社会開発調査部報告書

No. 22

JAPAN INTERNATIONAL COOPERATION AGENCY

CAPITAL DEVELOPMENT CORPORATION
THE CITY OF ASTANA

THE FEASIBILITY STUDY ON
WATER SUPPLY AND SEWERAGE IN THE CITY OF ASTANA
IN
THE REPUBLIC OF KAZAKHSTAN

FINAL REPORT

VOL. I EXECUTIVE SUMMARY

MARCH 2001

KISHO KUROKAWA ARCHITECT & ASSOCIATES
NIPPON KOEI CO., LTD.
INTERNATIONAL DEVELOPMENT CENTER OF JAPAN

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Vol. I	EXECUTIVE SUMMARY
Vol. II	MAIN REPORT
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Exchange Rate Applied

US$1.00 = Kazakhstan Tenge 144.00

= ¥110.00

(as of October 2000)

PREFACE

In response to a request from the Government of the Republic of Kazakhstan, the Government of Japan decided to conduct The Feasibility Study on Water Supply and Sewerage in the City of Astana and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Kisho Kurokawa, Kisho Kurokawa Architect & Associates to the Republic of Kazakhstan from July 2000 to March 2001. In addition, JICA set up an advisory committee that examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of the Republic of Kazakhstan and conducted field surveys at the study area. Upon returning to Japan, the team addressed comments from the Kazakhstan side and prepared the final report.

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

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

March, 2001

Kunihiko Saito
President
Japan International Cooperation Agency

March 2001

Mr. Kunihiko Saito
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

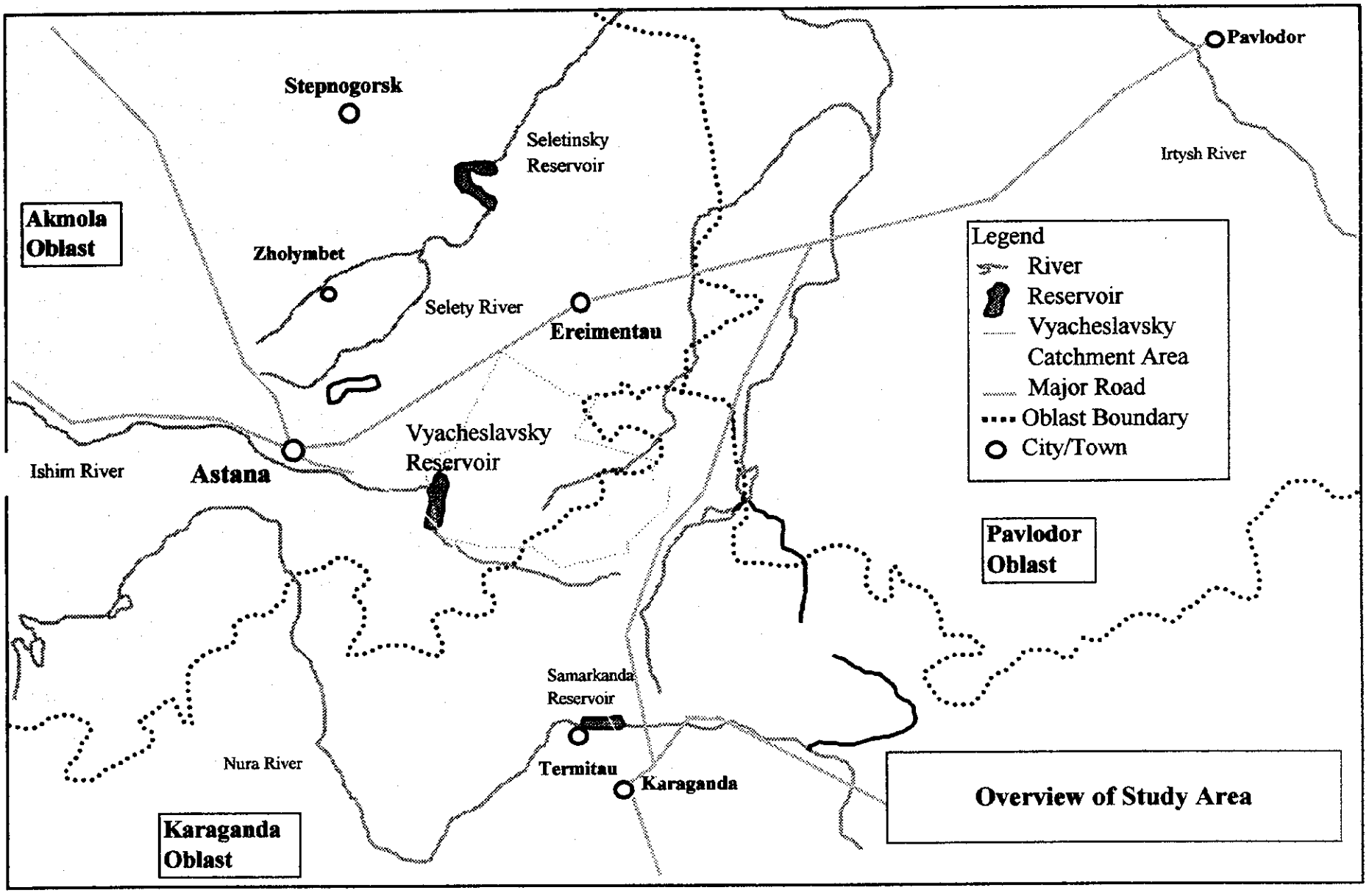
It is with great pleasure that we submit to you the Final Report of The Feasibility Study on Water Supply and Sewerage in the City of Astana in the Republic of Kazakhstan completed by the Study Team with cooperative efforts of the Capital Development Corporation (CDC) and other parties concerned. The report has been prepared for the Government of the Republic of Kazakhstan for implementing water supply and wastewater facilities in the new capital city of Kazakhstan, Astana City.

The report consists of four volumes, those being the Executive Summary, Main Report, Supporting Report and the Drawings. The Executive Summary presents the outline of the study results. The Main Report provides all the study results regarding water supply and wastewater from technical, environmental, organizational, financial and economical viewpoints. The Supporting Report provides investigation findings, assessment calculations and relevant agreements made with the Kazakhstan side. The Drawings present conceptual drawings in order to visualize both the existing and proposed facilities.

Taking this opportunity, on behalf of the Study Team, I would like to express my heartfelt gratitude to the personnel from JICA, Advisory Committee, Ministry of Foreign Affairs, Embassy of Japan in Kazakhstan and Kazakhstan officials participating in the State Expertise review who extended their kind assistance and cooperation for the entire study period to the Study Team. The Study Team hopes that the results of this study contribute to the future implementation of water supply and wastewater system in the City of Astana.

Yours faithfully,

Kisho Kurokawa
Team Leader
The Study for the Feasibility Study on Water Supply
And Sewerage in the City of Astana


Stepnogorsk
Seletinsky Reservoir
Pavlodor
Irtysh River
Akmola Oblast
Zholymbet
Selety River
Ereimentau
Legend
River
Reservoir
Vyacheslavsky Catchment Area
Major Road
Oblast Boundary
City/Town
Vyacheslavsky Reservoir
Ishim River
Astana
Pavlodor Oblast
Samarkanda Reservoir
Nura River
Termitau
Karaganda
Overview of Study Area
Karaganda Oblast

1. INTRODUCTION

1.1 Background of the Study

1. The capital of the Republic of Kazakhstan was transferred in December 1997 to the City of Astana. Since then, development in the City of Astana has progressed at a rapid rate in order to meet standards required for a capital city. The Government of Kazakhstan made a request to the Government of Japan for assistance in formulating an overall master plan for city development. This request was agreed in October 1999 and as part of this agreement, included the carrying out of a feasibility study following recommendations in the progress report.

The progress report recommended the completion of a feasibility study for water supply and sewerage. This feasibility study has now been completed and is summarized in this report.

1.2 Objective of the Study

2. The objective of the Study is:

- To assess the technical, financial and economic viability, and environmental and social soundness of the priority projects for the target year of 2010 in water supply and sewerage as selected by the JICA Master Plan Study,
- To transfer technical knowledge to counterpart personnel during the course of the Study.

1.3 The Study Area

3. The Study area mainly covers the area under the jurisdiction of Astana Municipality (Akimat). The operation of the water supply and wastewater system has been delegated to Astana Su Arnasy (ASA), a state municipal enterprise entirely owned by Akimat.

2. GENERAL CONDITIONS OF THE STUDY AREA

2.1 Natural Conditions

4. Astana City is located at the southern region of the steppes of Central Asia with its immense plain and little geomorphologic relief. The topography in Astana City is characterized by gentle slopes, generally between an elevation of 370 m to the east and 345 m to the west.

There are three major river systems around the City, the Ishim River flowing

through the center, the Nura River to the south and the Seleti River to the north. The average monthly temperature ranges from 20 °C to –10 °C with extremes of 35 °C and -40. °C. The average annual precipitation between 1990 and 1999 was 315mm, of which 100mm fell as snow. Floods can occur as a result of constrictions caused by logjams during spring thaw. Average humidity is comparatively low throughout the year with an annual average of 67% and is particularly low in summer. The annual average wind speeds is 3.6m/s with speed in winter being a little larger than those in summer, sometimes exceeding 4.0m/s. The predominant wind direction is from the south-west for about 25% of the year.

2.2 Socioeconomic Conditions

5. The population projection adopted for the planning of the water supply and sewerage system has been prepared by the JICA Master Plan Team and is presented in the following table.

Year	2000	2005	2010	2020	2030
Population	321,600	400,000	490,000	690,000	800,000

6. With about 60% of the former USSR's mineral resources, about 20% of the cultivated land in the former USSR, and rapid market reform, Kazakhstan is well placed for economic growth. Much of this cultivated land was located around Astana.

Outlook for industries in Kazakhstan is mixed with GDP growth of only 1.7% in 1999. Exports of oil and fuel make up 40% of total exports and have been increasing in recent years. Other growth sectors are mining and the export of primary goods. This growth is expected to have a direct impact on Astana as the capital of Kazakhstan where economic growth is projected to grow by 8.3% per annum over the next 30 years.

3. WATER SUPPLY

3.1 Current Status of Water Supply System and Facilities

7. In the 1950's, Astana City was served by a rural water supply system using groundwater, but it was replaced by a comprehensive water supply system which was constructed in the 1960's. The major water resource, Vyacheslavsky reservoir is located in the east, 50 km from the city center. Raw water is transferred to the

water treatment plant (WTP) in Astana which has a capacity of 165,000 m^3/day. An additional intake exists on the Ishim River in Astana. A total of about 489 km of pipelines make up the distribution system.

8. The water supply service coverage of Astana City has reached nearly 100%, and includes 27% served by public faucets. Water tankers and wells cover a few rural areas not served by the main distribution system.

9. The water demand data for Astana in the last two years are presented in the table below:

Item Year	1998	1999
Water Consumption (m^3/day)		
Domestic - Billed	37,452	46,667
Domestic - Unbilled *	18,726	23,334
Public	6,222	4,814
Industry and Commercial	26,578	22,049
Sub-Total	88,978	96,864
Unaccounted-for-Water (m^3/day)		
UFW Rate	26.5%	26.1%
UFW Volume	32,146	34,199
Total	121,124	131,063

10 All civil structures and equipment of Vyacheslavsky Intake Pump Station (P/S) are at an advanced stage of degradation and will not last until 2010. Many of the facilities of the existing WTP have deteriorated beyond repair and its treatment capacity has declined accordingly. Some of the existing distribution pipelines have suffered from severe corrosion leading to high leakage. There are very few customer water meters and bulk water meters to monitor leakage or wastage.

3.2 Plan of Future Water Supply System

11. The following are the basic policies guiding future system planning:
- Priority to rehabilitation and reuse of existing facilities combined with minimum extension.
- Water resources conservation through minimizing wastage and leakage.
- Facility design for easier operation and maintenance

12. Water demand projection is provided in the table below:

Items	Year	1999	2010	2020	2030
Drinking Water	Unit				
Population	(person)	300,800	490,000	690,000	800,000
Public		36,100	61,900	94,300	108,600
Industry		15,900	28,000	37,000	44,000
Commercial		95,300	164,900	247,800	287,500
Water Volume	(m^3/day)	96,783	115,180	164,970	201,090
Domestic		54,920	63,908	103,500	136,000
Public		4,814	5,520	8,016	8,688
Industry		14,790	2,550	3,145	3,520
Commercial			14,610	21,063	23,000
Thermal Plant		22,260	28,590	29,250	29,880
Leakage	(m^3/day)	34,599	28,800	41,240	50,280
Leakage Ratio		26%	20%	20%	20%
Total Drinking Water Demand		131,100	144,000	206,200	251,400
Per Capita Drinking Water Demand	(l/c/d)	436	293	299	314

13 The following works are proposed for implementation under the Project to secure the future of the water supply system:

- Consumer water meter installation (65,000)
- Replacement of deteriorated distribution pipelines (98 km)
- Construction of a new Vyacheslavsky Reservoir Intake P/S (200,000 m^3/day)
- Construction of a new WTP (100,000 m^3/d)
- Extension of the distribution system (73 km)

4. WASTEWATER

4.1 Background

14. The first wastewater collection system around the railway station was constructed in the 1950's by the railway administration. With expansion of the town as a result of the Virgin Land Agricultural Development Plan, a wastewater collection and treatment system was planned and construction started in 1959. The wastewater treatment plant was completed in 1970.

15. A separate system exists for surface water and drainage and this system is managed by Gorkomkhoz, a communal enterprise under the responsibility of Astana municipality.

4.2 Existing Situation

16. The wastewater system consists of a collection system, a wastewater treatment plant (WWTP) located about 8 km to the south west of Astana and a treated water storage reservoir (Taldy Kol Reservoir). The main characteristics of the wastewater

collection system are presented below:

Characteristics	Year 2000
Coverage area	3,500 ha
Service connections	61,000
Service coverage	70% of households
Cesspits and Septic Tanks	30% of households
Length of sewers	306 km
Number of manholes	5,300
Number of pump stations	32

The volume of wastewater arriving at the wastewater treatment plant is shown on the following table:

Wastewater Discharge	1999 Average (m^3/d)
Domestic	55,700
Others	23,400
Total	**79,100**
Infiltration estimate	7,900
Total Discharge	**87,000**
Wastewater treatment capacity	136,000

17. The hydraulic performance of the wastewater collection system is generally satisfactory but the following deficiencies have been noted:
- No replacement programme for old pipelines
- Use of unprotected steel pipeline for pumping mains (25-50 defects/100km/year)
- Poor quality manhole covers allowing surface water inflow
- Broken or missing manhole covers allowing debris to fall in
- Large number of blockages (approximately 1,500/100km/year)
- Old and inefficient sewage pumps (30% - 50%)
- Frequent breakdowns at pump stations (1.5 defect/pump/year)
- Old electromechanical plant

18. The WWTP is generally performing as designed, however, deficiencies have been noted and the most important ones are presented below:
- Poor concrete condition of grit channels
- Poor efficiency of inlet and effluent pumps
- Old and unreliable electromechanical equipment
- Old and unreliable air blowers
- Old and unreliable return activated sludge pumps
- Insufficient thickening of sludge and short retention in digestors
- Insufficient number of sludge drying beds

- Insufficient number of primary and final tanks
- Old and unreliable boilers

4.3 Development Plan

19. The proposed development plan is based on the reuse and rehabilitation of existing facilities, wherever possible, as a priority objective. Rapid urban expansion resulting from the change of status of the city to that of Capital of Kazakhstan is expected and therefore expansion of the wastewater collection network in new development area is also a priority. The target year for this feasibility study is 2010 and the proposed works has therefore been designed for the population by this time.

20. Predicted flows at the WWTP have been calculated and are presented in the following table:

Item	1999	2010	2020	2030
Domestic	66,800	69,000	112,000	147,500
Others	27,900	33,000	43,800	49,600
Total	**94,700**	**102,000**	**155,800**	**197,100**
Infiltration, 10%	9,500	10,200	15,600	19,700
Total at WWTP (m^3/day)	**104,200**	**112,200**	**171,400**	**216,800**
Population	300,800	490,000	690,000	800,000

21. The following rehabilitation and new works are proposed to secure the future of the wastewater collection system:
- Replacement of about 21 km of pipeline is necessary to reduce repair costs and to reduce the risk of pipe failure
- Replacement of about 5,300 manhole covers
- Rehabilitation of 17 medium and large pump stations
- Construction of 36 km of main collectors for the new development
- Three new pump stations with capacities of 49, 25, and 10 m^3/min respectively

22. The WWTP is to be rehabilitated and improved as follows:
- Replacement of screens and pumps at the inlet works
- Reconstruction of the grit channels, 2 x 10m diameter horizontal flow
- Construction of additional primary and final settlement facilities, 4 x 28m diameter
- Reconstruction of the return activated sludge pump station, 5 x950m^3/hr
- Replacement of air blowers, 6 x 20,100 Nm^3/hr

23 The sludge treatment facilities are to be improved and extended as follows:

- Replacement of sludge transfer pumps
- Replacement of two boilers (2 x 4.5 tonnes steam/hour)
- Rehabilitate existing digestors
- New belt thickener plant, 3x 80m^3/hr
- New secondary digestor, 2,500m^3
- Five additional sludge drying beds

24. The original development plan for the disposal of treated effluent is reuse for irrigation following storage in Taldy Kol reservoir. However, as a result of perestroika the treated effluent reuse project has been stopped during this period of transition for the agricultural sector. A preliminary study for reuse of treated wastewater has been carried out and concluded that reuse in agriculture still offers the most potential for the least cost. The limited dilution available in the rivers prevents direct discharge of biologically treated effluent. Costly advanced treatment, using filtration, activated carbon and disinfection is necessary to improve the treated effluent quality to that suitable for direct discharge.

25 Sludge disposal options investigated include direct agricultural and forestry use, composting, fertilizer production, pelletisation, incineration and landfill. It is recommended that the least cost option, disposal to agricultural land, be adopted. Sludge that is unsuitable for use on land shall be taken to landfill.

5. ENVIRONMENT

5.1 Environmental Impact Assessment (EIA) of Proposal projects

26. Although there is a basic framework of EIA procedure in Kazakhstan, EIA of this Study is carried out in accordance with JICA Environmental Guidelines. The reason is as follows:

- At present, the project is only at proposal stage, therefore it is difficult to hold a public hearing by mass media by the organizer of the project (ASA).
- In regard to environmental items to be considered in EIA, the items required by Kazakhstan law as defined in RND 03.02.01, are covered by JICA Environmental Guidelines (see Table 7.1.3).

5.2 EIA of Proposed Water Supply Projects

27. Overall, the proposed preliminary projects do not impact the environment significantly except noise and vibration during the construction period and the dried

sludge disposal for which the degree of impact cannot be estimated. After confirmation of details of the proposed plan, these impacts should be considered and the necessary countermeasures recommended in the event that the expected impacts are significant.

5.3 EIA of Proposed Wastewater Projects

28. Although the main factor to be considered is the increase in the amount of treated effluent, it is considered that significant impact should not be expected due to the following.

- The treated effluent will continue to be discharged to the Taldy Kol Reservoir which was designed as the discharging body of the treated effluent. It means that the effluent will not affect the Ishim River directly.
- The impact of surplus treated effluent discharged to the surrounding area is not expected to be significant because of the naturally occurring purification in marshland, such as assimilation of nitrogen and phosphorous by plants and absorption of organic substances and suspended materials by soil.

6. ORGANIZATION AND INSTITUTION

6.1 Institutional Framework

29. The institutional framework within Kazakhstan for the development, monitoring and enforcement of laws and regulations in the water sector is still in a state of flux. The principal regulatory agencies such as basin organizations and environmental protection departments are already in existence. However many of these agencies have seen their position within the framework changed a few times since independence.

The main stakeholders in an Astana City water supply and sewerage project would be:

- Astana Municipality (Akimat)
- Astana Su Arnasy (ASA)
- State Sanitary and Epidemiological Supervision
- Department of Environmental Protection, Astana

6.2 Legal Framework

30. Since independence, a series of basic laws has been enacted to protect the right of the population to have access to a clean and wholesome water environment. The

two main basic laws are:

- The Law of the Republic of Kazakhstan on Environmental Protection (Parliament of the Republic of Kazakhstan)
- Water Code of Republic of Kazakhstan, No.2061-12 (Parliament of the Republic of Kazakhstan)

31. In support of the basic laws many regulations and standards exist to provide detailed interpretation of the requirements of the basic laws. Most of these regulations are from the Soviet system. A list of the most important ones are listed below:

- RND 1.01.03 – 94, Regulation of Surface Water Protection of the Republic of Kazakhstan, Ministry of Natural Resources and Environmental Protection
- GOST 2761-84, Sources of Centralized Economic – Drinking Water Supply, Sanitary and Technical Requirement and Rules of Selection
- SanPin No. 4630-88, Sanitary Norms and Regulation of Surface Water Protection
- SanPin No. 2.1.4.559-96, Hygienic Requirement for Water Quality of Centralized System of Water Supply for Drinking Use, Agency of Public Health
- SNiP 2.04.02-84, External Water Supply Systems and Facilities
- SNiP 2.04.03-85, External Sewerage System and Facilities
- Resolution for Industrial Wastewater Discharge System of Astana City (Astana City)

6.3 Existing Situation

32. Although the institutional and legal frameworks exist, the application and enforcement of all the rules and regulations are very complex. The old Soviet Union had aspired to a very high standard in all matters from sanitary protection to design and construction. But these high standards have been incorporated into the regulations without regard to enforceability or local conditions. A more pragmatic risk assessment based approach should be adopted instead of the present restrictive attitude.

33. The capacity of ASA, one of the major stakeholders is of concern. The low management and planning staff ratios are hindering the development of ASA. This weak capacity is not even allowing it to collect and interpret the available information so as to support a tariff increase request.

34. The Regulation Agency for Natural Monopolies is only accepting very strict interpretations of existing rules and thus making it very difficult for ASA to apply full cost recovery tariffs as permitted under the Decree on State Enterprise of

January 2000.

35. There is at present no involvement of the private sector in the water industry and therefore much of the experience gained by the private sector in management of water companies and improved efficiencies cannot benefit ASA.

6.4 Capacity Building

36. In order to overcome the weak management, capacity-building activities such as development of human resources, the enhancement of skills, the adoption of up to date thinking and improvement of knowledge base are needed within ASA.

37. The need to build confidence between the various institutions and the public has to be addressed. To this effect a transparent management and financial system has to be developed. Proper auditing procedures will have to be installed. Management information system has to be set up to permit the correct level of data collection and analysis required at each management level, none of which is presently available within ASA.

38. Partnerships with the private sector need to be encouraged so as to benefit from management skill developed in the private sector.

6.5 Action Plan

39. To implement the changes proposed it is recommended that a review committee be set up to implement the required changes to the institutional set up and to oversee the capacity building of ASA.

40. Working groups will also be set up to study the problems in detail and propose solutions acceptable to all. In order to protect the interest of consumers and staff the working groups shall also include representatives or NGO representing professional staff, manual workers, both household and industrial consumers.

41. Five such working groups are proposed one for each of the five areas where improvements are necessary. The five areas are as follows:

- Tariff System Reform
- Revenue Collection and Customer Services
- Business development
- Staff Development
- Management Strengthening

7. CONSTRUCTION PLAN AND COST ESTIMATE

7.1 Construction Plan

42. It is assumed in this Study that the Project will require international funding for implementation and the contractor for each package of the Project is to be selected through international competitive bidding (ICB). This will be a requirement of the international funding agency.

7.2 Construction Packages

43. Seven construction packages have been identified, four water supply packages, two for wastewater and one for operation and maintenance (O & M) equipment.

7.3 Cost Estimate

44. The cost estimate for the proposed project is presented on the following table:

Cost Item	F.C. (Mil US$)	L.C. (Mil US$)	Total (Mil US$)
Direct Construction Cost			
- Package101 Water Intake	8.24	1.83	10.07
- Package102 WTP	37.78	9.55	47.33
- Package103 Distribution Network	27.97	7.76	35.73
- Package104 Individual Flow Meter	2.48	0.28	2.76
- Package151 WWTP	16.62	4.53	21.15
- Package152 Wastewater Collection Pipes	43.22	17.54	60.76
- Package190 O&M Equipment	8.00	2.00	10.00
Total of Direct Construction Cost	144.31	43.49	187.80
Indirect Cost	39.52	72.78	112.30
Project Cost	183.83	116.27	300.10

45. O & M costs have been estimated at 507.7 Million Tenge (US$ 3.53 Million) by 2010. This estimate is based on the operation and maintenance plan proposed by this Study, the present annual O&M cost of ASA.

7.4 Alternative Project with Reduced Scope

46. In order to verify the effect of reduction in the scope of the project, an alternative project assuming an absolutely minimum extension of the water supply and wastewater networks has been evaluated. All the reduction in costs are in the water

distribution and wastewater collection pipes. The cost estimate for the reduced scope is presented below:

Cost Item	F.C. (Mil US$)	L.C. (Mil US$)	Total (Mil US$)
Direct Construction Cost			
- Package101 Water Intake	8.24	1.83	10.07
- Package102 WTP	37.78	9.55	47.33
- Package103 Distribution Network	26.00	7.24	33.24
- Package104 Individual Flow Meter	2.48	0.28	2.76
- Package151 WWTP	16.62	4.53	21.15
- Package152 Wastewater Collection Pipes	30.47	11.40	41.87
- Package190 O&M Equipment	8.00	2.00	10.00
Total of Direct Construction Cost	129.59	36.83	166.42
Indirect Cost	36.56	62.55	99.11
Project Cost	166.15	99.38	265.53

8. FINANCIAL AND ECONOMIC ANALYSIS

8.1 Present Financial Situation

47. Water sales include both metered and non-metered sales. The operating cycle for the normal collection procedures should be approximately two months, but according to data as of end of June 2000, the turnover period for accounts receivable of ASA was 18.9 months, resulting in a significant amount of overdue water charges.

48. ASA has appropriated losses every year since 1997. These losses have accumulated and caused a decrease in net assets. Under these circumstances, ASA, in a sense, is insolvent as an independent company.

49. The main components of the water production cost are personnel expenses and power costs, accounting for around 60 % of the total O&M cost.

50. ASA has not revised the acquisition cost of fixed assets, therefore, this acquisition cost does not reflect the current costs and the amount of depreciation does not match the current price level. This method of depreciation based on the historical acquisition costs cannot reserve sufficient funds to replace the fixed assets.

51. There is a lack of transparency in respect to the availability of data for purposes of assessing the financial situation of ASA.

8.2 Evaluation of the Project

52. Financial Internal Rate of Return (FIRR) calculations were carried out to evaluate the feasibility and sustainability of the project using the following general assumptions:
    - The cash flows presented are only those of ASA. Evaluation is carried out in nominal US Dollars at current prices
    - A "Do Nothing" option is considered for comparison purposes. This option will assume that the proposed project will not be realized and no further capital investment will be carried out.

8.3 Financial Analysis of the Project

53. A simple cash flow analysis shows that present tariffs cannot sustain the capital expenditure required for the project. Even the total sales are insufficient to cover the capital expenditure. Thus reduction of O&M costs will not be sufficient to recover the total costs. The only measure which can be adopted is an increase in tariffs for sound financial management.
54. According to the affordability study of customers in Astana City, it is expected that tariffs can be doubled without affecting the ability of the average household to pay.
55. Generally speaking, enterprises have greater affordability to pay than individual customers do. In most countries where differing tariffs are applied between individual customers and enterprises, the tariff for enterprises is generally double that for the individual customer. It is proposed that the tariff for enterprises be four times the present tariff.
56. FIRR analysis result shows a return of 2.5 % on assumption of an increase in the tariff for domestic consumers by two and for enterprises by four.
57. The project is not sensitive to change in O&M cost but sensitive to change in capital cost. Reduction of capital cost is an effective way to increase the project feasibility in combination with an increase in tariff.

8.4 Economic Evaluation of the Project

58 In the economic evaluation, Economic Internal Rate of Return (EIRR) has been calculated on the estimated economic benefits in compliance with the comparison between "With Project" and "Without Project". The calculation of EIRR was carried out based on only the tangible benefits.

59 In order to estimate the economic benefit, these quantifiable items as 1) O&M and expansion cost for existing WTP operation, 2) Cost for purchase water after 2020,

3) Compensation cost for water delivery, and 4) Treatment cost of sewerage by individual were taken into account.

60 While, intangible economic benefit are not included in EIRR calculation because of lack of reliable data, technical difficulty or negligibility of benefits. Nonetheless, if these benefits are included in the EIRR, the EIRR will be higher. These are 1) health benefit, 2) amenity benefits and 3) agricultural benefits. The calculated EIRR for the project has resulted in 15.7 %. Assuming that opportunity cost of capital in Kazakhstan is 10 %, this project is acceptable.

61 It is expected that there is drastic increase in GRDP per capita, compared to other area in Kazakhstan. Therefore, in the case of "Without Project", there is not enough scapacity to meet the future demand of water and sewerage services, and increase in number of population and enterprise might be limited. The shortage of water supply and sewerage services would become one of the major constraints for the growth of GRDP in Astana City.

9. IMPLEMENTATION ARRANGEMENT

9.1 Requirements for Project Implementation

62. The main institutional and organizational recommendations for the project and for arrangement of financing from international sources are:

- Strengthening of the management of ASA
- Reform of tariffs in order to provide financial security for ASA and to achieve full cost recovery

9.2 Project Funding

63. Given the fiscal constraints of the Government of Kazakhstan, it is expected that financing for the project will be through international funding agency, which usually has conditions to be fulfilled prior to loan closure. These requirements can include the following:

- Legal framework for the borrowing agency (Assumed to be the Ministry of Finance)
- Commitment of Government to funding local portion of costs
- A repayment guarantee
- A counterpart agency for project implementation
- Implementation of institutional reforms as recommended in this Feasibility Study

It is recommended that negotiations with funding agencies are started as soon as possible.

9.3 Project Implementation Framework

64. The existing organizations do not have the capacity to take on the management of a project of this nature. A new agency, Project Management Unit for Water Projects (PMUWP) should be created by statute with the legal status to enter into contracts in the name of the Government of Kazakhstan.

9.4 Financial Control

65. A project account is to be arranged with the Ministry of Finance for exclusive use of the project and into which project funds either from International Funding Agencies or from the Government are to be deposited. All financial activities should be subject to periodic examination by the Audit Committee which is responsible directly to the Board of Directors.

9.5 Implementation Schedule for Pre-construction Activities

66. The following activities are considered essential during the period prior to construction:

- Implementation of Tariff Reforms
- Strengthening of ASA management
- Establishment of the PMUWP
- Loan negotiations
- Selection of consultant
- Appointment of Project Manager, Tender, Technical and Audit Committees
- Detailed design and preparation of bid documents
- Selection of Contractor

10. CONCLUSION

67. The basic policy for implementation of water supply and wastewater improvement in this Feasibility Study is based on the rehabilitation of existing facilities and minimal expansion of new facilities for the target year of 2010.

68. Water supply plan consists primarily of comprehensive facility rehabilitation and expansion at the intake, treatment plant, pumping and distribution facilities. Water meter installation in individual households are also planned to encourage leakage reduction and curb overuse, thereby conserving water resources and allowing for the establishment of an appropriate water charge collection system.

In order to effectuate the planning, designing and implementation of construction

works, the current standard as stipulated in SNiP should be reviewed and improved to cope with prevailing and new technology.

69. Wastewater disposal plan consists primarily of the rehabilitation of existing facilities including collector pipes, manholes, pumping facilities and wastewater treatment plant, and minimal expansion of the facilities on the new development area is considered.

For the treated wastewater and sludge, proposals are made for its reuse as agricultural purposes in the future. In this regard, implementation of a feasibility study for agricultural development in the near future should be a prerequisite for verifying the potential of its use.

70. There is no significant environmental impact for water and wastewater facilities planning. Minor impacts will be mitigated at the time of implementation of detailed design.

71. Strengthening of ASA's organization, operation and relevant institutional aspects as well as staff training and education are necessary. In addition tariff and collection system is required to establish sound financial management as soon as possible.

In order to realize improvement and implement the project, action plans proposed in this Study should be commenced as soon as possible.

72. Implementation program and construction plan for the project is prepared based on the assumption that financing will be by international financing and that tendering will be conducted by international competitive bidding. Cost estimate is made for two alternative project scopes. The one is US$ 300 Mil. and the other is US$ 265 Mil.

73. Financial management strengthening and tariff increase are required for ASA to attain full cost recovery, thus establishing a self-supporting system. Financial and economic evaluation for the implementation of the project revealed that the project is viable and sustainable.

74. For implementation arrangement, establishment of the Project Management Unit for Water Project and Project Executing Agency are proposed prior to the commencement of the project.

THE FEASIBILITY STUDY ON WATER SUPPLY AND SEWERAGE IN THE CITY OF ASTANA IN THE REPUBLIC OF KAZAKHSTAN

FINAL REPORT
VOL. I EXECUTIVE SUMMARY

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List of Abbreviations

ASA	Astana Su Arnasy
BOD,BOD_5	Biochemical Oxygen Demand, Five-day Biochemical Oxygen Demand
BOD_{total}	Total Biochemical Oxygen Demand
BOQ	Bill of Quantity
CDC	Capital Development Corporation
CIF	Cost including Insurance and Freight
COD	Chemical Oxygen Demand
CPI	Consumer Price Index
Dia	Diameter
DIP	Ductile Cast Iron Pipe
DO	Dissolved Oxygen
DS	Dry Solids
DWF	Dry Weather Flow
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
F.C.	Foreign Currency
FIRR	Financial Internal Rate of Return
F/M	Food/Microorganisms
FOB	Free On Board
F/S	Feasibility Study
GAC	Granular Activated Carbon
GDP	Gross Domestic Product
GM	General Manager
GRDP	Gross Regional Domestic Product
H	Height
IBRD	International Bank for Reconstruction and Development
ICB	International Competitive Bidding
IKIC	Iritysh-Karaganda-Ishim Canal
IMF	International Monetary Fund
JSC	Joint Stock Company
JICA	Japan International Cooperation Agency
L	Length
L.C.	Local Currency
MAC	Maximum Allowable Concentration
MCM	Million Cubic Meters
MLSS	Mixed Liquor Suspended Solids
MPN	Most Probable Number
M/P	Master Plan
O&M	Operation and Maintenance
OECD	Organization for Economic Development and Cooperation
pe	Population Equivalent
PEA	Project Executing Agency
PCWD	Per Capita Water Demand
PMUWP	Project Management Unit for Water Projects
P/S	Pumping Station

PVC	Polyvinyl Chloride Pipe
Q	Quantity
Q_{DA}	Daily Average Flow
Q_{DM}	Daily Maximum Flow
Q_{HM}	Hourly Maximum Flow
RAS	Return Activated Sludge
RC	Reinforced Concrete
RCP	Reinforced Concrete Pipe
RND	Research and Development
RK	Republic of Kazakhstan
SanPiN	Sanitary Norms and Regulations
SAR	Sodium Adsorption Ratio
SAS	Surplus Activated Sludge
SNiP	Construction Norms and Regulations
SS	Suspend Solid
USSR	Union of Soviet Socialist Republic
VSS	Volatile Suspended Solids
VAT	Value Added Tax
W	Width
WHO	World Health Organization
WPI	Water Pollution Index
WTP	Water treatment Plant
WWTP	Wastewater Treatment Plant

List of Units

ha	hectare
hr	hour
J	joule
kJ	kilo joule
kW	kilowatt
kWh	kilowatt-hour
m^3/day	cubic meter per day
m^3/hr	cubic meter per hour
m^3/s	cubic meter per seconds
m^2	square meter
m	meter
mm	millimeter
μ g/l	micrograms per liter
Nm^3	normalized cubic meter of air
km^2	square kilometer
m/s	meter per second
mg/l	milligram per liter
mol/l	moles per liter
MPa	mega pascal
MPN/100ml	most probable number per 100ml
NTU	nephelometric turbidity units
pc/100ml	population count per 100ml
ppm	parts per million
TCU	true colour units
TG	Kazakhstan Tenge
USD	United States Dollar

CHAPTER1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The capital city of the Republic of Kazakhstan was shifted in December 1997 from the City of Almaty to the City of Astana. Since then, development in the City of Astana has progressed at a rapid rate in order to meet standards of an international level. With the aim of proper development for the City of Astana, the Kazakhstan Government established the Capital Development Corporation (hereinafter referred to as "CDC") in May 1999. The Government of Kazakhstan then requested the Government of Japan (GOJ) for assistance in formulating an overall master plan for city development.

Based on this request, the Japan International Cooperation Agency (hereinafter referred to as "JICA") decided to carry out "The Study on the Master Plan for the Development of the City of Astana in the Republic of Kazakhstan" (hereinafter referred to as the "Master Plan Study"). Accordingly, JICA dispatched a preparatory mission to discuss and agree the contents of the Scope of Work for the Master Plan Study. A meeting was concluded with Minutes of Meeting signed between the Ministry of Foreign Affairs, the Agency for Strategic Planning and Reforms, CDC, the City of Astana and JICA on October 5 1999. In this meeting, it was agreed that a Feasibility Study would be implemented in compliance with the results of the Master Plan Study, however the Scope of Works for the Feasibility Study would be selected by the time of the presentation of the Progress Report in the Master Plan Study.

The Master Plan Study was commenced in January 2000, and the meeting for the Progress Report was held on April 12 2000. The Minutes of Meeting was signed between the Ministry of Economy, the Ministry of Foreign Affairs, CDC, the City of Astana and JICA on April 14 2000. Following the proposals in this Progress Report, it was agreed that the Feasibility Study be carried out for the sectors of water supply and sewerage. The Minutes of Meeting for the Scope of Work for the Feasibility Study (hereinafter referred to as "the Study") were signed between the aforementioned Kazakhstan organizations and JICA on April 14 2000.

1.2 Objective of the Study

The objectives of the Study are as follows.

(1) To assess the technical, financial and economic viability, and environmental and social soundness of the priority projects for the target year of 2010 in water supply and sewerage, and
(2) To transfer technical knowledge to the counterpart staff in the course of the Study.

1.3 The Study Area

The Study area agreed between JICA and the Kazakhstan side is defined by the existing city configuration as shown in Figure 1.3.1. The area basically covers the entire City of Astana including the surrounding suburban areas, together with the upstream and downstream of the Ishim River basin.

1.4 Target Year and Development Area for the Study

The target year for the Study is set for 2010. The development area for the target year is shown in Figure 1.4.1 as determined by the Master Plan.

1.5 Agreements with the Kazakhstan Side

Throughout the duration of the Study, a number of key agreements were made with the Kazakhstan side. First, the Inception Report Meeting to present the outline of the Study to concerned Kazakhstan organizations was held on July 25, 2000 and the Minutes of Meeting for the approval of the Inception Report were signed.

The Terms of Reference for the Study were subsequently defined and confirmed with Akimat.

In order to set the foundation of the Study, the unit water demand had to be agreed upon. The agreement with the Construction Committee, part of the Ministry of Energy, Industry and Trade was made.

An Interim Report was prepared and the results were presented during a meeting held on November 30, 2000 in Kazakhstan. The Minutes of Meeting for the approval of the Interim Report were signed.

The Draft Final Report was prepared and the results were presented during a meeting held on January 29, 2001 in Kazakhstan. The Minutes of Meeting for the approval of the Draft Final Report were signed.

1.6 Organization of The Study Team

The organization of the Study consists of the Study Team under the direction of JICA and JICA Advisory Committee, located in JICA headquarters in Tokyo.

Study Team

1) Team Leader	Kurokawa, Kisho
2) Co-team Leader/Water Supply and Sewerage Planning Expert	Okazaki, Keisuke
3) Water Supply Designer I	Watanabe, Takashi
4) Water Supply Designer II	Fujiwara, Masao
5) Sewage Designer I	Jean Claude Ah Man
6) Sewage Designer II	Inabe, Yoshiharu
7) Geotechnical Engineer/Land Surveyor	Matsuoka, Keiji
8) Institutional & Organizational Expert	Fujimoto, Noboru
9) Economic & Financial Analyst I	Kouprianov, Victor
10) Economic & Financial Analyst II	Nagao, Daisuke
11) Water Quality & Environmental Expert I	Sato, Shinsuke
12) Water Quality & Environmental Expert II	Naganuma, Kengo
13) Construction Planner/Cost Estimator	Otsuka, Yasushi
14) Interpreter	Akasaka, Yoshio
15) Coordinator	Yajima, Kaoru

JICA

1) Vice President	Izumi, Kenjiro,
2) Managing Director, Social Development Study Department (until June 2000)	Sakurada, Yukihisa
3) Managing Director, Social Development Study Department (from July 2000)	Jibiki, Takanori

4) Director, Planning Division, Social Development Study Department	Kikuchi, Fumio,
5) Director, 1st Social Development Study Division, Social Development Study Department (until September 2000)	Kaibara, Takao
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7) Deputy Director, 1st Social Development Study Division, Social Development Study Department	Honda, Eri
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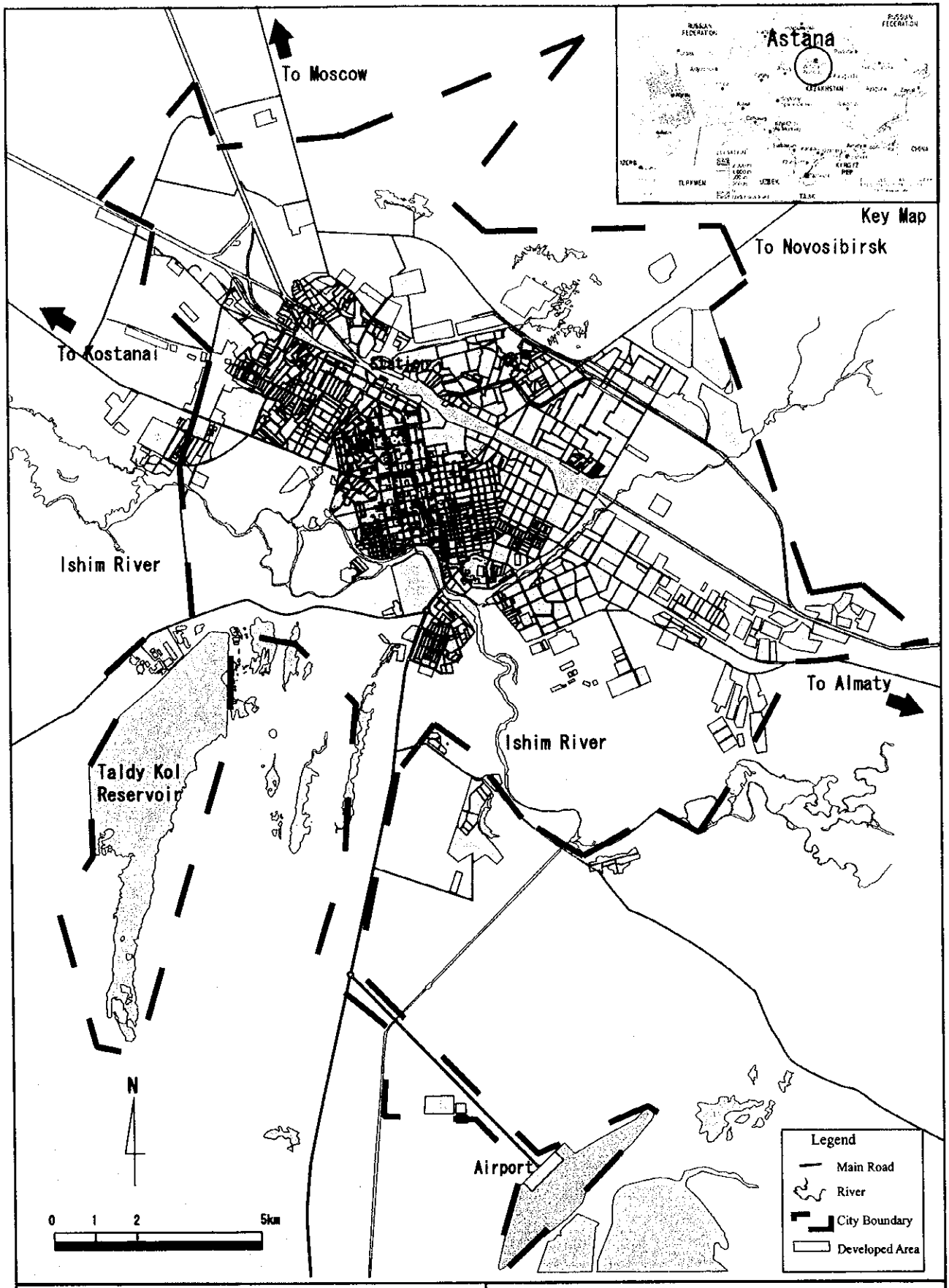
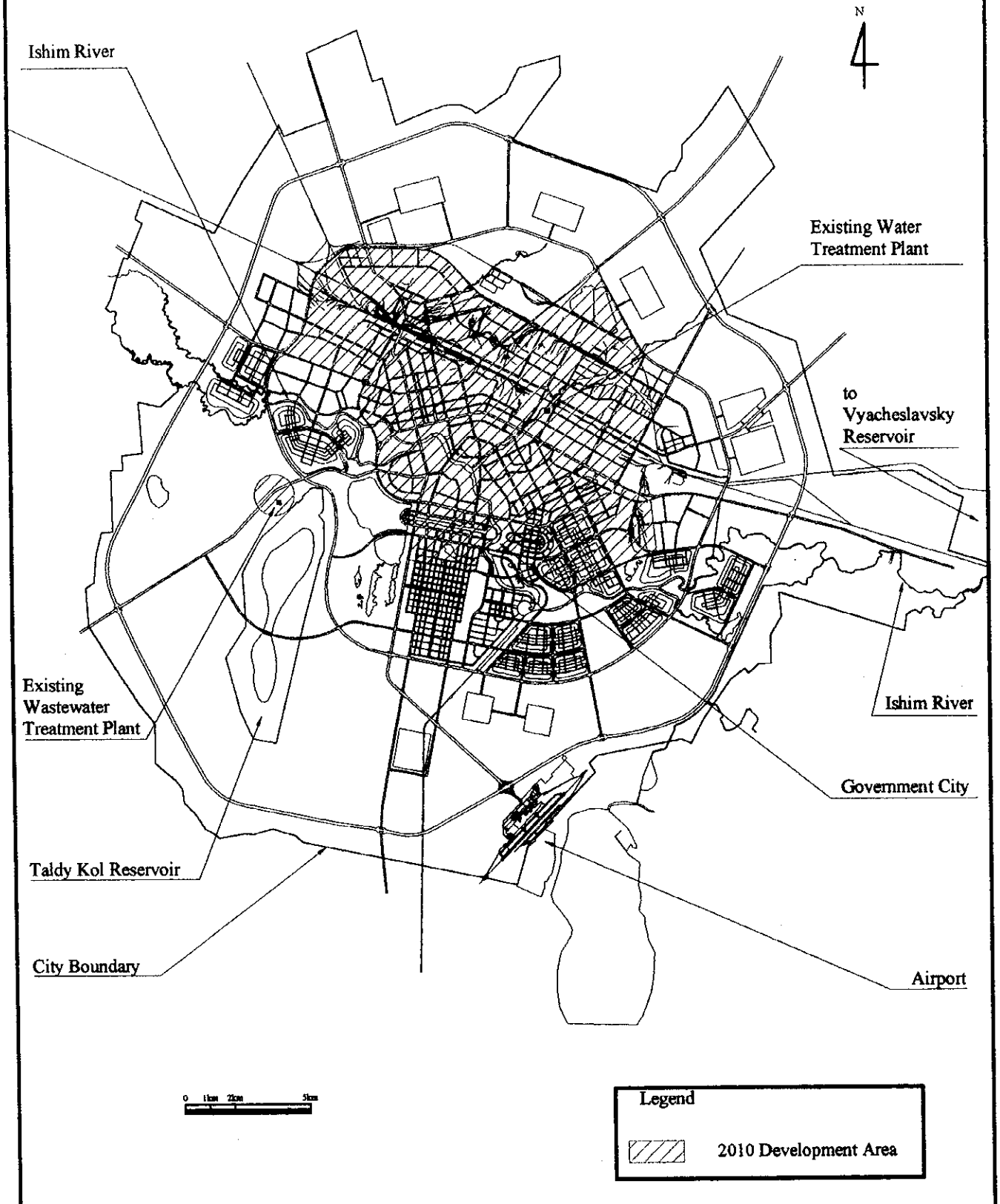
9) Development Specialist	Koyama, Nobuhiro,
10) Development Specialist	Yamamoto, Keiko
11) Development Specialist	Inagaki, Tomikazu,



Feasibility Study for Water Supply and Sewerage in the City of Astana

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 1.3.1
Location Map



The Feasibility Study on Water Supply and Sewerage in the City of Astana

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 1.4.1
2010 Development Area

CHAPTER 2
GENERAL CONDITIONS

CHAPTER 2 GENERAL CONDITIONS

2.1 Natural Conditions

(1) Topography

Astana City is located at the southern region of the steppes of Central Asia with its immense plain and little geomorphologic relief. The topography in Astana City is characterized by gentle slopes, generally between an elevation of 370 m to the east and 345 m to the west.

There are three major river systems around the City, the Ishim River flowing through the center, the Nura River to the south and the Seleti River to the north.

The Ishim River runs through the center of Astana City from the east to the west dividing the city into two parts. The old city area is on the right bank of the river and on the left bank there are small rural developments with grass and marsh lands at low elevations. The western half of the left bank is currently being developed for the new government city with commercial and residential areas. The eastern half, presently covered by grass and marsh lands will remain as a natural conservation area of water, grass and forest lands.

(2) Meteorology

Astana is almost at the centre of Kazakhstan, itself situated in the center of Eurasia and at very large distances from the oceans. This location and the large open land surrounding Astana has a large influence on the climate of the City which is typical of a continental climate zone. It is characterized by large fluctuations of temperature and small amounts of precipitation.

The average monthly temperature during the summer time from June to August is around 20 °C, and below –10 °C from December to February, fluctuating more than 30 °C through the year.

The average annual precipitation between 1990 and 1999 was 315mm of which 100mm fell as snow. The snowfalls accumulate in the plains during winter and causes noticeable increase in river flow during the spring thaw. Floods can occur as a result of constrictions caused by logjams.

Monthly average humidity is comparatively low throughout the year with an annual average of 67%. Between May and September, the humidity is particularly low,

because evapotranspiration during the summer is large as a result of the intense solar radiation.

The annual average wind speed is 3.6m/s with speed in winter a little larger than in summer, sometimes exceeding 4.0m/s. The predominant wind direction is from the south-west for about 25% of the year. During winter this duration increases to more than 30%. In summer the predominant wind direction is from the north east.

(3) Water Resources Availability

Prior to the construction of Vyacheslavsky Reservoir Astana relied on groundwater for its water supply. This source of water was abandoned on completion of the reservoir in 1970 and at present the city relies entirely on Vyacheslavsky Reservoir for its water supply. The groundwater sources were abandoned because of increasing mineral content. The other sources of water in the vicinity of Astana are presented and their availability discussed.

1) Vyacheslavsky Reservoir

The Vyacheslavsky reservoir has an effective storage capacity of 391 MCM and relies on the Ishim river for its water. The catchment area of the reservoir is 5,310 km^2 with a long term annual mean flow of 171 MCM/year. Recent estimates of the reliability of this water source shows that the 95% dependability yield of the reservoir is 89.2 MCM/year.

2) Nura River

The yield of the Nura River at Romanovska about 30 km south of Astana and upstream of the intake of the Nura-Ishim Canal is 17.5 m3/s with a reliability of 50%. The Nura River has also suffered from a deterioration of its water quality resulting from the discharge of industrial wastewater contaminated with mercury. Remediation of this contamination is in progress but it will take many years for the project to be completed and for the Nura to become a suitable source for water supply.

3) Irtysh-Karaganda Canal (IKC)

The Irtysh-Karaganda (IKC) is a system of canals, reservoirs and pump stations designed to transfer water from the Irtysh River mainly for the water supply to the industrial towns of Karaganda and Termitau. Construction was completed in 1975 but a branch intended to supplement the water supply for Astana via the Ishim River was not completed. A volume of 152.2 MCM per year is available from the IKC system for Astana, however after consideration

of losses the net volume available at Vyacheslavsky Reservoir is only 63 MCM per year. The construction of the pipeline is currently underway.

4) Groundwater

The four aquifers suitable for Astana's water supply area as follows:

- Akmolinsky aquifer 60 km to the north of the city
- Tselinogradsky aquifer along the Ishim River
- Rodjdestvensky aquifer about 25 to 45 km to the south of the city
- Nurinsky aquifer about 80 km to the southwest of the city

As mentioned earlier Astana has stopped utilization of these aquifers for its water supply but other users in the vicinity of the aquifers have continued extraction, which was of the order of 7,110 m^3/day in 1998.

The total yield of the four aquifers was formerly estimated at 128,300 m^3/day (46.83 MCM per year). However recent investigations between September 1999 and March 2000 on one of the aquifers show a 50% reduction in the yield of the Akmolinsky aquifer from the original 31,100 m^3/day. Further investigations are necessary to establish the reliable yield of the other three aquifers. In addition measures ought to be taken to protect these underground sources from pollution by creation and maintenance of a protection zone around each aquifer. This is necessary because water quality in all the aquifers have degraded as a result of pollution from the surface or through polluted rivers.

It is thus premature to place much reliance on groundwater for the continuous supply of Astana. However groundwater can be a source of emergency water after completion of the required improvement measures.

5) Demand Satisfaction

The water demand of Astana City in 2010 is projected by JICA Master Plan Study Team as follows:

Water Demand for Astana City in 2010

Item	Volume,MCM
Drinking Water	55.4
Technical Water	8.5
Irrigation	20.7
Greenery	0.3
Sanitary Flow	5.0
Landscaping and miscellaneous use	3.0
Water Loss	12.0
Total	**104.9**

The fulfillment of the water demand in the Astana area can therefore be satisfied mainly by the Vyachelavsky Reservoir which is evaluated to have the annual yield of 89.2 MCM. The deficit can be made up on completion of the extension of the IKC to Astana.

(4) Geology

At the beginning the pre-Paleozoic era, a considerable area of the Akmolinsky oblast was covered by sea with numerous volcanic islands. As a result of the intense volcanic activities at the time, large deposits of volcanic ash has accumulated together with large mineral ores such as gold, bauxite, antimony and copper.

Most of Kazakhstan belongs to the Urals-Mongol fold belt comprising of Paleozoic formations such as siltstone and sandstone. In the depressions of Tengiz and Turnay, Paleocene and Neocene formations are overlaid exclusively with continental sediments within the Paleozoic massif, and Quaternary sediments occur in the river courses and lakeshores.

Alluvium Quaternary sediments accumulated in river valleys and lakes, which were distributed on the flood plain of the Ishim and other river basins. Modern alluvium is characterized by shallow thickness and a motley granular structure. Fluvial alluvium sediments are also characterized by a heterogeneous granular structure. Loam, sandy loam and sands are observed in this alluvium layer. Beside the river, clays, heavy silt loam deposits with scattered penetration of rocks.

(5) Geotechnical Condition

In the course of this Study, geotechnical investigations were carried out on the proposed sites where new facilities are to be constructed.

A total of 20 borings were carried out, six at WTP and seven at WWTP and the remaining seven at the water intake and wastewater pumping stations. A summary of the conditions encountered at the main sites is provided below:

1) Water Treatment Plant (WTP)

The subsurface layer is comprised of loose coarse sand of 1.5 to 2.0 m thickness under the sandy clay surface. The main structures to be located on this site are water retaining structures founded between 0.5 and 2 m below existing ground level on the loose sand. It is considered that the loose sand does not have the necessary bearing capacity to support such structures and therefore piled foundations are proposed.

2) Wastewater Treatment Plant (WWTP)

The subsurface layer is comprised of loamy sand of 2.0 to 3.0 m thickness under the sandy clay surface. The main structures to be located on this site are water retaining structures founded between 0.5 and 2 m below existing ground level on the loamy sand. It is considered that the loamy sand does not have the necessary bearing capacity to support such structures and therefore piled foundations are proposed.

(6) Water Environment

The water environment around Astana consists of the three main river systems as described earlier and a large number of natural lakes and man-made reservoirs.

The main water bodies directly concerned with the water supply and wastewater system of Astana are as follows:

- Vyacheslavsky Reservoir
- Ishim River
- Nura River
- Taldy Kol Reservoir

Vyacheslavsky Reservoir is the water supply source for Astana. The Ishim River is used in Astana for recreational purposes such as swimming, boating etc. The Ishim River also provides technical water to the industrial sector in Astana. Settlements downstream of Astana rely on wells dug in the flood plain of the Ishim River. The Nura River is not used due to mercury contamination. Taldy Kol Reservoir is the receiving water body for treated wastewater from Astana.

Water quality of the rivers is regularly monitored by the hydrometeorological monitoring centre, State Enterprise Kazgidromet. A summary of the water quality in the Ishim River is provided below:

Water Quality in the Ishim River

	BOD_5 mg/l	COD mg/l	Suspended Solids mg/l
Maximum Allowable Concentration of Raw Water for Domestic Use	3.0	15	Not Specified
Vyacheslavsky Reservoir	0.8	23	0.7
Telman Village	1.6	22	0.5
Astana City	2.7	24	1.1
Kirov Village	2.0	23	1.3

2.2 Socio-economic Conditions

(1) Population

The population projection adopted for the planning of the water supply and sewerage system has been prepared by the JICA Master Plan Team. The forecast takes into consideration the selection of Astana as the Capital of Kazakhstan. It is therefore expected that the population growth will include a high immigration component in addition to natural growth. The expected population at the target years are presented below:

Expected Population

Year	2000	2005	2010	2020	2030
Population	321,600	400,000	490,000	690,000	800,000

(2) Economic Activities

With about 60% of the former USSR's mineral resources and about 20 % of the cultivated land in the former USSR and rapid market reform in Kazakhstan is well placed for economic growth. Much of the economy has been liberalized as the country changes from a centrally planned economy to a more market oriented economy. Poor infrastructure is presenting a major obstacle to development of the full potential of the country.

Outlook for industries in Kazakhstan is mixed with GDP growth of only 1.7% in 1999. Exports of oil and fuel make up 40% of total exports and have been increasing in recent years. Other growth sectors are mining and the export of primary goods.

(3) Sanitary Condition

Healthcare is an important consideration for the Government of Kazakhstan and for the Akimat of Astana and with availability of over 80 public and private medical facilities, the health of the population is considered reasonable in general.

There is no occurrence of typhoid or cholera but the occurrence of dysentery and hepatitis is relatively high as shown in the following table.

Cases of Water Borne Diseases

Water Borne Diseases	1998	1999
	No of Cases	No of Cases
Hepatitis A	573	161
Dysentery	765	658

Solid waste collection is regularly carried out by Akimat and disposed to the only landfill site located 6km to the North of Astana. About 1,000m^3 per day of waste is

received, of which 20% is of industrial origin. The site was opened in1972 and is expected to be full by 2010. The construction is not to present-day standard and lacks a proper impermeable lining.

(4) Agriculture

The agricultural sector in Kazakhstan is still in transition, and although production fell over the last seven years, it seems to have stabilized. Milk was the main product in the Akmola Oblast and the agricultural cycle was designed around fodder production.

Formal employment level has fallen but many people are still working the land to maintain a subsistence living standard with a small surplus disposed in local markets.

The semi arid condition around Astana means that irrigation is necessary for proper agricultural production and it has been used extensively in the past. The loss of guaranteed markets, the increase in energy costs and the privatization of farms has meant the abandonment of many irrigation schemes. Projects to rehabilitate some of the irrigation schemes are presently under way. Although in decline over the last few years, the prospect for the agricultural sector is promising given the on-going emergence of small and efficient farms out of the large inefficient agricultural enterprises of the Soviet era.