment and materials are procured from the following procurement sources.

Well drilling rig and air compressor shall be procured from Japan in consideration of reasons below.

- Both of equipment are not manufactured in Kazakhstan.
- The Russian products are not satisfied with required specification.
- The European products price is very similar to Japanese, however, easiness of procurement is behind.
- The Japanese products are more reliable in quality and delivery terms than Russian products.

The workshop equipment for the maintenance of well drilling rigs is also procured from Japan.

Supporting vehicle and submersible pump shall be procured from the third country, because Russian products are common in Kazakhstan and the after-sales services is available.

Construction materials such as casing pipe, screen pipe and transmission pipe shall be procured from Kazakhstan.

Table 2-16 Procurement Source of Equipment and Materials

Equipment and materials	Procurement source	Reason
Well Drilling Rig and related Equipment and Materials (Truck mounted type)	Japan	• It is not manufactured in Kazakhstan. • The Russian products are not satisfied with required specification. • The Japanese products are more reliable in quality, delivery terms and easiness of procurement than Russian and European products.
High pressure air compressor (Truck mounted type)	Japan	• It is not manufactured in Kazakhstan. • The Russian products are not satisfied with required specification. • The Japanese products are more reliable in quality and delivery terms than Russian products.
Supporting Vehicles (Cargo truck with crane and Water tank truck)	Third countries	• The Russian vehicles are common in Kazakhstan. • The procurement will be made through an agency from whom the spare parts can be easily procured, and the system of after-sales service is well established. • Operation and maintenance are easy in workshop of Esyl Su and Asutana Su.
Workshop Equipment	Japan	• This workshop equipment shall be procured from Japan since the equipment will be used for maintenance of Japanese drilling rigs.
Submersible motor pump	Third countries	• Although it is manufactured in Kazakhstan, it is possible to procure only one type with a capacity of 4.5 kw. • Procurement will be made through a local agency that will take care of after-sales services.
Casing and Screen Pipes	Local	• Although there is no circulation in local market, it is possible to procure it from a local drilling contractor.
Transmission Pipes etc.,	Local	• Pipes and fittings are manufactured and procured easily in Kazakhstan.