a) Presently, appropriate land for the reservoir has not been found in the relevant area. Also, local persons concerned are of the opinion that there is no land for a reservoir.

b) To reduce the high turbidity of the Amudarya river it is necessary to install a vast sedimentation basin beside the storage or to build the reservoir in the flow of the Amudarya river.

c) Groundwater of high salinity exists in the area where the reservoir is to be constructed. It is highly likely that it will pollute the stored water in the reservoir. Even if the land is prepared, costs will be incurred for preventing groundwater from infiltrating the reservoir.

d) The discharge rate of Amudarya river at the reservoir is not appropriate for storage especially during the summer season according to local persons concerned.

e) It is difficult to obtain water rights for the water to be stored.

8.2.4 Comparison of Alternatives

(1) Cost Comparison

To select the most appropriate Alternative from the four Alternatives, costs are compared. Total construction cost and operation and maintenance cost (O&M cost) are considered.

1) Conditions for cost estimation

i) General Conditions

- The exchange rate for the Uzbekistan Sum is taken as 40 Sum to 1 US dollar (as of July 1996).
- Costs are calculated taking 1996 prices.
- Facilities common to the four Alternatives are excluded and the O&M costs of the facilities are neglected. Consequently, only costs of water supply system for Karakalpakstan are compared.

ii) Construction costs

- For prices for equipment, machines and materials not procured in the Uzbekistan, the prices in Japan, Korea, China, etc. are used.
- Local rates and prices in Uzbekistan are used for estimation of labor, materials etc. procured in the Uzbekistan.
- Since the intake pumping station at the Kaparas reservoir and the raw water main up to each treatment plant in Tuyamuyun are common to all Alternatives, the total cost is divided in proportion to the treated quantity at each treatment plant in Tuyamuyun.

iii) O&M cost

- Future O&M costs after implementation of the project are estimated based on the existing O&M costs.
- For the unit electricity cost, 1.6 Sum/kWh (as of 1996) is used.

2) Total Construction Costs

Table 8.12 shows the total construction costs for each Alternative. Alternative 2 is the most economical Alternative. The construction cost for Alternative 3.1 is high because costs for construction of the RO plant and installation of two way distribution network in the whole KKP left bank block are high. However, the difference in the costs is so small that comparison of total construction costs cannot be a decisive factor in the selection.

Table 8.12 Comparison of Total Construction Costs

(unit: million US$)

Description	Alternative			
	1	2	3-1	4-1
Construction Costs	409.0	382.1	456.5	404.8

3) Operation and Maintenance Costs in 2010

Table 8.13 shows the O&M costs in 2010 for each Alternative. The costs for Alternatives 1 and 2 are high because electricity charges for water-transmission pumps are high. The lowest maintenance cost is for Alternative 4-1.

Table 8.13 Comparison of Operation and Maintenance Costs in 2010

(unit: million US$/year)

Description	Alternative			
	1	2	3-1	4-1
O&M costs	23.7	23.1	20.1	19.6

4) Net Present Value

In this part, the costs are compared by the Net Present Value Method, by which both construction and O&M costs can be compared simultaneously. The assumed conditions are shown below.

- **Implementation Schedule**

  For cash flow of costs by year, it is assumed that 70% of the total construction cost is equally distributed over a period of five years from 1998 to 2002 and the remaining 30% of the cost is equally distributed over a period of five years from 2003 to 2007. The first period of five years is the period of large-scale investments for improving the water supply systems radically, while the next four-year period is the period for the expansion of new and improved water supply systems to meet the future water demand.

- **O&M cost**

  O&M costs are estimated form 2001 to 2025 taking 25 years as project life
  The O&M cost for each year is estimated based on the O&M cost in 2010 and the annual water demands for each year.

Table 8.14 shows the calculated results of present value of total cost at discount rates of 3%, 5%, 10% and 15%. The same result was obtained for all discount rates, which indicated that the net present value for Alternative 4.1 is the lowest. However, the difference in the net present values is so small that comparison of the net present values cannot be a decisive factor in the selection.

Table 8.14 Comparison of Net Present Value of Total Cost by Discount Rate

(unit : million USD)

	Alternative 1			Alternative 2			Alternative 3-1			Alternative 4-1		
Year	Const. cost	O&M cost	Total cost	Const. cost	O&M cost	Total cost	Const. cost	O&M cost	Total cost	Const. cost	O&M cost	Total cost
1996												
1997												
1998	62.9		62.9	58.8		58.8	66.4		66.4	59.2		59.2
1999	62.9		62.9	58.8		58.8	66.4		66.4	59.2		59.2
2000	62.9		62.9	58.8		58.8	66.4		66.4	59.2		59.2
2001	62.9	15.8	78.8	58.8	15.5	74.2	66.4	13.4	79.8	59.2	13.1	72.3
2002	62.9	16.6	79.5	58.8	16.2	75.0	66.4	14.1	80.5	59.2	13.8	72.9
2003	27.0	17.3	44.3	25.2	16.9	42.1	28.5	14.7	43.2	25.4	14.4	39.7
2004	27.0	18.1	45.1	25.2	17.7	42.9	28.5	15.4	43.8	25.4	15.0	40.4
2005	27.0	18.8	45.8	25.2	18.4	43.6	28.5	16.0	44.4	25.4	15.6	41.0
2006	27.0	19.8	46.8	25.2	19.3	44.5	28.5	16.8	45.3	25.4	16.4	41.8
2007	27.0	20.8	47.8	25.2	20.3	45.5	28.5	17.6	46.1	25.4	17.2	42.6
2008		21.8	21.8		21.2	21.2		18.5	18.5		18.0	18.0
2009		22.7	22.7		22.2	22.2		19.3	19.3		18.8	18.8
2010		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2011		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2012		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2013		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2014		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2015		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2016		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2017		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2018		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2019		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2020		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2021		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2022		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2023		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2024		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
2025		23.7	23.7		23.1	23.1		20.1	20.1		19.6	19.6
Total	449.5	551.2	1,000.7	419.9	537.8	957.7	474.3	467.6	941.9	422.6	456.6	879.2
	Discount Rate		NPV	Discount Rate		NPV	Discount Rate		NPV	Discount Rate		NPV
	3%		738.5	3%		704.1	3%		708.1	3%		655.9
	5%		622.6	5%		592.3	5%		603.4	5%		556.4
	10%		441.4	10%		418.1	10%		437.0	10%		399.4
	15%		339.8	15%		320.9	15%		341.2	15%		310.1

(2) Non-Cost Comparison

A comparison of costs for the Alternatives would be the main method for selecting the optimum Alternative. However, Alternatives must be considered from factors other than costs, particularly when costs do not differ significantly. The factors to be considered are as follows:

- difficulty in maintenance and operation
- appropriateness of technology adopted
- Flexibility in an emergency
- Convenience of consumer

1) Difficulties in Maintenance and Operation

Difficulties in maintenance and operation for the Alternatives in Karakalpakstan are summarized in Table 8.15. The Alternative for Khorezm is not considered here because only one water supply system is proposed. Among the proposed facilities, the RO plant is the most difficult to maintain and operate properly. In addition, it needs specific spare parts and equipment, not available in Uzbekistan. Considering the existing state of the Study Area, RO plant is not recommended especially when large capacities are to be handled.

Table 8.15 Features of Maintenance and Operation for Alternatives in Karakalpakstan

Alt.	No. of major treatment plants	No. of pump stations	No. of RO plants	Features
1	1	6	0	With many large-lift pumps, maintenance and operation of the pumping station are troublesome; but where RO plants do not exist, this Alternative is preferable compared to Alternatives 2, 3-1, and 4. The treatment plant will be at one location in KKP enabling centralized control, which makes maintenance and operation easy.
2	1	5	1	With many large-lift pumps, maintenance and operation of the pumping plants are troublesome; in addition, maintenance and operation of RO plant in Muynak are cumbersome.
3.1	2	3	2	Since pumping stations are reduced to three, maintenance and operation are easier compared to Alternatives 1 and 2. However, the number of RO plants increases to two making maintenance, operation and management very difficult. In addition, the distribution of water treated in RO plant is very troublesome.
4.1	3	2	2	The number of treatment plants increases to three in addition to two RO plants, therefore, maintenance and operation are very troublesome. In addition, the distribution of water treated in RO plants is very troublesome.

A major question is whether maintenance and operation of the RO plant and its supply of treated water are possible or not. If the maintenance and operation of the RO plant are inadequate, the performance of the plant degrades steeply, and maintenance cost rises sharply. Procurement of spare parts that cannot be acquired within the country at high cost may become necessary, and whether such parts can be acquired or not considering availability of funds, needs to be confirmed. However, considering that the RO plant (capacity of 2,400 m^3/day) currently installed in Takhtakupyr, is operating for only five to six hours a day because of a shortage of chemicals, erection of a large-scale RO plant is difficult. If such a plant is erected, follow-up of maintenance and operation of the plant would probably become necessary.

2) Flexibility in an emergency

The ease or difficulty in responding to an emergency indicates the flexibility of the water supply system when the treatment plant stops because of an accident. In principle, the damage is less in Alternative 4, in which the water treatment facilities are dispersed. There is a risk, if the drinking water supply of the entire area depends on only one water supply system which extends to approximately 450 kilometers from Tuyamuyun to Muynak. Operation of standby treatment plants using local water sources in each region has to be considered as a countermeasure in an emergency. In addition, it is necessary to continuously operate the existing local water treatment plants in case water demand in summer increases unexpectedly.

3) Convenience of consumers

The water treated by the RO plant is distributed to consumers by the method of distribution which does not have individual house connections. From the consumer is viewpoint, this method is very inconvenient. For all consumers, a house connection is very convenient. Alternative 1 is preferable for all consumers.

8.3 Selected Water Supply System

The Study Team selected the optimum Alternative based on the results of the comparison described above, and after holding a series of the discussions with the concerned Uzbeki personnel.

Alternative 1 is selected as the optimum water supply system for the Study Area from the considerations below.

i) Total construction cost, present value of total cost including construction cost and operation and maintenance cost do not show appreciable differences; cost is not a decisive factor in the selection.

ii) Maintenance and operation of the water system are easy and distribution method is very convenient for the consumers. The water distribution method as well as the RO plan in KKP Left is very complicated and troublesome because the water from RO plant must be supplied to many cities and some rural locations dispersed over a vast area. Also, this distribution method is not considered to be a long term measure for large cities like Kungrad. Consequently, Alternatives 3-1 and 4-1 are not recommended.

iii) Many water supply facilities have already been constructed, or are under construction and machines and equipment have been procured ready for Alternative 1, which is similar to the water supply system of Uzbeki Water Supply Master Plan.

Although Alternative 1 is selected, there are some difficulties such as poor flexibility in an emergency. There is a risk, if the drinking water supply of the entire area depends on only one water supply system which extends to approximately 450 kilometers from

Tuyamuyun to Muynak. Operation of standby treatment plants using local water sources in each region has to be considered as a countermeasure in an emergency.

As stated above, Alternative I was selected as the optimum inter-regional water supply system for the Study Area. Once the inter-regional water supply system is selected, the regional water supply system of Vodokanal can be readily envisaged. Based on this Alternative, engineering design, project cost and implementation plan for both systems are proposed in the following sections.

8.4 Plan for Inter-Regional Water Supply System (Tuyamuyun System)

8.4.1 General

As stated in the previous section, the Tuyamuyun systems sells treated water by delivering it through the water trunk main to Vodokanal and Agro-Vodokanal, which supply the water to the residents of the area. Tuyamuyun-Nukus and Tuyamuyun-Urgench systems cover Karakalpakstan and Khorezm including the Amudarya region of Karakalpakstan respectively. The improvement plan for water supply is envisaged based on these two inter-regional systems- Tuyamuyun Nukus WSS and Tuyamuyun Urgench WSS. The outline of the selected water supply system is described as below.

i) Water Source : Kaparas Reservoir and local water sources with a small capacity
ii) Major Treatment Plant : Existing and expanded Tuyamuyun-Nukus WTP and Tuyamuyun-Urgench WTP
iii) Water Transmission System : Tuyamuyun - Nukus Transmission System and Tuyamuyun - Urgench Transmission System

The planned water supply facilities in 2010 is summarized in Table 8.31.

8.4.2 Expansion Capacity of Tuyamuyun Water Treatment Plants

(1) Future Water Demand and Supply Capacity

Table 8.16 shows the water demand in the future for the Tuyamuyun systems and Table 8.17 shows the capacity of the existing water treatment plants, including the local plants of Vodokanal and Agro-Vodokanal.

Table 8.16 Future Water Demand for Tuyamuyun System

(unit: thousand m³/day)

Water supply	1995		2000		2005		2010	
	Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.
Tuyamuyun-Nukus	233.4	268.5	304.0	349.6	379.6	436.6	477.5	549.2
Tuyamuyun-Urgench	279.4	321.2	322.2	370.5	409.6	471.2	484.5	557.2

Ave. : average daily water demand, Max.: daily maximum water demand

Table 8.17 Capacity of Existing Water Treatment Plants

(unit : thousand m³/day)

Water supply	Actual capacity	Present operative capacity	Actual capacity used in future
T-Nukus system			
Tuyamuyun	170.0	140.0	170.0
V.K and A.V.K	157.5 (Vodokanal)	135.1	98.0
total	-	275.1	268
T-Urgench system			
Tuyamuyun	180.0	180.0	180.0
V.K and A.V.K	-	69.1	55.0
total	-	249.1	235.0

V.K : Vodokanal, A.V.K : Agro-Vodokanal
excluding capacity of water treatment plants of UzTransGas

(2) Future Expansion Capacity

Expansion capacity of the water treatment plants in future shall be decided to suit the increasing demand in future As stated in the previous section, additional expansion capacity of Vodokanal was planned as below:

(Area covered by Tuyamuyun-Nukus system)
a) Nukus water treatment plant with a capacity of 30,000 m³ /day
(Area covered by Tuyamuyun-Urgench system)
b) Urgench water treatment plant with a capacity of 45,000 m³/day
c) Chalish wells with a capacity of 20,000 m³/day

Based on the above figures, the total required capacity of Tuyamuyun water treatment plants in the target year 2010 is planned as shown in Table 8.18. A capacity of 500 ths. m³/day each will be required for the Tuyamuyun water treatment plants in 2010.

Table 8.18 Future Expansion of Water Treatment Plant in 2010

(unit : thousand m^3/day)

Covered area	Total daily maximum demand (a)	Capacity of local (Vodokanal) WTP			Capacity of Tuyamuyun WTP		
		Existing max. daily cap. used in future (b)	Additional max. daily cap. (c)	total cap. (d = b + c)	Required cap. (e = a - d)	capacity incl. water use in WTP (f=1.1 x e)	Design cap. (g)
T-Nukus System	549.2	98.0	30.0	128.0	421.2	463.3	500.0
T- Urgench System	557.2	55.0	65.0	120.0	437.2	481.0	500.0

8.4.3 New Water Sources (Kaparas reservoir)

The existing water sources of Tuyamuyun systems are canals drawn from the Tuyamuyun Bed reservoir. In this improvement plan, the water source of both Tuyamuyun systems is changed from canals to the Kaparas reservoir. During the months of June, July and August when good-quality water is available at the Kaparas reservoir, water is stored in the reservoir to satisfy the annual total water demand of Karakalpakstan and Khorezm. The existing water sources of Tuyamuyun system are used as standby sources in an emergency.

On the other hand, some existing water sources of Vodokanal and Agro-Vodokanal (hereafter called "local water source") will continue to be used in future.

Table 8.19 shows the annual water quantity to be stored in the Kaparas reservoir for the Tuyamuyun water treatment plants, together with the quantity of local water sources for water treatment plants of Vodokanal. The annual water quantity required for sources is calculated as 1.1 times the annual water demand for the area covered by the water treatment plants, including the water quantity used in the water treatment plant.

Table 8.19 Required Annual Water Quantity in 2010 by Source

(unit : million m^3/year)

Description	All water sources	Kaparas reservoir	Local water source	
			Karakalpakstan	Khorezm
Water quantity	387	300	45	42

including water quantity used in treatment plant

In addition to this quantity, losses such as infiltration and evaporation at the reservoir should be accounted for in the storage capacity.

According to the table, at least 300 million m^3 per year of water should be stored at the Kaparas reservoir in 2010 so that water can be supplied to the regions. The concerned Uzbek authorities should operate the Tuyamuyun hydro-system including Kaparas reservoir properly and store the required water quantity during the flood season, when the quality of river water is good.

The natural depression for the reservoir has been prepared and construction of the control gate structure is complete. The water drawn from Ruslovoye reservoir is being stored in the Kaparas reservoir. However, good quality water has not been stored because intake facilities of the Tuyamuyun system are not yet ready.

8.4.4 Intake Facilities

The planned intake facilities are: Kaparas intake pumping station (Kaparas pumping station) and raw water mains to Tuyamuyun-Nukus and Tuyamuyun-Urgench water treatment plants.

Table 8.20 shows the daily maximum intake water quantity, which is calculated as 1.1 times the daily maximum water demand including the water used for treatment plants.

Note: 1.1 times the max. daily water demand may not be necessary for wells.

Table 8.20 Daily maximum Intake Water Quantity in 2010

(unit : thousand m^3/day)

Covered area	Daily maximum supply capacity			Intake water quantity		
	total	Tuyamuyun	Local	total	Tuyamuyun	Local
T-Nukus	549.2	421.2	128	604.1	463.3	140.8
T-Urgench	557.2	437.2	120	612.9	480.9	132.0
total	1,106.4	858.4	248	1,217.0	944.2	272.8

1) Kaparas pumping station

The transmission capacity of Kaparas pumping station is based on the daily maximum intake quantity in 2010 of 944.2 thousand m^3/day.
The capacity of the pumping station is decided in the water supply master plan of Uzbekistan as given below:

- Total delivery capacity : 1,350 ths. m^3/day
- Capacity at first stage : 690 ths. m^3/day
- Total water head : 63 m
- Number of pumps : 6 sets including 2 standby
- Minimum water level : 116 m

The pumping station is presently under construction. Part of the station has been completed and pumps, electric equipment, etc., are ready for installation. Four sets of pumps with a total capacity of approximately 1,350 thousand m^3/day have been purchased already. This capacity is sufficient for delivering the required quantity of raw water in 2010 to the Tuyamuyun water treatment plants.

However, construction has almost stopped because of the lack of funds. The pumping station will be completed during this project.

2) Raw water mains

The delivery capacity of raw water mains from the Kaparas pumping station to each Tuyamuyun water treatment plant is based on the daily maximum intake quantity in 2010 of 944.2 thousand m^3/day.

The existing water intake facilities of the two Tuyamuyun water treatment plants are located between each plant and the Kaparas pumping station. Therefore, the existing raw water mains can be used effectively in future. Table 8.21 shows the dimensions of these existing raw water mains.

Table 8.21 Dimension of Existing Raw Water Main

Raw water main pipeline	Diameter (mm)	Length (m)	Number	Total Length (m)
T-N WTP to intake PS	1,200	1,540	2	3,080
T-U WTP to intake PS	1,200	8,250	1	
	1,400	8,250	1	16,500

Hydraulic analysis of water mains showed that two pipelines each with diameter 1400 mm for the Tuyamuyun-Nukus water treatment plant or for the Tuyamuyun-Urgench water treatment plant are necessary. Table 8.22, figure 8.8 and figure 8.9 show the planned raw water mains from the Kaparas pumping station to each existing intake pumping station.

Table 8.22 Planned Raw Water Main from Kaparas Intake Pumping Station to Existing Intake Pumping Stations

Raw water main pipeline	Delivery capacity (ths. m³/day)	Specification				Remarks
		Diameter (mm)	Length (m)	Number	Total Length (m)	
to existing intake PS of T-N WTP	463.3	1,400	10,700	2	21,400	Amudarya river and left bank canal crossing
to existing intake PS of T-U WTP	480.9	1,400	9,000	2	18,000	Left bank canal crossing
total	944.2	-	-	4	39,400	

At present one line of dia. 1,400 mm, which will be connected to the existing water mains of Tuyamuyun-Urgench water treatment plant at the existing intake pumping station, is under construction and is scheduled for completion by the end of 1996.

8.4.5 Water Treatment Plant

Presently there are two Tuyamuyun water treatment plants: Tuyamuyun-Nukus plant with a design capacity of 200 thousand m³/day and a distribution capacity of 170 thousand m³/day, and Tuyamuyun-Urgench plant with a design capacity of 200 thousand m³/day and a distribution capacity of 180 thousand m³/day. The required design capacity of Tuyamuyun water treatment plants is calculated as shown in Table 8.23. In 2010, a total capacity of 500 thousand m³/day for each plant is necessary to meet the water demand in 2010.

Table 8.23 Planned Capacity of Tuyamuyun Water Treatment Plant

(unit : thousand m³/day)

Water treatment plant	Max. daily water demand	Required cap. (intake quantity) in 2010	Design capacity		
			total	existing	expansion
T-Nukus	421.2	463.3	500	200	300
T-Urgench	437.2	480.9	500	200	300
total	848.4	944.2	1,000	400	600

8.4.6 Transmission Pipeline System

(1) Tuyamuyun-Nukus Transmission Facilities

1) Existing Condition

As described in the chapter 3, the existing pipelines and pumping stations are installed and used in the existing system. In addition to these facilities, several transmission facilities are under construction or construction of some of them has been suspended due to lack of funds. In future, these incomplete facilities listed below need to be used effectively.

i) Pumping stations between Tuyamuyun-Nukus water treatment plant and Nukus Turtkul Pumping Station (Pumping station No. 1), 81st Bridge pumping station (Pumping station No.2), Kipchak pumping station (Pumping station No.3)
ii) Nukus North pumping station
iii) Transmission pipeline between Nukus North pumping station and Takhiatash

2) Planned Transmission Facilities

Transmission facilities are planned and designed to meet the daily maximum water demand in 2010 considering the existing facilities, especially the capacity of the water treatment plants of Tuyamuyun and Vodokanal. Results of hydraulic calculation in Table 8.24-(a) and -(b) show the planned transmission pipelines and pumping stations of the Tuyamuyun-Nukus system respectively: Fig. 8.10 shows the same for Karakalpakstan.

Table 8.24-(a) Planned Transmission Pipeline of Tuyamuyun-Nukus System in 2010

	Transmission pipeline	Specification		Remarks
		Diameter (mm)	Length (km)	
1	T-N WTP - PS 1	1,400	63.0	
2	PS 1 - PS 2	1,400	59.0	
3	Khalkabad - Kegeili	500	11.5	
4	Kegeili - Bozatau	400	50.0	
5	Karauzyak - Takhtakupyr	500	29.0	
6	Nukus - Takhiatash	1,200	11.0	10 km of total 21 km completed
7	Takhiatash - Kungrad	1,000	111.0	
8	Kungrad - Muynak	500	96.5	

Table 8.24-(b) Planned Transmission Pumping Station of Tuyamuyun-Nukus System in 2010

	Transmission pipeline	Specification		Remarks
1	PS 2 (81st bridge PS)	Pump Reservoir	3,600 m^3/h x H290 m x 6 units 3,000 m^3 x 3 basins	substation completed 5 % of remaining work completed
2	PS 3 (Kipchak PS)	Pump Reservoir	3,600 m^3/h x H 290m x 6 units 3,000 m^3 x 3 basins	substation completed 5 % of remaining work completed
3	Nukus North PS	Pump Reservoir	1,800m^3/h x H 190m x 6 units 10,00 m^3 x 1 basin	
4	Kungrad PS	Pump (Distribute pump) Reservoir	270 m^3/h x H 160m x 4 units (220 m^3/h x H90 m x 8 units) (200 m^3/h x H125 m x 4 units) 10,000 m^3 x 3 basins	

(2) Tuyamuyun- Urgench Transmission Facilities

1) Present Condition

The present condition is almost similar to that of the Tuyamuyun-Urgench transmission facilities.

2) Planned Transmission Facilities

Result of hydraulic calculation in Table 8.25-(a) and -(b) show specifications of the planned transmission pipelines and pumping stations of Tuyamuyun-Urgench system respectively, which are shown in Fig. 8.11.

Table 8.25-(a) Planned Transmission Pipeline of Tuyamuyun-Urgench System in 2010

	Transmission pipeline	Specification		Remarks
		Diameter (mm)	Length (km)	
1	T-U WTP - Khazarasp	1,200	27.0	
2	Node 1 - Khanka	1,200	15.6	
3	Khanka - Urgench	1,200	13.2	
4	Yangiaryk - Khiva	600	20.0	
5	SP. 1 - Koshkupyr	600	14.0	
6	Koshkupyr - Shavat	600	10.0	6 km out of total 16 km completed
7	Gurlen - Shavat	600	19.5	3.7 km out of total 23.2 km completed

Table 8.25-(b) Planned Transmission Pumping Station of Tuyamuyun-Urgench System in 2010

	Pumping station	Specification		Remarks
1	Khazarasp PS	Pump	3,300 m^3/h x H90 m x 6 units	
		Reservoir	3,200 m^3 x 3 basins	

8.5 Regional Water Supply System (Vodokanal System)

8.5.1 General

Based on the selected inter-regional water supply system, Vodokanal, the regional water supply system, is scheduled to be expanded for improving and rehabilitating the water supply.

The present problems in the Vodokanal system in both regions are summarized below:

i) Poor quality of treated water
ii) Aged and corroded pipes in network
iii) No water meters for consumers

The first point can be solved by improving the water quality in the Tuyamuyun system. The second and third points are major problems specific to Vodokanal.

8.5.2 Water Treatment Plant

In future, some of the existing water treatment plants of Vodokanal, and other plants after expansion, will continue to be used in case of accidents to the Tuyamuyun water treatment plants, with the aim of reducing the project cost. Two types of treatment plants and wells of the existing plants will be used effectively in future:

i) Only wells with relatively good quality of ground water as water source
ii) Nukus and Urgench water treatment plants, which have appropriate treatment processes, sedimentation and filtration processes

Future planned capacities of the water treatment plants that can be expanded, including Agro-Vodokanal plants, are shown in Table 8.26. Rehabilitation and improvement of Nukus and Urgench water treatment plants are also necessary.

Table 8.26 Capacity of Water Treatment Plants Used and Expanded in Future

(unit : thousand m^3)

Vodokanal Agro Vodokanal	Design capacity	Distribution Capacity: Capacity operated at present	Capacity used in future	Capacity expanded in future	total	Source of water	Type of treatment process
Karakalpakstan							
1 Nukus (V.K)	65.0	60.0	60.0	30.0	90.0	canal	sedimentation & filtration
2 Turtkul (V.K)	8.4	8.4	8.4		8.4	ground water	
3 Beruni (V.K)	4.6	4.6	4.6		4.6	ground water	
4 Chimbai (V.K)	5.7	1.0	2.0		2.0	ground water	
5 Kegeili (V.K)	2.5	1.0	1.0		1.0	ground water	
6 Beruni (A.V)	-	8.0	8.0		8.0	ground water	
7 Turtkul (A.V)	-	14.0	14.0		14.0	ground water	
total		97.0	98.0	30.0	128.0		
Khorezm							
1 Urgench (V.K)	50.0	45.0	45.0	45.0	90.0	canal	sedimentation & filtration
2 Chalish (V.K)	-	10.0	10.0	20.0	30.0	ground water	
total	-	55.0	55.0	65.5	120.0		

8.5.3 Distribution Network

(1) Existing Conditions

Distribution pipes

Information on existing distribution pipes was collected from Vodokanal Nukus (Vodokanal Urgench has not prepared it). Based on the information on pipes collected by the World Bank (almost same as that of the JICA Study Team collected from Vodokanal), the total length of the pipes and the length of aged and corroded pipes to be replaced are shown in Table 8.27.

Table 8.27 Existing Condition of Distribution Pipes in 1995

District	Length in 1995 (km)	Pipes to be replaced (km)	Aged pipes (km)	Corroded pipes (km)	Percent of pipes to be replaced (%)
Karakalpakstan	631.22	228.80	122.30	106.50	36
Khorezm	637.98	170.30	88.20	82.10	27

Source : World Bank report.

Pipes in the existing distribution network are mainly made of three types of materials: asbestos cement, cast iron and steel. Many of these pipes are corroded by alkaline soils and saline ground water with high water level (40 - 100 cm below ground) in addition to aging. According to the table, the length of such pipes account for 36 % of the total length in Karakalpakstan and 27 % of the total length in Khorezm.

Leakage

Corrosion of pipes and valves has been increasing as ground water level has increased since the seventies. These aged and corroded pipes and valves have caused leakage in the network. Most of these defective pipes have not been repaired or replaced because of lack of spare pipes, valves, machines and equipment for repair. Moreover, improper repairs to leaking pipes have increased leakage; in some cases, the leaking pipes are connected to sewers. Although cast iron pipes are coated with asphalt, this material is not very effective against-corrosion. As a result, leakage has been increasing year after year since Vodokanal started operation in the fifties. To reduce leakage, Vodokanal of Urgench controls the distribution pressure of the network by time as follows:

in summer		
	day time(7 -9, 12 - 14, 19 - 21) :	2.5 bar
	night	1.7 - 1.8 bar
in winter		1.8 bar

Vodokanal has leakage repair teams in each city or town, which monitor leakage 24 hours a day and repair only the reported leakage on the ground.

Influence of water used for gardens on the distribution network

In the Study area, piped water is used for watering gardens in households. This amount of water is considerable, accounting for more than 50 % of the total domestic consumption. The distribution network was not designed considering this amount. Therefore, the distribution capacity of the network is unable to deliver water to the outskirts of cities, especially in big cities such as Nukus and Urgench. The quantity of water used for watering gardens should be reduced to maintain the proper distribution capacity of the network.

Development of new pipelines

Although new pipes are needed to increase coverage, their installation has not progressed because of lack of funds. Vodokanal of Urgench could install only 2 km last year.

Wastage

In addition to the leakage in the network, leakage within buildings (wastage) is estimated to be considerable. Poor plumbing and packing in buildings cause considerable wastage of water. Wastage from flash toilets is estimated to be specially high. To estimate the amount of wastage currently, Vodokanal of Nukus conducted a site survey as described below:

In summer 1995, at midnight when water quantity is not supposedly used by consumers, wastage in sewer pits of several apartment buildings was measured. This water was very clean, did not look like sewerage, and was considered to be drinking water. The results of measurement, showed that wastage in all apartments in Nukus was about 10,000 - 12,000 m^3/day. When the wastage in individual houses, second and third groups are added, the total wastage adds up to a very significant amount.

(2) Planning

Planning should consider two types of tasks for distribution pipes: replacement of aged and corroded pipes for prevention of leakage and installation of new pipes for increasing coverage (extension). By taking these measures, target figures for leakage prevention (15%) and coverage rate in 2010, as stated in Chapter 4, will be achieved. The methodology of planning is as follows:

i) replacement plan for aged and corroded pipes

All aged and corroded pipes are to be replaced over 14 years from 1997 to 2010 at the same pace per year, that is: 16.3 km/year in Karakalpakstan and 12.2 km/year in Khorezm.

ii) extension plan for increased coverage

Time and information required for planning for these pipes are limited and inadequate for framing a detailed plan. Consequently, a simple plan is formed using the average existing pipe length per person of served population to arrive at the figures: 1.258 m/person in Karakalpakstan and 2.179 m/person in Khorezm.

From the calculations, the planned length of new pipes for the extension and replacement of pipes by 2010 is shown in Table 8.28. This plan starts from 1998.

Table 8.28 Planned Length of New and Replacement Pipes by 2010

(unit: km)

Year	Karakalpakstan Replaced and New Pipes			Khorezm Replaced and New Pipes		
	Replaced	Expansion	total	Replaced	Expansion	total
1998	17.6	40	57.6	13.1	24	37.1
1999	17.6	40	57.6	13.1	24	37.1
2000	17.6	40	57.6	13.1	24	37.1
2001	17.6	22	39.6	13.1	10	23.1
2002	17.6	22	39.6	13.1	10	23.1
2003	17.6	22	39.6	13.1	10	23.1
2004	17.6	22	39.6	13.1	10	23.1
2005	17.6	22	39.6	13.1	10	23.1
2006	17.6	26	43.6	13.1	12	25.1
2007	17.6	26	43.6	13.1	12	25.1
2008	17.6	26	43.6	13.1	12	25.1
2009	17.6	26	43.6	13.1	12	25.1
2010	17.6	26	43.6	13.1	12	25.1
total	228.8	360	588.8	170.3	206	376.3

8.5.4 Water Meters

(1) Existing Conditions

Presently, water consumed by consumers is not fully measured by water meters due to a lack of installed water meters. Almost no water meters are installed for the first group consumers. Table 8.29 shows the number of the existing water meters installed by consumer group.

Table 8.29 Number of Water Meters
as of June 1996

Description	1st group	2nd group	3rd group	total
Karakalpakstan				
meters installed	53	252	44	349
meters required	89,000 *	800		89,800
Percent of installed meters	0.1	49.3		0.4
Khorezm				
meters installed	123	107	257	487
meters required	50,442	248	562	51,252
Percent of installed meters	0.2	43.1	45.7	1.0

* JICA Team estimate

In recent years, the second and third group consumers are trying to install water meters on their own since the negotiated water prices for consumers without water meters has been exceeding and becoming much higher than the metered prices year after year. It is expected that all these consumers will install water meters in the near future under these circumstances. On the other hand, the first group consumers may not install water meters at their own expense because there are no incentives for them to install meters like the second and third group consumers. Besides, the income of a household is too low to allow installation of meters at their own expense. Therefore, water meters for the first group should be installed by Vodokanal or other public works by raising public funds.

(2) Planning

Water meters should be installed for all consumers for ensuring sound management of waterworks. This will enable proper collection of water charges according to consumption. Moreover, wastage and water consumption can be reduced or controlled by increasing the tariff rate.

Water meters are to be installed for the first group consumers only using public funds. Two type of consumers: the already-served households (existing consumers) without water meters and newcomers to the water supply system, are taken into account in the plan.

1) Planning for existing consumers without water meters

The target year for installing water meters for all consumers is 2010. According to the JICA Study Team estimate, the number of households served in 1996 is 89,000 in Karakalpakstan and 51,000 in Khorezm. 6,400 water meters per year for Karakalpakstan and 3,600 water meters per year for Khorezm must be installed at the same rate every year until 2010.

2) Planning for newcomers to the water supply system

Water meters will be installed in households when piped water connection is installed. The number of water meters to be installed is calculated from the service population and average number persons in a household (JICA estimates 6 persons per household).

The number of planned water meters is shown in Table 8.30. Installation of water meters starts from 1998.

Table 8.30 Numbers of Planned Water Meters to be Installed by 2010

Year	Karakalpakstan			Khorezm		
	Existing customers	New comers	total	Existing customers	New comers	total
1998	7,250	5,320	12,570	4,030	1,820	5,850
1999	7,250	5,320	12,570	4,030	1,820	5,850
2000	7,250	5,320	12,570	4,030	1,820	5,850
2001	7,250	2,880	10,130	4,030	790	4,820
2002	7,250	2,880	10,130	4,030	790	4,820
2003	7,250	2,880	10,130	4,030	790	4,820
2004	7,250	2,880	10,130	4,030	790	4,820
2005	7,250	2,880	10,130	4,030	790	4,820
2006	7,250	3,430	10,680	4,030	890	4,920
2007	7,250	3,430	10,680	4,030	890	4,920
2008	7,250	3,430	10,680	4,030	890	4,920
2009	7,250	3,430	10,680	4,030	890	4,920
2010	7,250	3,430	10,680	4,030	890	4,920
total	94,250	47,510	141,760	52,390	13,860	66,250

8.5.5 Restoration of Irrigation Channel

The inhabitants of the city had been obtaining the water for cultivating grain and vegetables from the irrigation channel. The roadside trees had also been maintained with this water. However, the earthquake destroyed the irrigation channel and is not functioning. Thus, the inhabitants have been forced to use the drinking water from the water works for cultivation. This has resulted in the shortage of water by increasing in the water consumption and the aggravation of management of water works. It is necessary to restore the irrigation channel for effective use of drinking water. The relevant authorities of the Uzbekistan should work up a restoration plan.

8.6 Project Costs and Implementation Plan

8.6.1 Construction Considerations

(1) Investigation of Materials, Unit Cost and Construction

Construction materials, construction machinery, labor and construction conditions were studied. The cost, quality and supply conditions of construction materials that can be procured in Uzbekistan and those that can be procured overseas were studied. The types and models, performance and cost of construction machinery used in Uzbekistan were studied. For labor, wages by occupation were studied, and with respect to construction conditions, the construction and operating methods were studied.

(2) Construction Cost

Currently, the economic activity in the Uzbekistan is relatively low and construction is not active. Therefore, construction costs are not so easy to estimate, especially information for imported material is insufficient.

However, in the Uzbekistan, construction costs are estimated by multiplying estimated coefficients and 1991 standard prices together. The 1991 standard prices are established under planned economy before independent from then USSR, accordingly the standard prices do not reflect market economy and also currency of the standard prices is Russian ruble not Uzbekistan's Sum. The coefficients are estimated considering exchange rates (ruble and sum) and rise in prices. Therefore, this method is not adequate.

In this report, construction costs are estimated considering investigated prices, construction situation in the Uzbekistan, and prices in CIS, Europe, and Asian countries.

Since the following listed facilities are under construction, the estimated costs in the report consider only remaining portion, of these facilities.

1) Kaparas intake station
2) Raw water main pipeline (Kaparas intake station to Tuyamuyun-Urgench intake station)
3) Tuyamuyun-Nukus water treatment plant (Receiving basin, Clarifier, Horizontal Sedimentation basin, Filter)
4) Tuyamuyun-Urgench water treatment plant (Receiving basin, Clarifier, Horizontal Sedimentation basin, Filter)
5) No. 1, No. 2, and No. 3 Booster pumping stations (Tuyamuyun-Nukus system)
6) Transmission pipeline (Nukus to Takhiatash)

The machinery and equipment listed below and stored on site were procured in 1992. As a result of inspection of these machinery and equipment it is difficult to judge visually whether there are problem in using these equipment, such as corrosion during the period of storage. However, these equipment should be used so that costs can be reduced. Inspections and operating tests should be carried out on the equipment below, repairs should preferably be carried out based on the results of the inspections and tests, and efforts made to utilize the equipment to the maximum. For this cost estimation, the cost of machinery and equipment is taken as 20% the cost of newly purchased machinery and equipment. For electrical equipment, the cost is taken as 70% of newly purchased electrical equipment.

(1) Machinery and electrical equipment for Kaparas intake station (without transformer)
(2) Machinery and electrical equipment for No. 1, No. 2 and No. 3 booster pumping stations (Tuyamuyun-Nukus system)

8.6.2 Construction Cost

The standards for estimating costs are given below.

(1) The major materials could be imported from the countries where the materials are reasonably available. However, the countries written bellow only for estimation.

1) Mild steel pipe (transmission pipeline) : Russia, Ukraine
2) Ductile cast iron pipe (distribution pipeline) : South Korea
3) Mechanical and electrical equipment : Japan
4) Water meters : Uzbekistan (joint venture with Republic of China)

(2) Import route

1) Route from Asia to Uzbekistan

The materials/equipment will be unloaded at the Port of Bandar Abbas in Iran and transported to Uzbekistan via Turkmenistan.

2) Route from Russia, Ukraine to Uzbekistan

The materials/equipment will be transported to Uzbekistan via Kazakhstan and Turkmenistan.

(3) Exchange rate

1 Uzbekistan sum	=	0.025 US dollar
1 Uzbekistan sum	=	2.75 Japanese yen
1 US dollar	=	40 Uzbekistan sum
1 US dollar	=	110 Japanese yen

(as of July 1996)

(4) Engineering fees were taken as 10% of the construction cost.

(5) Physical contingency fees were taken as 5% of the construction cost.

The total project cost was estimated as 1,018.6 million US dollars. The breakdown of this cost as shown in the implementation plan is as follows, with the figures in parentheses giving the period of the project and the percentage of the total project cost:

Phase I (1998-2000)	:	607.1 million US dollars (60%)
Phase II (2001-2003)	:	88.7 million US dollars (9%)
Phase III (2004-2010)	:	322.8 million US dollars (31%)
Total	:	1,018.6 million US dollars (100%)

The local currency portion of this project (indicated by L/C) expresses the cost of materials and labor procured within the country, while the foreign currency portion (indicated by F/C) expresses the cost of materials procured from foreign countries.

Please refer to Table 8.31

8.6.3 Operation and Maintenance Costs

(1) Calculation Conditions

Operation and maintenance costs (O&M costs) after this project start are calculated based on the conditions below.

a) O&M costs are calculated for four water supply enterprises of Tuyamuyun and Vodokanal in Karakalpakstan and Khorezm.
b) Using the income and expenditure reports of the four water supply enterprises, calculations are performed to predict the O&M costs in future, based on costs per unit quantity of accounted -for water (AFW).

c) Forecasted and actual O&M costs are shown in the income and expenditure reports, but here the costs are estimated based on the forecasted values that are considered to reflect the necessary and ideal operation and maintenance conditions for their water supply system.

d) The O&M costs for the Kaparas PS (the Kaparas PS) and raw water main shall be added after their operation starts. In addition, the costs for water treatment, particularly the cost of chemicals, can be reduced since the turbidity of the water in the Kaparas reservoir is low.

e) O&M costs for each year are calculated from the costs per unit quantity of AFW and quantity of AFW for each year.

(2) Estimation of Operation and Maintenance Costs after Project Implementation

1) Tuyamuyun system

The O&M costs per unit quantity of AFW in the Tuyamuyun system after implementation of this project is summarized as given below.

1. Electricity charges: The increase in the O&M costs of the Kaparas PS is considered only in the Tuyamuyun-Nukus system. Its increase in cost is 0.286 Sum/m^3.
The future increase in electricity charges of the proposed PSs are estimated and added to the above electricity charges when the PS starts operation.

Table 8.32 Annual Electric Power Consumption in 2010 and Its Ratio

Pumping Station	Annual electric power consumption (mil. kWh/year)	Ratio
Kaparas and T-Nukus WTP	175	1.00
NO 2 transmission	98	0.56
Nukus North	32	0.18
Kungrad	2	0.01

Note : Annual electric power consumption is estimated using the water demand in 2010.

2. Wages: Present unit expense per unit quantity of AFW are used.

3. Chemicals: Forecasted Cost of existing chemicals is probably lower than the actual cost. The cost of chemicals per unit

quantity of AFW estimated is used as the appropriate cost.

4. Repairs: The actual unit expense of repairs for existing facilities is used. Repair expense for new facilities is taken as 0.5% of the cost of new facilities.

5. Social insurance costs: Present unit expense per unit quantity of AFW is used.

6. Fuel, gas, lubricating oils: Present unit expense per unit quantity of AFW is used.

7. Others: Present unit expense per unit quantity of AFW is used.

The O&M costs per unit quantity of AFW excluding depreciation are set as given below.

T-Nukus : 4.19 Sum/m^3 + electricity charges of transmission PS + cost increase in repairs of new facilities

T-Urgench : 2.50 Sum/m^3 + cost increase in repairs of new facilities

Table 8.33 O&M Costs Per Unit Quantity of AFW of Tuyamuyun System Before and After the Implementation of the Project

(unit: Sum/m^3)

	Before project implementation	After project implementation	
		Basic cost	Additional cost
T-N	4.186	4.143	1. increase in electricity charge of transmission PSs 2. increase in repair cost for new facilities
T-U	2.864	2.535	1. increase in repair cost for new facilities

2) Vodokanal system

The expenditure items tabulated in the income and expenditure report vary for each Vodokanal system, but for calculations here, the expenses for receiving water is added to the expenditure items in the income and expenditure reports for the Tuyamuyun system. Expenses for receiving water are calculated separately based on the O&M costs, water tariff, future water demand and extension plan for supply capacity.

The values for 1996 are used in principle for calculating the cost per unit quantity of AFW for the Vodokanal system in future. However, considering the present condition of the water supply facilities, the repair cost for Vodokanal-Khorezm was judged to be inappropriate, the repair cost for Vodokanal-Karakalpakstan was deemed to be appropriate, and the repair cost for Vodokanal-Khorezm was estimated based on that for Vodokanal-Karakalpakstan and the depreciation costs of both Vodokanals. The costs per unit quantity of AFW were set as shown below.

Karakalpakstan : 2.54 Sum/m^3
Khorezm : 1.14 Sum/m^3

8.6.4 Project Implementation Plan

The implementation plan strives to make improvements to water quality, improvements to satisfy stringent demands, ensure a stable supply of water, and satisfy future water demand. To realize these objectives, the plan was divided into three phases according to priority. The targets for the phases were decided as follows:

Phase I : Improve water quality and solve the tight demand and supply problem
Phase II : Ensure stable supply of water
Phase III : Satisfy the demand in the target year

Details of the phases are described below. The periods for the phases starting from the time of tight demand and supply are:

Phase I	: 3 years	from 1998 to 2000
Phase II	: 3 years	from 2001 to 2003
Phase III	: 7 years	from 2004 to 2010

Refer to Fig. 8.12

Phase I

(1) To improve the quality of water, change the water source from the Amudarya river to the Kaparas reservoir
(2) To enable stable supply of treated water, improve the mixing basin, clarifier, rapid filter, and chemical feeding equipment
(3) Install monitoring equipment, control equipment, and recorders in the central control room to facilitate operation and management of the water treatment plant
(4) To solve the problem of tight water supply and demand, expand the treatment plants of Tuyamuyun-Nukus and Tuyamuyun-Urgench systems
(5) Lay transmission pipelines to supply good quality drinking water to Karakalpakstan and Khorezm
(6) Improve the waterworks facilities in all the cities.

Phase II

(1) Expand the Nukus, Urgench, and Chalish water treatment plants for responding to accidents in the pipelines of the Tuyamuyun-Nukus system and the Tuyamuyun-Urgench system and ensure a stable supply of water.

Phase III

(1) Expand the pipelines in the Tuyamuyun-Nukus system and the Tuyamuyun-Urgench system to satisfy the demand in the target year.

8.6.5 Planned Water Demand and Supply Capacity

The expansion schedule of the water supply capacity based on the project implementation schedule and the planned water demand are shown in Table 8.13 (Karakalpakstan covered by T-N system) and Table 8.14 (Khorezm covered by T-U system).

Table 8.31 Project Cost

(unit : million USD)

Work Item	Specification	Total			PHASE - I			PHASE - II			PHASE - III		
		Total	L/C	F/C	Total	L/C	F/C	Total	L/C	F/C	Total	L/C	F/C
1. Kaparas Raw Water Intake System													
1.1 Kaparas Intake Station	Q=1,000,000 m^3/d	12.9	8.0	4.9	12.9	8.0	4.9						
1.2 Raw Water Mains													
1.2.1 Kaparas I.S. to T-N existing intake station	D=1,400 L=10.7 km	18.7	4.5	14.2	18.7	4.5	14.2						
1.2.2 Kaparas I.S. to T-N existing intake station	D=1,400 L=10.7 km	15.0	1.6	13.4							15.0	1.6	13.4
1.2.3 Kaparas I.S. to T-U existing intake station	D=1,400 L= 1.0 km	1.6	0.1	1.5	1.6	0.1	1.5						
1.2.4 Kaparas I.S. to T-U existing intake station	D=1,400 L= 9.0 km	12.7	1.3	11.4	12.7	1.3	11.4						
Sub-Total		60.9	15.5	45.4	45.9	13.9	32.0	0.0	0.0	0.0	15.0	1.6	13.4
2. Tuyamuyun-Nukus Water Supply System													
2.1 Water Treatment Plant	Q=500,000 m^3/d												
2.1.1 Rehabilitation	Q=200,000 m^3/d	15.5	2.6	12.9	15.5	2.6	12.9						
2.1.2 Expansion Phase-I	Q=150,000 m^3/d	44.6	13.3	31.3	44.6	13.3	31.3						
2.1.3 Expansion Phase-III	Q=150,000 m^3/d	36.2	12.0	24.2							36.2	12.0	24.2
2.2 Transmission and Distribution Pumping Station													
2.2.1 No. 2 Booster Pumping Station	Q=306,940 m^3/d	9.5	6.3	3.2	9.5	6.3	3.2						
2.2.2 No. 3 Booster Pumping Station	Q=306,940 m^3/d	9.5	6.3	3.2							9.5	6.3	3.2
2.2.3 Nukus North Distribution Station	Q=255,910 m^3/d	10.8	5.0	5.8	10.8	5.0	5.8						
2.2.4 Kungrad Transmission and Distribution St.	Q= 55,020 m^3/d	18.9	13.3	5.6	10.5	6.7	3.8				8.4	6.6	1.8
2.3 Transmission Pipeline													
2.3.1 W.T.P. - No. 1 Pumping st.	D=1,400 L= 63.0 km	82.7	9.3	73.4	82.7	9.3	73.4						
2.3.2 No.1 P.S to No. 2 P.S.	D=1,400 L= 59.0 km	77.4	8.6	68.8							77.4	8.6	68.8
2.3.3 Nukus - Takhiatash (Khodjeili) L=21 km	D=1,200 L= 11.0 km	14.7	3.7	11.0	14.7	3.7	11.0						
2.3.4 Takhiatash (Khodjeili) - Kungrad	D=1,000 L=110.0 km	86.9	8.7	78.2	86.9	8.7	78.2						
2.3.5 Kungrad - Muinak (Q=12,090 m^3/d)	D=500 L= 96.5 km	28.5	3.6	24.9	28.5	3.6	24.9						
2.3.6 Khalkabad - Kegeili	D=500 L= 11.5 km	3.4	0.5	2.9							3.4	0.5	2.9
2.3.7 Kegeili - Bozatau	D=400 L= 50.0 km	15.0	1.4	13.6	15.0	1.4	13.6						
2.3.8 Karauzyak - Takhtakupyr	D=500 L= 29.0 km	8.6	1.1	7.5							8.6	1.1	7.5
Sub-Total		462.2	95.7	366.5	318.7	60.6	258.1	0.0	0.0	0.0	143.5	35.1	108.4
3. Tuyamuyun-Urgench Water Supply System													
3.1 Water Treatment Plant	Q=500,000 m^3/d												
3.1.1 Rehabilitation	Q=300,000 m^3/d	15.5	2.5	13.0	15.5	2.5	13.0						
3.1.2 Expansion Phase - I	Q=200,000 m^3/d	56.8	17.8	39.0	56.8	17.8	39.0						
3.1.3 Expansion Phase - III	Q=100,000 m^3/d	29.6	10.2	19.4							29.6	10.2	19.4
3.2 Transmission Pipeline													
3.2.1 W.T.P. - Khazarasp Pumping Station	D=1,200 L=27.0 km	27.6	2.8	24.8	27.6	2.8	24.8						
3.2.2 Khanki - Urgench	D=1,200 L=13.2 km	8.1	0.8	7.3	8.1	0.8	7.3						
3.2.3 Yangiaryk - Khiva	D=600 L=20.0 km	7.3	0.7	6.6	7.3	0.7	6.6						
3.2.4 S.P.1 - Koshkupyr	D=600 L=14.0 km	5.2	0.7	4.5	5.2	0.7	4.5						
3.2.5 Koshkupyr - Shavat	D=600 L=10.0 km	3.7	0.4	3.3							3.7	0.4	3.3
3.2.6 Gurlen - Shavat	D=600 L=19.5 km	3.3	0.3	3.0	3.3	0.3	3.0						
3.3 Transmission Pumping Station													
3.3.1 Khazarasp Pumping Station Phase-III	Q=256,290 m^3/d	12.1	6.3	5.8							12.1	6.3	5.8
Sub-Total		169.2	42.5	126.7	123.8	25.6	98.2	0.0	0.0	0.0	45.4	16.9	28.5
4. VodoKanal Karakalpakstan													
4.1 Water Treatment Plant													
4.1.1 Nukus W.T.P (Rehabilitation)	Q= 65,000 m^3/d	17.7	1.6	16.1	17.7	1.6	16.1						
4.1.2 Nukus W.T.P (Expansion) Phase-II	Q= 35,000 m^3/d	10.6	2.6	8.0				10.6	2.6	8.0			
4.1.3 Chimbai W.T.P (Rehabilitation)	Q= 2,200 m^3/d	1.6	0.1	1.5	1.6	0.1	1.5						
4.1.4 Water Treatment Plant (Rehabilitation) , 3Cities	Q= 14,000 m^3/d	6.6	0.5	6.1	6.6	0.5	6.1						
4.2 Distribution Network													
4.2.1 Replacement D=100～D=400	L=220.8 km	53.2	31.8	21.4	12.3	7.3	5.0	12.3	7.4	4.9	28.6	17.1	11.5
4.2.2 Expansion D=100～D=400 Phase - I	L=119.6 km	28.0	16.8	11.2	28.0	16.8	11.2						
4.2.3 Expansion D=100～D=400 Phase - II	L= 66.0 km	24.7	14.8	9.9				24.7	14.8	9.9			
4.2.4 Expansion D=100～D=400 Phase - III	L=174.0 km	40.6	24.3	16.3							40.6	24.3	16.3
4.3 Metering System													
4.3.1 Meter Installation D=20 Phase - I	N=37,710 Pieces	3.3	0.8	2.5	3.3	0.8	2.5						
4.3.2 Meter Installation D=20 Phase - II	N=30,390 Pieces	2.7	0.6	2.1				2.7	0.6	2.1			
4.3.3 Meter Installation D=20 Phase - III	N=73,660 Pieces	6.5	1.5	5.0							6.5	1.5	5.0
Sub-Total		195.5	95.4	100.1	69.5	27.1	42.4	50.3	25.4	24.9	75.7	42.9	32.8
5. VodoKanal Khorezm													
5.1 Water Treatment Plant													
5.1.1 Urgench W.T.P (Rehabilitation)	Q= 50,000 m^3/d	19.7	1.5	18.2	19.7	1.5	18.2						
5.1.2 Urgench W.T.P (Expansion) Phase-II	Q= 50,000 m^3/d	12.0	2.6	9.4				12.0	2.6	9.4			
5.1.3 Chalish(Rehabilitation)	Q= 11,000 m^3/d	1.9	0.1	1.8	1.9	0.1	1.8						
5.1.4 Chalish(Expansion) Phase-II	Q= 22,000 m^3/d	3.3	1.5	1.8				3.3	1.5	1.8			
5.2 Distribution Network													
5.2.1 Replacement D=100～D=400	L=170.3 km	39.9	23.8	16.1	9.2	5.5	3.7	9.2	5.5	3.7	21.5	12.8	8.7
5.2.2 Expansion D=100～D=400 Phase - I	L= 71.5 km	16.8	10.1	6.7	16.8	10.1	6.7						
5.2.3 Expansion D=100～D=400 Phase - II	L= 30.0 km	12.6	7.5	5.1				12.6	7.5	5.1			
5.2.4 Expansion D=100～D=400 Phase - III	L= 80.0 km	18.7	11.2	7.5							18.7	11.2	7.5
5.3 Metering System													
5.3.1 Meter Installation D=20 Phase - I	N=17,550 Pieces	1.6	0.4	1.2	1.6	0.4	1.2						
5.3.2 Meter Installation D=20 Phase - II	N=14,460 Pieces	1.3	0.3	1.0				1.3	0.3	1.0			
5.3.3 Meter Installation D=20 Phase - III	N=34,240 Pieces	3.0	0.7	2.3							3.0	0.7	2.3
Sub-Total		130.8	59.7	71.1	49.2	17.6	31.6	38.4	17.4	21.0	43.2	24.7	18.5
Total		1,018.6	308.8	709.8	607.1	144.8	462.3	88.7	42.8	45.9	322.8	121.2	201.6

L/C: Local currency portion, F/C : Foreign currency portion

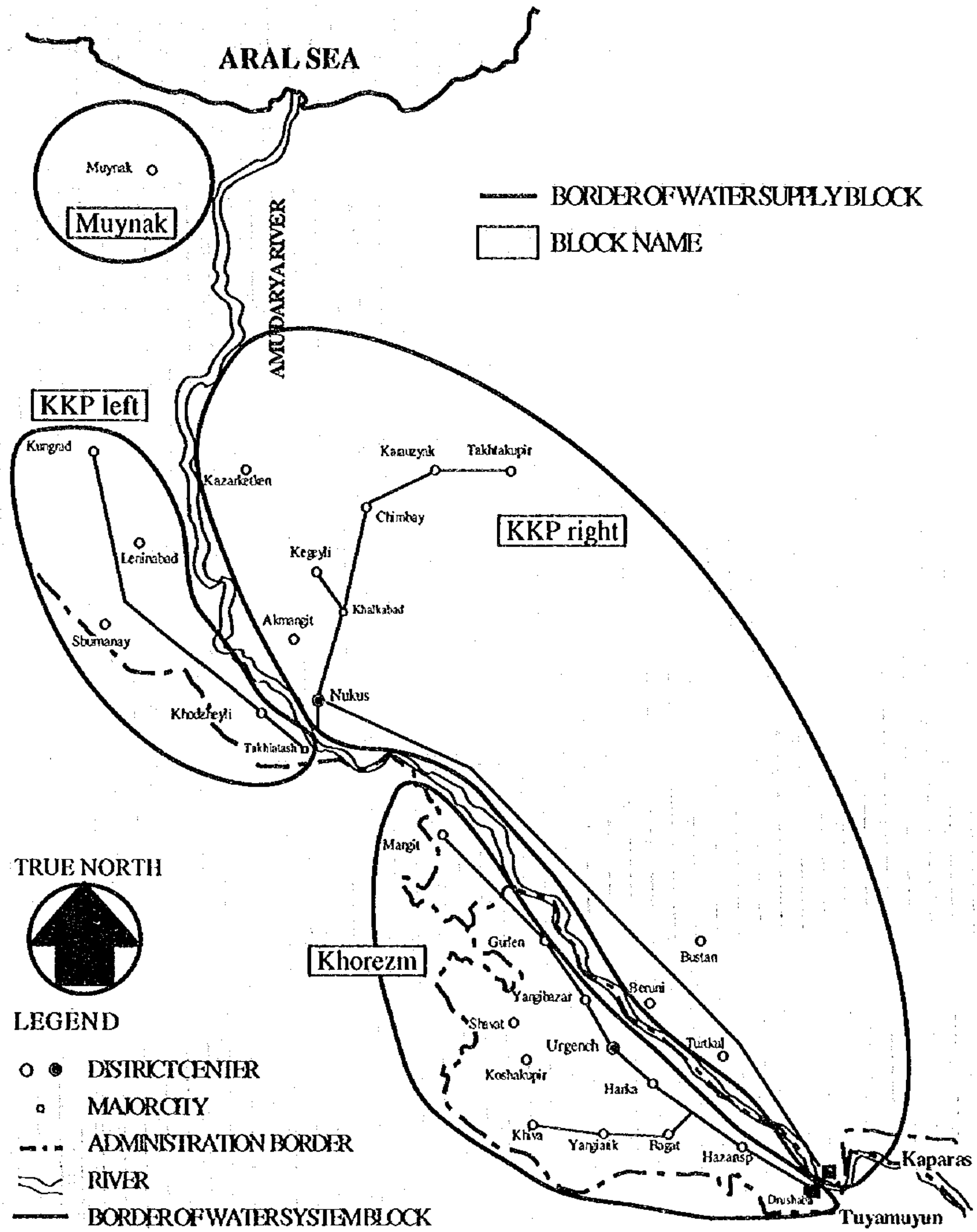


Fig. 8.1 Blocks of Water Supply System

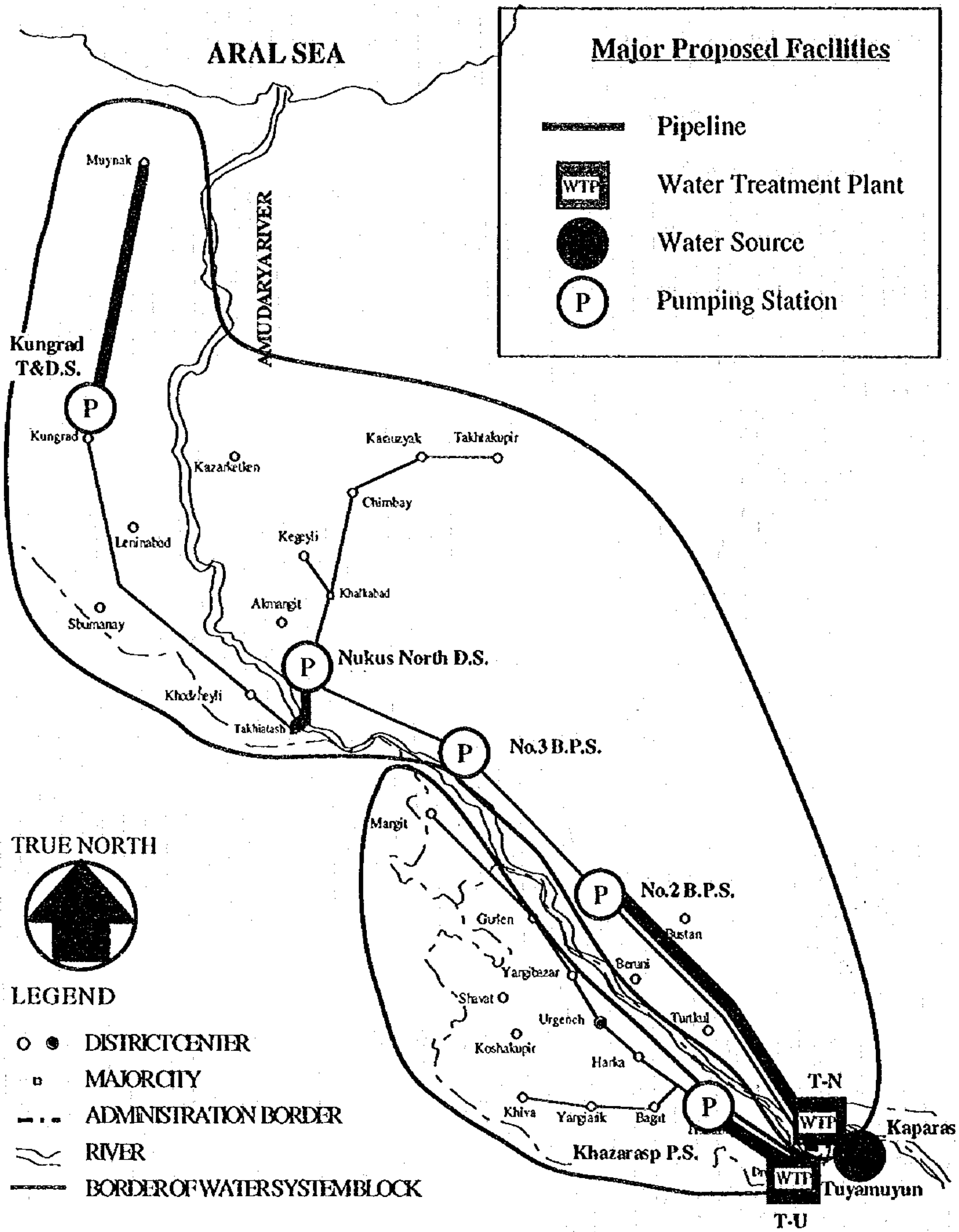


Fig. 8.2 Alternative 1

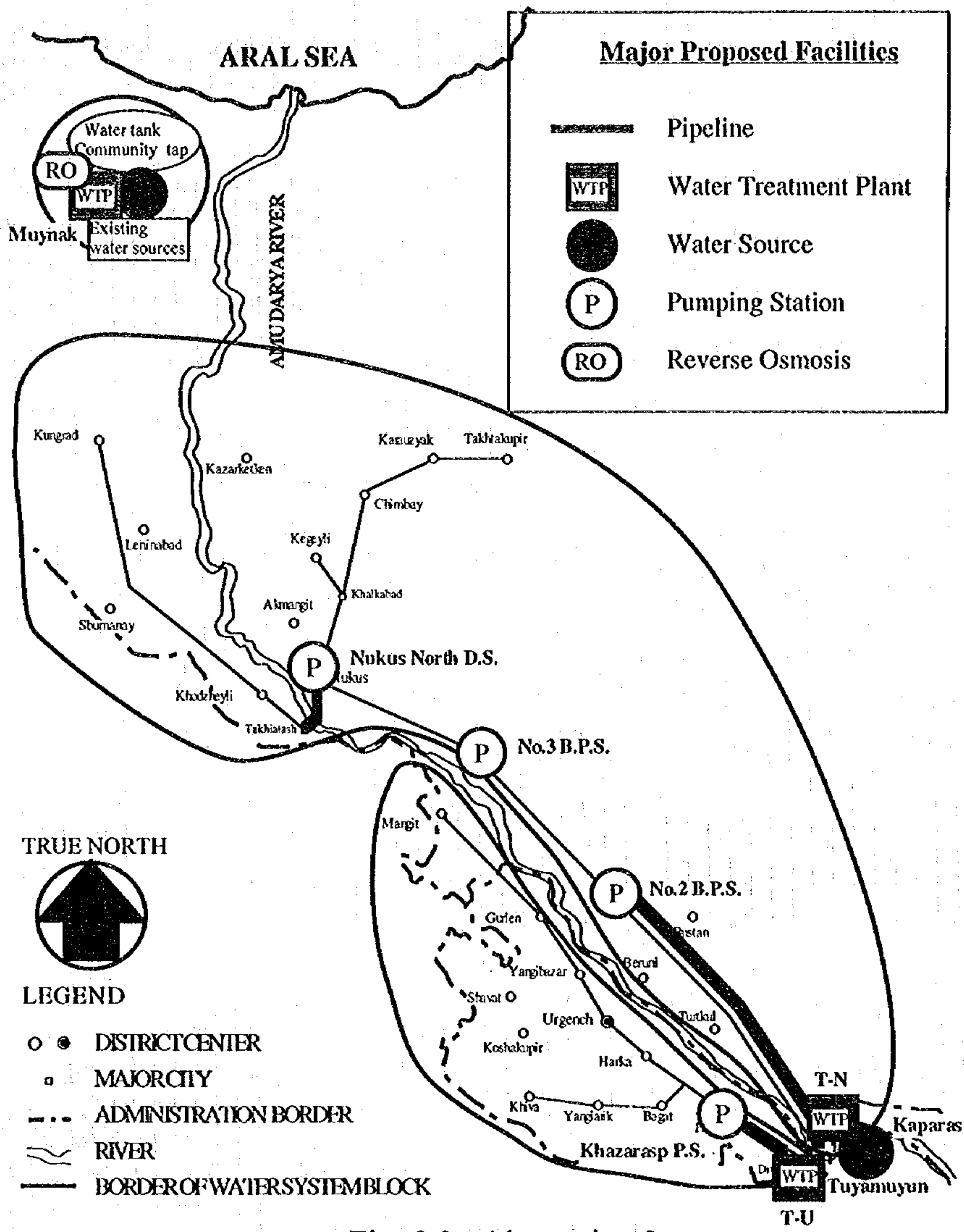


Fig. 8.3 Alternative 2

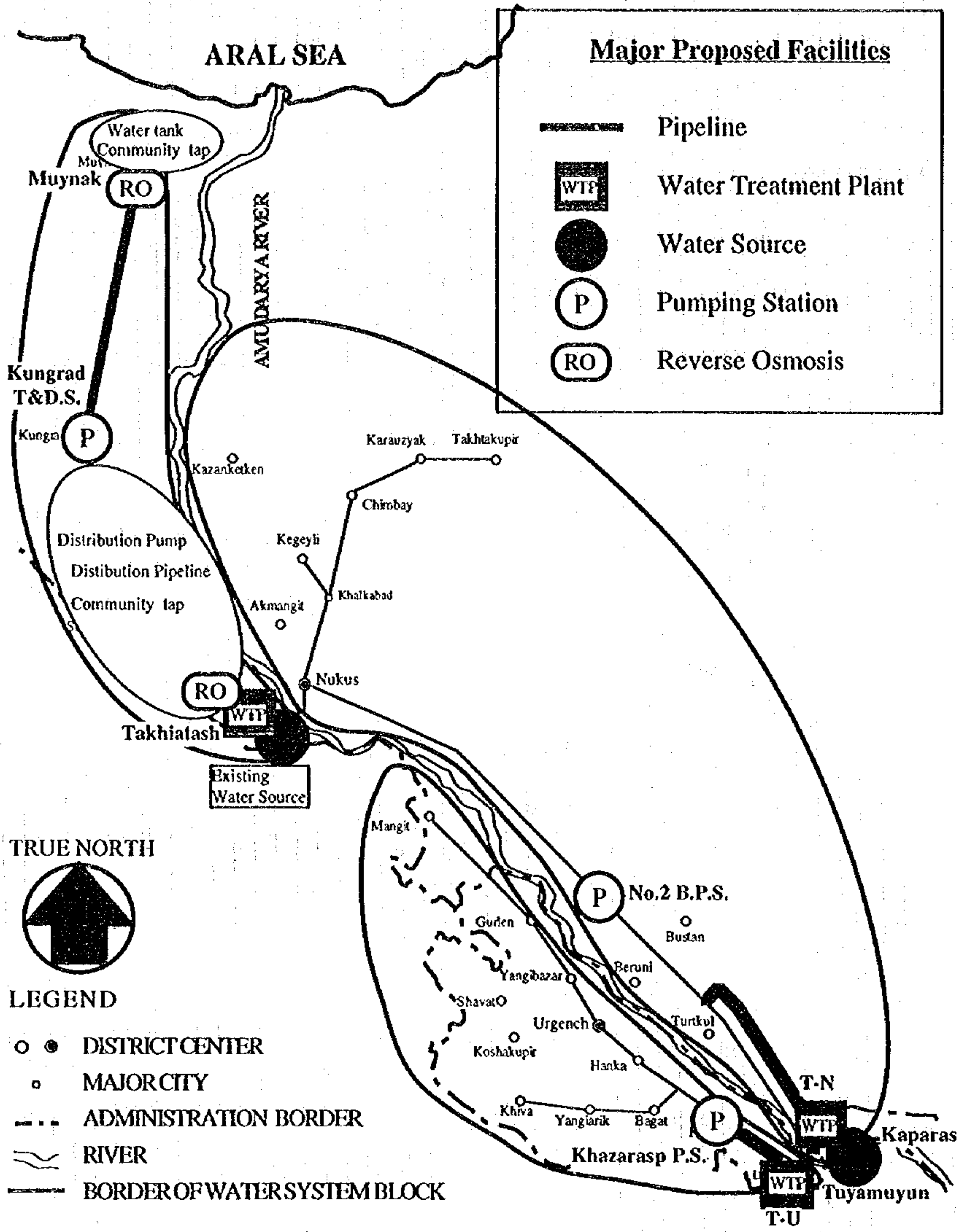


Fig. 8.4 Alternative 3-1

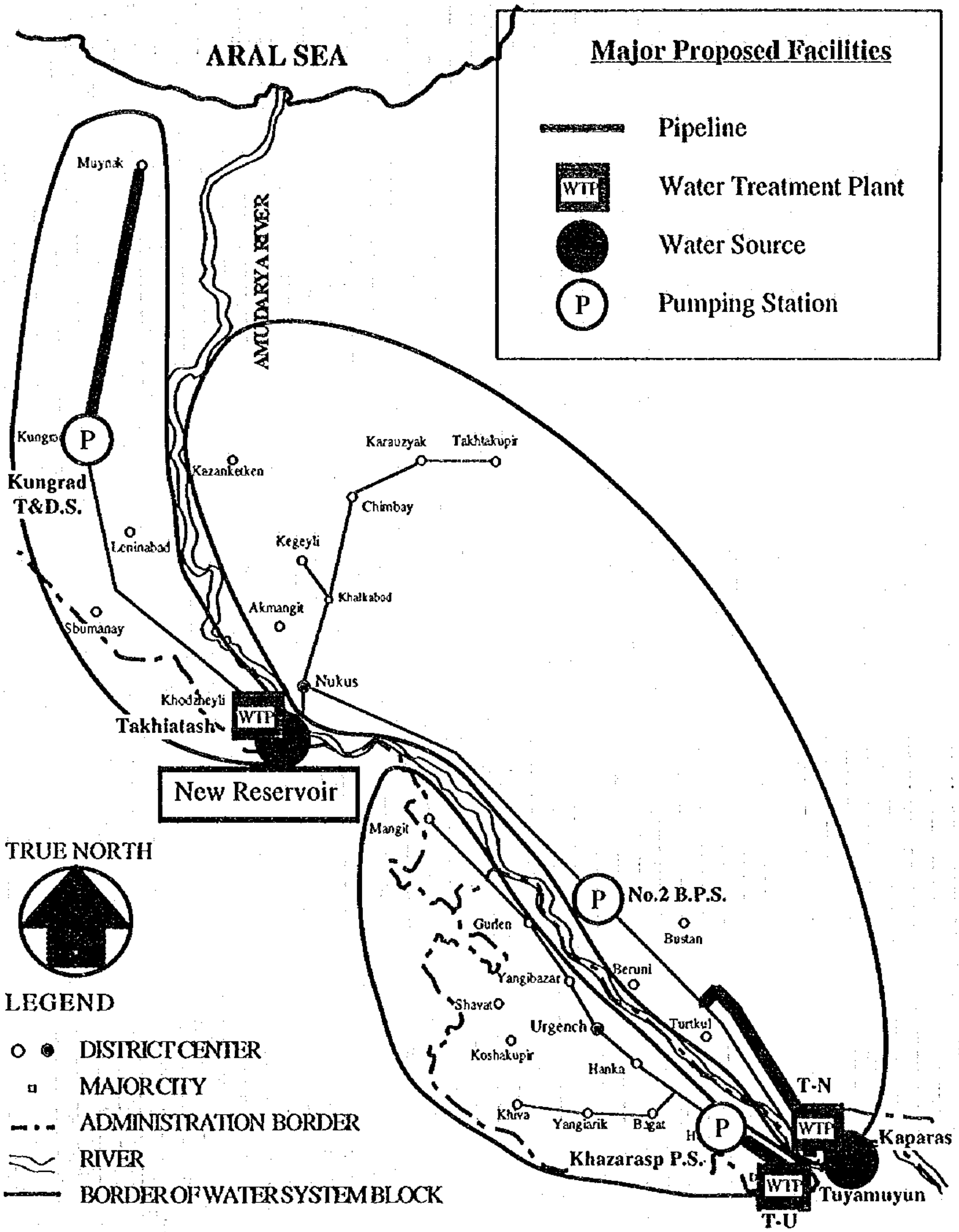


Fig. 8.5 Alternative 3-2

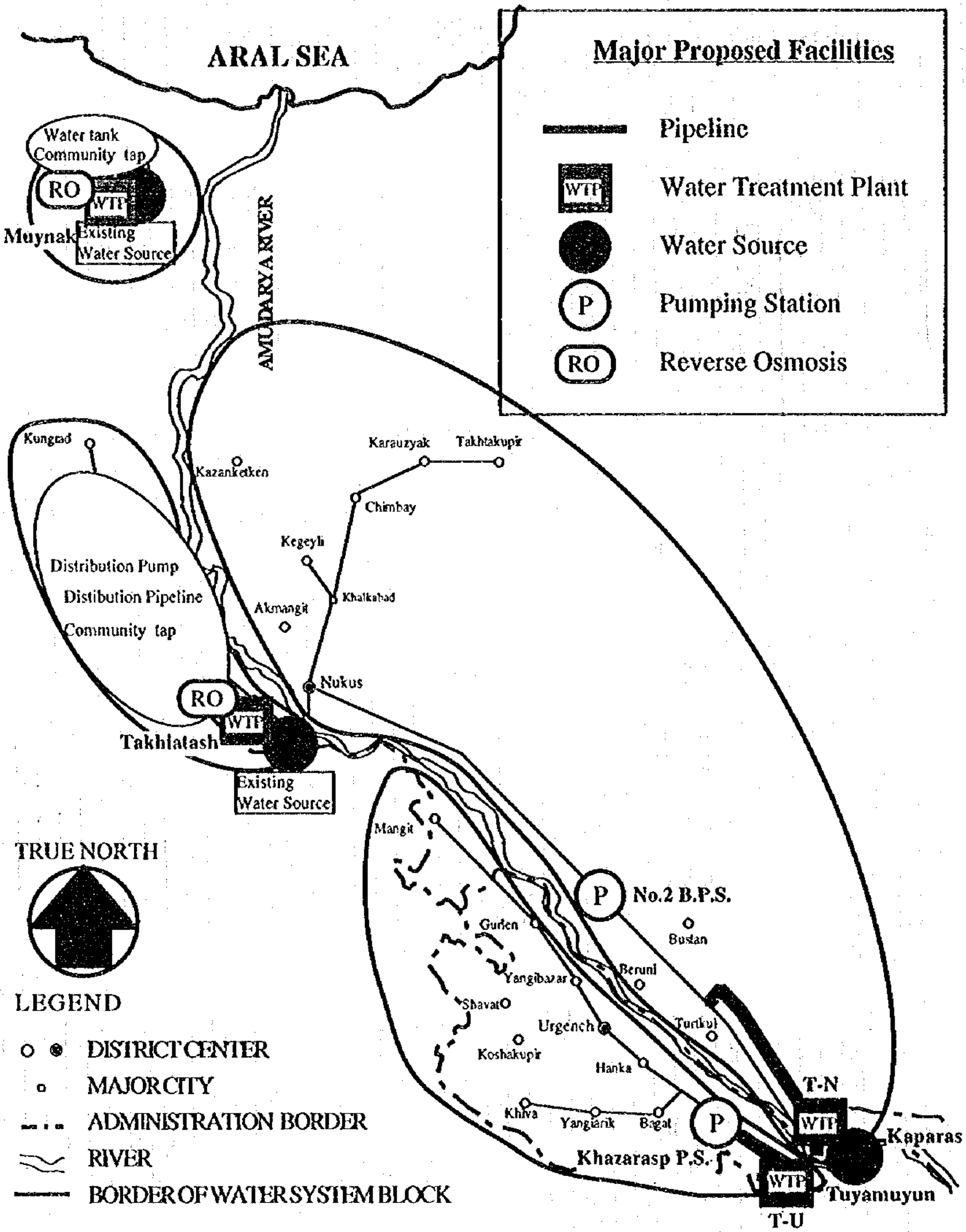


Fig. 8.6 Alternative 4-1

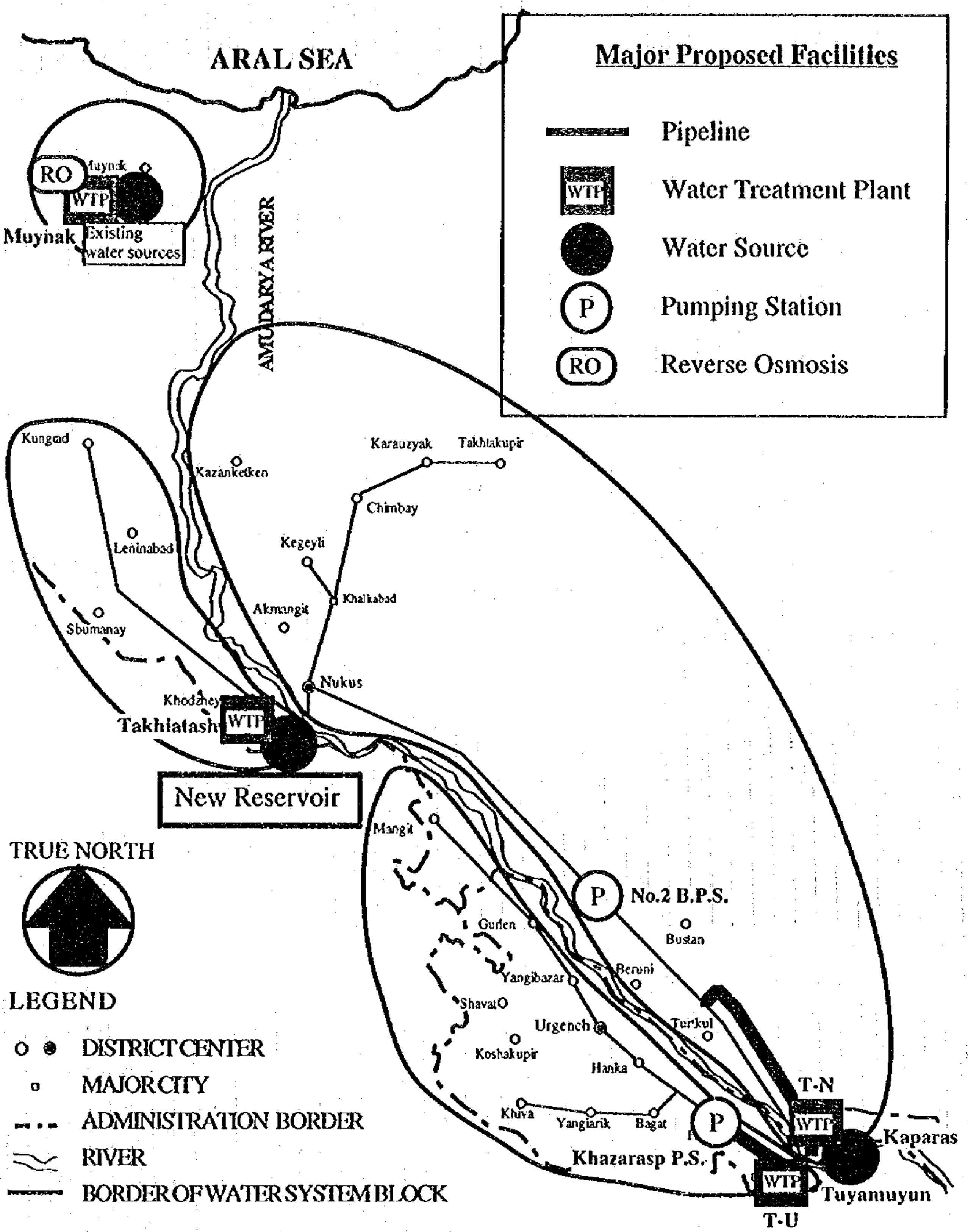
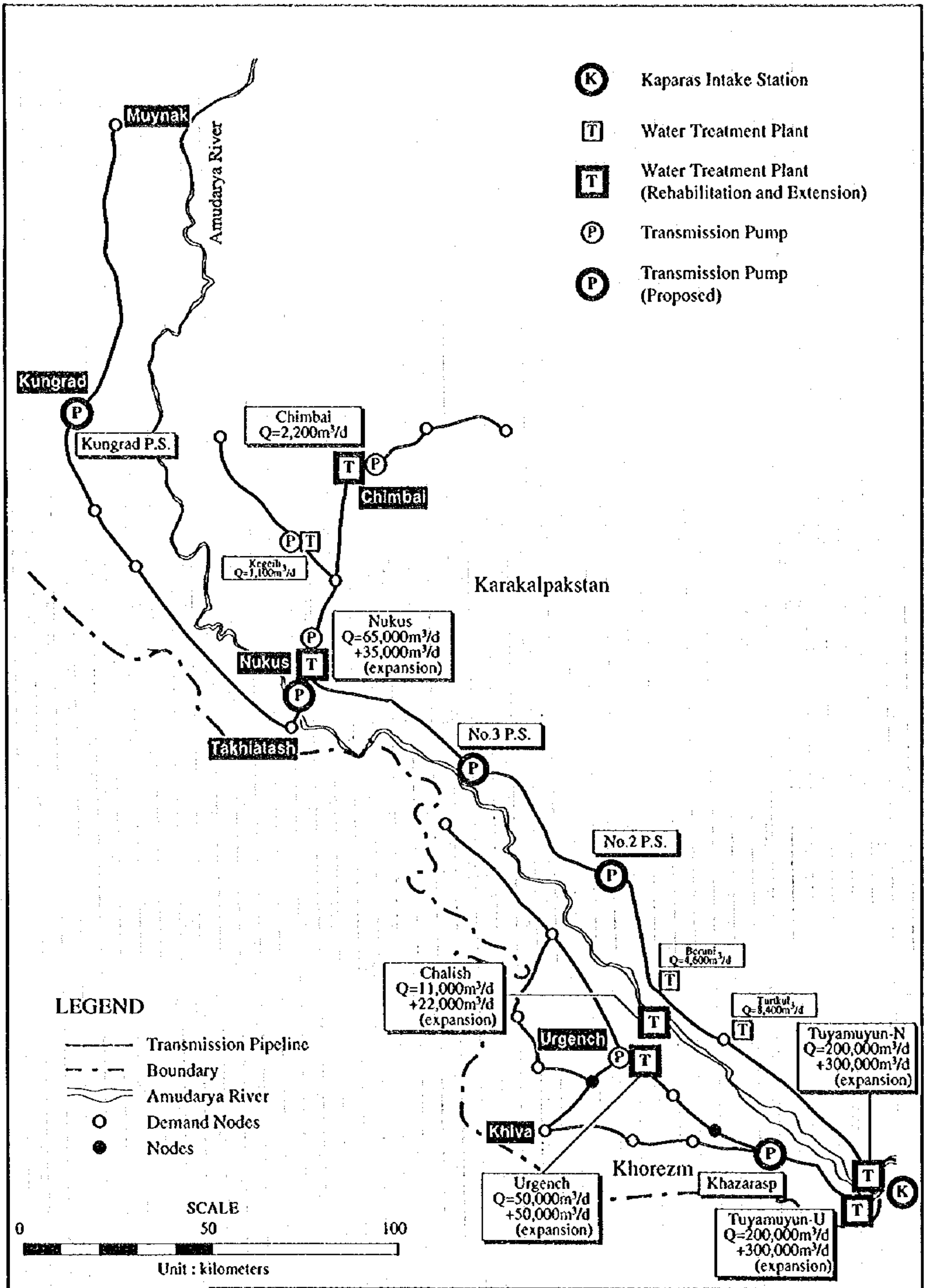


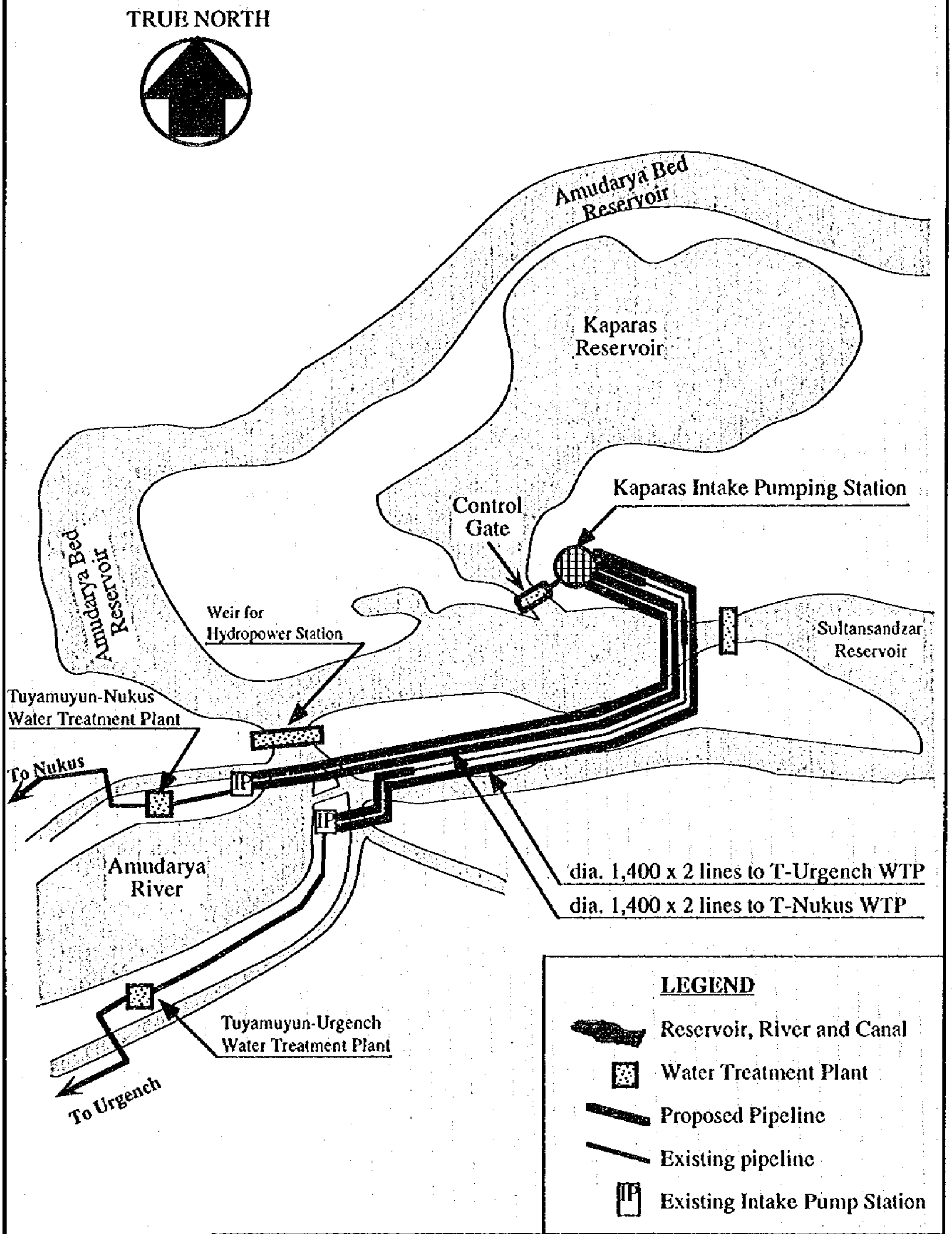
Fig. 8.7 Alternative 4-2



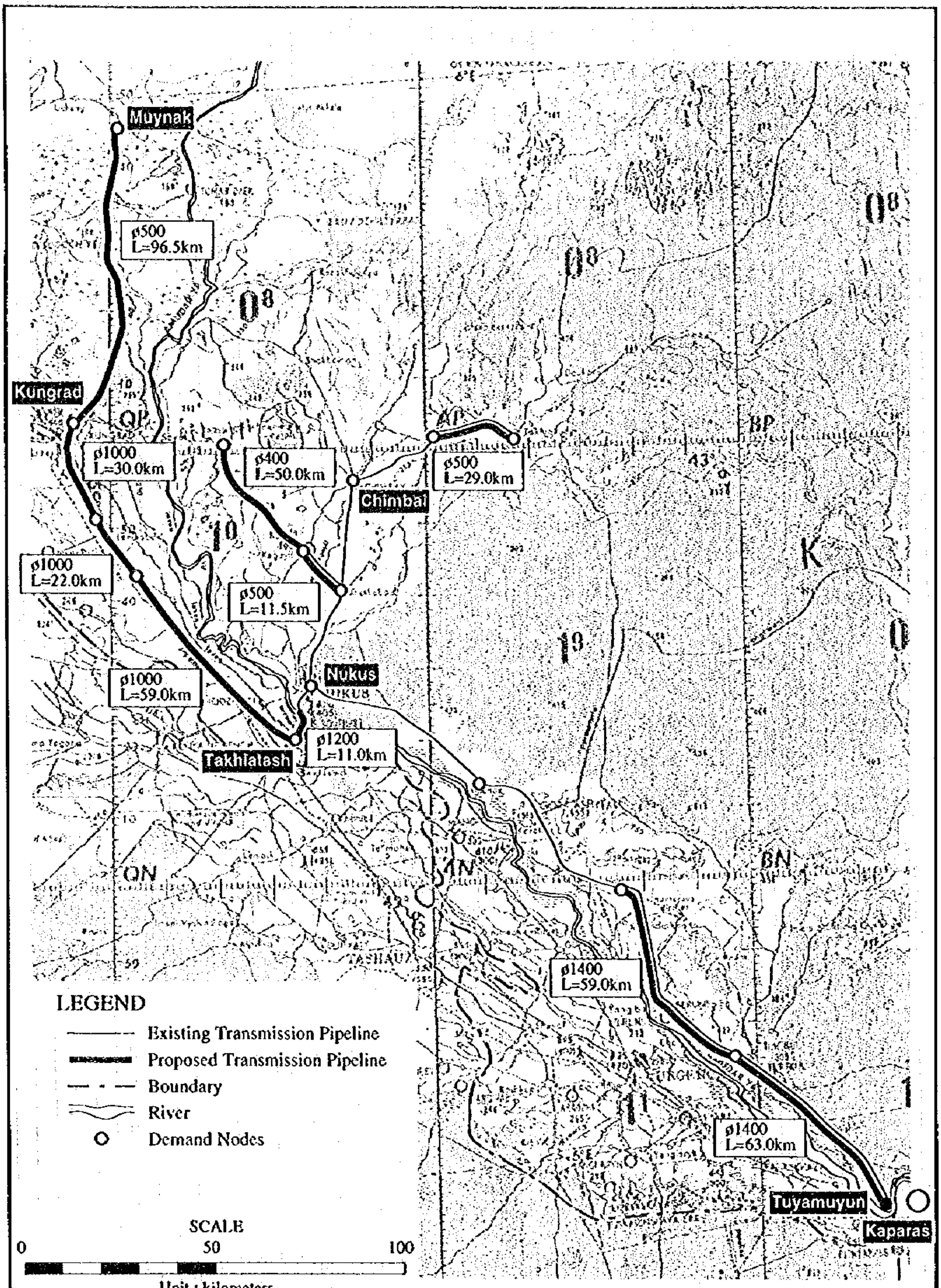
THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 8.8 Proposed Water Supply Sys. in 2010



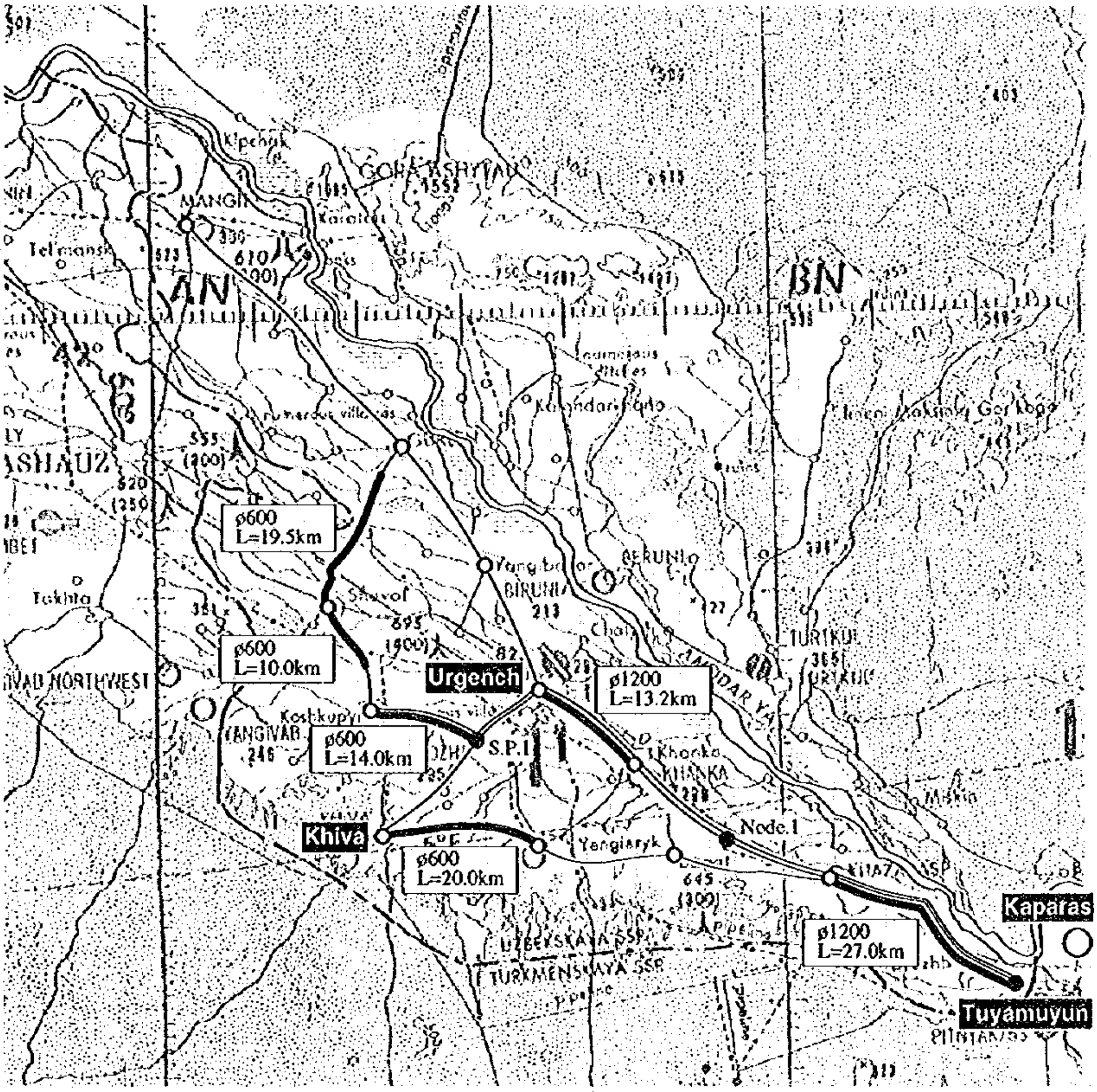
THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 8.9 Proposed Kaparas Intake Facility



THE STUDY ON
WATER SUPPLY SYSTEM IN SIX CITIES OF
THE ARAL SEA REGION IN UZBEKISTAN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 8.10
Proposed Transmission Sys.
(Tuyamuyun-Nukus 2010)



LEGEND

- Existing Transmission Pipeline
- Proposed Transmission Pipeline
- Boundary
- River
- O Demand Nodes
- ● Nodes

SCALE

0 50 100

Unit : kilometers

THE STUDY ON WATER SUPPLY SYSTEM IN SIX CITIES OF THE ARAL SEA REGION IN UZBEKISTAN	Fig. 8.11 Proposed Transmission Sys. (Tuyamuyun-Urgench 2010)
JAPAN INTERNATIONAL COOPERATION AGENCY	

Fig. 8.12 Implementation Schedule

Description \ Year		PHASE - I				PHASE - II			PHASE - III							Remarks
		0 1997	1 1998	2 1999	3 2000	4 2001	5 2002	6 2003	7 2004	8 2005	9 2006	10 2007	11 2008	12 2009	13 2010	
Loan Arrangement																
Preparation of Tender (Bids, Evaluations)																
1. Kaparas Raw Water Intake System																
1.1 Kaparas Intake Station	Q=1,000,000 m³/d															
1.2 Raw Water Mains																
1.2.1 Kaparas I.S. to T-N existing intake station	D=1,400 L=10.7 km															
1.2.2 Kaparas I.S. to T-N existing intake station	D=1,400 L=10.7 km															
1.2.3 Kaparas I.S. to T-U existing intake station	D=1,400 L= 1.0 km															
1.2.4 Kaparas I.S. to T-U existing intake station	D=1,400 L= 9.0 km															
2. Tuyamuyun-Nukus Water Supply System																
2.1 Water Treatment Plant	Q=500,000 m³/d															
2.1.1 Rehabilitation	Q=200,000 m³/d															
2.1.2 Expansion Phase-I	Q=150,000 m³/d															
2.1.3 Expansion Phase-III	Q=150,000 m³/d															
2.2 Transmission and Distribution Pumping Station																
2.2.1 No. 2 Booster Pumping Station	Q=306,940 m³/d															
2.2.2 No. 3 Booster Pumping Station	Q=306,940 m³/d															
2.2.3 Nukus North Distribution Station	Q=255,910 m³/d															
2.2.4 Kungrad Transmission and Distribution St.	Q= 55,020 m³/d															
2.3 Transmission Pipeline																
2.3.1 W.T.P. - No. 1 Pumping st.	D=1,400 L= 63.0 km															
2.3.2 No.1 P.S to No. 2 P.S.	D=1,400 L= 59.0 km															
2.3.3 Nukus - Takhiatash (Khodjeili) L=21 km	D=1,200 L= 11.0 km															
2.3.4 Takhiatash (Khodjeili) - Kungrad	D=1,000 L=131.0 km															
2.3.5 Kungrad - Muinak (Q=12,090 m³/d)	D=500 L= 96.5 km															
2.3.6 Khalkabad - Kegeili	D=500 L= 11.5 km															
2.3.7 Kegeili - Bozatau	D=400 L= 50.0 km															
2.3.8 Karauzyak - Takhtakupyr	D=500 L= 29.0 km															
3. Tuyamuyun-Urgench Water Supply System																
3.1 Water Treatment Plant	Q=500,000 m³/d															
3.1.1 Rehabilitation	Q=200,000 m³/d															
3.1.2 Expansion Phase - I	Q=200,000 m³/d															
3.1.3 Expansion Phase - III	Q=100,000 m³/d															
3.2 Transmission Pipeline																
3.2.1 W.T.P. - Khazarasp Pumping Station	D=1,200 L=27.0 km															
3.2.2 Khanki - Urgench	D=1,200 L=13.2 km															
3.2.3 Yangiaryk - Khiva	D=600 L=20.0 km															
3.2.4 S.P.I - Koshkupyr	D=600 L=14.0 km															
3.2.5 Koshkupyr - Shavat	D=600 L=10.0 km															
3.2.6 Gurlen - Shavat	D=600 L=19.5 km															
3.3 Transmission Pumping Station																
3.3.1 Khazarasp Pumping Station Phase-III	Q=256,290 m³/d															
4. VodoKanal Karakalpakstan																
4.1 Water Treatment Plant																
4.1.1 Nukus W.T.P (Rehabilitation)	Q= 65,000 m³/d															
4.1.2 Nukus W.T.P (Expansion) Phase-II	Q= 35,000 m³/d															
4.1.3 Chimbai W.T.P (Rehabilitation)	Q= 2,200 m³/d															
4.1.4 Water Treatment Plant (Rehabilitation), 3Cities	Q= 14,000 m³/d															
4.2 Distribution Network																
4.2.1 Replacement D=100～D=400	L=228.8 km															
4.2.2 Expansion D=100～D=400 Phase - I	L=119.6 km															
4.2.3 Expansion D=100～D=400 Phase - II	L= 66.0 km															
4.2.4 Expansion D=100～D=400 Phase - III	L=174.0 km															
4.3 Metering System																
4.3.1 Meter Installation D=20 Phase - I	N=37,710 Pieces															
4.3.2 Meter Installation D=20 Phase - II	N=30,390 Pieces															
4.3.3 Meter Installation D=20 Phase - III	N=73,660 Pieces															
5. VodoKanal Khorezm																
5.1 Water Treatment Plant																
5.1.1 Urgench W.T.P (Rehabilitation)	Q= 50,000 m³/d															
5.1.2 Urgench W.T.P (Expansion) Phase-II	Q= 50,000 m³/d															
5.1.3 Chalish(Rehabilitation)	Q= 11,000 m³/d															
5.1.4 Chalish(Expansion) Phase-II	Q= 22,000 m³/d															
5.2 Distribution Network																
5.2.1 Replacement D=100～D=400	L=170.3 km															
5.2.2 Expansion D=100～D=400 Phase - I	L= 71.5 km															
5.2.3 Expansion D=100～D=400 Phase - II	L= 30.0 km															
5.2.4 Expansion D=100～D=400 Phase - III	L= 60.0 km															
5.3 Metering System																
5.3.1 Meter Installation D=20 Phase - I	N=17,550 Pieces															
5.3.2 Meter Installation D=20 Phase - II	N=14,460 Pieces															
5.3.3 Meter Installation D=20 Phase - III	N=34,240 Pieces															

Fig. 8.13 Water demand and planned expansion capacity of W.T.P. in Karakalpakstan

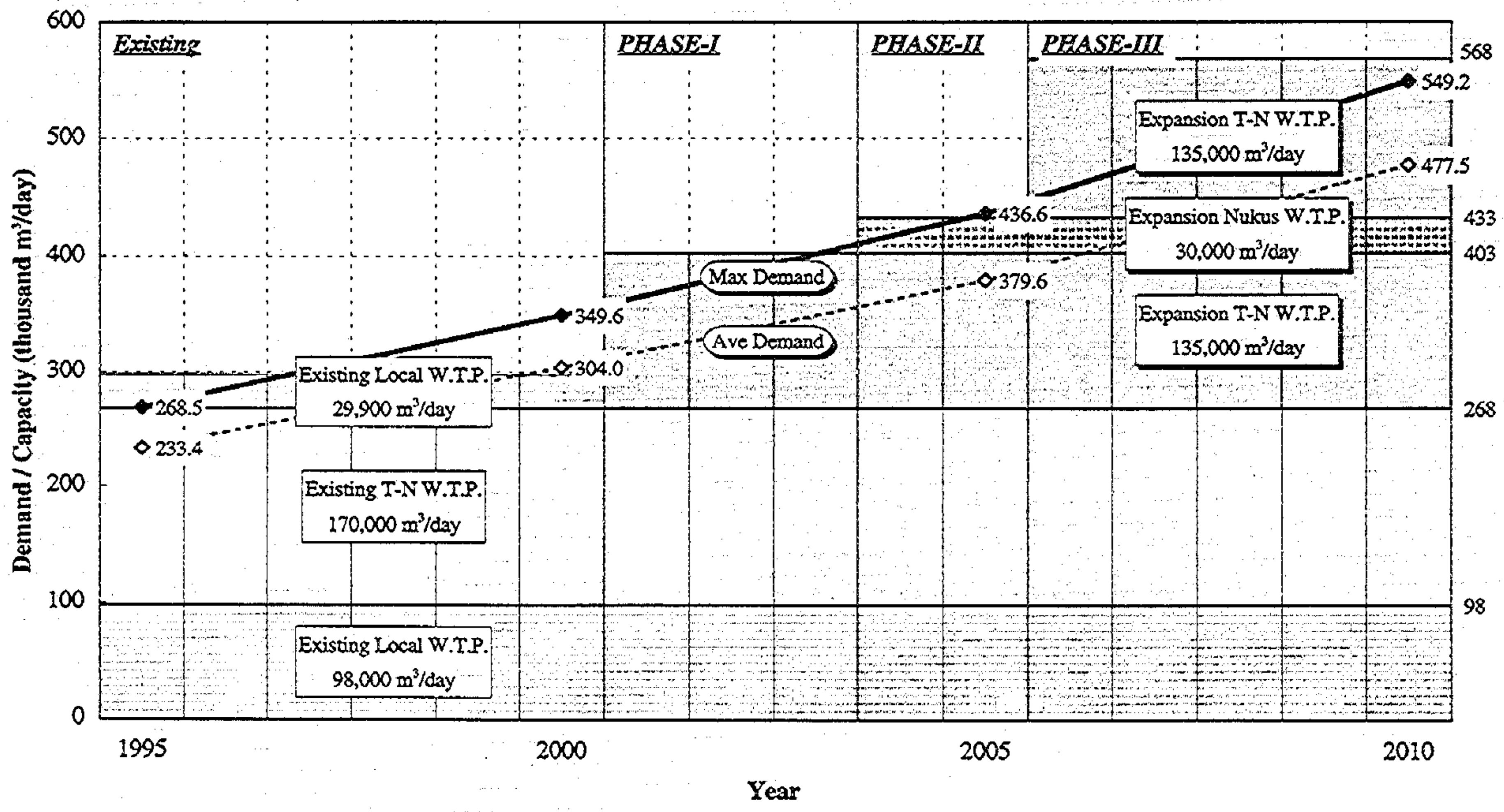
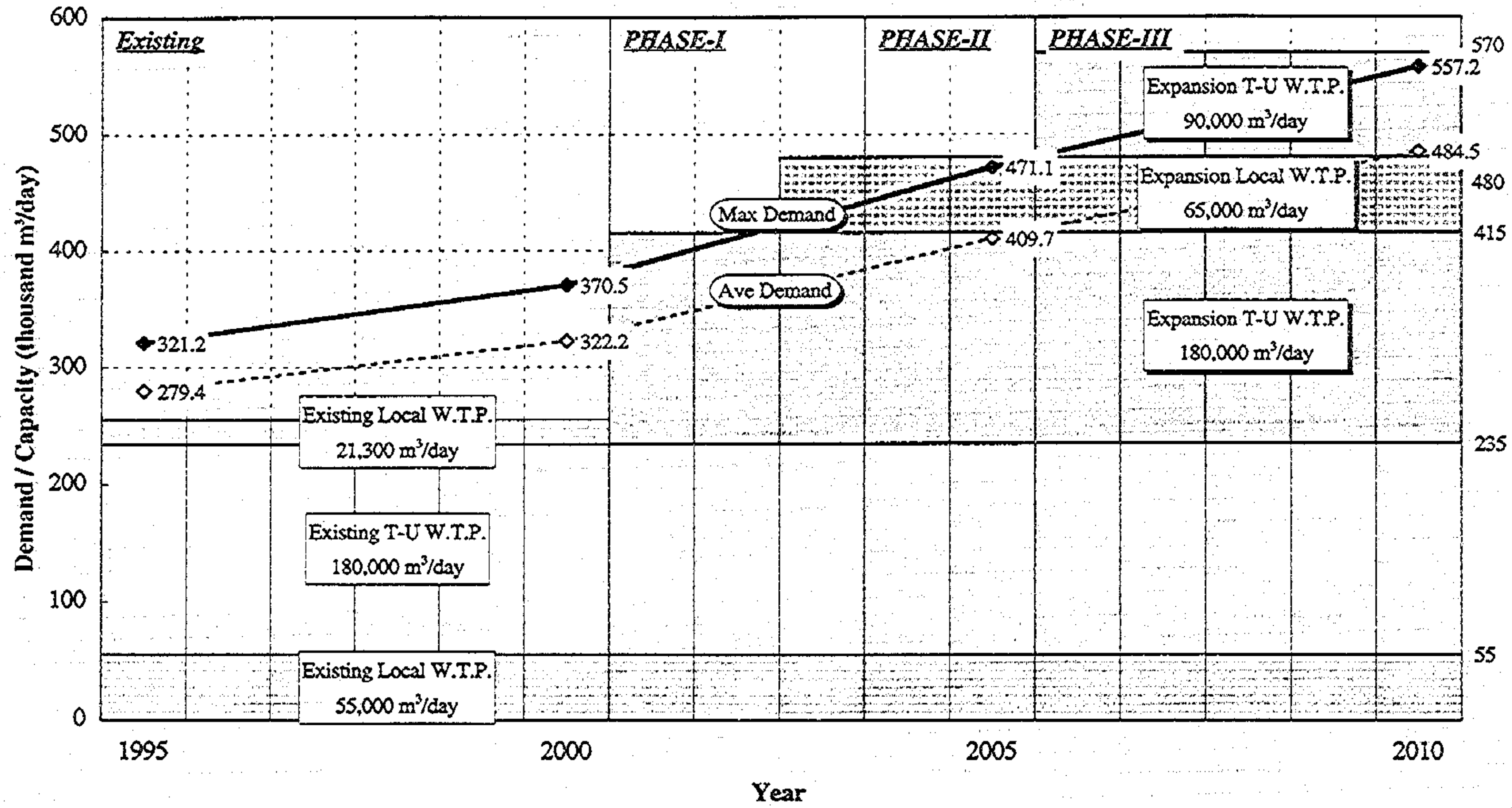


Fig. 8.14 Water demand and planned expansion capacity of W.T.P. in Khorezm



CHAPTER 9

PROJECT EVALUATION

CHAPTER 9 PROJECT EVALUATION

9.1 Introduction

The selected alternative of the Basic Plan for the improvement of water supply systems in the Study Area, has been discussed in Chapter 8 of the Main Report part 1.

Such a plan must however, be analyzed also from the financial and economic points of view. In this section, firstly the financial viability of the Basic Plan, including the Phases 1~3 of the project which is to be implemented over the period from year 1998 to 2010, is analyzed for the four entities involved, namely the two DOMIWPs of the Tuyamuyun Water Supply System:

(a)DOMIWP-T/N(In this chapter, referred to as T-N)

(b)DOMIWP-T/U(referred to as T-U)

and the two territorial level urban water supply enterprises:

(c)Vodokanal-ROK(referred to as KKP)

(d)Vodokanal-KZ(referred to as KZ)

The four entities can be grouped as Group-A (T-N with KKP) and Group-B (T-U with KZ) forming two separate groups in relation to the area they serve, being T-N and T-U as bulk water producers and KKP and KZ mainly as water distributors.

This analysis focuses on the financial feasibility of the total project in the Basic Plan by checking the viability of the respective Group-A and B and of all the four entities as individual self-supported enterprises. In proceeding with the analysis, first of all, the tariff for the three groups of Vodokanal consumers are assumed and the price of purchasing water from T-N or T-U is determined so that viability of both Vodokanals is secured for an appropriate discount rate. With the selling price of water from DOMIWPs to the Vodokanals having so obtained, the financial viability of both Vodokanals is secured for an appropriate discount rate. With the selling price of water from DOMIWPs to the Vodokanals having so obtained, the financial viability of T-N and T-U is then analyzed by calculating the Financial Internal Rate of Return (FIRR). Feasibility of the total project is evaluated thereafter by calculating the weighted average FIRR for the two groups of entities. If Uzbek side desire to obtain more improved rate of FIRR from DOMIWPs and/or Vodokanals, there will be solution to pursue alternative method such as by increasing consumers' water tariff and by supporting water enterprises with sufficient subsidies especially to the portion of construction cost.

9.2 General Assumption for the Analysis

For the analysis, the following assumptions were made with respect to fund procurement, water tariff levels, O&M costs etc.,

(a) Total Construction cost	: US$ 1,018,615 x 10^3
(b) Project life	: 30 Years
(c) Construction period	: 1998 ~ 2010 (Total)
Phase 1	: 1998 ~ 2000
Phase 2	: 2001 ~ 2003
Phase 3	: 2004 ~ 2010
(d) Base year for analysis	: 1998 (starting year of construction)
(e) Base of cost estimate	: 1996 prices (unescalated)
(f) Monetary unit	: US Dollar (US$)
(g) Rate of Exchange	: 1 US$ = 40 sum (as of July 1996)
(h) Water tariff	: Assumed as in Section 9.3
(i) O&M cost	: Operation and maintenance cost is determined based on actual expenditure shown in the financial statement and assumed to be made up of two components; O&M cost except depreciation that depends on the volume of water sold (accounted-for water), and additional annual cost of replacement and maintenance of facilities and water meters. For details refer to Chapter 8 and Section 9.4 Part 1 of the Main Report.
(j) Discount rate	: 7.5% per annual, as the rate currently offered by most international funding agencies.

9.3 Water Tariff

A high percentage (about 75 ~ 90%) of the O&M cost of both T-N and T-U have been subsidized by the government up to now. If such subsidies are to be gradually reduced, it is obvious that revenue of these entities should be increased by raising the selling price of the water they produce. This means that, on the other hand the Vodokanals, for their own financial stability, must cover the corresponding increase in the cost of water by appropriately increasing their tariffs. However, the tariffs should be acceptable by the consumers and the possible upper level of tariff will be governed by several factors including, affordability and willingness-to-pay which are related to income and comparison with current tariff and tariff of other public utility services, impact on industrial/production sectors, social security measures (such as privileges given to some consumers in Group-1) etc. Therefore in this analysis, these factors were taken into careful consideration in assuming the tariff for respective consumer groups.

(1) Assumed Consumer group-wise tariffs

The tariffs assumed in this analysis for three consumer groups to be served by the Vodokanals KKP and KZ are given in Table 9.1 and 9.2 in comparison with the current tariff as of June 1996.

(2) Basis of assumption of consumer group-wise tariffs.

(2) -1 As for Group 1;

(a) Household Expenditure on piped-water

As shown in Table 7.12 of chapter 7 of Part 1 report, household water expenditure in the study area is much lower than those of other utility services like electricity and gas. It is advisable that this family expense on water should be raised closer up to the international standard level. In this respect, world tendency in the developing countries stands between 2~5% and according to the World Bank literature "Investing in Development, Lessons of World Bank Experience" 4 % is upper limit.

(b) Average water expenditure of the households is 0.31% in Jan.1995, and 0.48% in Jan. 1996 as shown in Table 7.15 of chapter 7 of Part 1. With the assumed 2% of water expenditure as a upper limit in the study area, assumed water tariff for Group 1 was obtained as follows,

Table 9.1 Assumed Tariff for Group 1

	A) Current Tariff per m³		B) Assumed Tariff per m³		Ratio A/B
KKP	0.50sum	0.0125US$	2.10sum	0.0525US$	4.2
KZ	0.35sum	0.0087US$	1.47sum	0.0368US$	- 〃 -

(2) -2 As for Group 2 and Group 3,

Currently, consumers of these two groups are frequently complaining the tariff level, sometimes very reluctant to close the agreement. Even some consumers are planning to secure own water sources for self-supply without receiving from water supply enterprises due to expensive cost.

Accordingly it may be considered that water tariffs of these groups are already on the limit level of willingness-to-pay of the consumers. In view of the above, the assumed tariffs of Group-2, and 3 were determined same as the current tariffs as follows.

Table 9.2 Assumed Tariff for Group 2 and 3

		A) Current Tariff per m³	B) Assumed Tariff per m³	Ratio B/A
KKP	Group 2, and 3	9.64sum (US$0.241)	same as A)	1.0
KZ	Group 2(Ave.)	6.38sum (US$0.159)	- // -	//
	Group 3	7.90sum (US$0.198)	- // -	//

Thus, the relevant Ave. tariffs of Vodokanals are summed up below.

Table 9.3 Comparison of Weighted Ave. Tariffs

	A) Current Ave. Tariff per m³		B) Assumed Ave. Tariff per m³		Ratio B/A
KKP	5.198sum	0.130US$	5.976sum	0.149US$	1.15
KZ	3.313sum	0.083US$	3.937sum	0.098US$	1.19

9.4 Operation and Maintenance Cost

Basic concept on the O&M cost of basic plan was discussed in section 8.6.3 of part 1. Assumed data of the O&M cost adopted in the analysis are summarized in Table 9.4. The followings are some additional explanations.

(1) Basic O&M cost: unit cost per m^3 of AFW(Accounted-for Water)

Calculation is made from the itemized expenditure records per m^3 of AFW except depreciation cost. Total unit cost by each enterprise was applied to the starting year of the construction. Therefore, annual O&M cost vary depending on the volume of AFW.

(2) Electricity and Chemicals

Electricity cost will be increased on the completion of Kaparas intake system, transmission and distribution pumping stations in different stages. Chemical consumption's, on the other hand, will be decreased on the part of Tuyamuyun Facilities upon the utilization of water sources from Kaparas Reservoir.

(3) Repairs

Upon the completion of each of the facilities such as Kaparas Intake Station, Water Treatment Plant (Rehabilitation and Expansion) and transmission/distribution pumping station except Raw Water Mains, transmission pipeline and distribution network which shall be covered by depreciation cost, 0.5% of relevant asset value of the facilities are added to the annual repair cost from the following year.

As for water meters, replacement cost is assumed to be added as a part of repairs after ten (10) years on average from the installation.

Details of the above cost information of each enterprise are referred to Table 9.4.

9.5 Result of Financial Analysis and Observations

Calculation was made to obtain Financial Internal Rate of Return (FIRR) by the assumed condition as per Section 9.2 and by the water Tariff as per Section 9.3. As a principle, it is a requirement of "Financial Viability" to get revenue from the project enough to cover total investment cost. In this project, water tariff level was assumed at a lower side by the request of Uzbek side while the total investment costs remain huge even after the project has been reduced and rescheduled.

The followings are results and comments from these analysis.

(1) Case of 0% subsidies to the construction cost;

It was presumed that the total investment cost should be recovered by the total revenue under the assumed discount rate during the project life.

However due to the very low revenue rate, KKP's annual balance of account is constantly in the deficit, being naturally unable to obtain water purchasing rate, and KZ's obtained water purchasing rate is not enough to cover even T-U's O&M cost, being unable to get FIRR. Thus in total, this case can be said as "not feasible" as conclusion.

(2) Case of 100% subsidies to the construction cost;

The construction cost can be off-set by the corresponding 100% subsidies, and it is minimum requirement to cover the total O&M cost by the water revenue during the project life.

In this case, results are summarized as under.

Table 9.5 Viability under 100% Subsidies

	Group-A			Group-B		
	KKP	T-N	Total in Group	KZ	T-U	Total in Group
Ave. Water Tariff US$/m³	0.158 (0.213)			0.134		
Water Purchasing US$/m³	0.120 (0.189)			0.129		
Water Sales US$/m³		0.120 (0.189)			0.129	
Aggregated Balance of account	Balanced (Balanced)	Deficit (Balanced)	**Deficit (Balanced)**	Balanced	Surplus	Surplus

Note: Assumed Water Tariff is fixed and unescalated.

From the Table 9.5, Group-A has not viability, While Group-B appears viable under the assumed water tariff.

However Group-A can be viable by manipulating the Ave. water tariff by increasing to some extent independently from Group-B. As a result of manipulation of the water tariff of Group-A, obtained water tariff / water selling rate / water purchase rate are shown in Table 9.5 as parenthesized. In this case, Ave. Tariffs of KKP come out 1.64 times the current Ave. Tariff. Fore more accurate analysis, it is necessary to check the financial projection especially cash flow progress by year.

On the other side it must be taken into consideration that for such huge investment, if subsidies of the GOU depend on the money from the international fund procurement, it will be very difficult to find the available fund sources because of the amount of credit being limited against Uzbekistan.

To sum up all these factors, Basic Plan as a whole is not financially feasible or viable either without increased water tariff and / or sufficient subsidies.

Table 9.4 Basis of Calculation of O&M Cost
(For the Analysis of Total Basic Plan and Phase-1 of B/P)

1) K K P and K Z

No.	Stage of Project	Details of O&M Cost to be applied in the Analysis					
		KKP			KZ		
		Year	Item	Description	Year	Item	Description
1	phase I ~phase III	1998~ 2027	Basic Cost /m³ · AFW	US$ 0.0589(2.354 sum) as per Table 8.34	1998 ~2027	Basis Cost /m³ · AFW	US$ 0.0281(1.122 sum) as per Table 8.34
2	phase II ~phase III	2001~ 2027	Repairs	US$ 25,900×10³×0.5%per year =US$ 129,500/Year (Item 4.1.1, 4.1.3, 4.1.4)	2000(PH-1) ~2027	Repairs	US$ 21,600×10³×0.5% per year =US$ 108,000/Year (Item 5.1.1, 5.1.3)
3	phase III	2004~ 2027	Repairs	US$ 10,600×10³×0.5% per year =US$ 53,000/Year (Item 4.1.2)	2003(PH-2) ~2027	Repairs	US $15,300×10³×0.5% per year =US$ 76,500/Year (Item 5.1.2, 5.1.4)
4	phase III	2008~ 2027	Repairs	Water Meter Replacement US$ 210,000/Year	2008 ~2027	Repairs	Water Meter Replacement US$ 98,000/Year

2) T—N and T—U

No.	Stage of Project	Details of assumed O&M Cost to be applied in the Analysis					
		T—N			T—U		
		Year	Item	Description	Year	Item	Description
1	phase I	1998 ~1999	Basic Cost /m³ · AFW	US$ 0.1047(4.186 sum) as per Table 8.33	1998 ~1999	Basis Cost /m³ · AFW	US$ 0.0716(2.864 sum) as per Table 8.33
2	phase I	2000	Basic Cost /m³ · AFW	US$ 0.1036(4.143 sum) as per Table 8.33	2000 ~2027	Basis Cost /m³ · AFW	US$ 0.0634(2.535 sum)
3	phase II	2001 ~2027	Basic Cost /m³ · AFW	US$ 0.1532(6.130 sum) Increase of Electricity (Ttem 2.2.1, 2.2.3, 2.2.4) as per Table 8.32	2001 ~2027	Repairs	US$ 78,750×10³×0.5% per year =US$ 393,750/Year (Item 3.1.1, 3.1.2)
4	phase II	2001 ~2027	Repairs	US$ 97,350×10³×0.5% per year =US$ 486,750/Year (Item1.1,2.1.1,2.1.2,2.2.1,2.2.3,2.2.4)	—	—	
5	phase III	2006 ~2027	Repairs	US$ 54,100×10³×0.5% per year =US$ 270,500/Year (Item 2.1.3, 2.2.2, 2.2.4)	2006 ~2027	Repairs	US$ 41,700×10³×0.5% per year =US$ 208,500/Year (Item 3.1.3, 3.3.1)
6	phase III	2006 ~2027	Basic Cost /m³ · AFW	US$ 0.1903(7.613 sum) Increase of Electricity (Item 2.2.2) as per Table 8.32	—	—	

Note : PHASE I : Year 1998~2000, PHASE II : Year 2001~2003, PHASE III : Year 2004~2010

AFW : Accounted-for Water

For item No., refer to Table 8.31.

9.6 Steps for the financial Improvement

Followings are some effective measures for getting improvement toward implementation of the project.

(1)Need to reduce the investment cost of the project by reviewing from the technical and economical view point.

(2)Need to reduce especially the huge investment of phase 1 during the first three years, corresponding 60 % of total.

(3)Need to supply subsidies from the GOU, flexibly when it is necessary if the water tariff may not be raised above the assumed tariff herein.

(4)Need to increase the revenue by the diversification of the sources, such as fee of meter connection service and penalty charge for over volume consumers than the contracted.

(5)Need to adopt the system of gradual increase of the water tariff step by step according to the economic development of the study area.

9.7 Recommendation

As a general rule, water supply enterprise should be self-efficient on its own water revenue enough to cover regular services and the capital investment. In this particular case, due to the fact that water tariff is much lower than the international level and construction cost is huge especially in the initial stage for phase-1, some special counter-measures should be contemplated.

It is essential and recommendable that this counter-measures should be finally decided by Uzbek side such as arrangement of special loan to water enterprises, arrangement of the government support as subsidies, setting up the water tariff as an international level.

CHAPTER 10

INITIAL ENVIRONMENTAL EXAMINATION

B/P

CHAPTER 10 INITIAL ENVIRONMENTAL EXAMINATION

10.1 Concept of Environmental Consideration

Environmental destruction has been proceeding on a global scale today. The environmental damage to the Aral Sea region may be considered as one such example. There have been many alarming reports about the contamination of drinking water, the source of which is the Amudarya river, and the adverse effects on the health of the inhabitants of the region because of the environmental destruction. An objective of this Study is to improve the quality of water supplied to this region.

"Environmental Consideration" has been defined in this project as "consideration of countermeasures to prevent and mitigate excessive environmental impacts due to a development project by carrying out investigations to check and assess environmental impact." The prerequisite of this definition is the awareness that development aid is sustainable and not a temporary measure. That is, environmental consideration is a necessary requirement for ensuring sustainable development.

If environmental consideration is inadequate, for instance, if the control of natural resources (i.e. water, energy, etc.) in the surroundings during the implementation of a development project is neglected, the base for development itself is lost and development cannot be sustained. Moreover, this will also lead to a situation where the basis of livelihood and survival of the inhabitants is endangered. Consequently, sustainable development that takes into account a good balance between the development project and the natural resources in the surroundings, and the foundation of livelihood and survival of the inhabitants, is essential.

That is, the fundamental policy for environmental consideration in JICA is to promote sustainable development for improving the livelihood of people according to the wishes of the country for which the Study is being carried out, and to assist in achieving harmony with the environment.

Neglect of this environmental consideration and plans that give priority to economic aspects have resulted in the destruction of the environment on a global scale today. The environmental crisis of the Aral Sea is a typical example of how the environmental consideration has been neglected.

10.2 Guidelines For Initial Environmental Examination

(1) Uzbekistan Environmental Regulations

The basic environmental law regulating every environmental law and regulation has entered into force. For water environment, there are several laws and regulations such as Water Works Law and Regulation for Industrial Effluent Control. Laws and regulations on Environmental Impact Assessment (EIA) have not been entered into effect in Uzbekistan[1].

(2) Environmental Guidelines of the JICA Study Team

During the study, the environmental impacts of the project on the regional environment will be examined. Results of the examination will be evaluated, and if necessary, measures to prevent or mitigate environmental impacts will be framed. The Study needs an Initial Environmental Evaluation (IEE) during the basic planning stage, and an EIA at the feasibility study stage based on the results of the IEE.

According to JICA's policy on environmental examination for international cooperation projects, IEE (or EIA as required) shall follow the environmental guidelines of the host country as far as possible. But if there are no guidelines available in that country or the guidelines are insufficient, Environmental Guidelines prepared by the JICA Study Team (JICAEG) shall be adopted. Considering the present situation in Uzbekistan, IEE for this project is to be made using JICAEG.

Based on JICAEG, the major environmental elements to be examined for water supply projects are as follow. Details are given in later section.

i) Pollution.
ii) Natural environment.
iii) Social environment.

10.3 Existing Condition and Background for Environmental Study

In general, the environmental impact of a water supply project is considered to be very

[1] It is not until the final stage of this Study that the Study Team noticed that the ROU had the law and the regulation for EIA as follows. Since 1993 a system for EIA in the ROU has been in effect. Requirements regarding EIA procedures are specified in Guideline and Construction Norm and Rules (RD 118.0027714.24-93, RD 118.0027714.22-93 and KMK 1.03.01-96)

minimal, but as long as there is a possibility of an impact, environmental consideration (study) of the project is necessary. The IEE for the proposed water supply system in the chapter 8 is discussed here.

Prior to the environmental study, the existing condition and background of the study and the existing & proposed water supply system are briefly summarized in this section. For details please refer to other parts of this report.

(1) Existing Condition of the Study Area

The existing condition of the Study Area is detailed in Chapter 2

(2) Existing and Proposed Water Supply System

Details of the existing and proposed water supply system and plan are given in Chapters 3, 4 8. Both water supply systems, classified as Tuyamuyun and Local (VodoKanal) system, are briefly compared in Table 10.2 to identify the differences.

(3) Major Works in the Proposed Plan

The facilities in Table 10.2 are to be constructed or rehabilitated.

Table 10.1 Comparison between Existing and Proposed Water Supply System

Item	Existing system	Proposed system
Tuyamuyun System (Tuyamuyun-Nukus and Tuyamuyun-Urgench)		
1. Water sources	Irrigation canals at the Tuyamuyun gorge (Kaparas reservoir for water source has been completed but is not in operation.)	Kaparas reservoir (Kaparas reservoir will be put into operation.)
2. Water intake	Each water treatment plant has intake facility near the plant.	New intake facility will be put into operation at Kaparas reservoir.
3. Raw water main	From water intake points to the existing water treatment plants	From Kaparas reservoir to the existing water treatment plants
4. Water treatment plant	Tuyamuyun-Nukus and Tuyamuyun-Urgench water treatment plants	Both plants will be partially rehabilitated and expanded to meet future demand.
5. Transmission system	There are several pipelines and pumping stations for distributing water to regions and cities.	Some pipelines and pumping stations will be added.
Local (VodoKanal) System		
1. Water source	There are several water sources. Details are given in chapter 5.	Some of the existing water sources are used.
2. Water intake	Intake points are located in the vicinity of the existing water treatment plants	Some of the existing water intakes are used.
3. Water treatment plant	There are several water treatment plants.	Some plants are rehabilitated, improved and expanded.
4. Distribution system	There are existing distribution water networks and pumping station.	Aged and corroded pipes are replaced and water networks are extended.
5. Water Meter	Water meters now are installed for some of 2nd and 3rd group customers.	Water meters are installed for all customers.

Table 10.2 Construction and Rehabilitation Works

Proposed facilities and equipment	Proposed Rehabilitation
Tuyamuyun system	
1. Kaparas intake pumping station 2. Raw water main 3. Water treatment plants (Expansion) 4. Transmission pumping stations 5. Transmission pipelines (Extension)	1. Water treatment plants
Regional (VodoKanal) system	
1. Water treatment plant (Expansion) 2. Distribution network (Extension)	1. Water treatment plants 2. Aged and corroded distribution network

10.4 Environmental Impact Screening

(1) Environmental Examination Matrix

An environmental examination matrix (EEM) is a useful tool for a brief screening of the project's impact on the environment. The components of the matrix include project activities and environmental elements.

1) Project activities
According to the plan, construction / rehabilitation and operation of the facilities as stated in the Table 10.2 are included in the project activities. In addition, operation of Kaparas reservoir and increase in sewage water as a result of development of water supply are considered as environmental activities.

2) Environmental elements
These are mentioned in the section 10.2 and Table 10.4 -a and b.

(2) Environmental Impact Screening by EEM

Table 10.4 -a and b show the EEM for this project using the above mentioned matrix components. The EEM is utilized for the first screening in this study. All the environmental elements are screened with reference to each project activity.

Also the Uzbek side, VodGEO, has prepared the results of screening and scooping by the EEM as shown in the Supporting Report.

As indicated in the table, from viewpoints of environmental elements, the following elements cannot be ignored during overall project activities and need to be examined at feasibility study further.

1) Noise and vibration
2) Landscape
3) Archaeological treasures

On the other hand, from the view point of the project activities, the following activities may have an impact on the environment in the study area and need to be examined at feasibility study further.

1) Operation of the Kaparas reservoir
2) Operation of the water treatment plant

3) Increase in sewerage water as the water supply system develops (Vodokanal system)

In addition, the following specific activities are to be considered:

1) Rehabilitation and replacement of existing facilities, and increase of solid waste.
2) Construction of pipelines that hinders traffic.

Table 10.4-a Environmental Examination Matrix (Tuyamuyun System)

Environmental Elements	Project Activities	Operation of Kaparas reservoir	Intake pumping station		Raw water main		Water treatment plants		Rehabilitation of existing plants		Transmission pipelines		Transmission pumping station	
		O	C	O	C	O	C	O	C	O	C	O	C	O
Pollution	Offensive Odor	O												
	Ground Subsidence													
	Noise and vibration		O	O	O		O	O	O		O		O	O
	Soil pollution							O						
	Water pollution	O						O						
	Air Pollution													
Natural Environment	Landscape		O	O	O		O	O					O	O
	Weather													
	Flora and Fauna	O												
	Coastal and sea areas													
	Lake and rivers	O						O						
	Groundwater	O												
	Soil erosion													
	Topography/Geography													
Social Environment	Risk of disaster													
	Solid waste							O	O					
	Public health													
	Water right	O												
	Archaeological treasures		O	O	O	O	O	O			O		O	O
	Traffic/public facilities				O						O			
	Economic activities													
	Area Separation													
	Resettlement													

Note C: Construction phase, O: Operation phase
Shaded area: No impact is anticipated; Circle: Impact cannot be ignored and further examination is needed.

Table 10.4-b Environmental Examination Matrix (Vodokanal System)

Environmental Elements	Project Activities	Water treatment plants		Rehabil. of existing plants		Distribution network		Sewerage increase
		C	O	C	O	C	O	
Pollution	Offensive Order							O
	Ground Subsidence							
	Noise and vibration	O	O	O	O	O		
	Soil pollution		O					O
	Water pollution		O					O
	Air Pollution							
Natural Environ-ment	Landscape	O	O					
	Weather							
	Flora and Fauna							
	Coastal and sea area							
	Lake and rivers		O					O
	Groundwater							O
	Soil erosion							
	Topography/Geography							
Social Environ-ment	Risk of disaster							
	Solid waste		O	O				
	Public health							O
	Water right							
	Archaeological treasures	O	O			O		
	Traffic/public facilities					O		
	Economic activities							
	Area Separation							
	Resettlement							

Note C: Construction phase, O: Operation phase
Shaded area: No impact is anticipated; Circle: Impact cannot be ignored and further examination is needed.

Terminology

Environmental Impact

Refers to adverse effects on the overall environmental situation that encompasses atmosphere, water, soil, living organisms and assets, social data, distribution, relevant to livelihood and their mutual relations.

Preliminary Environmental Survey

An environmental study implemented in the preliminary stage. The Preliminary Environmental Survey is meant for carrying out screening and scooping of the environmental effects of a project; it is ranked as a part of the Initial Environmental Examination

Initial Environmental Examination (Initial Environmental Evaluation) (IEE)

It refers to the evaluation during the very initial stage of formulating plans of a development project of the environmental effects, which are predicted by acquiring existing and readily available information and data, or by referring to judgments of experts having a good knowledge of environmental effects of similar projects. Another objective of this examination is to investigate environmental relief measures from environmental considerations for a project that does not require EIA.

Environmental Impact Assessment (EIA)

Environmental Impact Assessment refers to the study of environmental effects for a development project for which detailed investigations on environmental effects are considered to be necessary, prediction and assessment of the effects, setting environmental conservation targets and specifying measures to prevent or mitigate adverse effects on the environment.

Environmental Management Plan

The Environmental Management Plan here refers to a plan for establishing a monitoring system or method considering environmental conservation targets during or in parallel with the implementation of a project for monitoring the environmental impact on the surroundings with the aim of conserving the environment appropriately.

Screening

Screening refers to the action of judging whether the implementation of environmental consideration is necessary or not for a development project. The screening carried out within Japan for prior surveys is called preliminary screening.

Scooping

Scooping refers to clearly defining the study items for Initial Environment Examination (IEE) and Environmental Impact Assessment (EIA) by finding out the items considered to be important from environmental impacts that are predicted to occur together with the implementation of the development plan or development project.

PART II FEASIBILITY STUDY

CHAPTER 1

SELECTED PROJECTS FOR FEASIBILITY STUDY

CHAPTER 1 SELECTED PROJECTS FOR FEASIBILITY STUDY

1.1 Introduction

This part of the report consists of seven chapters: Chapter 1 describes planning conditions and selection of high priority projects (facilities) for the feasibility study. Chapter 2 describes the engineering design of the facilities selected for the feasibility study. Chapter 3 deals with operation and maintenance aspects. Chapter 4 proposes improvement plans for management and organization. Chapter 5 presents the cost of the Project and its implementation schedule. Chapter 6 deals with the most important part of this report, that is, project evaluation. Chapter 7 is environmental impact assesement and Chapter 8 is the conclusion.

The Basic Plan for improving the water supply system giving emphasis to drinking water quality in the Study area, has been formulated as part I of this report. Following the Basic Plan, a feasibility study for the high priority projects that mainly contribute to improving water quality, was conducted as discussed in Part II of this report. The priority projects for the feasibility study have been selected from the Basic Plan to meet the water demand in the target year.

1.2 Planning Conditions

(1) Target Year

The target year for the Basic Plan is 2010 with the probable start of this project taken as 1997. The construction will start from 1998. After discussions with the Uzbeki side, the target year for the feasibility study was set at the end of 2002, 5 years after the start of the project. The high priority projects (facilities) are, therefore, selected from the Basic Plan to meet the water demand in 2002.

(2) Water Supply System

In the Basic Plan, plans for the inter-regional water supply system - the Tuyamuyun system, and the regional water supply system - Vodokanal system, have been formulated based on the selected water supply system for the Study Area. The plan for the feasibility study is formulated based on these water supply systems.

The Uztransgas water supply system now provides water to some cities in the Study

Area. After discussions with the Uzbeki side, it was decided to separate this water supply system from the Tuyamuyun water supply system in future, that is; to stop depending on the water supply from the Uztransgas system when the Tuyamuyun system goes into full operation. Consequently, the inter-regional water supply system in the Study area will be integrated into a single system, namely the Tuyamuyun system.

(3) Population and Water Demand

The population and the water demand of the Study Area were projected for the years 2000, 2005 and 2010 in the Basic Plan. The population and water demand in the year 2002 are estimated by proportional allotment of the figures for 2000 and 2005. The summary of the figures so calculated are shown in Table 1.1 (by territory) and Table 1.2 (by Tuyamuyun system). Table 1.3 shows population and water demand by city or district.

Table 1.1 Summary of Population and Water Demand by Territory in 2002

District	Total population (ths.)	Coverage rate (%)	Served population (ths.)	per capita consump. (l/ca./day)	Average water demand (ths. m^3/d)	Maximum water demand (ths. m^3/d)
Karakalpakstan						
urban	746.2	92.4	689.3	442	304.6	350.2
rural	843.1	61.3	516.8	106	55.0	63.2
sub-total	1,589.3	75.9	1,206.1	298	359.6	413.5
Khorezm						
urban	368.2	97.0	357.1	650	232.1	266.9
rural	1,098.1	69.4	762.6	131	99.8	114.8
sub-total	1,466.3	76.4	1,119.7	296	331.9	381.7
total	3,055.6	76.1	2,325.8	297	691.5	795.2

Note : Per capita consumption includes water consumption for Group(1), Group(2) and Group(3).

Table 1.2 Summary of Population and Water Demand by Tuyamuyun System in 2002

District	Total population (ths.)	Coverage rate (%)	Served population (ths.)	per capita consump. (l/ca./day)	Average water demand (ths. m^3/d)	Maximum water demand (ths. m^3/d)
T-Nukus						
urban	712.7	92.4	658.4	435	286.3	329.2
rural	731.1	61.7	451.3	106	48.0	55.2
sub-total	1,443.8	76.8	1,109.7	301	334.3	384.4
T-Urgench						
urban	401.7	96.6	388.0	645	250.4	287.9
rural	1,210.1	68.4	828.1	129	106.8	122.9
sub-total	1,611.8	75.4	1,216.1	294	357.2	410.8
total	3,055.6	76.1	2,325.8	297	691.5	795.2

Note : Per capita consumption includes water consumption for Group(1), Group(2) and Group(3).

In Vodokanals, consumers are classified in three (3) categories with different basic tariffs. They are;

- Group (1): The Residents
- Group (2): Budgetary Institutions, Self-Sufficient Sanatoria and Health Resorts, Medical and Sanitation Institutions, Public Dietary Enterprises, Municipal and Public Services Enterprises, Collective Farms and State Farms
- Group (3): Industrial, Construction, Commercial and other Enterprises, Organizations and Establishments.

Table 1.3 Population and Water Demand in 2002

Karakalpakstan					Khorezm				
Cities, Villages	Pop. ths.	Srv.P ths.	Ave.D ths. m³/day	Max.D	Cities, Villages	Pop. ths.	Srv.P ths.	Ave.D ths. m³/day	Max.D
(Urban)					(Urban)				
Nukus	252.4	232.2	95.04	109.30	Urgench	152.4	152.4	96.63	111.12
Takhiatash(G.P)	54.0	51.3	23.12	26.59	Khiva	50.8	50.8	25.94	29.83
Turtkul	49.7	45.8	20.09	23.10	Khanka	32.1	29.7	16.20	18.63
Muynak	14.9	14.2	6.62	7.61	Khazarasp	16.0	14.7	9.42	10.84
Khodjeili(G.P)	71.4	65.7	29.73	34.19	Shavat	15.0	13.8	10.57	12.16
Beruni	48.5	44.7	21.10	24.27	Gurlen	21.7	20.0	15.65	17.99
Chimbai	34.9	32.2	16.95	19.49	Karaul	15.3	15.3	11.63	13.37
Shumanai	13.8	12.7	4.59	5.27	Koshkupyr	16.6	15.2	7.97	9.16
Kungrad(G.P)	61.6	56.7	22.88	26.32	Bagat	9.4	8.7	8.19	9.41
Khalkabad	12.0	11.0	5.20	5.97	Yangiaryk	10.8	9.9	8.74	10.05
Kegeili	14.2	13.1	5.89	6.77	Druzhba	16.4	15.9	12.38	14.24
Akmangit	8.3	7.7	2.99	3.44	Yangibazar	5.9	5.4	5.97	6.87
Karauzyak	13.9	12.8	4.88	5.61	Chalish	5.8	5.3	2.76	3.18
Takhtakupyr	18.4	17.0	6.52	7.49					
Kanlykol	9.9	9.1	3.46	3.98					
Bozatau	4.2	3.9	1.49	1.71					
Ellikkala	11.9	11.0	8.42	9.68					
Karatau	3.6	3.4	2.55	2.93					
Djumurtan	3.6	3.3	1.92	2.20					
Komsomol	0.6	0.5	0.18	0.20					
Karakalpakia	4.1	3.8	1.30	1.49					
Zhaslik	4.1	3.8	1.30	1.49					
Vodnik	6.3	5.8	1.98	2.28					
Mangit	29.9	27.6	16.40	18.86					
Urban total	746.2	689.3	304.60	350.24	Urban total	368.2	357.1	232.05	266.85
(Rural)					(Rural)				
Amudarya	112.0	65.5	6.99	8.04	Gurlen	93.3	64.7	8.49	9.76
Takhtakupyr	29.7	19.7	2.04	2.35	Koshkupyr	114.7	67.2	8.94	10.28
Kungrad	43.0	31.3	3.28	3.77	Khanka	106.7	93.0	11.98	13.78
Karauzyak	33.0	19.3	2.09	2.40	Khazarasp	159.2	105.8	13.51	15.54
Kegeili	37.4	21.9	2.33	2.68	Shavat	115.3	76.6	10.12	11.63
Kanlykol	30.2	22.0	2.17	2.49	Urgench	137.6	87.6	11.63	13.37
Chimbai	61.5	38.8	4.11	4.73	Khiva	124.9	102.6	13.40	15.42
Ellikkala	104.4	74.1	7.91	9.10	Yangibazar	60.0	35.2	4.69	5.39
Khodjeili	73.1	35.5	3.62	4.16	Yangiaryk	75.4	44.2	5.88	6.76
Turtkul	109.7	70.8	7.67	8.83	Bagat	111.0	85.7	11.20	12.88
Nukus	42.8	29.2	3.13	3.60					
Shumanai	32.7	15.9	1.62	1.86					
Beruni	99.6	52.5	5.80	6.68					
Muynak	16.5	10.1	1.10	1.26					
Bozatau	17.5	10.2	1.11	1.28					
Rural total	843.1	516.8	54.97	63.23	Rural total	1,098.1	762.6	99.84	114.81
total	1,589.3	1,206.1	359.6	413.5	total	1,466.3	1,119.7	331.9	381.7

Pop.: Population, Srv. P: Served Population, Ave. D : Daily Average Water Demand,
Max. D : Daily Maximum Water Demand

(4) Water Supply and Demand Gap

Currently, the water supply capacity does not meet the water demand in the Study Area, especially in Khorezm. The gap between supply and demand will widen as the population and the coverage rate increase, that is; as the water demand increases. The present total water supply capacity, excluding Uztransgas system in Karakalpakstan is 275 thousand m^3/day and that in Khorezm is 249 thousand m^3/day. According to the Basic Plan, some of the existing water treatment plants can be used in the future. The total capacity of these plants are: 268 thousand m^3/day in Karakalpakstan, including 170 thousand m^3/day in the Tuyamuyun-Nukus WTP, and 235 thousand m^3/day in Khorezm including 180 thousand m^3/day in the Tuyamuyun-Urgench WTP. The capacity by region is shown in Table 1.4. Consequently, the gap between supply and demand in 2002 will be widen to 116 thousand m^3/day in the Tuyamuyun Nukus system and 176 thousand m^3/day in the Tuyamuyun Urgench system, as shown in Table 1.5. The water supply capacity, therefore, needs to be increased to meet this shortage .

Table 1.4 Capacity of Existing Water Treatment Plants to be Used and Expanded in Future

(unit : thousand m³/day)

	Name	Design capacity	Capacity operated at present	Capacity to be used in future	Source of water	Type of treatment process
	Karakalpakstan					
1	Nukus (VK)	65.0	60.0	60.0	canal	sedimentation & filtration
2	Turtkul (VK)	8.4	8.4	8.4	ground water	
3	Beruni (VK)	4.6	4.6	4.6	ground water	
4	Chimbai (VK)	5.7	1.0	2.0	ground water	
5	Kegeili (VK)	2.5	1.0	1.0	ground water	
6	Beruni (AV)	-	8.0	8.0	ground water	
7	Turtkul (AV)	-	14.0	14.0	ground water	
	sub total		97.0	98.0		
	T-Nukus	200.0 (170.0)	140.0	170.0	canal	sedimentation & filtration
	total	-	237.0	268.0		
	Khorezm					
1	Urgench(VK)	50.0	45.0	45.0	canal	sedimentation & filtration
2	Chalish (VK, AV)	-	10.0	10.0	ground water	
	sub-total	-	55.0	55.0		
	T-Urgench	200.0	180.0	180.0	canal	sedimentation & filtration
	total	-	235.0	235.0		

VK : Vodokanal, AV :Agrovodokanal

Table 1.5 Water Supply and Demand Gap for Tuyamuyun System in 2002

(unit : thousand m³/day)

Water supply	Maximum water demand	Existing water supply capacity		Difference
		Total	including Tuyamuyun	(Shortage in capacity)
T-Nukus	384.4	268	170	116.4
T-Urgench	410.8	235	180	175.8
total	795.2	503	350	292.2

According to the Basic Plan, this difference can be eliminated by expanding the Tuyamuyun water treatment plants by 2002. Consequently, the additional design capacity of each Tuyamuyun water treatment plant is planned as shown in Table 1.6.

Table 1.6 Planned Additional Capacity and Total Capacity in 2002 for Tuyamuyun Water Treatment Plant

(unit : thousand m^3/day)

Water treatment plant	Required capacity of water treatment plant for water demand in 2002		Design capacity	
	Additional	Total	Additional	Total
T-Nukus	128.0	328.0	150	350
T-Urgench	193.4	393.4	200	400
total	321.4	521.4	350	750

Required capacity of water treatment plant, calculated as 1.1 times the daily maximum water demand, includes water quantity to be used in the plant in addition to the daily maximum water demand.

1.3 Water Supply Facilities for the Feasibility Study

Water supply facilities are planned and designed to satisfy the water demand in 2002. The facilities for the feasibility study from the Basic Plan are shown in Table 1.7.

Table 1.7 Facilities for the Feasibility Study

Work Items	Specification
1. Kaparas Raw Water Intake System	
1.1 Kaparas intake pumping station	Q=1,000,000 m^3/d
1.2 Raw water main (Kaparas to T-Nukus intake station)	D=1,400 1 Line
1.3 Raw water main (Kaparas to T-Urgench intake station)	D=1,400 2 Lines
2. Tuyamuyun-Nukus Water Supply System	
2.1 Tuyamuyun Nukus water treatment plant	
2.1.1 Rehabilitation	Q=200,000 m^3/d
2.1.2 Expansion	Q=150,000 m^3/d
2.2 No.2 booster pumping station	Q=306,940 m^3/d
2.3 Nukus North distribution pumping station	Q=255,910 m^3/d
2.4 Kungrad transmission and distribution pumping station	Q= 55,020 m^3/d
2.5 Transmission pipeline	
2.5.1 T-Nukus WTP to No.1 booster pumping station	D= 1,400 mm L= 63.0 km
2.5.2 Nukus to Takhiatash	D= 1,200 mm L= 11.0 km
2.5.3 Takhiatash to Kungrad	D= 1,000 mm L= 111.0 km
2.5.4 Kungrad to Muynak	D= 500 mm L= 96.5 km
2.5.5 Kegeili to Bozatau	D= 400 mm L= 50.0 km
3. Tuyamuyun-Urgench Water Supply System	
3.1 Tuyamuyun Urgench water treatment plant	
3.1.1 Rehabilitation	Q=200,000 m^3/d
3.1.2 Expansion	Q=200,000 m^3/d
3.2 Transmission Pipeline	
3.2.1 T-Urgench WTP to Khazarasp Booster Pumping Station	D= 1,200 mm L= 27.0 km
3.2.2 Khanki to Urgench	D= 1,200 mm L= 13.2 km
3.2.3 S.P.1 to Koshkupyr	D= 600 mm L= 14.0 km
3.2.4 Yangiaryk to Khiva	D= 600 mm L= 20.0 km
3.2.5 Gurlen to Shavat	D= 600 mm L= 19.5 km
4. Vodokanal-Karakalpakstan	
4.1 Nukus water treatment plant (Rehabilitation)	Q=65,000 m^3/d
4.2 Chimbai water treatment plant (Rehabilitation)	Q= 2,200 m^3/d
4.3 Turtkul water treatment plant (Rehabilitation)	Q= 8,400 m^3/d
4.4 Beruni water treatment plant (Rehabilitation)	Q= 4,600 m^3/d
4.5 Kegeili water treatment plant (Rehabilitation)	Q= 1,000 m^3/d
4.6 Distribution network	
4.6.1 Replacement	D= 100 to 400 mm
4.6.2 Expansion	D= 100 to 400 mm
4.7 Water meter	D= 20 mm
5. Vodokanal-Khorezm	
5.1 Urgench water treatment plant (Rehabilitation)	Q= 50,000 m^3/d
5.2 Chalish water treatment plant (Rehabilitation)	Q= 11,000 m^3/d
5.3 Distribution network	
5.3.1 Replacement	D= 100 to 400 mm
5.3.2 Expansion	D= 100 to 400 mm
5.4 Water meter	D= 20 mm

1.4 Preliminary Evaluation of the Project for Feasibility Study

The conclusions below were arrived at after financial evaluation of this project included in the Basic Plan. The total construction cost of the project in the Basic Plan amount to as much as US$ 1,019 million. It will be very difficult to find the available fund sources. While the financial internal rate of return (FIRR) can not be obtained even if subsidy cover fully total construction cost. The economic and financial condition of Uzbekistan, Karakalpakstan and Khorezm are very severe, and it is clearly impossible to implement the whole project even if external assistance or loan are considered. Consequently, Basic Plan as a whole is not feasible or viable.

Even if implementation of the project is restricted to projects before 2002 included in the feasibility study (Table 1.7), the total investment for construction amounts to US$ 607.1 million. Therefore even if a feasibility study is carried out, there is a high probability that the project will not be realized. Here, the project to be implemented by 2002 for feasibility study is evaluated preliminarily. The results summarized in Table 1.8. Also for reference, see Chapter 6 in this part of report.

Table 1.8 Preliminary Evaluation of the Project for Feasibility Study

Description	Evaluation
Possibility of financing	As of this stage, financing the project to the amount of US$ 607.1 million over a three-year period is impossible.
Financial Internal Rate of Return (FIRR)	FIRR can not be obtained since high operation and maintenance cost and construction cost. Government subsidy and high water tariff rate is necessary for realizing this project.
Implementation schedule	Implementation of such a large-scale construction schedule within a period of only three years is impractical.

FIRR calculation conditions:

1) FIRR was calculated in principle using conditions of the project evaluation implemented in Chapter 9 of the Basic Plan.
2) Increase in costs due to inflation is not considered.
3) The water tariff for Group(1) was fixed at 2% of the household income.
4) The water tariff for Groups(2) and(3) were taken at the current water tariff.

As indicated by the above evaluation, the possibility of realization of the selected projects for the Feasibility Study is extremely low. Consequently, it is necessary to reschedule and cut down the project scale in order to enable the realization of the project. The method is described below.

1) Abandon the construction of approximately 111 km of pipeline (diameter 1,000

mm) between Takhiatash and Kungrad, and use the existing Urgench Transgas water supply pipeline.

2) Reschedule the extension plan for water supply.

   In other words, cut down the scale of the project. More specifically, postpone the implementation of projects included in the feasibility study that are to be implemented by 2002 in the Basic Plan, and implement them by 2010, the target year for the Basic Plan.

To cut down the project to a scale at which realization is feasible, the two methods mentioned above should be adopted simultaneously.

A feasibility study should be carried out for this project (hereinafter called as "rescheduled project")

1.5 Water Demand of Rescheduled Project

1.5.1 Revised Planned Water Supply Capacity

As a result of rescheduling the project, the total capacity of water that can be supplied in 2010 is 828,000 m^3/day (T-Nukus: 413,000 m^3/day; T-Urgench: 415,000 m^3/day) as shown in Table 1.9. The increase in the water supply capacity of the rescheduled project will be 325,000 m^3/day (T-Nukus: 145,000 m^3/day; T-Urgench: 180,000 m^3/day).

Table 1.9 Design Capacity and Maximum Supply Capacity in 2010

(unit: thousand m³/day)

Water Supply System	Treatment plant design capacity		Maximum supply capacity	
	Total	Increase	Total	Increase
T-Nukus system				
T-Nukus WTP	350	150	315	145
Local WTP	N.A.	0	98	0
Total		150	413	145
T-Urgench system				
T-Urgench WTP	400	200	360	180
Local WTP	N.A.	0	55	0
Total		200	415	180

1.5.2 Rescheduled Water Demand

The rescheduled project cannot meet the water demand planned in the Basic Plan. The water demand is re-evaluated here.

(1) Revised Rural Water Demand

Although in the Basic Plan, the demand in the Plan 1 (ambitious program) of the Water Supply Plan[1] proposed by the World Bank was used as the water demand in the rural areas, the water demand in Plan 2, which was actually used by the World Bank in their planning, will be used for the rescheduled project. In the Plan 2, the water demand is divided into two categories - demand that depends on water supply pipelines and demand that does not depend on water supply pipelines but small wells and hand pumps. In the rescheduled project, the water demand that depends on water supply pipelines will be used. The Table below shows the water demand and water supply coverage rate in the rural areas of the Plan 2.

[1] Uzbekistan Water Supply, Sanitation and Health Project, Binnie & Partners etc., 1996

Table 1.10 Water Demand and Water Supply Coverage Rate Depending on Water Supply Pipelines in Rural Areas

(World Bank Water Supply, Plan 2)

Description	1995	2000	2005	2010
Daily average water demand (thousand m³/day)				
T-Nukus	49.2	36.0	48.5	64.9
T-Urgench	88.2	85.0	116.0	153.9
Coverage (%)				
T-Nukus	45	49	55	60
T-Urgench	47	51	56	61

Source: Uzbekistan Water Supply, Sanitation and Health Project, Binnie & Partners etc., 1996

Table 1.11 show the water demand in rural areas mentioned above and the water demand in urban areas of the Basic Plan for the Tuyamuyun system.

Table 1.11 Water Demand for the Tuyamuyun System

(Unit : thousand m³/day)

Description		1995	2000	2005	2010
Daily average water demand					
T-Nukus	Urban	184.1	259.8	286.3	314.5
	Rural	49.2	36.0	48.5	64.9
	Total	233.3	295.8	334.8	379.4
T-Urgench	Urban	191.0	234.0	246.6	258.2
	Rural	88.2	85.0	116.0	153.9
	Total	279.2	319.0	362.6	412.1
Daily maximum water demand					
T-Nukus	Urban	211.7	298.8	329.2	361.6
	Rural	56.6	41.4	55.8	74.6
	Total	268.3	340.2	385.0	436.2
T-Urgench	Urban	219.7	269.1	283.4	296.9
	Rural	101.4	97.8	133.2	176.9
	Total	321.1	366.9	416.6	473.8

(2) Decrease in Water Demand by Rational and Efficient Use of Water

The planned maximum water supply capacity in the T-Nukus system can meet the daily maximum water demand in 2008 and the daily average water demand in 2010. On the other hand, in the T-Urgench system it can meet the daily maximum water demand in 2005 and the daily average water demand in 2010. The planned maximum supply capacity can not meet the daily maximum water demand in 2010. The shortfall in water supply needs to be compensated by efficient use of water. Installation of water meters and proper arrangement of water tariff system will generally bring about a reduction in the consumption of water which means rational and efficient use of water. An example of the reduction in water consumption by installing water meters in Spain is given below.

Barcelona Average reduction of 16.9% in water consumption.
Terrassa Average reduction of 12.7% in water consumption.
Mataro Average reduction of 15.9% in water consumption.
Source: Influence of Water Metering on Water Consumption, C. Sanclemente

In the example given here, a reduction of approximately 15% in water consumption can be achieved by installing water meters.

The water demand plan for urban areas in the Basic Plan reflects the trends of consumption in the past and the values in the ideal future plans of the Uzbekistan side, having comparatively high values. In the Basic Plan, the daily average per capita consumption including leakage and demand for Groups(1), (2) and (3) in 2010 for urban area in Karakalpakstan is 467 l/ca./day and in Khorezm is 660 l/ca./day. Examples for other countries are given in Table 1.12. Compared to cities in developed countries also, the consumption for the two areas are on the higher side. The water demand in future should be reduced by rational and efficient use of water.

Table 1.12 Daily Average Per Capita Consumption

(unit: l/ca./day)

City	Study Year	Per capita consumpt.	City	Study Year	Per capita consumpt.
Developed	Countries		Geneva	1985	753
Tokyo	1992	440	Rome	1985	554
Sapporo	1992	313	Dublin	1985	324
Los Angeles	1986	710	Developing	Countries	
Boston	1985	730	Cape Town	1986	248
Melbourne	1985	456	Singapore	1985	206
London	1985	341	Bangkok	1985	469
Paris	1985	229	Hong Kong	1985	389

Assuming that water consumption can be reduced by 15% by installing water meters, the water demands in 2010 for the rescheduled project are given in Table 1.13.