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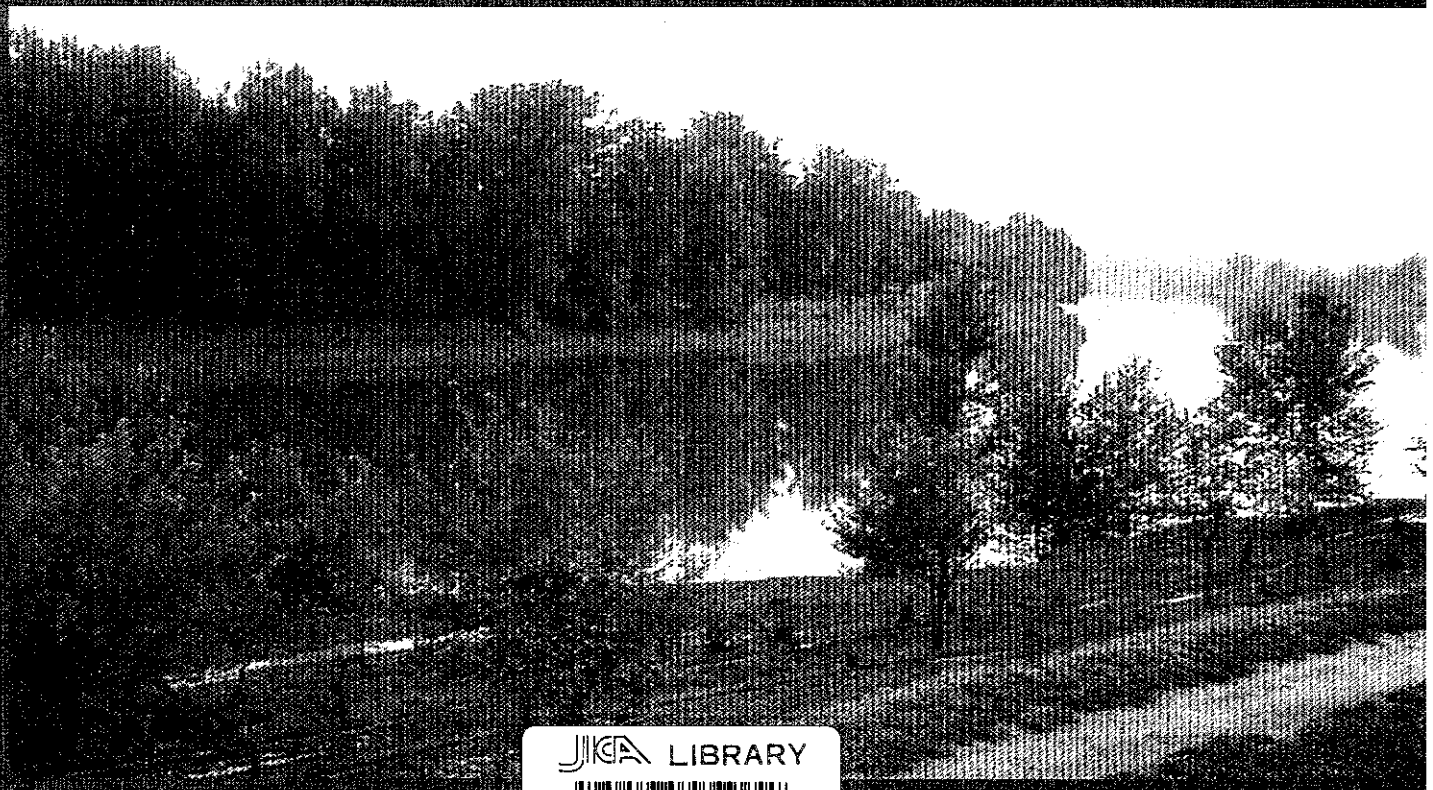
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

No.

MINISTRY OF ECONOMY
MINISTRY OF AGRICULTURE AND FOOD INDUSTRY
THE STATE WATER RESOURCES MANAGEMENT CONCERN
"APELE MOLDOVEI"
THE REPUBLIC OF MOLDOVA

# THE STUDY ON WATER SUPPLY SYSTEMS FOR THE NORTHERN REGION IN THE REPUBLIC OF MOLDOVA

## FINAL REPORT
## Summary





January 2003

PACIFIC CONSULTANTS INTERNATIONAL, TOKYO
TOKYO ENGINEERING CONSULTANTS, TOKYO

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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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**EXCHANGE RATES**

In this report, project costs are estimated base on the following exchange rates:

| | |
|---|---|
| Master Plan Stage: | 1 US$ = 12.80 *Lei* = 125 Japanese Yen (August 1, 2001) |
| Feasibility Study Stage: | 1 US$ = 13.60 Lei = 120 Japanese Yen (August 1, 2002) |

## PREFACE

In response to a request from the Government of the Republic of Moldova, the Government of Japan decided to conduct a master plan and feasibility study on Water Supply Systems for the Northern Region and entrusted the study to the Japan International Cooperation Agency (JICA).

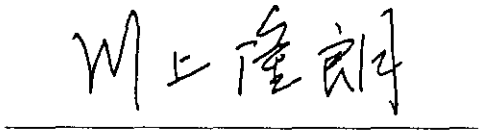
JICA selected and dispatched a study team headed by Dr. Akira UCHIDA of Pacific Consultants International (PCI) and composed of PCI and Tokyo Engineering Consultants (TEC) to Moldova three times between March 2001 and November 2002. In addition, JICA set up an advisory committee headed by Mr. Yoshiki OMURA, Senior Advisor, Institute for International Cooperation, JICA between March 2001 and January 2003, which examined the study from specialist and technical point of view.

The team held discussions with the officials concerned of the Government of Moldova and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this 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 Moldova for their close cooperation extended to the team.

January 2003



Takao Kawakami
President
Japan International Cooperation Agency

January 2003

Mr. Takao Kawakami
President
Japan International Cooperation Agency

**LETTER OF TRANSMITTAL**

Dear Sir,

We are pleased to submit to you the final report entitled "The Study on Water Supply Systems for the Northern Region in the Republic of Moldova." This report has been prepared by the Study Team in accordance with the contracts signed on 21 March 2001 and 26 April 2002 between the Japan International Cooperation Agency (JICA) and the consortium of Pacific Consultants International and Tokyo Engineering Consultants.

The report examines the existing conditions related to water supply in the northern region, proposes a master plan for the water supply systems, and presents the results of the feasibility study on the priority project which was identified in the master plan.

The report consists of the Summary, Main Report, Supporting Report, and Drawings. The Summary summarizes all the results of the Study. The Main Report presents the existing conditions, the proposed master plan, the results of the feasibility study, and recommendations. The Supporting Report includes technical details to support reasoning of the contents of the Main Report. The Drawings volume contains principal design drawings of the priority project.

We wish to express grateful acknowledgements to the Japan International Cooperation Agency, JICA Advisory Committee, Ministry of Foreign Affairs, Ministry of Health, Labour and Welfare, Embassy of Japan in Ukraine, and also to Modovan officials and individuals concerned for their assistance and cooperation extended to the Study Team. We sincerely hope that the results of the Study will contribute to the promotion of the water supply improvement projects in the northern region.

Yours faithfully,

内田 顕

Akira Uchida
Team Leader

## ABBREVIATIONS

| | |
|---|---|
| ACB | Apa Canal Balti (Balti Municipal Water Supply and Sewerage Utilities) |
| ACF | Apa Canal Falesti (Falesti Municipal Water Supply and Sewerage Utilities) |
| ACR | Apa Canal Riscani (Riscani Municipal Water Supply and Sewerage Utilities) |
| ACS | Apa Canal Soroca (Soroca Municipal Water Supply and Sewerage Utilities) |
| ACSB | Apa Canal Soroca-Balti (Soroca-Balti Water Supply Corporation) |
| AGeoM | State Agency of Underground Resources and Geology |
| Apele Moldovei | The State Water Resources Management Concern |
| DAPRE | District Association for Production, Repair and Exploitation (under Apele Moldovei) |
| EIA | Environmental impact assessment |
| EIRR | Economic internal rate of return |
| FIRR | Financial internal rate of return |
| GDP | Gross domestic product |
| GNP | Gross national product |
| GOST | National Standards (of the former Soviet Union) |
| GWh | Giga watt-hour |
| IEE | Initial environmental examination |
| MAFI | Ministry of Agriculture and Food Industry |
| MECTD | Ministry of Environment, Construction and Territorial Development |
| NPV | Net present value |
| O/M (or O&M) | Operation and maintenance |
| PS | Pumping station (e.g., PS-1: Pumping Station No. 1) |
| TR | Transmission Reservoir (e.g., TR-1: Transmission Reservoir No. 1) |
| WS | Water supply |
| WSS | Water supply service |
| WTP | Water treatment plant |
| WWTP | Wastewater treatment plant |

## UNITS

| | |
|---|---|
| m | meter |
| cm | centimeter |
| mm | millimeter |
| km | kilometer |
| $m^2$ | square meter |
| ha | hectare |
| $km^2$ | square kilometer |
| $m^3$ | cubic meter |
| cm/s | centimeter per second |
| $m^3/s$ (or $m^3/sec$) | cubic meter per second |
| $m^3/min$ | cubic meter per minute |
| $m^3/h$ | cubic meter per hour |
| $m^3/d$ (or $m^3/day$) | cubic meter per day |
| $m^3/y$ (or $m^3/yr$) | cubic meter per year |
| Lcd | liter per capita per day (specific water consumption of people) |
| Lhd | liter per head per day (specific water consumption of livestock) |
| kW | kilowatt |
| MW | megawatt |
| kWh | kilowatt-hour |
| TWh | terawatt-hour |
| V | volt |
| kV | kilovolt |
| kgf | kilogram force |
| kg-$m^2$ | kilogram square meter |
| mg/l | milligram per liter |
| r.p.m. | revolution per minute |

# Outlines of the Study Results

## 1. Background, Study Area, Objectives

In the Republic of Moldova, there are problems in the present water supply systems that are not adequately provided and the facilities are deteriorating under the tight financial situation. In the northern region including the City of Balti, the water supply problems are serious.

The areas of this Study are the cities of Balti and Soroca, and towns of Falesti and Riscani. All of these 4 cities/towns are using or used to use groundwater resources for their water supply systems. But, except for Soroca, the water quality is not suitable for drinking and the groundwater potential is not sufficient.

By 1984, the Soroca-Balti water supply system, which uses Nistru River water as water source, was developed, and Apa Canal Soroca-Balti (ACSB) was operating to supply water to the cities of Balti and Soroca. However, due to the problems including over sized facilities, increasing power tariff, downfall of industries that were a large revenue source, and very low water tariffs to the population, ACSB was financially broke and stopped the operation of the system in September 2000 as the power supply was stopped. The operation was resumed in August 2001, but it has been intermittent since then with varying intervals due also to deterioration of facilities. In Falesti and Riscani, construction of respective water supply facilities using the Prut River water started in late 1980s, but the works were suspended with the disintegration of the Soviet Union. The water supplies in these two towns are still entirely dependent on the groundwater of which the quality is not suitable for drinking.

The objectives of this Study are to formulate a water supply master plan for the 4 cities/towns with a target year of 2015, and to conduct a feasibility study on the priority project that covers important and urgent components of the master plan.

## 2. Master Plan

The outlines of the master plan, which was formulated through comparative studies on 3 alternatives, are as follows:

1) The existing ACSB water supply system is rehabilitated with suitable capacity to supply water to all of the 4 cities/towns.
2) To this end, the water transmission mains are extended to the towns of Falesti and Riscani.

### (1) Population Served and Water Demand

Table 1 shows the projected population served and water demand in the Study Area by 2015.

**Table 1 Planning Population Served and Water Demand**

| City/Town/Village | Population served (persons) | | | Water demand ($m^3$/d) | | |
|---|---|---|---|---|---|---|
| | 2000 | 2008 | 2015 | 2000 | 2008 | 2015 |
| Soroca City | 44,988 | 45,667 | 46,442 | 7,961 | 9,901 | 12,178 |
| Balti City | 158,230 | 164,040 | 168,086 | 33,907 | 37,890 | 44,950 |
| Riscani Town | 4,366 | 10,396 | 16,182 | 1,100 | 2,670 | 4,347 |
| Falesti Town | 9,500 | 14,370 | 18,749 | 2,718 | 4,014 | 5,197 |
| Sub-total | 217,084 | 234,473 | 249,459 | 45,688 | 54,475 | 66,673 |
| Other towns and villages | 50,340 | 73,376 | 109,512 | 7,812 | 14,680 | 24,051 |
| Total | 267,424 | 307,849 | 358,972 | 53,500 | 69,155 | 90,724 |

Note; The populations of other towns and villages along the pipelines were also taken into account.

### (2) Approximate Cost

Approximate costs of implementing the master plan are estimated as follows:

| Item | | Cost (US$) |
|---|---|---|
| Direct construction cost | Rehabilitation of the ACSB pumping stations and transmission mains | 5,500,000 |
| | Improvement of the ACSB water treatment plant | 3,400,000 |
| | Completion of unfinished distribution reservoirs (2 sets in Balti) and construction of a new reservoir in Soroca | 1,300,000 |
| | Extension of transmission mains to Falesti and Riscani with provision of new distribution reservoirs | 7,600,000 |
| | Sub-total | 17,800,000 |
| Engineering cost | | 1,400,000 |
| Physical contingency | | 1,800,000 |
| Total | | 21,000,000 |

Approximate costs for renewal and expansion of distribution pipes in the 4 cities/towns, that are necessary to be implemented in parallel to above projects, are as follows:

| City/Town | Cost (US$) |
|---|---|
| Balti | 7,300,000 |
| Soroca | 890,000 |
| Riscani | 580,000 |
| Falesti | 520,000 |
| Total | 9,290,000 |

## 3. Feasibility Study on the Priority Project

### (1) Outline

A feasibility study was conducted on the priority project consisting of the following components having high importance and urgency in the master plan:

1) Renewal of the existing transmission pumps for raw and clear waters and urgent repair works of the transmission mains of the Soroca-Balti water supply system,

2) Rehabilitation and improvement of the existing water treatment plant of the Soroca-Balti water supply system,

3) Completion of the unfinished distribution reservoir (one set) in Balti,

4) Extension of the clear water transmission main to Falesti (35 km) with provision of a distribution reservoir, and

5) Extension of the clear water transmission main to Riscani (37 km) with provision of a distribution reservoir.

The served areas are the 4 cities/towns (excluding the other towns and villages on the routes). As a reference case, the capacities of the facilities are planned with the water demand at 67,000 $m^3/d$ in 2015 as shown in Table 1 (Case 2015). An additional case was also planned as an urgent implementation case where the capacities of transmission pumps were determined based on the water demand at 54,500 $m^3/d$ in the year 2008 (Case 2008). In this case, a part of the instrumentation system that is not considered to have an urgent necessity is excluded.

### (2) Project Cost

| Item | | Cost (US$) | |
|---|---|---|---|
| | | Case 2008 | Case 2015 |
| Direct construction cost Package (1) - (4) | (1) Rehabilitation of the existing ACSB facilities: components 1) and 2) indicated above | 9,522,000 | 10,731,000 |
| | (2) Completion of the unfinished distribution reservoir in Balti | 336,000 | 336,000 |
| | (3) Construction of the common section of the transmission mains to Riscani and Falesti | 1,410,000 | 1,410,000 |
| | (4) Construction of the transmission mains from Balti to Riscani and Falesti with provision of the distribution reservoirs | 8,596,000 | 8,596,000 |
| | Sub-total | 19,864,000 | 21,073,000 |
| Land acquisition cost | | 9,000 | 9,000 |
| Engineering cost | | 1,990,000 | 2,110,000 |
| Physical contingency | | 1,990,000 | 2,110,000 |
| Total | | 23,853,000 | 25,300,000 |

Note: 1) Since above 2 cases are mutually exclusive, one of them should be considered for the implementation.

2) Major reasons why above costs are larger than that of the master plan are: i) detailed investigations in the feasibility study revealed that there were more items needing improvement in the existing pumping stations and the treatment plant, and ii) the total length of the new transmission mains increased as a result of the route survey.

### (3) Implementation Schedule

| Package | | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| Package (1) | Design/tender | | | | | |
| | Procurements | | | | | |
| | Construction | | | | | |
| Package (2) | Design/tender | | | | | |
| | Construction | | | | | |
| Package (3) | Design/tender | | | | | |
| | Construction | | | | | |
| Package (4) | Design/tender | | | | | |
| | Construction | | | | | |
| ACSB system not operable | | | | | | |

### (4) Project Evaluation

1) Economic Evaluation

Among various economic benefits expected from the implementation of the project, the benefit of the reduction of labours for obtaining water was evaluated. In the 2015 case, the EIRR is found to be 4.75 % when all of 4 packages are implemented, and 8.75 % when the packages (1) and (2) only are implemented. In the 2008 case, the EIRR is increased to 5.88 % when all of 4 packages are implemented, and 11.22 % when the packages (1) and (2) only are implemented.

2) Financial Evaluation

In the 2015 case, the FIRR is found to be as follows: i) 3.62 % when all of 4 packages are implemented by soft loan, ii) 7.99 % when packages (1) and (2) are implemented by soft loan and the rest by subsidy, and iii) 6.51 % when packages (1) and (2) only are implemented by soft loan.

In the 2008 case, the FIRR is found to be as follows: i) 2.15 % when all of 4 packages are implemented by soft loan, ii) 7.45 % when packages (1) and (2) are implemented by soft loan and the rest by subsidy, and iii) 6.26 % when packages (1) and (2) only are implemented by soft loan.

3) Environmental Evaluation

The preliminary design of the priority project has incorporated countermeasures to the factors that would otherwise have significant environmental impacts. The implementation of the priority project will improve hygienic conditions and daily activities of the population.

**The Study on Water Supply Systems for the Northern Region in the Republic of Moldova**

**FINAL REPORT**
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# PART 1

# INTRODUCTION AND PRESENT CONDITIONS

## CHAPTER 1 INTRODUCTION

### 1.1 Background to the Study

After the disintegration of the Soviet Union, most of development projects in Moldova including water supply projects halted. In the northern region of the country particularly, there are many problems in water supply systems. The Soroca-Balti water supply system, which was commissioned in 1984 to supply treated water to the cities of Soroca, Balti and neighboring communities, stopped the operation completely in September 2000 because of financial difficulties. For the towns of Riscani and Falesti, new water supply systems utilizing the Prut River water were being developed until early 1990s, but the construction works stopped suddenly corresponding to the disintegration of the Soviet Union. Facing such situations, the municipal water supply and sewerage utilities (Apa Canals) in above cities/towns have been forced to supply groundwater, which is neither sufficient in quantity nor satisfactory in quality.

The current study (hereinafter called "the Study") was evolved under such circumstances being aimed at the improvement of the state of water supply in the region. The Scope of Work for the Study was agreed in December 2000 between Japan International Cooperation Agency (JICA) and the Moldovan authorities concerned. The Study started in April 2001 when the Study Team visited Moldova for the first time.

### 1.2 Objectives of the Study

The objectives of the study are as follows:

(1) To formulate a master plan for water supply systems for four cities/towns (Balti, Soroca, Falesti and Riscani) in the northern region of Moldova with the target year of 2015

(2) To conduct a feasibility study on priority project(s) which will be selected from projects constituting the master plan

(3) To pursue technology transfer to the Moldovan counterpart personnel in the course of the Study

## 1.3 Study Area

The Study will cover the following four cities/towns in the northern region of Moldova: Balti, Soroca, Falesti, and Riscani. Their locations are shown in Figure 1.1. Figure 1.2 shows a proposed scheme of water supply in the master plan for these 4 cities/towns. In the development of the master plan, however, other towns/villages were also taken into consideration for determining the capacities of relevant water supply facilities, as indicated in Chapter 3.

## 1.4 Study Schedule

The Study has been composed of 2 phases and 6 stages as shown below.

| Phase | Stage | Place and Period | Report |
|---|---|---|---|
| Phase I Master Plan Study | 1 | Work in Moldova (April - October 2001) | Progress Report (1) |
| | 2 | Work in Japan (October - December 2001) | Interim Report |
| Phase II Feasibility Study | 3 | Work in Moldova (May - August 2002) | Progress Report (2) |
| | 4 | Work in Japan (September - October 2002) | Draft Final Report |
| | 5 | Seminar and discussion in Moldova (October/November 2002) | |
| | 6 | Work in Japan (November 2002 - January 2003) | Final Report |

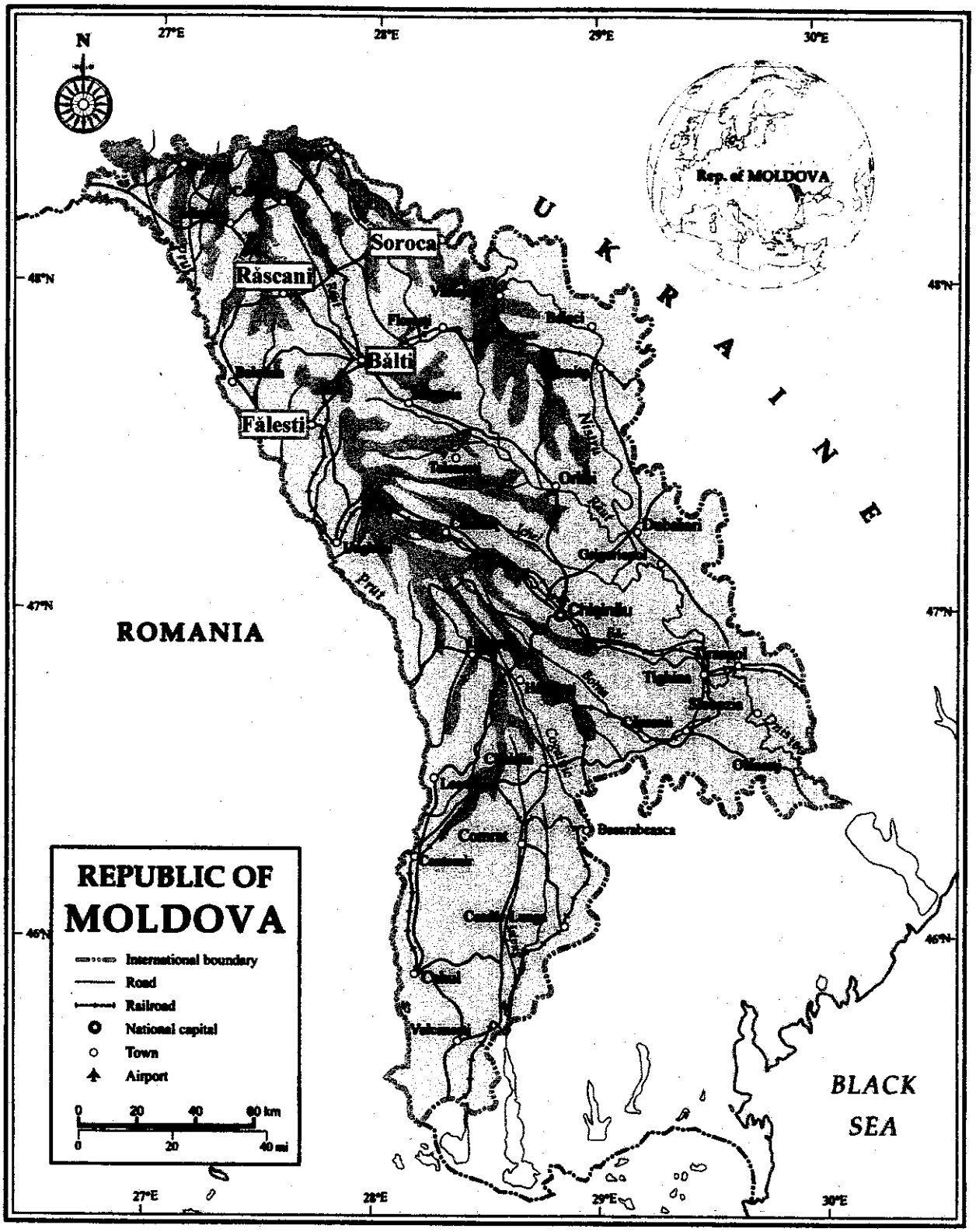
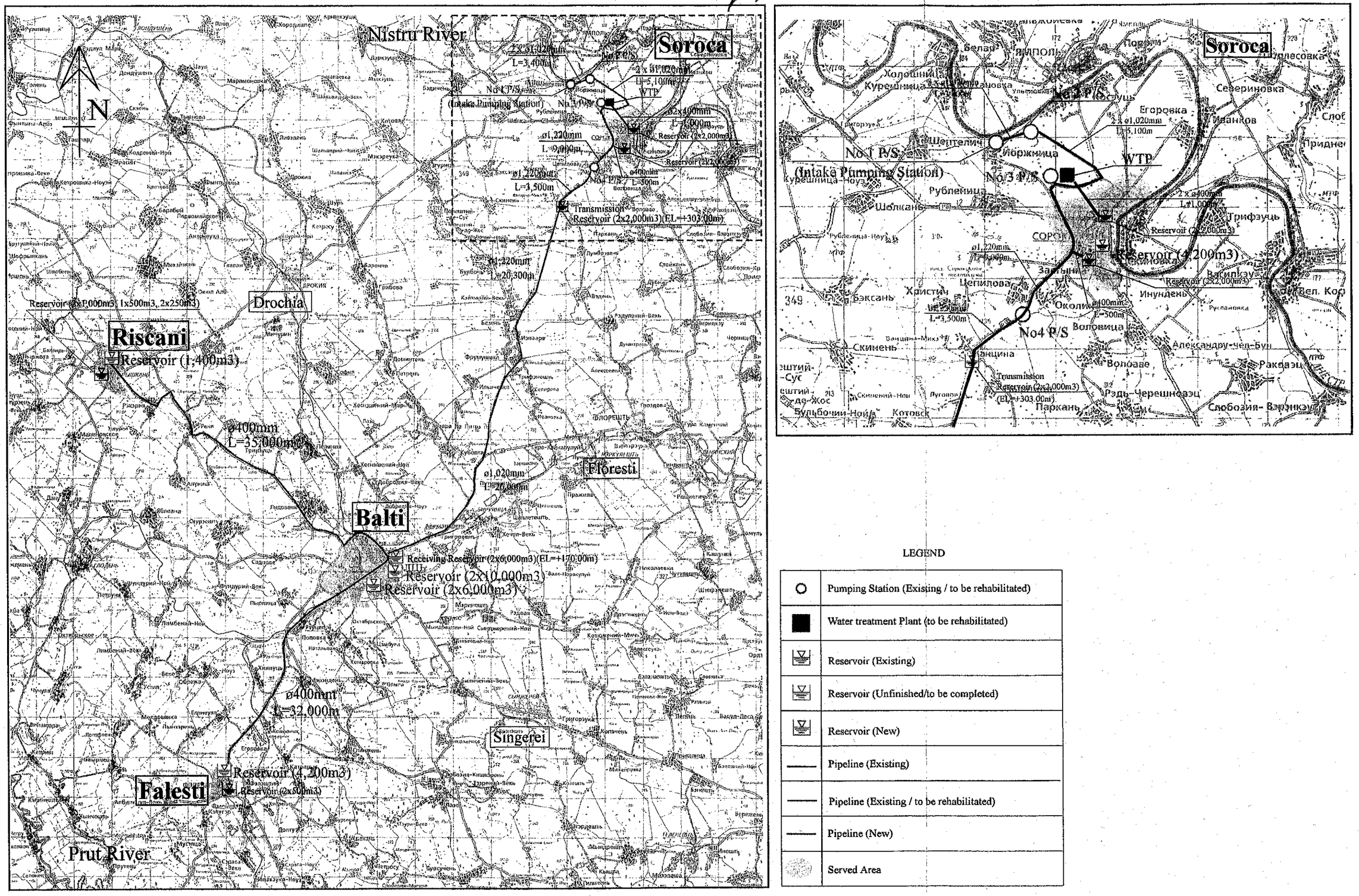



**Figure 1.1 Location of the Study Area**




LEGEND

| | |
|---|---|
| ○ | Pumping Station (Existing / to be rehabilitated) |
| ■ | Water treatment Plant (to be rehabilitated) |
| | Reservoir (Existing) |
| | Reservoir (Unfinished/to be completed) |
| | Reservoir (New) |
| —— | Pipeline (Existing) |
| —— | Pipeline (Existing / to be rehabilitated) |
| —— | Pipeline (New) |
| | Served Area |

Figure 1.2 Proposed Scheme of Water Supply

# CHAPTER 2 PRESENT CONDITIONS

## 2.1 Socio-economic Conditions

### 2.1.1 Population

The total population of the Republic of Moldova was 4,264,300 in January 2001. The population has been steadily decreasing in the latest several years. It decreased since 1991 to 2001 by about 100,000, of which a large portion of the decrease occurred in the territorial unit on the left bank of Nistru River (UATSN). The population emigrated to foreign countries during the 4 year period of 1997 - 2000 was 25,700. The population density of the country in 2001 was 126.2 persons/km$^2$.

The population in the Study Area is described in Chapter 3.

### 2.1.2 Economy, Industry and Income

#### (1) Country

The GDP per capita at purchasing power parity (PPP) decreased from 2,975 USD in 1994 to 2,105 in 1995, 29% reduction from the previous year. Since then, it remains at similar levels.

The agriculture/forestry/fishery sector has the largest share in the GDP, but its share has been decreasing from 30% in 1997 to 28% in 2000. The shares of the industry and construction sectors in the GDP have been also decreasing in the latest 3 years, while that of commerce, transportation/communication, and others have been increasing.

The average monthly family income in the country was 305 Lei in 1999 and 407 Lei in 2000. It was largest in Chishinau City at 615 Lei in 2000 followeed by Balti County at 359 Lei. The differences in income levels between Chisinau City and all other regions are remarkable.

#### (2) Study Area

Characteristics of industrial developments of the 4 cities/towns in the Study Area in the Soviet era were as follows:

Balti — Important industrial, commercial, trade and administrative center in the northern Moldova; 70,700 people were employed in the industries.

Soroca — Important industrial center in the northern Moldova; 20,000 people were employed in the industrial enterprises.

Falesti Agricultural products processing and machinery assembling town; 12,000 people were employed in the industries.

Riscani Agricultural products processing town; 6,500 people were employed during the Soviet era in the industrial enterprises.

Now, much less number of enterprises are operated stably. Some are adopted for small-scale private production. On the other hand in Balti, a large number of small individual shops, production and processing enterprises, service enterprises have been created.

According to the questionnaire survey conducted for randomly selected households in the four cities/towns of the Study Area, sectoral distribution of jobs of the respondents is as shown in Table 2.1, which also shows average monthly household income.

**Table 2.1 Working Sectors and Income of Households in 4 Cities/Towns**

| | Balti | Soroca | Falesti | Riscani |
|---|---|---|---|---|
| Number of samples (households) | 255 | 114 | 60 | 76 |
| Working sectors (%) | | | | |
| Agriculture | 2.7 | 0.9 | 15.8 | 16.4 |
| Industry | 14.1 | 9.6 | 14.0 | 11.0 |
| Construction | 4.3 | 1.8 | 7.0 | 4.1 |
| Transport and communications | 9.0 | 6.1 | 3.5 | 4.1 |
| Trade and public food | 15.7 | 19.3 | 26.3 | 13.7 |
| Education, culture, research | 9.4 | 11.4 | 10.5 | 2.7 |
| Health | 3.5 | 11.4 | 5.3 | 8.2 |
| Others | 31.4 | 30.7 | 17.5 | 39.7 |
| | | | | |
| Average monthly income/household (Lei) | 602 | 616 | 414 | 411 |
| Average number of persons/household | 3.1 | 3.3 | 3.2 | 3.4 |

Source: Sociological Survey (5 - 16 June 2001) entrusted to Acvaproiect.

### 2.1.3 Energy

In Moldova only 3% of the demand for primary energy is covered by the domestic sources. In 1995 primary energy supply was dominated by natural gas (48%). The main energy suppliers are in Russia (100% of gas imports), Ukraine (with Russia it accounts for 100% of country's coal imports), and several European countries (oil products). The Republic annually spends about 25 - 30% of the GNP for energy import.

Some 60% of final energy consumption is in the form of electricity and heat, of which industry is the main consumer (41% and 47%, respectively). Until 1998, electricity was supplied by only one enterprise "Moldenergo," a state company.

The consumption of primary energy dropped by more than 50% from 1990 to 1995. Electricity consumption also decreased from 12,700 GWh to 5,400 GWh.

The former State Company "Moldenergo" was transformed in 2000 into the following three categories of enterprises, and most of them have been privatized:

- Power generation companies: MTPP-Dniestrovsk, TPP-1, TPP-2, TPP-Balti
- Transmission company: Moldtranselectro
- Distribution companies: RED Chisinau, RED Central, RED South (all privatized by UNION Fenosa), and
  RED North, RED Noth-West (state owned companies).

Two power distribution companies supply electricity in the Study Area: RED North Company to Balti City, Falesti Town and Riscani Town, and RED North-West Company to Soroca City. Both companies are still state-owned, while remaining 3 power distribution companies have been privatized.

### 2.1.4 Land Use

Residential areas dominate in the cities of Balti and Soroca, and agricultural areas dominate in the town of Riscani. In the town of Falesti, the land use is relatively mixed being shared by agriculture, residence, natural reserves, forests/green, and industry/transport, in that order. The total area of Riscani is the largest among 4 municipalities, followed by Balti, Falesti and Soroca. The industry/transport areas are largest in Balti, followed by Falesti, Riscani and Soroca.

## 2.2 Natural Conditions

### 2.2.1 Topography and Geology

The most part of the national land is gently undulating hills, and agricultural areas account for about 67 percent of the whole national land. Consequently, the landscape tends to be of bare rolling cultivated hills, with little natural woodland.

The Study area has the similar topographic conditions. The 4 cities/towns in the Study Area lie on the gently undulating hills of the following elevations: 90 m - 160 m in Balti, 45 m -170 m in Soroca, 70 m - 150 m in Falesti, and 120 m - 185 m in Riscani. The maximum and minimum elevations in the Study Area are approximately 350 m at the point near Soroca City, and 45 m at the bank of Nistru River in Soroca City, respectively.

The most part of the Study Area is covered by the Miocene geological formation (clay, limestone, sands, and sandstone). Balti City, Riscani and Falesti towns are situated at the Miocene geological formation. While, Soroca City is located at the border of two geomorphological regions, namely, Middle Nistru Subregion of Nisterian Terraces Plain (presented by Late Pliocene deep and narrow canyons) and Soroca Subregion of Nisterian Swell Height (to the west from the town, presented by Late Miocene accumulation deposits with canyons and valleys).

### 2.2.2 Meteorology

The climate throughout Moldova is created by continental air masses, influenced by the Carpathian Mountains in the northwest and the Black Sea in the southeast. Compared to other countries of Eastern Europe, the climate of Moldova is moderate throughout the year.

In the Study Area, the annual average air temperature is at 8 - 9 °C, with the registered maximum at 39 °C in Falesti and the minimum at −35 °C in Soroca. The average temperature in July is about 20 °C, while that in January is −4 °C.

The annual average precipitation in the Study Area is approximately 560 mm, of which about 50% concentrates in the four warmer months of May through August (see Figure 2.1). The annual evaporation is approximately 740 mm in the northern part of Moldova and 870 mm in the central part. In the Study area, the potential evaporation exceeds the precipitation by 310 mm/year. This deficit of the precipitation has significant influences on both surface and groundwater resources.

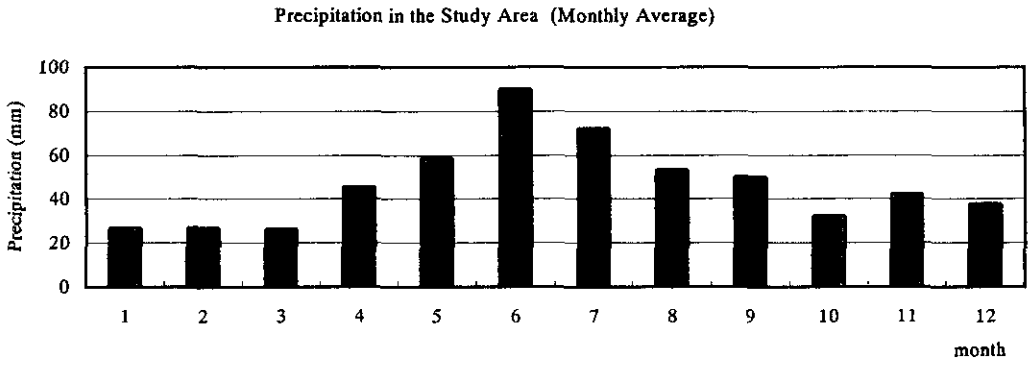



**Figure 2.1 Precipitation in the Study Area**

### 2.2.3 Hydrology

There are three major river basins in the Study area, namely Nistru River, Prut River and Reut River.

Nistru River rises in the Carpathian Mountains in Western Ukraine, where the river passes over 50% of its total length. It finally discharges into the Black Sea, west of the city of Odessa. Prut River

also rises in the Carpathian Mountains in Ukraine, and forms Moldova's western border with Romania, until the river discharges into the Danube. Reut River runs between Nistru River and Prut River, and merges to Nistru River at the north of Chisinau.

The catchment area of Nistru River covers about 35% of the national total area, and Prut River and Reut River account for a little over 20%, respectively.

| River | Length (km) | | Catchment area ($km^2$) | |
|---|---|---|---|---|
| | Total | in Moldova | Total | in Moldova |
| Nistru River | 1,352 | 630 | 64,340* | 11,310* |
| Prut River | 976 | 695 | 27,500 | 7,990 |
| Reut River | 286 | 286 | 7,760 | 7,760 |

Note: * Excluding the catchment area of Reut River.

The two major rivers, Nistru River and Prut River have a large water discharge throughout the year. However, some of their tributaries are drying up due to the large deficit of the precipitation against the potential evaporation during the summer months.

## 2.3 Water Sources and Water Quality

### 2.3.1 Groundwater

#### (1) Quantity of Groundwater

In Moldova, about 70 % of the groundwater resources are contained within the Baden-Sarmat formation, 10 % in the Middle Sarmat formation, 10 % in the Mel formation, and remaining 10 % is distributed over other aquifers.

In the towns of Falesti and Riscani, water sources of the central water supply systems are deep wells, and the cities of Balti and Soroca also have to use deep wells when the Soroca-Balti water supply system is not in operation.

Community or private shallow wells are widely used in the Study area to compensate the insufficiency of central water supply systems. However, some shallow wells in the central areas of the cities/towns have now much smaller yield than before as a result of over extraction.

Except for Soroca, groundwater exploitation is already at high levels, and further exploitation does not seem to be viable.

### (2) Quality of Groundwater

At present, Apa Canals of Falesti and Riscani, and Balti and Soroca as well when the ACSB system is not operated, supply groundwater to consumers without disinfection. According to the water quality survey, the following water quality parameters exceeded the drinking water standards in Moldova.

Deep well water (supplied by Apa Canals)

| | |
|---|---|
| Fluorides, ammonia: | Balti, Falesti, Riscani |
| Nitrates: | Balti |
| Total solids: | Falesti, Riscani |
| Color: | Balti, Falesti |

Shallow well water (community and private wells)

| | |
|---|---|
| Nitrates, total hardness: | Balti, Soroca, Falesti, Riscani |
| Total solids: | Balti, Falesti, Riscani |
| E. coli: | Falesti |

It is clear that both the deep well and shallow well water in the 4 cities/towns are not suitable for drinking, except for the deep well water in Soroca.

## 2.3.2 Surface Water

### (1) Quantity of River Waters

The waters of Nistru River and Prut River are available as sources for water supply systems.

1) Prut River

The water of Prut River is evenly shared by Moldova and Romania in accordance with the convention in the Soviet era and the treaty of October 1993. A reservoir of the Costesti-Stinca hydrosystem was constructed in 1978 to regulate the flow. The priorities of water allocation are set to supply drinking water to the population, and to maintain the minimum river flow of 17 $m^3/s$ to satisfy ecological requirements.

The minimum daily average flow in the past 23 year occurred in 1991, and the excess over the minimum flow to be maintained was 233,000 $m^3/d$. This amount is about 16 times the water supply demand quantity projected for the towns of Falesti and Riscani, and nearby villages together. Therefore, the uninterrupted water supply is ensured throughout the year.

2) Nistru River

The flow of Nistru River is regulated by the reservoir of the Nistru Complex Hydrosystem in Novo-Dniestrovsk, located upstream from Soroca near the border between Ukraine and Moldova on the side of Ukraine. According to the agreement between Moldova and Ukraine in November 1994, use of available water of the river is evenly shared by two countries.

The regulatory capacity of the reservoir ensures allocation of the river water to all users in the catchment areas. The priorities are set to allocate available water for the supply of drinking water to the population, and to maintain the minimum river flow of 80 $m^3/s$ to satisfy ecological requirements.

According to the past 11-year records, the minimum daily average flow occurred in 1994, and the water usable in Moldova was 1,166,400 $m^3/d$. This amount is more than twelve times the projected water supply demand quantity for all the 4 cities/towns and peripheral towns/villages together. Stable water supply can be achieved in the region by taking water from Nistru River.

### (2) Quality of River Water

In the water quality survey of Prut River and Nistru River, heavy metals and toxic chemical substances were not detected. On the other hand, color and total coliform values exceeded the raw water quality standards. The water quality monitoring of Nistru River was also conducted by the Environmental Inspectorate in 1998-1999. BOD, ammonia, and nitrates concentrations were higher at downstream from Soroca City than upstream, indicating that Soroca City was a significant source of pollutants. In summary, the waters of both Nistru River and Prut River can be the sources of water supply with appropriate treatment. .

## 2.4 Present Water Supply Systems in the Study Area

### 2.4.1 Water Supply Systems of Four Apa Canals

### (1) Outlines

Until 1983, the water supply systems in all of the 4 cities/towns were using groundwater as water source. Since 1984 when the water supply system of Apa Canal Soroca-Balti (ACSB) using the Nistru River water was commissioned, the cities of Balti and Soroca were receiving treated water from the ACSB system. The operation of the ACSB system stopped in September 2000, resumed in August 2001, and stopped again in June 2002. When the ACSB system stops its operation, these two cities must use their own groundwater supply systems.

As regards the towns of Falesti and Riscani, the construction of new water supply systems based on Prut River as the water source stopped as a result of the disintegration of the former Soviet Union, and the water supply systems using groundwater remain unchanged to the present.

Outlines of the present water supply systems in these 4 cities/towns are summarized in Table 2.2, which apply to the case when the water from ACSB is not available for Balti and Saroca.

**Table 2.2 Outlines of Present Water Supply Systems in the 4 Cities/Towns (Year 2000)**

| City or town | | Balti | Soroca | Riscani | Falesti |
|---|---|---|---|---|---|
| Population (persons) | | 164,179 | 46,184 | 16,433 | 19,039 |
| Population served (persons) | | 158,230 | 44,988 | 4,366 | 9,500 |
| Service rate (%) | | 96.4 | 97.4 | 26.6 | 49.9 |
| Water supply capacity ($m^3$/d) | | 27,000 | 3,500 | 1,500 | 1,200 - 1,500 |
| Accounted-for water ($m^3$/d) | | 22,000 | 2,400 | 300 | 600 |
| Water source | | wells | wells | wells | wells |
| Water quality problems | | fluorides, ammonia, nitrates | no serious problem | fluorides, ammonia | fluorides, ammonia |
| Number of operating wells | | 58 | 10 | 5 | 15 |
| Depth of wells (m) | | 60 - 280 | 50 | 150 | 180 |
| Distribution reservoirs | Number | 14 | 3 | 5 | 2 |
| | Total capacity ($m^3$) | 24,000 | 6,000 | 3,000 | 1,000 |
| Distribution pipes | Total length (km) | 266 | 69 | 27 | 31 |
| | Year of laying | 1950s - 1990s | 1970s - 1980s | 1950s - | 1980s |
| Rate of provision of water meters (%) | | 40 | 26 | 30 | 80 |
| Hot water supply | | suspended | suspended | suspended | suspended |
| Water supply time | | 6:00 - 11:00<br>18:00 - 23:00 | 5:00 - 24:00<br>24 hours in a part of the area | 2 days a week<br>8:00 - 23:00<br>24 hrs for high-rise apartments | 2 days a week<br>5:00 - 9:00 or<br>17:00 - 21:00 |

### (2) Distribution Networks

The population served with water supply system is nearly 100% in the cities of Balti and Soroca. But many of distribution pipes are old. The rates of water leakage are considered to be around 30%. In Falesti and Riscani, the rates of water supply service remain at only 50% and 27%, respectively. The expansion of the distribution network is badly needed in both towns towards the future. The present distribution pipes are generally old in these towns also, and the water leakage rates are similar to those in Balti and Soroca.

Necessary extension and replacement of distribution pipes have been estimated as shown below.

| | Balti | Soroca | Riscani | Falesti |
|---|---|---|---|---|
| Existing pipes (km) | 266 | 69 | 27 | 31 |
| Required pipe replacement (km) | 139 | 42 | 3 | 5 |
| Required pipe extension (km) | 0 | 0 | 36 | 28 |
| Required total pipe length (km) | 266 | 69 | 63 | 59 |

### 2.4.2 Water Supply Facilities of Apa Canal Soroca-Balti

#### (1) Outline of the Soroca-Balti Water Supply System

The Soroca-Balti water supply system uses the Nistru River water. Its construction started in 1976. The originally planned total water supply capacity was 182,000 $m^3/d$, which included 115,000 $m^3/d$ for Balti, 39,400 $m^3/d$ for Soroca, 21,200 $m^3/d$ for Floresti, and 10,700 $m^3/d$ for other settlements along the pipeline. Apa Canal Soroca-Balti (ACSB) started the operation of this system in 1984. The amount of supplied water at that time was 90,000 $m^3/d$, which was a half of the original plan. The water was supplied to the cities of Balti and Soroca, but not to the town of Floresti because the pipeline to the town was not completed.

The system was operated continuously until 1996, then intermittently until September 2000 when the operation stopped completely due to financial difficulty of paying accumulated electricity bills. The operation resumed in August 2001, but again suspended in June 2002 for the same cause. Table 2.3 shows outlines of the water supply facilities of ACSB and major items of improvement required. The present system of water treatment in the water treatment plant located in Soroca is shown in the Figure in Section 8.3.3.

**Table 2.3 Outlines of ACSB Water Supply Facilities**

| Facility | Outline | Major Items for Improvement |
|---|---|---|
| Water intake | - Concrete intake pipes: 2 x 1,000 mm<br>- Screen: 2 mm nets | - To repair the net screen |
| Pumping station No.1 (PS-1) | - Circular pumping basin divided into 2 parts<br>- 3 pumps of 1,250 kW (one is for standby), over-sized<br>- Automatic rubbish remover is broken | - Replacement of pumps<br>- Water hammer protection measures<br>- Replacement of the automatic rubbish remover |
| Pumping station No.2 (PS-2) | - Booster pumping station for the water from PS-1<br>- 3 pumps of 1,250 kW (one is for standby), over-sized | - Replacement of pumps<br>- Water hammer protection measures<br>- Interlocking system with PS-1 |
| Water treatment plant (WTP) | - Consists of contact chamber, mixing chamber, flocculation basin, sedimentation basin, filtration chamber, filter backwash separation tank, clear water reservoir, and sludge retaining ponds | - Replacement of various pumps, valves, and other mechanical parts<br>- Modification of structures of some facilities<br>- Control system |

| Facility | Outline | Major Items for Improvement |
|---|---|---|
| Pumping station No.3 (PS-3) | - Located within the premise of WTP to transmit the treated water to PS-4<br>- 3 pumps of 1,250 kW (one is for standby), over-sized | - Replacement of pumps |
| Pumping station No.4 (PS-4) | - To transmit the treated water to the transmission reservoir (TR) at the hill top<br>- 3 pumps of 1,250 kW (one is for standby), over-sized | - Replacement of pumps |
| Transmission reservoir (TR) | - Capacity: 3 x 3,000 $m^3$ | |
| Distribution reservoir (DR) | - Located in Balti to receive the treated water from the TR by gravity, and distribute to the city<br>- Capacity: 2 x 6,000 $m^3$ | - Completion of unfinished reservoir in Balti (2 x 10,000$m^3$) |
| Water transmission pipes | - From PS-1 to PS-2: 2 x 1,020mm, L = 3,400m<br>- From PS-2 to WTP: 2 x 1,020mm, L = 5,100m<br>- From PS-3 to PS-4: 1,220 mm, L = 9,000m<br>- From PS-4 to TR: 1,220 mm, L = 3,500 m<br>From TR to RR: 1,220 mm, L = 20,300m<br>1,020 mm, L = 26,000m | - Cathode protection<br>- Pipe protection<br>- Replacement of water valves and air valves |

## 2.5 Uncompleted Water Supply Facilities

### 2.5.1 Facilities in Falesti

Construction of the water supply system for the town of Falesti using the Prut River water started in 1984 with the aim to supply water of the good quality for the population and irrigation. However, the construction work stopped in early 1990s. The structures were nearly completed, but the most of mechanical and electrical equipment was not installed The outline of the planned system is as follows: the river water enters the intake and is pumped by the No.1 and No.2 pumping stations via the pressure main with a diameter of 920 mm and a length of 21 km to the water treatment plant near Falesti town. The raw water was to be distributed for irrigation from two irrigation outlets on the way to the treatment plant.

The sizes of the facilities are too large for the planned water demand in 2015. Completed structures are heavily deteriorated by several years of weathering. Most of mechanical and electrical facilities are not installed. It is judged that there are no economical merits to rehabilitate the existing facilities and complete the construction of the remaining parts.

### 2.5.2 Water Supply Facilities in Riscani

The unfinished water supply system in Riscani was also intended to use Prut River water as water resource as was the Falesti system. The construction began in 1988 but suspended in early 1990s.

The sizes of the facilities are too large for the planned water demand in 2015. Completed structures are heavily deteriorated by several years of weathering and robberies. Most of mechanical and

electrical facilities are not installed. It is judged, as is the case in Falesti, that there are no economical merits to rehabilitate these existing facilities and complete the construction of the remaining parts.

### 2.5.3 Distribution Reservoirs in Balti

There are uncompleted water distribution reservoirs at 2 locations in the city of Balti. One is located at the northeastern part of the city adjacent to the distribution reservoir presently operated by Apa Canal Balti. This unfinished reservoir has 2 basins, each of which having a capacity of 10,000 $m^3$. Another is located at the northwestern part of the city having 2 basins, each of which has a capacity of 6,000 $m^3$.

These reservoirs are made of pre-cast concrete parts: wall panels, pillars, and roof panels. They were almost completed when the construction works stopped, and remain relatively undamaged to the present. Since there is a serious shortage in the capacity of operable distribution reservoirs in Balti, these unfinished reservoirs can be effectively utilized after appropriate works for the completion.

## 2.6 Institutional Framework in the Water Supply Sector

### (1) Institutional Aspects on Water Supply Sector

1) General

The administration of the water supply and sewerage sector in Moldova comes under the jurisdiction of the Ministry of Agriculture and Food Industries (MAFI) (as of end August 2001). However, there is no particular department or section in MAFI directly responsible for the administration of the sector. Instead, the State Water Resources Management Concern "Apele Moldovei", which is directly in charge of the Cabinet of Ministers, undertakes the actual sector administration for water supply, sewerage, irrigation, flood control, etc. Apele Moldovei carries out the planning, design, procurement, and construction supervision of, inter alia, water supply and sewerage projects.

The administration of the sector is being developed, so the demarcation of responsibilities between the Ministry and Apele Moldovei is not well defined. Apele Moldovei drafts laws related to, among other things, the water supply and sewerage sector, which are then submitted to the Cabinet of Ministers for their enactment. However, it has no power to enforce laws under its name and execute decrees. Apele Moldovei has the right to issue licenses to new water supply utilities. It also issues authorization to such entities for the use of the surface water source. The National Geological Direction and the Ecological Inspection also issue licenses in the use of groundwater.

2) Apele Moldovei

Apele Moldovei, an independent judicial person, is headed by a President, and there are two vice presidents. One of them is First Vice President cum Chief Engineer, under whom Deputy Chief Engineer, five section chiefs and a legal advisor are incumbent. The Chief Engineer also supervises 11 DAPREs (District Associations for Production, Repair and Exploitation). The total staff size of Apele Modovei is 46 except for DAPREs. Despite its declaration of independence from the government, Apele Moldovei is still actually a budget organization.

3) Acvaproiect

The Water Resources Management System Design Institute "Acvaproiect", under contracts with Apele Moldovei, carries out planning, design, procurement and construction supervision works in the fields of water supply, sewerage, irrigation, flood control, etc. Acvaproiect is headed by the General Manager, who directs five departments, one technical council, and four task units. Its total staff size is 262.

**(2) Status of the Sector at the Local Level**

1) General

The government has a policy that all the public utilities including water supply should be run on themselves institutionally and financially. However, most Apa Canals (water supply utilities) are actually owned by respective municipalities. Historically, Apa Canals have been operated based on the low average water rate, which is realized by subsidies from the respective municipalities and a heavy cross subsidy from non-domestic users. As consumers' strong resistance is expected, directors of Apa Canals, who are normally appointed by the city council, and city mayors are reluctant to propose water rate hikes to respective city councils.

The status of most Apa Canals is in general seriously unstable, especially for financial reasons. The major trouble is their grossly reduced revenue. One of main reasons is unpaid water bills, especially for the non-domestic users. Their non-payment gives heavier impact to the respective Apa Canal due to their much higher water rate than that for domestic users. The second reason is the reduction in water demand, which is chiefly caused by the shrinking number of industries as water users due to their liquidation and their reduced water consumption due to the fewer production hours than before. The third reason is the low average water rate. In many cases, the average water rate is set lower than the average cost of water production.

2) Apa Canal Soroca-Balti

Apa Canal Soroca-Balti (ACSB) was formed in mid 1980s as a wholesale state enterprise for water supply mainly to Soroca and Balti Cities. As to the ownership of ACSB's property and representation, there have been disputes between the Counties of Soroca and Balti on the prerequisite 40% - 60% shares of the ownership. The statute of ACSB stipulates that the scope of existence is defined as the generation of permanent profits. The supreme decision-making organ of ACSB is the General Assembly of shareholders. ACSB is operated under the administration of Director, who reports to the General Assembly, and his staff. The statute lacks an article on the composition, function and authority of the board of directors. Although the above statute sets forth that ACSB stands as a joint-stock corporation, stocks have never been issued. Likewise, the General Assembly of stakeholders has never been held

Under Director, there are five senior staff members consisting of (1) Chief Engineer, (2) Personnel Manager, (3) Labor safety engineer, (4) Lawyer, and (5) Chief Accountant. Chief Engineer supervises chiefs of (a) Boiler house, (b) garage, (c) laboratory, (d) water treatment, (e) Pumping station, (f) Electric facilities, (g) Water dispatch, (h) Logistics, and (i) Shiftsmen.

The very major problem facing ACSB is insufficient and unstable revenue. The sole reason for this situation stems from a large amount of unpaid water bills for its customers, Apa Canal Soroca and Apa Canal Balti. Although the wholesale agreements between ACSB and Apa Canal Soroca and Apa Canal Balti set forth the period of the contract, tariff, and the disposition in the case of failure due to uncontrollable situation, it does not state the minimum quantity of water the customers are obliged to receive under any circumstances.

As to the maintenance of facilities, ACSB has a typical problem like other water utilities in the sector. The principle of preventive maintenance is not practiced. All the facilities in the pumping stations and the water treatment plant have defects or are malfunctioning after the use only for 17 years. ACSB has no written manuals for the maintenance specifically for its equipment. The functions to be performed by respective divisions and sections of ACSB are not clearly defined. The job descriptions of principal staff members including maintenance staff are missing.

3) Other Apa Canals under the Study

Director heads up Apa Canal Balti (total staff size: 437), and directly supervises (1) Chief Engineer, (2) Deputy Director, (3) Personnel Manager, (4) Chief Accountant, (5) Customer Manager, and (6) Planning Manager. Chief Engineer directs (a) Distribution Network Sec., (b) Sewer Network Sec.,

(c) Wastewater Treatment Plants Sec., (d) Pumping Stations Sec., etc. The maintenance of the facilities of the utility is definitely inadequate mainly because of shortage in financial resources.

The institutional status of Apa Canal Soroca is identical to that of Apa Canal Balti (staff size: 119). It also owns groundwater supply facilities in addition to those for receiving water from ACSB. The condition related to maintenance is virtually the same as for Apa Canal Balti.

The institutional status of Apa Canal Falesti (staff size: 75) and Apa Canal Riscani (staff size: 63) is similar to that of Apa Canal Balti. Both of them operate groundwater supply facilities. The maintenance of their facilities is inadequate. The quality of source water is markedly bad. They eagerly hope that they are included in the forthcoming project.

### (3) Legislative Aspects of the Sector

Legislative provisions of Moldova in general is premature from the market economy point of view. The legislative framework in the water supply sector mainly consists of the following:

1. Water Act [Code of Water] (date of enactment: June 1993),
2. Law on Potable Water (No. 272, February 1999),
3. Decree on the Formation and Management of Public Utilities (No. 530: June 2000),
4. Law on Joint-Stock Companies (No. 1134-XIII, April 1997)
5. Ordinance for the Approval of Water Tariff (November 1999),
6. GOST (Industrial Standards)

The Water Act principally deals with rules of utilizing water sources, namely the rights and obligations of water users. The Portable Water Law loosely sets forth the principle of water supply sector administration, the basic hygienic conditions of drinking water, liabilities of water utilities etc. However, there are no clauses directly related to the licensing of water supplies.

### (4) Issues

The administrative structure at the national level is markedly inadequate in the water supply and sewerage sector. Although the actual administrative activities have been vested in Apele Moldovei from the MAFI its technical and clerical resources are insufficient for proper administration of the sector at the national level. At the local level, despite the decentralization policy of the government, the counties lack experience and have no technical and clerical resources for the administration of the sector including the licensing of water utilities.

Although Apele Moldovei is the licensing agency, there are no established administrative and legislative procedures for a new water utility on how to apply for a license and start its business. The requirements for such licensing are also unclear. There must be a law, which stipulates the general rule for the financing of a new or rehabilitation water supply project. There is no information on how a new or rehabilitation or expansion water supply project is financed for (1) its foreign exchange cost component, and (2) local currency cost component, respectively.

One of institutional problems at the water utility level is the complex, but premature organizational structure of the utilities, which has resulted in inefficient operations. Another serious issue with them is their financial difficulty. Main causes are (1) low water rate, (2) low water bill collection rate, (3) large water wastage and losses, (4) low service quality (available water quantity, pressure and quality), which discourage consumers' willingness-to-pay, and (5) redundancy in manpower. The low water rate is the remnant of the old Soviet regime, under which people are accustomed to use tap water almost for free. They need to be enlightened to have the right to receive high quality service, and at the same time, to pay for it. To raise the water bill collection rate, needed are such policies as (1) metering, (2) improved methods of bill collection, (3) correction of the water rate structure, which at present provides abnormally heavy cross subsidy from non-domestic users to domestic ones, (4) elimination of too many tariff exempt customers, and (5) restoration of the consumer confidence to water utilities through high quality of services.

## 2.7 Financial Status of Water Supply Utilities

### 2.7.1 Financial Status of Apa Canal Soroca-Balti

Apa Canal Soroca-Balti (ACSB), water supply wholesaler, has been supplying treated water to Apa Canal Balti (ACB) and Apa Canal Soroca (ACS). But the ACSB water supply was suspended in September 2000 because ACSB was not able to pay the accumulated arrears of electricity bills.

There are two causes for the financial problem of ACSB. The first cause is that the wholesale price of water to two retail Apa Canals (ACB and ACS) is less than its water production cost of ACSB. The second cause is the significant delay of the payment to water bills from the two retail customers.

Then the problem is turned to the two retail Apa Canals. The reason why the two Apa Canals are unable to pay the wholesale water bill has two factors. The one factor is the average retail water price is less than the water supply cost of these two retail Apa Canals. The other factor is the delay of collection of water charge at retail level.

Although ACSB is independent organization from two retail customers, the financial sustainability of ACSB is completely dependent upon financial performance of these two Apa Canals. Without the solution of the financial problems of the retail Apa Canals, ACSB is unable to achieve financial sustainability.

### 2.7.2 Financial Status of Four Retail Apa Canals

#### (1) Apa Canal Balti

ACB is the largest organization among the Apa Canals (including ACSB) in the Study Area in terms of financial scale. After the collapse of the communism regime, ACB fell in to the financial trouble because: 1) the differential water tariff system, in which water rates are 1.435 Lei/$m^3$ for domestic use and 14.01 Lei/$m^3$ for industrial use, has not been changed until the present, 2) most of water consuming enterprises stopped or significantly down-sized their operation. Overdue payment of ACB to ACSB has accumulated. There have been strong oppositions to the rectification of the differential tariff system. The largest debtors are public institutions since they have no budget allocation of water tariff.

#### (2) Apa Canal Soroca

ACS has groundwater resources of satisfactory quality, and its financial management is soundest among the four Apa Canals. Still ACS has arrears to ACSB. Dependence of revenue on enterprises has not been as high as ACB. Having the groundwater resource, ASC is most reluctant to accept the price hike of the ACSB water.

#### (3) Apa Canal Falesti

The water supply of Apa Canal Falesti (ACF) is entirely dependent on the groundwater. The water supply is intermittent because of inability to pay the electricity charge for the 24 hour water supply. Salaries for employees have been delayed for 5 months. ACF has been appealing to the municipality to revise the current water tariff system having a gap between domestic and industrial uses, but no significant progress has been made. It strongly hopes to receive water from ACSB, but depending on the wholesale price, the problem of payment may arise. The present book value of the facilities is very large, but it should be revaluated on the current value basis.

#### (4) Apa Canal Riscani

The financial status of Apa Canal Riscani (ACR) is most depressed among four Apa Canals, and ACR is close to the collapse. The ACR water supply is also entirely dependent on the groundwater. The

water is supplied intermittently, but there are some areas where no water is available. The largest debt is the electricity charges. Delay of the salaries has reached over half a year. There are cases that water charges to enterprises are received in a form of their products which are substituted as salary to the personnel. ACR also strongly hopes to receive water from ACSB, but depending on the wholesale price, the problem of payment may also arise.

### 2.7.3 Finantial Issues

In essence, the financial aspects of the problems for the Apa Canals are the shortage and unreliability of their revenue.

#### (1) Emphasis of Cash Position

It is a progress that Apa Canals have introduced accrual basis accounting at 1998. But the revenue must be realized in any organization including Apa Canals for the accrual accounting system to work.

Whole accounting system in Apa Canals must be focused on cash position. In the balance sheet, top location of assets should be cash, and near-cash assets should follow. In the liability side, short-term liabilities that have to be paid within one year must have top position. Large fixed assets and owner's equity should be located in the lowest position. They do not need daily concentration of attention.

#### (2) Collection of Water Tariff

Collection of water tariff is a fundamental activity to sustain water supply organization. Water distribution does not work without financial basis. The lack of the water budget in government organizations is out of control of individual Apa Canals. It is recommendable for Apa Canals to outsource tariff collection to professional collection businesses with incentive scheme.

#### (3) Cost Recovery from Domestic Customers

Except for water tariff, any assistance from central and local governments cannot be expected in the area of operational and maintenance costs. Therefore, Apa Canals have to recover at least O&M costs from tariff revenue. As 70 % - 80 % of water supply goes to the population, Apa Canals have to be sustained mainly with the revenue from the population. Demand from enterprises has decreased drastically. Most factories currently closed do not have the schedule to reopen. Considering, the country's location and the size of the population, large-scale industrial development except for the food processing industry is difficult in the near future.

Major remaining role of government (both central and local) is to facilitate the development of tariff structure to recover costs of Apa Canals and to allocate water budget to public organizations.

**(4) Reduction of Water Supply Cost**

The primary cost item of water distribution is electricity bill. The effort to increase energy efficiency is required. Especially, the pumps in Apa Canal Soroca-Balti should be replaced with more efficient equipment.

**(5) Introduction of Management Accounting System (Cost Control)**

After improvement of the tariff structure and tariff collection, then, cost control measure should be introduced in order to improve labor efficiency and material efficiency. Under current unstableness of operation, typical cost control system will not work

**(6) Financial Stability of Apa Canal Soroca-Balti.**

Although ACSB and ACB are independent to each other, the water supply from ACSB to ACB is not stabilized without financial stability of ACSB,. The financial stability of ACSB depends on the financial performance of the retail utilities, ACB and also Apa Canal Soroca (if ACS wants to receive water supply from ACSB). But because of its size, the critical utility is ACB. Therefore, the financial issues of both ACSB and ACB are closely interrelated.

In order to coordinate the financial issues between wholesaler and retailers, it is recommended to establish a comprehensive long-term financial plan that covers the financial aspects of both parities to solve the following issues:

1) To realize the wholesale price to sustain ACSB financially.
2) To realize the retail water tariff that recovers whole retail costs including water purchase cost from ACSB.
3) To collect retail water tariff to the maximum.

As retail Apa Canals have their own wells, they have tendency to prefer freehand on purchasing the water from ACSB according to the price. In the case of perfect free market, freehand of buyers are acceptable and necessary to improve the performance of wholesalers. But in the case of the current issue, substantial coordination and cooperation is required between the parties.

**(7) Establishment of Long-term Payment Plan for Liabilities**

By showing a feasible and reliable payment plan, ACSB has to negotiate with its creditors to get their acceptance.

## 2.8 People's Awareness of and Demand for Water Supply

A sociological survey was conducted in June 2001 to obtain the following information from general inhabitants in the 4 cities/towns: 1) actual state of water provision at households, 2) degree of satisfaction or dissatisfaction, 3) actual water consumption, 4) actual payment and willingness to pay for water charge, 5) expectation and demand for water supply service.

At that time, the central water supply systems in the cities of Balti and Soroca, as well as the towns of Falesti and Riscani, were entirely dependent on the groundwater sources. The survey was made through on-site interview using a questionnaire form. Sample households were selected randomly from each of characteristic zones in terms of water supply provisions and topography. The numbers of households sampled were 255 in Balti, 114 in Soroca, 60 in Falesti, and 76 in Riscani.

The following are major features of the results that are of particular interest.

1) Shares of households connected to central water supply service (WSS) which additionally use private or community wells are: 100 % in Falesti and Riscani, 73 % in Balti, and 66 % in Riscani. This is due to the situation that water is not sufficiently available from WSS.

2) Naturally, overwhelming majority of households not having WSS want to have it. This demand is highest in Riscani (95 %) and lowest in Soroca (71 %).

3) Majority of households think that present water may harm the health (63 % - 82 %), water source must be changed (61 % - 76 %), and improvement of WSS is vital (97 % - 100 %).

4) Average amount of water consumption per household or per person is very small: smallest at 27 liter/day/person in Falesti and Riscani, and largest in Balti at 39 liter/day/person. Even in the households having water supply and sewerage services in Balti, the specific water consumption is around 42 liter/day/person.

5) The share of the expense for water and sewerage services in the total family income is between 2.8 % (Riscani) and 4.4 % (Falesti). The actual average monthly expense for water and sewerage is higher than the amount the respondents think acceptable, except in Riscani.

6) Among households having WSS, the share of those having water meter is still low: about 50 % in Balti, 46 % in Soroca, 36 % in Riscani, and 26 % in Falesti. Majority of households (91 % - 100 %) prefer to pay water charges according to consumed amount measured by water meter.

7) Most people think that priorities for water supply improvement are: 1) stable water supply schedule (80 % - 98 %), 2) reduction of water borne diseases morbidity (69 % - 87 %), and 3) correction of unfair conditions in water provision (59 % - 75 %). The order of the priorities is the same in all of the 4 cities/towns.

## 2.9 Health and Water Quality

Table 2.4 shows morbidity of inhabitants in the 4 cities/towns in water related diseases, and Table 2.5 shows assessment of water quality of deep wells, shallow wells, and distributed water, both data having compiled by the National Center of Preventive Medicine.

**Table 2.4 Morbidity of the Population in the Study Area (2000)**

| City / Town | Morbidity Indices (number of cases registered per 10 thousand inhabitants) | | | | | Dental fluorosis (prevailing) for children under 14 years old (%) |
|---|---|---|---|---|---|---|
| | Cardio-vascular diseases | Digestion diseases | Kidney diseases | Viral hepatitis A | Acute Intestinal diseases | |
| Balti | 584.8 | 63.80 | 8.0 | 11.2 | 68.0 | 2 |
| Soroca | 260.4 | 9.98 | 3.75 | 5.8 | 54.6 | 0 |
| Falesti | 433.0 | 56.20 | 3.2 | 13.5 | 18.8 | 80 |
| Riscani | 435.0 | 52.86 | 5.1 | 13.9 | 63.4 | 5 |
| Country Average | 103.3 | 25.1 | 3.5 | 7.27 | 25.6 | 12 |

Source: National Center of Preventive Medicine, Ministry of Health

**Table 2.5 Assessment Scores for Quality of Drinking Water in the Study Area (Year 2000)**

| City / Town | Deep wells | | Shallow wells | | Distribution networks | |
|---|---|---|---|---|---|---|
| | Chemical indices (%) | Micro-biological indices (%) | Chemical indices (%) | Micro-biological indices (%) | Chemical indices (%) | Micro-biological indices (%) |
| Balti | 47.4 | 5.0 | 88.5 | 70.4 | 22.6 | 3.7 |
| Soroca | 4.0 | 0.0 | 62.9 | 75.8 | 4.3 | 2.9 |
| Falesti | 100.0 | 7.0 | 89.0 | 35.0 | 13.7 | 9.5 |
| Riscani | 42.0 | 3.0 | 90.0 | 21.5 | 15.0 | 7.9 |
| Country Average | 49.4 | 9.2 | 82.4 | 31.3 | 17.9 | 9.7 |

Source: National Center of Preventive Medicine, Ministry of Health
Note: Percentage of water samples that did not satisfy the drinking water standards. A sample is assessed to be unsatisfactory when any of water quality parameters does not satisfy the standard.

The relation between some chronic diseases and poor water quality is demonstrated by the morbidity indices. The indices are greatest in Balti City where the chemical indices of tap water quality were worst among the 4 cities/towns, particularly because of nitrates. The investigations by National Center of Preventive Medicine indicate that the health risks increase in direct proportion to the

increase of the nitrate concentration in drinking water. The best situation is seen in Soroca City, where no particular water quality problems are found compared to the other 3 city/towns, except for shallow well waters.

Special situation was observed in Falesti town regarding dental fluorosis among children (80 %), and 66 % of the children appeared to have dental fluorosis of more advanced second degree. It means that even the teeth structure is affected. Futhermore, 35 % of the children appeared to have different osseous diseases, i.e. starting phase of osteofluorosis (bone fluorosis). This town is the most affected by dental fluorosis in the country.

# PART 2

# MASTER PLAN

## CHAPTER 3 FRAMEWORK FOR THE WATER SUPPLY MASTER PLAN

### 3.1 Planning Areas and Target Year

The target year for the water supply master plan in the planning areas is the year 2015.

The planning areas of water supply are basically the 4 cities/towns: Cities of Balti and Soroca, and Towns of Falesti and Riscani. However, the towns of Floresti, Drochia, and Singerei, and other villages in the region have been also taken into consideration when projecting the water demand. Specific villages taken into consideration in the alternatives for the master plan are as follows:

1) When the master plan consists of the improvement of the existing Soroca-Balti water supply system and its extensions to the towns of Falesti and Riscani:

   i) 18 villages along the route of the water transmission pipeline from Soroca to Balti
   ii) 4 villages along the route of the pipeline from Balti to Falesti
   iii) 4 villages along the route of the pipeline from Balti to Riscani
   iv) 2 villages along the route of the pipeline from Balti to Singerei
   v) 5 villages along the route of the pipeline from Soroca to Drochia

2) When the master plan consists of the improvement of the existing Soroca-Balti water supply system and construction of new water supply systems for the towns of Falesti and Riscani using the Prut River water as the water source:

   Instead of ii) and iii) above, 25 villages along the pipeline routes from the new water treatment plants near Prut River to the respective towns are taken into consideration.

### 3.2 Population Served

Population forecasts for the planning areas until the year 2015 were made based on the actual population in the base year 1998. Annual change in the population of the respective areas were set as shown below, in consideration of the national level population trend in the past, the existing data for projected population, and future situations in the planning areas.

| Area | Annual population growth rate |
|---|---|
| City of Balti | 0.5 % |
| City/Towns of Soroca, Falesti, Riscani, Floresti, Drochia, Singerei | 0.2 % |
| Villages | 0 % |

The projected population figures are shown in Table 3.1.

**Table 3.1 Population Forecast for the Study Area (Persons)**

| Area | Year | | | | |
|---|---|---|---|---|---|
| | 1998 | 2000 | 2005 | 2010 | 2015 |
| Soroca | 46,000 | 46,184 | 46,741 | 47,305 | 47,875 |
| Balti | 162,550 | 164,179 | 168,325 | 172,575 | 176,933 |
| Floresti | 20,100 | 20,180 | 20,424 | 20,670 | 20,919 |
| Drochia | 22,000 | 22,088 | 22,354 | 22,624 | 22,897 |
| Singerei | 15,969 | 16,033 | 16,226 | 16,422 | 16,620 |
| Soroca - Balti | 25,886 | 25,886 | 25,886 | 25,886 | 25,886 |
| Balti - Singerei | 4,252 | 4,252 | 4,252 | 4,252 | 4,252 |
| Soroca - Drochia | 14,486 | 14,486 | 14,486 | 14,486 | 14,486 |
| Subtotal | 311,243 | 313,288 | 318,694 | 324,220 | 329,868 |
| Riscani | 16,367 | 16,433 | 16,631 | 16,831 | 17,034 |
| Falesti | 18,963 | 19,039 | 19,269 | 19,501 | 19,736 |
| Balti - Falesti | 8,116 | 8,116 | 8,116 | 8,116 | 8,116 |
| Balti - Riscani | 12,150 | 12,150 | 12,150 | 12,150 | 12,150 |
| Subtotal | 55,596 | 55,738 | 56,166 | 56,598 | 57,036 |
| Total | 366,839 | 369,026 | 374,860 | 380,818 | 386,904 |
| In the case when independent water supply systems are considered for Riscani and Falesti with Prut River as water source. | | | | | |
| Riscani | 16,367 | 16,433 | 16,631 | 16,831 | 17,034 |
| Prut - Riscani | 21,017 | 21,017 | 21,017 | 21,017 | 21,017 |
| Total | 37,384 | 37,450 | 37,648 | 37,848 | 38,051 |
| Falesti | 18,963 | 19,039 | 19,269 | 19,501 | 19,736 |
| Prut - Falesti | 11,517 | 11,517 | 11,517 | 11,517 | 11,517 |
| Total | 30,480 | 30,556 | 30,786 | 31,018 | 31,253 |

The population served, which is the basis of planning the water demand, was projected by setting the served rates as shown below.

| Area | Served rate in 2015 |
|---|---|
| 7 cities/towns | 95 % (but 98 % in Soroca City as it is in the present) |
| villages | 80 % |

The projected population served until 2015 is shown in Table 3.2.

**Table 3.2 Forecast of Population Served in the Study Area (Persons)**

| Area | Year | | | | |
|---|---|---|---|---|---|
| | 1998 | 2000 | 2005 | 2010 | 2015 |
| Soroca | 44,988 | 44,988 | 45,339 | 45,886 | 46,442 |
| Balti | 158,230 | 158,230 | 161,592 | 165,672 | 168,086 |
| Floresti | 18,150 | 18,150 | 18,382 | 18,604 | 19,873 |
| Drochia | 9,235 | 9,235 | 13,413 | 16,968 | 21,752 |
| Singerei | 10,400 | 10,400 | 12,169 | 13,958 | 15,789 |
| Soroca - Balti | 6,760 | 6,760 | 6,760 | 14,875 | 20,893 |
| Balti - Singerei | 0 | 0 | 0 | 1,701 | 3,402 |
| Soroca - Drochia | 1,961 | 1,961 | 1,961 | 5,795 | 11,589 |
| Subtotal | 249,724 | 249,724 | 259,614 | 283,459 | 307,826 |
| Riscani | 4,366 | 4,366 | 8,316 | 11,782 | 16,182 |
| Falesti | 9,500 | 9,500 | 12,525 | 15,600 | 18,749 |
| Balti - Falesti | 510 | 510 | 1,077 | 3,716 | 6,493 |
| Balti - Riscani | 3,324 | 3,324 | 5,060 | 7,461 | 9,721 |
| Subtotal | 17,700 | 17,700 | 26,978 | 38,560 | 51,145 |
| Total | 267,424 | 267,424 | 286,594 | 322,018 | 358,972 |
| In the case when independent water supply systems are considered for Riscani and Falesti with Prut River as water source. | | | | | |
| Riscani | 4,366 | 4,366 | 8,316 | 11,782 | 16,182 |
| Prut - Riscani | 4,246 | 4,246 | 5,319 | 9,718 | 16,814 |
| Total | 8,612 | 8,612 | 13,635 | 21,500 | 32,996 |
| Falesti | 9,500 | 9,500 | 12,525 | 15,600 | 18,749 |
| Prut - Falesti | 455 | 455 | 2,992 | 5,938 | 9,213 |
| Total | 27,179 | 27,179 | 42,787 | 64,538 | 93,954 |

## 3.3 Water Demand Forecast

The water demand was projected by dividing it into the following uses: domestic, commercial/institutional, industrial, and livestock.

### (1) Domestic Water Demand

The domestic water demand was projected based on the specific water consumption standards defined by Apele Moldovei indicated below after studying their appropriateness.

| Water Use Mode | Norm(1) | Standards of (2) Apele Moldovei |
|---|---|---|
| Residences having house connection of water supply and sewerage | | |
| With centralized hot water supply | 230 - 350 Lcd | 250 Lcd |
| With bathrooms and individual water heaters | 160 - 230 Lcd | 190 Lcd |
| Without bathroom | 125 - 160 Lcd | 140 Lcd |
| Yard taps and stand posts | 30 - 50 Lcd | 50 Lcd |
| Schools | 10 Lcd | Included in above |

Source: (1) Construction Norms and Rules 2.04.02-84, "Water Supply, External Networks and Facilities," GOST.
(2) Specific water consumption defined by Apele Moldovei

The population distribution in each city/town/village according to above water use modes was obtained based on the questionnaire. Since the most water consuming mode "with centralized hot water supply" has been suspended in all the areas except for one village (applicable population at 60 persons) and no prospect of resumption in the future, the population of this mode was assumed to be zero in the future except for that village. It was assumed that the population of the modes below "with bathrooms and individual water heaters" would be gradually shifted to the upper modes towards 2015, but the upper limits of the percentage were set for 2015 in consideration of the present state.

### (2) Commercial/Institutional and Industrial Water Demands

Commercial and institutional demand of water is assumed to be 10 % of the domestic demand, as this ratio was adopted in a recently developed plan in other areas in Moldova.

Since industrial water demand varies with characteristics of city/town, it is desirable to determine the demand for each of cities/towns based on actual existing demand and future prospect. However, such data have not necessarily been available for all the cities/towns considered. Therefore, the case of the City of Balti has been referred, because the city predominantly affects to the total water demand in the areas being considered, and some data are available. In 1999, when the Soroca-Balti water supply system was operating throughout the year, the annual water consumption by enterprises was reported to be 606,000 $m^3$ (equivalent to 1,660 $m^3/d$), which is 8.4 % of the calculated present domestic demand (year 2000). By adding a safety margin, industrial demand is assumed to be 10 % of the domestic demand in the 7 cities/towns.

### (3) Livestock Water Demand

The specific water consumption values for livestock given by the Norms in Moldova were used. It was assumed that the livestock consumption of water is met by 50 % by natural waters such as streams, ponds and shallow wells, and the remaining 50 % is supplied by the water supply system.

### (4) Design Water Demand (Maximum Daily Water Demand)

The ratio of the maximum daily demand to the average daily demand is given by the Norm as 1.1 - 1.3. For the cities and towns, the average value of 1.2 was adopted. For the villages, the value of 1.3 was adopted, considering higher ratio of watering for cultivation due to wider area of residence premise. These values were applied to the domestic demand and the commercial / institutional demand.

### (5) Leakage

The leakage rates in the 4 cities/towns estimated in the present Study based on the field survey, existing data, and relevant references were 27 % - 38 %. Based on the assumption that the water losses will be reduced through continual effort in replacing deteriorated distribution pipes and increasing installation of water meters, the leakage rate was set 20 %.

### (6) Water Demand Forecast

Table 3.3 shows the maximum daily water demand calculated for a five-year interval from 2000 to 2015. As regards the amount of water production, internal use of water such as that in the treatment plant must be added. This amount is assumed to be 3 % of the maximum daily water demand. In the case of expanding the Soroca-Balti water supply system to cover all the applicable areas, the total maximum daily water demand in 2015 (90,724 $m^3$/day) is 1.70 times of that in 2000 (53,500 $m^3$/day).

The daily average domestic water demand in above case is shown in Table 3.4, and breakdown of the maximum daily water demand by water use categories is shown in Table 3.5.

**Table 3.3 Water Demand Forecast ($m^3$/day) in the Study Area (Daily Maximum)**

| Area | Year | | | |
|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 |
| Soroca | 7,961 | 8,942 | 10,541 | 12,178 |
| Balti | 33,907 | 34,879 | 39,877 | 44,950 |
| Floresti | 4,039 | 4,338 | 4,795 | 5,515 |
| Drochia | 1,274 | 2,622 | 4,006 | 5,795 |
| Singerei | 927 | 2,025 | 3,217 | 4,254 |
| Soroca - Balti | 630 | 630 | 2,127 | 3,272 |
| Balti - Singerei | 0 | 0 | 275 | 551 |
| Soroca - Drochia | 189 | 189 | 901 | 1,801 |
| Subtotal | 50,927 | 53,625 | 65,739 | 78,317 |
| Riscani | 1,100 | 2,081 | 3,063 | 4,347 |
| Falesti | 2,718 | 3,515 | 4,346 | 5,197 |
| Balti - Falesti | 128 | 221 | 611 | 1,072 |
| Balti - Riscani | 625 | 880 | 1,285 | 1,791 |
| Subtotal | 4,572 | 6,696 | 9,305 | 12,407 |
| Total | 53,500 | 60,321 | 75,044 | 90,724 |
| Total of 7 cities/towns | 51,928 | 58,401 | 69,845 | 82,237 |
| Total of the villages | 1,572 | 1,920 | 5,199 | 8,487 |
| In the case when independent water supply systems are considered for Riscani and Falesti with Prut River as water source. | | | | |
| Riscani | 1,100 | 2,081 | 3,063 | 4,347 |
| Prut - Riscani | 497 | 738 | 1,685 | 2,896 |
| Total | 1,597 | 2,819 | 4,748 | 7,243 |
| Falesti | 2,718 | 3,515 | 4,346 | 5,197 |
| Prut - Falesti | 117 | 560 | 1,111 | 1,704 |
| Total | 6,029 | 9,713 | 14,953 | 21,387 |

**Table 3.4 Daily Average Domestic Water Demand**

| | Year 2000 | | | Year 2008 | | | Year 2015 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Population served (persons) | Water demand ($m^3$/d) | Specific water demand (Lcd) | Population served (persons) | Water demand ($m^3$/d) | Specific water demand (Lcd) | Population served (persons) | Water demand ($m^3$/d) | Specific water demand (Lcd) |
| Total | 267,424 | 31,046 | 116 | 307,849 | 40,090 | 130 | 358,972 | 52,509 | 146 |
| City of Balti | 158,230 | 19,717 | 124 | 164,040 | 22,040 | 134 | 168,086 | 26,186 | 156 |
| Other 6 Cities/ Towns | 96,639 | 10,477 | 108 | 117,736 | 15,946 | 135 | 138,787 | 21,724 | 157 |
| Villages along the pipeline | 12,555 | 852 | 68 | 26,073 | 2,104 | 81 | 52,098 | 4,599 | 88 |

**Table 3.5 Daily Maximum Water Demand by Water Use Categories ($m^3$/day)**

| Water Use | 2000 | 2008 | 2015 |
|---|---|---|---|
| Domestic | 37,341 | 48,319 | 63,472 |
| Commercial / Institutional | 3,734 | 4,832 | 6,346 |
| Industrial | 3,019 | 3,798 | 4,791 |
| Livestock | 489 | 680 | 994 |
| Sub-total | 44,583 | 57,629 | 75,603 |
| Losses | 8,917 | 11,526 | 15,121 |
| Total | 53,500 | 69,155 | 90,724 |

# CHAPTER 4 DEVELOPMENT OF THE WATER SUPPLY MASTER PLAN

## 4.1 Alternatives for Facility Development

The existing conditions and problems of water supply in the cities/towns of Balti, Soroca, Falesti, and Riscani were described in Chapter 2, and the future water demands were described in Chapter 3. Based on the analyses of above conditions, problems, and present and future needs in these areas, the following 3 Alternatives have been considered as the candidates for the water supply facility development master plan. Components of the facility development in these Alternatives are summarized in Table 4.1.

Alternative 1: The Soroca-Balti water supply system is rehabilitated and expanded to supply water to all of 4 cities/towns.

Alternative 2: The Soroca-Balti water supply system is rehabilitated to supply water to Soroca and Balti, and two independent water supply systems are developed using Prut River water to supply water to Falesti and Riscani.

Alternative 3: Groundwater resources are used in all of 4 cities/towns by constructing additional wells, and water treatment facility is constructed in Balti, Falesti and Riscani for fluoride removal. This alternative seems to be unrealistic, but was studied for comparison.

## 4.2 Facility Development Plan in the Alternatives

### (1) Alternative 1

1) Existing Soroca-Balti Water Supply System

The number and specifications of transmission pumps suitable for the new demand (94,000 $m^3/d$ including internal consumption) to replace existing ones have been determined as follows:

| Pumping Station | Pump Specification | Number of Pump* |
|---|---|---|
| PS-1 | 32.7 $m^3/m$ x 56m x 450 kW | 3 |
| PS-2 | 32.7 $m^3/m$ x 96m x 750 kW | 3 |
| PS-3 | 29.4 $m^3/m$ x 71m x 500 kW | 3 |
| PS-4 | 27.3 $m^3/m$ x 73m x 500 kW | 3 |

* Including one standby each

**Table 4.1 Three Alternatives for the Water Supply Master Plan**

| System | Components | | Alternative | | | Remark |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | |
| Soroca-Balti Water Supply System | Water Treatment Plant | Rh | ○ | ○ | | Alt-1: 94,000 $m^3/d$<br>Alt-2: 80,700 $m^3/d$ |
| | Pumps (PS-1 - PS-4)) | Rp | ○ | ○ | | - |
| | Transmission Pipeline | Rh | ○ | ○ | | - |
| | Transmission Pipeline to Falesti and Riscani (extension) | N | ○ | | | 32 km (to Falesti)<br>35 km (to Riscani) |
| Balti | Reservoirs | C | ○ | ○ | ○ | 2 x 10,000$m^3$<br>2 x 6,000$m^3$ |
| | Wells and Raw Water Transmission Pipeline | N | | | ○ | 67 wells,<br>Pipeline: 6 km |
| | Fluoride Removal Plant | N | | | ○ | Q = 75,000 $m^3/d$ |
| Soroca | Reservoirs | N | ○ | ○ | ○ | 4,200 $m^3$ |
| | Wells and Raw Water Transmission Pipeline | N | | | ○ | 25 wells,<br>Pipeline: 12 km |
| Falesti | Reservoirs | N | ○ | ○ | ○ | 4,200 $m^3$ |
| | Water Treatment Plant (Prut River) | N | | ○ | | Q = 7,100 $m^3/d$ |
| | Transmission Pipeline and P/S (from Prut River) | N | | ○ | | 32 km |
| | Wells and Raw Water Transmission Pipeline | N | | | ○ | 72 wells,<br>Pipline: 20 km |
| | Fluoride Removal Plant | N | | | ○ | Q = 8,700 $m^3/d$ |
| Riscani | Reservoirs | N | ○ | ○ | ○ | 1,400 $m^3$ |
| | Water Treatment Plant (Prut River) | N | | ○ | | Q = 7,500 $m^3/d$ |
| | Transmission Pipeline and P/S (from Prut River) | N | | ○ | | 34 km |
| | Wells and Raw Water Transmission Pipeline | N | | | ○ | 20 wells,<br>Pipeline: 10 km |
| | Fluoride Removal Plant | N | | | ○ | Q = 7,700 $m^3/d$ |

Note) Rh : rehabilitation, Rp: replacement, N: new construction, C: completion of unfinished work

Table 4.2 shows the facilities and equipment in the water treatment plant, of which rehabilitation, replacement, or new installation are necessary.

**Table 4.2 Facilities and Equipment Required in the Treatment Plant**

| Name of Facilities and Equipment | Specification | Quantity |
|---|---|---|
| Coagulation equipment with pump | $\phi$100 mm- 0.6 $m^3$/m x 5.5kW | 3 |
| Coagulation equipment with pump | $\phi$125 mm-0.8 $m^3$/m x 11kW | 3 |
| Chlorine gas injection equipment with pump | | 2 |
| Butterfly valve with motor | $\phi$400 | 12 |
| Sluice valve with motor | $\phi$250 | 12 |
| Sludge pump at the retaining pond | $\phi$200 mm- 2.3 $m^3$/m x 11kW | 2 |
| Pump for returning water from the retaining pond to the contact chamber | $\phi$300 mm-4.3 $m^3$/m x 22kW | 2 |
| Pipe for sludge conveyance | $\phi$300 mm | 200 m |
| Pipe for returning water | $\phi$400 mm | 300 m |
| Discharge pipe from sludge drying beds to Nistru River | $\phi$500 mm | 2000 m |
| Sludge drying beds | 6,000 $m^2$ | 1 |
| Elevated tank for backwashing | 800 $m^3$ | 1 |
| Instrumentation | | 1 |
| Boiler | | 1 |
| Heating system | | 1 |

2) Expansion of Transmission Pipelines to Falesti and Riscani

The water transmission by gravity is possible. The required diameter and length of the pipes are as follows:

To Riscani: diameter: 400 mm, length: 35,000 m

To Falesti: diameter: 400 mm, length: 32,000 m

3) Distribution Reservoirs

There is no design standard in Moldova regarding the capacity of distribution reservoirs. Since the frequency of power stoppage is relatively high in this region, it is desirable to store a sufficient amount of water in the distribution reservoirs for stable supply of water to consumers. Therefore, as recommended by Apele Moldovei, the design capacity of distribution reservoirs has been determined to be the volume equivalent to the daily maximum water demand. The capacities of newly required reservoirs for four cities/towns were determined as the difference between the water demand in 2015 and the existing reservoir capacity. The required capacities of the reservoirs to be added are shown below. In Balti, there are the uncompleted reservoirs of which the completion of the construction is recommended.

| City/Town | Daily Maximum Water Demand in 2015 ($m^3$/d) | Existing Reservoirs Capacity ($m^3$) | Required Capacity to be Added ($m^3$) | Method |
|---|---|---|---|---|
| Soroca | 12,200 | 8,000 | 4,200 | New construction |
| Balti | 45,000 | 12,000 | 32,000 | Completion of unfinished reservoirs (1 x 20,000 + 2 x 6,000) |
| Falesti | 5,200 | 1,000 | 4,200 | New construction |
| Riscani | 4,400 | 3,000 | 1,400 | New construction |

**(2) Alternative 2**

1) Rehabilitation of the Soroca-Balti Water Supply System

In this case, the water demand in the Soroca-Balti water supply system is 80,700 $m^3$/d (including internal consumption) which is different from that in Alternative 1, since the towns of Falesti and Riscani will have their independent systems. The number and specifications of the transmission pumps suitable for the new demand to replace existing ones are shown below.

| Pumping Station | Pump Specification | Number of Pump* |
|---|---|---|
| PS-1 | 28.0 $m^3$/m x 54m x 400 kW | 3 |
| PS-2 | 28.0 $m^3$/m x 93m x 650 kW | 3 |
| PS-3 | 23.0 $m^3$/m x 68m x 400 kW | 3 |
| PS-4 | 20.3 $m^3$/m x 71m x 400 kW | 3 |

* Including one standby each

In the water treatment plant, the required works are largely the same as in Alternative 1.

2) New Water Supply System in Falesti

The water demand in 2015 for the new water supply system in Falesti is 7,100 $m^3$/d. The new water supply system will be composed of the following facilities:

- Water intake (Pumping station No. 1 with a capacity of 7,100 $m^3$/d)
- Water treatment plant (with a capacity of 7,100 $m^3$/d)
- Pumping station No. 2 (with a capacity of 6,900 $m^3$/d)
- Transmission main (Φ 400 mm x 15.6 km, Φ 450 mm x 16.4 km)
- Distribution reservoir (with a capacity of 4,200 $m^3$)

The required pumps in the pumping stations are as follows:

| Pumping Station | Specification of Pump | Number of Pump | Remarks |
|---|---|---|---|
| PS-I | 2.5 $m^3$/m x 131.6 m x 90 kW | 3 | One pump is standby |
| PS-II | 2.4 $m^3$/m x 62.2 m x 45 kW | 3 | One pump is standby |

* Including one standby each

3) New Water Supply System in Riscani

The water demand in 2015 for the new water supply system in Riscani is 7,500 $m^3$/d. The new water supply system will be composed of the following facilities:

- Water intake (Pumping station No. 1 with a capacity of 7,500 $m^3$/d)
- Water treatment plant (with a capacity of 7,500 $m^3$/d)
- Pumping station No. 2 (with a capacity of 7,200 $m^3$/d)
- Pumping station No. 3 (with a capacity of 7,200 $m^3$/d)
- Transmission main (Φ 400 mm x 30.2 km, Φ 250 mm x 3.9 km)
- Distribution reservoir (with a capacity of 1,400 $m^3$)

The required pumps in the pumping stations are as follows:

| Pumping Station | Specification of Pump | Number of Pump* |
|---|---|---|
| PS-I | 2.6 $m^3$/m x 103 m x 75 kW | 3 |
| PS-II | 2.5 $m^3$/m x 107 m x 75 kW | 3 |
| PS-III | 2.5 $m^3$/m x 65 m x 45 kW | 3 |

* Including one standby each

**(3) Alternative 3**

In this Alternative, the planning areas are limited to the service areas of the 4 cities/towns and all the systems use groundwater as water source. The water demand in 2015, the present water supply capacity, and the required expansion of well are shown in Table 4.3.

City of Balti and towns of Falesti and Riscani need to construct a water treatment plant mainly to remove fluorides in the well water.

2) Fluorides Removal Plant

In the city of Balti and the towns of Falesti and Riscani, groundwater treatment facility must be provided to remove fluorides using the reverse osmosis (RO) technology. This method requires the amount of raw water larger than the produced water by 40 %.