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ACRONYMS

ABR	Anaerobic Baffled Reactor
ADC	Austrian Development Cooperation
BOD	Biological Oxygen Demand
CAPEX	Capital Expenditure
CHP	Combined Heat and Power
COD	Chemical Oxygen Demand
CP	Code of Practice
CPS	Central Pumping Station
CW	Constructed Wetland
DHPC	Dniester Hydropower Complex
DM	Dry matter
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FS	Feasibility Study
GIS	Geographical Information System
GPS	Global Positioning System
GW	Groundwater
HMI	Human Machine Interface
H_2S	Hydrogen Sulfide
HR	Human Resources
HSE	Health Safety and Environment
LPA	Local Public Authorities
LV	Low Voltage
MAC	Maximum Allowable Concentration
m.a.s.l	Meters above sea level
MBBR	Moving Bed Bioreactor
MARDE	Ministry of Agriculture, Regional Development and Environment
MH	Ministry of Health
MoE	Ministry of Environment
MV	Medium Voltage
NCM	Moldovan Construction Norms
NH4	Ammonium
NRW	Non Revenue Water
O&M	Operations and Maintenance

OPEX	Operational Expenditure
PE	Population Equivalent
PLC	Program Logic Controller
PPE	Personal Protective Equipment
REX	Return of Experience
SBR	Sequencing Batch Reactor
SCADA	Supervisory Control And Data Acquisition
SDC	Swiss Agency for Development and Cooperation
SPS	South Pumping Station
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
VSS	Volatile Suspended Solids
WB	World Bank
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

In the frame of the Moldova Water Security and Sanitation Project (MWSSP), and with funding of the ECAPDEV Grant No. TF071624, the P. I. Environmental Projects Implementation Unit, on behalf of the Ministry of Environment (MoE) of the Republic of Moldova (previously Ministry of Agriculture, Regional Development and Environment), mandated Seureca to develop the **Feasibility Study (FS)** and **Environmental and Social Impact Assessment (ESIA)** for the sanitation system of Soroca town and neighboring villages. The development of the Soroca sanitation system has been identified as a national priority within the MWSSP and will be financed with a 11 Million US$ transitional IDA credit and IBRD financing.

This report is the **Final Report of the Feasibility Study**. It answers the FS objectives and tackles all the tasks mentioned in the Terms of Reference under Task 1: Feasibility Study of the Soroca Sanitation Project as detailed below:

ORGANISATION OF THE FS FINAL REPORT

I. Overview of the current situation
- Socio-economic and environmental context (*Section 2*)
- Legal and institutional framework (*Section 3*)
- Current sanitation system assessment (*Section 4*)

II. Project strategy and design criteria (*Section 5*)

III. Assessment and recommendations
- Wastewater collection system (*Section 6*)
- Wastewater treatment and disposal, including water and sludge reuse strategies (*Section 7*)
- Resilience of the Sanitation System (*Section 8*)
- SA “Regia Apa canal Soroca” organisation and O&M (*Section 9*)

IV. Investment strategy and financial impact
- Investment plan (*Section 10.1 & 10.2*)
- Procurement plan for short term (*Section 10.3*)
- Financial analysis and impact on the tariffs (*Section 11*)

Soroca Municipality is located in the northeast of the Republic of Moldova, on the border with Ukraine, on the right bank of the Nistru River, at a distance of 160 km from the capital Chisinau. The city has at present a total of about 35 000 inhabitants (2020). The existing centralized sewerage network which extends over 58 km in Soroca city is in poor condition, pumping stations are not functional and there is no wastewater treatment plant. The untreated wastewater is directly discharged into the Nistru river, which causes a negative environmental and social impact.

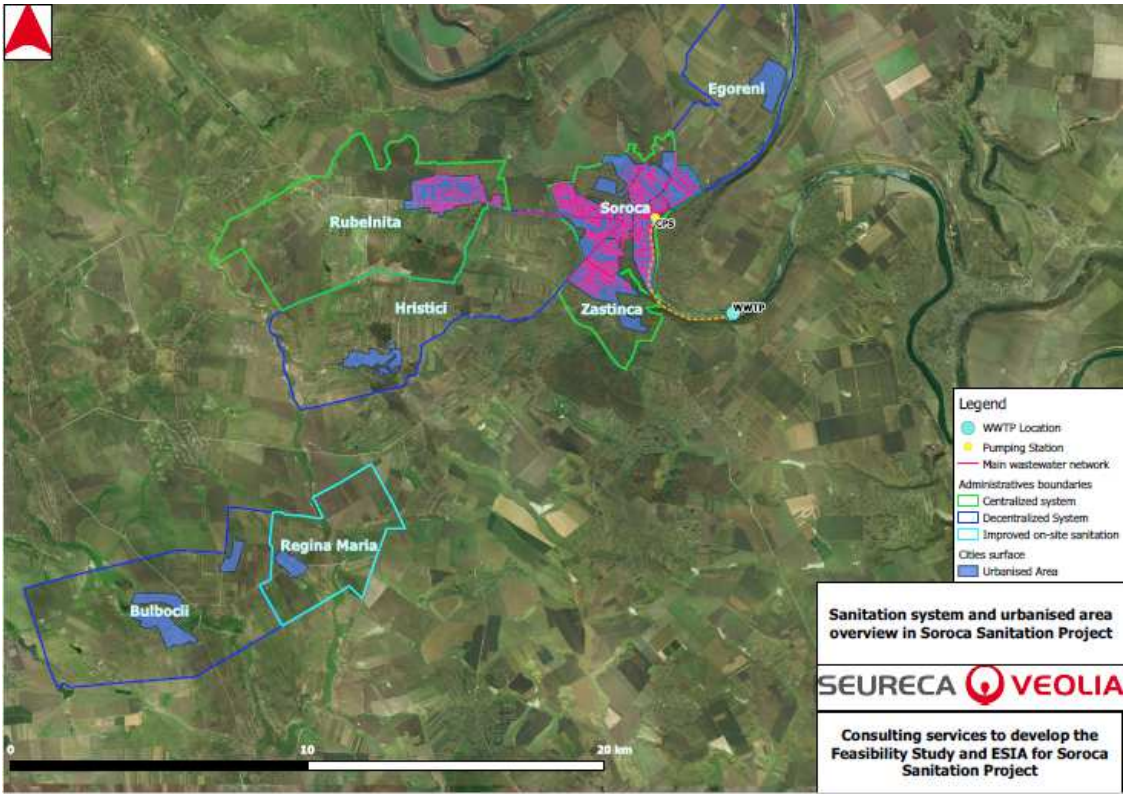
The connection to the centralized sewerage network is low, covering about 42% of the actual city’s population. The rest of the population in Soroca city and in the villages uses on-site sanitation solutions, mainly pit latrines with direct infiltration into the soil. The industrial sector (principally

agro-food and textile industries), although much less important than during the Soviet Union, plays an important economic role in the city, and is a significant source of wastewater pollution.

The municipally-owned SA “Regia Apa Canal Soroca”, established in 2000, is responsible for water supply and wastewater services in the city of Soroca and in some neighbouring villages and communes. The total population served is about 46 000 inhabitants. The Utility lacks financial capacity and the numerous changes of Administration over the recent years has hindered the development of the Company’s long term vision. However, since May 2019, a new committed Administration has been established and is succeeding in developing and improving the organizational and financial aspects of the Company.

This Feasibility Study provides a thorough assessment of the technical, institutional, organizational and financial sanitation situation at Soroca and its background conditions. The FS presents the current and future wastewater volumes and loads, and evaluates the alternatives for wastewater collection and treatment in Soroca and surrounding villages to improve the sanitation services. Taking into account the current deficiencies of the sanitation system, and according to the current available budget for Soroca, a number of prioritized measures are proposed for the short, medium and long term:

- The priority works for the short term (2023 - 2025) include the construction of two main pumping stations in the city, the rehabilitation of some critical parts of the network and the construction of a new WWTP;
- For the mid-term (2025 - 2035), the priority is given to the rehabilitation of the sewerage network, to the connection of new customers to increase the coverage rate and to the reinforcement of SA “Regia Apa Canal” capacities;
- For the long term (>2035), new extensions and rehabilitation works of the network are proposed to increase the sanitation coverage rate, together with the upgrade and extension of the WWTP.



A **total budget of 46,6 Million US$** has been estimated to align Soroca with the local and national sanitation strategies at horizon 2045 (75% coverage rate), and with the more ambitious target of 90% coverage rate by 2065. This budget can be divided up into:

- 11,1 MUS $ in the short term,
- 4,5 MUS$ in the mid-term
- 31,1 MUS$ in the long term.

The summary of the Investment Plan is shown below.

Component	Short term <2025	Medium term 2025 - 2035	Long term > 2035
On-site systems management (vacuum truck)		0,12 Million €	
HSE Equipment		0,05 Million €	
Pumping stations and pressure networks - New	0,85 Million €	0,03 Million €	0,74 Million €
Replacement / rehabilitation of existing network	3,8 Million €	1,4 Million €	2,4 Million €
New extensions of sewerage system - Gravity pipes	- €	- €	8, 64 Million €
Individual connections	0,17 Million €	0,68 Million €	6,04 Million €
Services to support rehabilitation program		0,2 Million €	0,4 Million €
WWTP	6,33 Million €	- €	4,5 Million €
Technical assistance / Capacity building		0,8 Million €	
TOTAL Million EUR (without VAT)	**7,72 M EUR**	**3,29 M EUR**	**22,71 M EUR**
Employers' rate (detailed studies, tender preparation and supervision)	15%	15%	15%
TOTAL Million EUR (without VAT)	**8,9 M EUR**	**3,8 M EUR**	**26,1 M EUR**
Implementation of Environmental and Social Management Plan	0,49 M US$		
TOTAL Million US$ (without VAT) with Employer's rate	**11,1 M US$**	**4,5 M US$**	**31, 1 M US$**

The new infrastructure will substantially impact the cost of sanitation operations of SA “Regia Apa Canal Soroca”. In order to be financially viable, it has been estimated that **the average 2020 tariff for centralised sanitation services** will need to be increased by x 1.3 by 2025 and by x 4 by 2045 for basic cost recovery (OPEX only), and by x 2.2 by 2025 and x 7 by 2045 for full cost recovery. These conclusions are made based on an average tariff, but it is highly recommended to perform a **specific tariff study** to look into the setup of a social tariff for low-income households and to improve the cross-subsidization between customers’ categories.

1. INTRODUCTION

1.1. PRESENTATION OF THE PROJECT

Soroca Municipality is located in the northeast of the Republic of Moldova, on the border with Ukraine, on the right bank of the Nistru River, at a distance of 160 km from the capital Chisinau. The city has at present a total of about 35 000 inhabitants. The municipally-owned SA “Regia Apa Canal Soroca”, established in 2000, is responsible for water supply and wastewater services in the city of Soroca and in some neighbouring villages.

The existing centralized sewerage network which extends over 58 km in the city is in poor condition, pumping stations are not functional and there is no wastewater treatment plant. The connection to the sewerage network is low (42%). The rest of the population uses on-site sanitation solutions, mainly pit latrines with direct infiltration into the soil. The industrial sector (mainly agro-food and textile), although much less important than during the Soviet Union, plays an important economic role in the city, and it may be a significant source of wastewater pollution discharges.

The untreated wastewater is directly discharged into the Nistru river, which causes a negative environmental impact. The Nistru River is a transboundary river with a length of 1352 km, which starts in the Ukrainian Carpathians, flows through Moldova and reaches Ukraine again near the Black Sea. More than 5 million people populate its basin, being the Nistru River, the main source of drinking water for Moldova and for a significant part of Ukraine, including Chisinau and the City of Odessa.

The development of the Soroca sanitation system has therefore been identified as a national priority and is part of the Moldova Water Security and Sanitation Project (MWSSP) financed through a transitional IDA credit and IBRD financing of approximate 50 Million US$, from which 11 Million US$ have been predefined to Soroca.

MOLDOVA WATER SECURITY AND SANITATION PROJECT (MWSSP)

The Project Development Objective (PDO) of the MWSSP is to increase access to improved water supply and sanitation services in selected rural areas and small towns, and to strengthen institutional capacities for water supply and sanitation service delivery, both at national level planning as well as utility level.

1.2. Objectives of the Feasibility Study

The objective of this assignment is to prepare a detailed feasibility study for the Soroca Sanitation Project with the following main tasks:

- Review and assess the existing sanitation situation at Soroca and its background conditions: central sewerage system, pumping stations, individual sanitation systems, outlets;
- Review the institutional, operational and financial management of wastewater and sanitation in the study area;
- Assess the current wastewater volumes and loads from domestic and non-domestic sources, including septage generation in on-site sanitation systems, and evaluate its future development for the project horizon;
- Perform a detailed topographical campaign and prepare a GIS database of the sewer network;
- Evaluate with technical, financial and environmental criteria the alternatives for wastewater collection and treatment in Soroca and surrounding villages, including:
    - Selection of potential sites for the construction of a Wastewater Treatment Plant in the city;
    - Analysis of process options for wastewater and sludge treatment for the Wastewater Treatment Plant;
    - Assessment of the upgrade and expansion of the centralised sewer system;
    - Analysis of sanitation options for villages: improvement of on-site solutions, management of septage, construction of sewer system with a decentralised Wastewater Treatment Plant, connection to the Wastewater Treatment Plant in Soroca, etc.
- Prepare an hydraulic model of the sewer network and analyse the current and future operation, including the future extensions;
- Identify wastewater and sludge reuse options;
- Analyse the resilience of all components of the sanitation infrastructure;
- Define the necessary measures to improve sanitation services in the short, medium and long term, and prepare the associated investment plan, including:
    - Institutional strengthening activities and resources for management of the sanitation system;
    - Technical solutions for the onsite systems, wastewater collection system and Wastewater Treatment Plant.

1.3. Overview of the Service Area and Project Horizon for the Soroca Sanitation Project

This Feasibility Study focuses on the municipality of Soroca and the surrounding communes - villages where currently SA “Regia Apa Canal Soroca” provides water services, as shown in the figure below.

The design horizon considered in the study is the year 2045 for the WWTP and the year 2065 for the sewer.

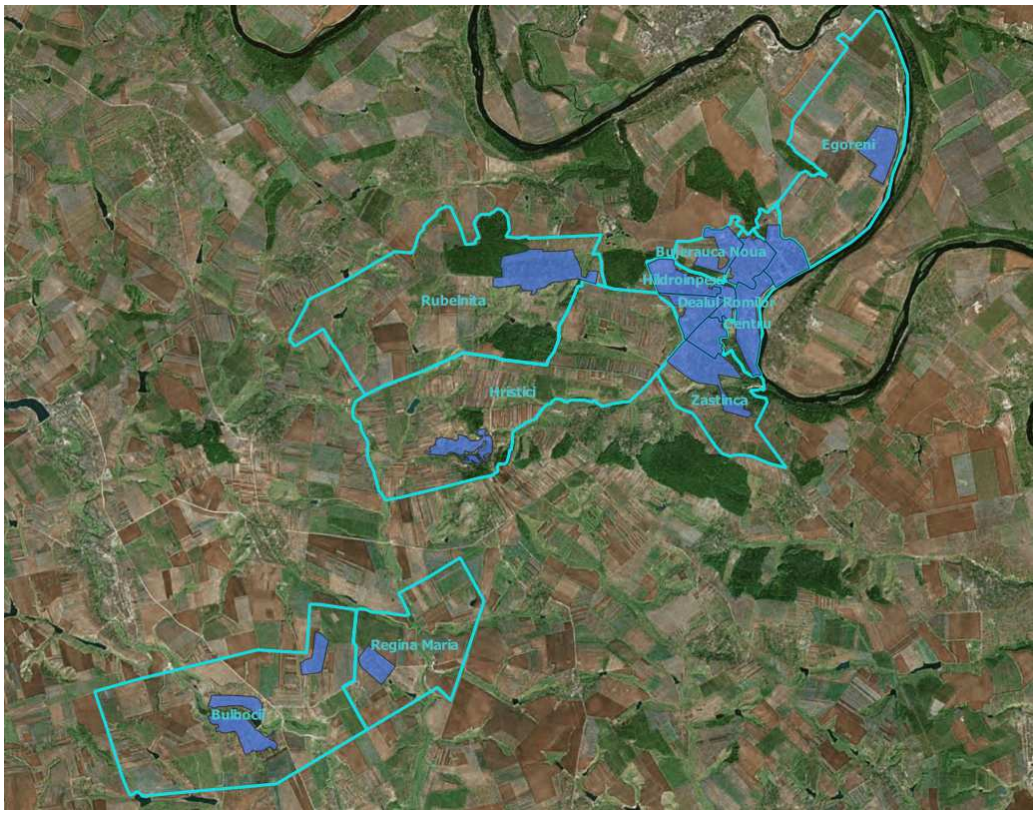


Figure 1: Overview of project area including the city of Soroca and the surrounding villages where water services are supplied by SA “Regia Apa Canal Soroca”

Table 1: Localities where Apa Canal Soroca provides water services

No	Territorial administrative unit	Locality
1	Mun. Soroca	Soroca
2	Village Egoreni	Egoreni
3	Commune Regina Maria	Regina Maria
4		Lugovoie
5	Village Hristici	Hristici
6	Village Zastinca	Zastinca
7	Commune Rublenita	Rublenita
8		Rublenita Noua
9	Commune Bulboci	Bulboci
10		Bulbocii Noi

2. Overview of environmental and socio-economic context

2.1. Geography and Topography

Soroca district is located in the northeastern part of the Republic of Moldova, having direct borders to the northwest with Donduseni district, to the west with Drochia district, to the south with Floresti district, to the southeast with the administrative-territorial unit on the left bank of the Nistru and to the east with Ukraine.

The main city, Soroca, is located on the right side of the Nistru river. Soroca is the second largest city in the northern region and the eighth in the country.

Figure 2: Soroca district situation

The main form of relief within the district is the Nistru Plateau, with hilly relief and intensely fragmented by a dense network of valleys and deep valleys, ravines.

Soroca district is located between the Nistru river which is between 57 m above sea level and some hills up to 371 m above sea level.

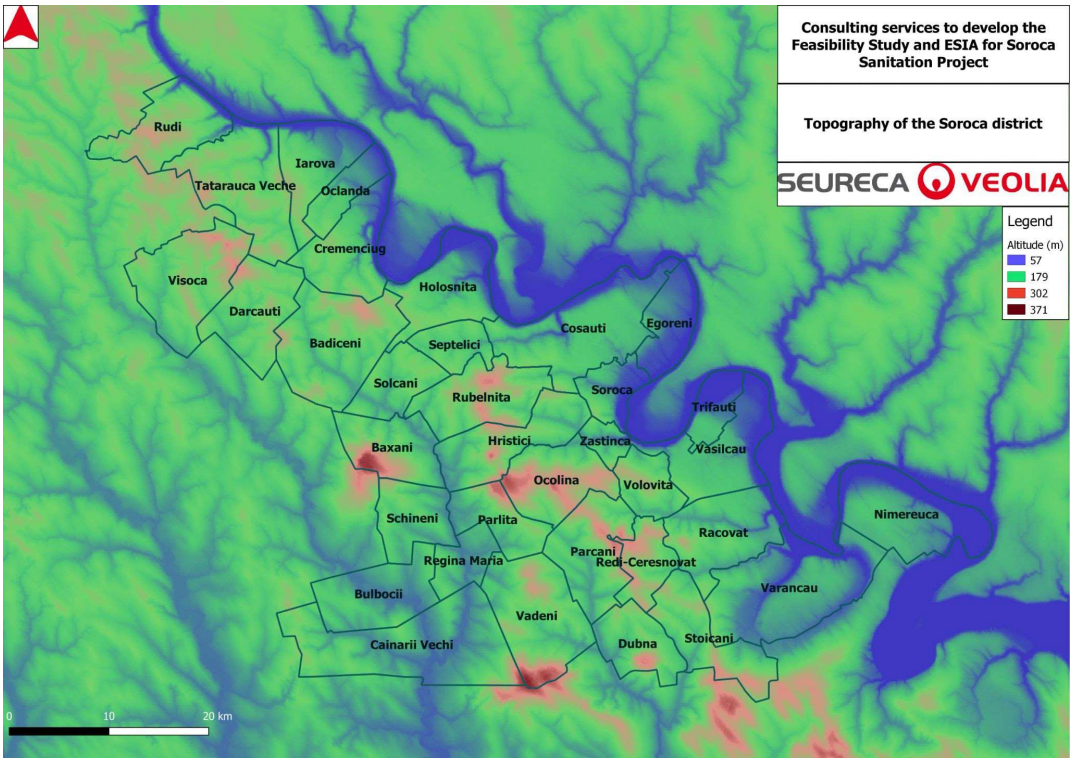


Figure 3 : Topography of Soroca district

Erosion processes, karst, mud torrents and landslides are active in some parts of the district. As observed in the following map, soils suffer from erosion in some parts of Soroca city and the surroundings.

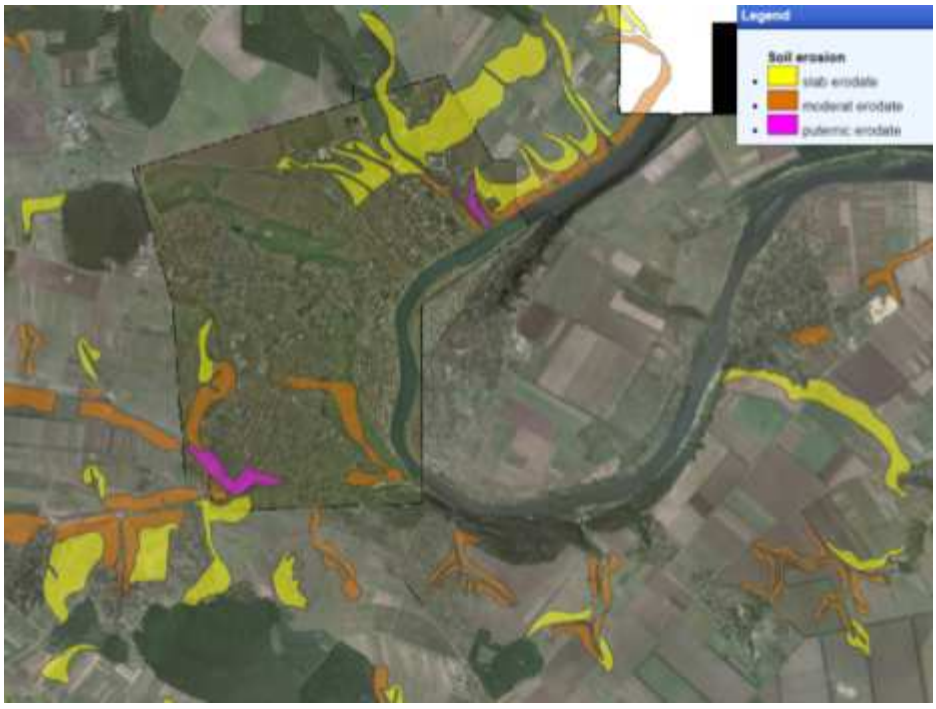


Figure 4: Soil erosion around Soroca city

The type of soils in Soroca district are mainly grey forest soils, humic-calcareous, chernozems, alluvial hayfields, swamps, solonceacuri (surface saline soil with high salt content). Soroca height, part of the Nistru Plateau, is the region of typical and leached chernozems, very fertile soils for agriculture.

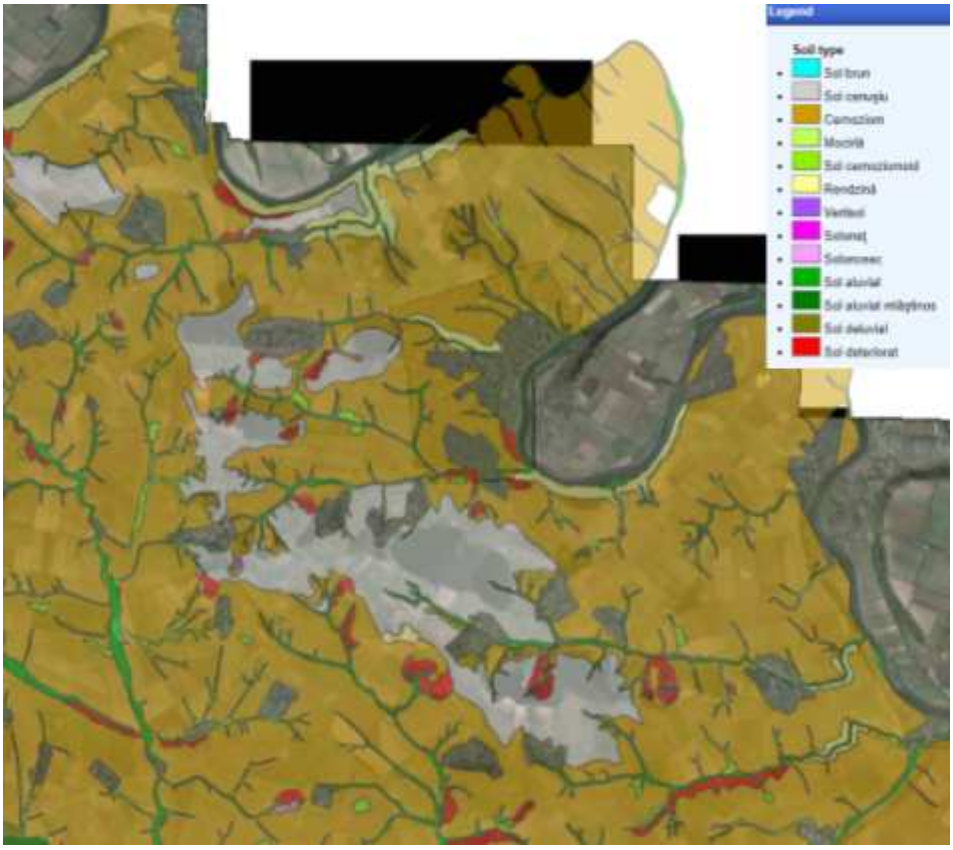


Figure 5 : Soil types in Soroca district

2.2. Surface and Groundwater Bodies

There are two main catchment areas in the Soroca district :

1. The Nistru catchment area which includes Soroca and other communes and villages on the east side of the district;
2. The Căinări catchment area which includes the communes and villages on the west side of the district. The Căinări river is a left tributary of the Răut river.

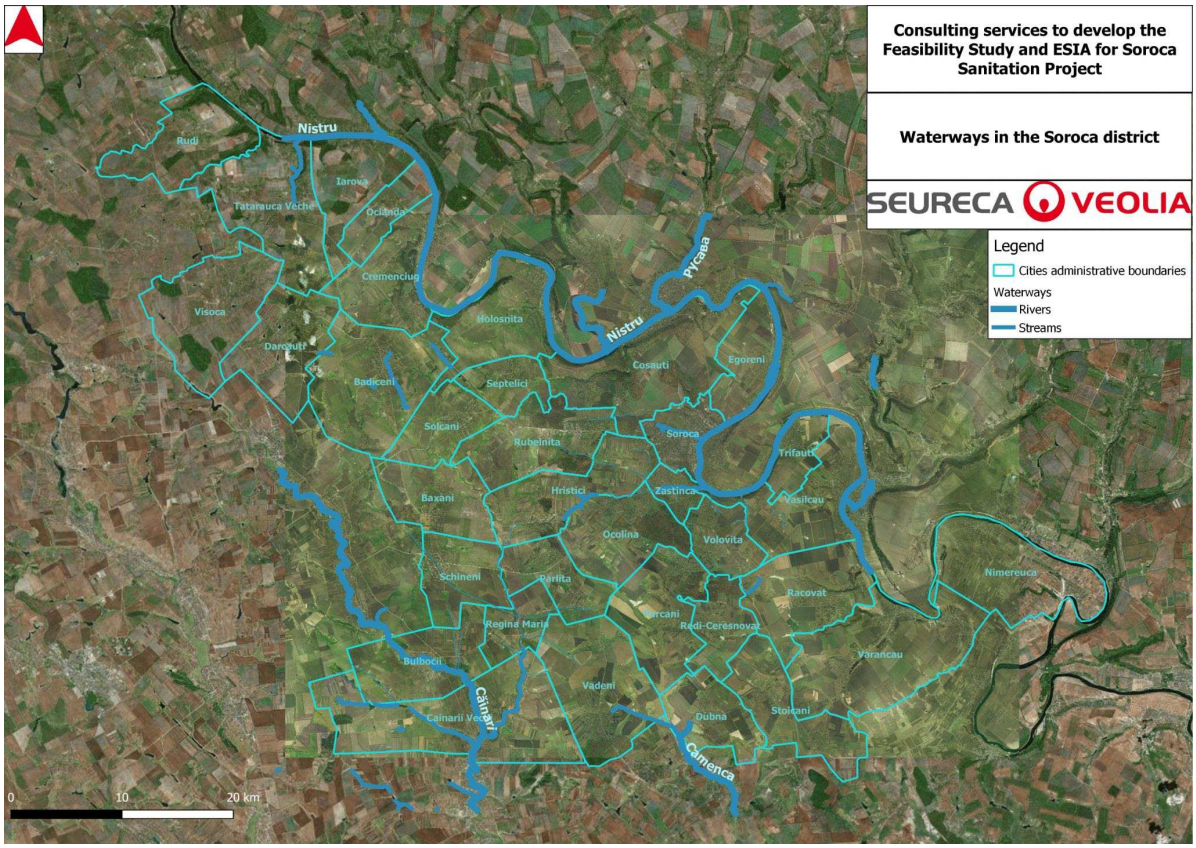


Figure 6 : Waterways in the Soroca district

The Nistru river is the most important river in Moldova with a total annual volume discharged of about 10,3 km^3. The river flows from Ukraine to Moldova on over 1 329 km with nearly 8 million inhabitants in its basin[1].

The width of the river is about 300 m near Soroca. The average flow registered during the last three years at the station of Hruşca Station, downstream of Soroca, was 223 m^3/s, with a peak up to 1895 m^3/s during the floods of 2020.

[1] ENVSEC Initiative, 2010. Transboundary monitoring of the Nistru River. Assessment and evaluation. Action Programme to Improve Transboundary Cooperation and Sustainable Management of the Nistru River Basin (Nistru - III)

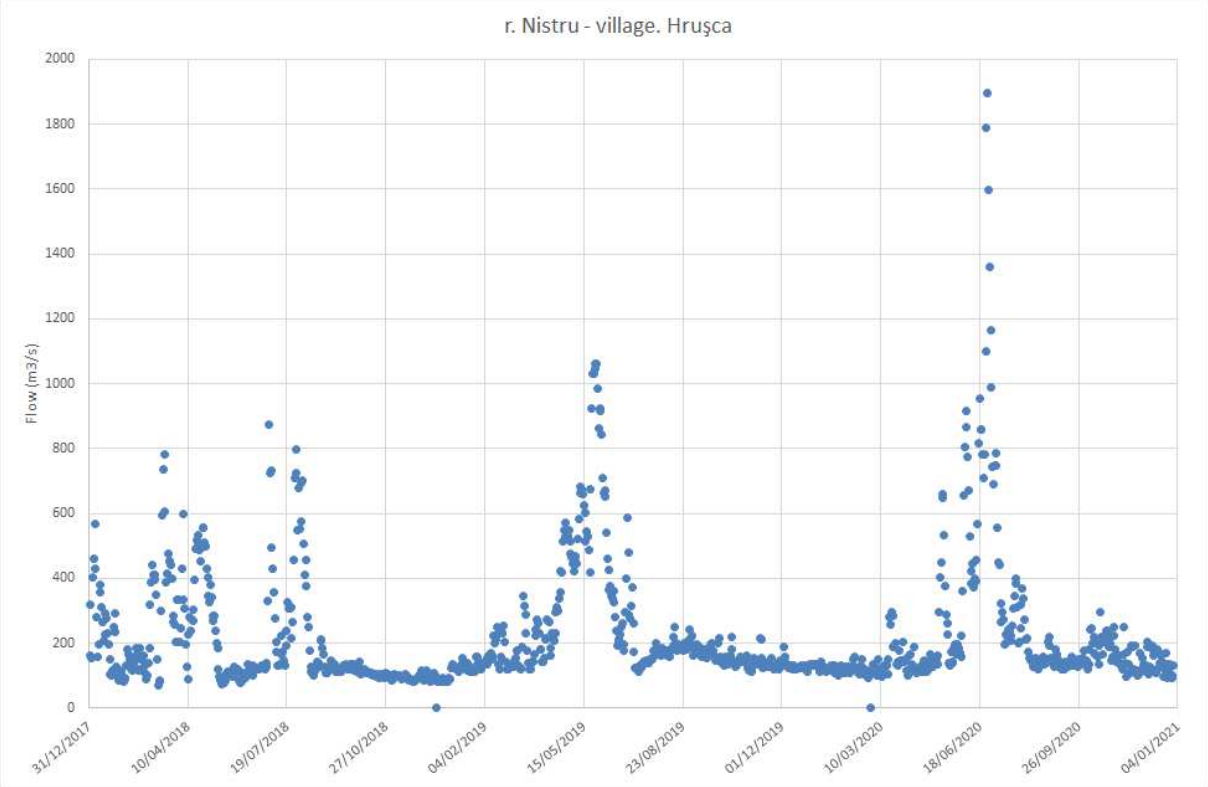


Figure 7: Nistru flow (m3/s) in the village of Hruşca

Groundwaters are located mainly in deep confined aquifers. Sub-surface waters are the main source of potable water for the rural population in the Republic of Moldova and almost a third of the urban population[2].

2.3. Climatic Features

The climate in Soroca is temperate continental, characterized by relatively mild-cold winters and long warm summers. The annual precipitation varies between 300-734 mm per year and the average air temperatures vary between 9 - 10.7 ºC.

The Soroca district is located in a region with favorable agro-climatic conditions for cereals, sugar beet, tobacco, and fruit development. The vegetation period of these crops varies between 167-176 days.

2.4. Population and Economic activities

2.4.1. Population

Soroca is the main city and center of residence of Soroca district. The surface of the city is 13.11 km^2, and the number of inhabitants is about 35 thousand people (2020).

The 2019-2021 Soroca Urban Revitalisation Plan presents the city urban plan organisation which comprises 8 sectors as follows:

[2] MWSS Project, 2021. Environmental and Social Management Framework.

1. **"Centru"** sector represents the old part of the city, where the most important historical, cultural and administrative sites are located;
2. **“Dealul Sorocii”** is the hilly sector, adjacent to the village of Zastînca, with which the town is connected. Soroca practically merges, there is no visible border;
3. **“Colegiul Agricol”** comprises in particular the Agriculture School which has had and continues to have a substantial importance in the district since its foundation (1907);
4. **"Hidroinpex"** is a new district, accentuated by the development of an imposing industrial complex, now run by the "Hidroinpex" SA, which also gave the district its name;
5. **“Bujerauca Noua"** sector is also a new neighbourhood, where there are mainly residential houses and which has extended the town to the outskirts;
6. **“Bujerauca"** sector is the district where a village of the same name was once present and after the expansion of the city to the north-east is an integral part of the city;
7. **“Dealul Rominor”** or the "Roma Hill" sector is characterized by a spontaneous architecture, which has developed more strongly in the last 30 years, where Roma citizens have intervened in shaping the visual aspect;
8. "**Soroca Nouă**" sector, intensively developed during the industrialization of the city, where housing blocks for workers were massively built and which is known as the "sleeping quarter", and the "FAT" sector, built mainly of residential houses, is de facto part of sector 8.

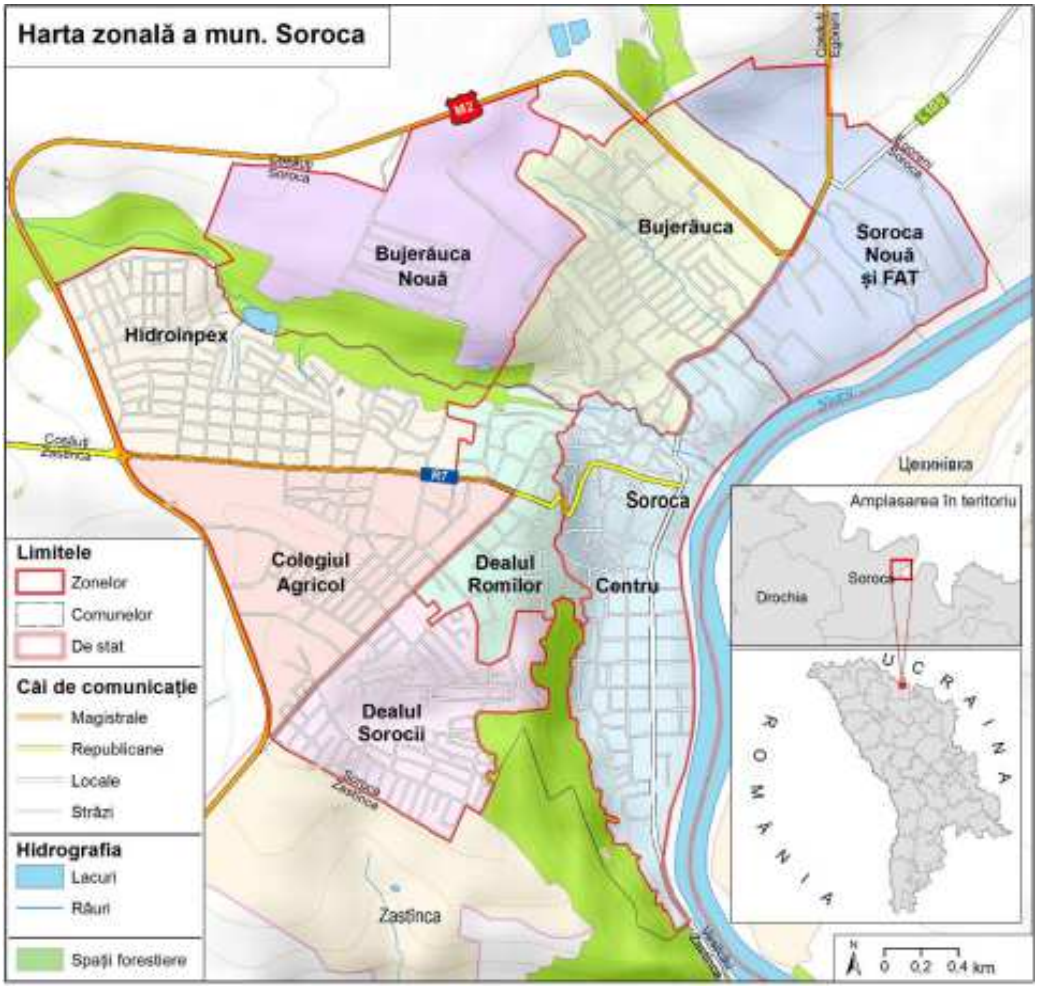


Figure 8: Administrative division of Soroca municipality according to the Soroca Urban Revitalisation Plan 2019 - 2021

Besides Soroca municipality, there are 34 communes in the Soroca district, all of them with less than 4 000 inhabitants.

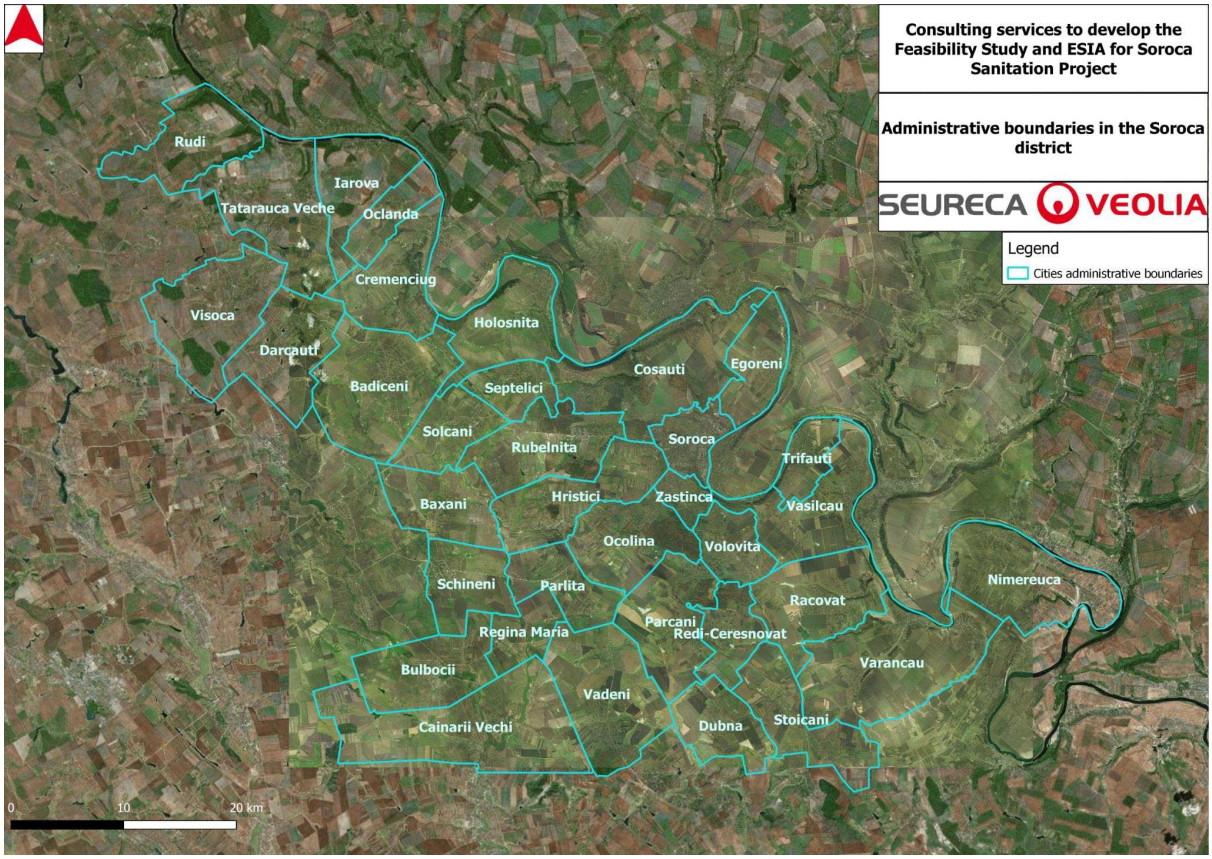


Figure 9: Administrative boundaries in the Soroca district

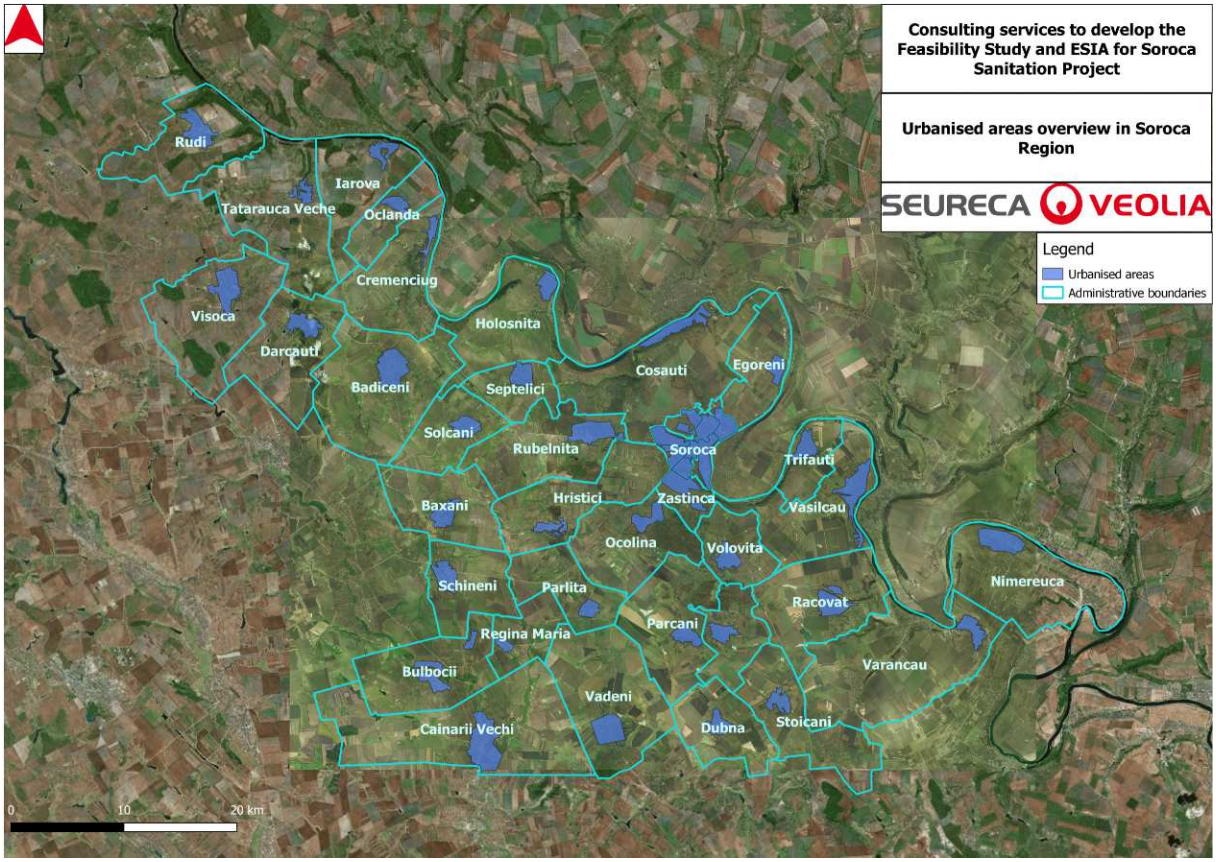


Figure 10: Overview of main urbanised areas in the Soroca district

Adequately evaluating the current population and projecting its future evolution in the project area is a core factor of this Feasibility Study at different levels:

- First of all **technically** as the infrastructures recommended need to be rightly dimensioned for the wastewater generation on the project area, but also
- **Financially** as the population on the project area will bear the cost of new infrastructure and its number will be key to the tariff recommendations.

As far as the current situation is concerned, a number of source documents were assessed in order to establish the population baseline. The last national census took place in 2014 and its reliability seems to be questionable. As such, the recent Soroca City Development Strategy for 2021-2025 provided the baseline for the population data which was used for this Feasibility Study:

Table 2: Population baseline and source within SA "Regia Apa Canal Soroca" service area

Location	2019	2020	Source
	Baseline (inhab.)		
Soroca city	37,500	35,300	*Data from the Soroca City Development Strategy for 2021-2025*
Egoreni	1,078		*World Bank Utility diagnosis, 2021*
Hristici	1,240		
Regina Maria	674		
Rublenița	3,781		
Zastinca	2,308		
Bulboci	1,959		

Within Soroca city and based on National Statistics data, the population is distributed among the 8 city sectors as detailed below. It is assumed that this spatial distribution will remain equal in proportion over the period covered by this Feasibility Study.

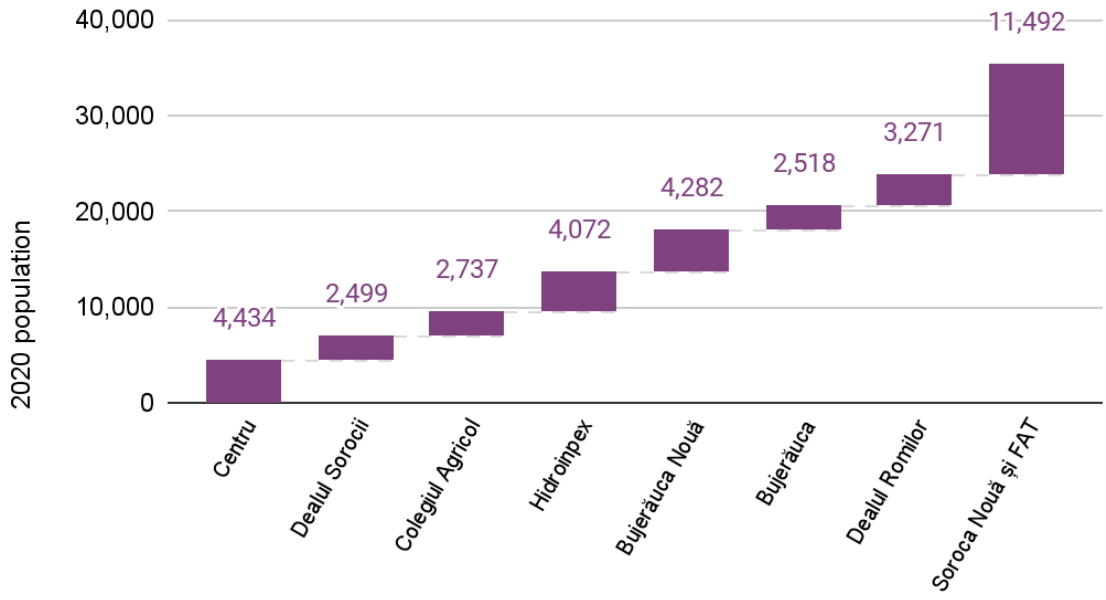


Figure 11: Soroca population distribution in districts - 2020

According to the World Bank[3], Moldova's current demographic trends indicate an overall declining and aging population, with the younger population emigrating. The World Bank also anticipates that Moldova will be losing about a fifth of its current population by 2050.

[3] *Moldova Water Security Diagnostic and Future Outlook Report, The World Bank Group and the Global Water Security & Sanitation Partnership, 2014*

Similarly, National statistics[4] data have shown a regular decrease in the population of the entire Soroca region of 0.14% per year on average over the past 10 years. Hence, for purposes of this feasibility study, **we have therefore assumed a decrease of the Soroca regions population in the coming years at an annual rate of 0.14%** which is anticipated to affect the population of the current perimeter of SA "Regia Apa Canal Soroca" as follows:

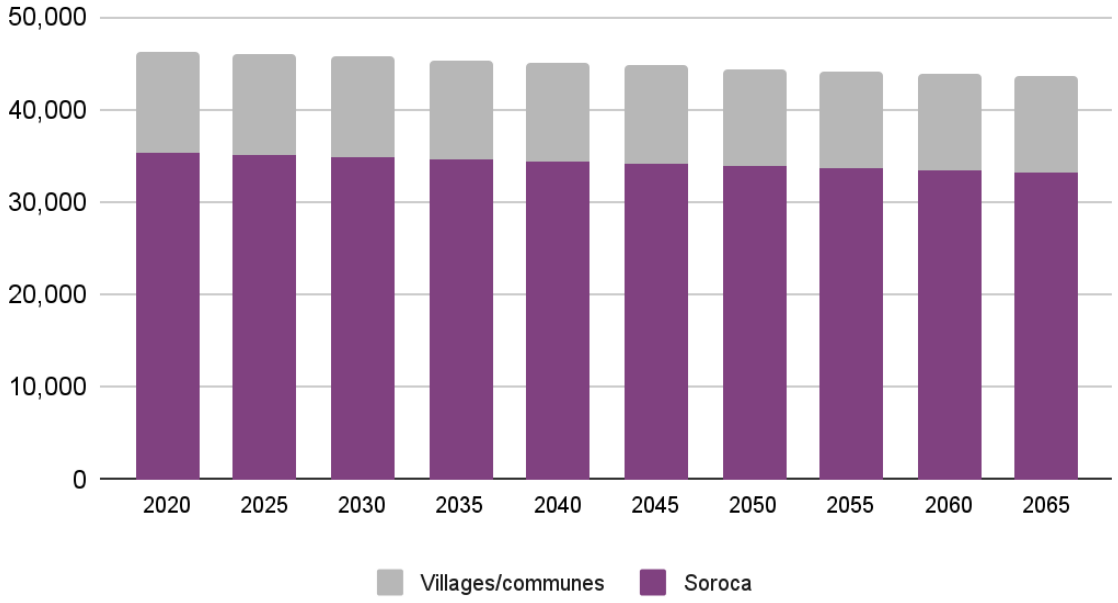


Figure 12: Evolution of the population in the service area of SA "Regia Apa Canal Soroca"

2.4.2. Population socio-economic profile

The Soroca's population is multinational with 68 % Moldovas, 15 % Ukrainians, 12 % Russians, 3 % Roma and other nationalities[5].

According to SA "Regia Apa Canal Soroca"'s reporting to ANRE, Soroca 2019 city population was characterised by the following socio-economic elements:

- composed of 17,725 women and 17,575 men;
- 16% of the population is below 18 years old;
- 10% of the population presents disabilities;
- 14% are retired;
- 6% depend on social assistance;
- 1% of households have 3 children or more.

In 2019, the city comprised 6,407 apartments within 149 multi-story buildings and 7198 private houses.

There were also:

- 5 schools and kindergartens with 3650 students;
- 9 kindergarten with 1319 children;

[4] *Statbank Statistica Moldova (http://statbank.statistica.md/PxWeb/pxweb/en/20%20Populatia%20si%20procesele%20demografice/20%20Populatia%20si%20procesele%20demografice__POP__POP010/POP010400reg.px/table/tableViewLayout1/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774)*

[5] *MWSS Project, 2021. Environmental and Social Management Framework.*

- 122 public institutions in Soroca;
- 1321 economic agents.

According to National statistics data, monthly gross average earnings in the Soroca region has been by an average of 11.5%/year for the last 5 years reaching 5,994.1 Lei in 2020. It must be noted that average earnings in the Soroca region are about 35% below the national average.

Tariff considerations in this Feasibility study will take into account the current national minimum salary of 2,935 Lei/month.

2.4.3. Industry and Economy

The industry sector in Soroca district is mainly focused on the processing of agricultural products and manufacturing of clothing and footwear. Other sectors such as carpentry, handicrafts, extraction and production of construction materials and metalworking activities are also found. The industrial sector accounts for about 15% of Soroca city's economy and considerably impacts revenues. The industrial complex of the city covers over 100 enterprises on various economic activities, out of which 20 can be considered as big economic enterprises[6].

Agriculture is the main activity of Soroca district's economy, and for more than half of the population, it is the only source of existence, most of the inhabitants being located in rural areas.

Over 60% of the districts' territory is agricultural land (63,2 thousand hectares out of a total of 104,3 thousand ha), including 54,5 thousand hectares arable and 7117 ha orchards, 98 ha vineyard, walnuts, 1098 ha fruit bushes, 397 ha pastures and other lands. Currently, more than 150 economic agents are active in the agricultural sector of the district and there are registered more than 20.0 thousand GT (Gospodarie Taraneasca).

2.4.4. Land register

The national geospatial data fund is an important resource for the study by giving access to the buildings and land parcels updated with information about the parcel whether it is public or not. It gives important information to study areas for the future wastewater treatment plant and future extensions of the wastewater network.

Figure 13: Example of use for land parcels collecting information

[6] *Studiu de prefezabilitate privind construirea unei stații de epurare ape uzate în Municipiul Soroca, Republica Moldova, 2019, accesat la 31.05.2021. http://www.primsoroca.eu/uploads/article/SPF_Soroca_Romana_-gel.pdf*

2.5. Drinking water supply

2.5.1. Soroca Municipality

Drinking water is currently supplied to the city of Soroca by the Soroca - Balti aqueduct, managed by Acva Nord. It is estimated that approximately 85% of Soroca municipality is connected to the central water supply.

The water intake and Soroca-Balti water supply network was built in 1984 to treat water from the Nistru River. The system was designed with a maximum capacity of 180,000 m^3/day, and it is currently operating at a capacity of 90,000 m^3/day. The capacity of the aqueduct is approximately 3500 m^3/day for Soroca, which largely covers the needs of the city..

SA "Regia Apa Canal Soroca" has a second drinking water source in Egoreni. It consists of 10 wells located on the banks of the Nistru and a pumping station which were rehabilitated in 2007. This source is currently a reserve for SA "Regia Apa Canal Soroca", because there is an obligation to buy water from Acva Nord according to a Government Decision.

2.5.2. Villages

The villages under the scope of service of SA "Regia Apa Canal Soroca" are supplied with water from the Soroca - Balti aqueduct, except for Egoreni, which is directly supplied from one of the reservoirs of Soroca.

Some of the villages do not have centralized water services such as Lugovoie[7] and Rublenita Noua. According to SA "Regia Apa Canal Soroca", there are more and more demands for drinking water connections in Bulboci, which has the lowest coverage rate.

The current drinking water coverage in the communes/villages is shown below (sources: Soroca Utility Report, WB 2021 and SA "Regia Apa Canal" customer database analysed by the Consultant).

Table 3: Drinking water coverage ratio in surrounding villages

Administrative unit	Coverage rate (%) Utility Report WB 2021	Coverage rate (%) Active customers - database
Egoreni	90%	61%
Regina Maria	57%	53%
Bulboci	31%	26%
Hristici	72%	66%
Zastinca	53%	45%
Rublenita	62%	55%

Drinking water network expansions are planned by SA "Regia Apa Canal Soroca", especially in Zastinca, and in Volovita (currently not under the scope of services of SA "Regia Apa Canal Soroca").

[7] According to the interviews held with SA "Apa Canal Soroca", Lugovoie is supplied by Acva Nord.

3. Overview of Strategic, Legal and Institutional Framework

3.1. Moldovan Water and sanitation Legal and Policy framework

Over the past 15 years and driven by multilateral environmental agreements, the aspiration of European integration as well as the national reform process, the Government has been able to substantially develop its water and sanitation sector strategic framework.

In 2021, the development and operation of the Moldovan water and sanitation sector is guided and regulated at national, regional and local level through a number of policies and strategic documents:

Figure 14: Summary of the current Moldovan water and sanitation legal and strategic framework

3.1.1. National legal and policy framework regulating the Moldovan water and sanitation sector

At national level, the Moldovan water and sanitation is regulated by the following laws and regulations:

- **Law No. 303 of December 13, 2013** on public service of water supply and the sewerage regulates the single legal base in the field of creation, the organization, management, financing, operation, monitoring and control of work of public services in supply with drinking, technological water and the sewerage of household sewage.
    - In particular, the **Regulation on requirements for collection, treatment and discharge of wastewater into the sewerage system and/or outfall for urban and rural localities, approved by GD No 950/2013**, partially transposes the provisions of Council Directive No 91/271/EEC of 21 May 1991 concerning Urban Wastewater Treatment. The Regulation aims to establish requirements for the operation of wastewater collection systems and for the operation of treatment plants in terms of a) the method and degree of treatment to be provided depending on the number of inhabitants/size of the locality served or to be served by a collection system and a treatment plant and/or the quality of the outfalls into which treated wastewater is discharged; b) the identification and classification of such outfalls, designated as sensitive or less sensitive areas; c) the obligation to discharge all industrial wastewater into a collection system in urban areas, which must be based on a contract and/or permit issued by the operator; d) conditions for the management of sludge resulting from the treatment process; e) the obligation to monitor discharges of liquid waste and to monitor their effects, as well as reporting requirements; and protection of the quality of water resources;
    - **Regulation on the conditions of wastewater discharge into water bodies, approved by GD No 802/2013.** The Regulation partially transposes Directive 2006/44/EC of the European Parliament and of the Council of 6 September 2006 on the quality of fresh waters needing protection or improvement in order to support fish life, Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control), Commission Directive 2009/90/EC of 31 July 2009 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status, Council Directive 91/271/EC of 21 May 1991 concerning urban waste water treatment, published in the Official Journal of the European Union L 135 of 30 May 1991, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Directive 2006/11/EC of the European Parliament and of the Council of 15 February 2006 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community. The Regulation aims to regulate the conditions for discharging specific substances into a body of surface water, groundwater or land. Included in the Regulation are the general conditions and limit values applicable for the issuance of the environmental permit for the special use of water for the purpose of wastewater discharge, monitoring of waste water discharge and compliance with the limit values set out in the Annexes to the Regulation;
- **Law No. 440/1995** on water protection zones and strips of rivers and water basins, aimed at regulating the creation and use of water protection zones and water basins. The construction

of sewerage collectors and wastewater treatment plants is prohibited in water protection zones (1000m in case of the Nistru) without written coordination with the central authority responsible for natural resources management and environmental protection (MoE) and the central authority for health (MH). In cases when their location outside water protection zones is impossible (due to construction conditions, land configuration or other reasons), their construction is allowed as an exception, provided that measures to prevent pollution of rivers and water basins are implemented;

- **Law 182/2019 on drinking water quality** establishes the requirements for ensuring safe operation of water supply and was meant to be revised according to the Directive 98/83/EU on quality of the water intended for consumption of the population;
- **Law No. 1402-XV of October 24, 2002** on public services of municipal services establishes the unified legal basis of creation and the organization of activities of public services of municipal services of administrative and territorial units, including monitoring and control of their operations;
- **Law No. 436-XVI of December 28, 2006** on local public authority establishes and regulates the organization and operation of local public authority in administrative and territorial units;
- **Law No. 10-XVI of February 3, 2009** on the state supervision of public health establishes the state's responsibilities in providing optimum conditions for protection and strengthening of health of the population and improvement of the quality of life;
- **Law No. 272 on water of December 23, 2011** establishes the minimum content of national wastewater policy documents: (a) the design, financing, construction, commissioning and operation of wastewater collection systems and wastewater treatment plants in urban settlements, as well as the deadline by which the Republic of Moldova must comply with the requirements applicable in the European Union in this area; b) identification and implementation of measures that would provide cost-effective wastewater treatment in rural localities so as to reduce and minimise water pollution, and that would protect the drinking water supply, as well as the design, financing, construction, commissioning and operation of local wastewater collection systems, treatment plants, implementation of appropriate alternative processes, technologies and methods. This normative act also makes it compulsory to obtain an environmental permit for the special use of water for waste water discharge activities.

Although there is political will to align the national water and sanitation legal framework to the EU legislation, the **2014-2028 National Water and Sanitation Strategy** recognizes that the current water supply and sanitation sector legal framework has significant gaps, mainly relating to:

- planning instruments to enable investment in developing water supply and sanitation infrastructure;
- selecting the most cost-effective, appropriate and efficient technical solutions for the operation and maintenance of water supply and sanitation systems;
- defining the appropriate criteria for assessing the performance of companies providing water supply and sanitation services;
- preventing and controlling environmental pollution;
- facilitating and speeding up procedures and mechanisms for obtaining approvals and permits required for operations through a necessary simplification of legislation.

Moldova National Development Strategy "Moldova 2030"

Moldova National Development Strategy "Moldova 2030" was approved on November 7, 2018 by the Government of Moldova and identifies national and regional development objectives as well as expresses the responsibility assumed by the Government (in particular the Ministry of Economy and Infrastructure) to implement state policies in the field of regional development. Aligned with the United Nations 2030 Sustainable Development Goals, "Moldova 2030" includes ten sustainable development objectives that the country is to achieve by 2030 among which expanding people's access to utilities (safe water supply and sanitation) has been defined as a priority objective aimed at improving the quality of life of the population of Moldova. In particular, the following objectives can be highlighted as the main drivers of the country's water and sanitation sector development:

- **Objective 2:** Improving people's access to physical infrastructure, public utilities and living conditions, which provides for the strategic goal of increasing people's access to safe water sources, sanitation systems;
- **Objective 10:** Ensuring the fundamental right to a healthy and safe environment provides, as a specific objective, through the enhancement of water and soil quality by reducing pollution from wastewater discharges to outfalls or the natural environment, minimising the discharge of chemicals and hazardous substances and reducing the share of untreated wastewater.

To achieve these objectives, the following priority actions are proposed:

- Construction/rehabilitation of wastewater treatment plants in localities with more than 15,000 inhabitants, which will treat wastewater in accordance with the permissible limit values of wastewater quality indicators for discharge into water bodies;
- Compliance with the quality indicators of industrial wastewater discharged into centralized sewerage networks and water bodies by all economic agents, operating on the territory of the Republic of Moldova.

It must be noted that, according to the FAO[8], the volume of available water per capita is about 500 m^3/year as opposed to international standards which range around 1700 m^3/capita/year. This also raises concerns in Moldova on the level of access to renewable fresh water and as such, improving water and soil quality by reducing pollution due to wastewater discharged into receivers or into the environment, minimizing the discharge of chemicals and hazardous substances and reducing the share of untreated wastewater, have been identified as key priorities within the "Moldova 2030" strategy.

National Water Supply and Sanitation Strategy (2014-2030)

The National Water Supply and Sanitation Strategy (2014-2030) is the main policy document for the development of the water supply and sanitation sector in order to ensure the human right to drinking water. In particular, this strategy sets two key sectoral objectives:

- Planning and development of public water supply and sanitation systems in order to increase the level of access of the population to high quality services;
- Harmonisation of national legislation in the water supply and sanitation sector in line with Community standards and international commitments.

More specifically, the strategy sets the following objectives in the field of sanitation:

[8] *http://www.fao.org/faolex/results/details/en/c/LEX-FAOC191490/*

- To ensure 100% access of the population to improved sanitation systems, including up to 50% access to sanitation systems by 2025;
- To increase the performance levels of collective water supply, sanitation and other systems;
- To increase the application of recognised good practices in integrated water management and water supply and sanitation;
- To reduce by 50% the discharge of untreated wastewater and reducing the discharge of untreated stormwater into natural receptors;
- To improve sludge management and the quality of treated wastewater from centralised sewerage or other sanitation systems.

The National Water and Sanitation Strategy highlights a number of elements which are key to structuring this Feasibility Study and in particular the following areas of focus:

- **The regionalisation of water supply and sanitation service provision** with the intermediate target of creating regional companies that will be responsible for providing water supply and sanitation services within areas covering at least 100 000 urban/semi-urban inhabitants, and the ultimate ambition of creating 3-5 regional companies that will provide water supply and sanitation services to the entire urban/semi-urban population of Moldova;

  This Feasibility Study takes place within a changing institutional context with, in particular, the regionalisation of water supply and sanitation service provision aimed at facilitating and accelerating the development process of water and sanitation utilities. In accordance with the 2014-2030 National Water and Sanitation Strategy, it is understood that the ultimate target is to create regional companies to provide water and sanitation services for at least 100,000 inhabitants with a minimum threshold of 500 and 5,000 inhabitants for water and sewerage services respectively.

- **The performance improvement of water and sanitation companies** through the setup of a strong measuring and monitoring system, the deployment of tailored action plans to improve operational efficiency, risk management with the implementation of water safety plans as well as the development of Information Management Systems.

The 2014-2030 National Water and Sanitation strategy also mentions the Soroca District as part of the priority areas for the construction and extension of water supply and sanitation systems thanks to a mix of financial sources (World Bank, BERD, BEI, IPVE, contribution of local public authorities, etc.).

National Environmental Strategy (2014-2023)

The Environmental Strategy for 2014-2023 and the Action Plan for its implementation, approved on 24 April 2014, is the main policy document, approved with the aim to guarantee the population of the Republic of Moldova the right to a clean and healthy sustainable environment, in harmony with economic development and social welfare. The environmental strategy was developed on the basis of the reform of the environmental protection sector, adjusted to the European Union requirements, ensuring environmental sustainability and increasing the quality of environmental factors.

The general objective of the strategy is the creation of an effective environmental management system, which will contribute to ensuring the population's right to a clean, healthy and sustainable natural environment by a) improving the quality of at least 50% of surface waters and the implementation of the river basin management system and b) ensuring access, by 2023, to safe water

supply systems and services for about 80% of the population and to safe sanitation systems and services for about 65% of the population.

In particular, the approved Management Plan of the Nistru River Basin District established a framework for Community action in the field of water policy, has determined 3 general objectives:

- Prevention of deterioration of the status of surface water and groundwater by 2022;
- Protection and improvement of the status of surface water bodies, including those subject to the designation of heavily modified and artificial water bodies, and groundwater bodies with the aim of achieving "good status" by 2030;
- Progressiv reduction of point and diffusion of source, surface water and/or groundwater resources pollution. In particular, point source pollution should be reduced by 25% by 2022, through the identified action of the **construction of the wastewater treatment plant in the city of Soroca** (scheduled for quarter IV, 2022).

National Programme for the Development of growth towns (2021-2027)

The National Programme for the Development of Growth Towns in the Republic of Moldova for 2021-2027, approved by GD 916/2020, identified 6 growth towns in the Republic of Moldova: Soroca, Edinet, Ungheni, Orhei, Cahul, Comrat and their adjacent rural areas. The overall objective of the National Programme is to create a network of regional growth cities in the Republic of Moldova that are attractive to residents, entrepreneurs and visitors, generating growth, employment and stimulating the development of adjacent territorial areas.

Specific objectives have been formulated to achieve this goal, including the modernization of the technical and sanitary infrastructure and public utility networks, **aiming to increase the coverage rate with centralized sewerage services to at least 70%** and to provide all growth pole cities with functioning wastewater treatment plants (in 2019, wastewater treatment plants did not exist at all or were only partially functioning in four out of six municipalities).

3.1.2. Regional water and sanitation strategic framework

“Moldova 2030” also provides directions for regional development which are then integrated and detailed into specific Regional Development Strategy documents. The North Regional Development Strategy covered the period 2016-2020 and an updated version has not yet been published. The document identified a series of issues to be addressed in priority related to the water and sanitation sector including:

- Inadequate coverage of water supply systems in Soroca district (in 2015, only 12 localities out of 68 had centralized water supply systems);
- Highly degraded water and sanitation networks;
- Low water quality in systems that are supplied from underground sources;
- Inadequate coverage of wastewater systems;
- Absence of wastewater treatment facilities.

The strategy sets the provision of water supply and sewerage services for all residents of the district as a priority and hence recommended the construction of a WWTP as well as the development of sewerage networks and rehabilitation of water networks in Soroca City.

3.1.3. Local Frameworks for the development of the water and sanitation sector

The **Soroca Municipality Community Development Strategy (2021-2025)** is the main strategic document guiding development at the local level. The strategy provides a number of descriptive data regarding the population and socio-economic context which will be of use to understand the local context. In particular, the Strategy provides the latest information regarding the population of Soroca as well as indicates the construction of the wastewater treatment plant as a priority to be finalised by 2025 (budget of 100 Million MDL financed with the support of international donors).

Although outdated, the **Soroca 2019-2021 Urban Revitalisation Plan** also provides information on the city's development strategy. Indeed, it targets the district "Dealul Romilor" as the priority area for urban development as well as the adjacent section of the Colegiul Agricol district (the College itself and the Street Calea Baltului).

The **General Urban Plan** was approved by decision no. 16/1 of the Soroca City Council on June 12, 2012 and, although outdated, remains the main document guiding the city's urban planning.

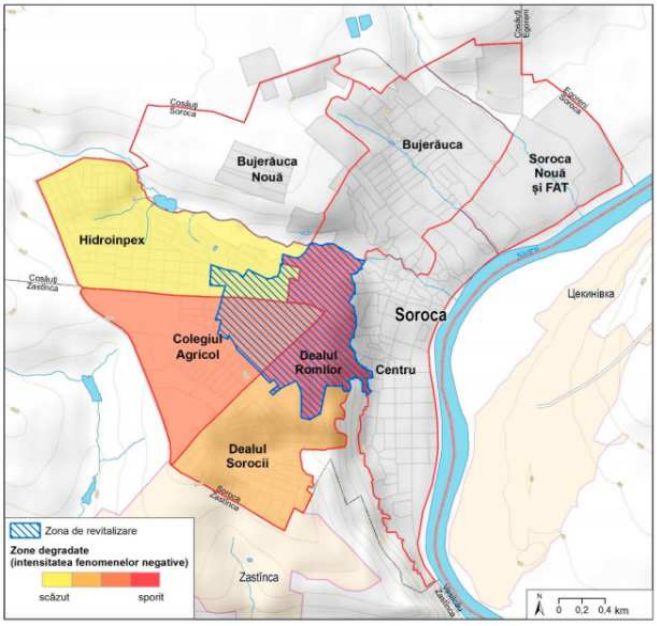


Figure 15: Soroca's priority development areas

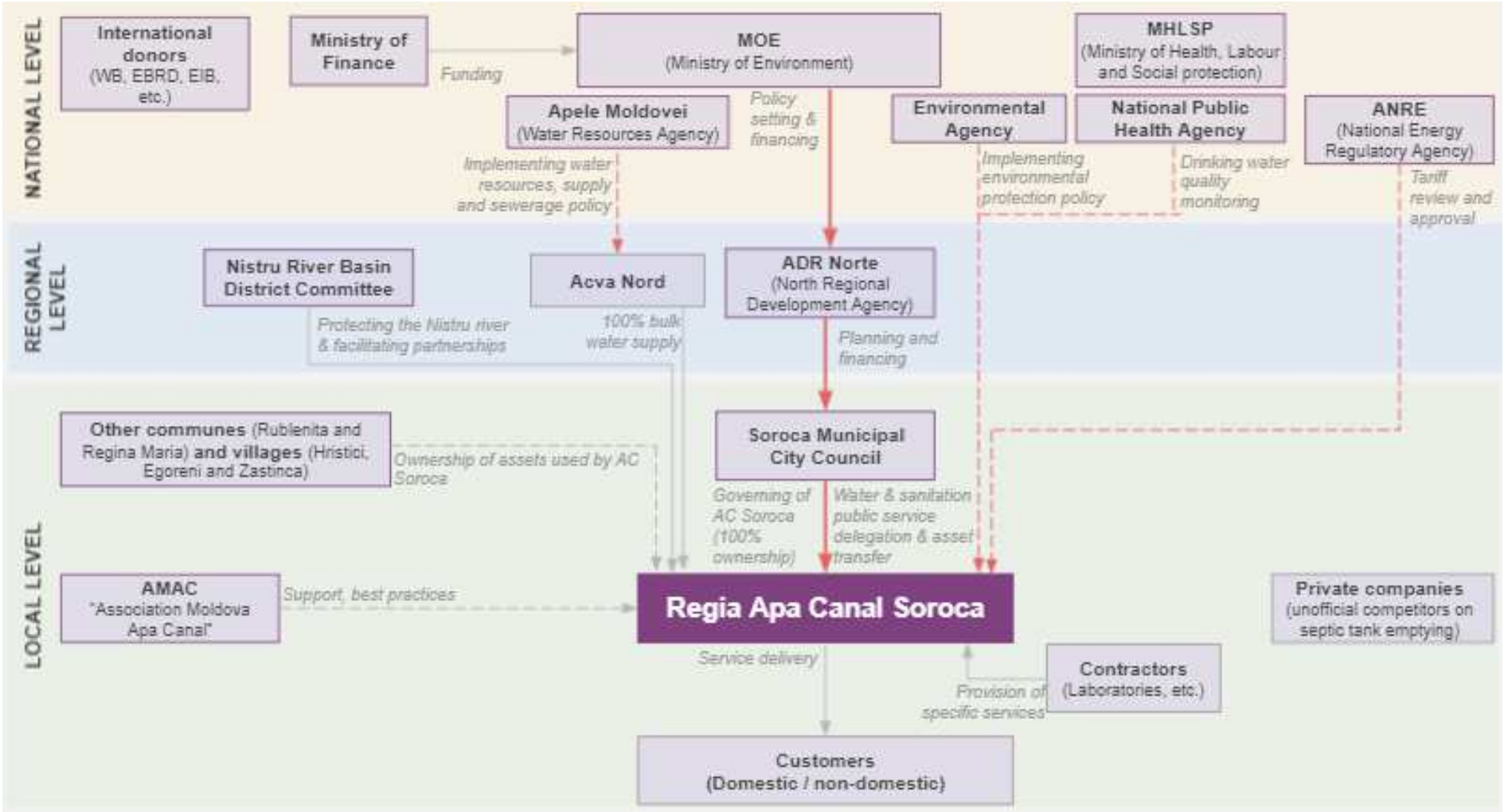
3.2. Institutional framework

3.2.1. Stakeholder mapping

In spite of a number of sectoral changes in the past years, the 2014-2030 National Water and Sanitation Strategy recognizes the necessity to address a number of institutional challenges which impact the current performance of water and sanitation services in Moldova, mainly relating to:

- ineffective sectoral policies for supervision, management and monitoring water supply and sanitation;
- fragmented, insufficiently defined responsibility and overlapping tasks among coordinating and regulatory institutions at national level but also between the national and local level;
- limited staff in the area of sectoral policy development, sector monitoring and investment programming;
- ineffective communication and coordination between existing institutions, in particular on programming and monitoring of water supply and sanitation investments;
- uncoordinated development of the water and sanitation infrastructure at local level, often driven by donor interests, without oversight or monitoring monitoring at national level;
- lack of laboratory capacity to monitor drinking water and water quality wastewater according to the national legal requirements.

The stakeholder mapping overleaf illustrates the interactions between national, regional and local stakeholders involved in the delivery of sanitation services to the population of Soroca and its neighbouring villages/communes:


NATIONAL LEVEL
REGIONAL LEVEL
LOCAL LEVEL
International donors (WB, EBRD, EIB, etc.)
Ministry of Finance
Funding
MOE (Ministry of Environment)
MHLSP (Ministry of Health, Labour and Social protection)
Apele Moldovei (Water Resources Agency)
Policy setting & financing
Environmental Agency
National Public Health Agency
ANRE (National Energy Regulatory Agency)
Implementing water resources, supply and sewerage policy
Implementing environmental protection policy
Drinking water quality monitoring
Tariff review and approval
Nistru River Basin District Committee
Acva Nord
ADR Norte (North Regional Development Agency)
Protecting the Nistru river & facilitating partnerships
100% bulk water supply
Planning and financing
Other communes (Rublenita and Regina Maria) and villages (Hristici, Egoreni and Zastinca)
Ownership of assets used by AC Soroca
Soroca Municipal City Council
Governing of AC Soroca (100% ownership)
Water & sanitation public service delegation & asset transfer
AMAC "Association Moldova Apa Canal"
Support, best practices
Regia Apa Canal Soroca
Private companies (unofficial competitors on septic tank emptying)
Service delivery
Contractors (Laboratories, etc.)
Provision of specific services
Customers (Domestic / non-domestic)

3.2.2. Focus on key stakeholders related to the provision of sanitation services in Soroca

Ministry of Environment (MOE) - Project Owner

(previously Ministry of Agriculture, Regional Development and Environment (MARDE))

Guvernul Republicii Moldova
Ministerul Agriculturii, Dezvoltării Regionale și Mediului

The Ministry of Environment (MoE) is the central specialized body of public administration that develops and promotes state policy in the field of environment, responsibilities stipulated in Law 136/2017 on the Government and Law 98/2012 on central specialized public administration.

Through the Government Work Program (Parliament Decision 88/2021), the Ministry of Environment was established as a separate institution following the reorganization of MARDE. The Ministry of Environment operates according to the Regulation of organization and functioning approved by GD 145/2021. The Authority develops and promotes state policy in the field of:

- environmental protection;
- climate change;
- sustainable management of Natural Resources, water resources, water supply and sanitation.

Soroca Municipal Council

Primaria Municipiului
SOROCA

The statute of Soroca municipality was approved by Decision of the Soroca Municipal Council 10/1 of 31.03.2021. In accordance with Law No. 436/2006 on administrative decentralization, Law No. 435/2006 on local public administration and Law No. 1402/2002 on municipal public services, the Soroca Municipality is responsible for the provision of public water supply and sewerage services, according to the standards set by the legislation in force.

As such, Soroca local public authority has the exclusive responsibility for the establishment, organisation, coordination and control of the operation of public municipal utilities, and the **development, management and operation of publicly-owned infrastructure assets** within their respective administrative-territorial units.

In particular, the rainwater drainage management is under the responsibility of Soroca Municipality. This system is poorly developed in the city, which creates problems in the sanitation sewerage system.

Local Public Authorities Leadership in planning and implementing

In accordance with the National 2014-2030 Water and Sanitation Strategy and in order to ensure the functioning of public water supply and sanitation systems within the established parameters and in order to create optimal conditions for sustainable and quality service provision, local public authorities shall draw up plans on investment objectives, based on multiannual investment planning, in accordance with the stages of the budgetary process and in accordance with the legislation in force.

In the specific context of Soroca, financial constraints and the absence of internal capacity have strongly impacted the utility's ability to plan for its infrastructure development.

SA "Regia Apa Canal Soroca"

SA "Regia Apa Canal Soroca" was registered at the State Registration Chamber on 03.04.2012 as a commercial Joint Stock Company fully owned by the Soroca City Council (with a share capital in the amount of 39 028 000 MDL) and given the mandate to provide water and sanitation services over its perimeter.

The founder of SA "Regia Apâ-Canal Soroca" according to the Declaration of Establishment No 13/1 of 20 May 2012, is the Soroca City Council, via the transformation of the Municipal Soroca Water and Sewerage Department into a commercial company "Regia Apa-Canal Soroca" Joint Stock Company. As such, SA "Regia Apa Canal Soroca" management and control bodies are the following:

- General Meeting of Shareholders;
- The company's board of directors;
- Executive Body - Director;
- Censors committee.

Republica Moldova

Agenția Națională pentru Reglementare în Energetică

LICENȚĂ

Seria AC Nr. 000559

Denumirea, forma juridică de organizare, adresa juridică a titularului de licență: Societatea pe Acțiuni „Regia Apă-Canal Soroca" MD-3001, or. Soroca, str. Uzinelor, 9, Republica Moldova

Data și numărul Certificatului/Deciziei de înregistrare de stat a titularului de licență: 03 aprilie 2012, nr. 1003607000120

Numărul de identificare de stat/codul fiscal: 1003607000120

Genul de activitate, integral sau parțial, pentru a cărui desfășurare se eliberează licența: Furnizarea serviciului public de alimentare cu apă și de canalizare la nivel de oraș și furnizarea serviciului public de alimentare cu apă la nivel de sat

Anexa nr.1 și nr.2

Data eliberării licenței: 22 decembrie 2015

Valabilă pînă la: 22 decembrie 2040

Conducătorul autorității de licențiere: Sergiu CIOBANU

Figure 16: SA Regia Apa Canal Soroca ongoing 25-years operating license

The regional water supply and sewerage service delegation contract was signed in 2013 for 25 years for the following locations:

- Soroca city,
- Zastinca,
- Egoreni,
- Hristici,
- Rublenita,
- Regina Maria.

The addition of Bulboci to the service area served by SA “Regia Apa Canal Soroca” is ongoing and its finalization is among the utility’s 2021 priorities.

While Apa Canal currently supplies water to all the above-listed locations and with various coverage rates, wastewater services are today solely centered on a part of Soroca City.
It must be noted that although the Utility has received assets (network and equipment) from various Local Public Authorities, the latter do not have a voice in the management of these assets as the only shareholder is the Soroca City Council.

Although SA “Regia Apa Canal Soroca” has the monopoly for water and sanitation services over its perimeter, a number of private individuals equipped with vacuum trucks (5 or 6 trucks in Soroca) illegally perform the emptying of septic tanks. Although they are not licensed and hence not officially authorised to perform these services, their prices are low generating unlawful competition for the utility. Moreover, the impossibility to control their discharge points is posing a strong threat to the preservation of the environment and the achievement of the objectives of this project.

Apele Moldovei Agency

The "Apele Moldovei" Agency is the administrative authority for water and land management under the Ministry of Agriculture, Regional Development and Environment, operating on the basis of the Regulation approved by GD no. 882/2014. The Agency's mission is to implement the state policy in the field of water management and hydro-remediation, water supply and sewerage. In order to achieve its mission, the Agency has the following basic functions:

- participating in the development and implementation of water resources management plans according to the river basin principle;
- ensuring protection of the population and agricultural land against floods;

- maintaining the State Water Cadastre;
- ensuring the operation and maintenance of the state-owned hydro-improvement, water supply and sewerage systems, flood protection dams through state-owned enterprises in which the Agency exercises the status of a founder;
- coordinating activities on training, further training and evaluation of professional performance of staff in its fields of activity.

Environmental Agency

The Environment Agency is an administrative authority under the Ministry of Environment (MM).

Ministerul Agriculturii, Dezvoltării Regionale și Mediului
Agenția de Mediu

The Agency operates on the basis of the Regulation on the organization and functioning of the Environment Agency, approved by GD no. 549/2018 with the mission to ensure the implementation of the environmental protection policy, achieving the best ratio between the expected results and the budget allocations approved by the annual budget law. Some of the basic functions of the Agency are:

1. regulating and authorizing activities with an impact on the quality of the environment, issuing individuals and legal entities with permits for the practice of entrepreneurial activities with an impact on the environment (authorizations, environmental agreements, permits, certificates, notifications, opinions and coordination), provided for in the permits nomenclature, approved by Law No 160 of 22 July 2011 on the regulation by authorization of entrepreneurial activity;

2. monitoring the quality of environmental factors (monitoring the quality of water, air, soil, forestry and state protected natural areas, monitoring the state and use of water and soil resources, monitoring the plant and animal kingdom, monitoring fisheries, monitoring the state of the subsoil, monitoring air pollution, geological monitoring, monitoring environmental pollution) in order to provide individuals and legal entities with information on the quality of the environment, to develop the system of statistical indicators in the field of environmental protection, as well as to prepare and publish the National Report on the State of the Environment in the Republic of Moldova.

The main tasks of the Environmental Agency in the field of protection and regulation of water resources are to:

- participate in the implementation of national legislation on the quality and protection of surface and ground water resources, submits proposals for amendments and additions to this legislation;
- participate in the process of gradual harmonisation of national legislation with Community environmental legislation in the field of water quality;
- participate in the implementation of the provisions of policy documents and international environmental treaties to which the Republic of Moldova is party in the field of water quality and protection;
- establish limit values for pollutant emissions into surface waters according to the existing degree of pollution, as well as their measurement methods;
- issue, suspend, withdraw or extend the validity of the environmental permit for special water use to natural and legal persons;

- establish and ensure the functioning of the monitoring system of surface and ground water quality;
- ensure the functioning of the water quality laboratory and carry out measurements, analyses and ecological investigations of surface and groundwater;
- provide technical support to the Ministry in the development of monitoring programmes for the status and use of surface water and groundwater and ensures their implementation;
- manage the state water resources and information systems within the scope of the competence established by law.

The Environmental Agency is supported by the **Inspectorate for Environmental Protection** (also subordinated to MM) which mission is to implement the state policy in the field of environmental protection and rational use of natural resources, exercise state control and supervision, prevent and counteract violations in the areas of competence, to ensure a high level of supervision and protection of the environment, public interests, ecological safety of the state and other values protected by legislation

ANRE - National Sector Regulator

In December 2013, the Parliament adopted the Law on Public Service of Water Supply and Sewerage, which enables ANRE to regulate the public service of water supply and sewerage. In 2014-2015, ANRE elaborated and approved a series of regulatory acts stipulated by the Law on water supply and sewerage public service. Shortly after, the Agency started to issue licenses for operators using the public water supply and sewerage systems.

The agency is also responsible for endorsing tariffs for services provided at city/municipality, regional level. To this end, ANRE approves the methodology for determining, approving and applying tariffs for public water supply, sewerage and wastewater treatment services.

Nistru River Basin District Committee

The Nistru River Basin District Committee is a coordinating and advisory structure, independent in the exercise of its functions, which has the competence to participate in the activities of efficient water resources management within the boundaries of the respective river basin district.

САЙТ ДНЕСТРОВСКОЙ КОМИССИИ
СОХРАНИМ ДНЕСТР ВМЕСТЕ

The purpose of the Committee is to ensure effective collaboration between the central and territorial public water management and protection authorities and local public administration authorities, water users in the respective river basin district, beneficiaries of water management services, representatives of scientific research institutions, civil society organisations on water resources management, use and protection issues within the respective river basin district.

In order to achieve the purpose of its activity, the Committee shall exercise the powers assigned to it by GD no. 867/2013, and hence: consults the competent authority in the field of environmental impact assessment, the competent authority for issuing environmental permits on planned large-scale infrastructure objects that use water resources or have an impact on water resources; participates in the process of making management decisions on water use, quantity and quality, land use, protection and improvement of aquatic and forest ecosystems at the river basin level; facilitates the improvement

of the level of water partnership in integrated water resources planning and management, ensures the exchange of information between state authorities, water users and civil society, etc.

Ministry of Health (MH)

The Ministry of Health controls the quality of drinking water, monitors compliance with the quality level, evaluates water quality from various sources, develops and adopts health policies. Under the authority of the Ministry of Health, the National Agency for Public Health and its territorial units - Soroca Public Health Center - monitors the quality of water supplied as well as the quality of receiving natural water bodies.

3.3. Planning and development of wastewater infrastructure development in Soroca

The improvement of sanitation and wastewater management in Soroca has been a subject of discussion between stakeholders for a number of years now and international donor partners have financed a number of studies to support discussions with stakeholders over the past 15 years. In general and as detailed below, the development of sanitation infrastructure has mainly been supported by the World Bank and EBRD/EIB in the past 15 years.

Figure 17: History of sanitation infrastructure development in Soroca in the last 15 years

It must be highlighted that the development of sanitation infrastructure in Soroca is entirely dependent on the financial support of international donor partners as neither the Soroca Municipality nor SA “Regia Apa Canal Soroca” itself have the financial capacity to finance such investments.

4. Assessment of Sanitation System

4.1. Overview of the Sewerage System in Soroca City

4.1.1. Main Wastewater catchments and Outlets

The initial network was designed to route the wastewater by gravity to the Central Pumping Station (CPS) to send the wastewater through the Nistru river with an underwater pipe to a Wastewater Treatment Plant situated in Tsekinovka on the Ukrainian side.

The former WWTP, built in 1980, has not operated for more than 20 years. It was abandoned in the nineties, when the pipeline which crossed the Nistru and connected the Central Pumping Station to the WWTP broke down.

The wastewater network is divided into **4 main catchments**, connected to the CPS. Two other pumping stations were located respectively on the northside (North Pumping Station) and on the southside of the city (South Pumping Station) with small catchment areas to pump the wastewater to the main network.

The current wastewater network is shown in the following map (enclosed in Annex).

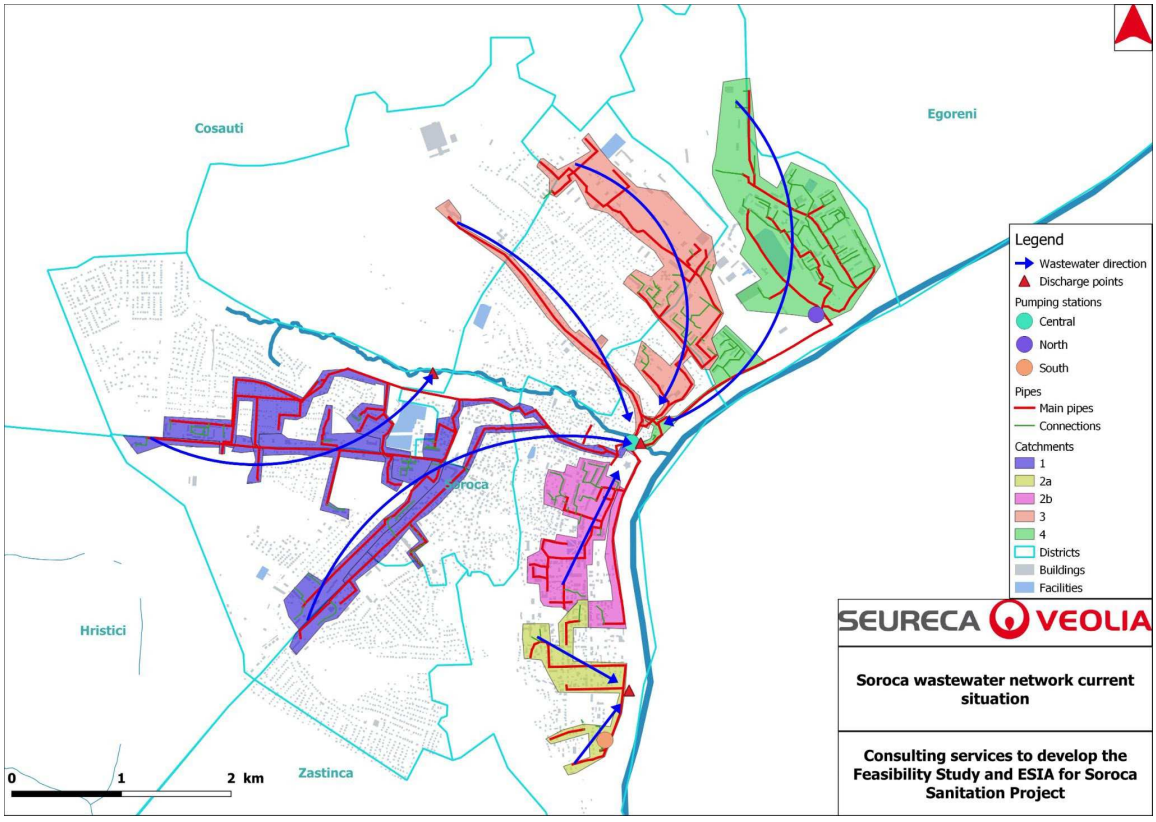


Figure 18 : Soroca wastewater network current situation

Since the breakage of the connection pipe to the WWTP, the pumping stations were no longer operated, and no maintenance was done to the electromechanical equipment. Therefore, all existing equipment is in critical condition.

Figure 19: Central Pumping Station

Figure 20: South Pumping Station

Figure 21: North Pumping Station

Raw wastewater is currently discharged to the Nistru river by two main outlets:

- The first one is close to the Central Pumping Station and discharges most of the city's wastewater volume (part of catchment 1 and catchments 2b, 3 and 4). This outlet is close to the Soroca Fortress (Cetatea Soroca), which is the main tourist sightseeing spot of the city;
- The second outlet is not far from the South Pumping Station, discharging only the catchment area 2a. As the SPS is out of order, a hole has been made in the upstream pipe, so that the wastewater can flow into the river.

Also, a third “unplanned” outlet exists on the heights of the city, where a breakage of the sewerage contributes to discharging raw wastewater from part of the catchment area 1 into a small water stream that crosses the city before reaching the Nistru river.

Figure 22: Wastewater network outlets to the Nistru river

Figure 23: Main wastewater outlet to the Nistru river (next to Soroca Fortress)

Figure 24: Second wastewater outlet to the Nistru river (next to SPS)

4.1.2. Sewerage network characteristics

Soroca's existing central sewerage network is a separate system which consists of **58,7 km** of gravity pipes. It principally covers the lower part of the Soroca municipality, with multi-storey houses and most of the state institutions, which constitutes about 50% of the municipality's territory and about 42 % of the actual Soroca's population (refer to Section 5).

Based on the data collected during the topographical survey performed during the project, the network is composed of:

- 1940 manholes
- Pipelines

Type	Length (m)
Main	11 398,62
Secondary	42 490,84
Tertiary	4 958,34
Total	**58 847,8**

Most of the network is made of asbestos, ceramic and reinforced concrete. The last network extensions have been made in PVC (1.8 km of sewer network connecting 20 households - EBRD Project 2011-2014).

The breakdowns of the type of materials and diameters present in the network are the following:

- Almost half of the network is equal or larger than DN300;
- Asbestos and ceramic are the principal materials (77 % of the network).

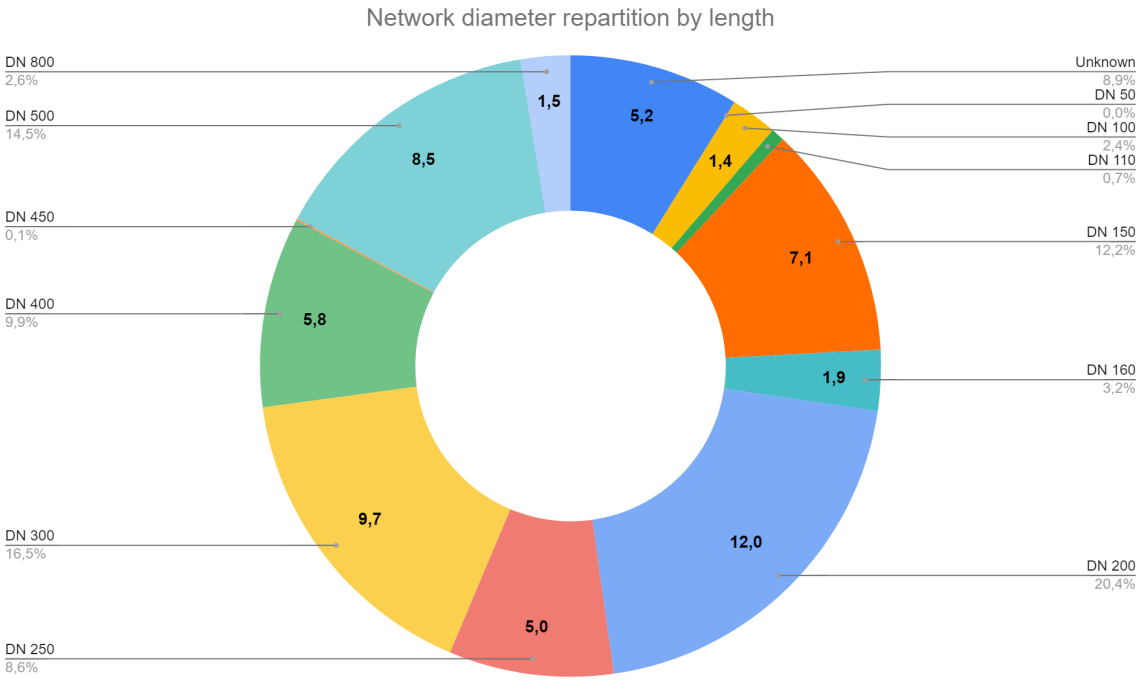


Figure 25: Sewer network diameters breakdown

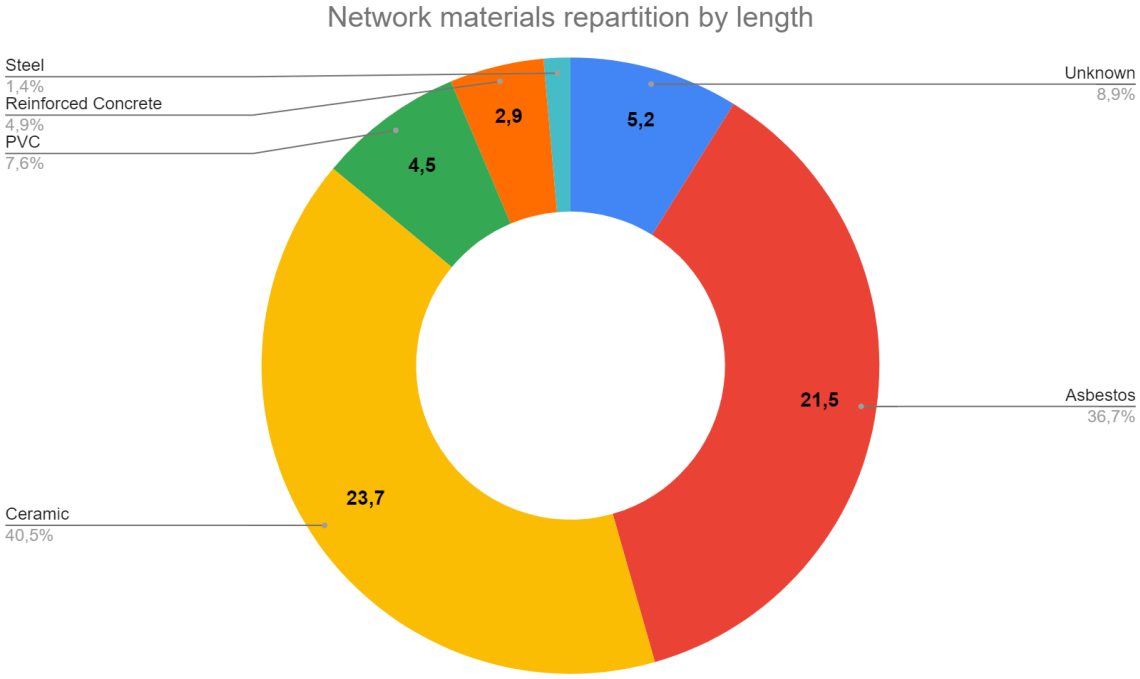


Figure 26: Sewer network materials breakdown

4.1.3. Diagnostic of the Existing Network Capacity

The existing sewerage network diameters are quite oversized compared to the number of wastewater connexions and to the type of sanitation system, which is supposed to be a separate system (only designed for wastewater, no stormwater).

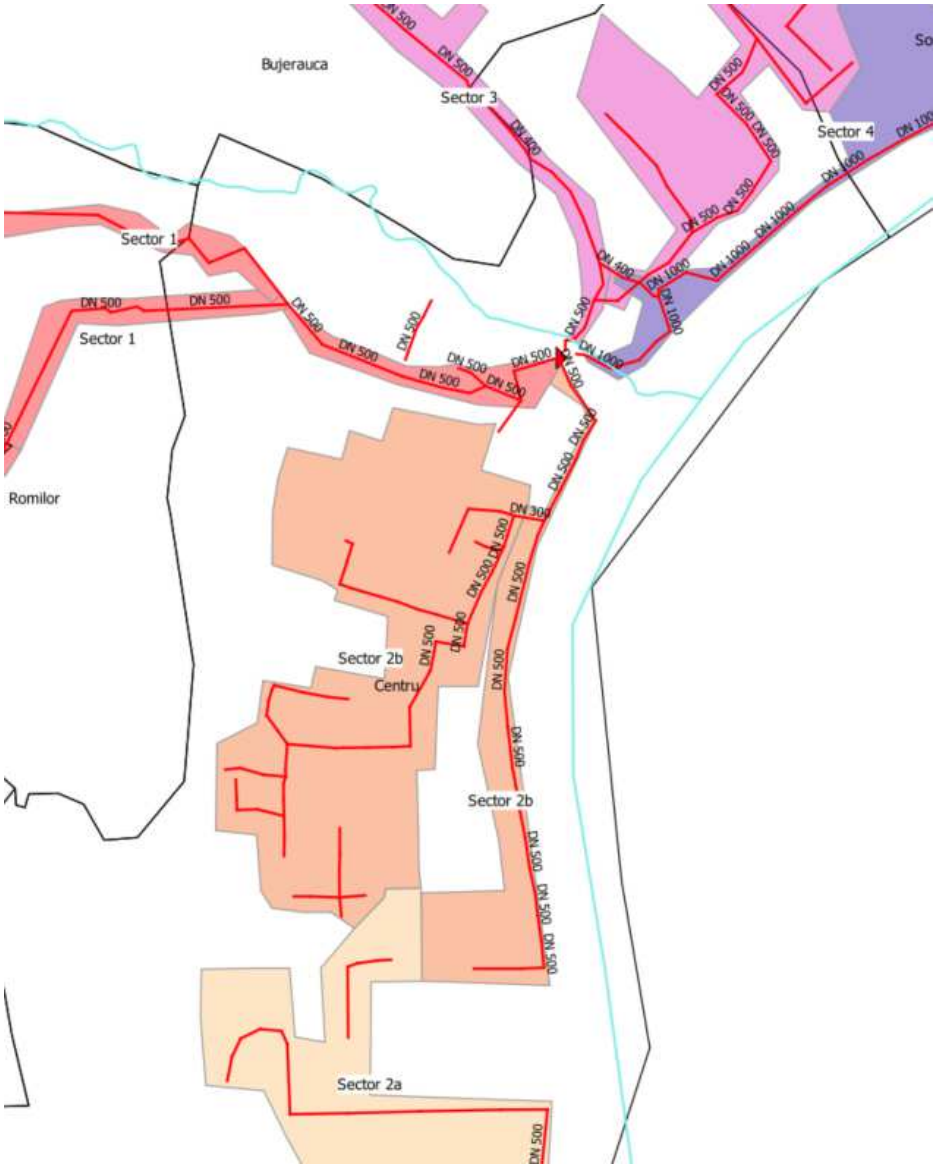


Figure 27 Main networks upstream from the pumping stations

The current wastewater balance has been done on each main wastewater sector, including:

- A wastewater generation per capita at horizon 2065 of 104 lpdc
- Non-domestic wastewater generation
- The estimated ratio of clear water infiltration in the sewer network
- Wastewater peak factor

Considering the low connection rate and the number of inhabitants, the existing sewage network is largely oversized. The current diameters upstream from the old pumping stations are between 500 and 1000 mm. The needed capacity according to the wastewater flow is between 200 and 250 mm.

According to the sewer network residual capacity, the entire city could therefore be connected to the network.

Currently, considering the stormwater connections to the sewer network, it happens that the network overflows in some parts of the city, but this is due to the lack of maintenance (blockages, non functional pumping stations) and investment in the existing networks (both stormwater and sanitary).

	Sector 1	Sector 2a	Sector 2b	Sector 3	Sector 4
Domestic average flow (m3/h)	22,0	4,4	10,8	21,3	32,5
Non domestic average flow (m3/h)	5,8	0,7	4,9	2,1	5,4
Daily average flow (m3/h), including infiltration	27,8	5,1	15,7	23,4	37,9
Dry weather peak flow (m3/h)	54,2	9,9	30,7	45,6	74,0
Rain flow to be treated (m3/h)	18,0	3,6	7,2	5,4	1,8
Max. flow (m3/h)	**72,2**	**13,5**	**37,9**	**51,0**	**75,8**
Minimum diameter needed (mm)	**DN 250**	**DN 160**	**DN 200**	**DN 200**	**DN 250**
Equivalent capacity (m3/h)	119	34	66	66	119
Actual diameter (mm)	**DN 500**	**DN 500**	**DN 500**	**DN 500**	**DN 1000**
Network capacity (m3/h)	779	779	779	779	5300
Residual capacity (m3/h)	**706,8**	**765,5**	**741,1**	**728,0**	**5224,2**
Population per household - 2.5					
Future Lpcd (l/pers/day) - 104					
Peak factor 1.95					
Residual connexions capacity (u)	33414	36187	35036	34414	246969

Figure 28: Current wastewater capacity of the sewer network

4.1.4. Current Condition of the Network and Main O&M Issues

The sewerage network in Soroca has not been developed significantly in recent years and it has not been maintained, it is currently in a deplorable state. In 2019, 313 failures were registered in the sewerage network in Soroca, which indicates a high degree of wear.

Some critical dysfunctional points (black spots) have been identified in the sewerage network:

- There is a **main break of the network** located in the “Dealul Romilor” sector (Gipsy hill). A part of this network is located in the forest and in private plots, and it is not possible to control it and ensure the maintenance. Part of the collected wastewater leaks from the network and goes directly into the soil and the small water stream nearby.
- **Upstream pipe from the CPS in sector “Centru”** along the river: Since the CPS is out of order, the 500 mm pipe is constantly filled up to the manholes. It causes wastewater stagnation in the pipe and makes the maintenance impossible (no access to the pipe).

Figure 29: Manhole completely filled up by wastewater next to the river

- **Rainwater connections to the sewer network:** The separate sewer network is not perfect, and there are many rainwater connections to the sewer network. For example, in the Gipsy Hill, wastewater overflows can be observed on the street several times a year, according to SA “Regia Apa Canal” staff, due to the entrance of stormwater into the network.

- **Lack of stormwater system**[9] in certain areas of the city: In some flat areas of Soroca, where the stormwater network does not exist or is dysfunctional, for example in the sector “Centru”, there are flooding episodes during rainy periods. It regularly happens that the manholes of the sewage system are opened in order to evacuate the stormwater. This practice cannot be recommended because both systems (sewage and stormwater) have to stay seperate, above all, when the WWTP will be in operation. The municipality, which is in charge of the maintenance of the roads and of the stormwater collection system, needs to invest in the stormwater system and improve it to reduce flooding.

[9] The diagnosis of the stormwater network does not make part of this study.

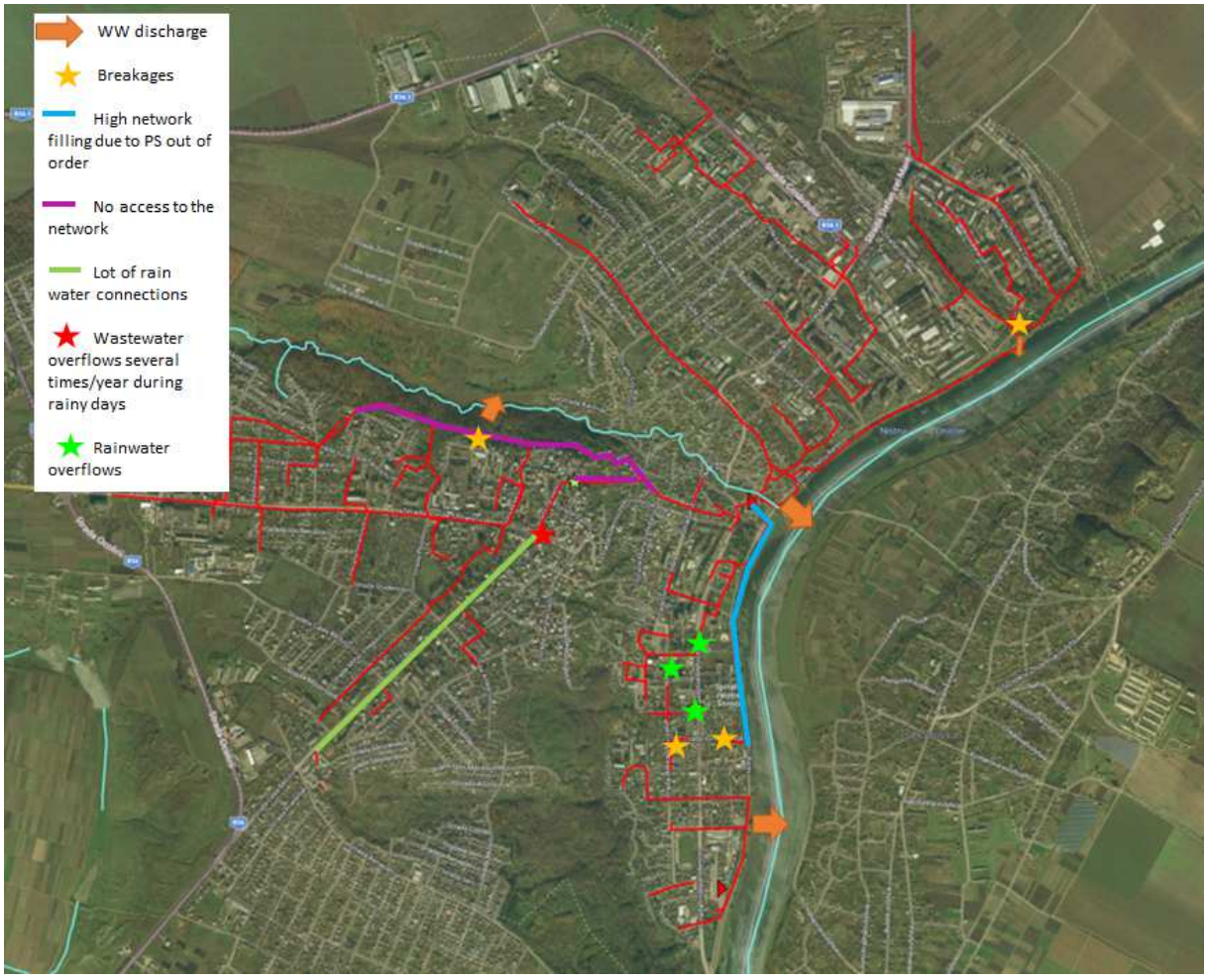


Figure 30: Identified black spots on the sewerage system

4.2. Geographical Information System

4.2.1. Digitalization of the sewerage network

In the frame of this Feasibility Study, a digital GIS database of the sewerage network of Soroca has been prepared. A Geographical Information System (GIS) is a cartographic tool that stores, analyzes, manages and presents data that is linked to a location. Each graphic element is associated with its characteristics, e.g. a pipe can be associated with its age, dimensions, and material. A GIS is the perfect tool for water utilities for asset management. It allows users:

1. To centralise and store information on the assets of the water and wastewater networks;
2. To provide a complete knowledge of the network facilities (analyse spatial information, edit data and maps, etc.);
3. To permit work planning for the maintenance of the assets.

All the available data has been collected and implemented in the GIS database for Soroca, such as:

- The digital MapInfo GIS from SA “Regia Apa Canal Soroca”: the water and sewerage networks of Soroca had been located with MapInfo (a GIS software product) but it is not geo-referenced and has no attributes (there is no information on dimensions of pipes, materials, age, etc.). It is estimated that the degree of reliability of this data is 60%;
- The water and wastewater customers of SA “Regia Apa Canal Soroca” database: most of the customers have been located in the GIS thanks to the information available in the customers’ database, which includes their addresses;
- The pdf plans of water networks from Soroca, Rublenita and Egoreni;
- The general topography and the main waterways of the study area.

All these items have been exported and georeferenced in the moldovan system (MOLDREF99 ; EPSG 4026) in QGIS.

QGIS is one of the most common open source GIS softwares. It is an official project of the Open Source Geospatial Foundation (OSGeo) and supports numerous vector, raster, and database formats and functionalities. SA “Regia Apa Canal Soroca” is currently being trained on this software in the frame of another project.

The GIS database will be handed over to SA “Regia Apa Canal Soroca” at the end of the project. It will be useful to improve the knowledge of the network, to have a better understanding of the assets (breakdown of assets per material, diameter, condition, etc.) and for modeling the system. In the mid-term, it will allow SA “Regia Apa Canal Soroca” to investigate areas, identify critical points and prepare pluri-annual replacement plans for the sewerage network.

Figure 31: Soroca drinking water network and customers

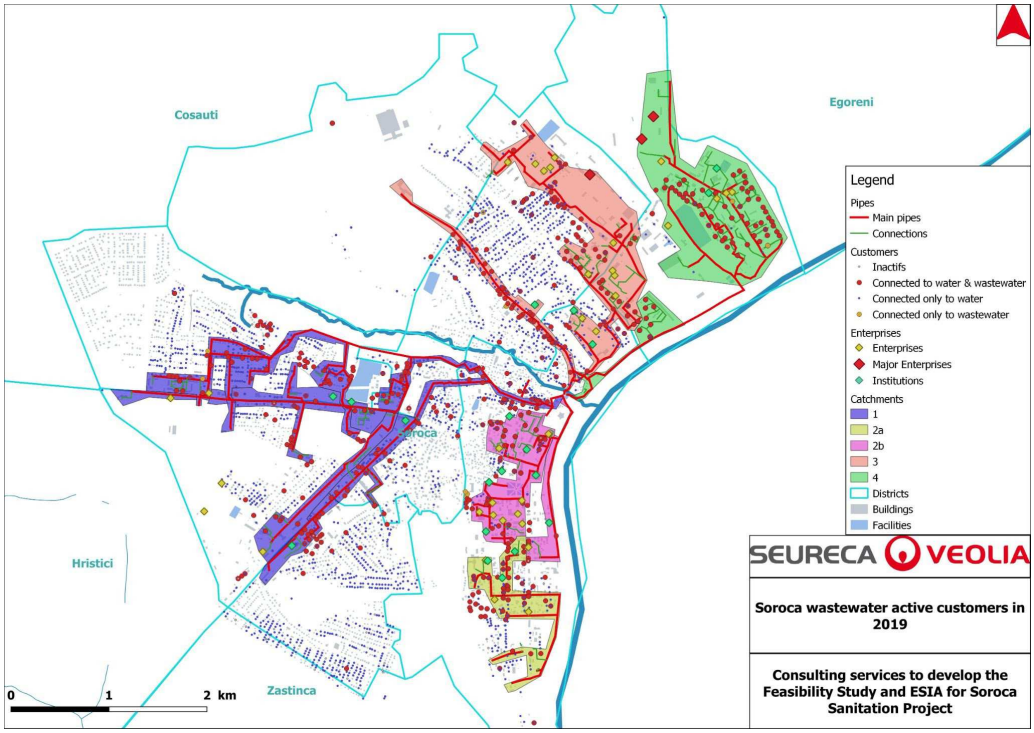


Figure 32: Soroca wastewater active customers in 2019

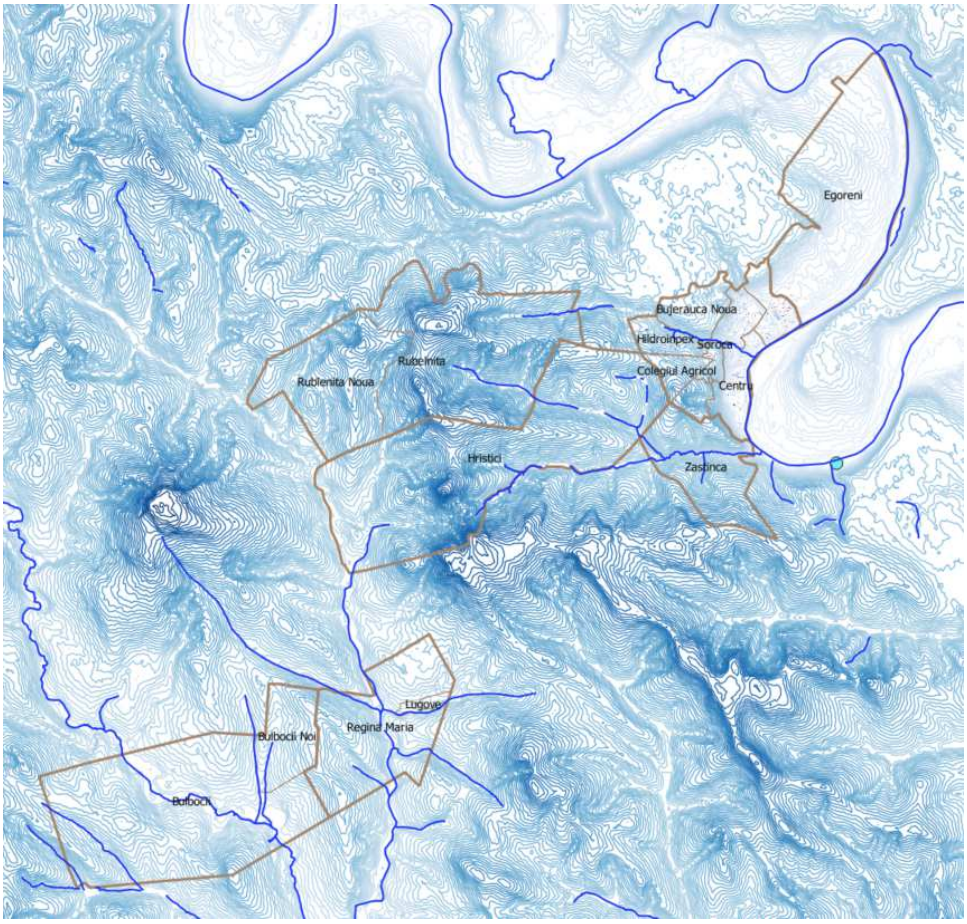


Figure 33: Topography and waterways of the study area

4.2.2. Topographical Survey

The topographical survey of the whole sewerage network will correct and complete the GIS database. The following information has been collected:

Manholes	Pipes
ID	ID
X, Y, Z	Diameter (mm)
Depth	Form
Invert level	Length
Wastewater height	Invert level upstream and manhole's ID
Deposits	Invert level downstream and manhole's ID
Material	Material
Picture	

4.3. Wastewater Flow Measurement Campaign

The wastewater measurement campaign has been conducted for one week from the 7th of June till the 15th of June in one strategic point of the sewerage network.

The wastewater flow measurement aims to:

- Assess the volume of wastewater arriving at one specific point;
- Define the daily profile of the wastewater discharge in the network (peak coefficient);
- Estimate the volume of additional clear water (intrusive water) under dry weather conditions;
- Gather data for the calibration of the hydraulic model.

The wastewater **flow measuring point** was selected after the review of the network structure and its hydraulic basins (catchment areas) and sub-basins in order to have a relevant and representative flow measurement. The exact manhole was validated after an on-site visit, considering the conditions for access, security, state of the pipe (not too much deposit) and hydraulic conditions (no angle, no vortex).

The flow monitoring point was located downstream of the **catchment area number 1** as shown below.

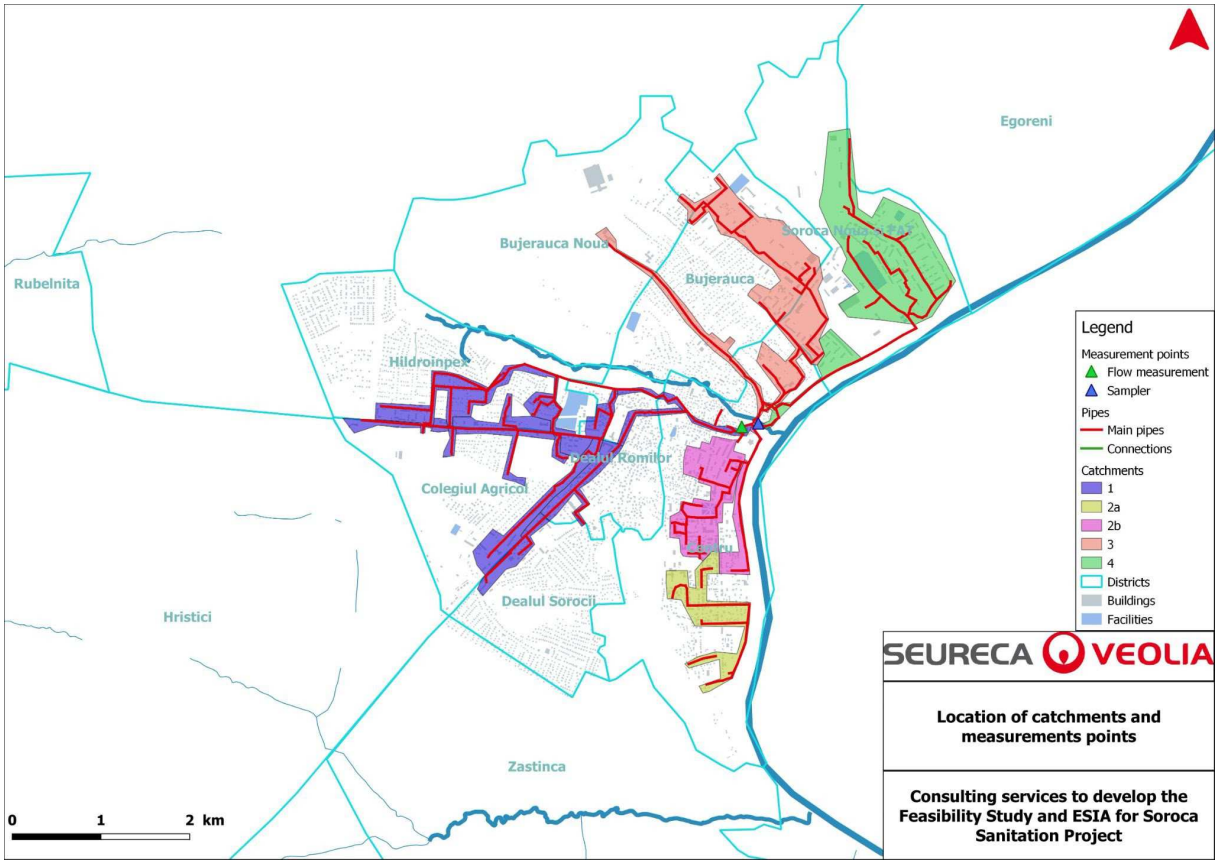


Figure 34: General overview of catchments and measurements points

Manhole Location: X = 48°09'44.278' ; Y = 28°18'15.493" (in WGS-84 UTM)

Figure 35: Location flowmeter for measurement campaign

Wastewater flow in the sewer pipe has been obtained by recording the fluctuation of two parameters:

- Water level: with a piezometric sensor;
- Velocity: with an ultrasonic sensor (Doppler).

Those are called **level-speed measurements**. The level and speed have been measured in parallel and sent to a data logger with a recording time step of 30 seconds.

The description of the measurement point is found in Annex.

Weather data has been collected from the Weather Data Platform (an IBM Business) which provides historical weather data precipitation rates worldwide and from the meteorological station of Cosauti, near Soroca, managed by the State Hydrometeorological Service.

The results from the measurement campaign are shown in the following figure.

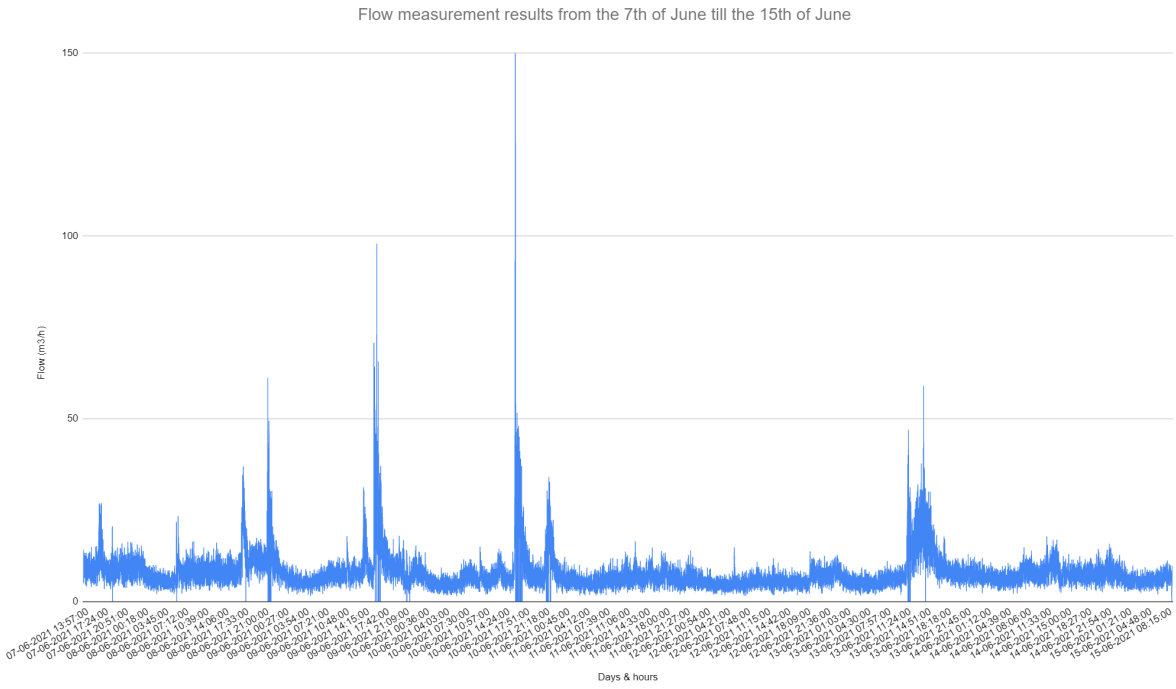


Figure 36: Flow measurements results from the 7th of June till the 15th of June

As observed in the graph, the high flow peaks are due to rainfall episodes during the campaign.

To identify and evaluate the influence of the rain on the flow measurements, the average flow is represented together with the precipitation measurements as shown below:

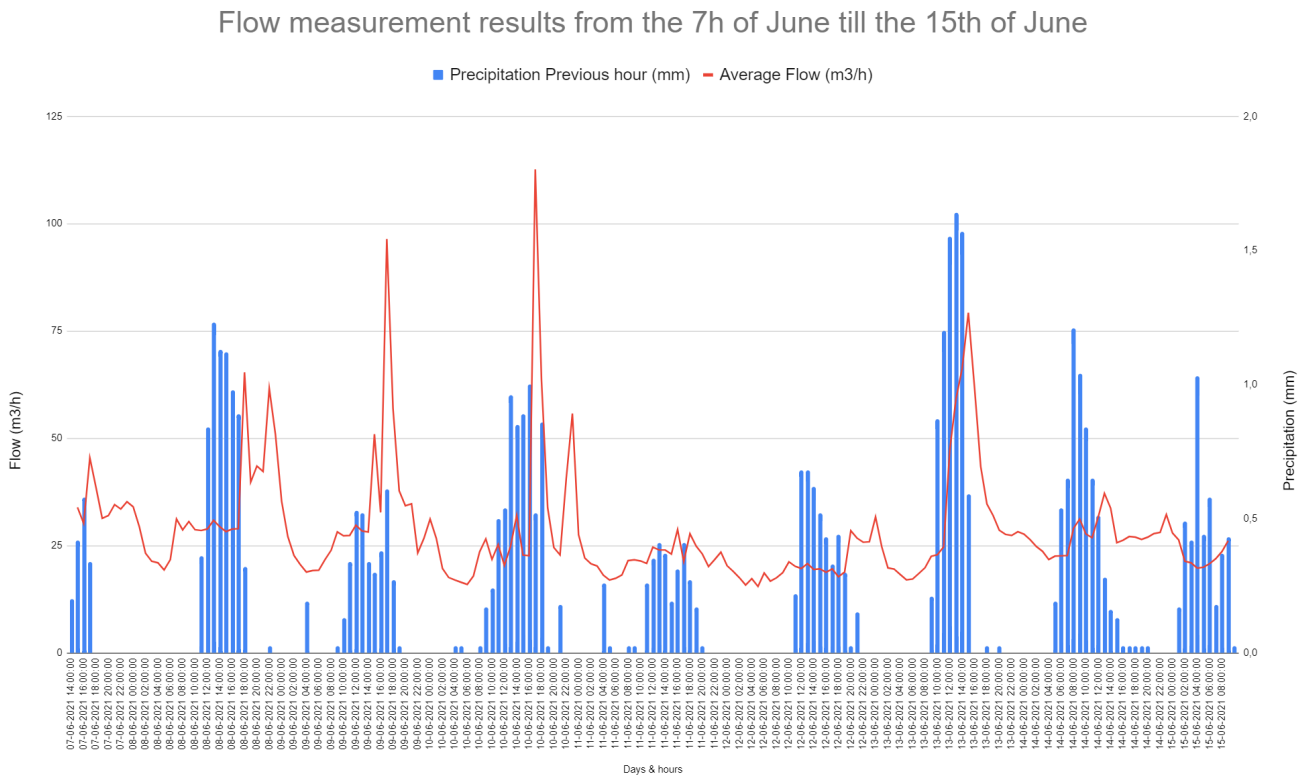


Figure 37: Average flow measurement and rainfall results from the 7th of June till the 15th of June

To assess the volume of wastewater arriving at one specific point and to estimate the volume of additional clear water (intrusive water), it is necessary to have dry weather conditions. Therefore, a dry period has been selected to calculate the intrusive water and the peak coefficient. After analysing the results, the period between the 11th and 12th June was selected (there was some rainfall, but not significantly enough to have an impact on the wastewater flow).

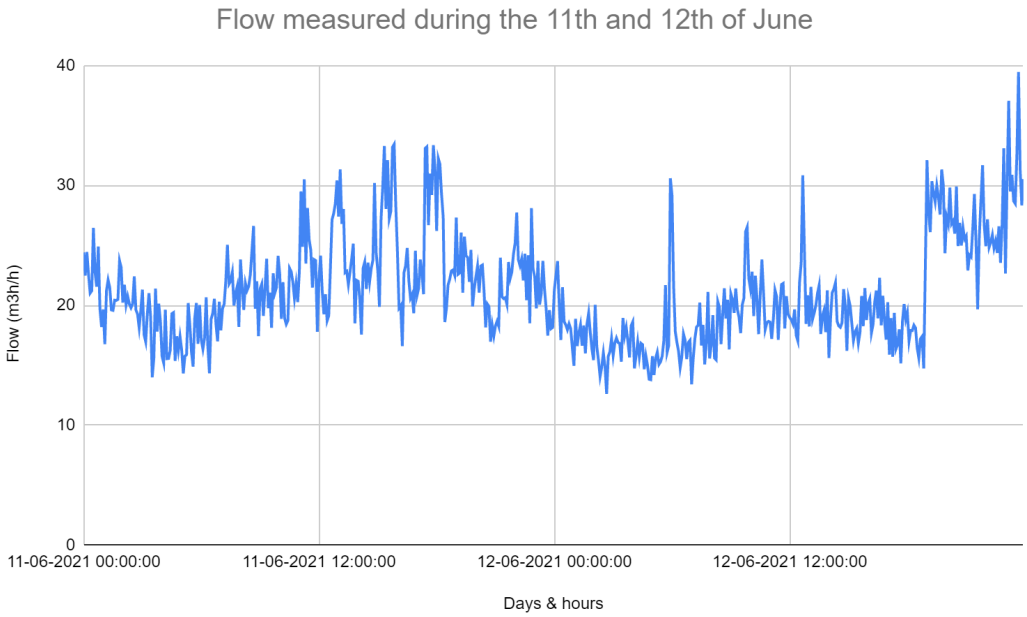


Figure 38: Flow measured during the 11th and 12th of June

The minimum night flow measured is 12,82 m^3/h at 2:40 AM on the 12th June. Usually, intrusive water represents about 80 % of the total night flow, which means that 10,30 m^3/h is intrusive water.

The average daily volume during these two days is 508 m^3 and the intrusive water calculated is then 242 m^3 which means that **the additional clear water represents around 48 % of the total wastewater flow.**

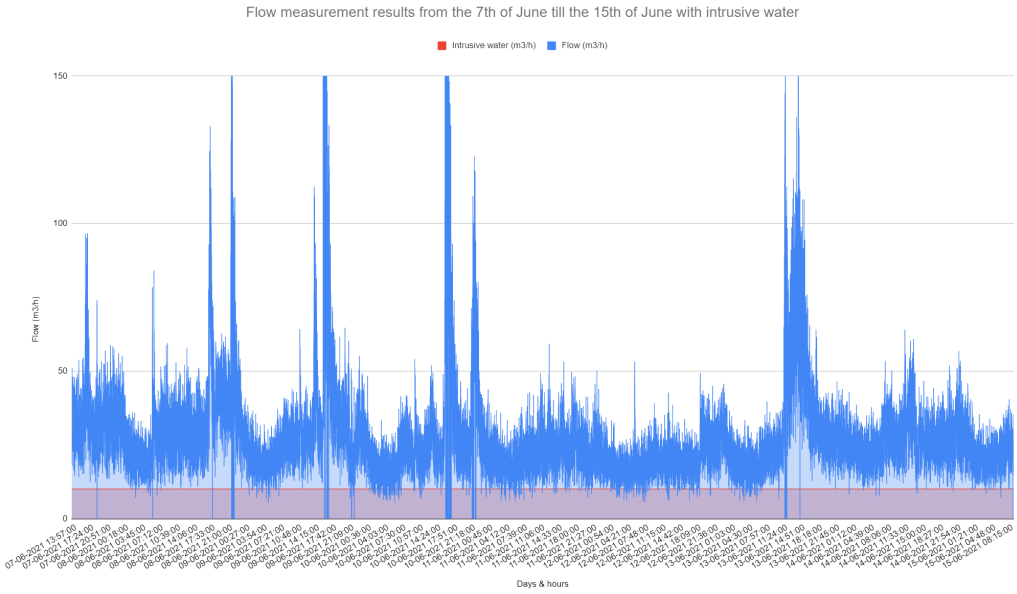


Figure 39: Flow measurement results from the 7th till the 15th of June with intrusive water

The hourly average flow for these two days has been calculated at 21,1 m^3/h (**10,8 m^3/h wastewater + 10,3 m^3/h infiltration**).

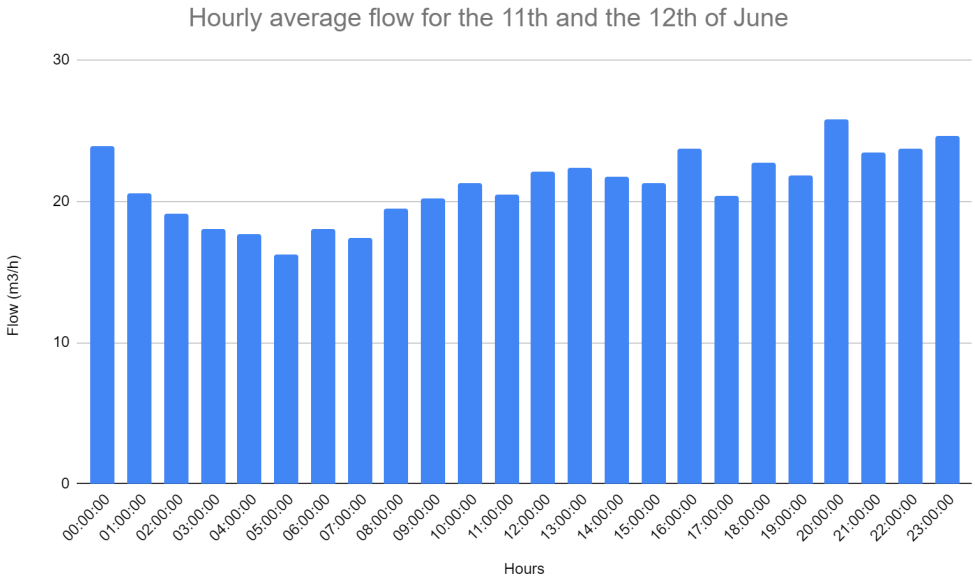


Figure 40: Hourly average flow for the 11th and the 12th of June

The daily volume of domestic and non-domestic wastewater for this catchment area nb. 1 is estimated at 299 m^3/day **(12.5 m^3/h)** with the database provided by Soroca Apa Canal and geo-referencing process of customers. This result is 16% higher than the **10,8 m^3/h** obtained from the measurement campaign without the additional clear water. This can be explained by the breakages of the network that have occurred in this sector, especially in the forest. About **1.7 m^3/h of wastewater is currently not collected and goes directly to the river or infiltrates into the soil of the Gipsy hill.**

According to the database, the repartition of industrials and domestic on this catchment is as follows:

- 5.3 m3/h industrials and publics services
- 7.2 m3/h domestics for 1156 connections

This corresponds to a lpcd of about 74 liters/day.

The results of the campaign show a high percentage of additional clear water which is coherent with the current condition of the wastewater network. This infiltration ratio will be used to estimate the current infiltration on the other catchments.

4.4. WASTEWATER QUALITY

4.4.1. WASTEWATER QUALITY MONITORING

The wastewater quality currently discharged at the two main outlets (Central Pumping Station and next to South Pumping Station) is monitored by the North Environmental Agency (Agenția de Mediu - Direcție Nord) four times a year. The sampling is performed by the same person through grab sampling (the sample is collected at one location and at one point in time).

The following table shows the yearly average values for the analysed parameters in each outlet and the Maximum Allowable Concentration (MAC) for urban discharges to water bodies (HG 950/2013). The complete reports from the last 3 years are shown in Annex.

Table 4: Annual average values for the two main wastewater outlets in Soroca

Average CPS	pH	SS	COD	BOD	NH4+	NO2-	NO3-	TDS	Cl-	Hard
2018	6,70	238,8	434,8	193,8	35,5	0,39	4,3	1527,0	355,2	10,0
2019	6,37	270,8	450,5	197,4	34,4	0,39	3,0	1544,5	322,6	9,9
2020	6,51	254,3	460,4	193,1	32,2	0,41	3,4	1365,8	283,6	9,0
2021	6,48	253,0	560,7	219,7	36,0	0,41	3,1	1366,0	276,5	9,2
Average	**6,5**	**254,2**	**476,6**	**201,0**	**34,5**	**0,40**	**3,5**	**1450,8**	**309,5**	**9,5**
Average SPS	**pH**	**SS**	**COD**	**BOD**	**NH4+**	**NO2-**	**NO3-**	**TDS**	**Cl-**	**Hard**
2018	6,92	191,3	287,3	120,2	26,5	0,33	4,7	1332,0	305,6	9,2
2019	6,57	234,3	410,6	179,0	30,6	0,35	3,8	1483,0	311,0	9,4
2020	6,60	215,0	370,4	168,7	27,0	0,34	4,0	1334,3	266,7	9,0
2021	6,70	219,0	420,5	175,8	28,4	0,38	3,9	1261,0	269,4	8,9
Average	**6,7**	**214,9**	**372,2**	**160,9**	**28,1**	**0,35**	**4,1**	**1352,6**	**288,2**	**9,1**
MAC	6,8 - 8,5	35	125	25	2			1500	300	

It can be observed that wastewater has a medium-low concentration of organic load (BOD, COD), suspended solids and ammonium whereas the salinity content (TDS, chloride) is quite high. These analyses show that collected wastewater in Soroca is very diluted, which is coherent with the high infiltration rate of groundwater through the broken network, as explained before.

The high salinity values can be due to the intrusion of saline groundwater into the system.

Discharged wastewater in the Central Pumping Station is more concentrated, around 18 - 22%, than in the South Pumping Station, which can be explained by the industrial effluent discharges which are received in the CPS.

4.4.2. Wastewater Quality Campaign

A wastewater quality survey of the sewerage network was performed during 7 consecutive days from the 7th to the 14th June. An automatic 24h composite sampler (Model Hach Lange AS 950) was installed in one manhole downstream of the catchment area number 4. This point was considered to be representative of the wastewater quality of the city - a mix of domestic and industrial wastewater. Composite time-proportional samples were collected daily, preserved and sent to the laboratory of Apa Canal Chisinau for wastewater analysis.

Manhole Location: X = 48°09'45.570"; Y = 28°18'21.669" (in WGS-84 UTM)

Figure 41: Location and picture of sampler

The following parameters have been analyzed[10]:

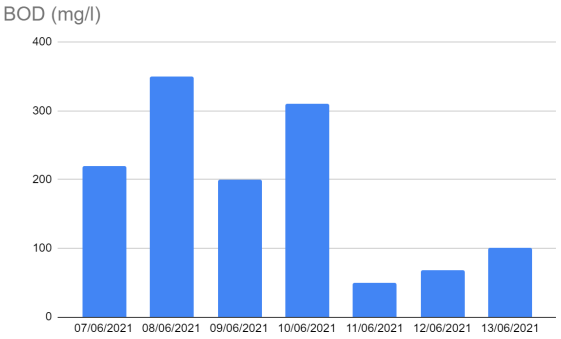
- pH ;
- Biological Oxygen Demand (BOD5);
- Chemical Oxygen Demand (COD);
- Total Suspended Solids (TSS);
- Ammonium (NH4) ;
- Total Phosphorus (TP);
- Total Dissolved Solids (TDS);
- Chlorides (Cl-)

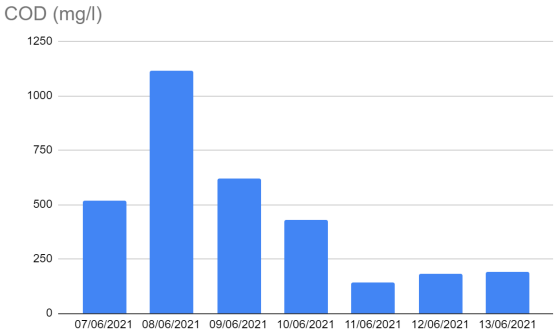
The wastewater temperature, registered with the sensor installed in the flowmeter, varied between 14,5 and 20,5 °C. The results of the campaign are shown below.

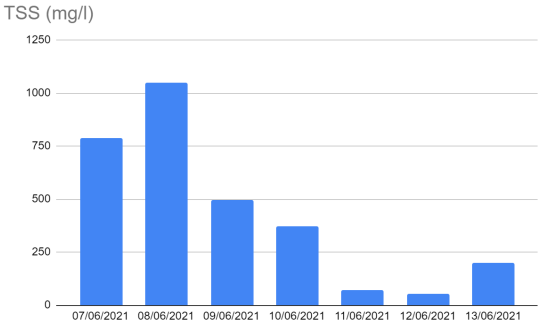
[10] The original list in the TdR also included conductivity, alkalinity, Volatile Suspended Solids (VSS) and Total Nitrogen (TN). Conductivity was replaced by Total Dissolved Solids (TDS) and Chlorides (Cl-) because there were historical results available for these parameters. The other three parameters could not be performed by the laboratory.

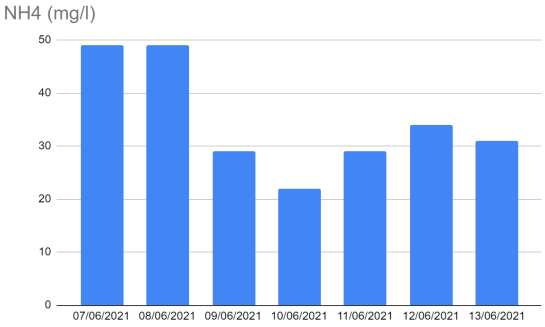
Table 5: Results of wastewater quality campaign in Soroca

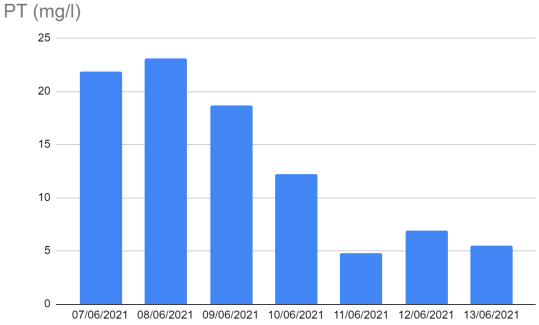
Parameter	Mon 07/06	Tu 08/06	Wed 09/06	Thu 10/06	Fri 11/06	Sat 12/06	Sun 13/06	Ave.	Max	Min
BOD	220	350	200	310	50	68	100	**185**	350	50
COD	520	1115	620	430	140	180	190	**456**	1115	140
TSS	786	1050	496	371	73	51	198	**432**	1050	51
NH4	49	49	29	22	29	34	31	**35**	49	22
TP	21,9	23,1	18,7	12,2	4,8	6,9	5,5	**13**	23,1	4,8
TDS	745	735	424	411	661	727	576	**611**	745	411
Cl-	100	120	80	92	70	62	47	**82**	120	47
pH	7,54	7,46	7,53	7,54	7,46	7,39	7,47	**7,5**	7,54	7,39

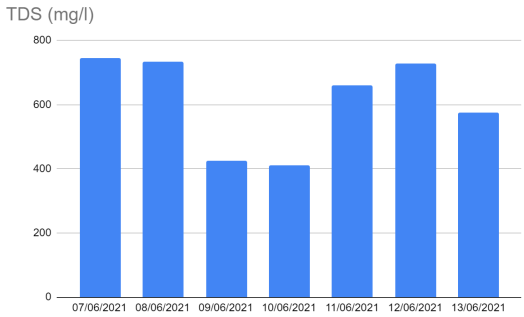












The analytical campaign shows a great variability in the wastewater quality at this point of the network. The daily biodegradable organic matter (BOD) varies from 50 to 350 mg/l and the Suspended Solids Content from 51 to 1050 mg/l. It can be observed that wastewater is more concentrated at the beginning of the week (Monday to Thursday) and it gets diluted from Thursday to Sunday. This variation can be explained by the impact of industrial discharges which are probably done during the working days (the two largest industrial sites, Fabrica de brinceturi and Alfa Nistru discharge to this catchment area - refer to Section 5.4.2 Assessment of Industrial Wastewater Generation: Loads and Flows).

The dilution at the end of the week is also probably due to the larger influence of groundwater and rainwater intrusion inside the network after several days of rain (there was a bit of rainfall almost everyday, although it was more abundant on Thursday). During the last days, it could be observed that the water level in the manhole rose considerably.

Compared to the historical wastewater analysis, the average values of this sampling campaign are similar for the parameters BOD, COD, NH4, whereas the TSS is much higher. The salinity parameters (Chloride, TDS) are 3 times lower than the historical recorded values.

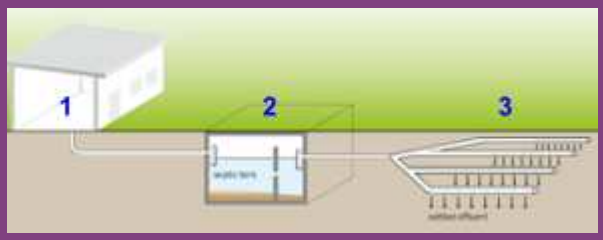
4.5. Assessment of On-site Sanitation Systems in Soroca and Surrounding Villages

Glossary of On-site sanitation

Dry toilet	Toilet that operates without flush (running) water
Flush toilet	Toilet that operates with flush water
Latrine	Common name for a toilet facility mostly operated without water to collect human excreta. The main components of a latrine are the pit, a slab and a stall (structure)
Urine Diverting Dry Toilets (UDDT)	Dry toilet that has a divider so that the urine and the faeces are collected separately. Also called ECOSAN (commercial trade)
Cesspit or Holding Tank	Watertight tank used as blackwater storage. It has to be emptied frequently and does not treat blackwater
Septic tank	Watertight chamber which provides primary partial treatment of wastewater (sludge settling and digestion). The overflow or effluent of the septic tank is then dispersed by using a soak Pit, a Leach Field or directed to the sewer
Soak pit	Also known as a soakaway or leach pit. It is a covered, porous-walled chamber that allows water to slowly soak into the ground.
Leach field	Also known as a drainage field. It is a network of perforated pipes that are laid underground to dissipate wastewater from a collection and treatment unit (typically septic tank) or a small wastewater treatment plant.

On-site Sanitation Scheme

An on-site sanitation system typically consists of the following items:



1. **Collection and storage:** Dry of flush toilet connected to a pit, either soak pit or watertight holding tank;
2. **Treatment (optional):** Treatment options range from septic tank (simplest technology) to more complex and mechanized systems such as compact treatment units or micro WWTPs (SBR, trickling filter, fixed film reactor, etc.);
3. **Disposal of effluent:** Treated effluent is discharged either to surface water bodies, to the sewer or infiltrated to the soil.

4.5.1. Description of Existing Situation

As it has been described above, it has been estimated that only 42% of the population of Soroca city is connected to the sewerage system. All the multi-storey buildings are connected to the existing sewerage system, whereas only 24% of the individual houses and 21% of economic agents and budgetary institutions are connected.

Regarding the villages, none of them have centralized sewerage systems and all the domestic and non-domestic customers rely on decentralized or on-site sanitation systems.

The most common on-site sanitation system in Soroca and surrounding villages are single **soak pits** made of reinforced concrete rings or stones and cement where urine and water percolates into the soil through the bottom of the pit and the wall, whereas excreta accumulates and partly degrades. The existence of septic tanks or other types of pre-treatments is not common, therefore, wastewater does not receive any type of pretreatment before percolating into the soil.

Both dry or flush toilets are used, depending on the population habits and type of houses. Dry toilets are normally located in the garden next to the house, in an independent cabin, whereas flush toilets are used inside the house. Some houses have common soakpits to collect both black and greywater[11] whereas others dispose of two different soakpits for the different wastewater streams produced in the house.

Some dwellings, economic agents and institutions dispose of watertight tanks (cesspits), but they remain an exception.

[11] Greywater is dirty water coming from kitchen, laundry and bathroom drains from activities such as dish washing, cooking, clothes washing, showering and bathing Blackwater refers to toilet water, including urine and faeces.

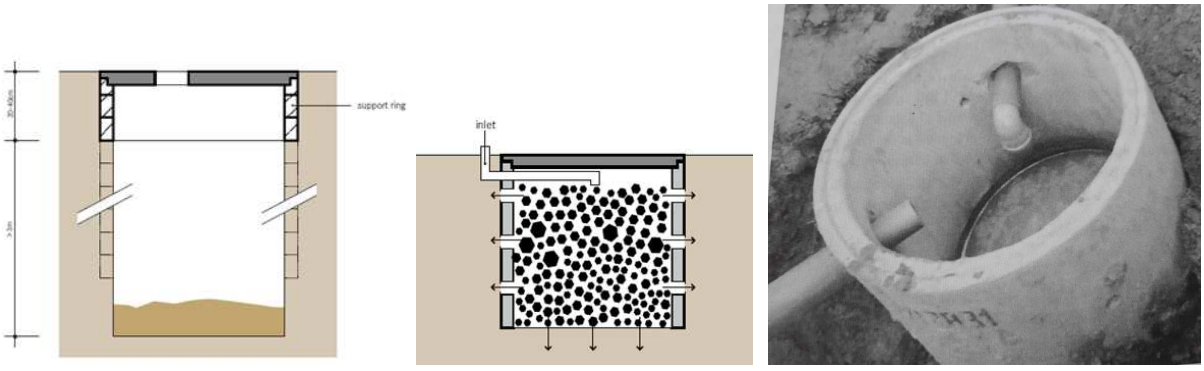


Figure 42: Scheme of Dry pit, Soak Pit and Picture of Pit typically found in the study area

Figure 43: Pit latrines installed in the backyard of individual houses

Figure 44: Soak pit which receives greywater from an individual house (left) and water-tight holding tank from an industrial site (right)

Figure 45: Picture of pit latrine in public buildings and institutions (left: Town hall of Regina Maria; right: Candle Monument in Soroca)

Routine analyses of groundwater sources are performed in Soroca surrounding villages by the National Agency for Public Health. These analyses show that groundwater suffers from a significant pollution of nitrates and fecal bacteria, which indicates the negative impact of the on-site sanitation systems on the groundwater resources.

Table 6: Groundwater quality in Soroca area (National Agency for Public Health)

Type	Locality	Total Coliforms	E. coli	Ente. Fec	Colour	Turbidity	pH	NH4	NO2	NO3	TDS	Cl-	SO4	F	Hardness
PF	s. Regina Maria	0	0	0				0,08	0,009	44,8					
PF	s. Bulboci	201	11	10	<5	<1	7,46	0,35	0,01	36,5	1393,5	59	422,6	0,29	39,9
PF	s. Bulboci	201	38	202	<5	<1	7,51	0,12	<0.003	49,9	1160,5	43	348,7	0,38	31,5
PF	s. Bulboci	201	6	78	<5	<1	7,42	0,05	<0.003	50,5	1263,5	45,3	389,9	0,5	35
PF	s. Bulboci	201	0	41	<5	<1	7,42	0,18	<0.003	40,2	1027,5	43,5	253,5	0,64	33,6
W	s. Egoreni	36	0	0	<5	<1	7,35	<0.05	0,02	82,9	677,5	49	21,2	0,58	19,8
W	s. Egoreni	51	1	1	<5	<1	7,49	<0.05	0,01	82,9	665,5	41	50,8	0,54	18,1
PF	s. Egoreni		0	0	<5	<1	7,64	<0,05	<0,003	80,1	668	41	61		20,1
PF	s. Egoreni		0	0	<5	<1	7,58	<0,05	<0,003	88,1	635	34,5	57		18,5
PF	s. Egoreni		0	0	<5	<1	7,5	<0,05	<0,003	80,4	672	34,5	64		19,8
W	s. Hristici	74	16	3	10,3	<1	7,84	<0.05	0,01	50,3	973	29,5	150,2	0,51	36,5
W	s. Hristici	201	4	0	7	<1	7,97	0,08	0,09	187,9	1599	79,5	237,4	1	56
W	s. Rublenita	4839	0	0	<5	<1	7,79	<0.05	<0.003	21	816	36		1,26	32,2
W	s. Rublenita	483	0	31	<5	<1	7,46	<0.05	<0.003	154,8	1157	61		0,61	41,4
W	s. Rublenita	4839	56	6	<5	<1	7,34	<0.05	0,04	255,2	1482,5	130		0,53	54
W	s. Rublenita				5,3	<1	7,63	<0.05	0,02	264	1935	142,5		0,3	56,1
PF	s. Rublenita	160	60	18				<0,05	0,009	106,5					
PF	s. Rublenita	92	28	0	<5	<1	7,64	<0,05	0,008	79,5	858	21	51		34,3
PF	s. Rublenita	240	0	0	<5	<1	7,87	<0,05	0,04	134,7	2407	137,5	69		56,8
PF	s. Rublenita	40	0	0	5,7	<1	8,15	<0,05	<0,003	65,5	853	195	70		31,5
PF	s. Rublenita	0	0	0	<5	<1	7,95	<0,05	0,007	152	2582	175	327		67,3
W	s. Rublenita Nouă	321	8	10				<0.05	0,03	253,4		86			53,3
W	s. Rublenita Nouă	4839	47	154	10,2	6,2	7,83	<0.05	0,07	63,8	733,5	20,5		0,7	35,8
PF	s. Zastînca	10	0	66	<5	<1	7,6	<0.05	0,01	144,1	857	60	8	0,69	28
PF	s. Zastînca	74	0	1	<5	<1	7,68	<0.05	0,01	94,3	779,5	37,5	26,3	0,8	29,4
PF	s. Zastînca	201	0	0	56,2	5,7	7,63	<0.05	0,02	28,9	608	8,5	36,4	0,98	26,6
PF	s. Zastînca	89	0	0	<5	<1	7,47	<0.05	0,01	39,3	663,1	12,5	46,5	0,94	28
PF	s. Zastînca				6,6	<1	7,11	<0.05	0,04	159,8	1031		28	0,59	39,2
PF	s. Zastînca	401	0	0											
PF	s. Zastînca	0	0	0	<5	<1	7,89	<0.05	<0,013	154,8	693	38	12,1		29,4
PF	s. Zastînca	0	0	0	<5	<1	7,62	<0,05	0,01	152	1067	84	55		49,1
PF	s. Zastînca	0	0	0	5,3	<1	7,46	<0,05	<0,003	128,2	841	65	14,2		32,2
PF	s. Zastînca	0	0	0	5,5	<1	7,38	<0,05	<0,003	154,5	1470	125	48		46,3
PF	s. Zastînca	272	112	118	<5	<1	7,94	<0,05	<0,003	122,3	857	53,5	39,3		38,5
PF	s. Zastînca	360	192	0	<5	<1	7,53	<0,05	<0,003	38,5	586	10	31,6		36,4
PF	s. Floriceni	120	40	34	10,3	<1	7,48	<0,05	0,04	107	1037	41,5	136		35,8
S	s. Cănarii Vechi	0	0	0	10,1	<1	7,47	<0,05	0,2	14,4	1430	40	548		45,5

Legend:

Type of well
W: Well
PF: Public Fountain
S: Spring

Microbiological analyses
TC: Total coliforms
E. coli: Escherichia coli
Ent. F: Enterococcus Faecalis

Physical- chemical parameters
Ammonium
Nitrite
Nitrate
Total Dissolved Solids
Chloride
Sulfate
Fluorine
Hardness

4.5.2. Septage Production And Disposal

The average volume of a soakpit at a dwelling house is 4 m^3. Some larger pits, up to 10 m^3, are used by 2 or 3 houses. The largest tanks are owned by schools, kindergartens and a children's summer camp (20 m^3).

The service of septage removal from decentralized sanitation systems is currently performed by SA "Regia Apa Canal Soroca", mainly in the city of Soroca, and by informal private economic agents. SA "Regia Apa Canal" disposes of a vacuum truck of 3,8 m^3 volume, which currently discharges into the Central Pumping Station, where septage is directly rejected into the river with the rest of the collected wastewater.

The informal private agents performing the septage removal are not officially registered and the final use or disposal of sludge is not known (illegal dumps site, river?).

Figure 46: Vacuum truck for septage collection and transport (Apa Canal)

According to the information provided by SA "Regia Apa Canal Soroca", the collection and disposal of septage from latrines is performed during the whole year although they perform 3 times more services during the spring-summer period than in winter. SA "Regia Apa Canal Soroca" can perform this service in all the surrounding villages at a maximum distance of 25 km, although in reality, the emptying of pits is mainly performed in Soroca city.

During 2020, a total of 175 services were done by their truck. Considering an average volume of 3.8 m^3 per truck service, this results in a total volume of 665 m^3 collected per year.

The actual characteristics of septage collected in the study area are not known. According to literature, septage characteristics are very variable and depend on several factors:

- Households habits and type of toilets (dry or flush)
- Origin of wastewater: only blackwater or blackwater and greywater

- Fillining rate and storage duration: The filling rate depends on the volume of the pit and the number of people using the system. The length of time that septage is stored onsite greatly affects the characteristics due to the digestion (stabilisation) of organic matter that occurs during storage.
- Infiltration and leaching into the soil and from groundwater into the pit
- Climate, mainly due to temperature and rainfall (due to overflowing or flooding of onsite systems)

The average quality of septage which is typically used to design WWTP is shown below. It can be observed that it is appr. 30 times more concentrated than average wastewater.

- BOD = 10 000 mg/l
- COD = 15 000 mg/l
- TSS = 12 000 mg/l
- TKN = 1 000 mg/l
- PT = 150 mg/l
- pH = 7
- Dry matter = 15 g/l

A rough estimation of the real annual volume of septage production in the service area currently covered by Apa Canal Soroca is done below. The following hypotheses are used:

- Number of customers with decentralized systems: SA “Regia Apa Canal Soroca” database
- Volume of pit for domestic customer: 4 m^3
- Volume of pit for non-domestic customer: 10 m^3
- Frequency of septage removal: Once in 10 years

Table 7: Estimated production of septage in on-site sanitation systems in Soroca Municipality

Soroca Municipality	Total customers	Connected to centralized system	Not connected	Estimated number of pits	Average pit volume (m3)	Estimated septage volume (m3/year)
Domestic - Apartments	6407	6407	0			0
Domestic - Houses	7198	1719	5479	3000	4	1200
Economic agents	1321	299	1144			
Budgetary institutions	122			1144	10	1144
					TOTAL	**2344**

Data source: SA “Regia Apa Canal Soroca” database

Table 8: Estimated production of septage in on-site sanitation systems in surrounding villages

Village	Total customers	Number of decentralized systems	Average pit volume (m3)	Estimated septage volume (m3/year)
Egoreni				
Domestic - Houses	385	385	4	154
Economic agents	5	5	10	5
Budgetary institutions	3	3	10	3
Hristici				
Domestic - Houses	369	369	4	147,6
Economic agents	3	3	10	3
Budgetary institutions	5	5	10	5
Regina Maria				
Domestic - Houses	270	270	4	108
Economic agents	5	5	10	5
Budgetary institutions	4	4	10	4
Rublenița				
Domestic - Houses	1300	1300	4	520
Economic agents	12	12	10	12
Budgetary institutions	5	5	10	5
Zastinca (*)				
Domestic - Houses	924	924	4	369,6
Economic agents	12	12	10	12
Budgetary institutions	5	5	10	5
Bulboci				
Domestic - Houses	940	940	4	376
Economic agents	17	17	10	17
Budgetary institutions	8	8	10	8
TOTAL				**1759**

Data Source: Municipality of Soroca; the number of domestic and non-domestic customers for Zastinca has been estimated from the SA “Regia Apa Canal Soroca” database.

According to this rough estimation, **an approximate of 2 350 m^3 of septage is produced in Soroca Municipality per year and 1760 m^3 in the surrounding villages.**

Compared to the real figure of 665 m3 of septage collected in 2020, it can be concluded that most of the septage is currently collected and disposed of by non-official means.

5. Current and Future Wastewater Flows and Pollution Loads

5.1. SA "Regia Apa Canal Soroca" Customer Database and Baseline Data

Based on historical extractions from the SA "Regia Apa Canal Soroca" billing system, the customer database for water and sanitation services has evolved as follows for the service area:

Table 9: Evolution of water and sanitation customers over the past 3 years

	2018	2019	2020	Average annual variation
Number of water customers	**13,554**	**13,677**	**14,446**	**+2,23%**
Number of water customers - Urban	*11,271*	*11,370*	*11,818*	*+2,43%*
Number of water customers - Rural	*2,283*	*2,307*	*2,628*	*+1.33%**
Number of wastewater customers	**7,426**	**7,464**	**7,851**	**+2,86%**

Data Source: SA "Regia Apa Canal Soroca" Customer database extractions

Note: *This rate has been calculated without taking into consideration Bulboci customers which have been included in the database in 2020 and therefore artificially increase the annual customer increase rate.*

SA "Regia Apa Canal Soroca" not having performed any network extension over the past few years, the increase in the number of customers registered in their customer database is therefore considered to be "densification" on the existing network: either through the regularisation of inactive connections or through the connection of new customers. For projecting purposes, we propose to retain a certain densification ratio in the future but lower than values of the past few years, we are proposing the following densification ratios (which do not take into account drinking water network extensions that have not been planned at this stage and are not part of this study):

- Water annual densification ratio - Urban : **0,61%**;
- Water annual densification ratio - Rural : **0,33%**;
- Wastewater annual densification ratio - Urban / Rural : **0,26%**.

Furthermore, the analysis of the customer database shows that **on average, only 80% of water connections and 75% of wastewater connections are active**[12] which has to be taken into account in the revised customer baseline and coverage ratio as follows:

[12] Active customers are the customers registered within the SA "Regia Apa Canal Soroca" customer database with water consumption for the year 2019. Inactive customers are considered to be residents that no longer live in Soroca, (empty houses for which the previous occupant did not terminate its water service contract).

Table 10: Water and Wastewater active customers and coverage ratio baseline

	Number of active water connections 2020 baseline	Water coverage ratio*	Number of active wastewater connections 2020 baseline	Population Wastewater coverage ratio*
Soroca	9,333	66%	5,902	42%
Villages	2,177	50%	0	0%
Total SA "Regia Apa Canal Soroca"	**11,510**	**62%**	**5,902**	**32%**

Data Source: SA "Regia Apa Canal Soroca" Customer database extractions

**Note: Based on an assumption of 2,5 inhabitants per connection (connection = customer).*

SA "Regia Apa Canal Soroca" customer database comprises domestic customers and non domestic customers (budgetary institutions and economic agents). A more detailed assessment of these categories of customers is presented in the following sections.

It must be noted that whereas all wastewater customers are currently located in Soroca city, the company's water customer base extends to 6 neighbouring communes and villages. The graph below illustrates the distribution of domestic water customers within the company's service perimeter which provides an idea of the possible future trend of wastewater customer base distribution.

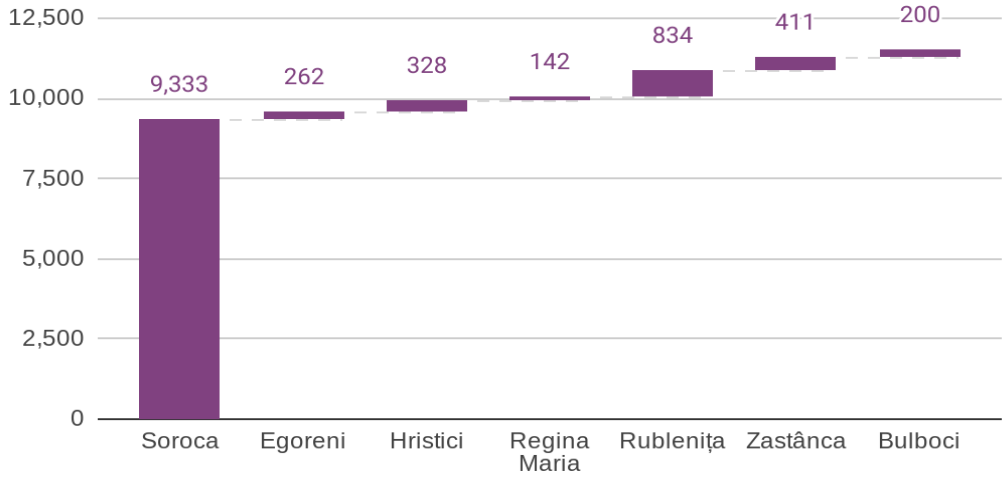


Figure 47: Distribution of SA "Regia Apa Canal Soroca" active domestic water customers within its service area

Note on agglomeration for wastewater services: For the later analysis of the future central sewerage network and WWTP in Soroca, the urbanised areas of Soroca and Zastinca are considered as the same "agglomeration". Even if they correspond to different administrative areas, there is no geographic or topographic boundary and they can be treated as the same area for centralised wastewater services.

5.2. Domestic customers and wastewater generation

The assessment of the SA "Regia Apa Canal Soroca" Customer database shows that domestic customers represent 96% of all wastewater customers and generate 80% of the total wastewater volumes estimated by the utility. Hence, correctly forecasting future domestic flows is key.

Domestic wastewater generation is directly dependent on their water consumption. Hence, for projection purposes, following discussion and approval by the PIU on 06/07/21, **the following final assumptions have been adopted** for this Feasibility study:

- **Annual increase of water consumption/connection:** The National Water and Sanitation Strategy (2014-2030) recommends a water consumption level of 160 liter/capita/day in an urban context and 50 liter/capita/day in a rural context. Following discussions with the PIU, these recommendations were considered unrealistic. Therefore, in order to avoid over-dimensioning the wastewater infrastructure, it was agreed with the Client to **target a domestic water consumption of about 100 liter/capita/day by 2065**. To reach these targets, the domestic water consumption will therefore gradually increase by +2.74%/year until 2025 (aligned with data from the past 3 years) and thereafter by only +0.5%/year until the end of the planning horizon.

- **Billed water consumption versus real water consumptions:** Existing water consumption data comes from the company's billing system and therefore corresponds to the metered or estimated amount billed to customers. However, the utility suffers from a very high rate of Non-Revenue Water (NRW) and even though NRW reduction has been one of the top priorities of the management in recent years, indicators communicated to ANRE still indicated 39% of NRW in 2019. There is no data available to know the exact proportion of NRW related to physical and commercial losses, however, for the purpose of this study, we have estimated that :
  - 80% of water losses are physical due to the old and unmaintained network infrastructure; and
  - only **20% are related to commercial losses** such as undermetering, unauthorised consumption or theft. **Commercial losses must be taken into account to estimate the real water consumption, later discharged as wastewater**.

- **Wastewater coverage rate**: The current wastewater coverage rate is 42% in Soroca, 40% when considering Soroca + Zastinca and 32% over the entire company's service area. The National Water and Sanitation Strategy (2014-2030) had set a target for a wastewater coverage rate of 70% by 2018 which was not attained. The National Programme for City-growth in the Republic of Moldova (2021-2027) also identified the increase of the wastewater coverage rate in Soroca up to at least 70%. The first version of this Feasibility Study proposed, therefore, a wastewater coverage rate of 70% for Soroca agglomeration by 2035 and 90% by 2045. However, these coverage rates were deemed unrealistic by the PIU, due to the fact that the actual evolution of wastewater connection rates in the country is much lower than expected, resulting in oversized sanitation projects (network and WWTP). Moreover, the available budget of 11 Million US$ does not allow the construction of a first phase of WWTP with 70% coverage rate capacity (28 400 Population Equivalent).

The evolution of the wastewater coverage rate has been revised in this final Version in order to align with the available initial budget and delay the increase of coverage rate for the mid-long term:

- 47% population connected to central sewerage network in 2035
- 75% population connected to central sewerage network in 2045
- 90% population connected to central sewerage network in 2065

- **Domestic wastewater return ratio**: As SA "Regia Apa Canal Soroca" does not measure the volume of wastewater at discharge points, it is not possible to estimate the total wastewater return ratio. The National Water and Sanitation Strategy (2014-2030) recommends to consider a wastewater return ratio of 100% for domestic customers, however, in accordance with international best practices and as agreed with the Client, **an 80% wastewater return ratio was adopted for domestic customers** which seems reasonable given that some of the supplied water is not discharged when used for cooking, cleaning, watering gardens in the peri-urban areas, etc.

It must be noted that the wastewater return ratio used to project volumes (80%) is based on reality but is different from the ratio used by the company to compute wastewater bills which, by law, is 100% for domestic customers.

Moreover, the wastewater volumes recorded by the company are entirely based on a 100% return ratio assumption as the utility does not measure the wastewater flows. Hence, we revised the baseline in line with the more realistic assumptions detailed above to ensure comparability of trends in our projections.

Given the above, domestic wastewater discharge is projected as follows:

Table 11: Domestic water consumption and wastewater discharge projections

Item	Unit	2020	2025	2035	2045	2065
Domestic water consumption - urban	lpcd	75	86	90	95	104
Domestic water consumption - rural	lpcd	65	74	78	81	90
Domestic wastewater discharge Soroca city	lpcd	60	68.8	72	76	83.2

- **Specific pollution load per capita:** The Government Decision no. 950/2013 and the Code for construction NCM G.03.01 indicate that a standard ratio of domestic pollution of 60 g BOD per capita per day should be used for estimating the capacity of WWTP in the Republic of Moldova. Due to the current socio-economic situation in Soroca, this ratio is considered too high and not representative of the actual domestic pollution. According to the consultant's experience, the domestic pollution, including commercial and institutional agents, can be

estimated by 45 - 50 g BOD per capita/day, to which main industrial loads should be added (see below the section on industrial customers). The standard value of 60 g BOD per capita/day can be used to design the future capacity of the WWTP in the mid-term (year 2035), considering that this ratio also includes all budgetary and industrial pollution loads.

5.3. Budgetary institution customers and wastewater generation

SA "Regia Apa Canal Soroca" provides centralized wastewater services to 47 budgetary institutions in the service area (2019 Customer database) out of the 150 institutions recorded in the current service area of SA "Regia Apa Canal Soroca" (hence a coverage rate of 30% on this customer category). Budgetary institutions comprise educational institutions (schools, highschools, etc.), sanitary facilities (hospital) and institutional buildings (town halls, administrative buildings).

In 2019, and according to the company's volume estimates, the wastewater generated by budgetary institutions accounted for 15% of the total volume of wastewater generated in the company's service area. The three largest budgetary institution customers represent 70% of the overall wastewater volume of institutions and 12% of the overall volume collected by the company. According to general practice, it is assumed that budgetary institutions discharge at a rate similar to domestic customers. In Soroca, SA "Regia Apa Canal Soroca" estimates the volumes based on the legal 100% discharge which is used to compute the bill.

Table 12: Top 3 budgetary institution wastewater customers

	Budgetary institution	2019 annual wastewater volume (m^3)
1	Penitenciarul Nr. 6	40,159
2	Spitalul Raional Soroca IMSP	13,351
3	Primaria Soroca	9,623

Given the above, **the following assumptions have been adopted** for this Feasibility study:

- **Budgetary institutions water consumption is anticipated to vary proportionally to the domestic volume**: The forecasts indicate that Soroca city's population will reduce progressively and it is therefore assumed that budgetary institutions, which missions are to serve the local population (schools, hospitals, government buildings, etc.) will follow the same trend. Hence, the variation of their water consumption has been projected proportionally to the one of domestic customers:
    - In Soroca, budget institutions consume 12% of the domestic water consumption (according to the company's customer database assessment);
    - In the villages, budget institutions consume 8% of the domestic water consumption (according to the company's customer database assessment);

  A ratio of 10% has been established for projections.

- **Wastewater coverage rate**: Although according to the law, all budgetary institutions should be connected to the centralised sewer system, the existing infrastructure does not allow it and

the **overall wastewater coverage rate for budgetary institutions which is currently estimated at 30%, will increase proportionally to the domestic connection rate**;

- **Wastewater return ratio:** Based on discussions with the Client, it was agreed to reasonably consider a **80% wastewater return ratio** for budgetary institutions, just like for domestic customers, and the baseline data was therefore revised accordingly.

> Similarly to domestic customers, we note that by law, a return ratio of 100% is applied by SA "Regia Apa Canal Soroca" to compute the wastewater bills but we have opted to project the volumes realistically in order to adequately dimension the infrastructure.

5.4. Economic agents customers and wastewater generation

5.4.1. Context

The main economic activities in the city of Soroca are the agro-food (fruits and vegetables processing, milk and dairy products, meat products and tobacco) and the manufacturing (clothing and footwear) industries. The map below shows the location of the largest economic agents and budgetary institutions in the city, including the three major agro-food industries (Fabrica de brinzeturi S.A., Alfa Nistru S.A. and Debut-Sor SRL).

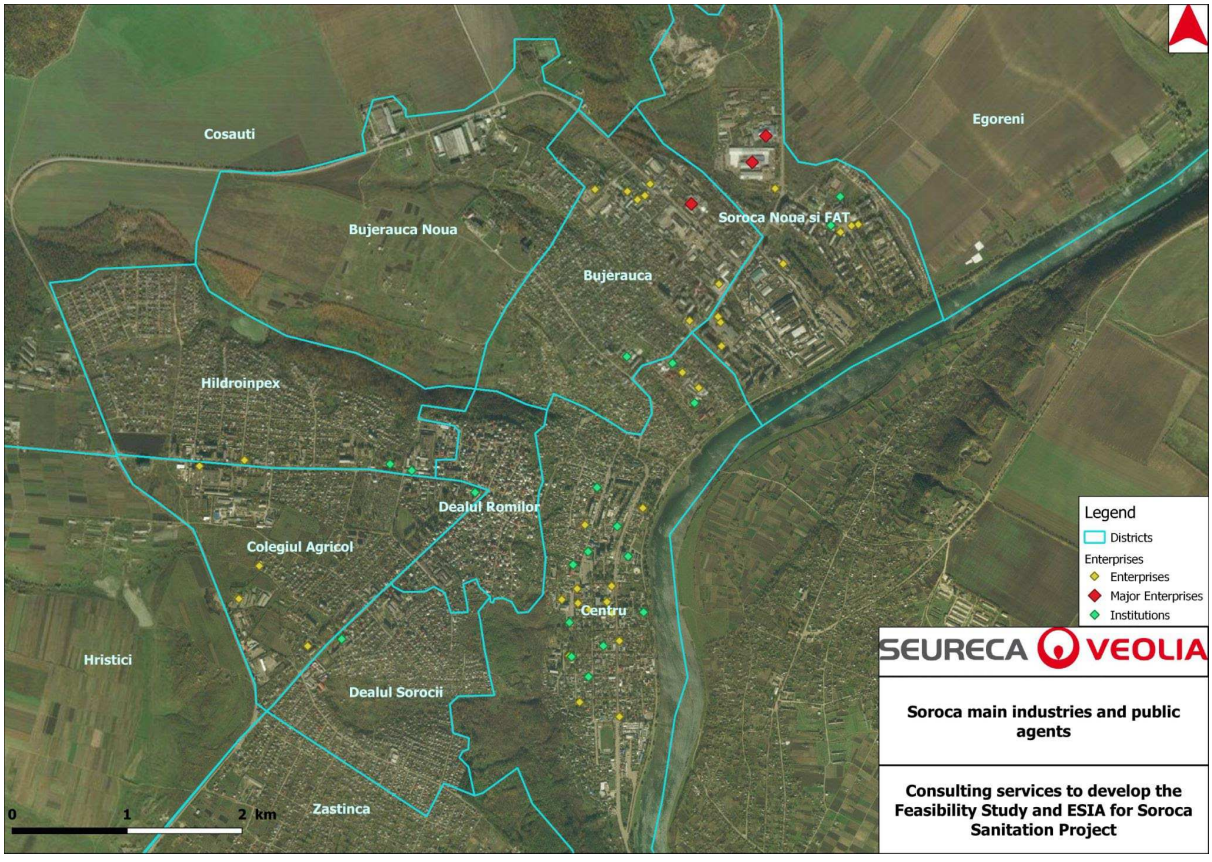


Figure 48: Soroca main industries and public agents

- ***Fabrica de Brînzeturi S.A.*** specializes in the production of hard curd cheeses and butter, with a processing capacity of 100 tons of milk per day, which is collected from all over the north part of the republic where 28 refrigerators are installed;
- ***Alfa Nistru S.A.*** produces juices and canned vegetables and fruits. A special place is occupied by the production of concentrated juice in the Tetra Pack format. The company processes about 100 thousand tons of raw material per year.
- ***Debut Sor SRL.*** produces different types of sausages for the local market.

It must be highlighted that economic activities are scattered through the entire territory of the city, but the main active sectors are found in the “Bujerauca" and “Colegiul Agricol" sectors. The General Urbanistic Plan of Soroca (Urbanproiet, 2011) describes the industrial areas in the different sectors of the city as follows:

1. **"Centru" sector:** The compact territory of this area is located in the center of the city near Independence and Alexander the Good streets and covers an area of 2.91 ha. Here the most important companies that operate are: "Testor" SRL (bakery); “Tipografia” SA (printing) and other small enterprises and shops in different fields of activity;

2. **"Dealul Sorocii" sector;** The mentioned area is located on the further east of the "Center" area in the perimeter of Renaşterii Street and includes an area of 7.37 ha. The most important enterprises currently operating are the companies “Silva Alexei” Î.I and “Uniconst” SRL (construction materials storehouse);

3. **“Colegiul Agricol” sector:** The industrial area near Calea Baltului streets and the detour road are located in the western part of the city. The total area of the existing enterprises is about 28.27 ha. The most important companies operating in this area are the company for the production of hydraulic materials "Hidroimpex" SA; reinforced concrete factory “Fauritorul” SA; the joint venture for the production of clothes “ErmoGrup” SRL; JSC "Red Nord" and other small production entreprises and storehouses of various fields of activity;

4. **Hidroimpex" sector:** The industrial area is located along Stroiescu Street. The enterprises in this area are located in small groups on a total area of 1.53 ha. The main company is “Balsor” SRL (Processing of milling and cormer products);

5. **“Bujerauca Nouă” sector:** The area is located in the northern part of the city along the bypass with all types of technical insurance and occupies an area of 8.93 ha. The most important enterprises currently operating are: the sunflower hybrid production enterprise Î.M. “AMG-Magroselect” SRL; power station Î.M. “Moldelectrica”; construction materials storehouse “Dumbrava Nord” SRL;

6. **“Bujerauca” sector:** This area is located in the eastern part of the city along Cosăuţilor streets. The total area of existing enterprises is about 25.08 ha. The most important enterprises currently operating are: the natural stone processing factory; SA “Autoservice”; “Debut Sor” SRL (meat processing), the shoe factory “TIRAS” SRL, and other small production and storehouses enterprises of different fields of activity;

7. **“Dealul Romilor” sector:** The economic activities are not functional in this area;

8. **"Soroca Nouă" sector:** The enterprises of this area are located along the road to Cosăuţi and in the rugged area of the Nistru River on a total area of 38.86 ha. The most important enterprises operating in this area are: the cannery “Alfa-Nistru” SA; “Fabrica de brinzeturi”

(cheese and dairy products from Lactalis group); Ltd “Comtiras”; the universal cooperative “Universal Coop”; SRL “AvanConst”; “MenajConstruct” SRL and others.

The National Bank of Statistics offers a general overview on the industrial activities in Soroca region, in terms of activity and production from 2017 to 2019 as listed below. It can be observed that most industrial activities have declined over that period.

Table 13: Production of main industrial goods in Soroca Raion (National Bank of Statistics)

Activity	Year	Quantity
Other carving or building stones, excluding granite or sandstone, thousand tons	2017	8,1
	2018	7,6
	2019	4,9
Sand, thousand tons	2017	137,1
	2018	130,6
	2019	131,1
Gravel, pebbles, boulders and flint, thousand tons	2017	334,3
	2018	323,6
	2019	366,8
Meat, including poultry, tonnes	2017	48,0
	2018	3,9
	2019	2,6
Sausages, tons	2017	376,0
	2018	342,5
	2019	322,4
Vegetable and fruit juices, thousand liters	2017	5872,5
	2018	9919,6
	2019	11086,9
Canned vegetables and fruits, tons	2017	6688,6
	2018	5707,3
	2019	5312,7
Processed and preserved fruits, tons	2017	115,3
	2018	261,1
	2019	506,3
Milk and cream with a fat content of up to 6%, tons	2017	2548,7
	2018	2914,1
	2019	2693,7
Butter, tons	2017	78,5
	2018	45,4
	2019	23,7
Fresh cheeses, tons	2017	50,0
	2018	8,6
	2019	18,9
Cheese and greasy cheese, tons	2017	1699,7

	2018	1710,2
	2019	1696,6
Caught milk, yogurt, kefir, sour cream and other fermented products, tons	2017	5041,8
	2018	4469,9
	2019	4222,9
Flour, tons	2017	774,9
	2018	1011,8
	2019	399,1
Groats, semolina and agglomerates, tons	2017	1938,8
	2018	1388,0
	2019	-

5.4.2. Assessment of Industrial Wastewater Generation: Loads and Flows

SA "Regia Apa Canal Soroca" provides water and wastewater services to 228 economic agents (2019 Customer database), situated mainly within the city of Soroca. Economic agents range from large industrial production sites to all kinds of economic activities (shops, hotels, supermarkets, etc).

In 2019 and according to the utility's volume estimates, the wastewater generated by economic agents accounted for 15% of the total volume of wastewater generation in the utility's service area.

For the purpose of this study, a more detailed assessment of the largest wastewater producers in the city of Soroca has been done in order to correctly evaluate the production of wastewater and its characteristics, as well as assess the current industrial wastewater management. The table below lists the top 10 economic agents in terms of wastewater generation. They represent 70% of the overall wastewater volume of economic agents and 10% of the overall volume collected by SA "Regia Apa Canal Soroca". The sites which have been visited are underlined in the table below and the results of the interviews presented in the fact sheets in Annex.

Table 14: List of the top 10 economic agents in terms of wastewater generation

	Economic agent	Activity	Yearly wastewater volume 2019 (m^3)
1	Fabrica de brinzeturi S.A.	Dairy products	32411
2	Alfa-Nistru S.A.	Canned vegetables and fruits	5565,4
3	Debut-Sor SRL	Sausages	4018,2
4	Bilprocom-lux SRL	Supermarket	3323,6
5	Maritan - Sor ICS SRL	Footwear	3126
6	Alimer Comert SRL	Restaurant	2149
7	NouStil SRL	Textile, sewing	2055,6
8	Ermo-Grup SRL	Textile, sewing	1667
9	Uniform CSM SRL	Textile, sewing	1019,7
10	Arol SRL	Shops	1011

The map below illustrates the location of the economic agents interviewed as part of this study.

Figure 49: Location of economic agents visited and interviewed in the framework of the FS

Fabrica de brînzeturi din Soroca" SA (Alba)

The Alba factory in Soroca produces several types of dairy products including cheese, milk, sour cream, kefir, butter and yoghurt drinks (Yoli).

Water is used in the cooling system (20%), for production (10%), washing, cleaning and rinsing. The wastewater discharge from this dairy industry (approx. 40,000 m^3/year) accounts for around 6% of the total wastewater volume produced in the city. The facility has a seasonal production, with a peak production season between May – September (and the associated peak on wastewater discharge). The figure below shows the monthly wastewater discharge during the year 2020.

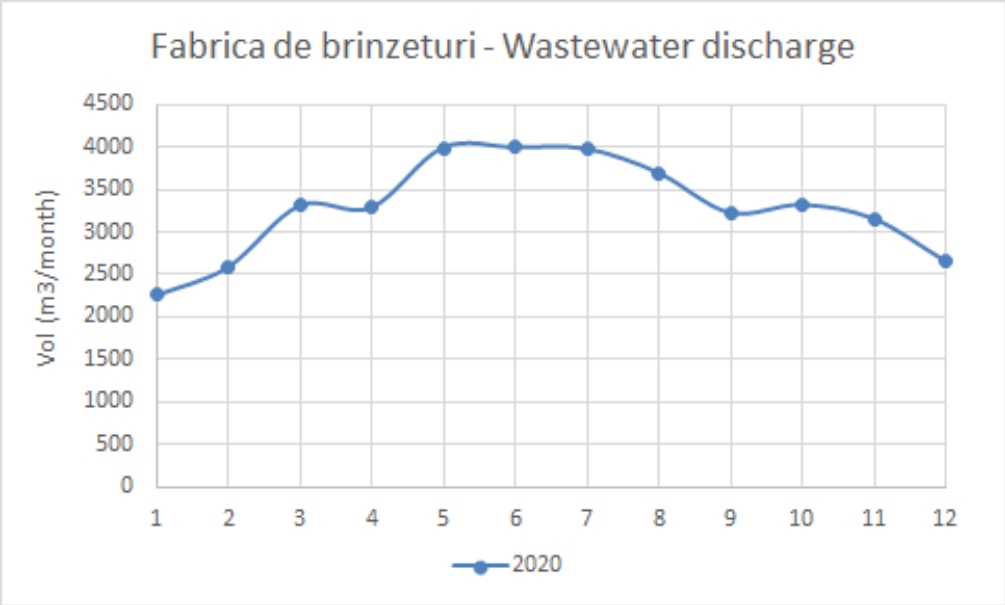


Figure 50: Monthly wastewater discharge profile of Fabrica de Brinceturi

This facility does not have any kind of homogenization or storage tank, nor any pre-treatment (mechanical or biological), and it discharges wastewater directly to the municipal sewerage network. Wastewater composition can therefore be extremely variable. According to the interviewed managers of Fabrica de Brinceturi, some analyses of discharged wastewater have been performed by an external laboratory, but these results have not been made available.

Dairy industries generate considerable amounts of wastewater, mainly through cleaning processes (pre-washing, washing with basic and acidic solutions and water rinsing). The pollution load mainly results from the acidic and basic washing steps. Most of the wastewater is loaded with fat.

Wastewater composition depends on:

- the raw materials composition (lactose, proteins, lipids, mineral salts…)
- the cleaning solutions used (bactericidal, antiseptic, soda, acids…)
- the manufacturing technologies implemented
- the production type: multipurpose plants generate more complex wastewater

The following figure shows typical water consumption ratios and wastewater characteristics for different dairy products' production.

Table 15: Water consumption ratios and wastewater characteristics for different dairy products

	Water consumption (l/l of milk)	COD (g/l of wastewater)	BOD (g/l of wastewater)	SS (g/l of wastewater)	N_{TK} (mg/l of wastewater)	P (mg/l of wastewater)
Milk	1.2 - 4	2.2	1.2	1.5	150	70
Milk powder	1 - 3	0.5-1.8	0.3 - 1	0,1	10	10
Fresh products	3	8-19	4.5 - 10	7.5	300 - 600	90
Yogurts	2 - 2.5	10.8- 19.8	6 - 11	2 - 3.5	200 - 400	200
Cheese	2.5 - 3	2.7-12.6*	1.5 - 7*	0,8 -1.2	200	100
Ice creams	3 - 10	14 - 35.6	19.8	7	170	300

** for pressed cheeses*

The pollution loads of this factory have been estimated based on industrial wastewater characteristics from a similar production site (Veolia internal database).

Based on an average wastewater discharge of 150 m^3/d (considering an average monthly discharge of 3300 m^3 and 22 production days per month), the daily load accounts for 299 kg BOD/d, that is, almost **5 000 Population Equivalent.**

Parameter	Concentration (mg/l)	Average load (kg/d)
BOD	2000	299
COD	3000	448
TSS	350	52
TN	185	28
TP	50	7
Fats	150	299

Alfa Nistru - Canned vegetables, fruits and juices

The factory of Alfa Nistru produces canned vegetables and fruits, juices and concentrates, from vegetables and fruits produced mainly in the region (from their own fields and bought from farmers).

Fruit and vegetable production is a highly seasonal activity, and wastewater is quite variable both in terms of quality and volume. Wastewater is produced mainly during the rinsing of cans and washing of raw vegetables and it accounts for 50% of the total drinking water consumption (30% is evaporated in the cooling system and 20% is used in the production). The average monthly wastewater production is estimated at 464 m^3, which represents around 1,2% of the total wastewater flow of the city.

This facility has a pre-treatment which consists of fine screening and settling. The quality of raw wastewater and discharged wastewater to the municipal network is monitored by an external laboratory four times a year. The wastewater quality complies with the discharge limits set in the Government No 950/2013, Annex 1.

Debut-Sor SRL

The factory of Debut Sor produces different types of sausages. Wastewater is produced during the cleaning of equipment and the cooling of products (estimated at 70% of total drinking water consumption). Production and wastewater discharge is variable during the year, depending on the market, with a monthly average of 335 m^3, which represents less than 1% of the total wastewater flow of the city.

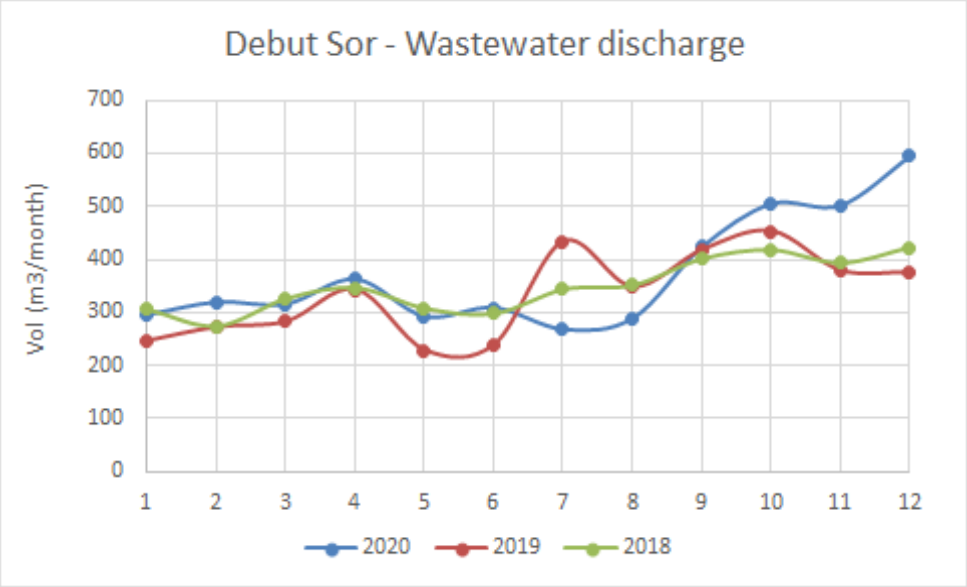


Figure 51: Monthly wastewater discharge profile of Debut Sor

Wastewater undergoes a pre-treatment (grease trap) before discharge into the municipal sewerage network. No analyses are performed and wastewater quality is not known.

According to data provided from a similar meat production site in Moldova (Seureca database, Chisinau Water Supply and Sewage Treatment - Feasibility Study, 2012), wastewater quality is highly variable and heavily polluted in BOD (260 - 1000 mg/l), COD (120 - 3460 mg/l) and TSS (168 - 7750 mg/l). Assuming an average wastewater quality of 655 mg/l BOD, the factory of Debut Sor accounts on average for **250 Population Equivalent**.

Other economic agents

Wastewater generated by the other largest economic agents can be assimilated to domestic wastewater (water is generated from domestic uses such as hygiene activities, water closets and cooking). This is the case of wastewater produced in supermarkets, shops, hotels and also from the manufacturing sites such as footwear and textile industries. These sites do not perform any polluting activity such as dying or bleaching.

The wastewater discharge from other smaller economic agents, which have been identified as potentially polluters such as Hidroinpex (metal pieces production), gas stations, car washers, laundries, and construction materials manufacturers, is negligible compared to the total wastewater volume of the city (<0,1%).

Wastewater return ratio

The wastewater return ratio of economic agents is individually approved by Apele Moldovei in order to reflect the specificities of the business processes. The interviews carried out with some of the largest industries confirm the return ratios approved by Apele Moldovei and registered by SA "Regia Apa Canal Soroca" for these companies. **Economic agents wastewater return ratios range from 50% to 90% based on the business category:**

- Fabrica brinceturi (Alba Cheese Factory): it accounts for 40% of total wastewater from economic agents and has a return ratio of 80%;
- Alfa Nistru (canned vegetables and juices): it accounts for 7% of total wastewater from economic agents and has a return ratio of 50%;
- Debut Sor (sausage factory): it accounts for 5% of total wastewater from economic agents and has a return ratio of 70%
- Textile companies and other economic agents such as supermarkets, shops, hotels have a return ratio of 90%.

Based on these values, the average wastewater return ratio by economic agents has been estimated at 80%.

We note that the legal context has recently evolved as from May 2021, the economic agents sanitation tariff will be applied to 100% of their water consumption volume instead of the previously approved 70% to 90% return ratio. However, to project the volumes and adequately dimension the infrastructure, we have opted to retain a realistic return ratio.

Based on the above **the following assumptions have been adopted** in this study:

- **Wastewater volume and coverage rate:** It is assumed that part of the current Economic agents' water consumption - and wastewater discharge - will remain stable over the years since the information gathered from the urban planning of the city of Soroca and neighbouring villages does not indicate any change in the economic landscape. This volume is fixed at 60% of current domestic wastewater discharge.

  The rest of the Economic agents' water consumption, which is estimated at 10% of the one of domestic customers, will vary proportionally to the water consumption of domestic demand, in order to follow the overall increase of wastewater coverage rate in the city (given that economic agents are distributed throughout the city).

- **Wastewater return ratio:** An average value of 80% is considered for projection purposes.

- **Pollution load:** nowadays, the Alba Cheese Factory (Fabrica de brinceturi) represents a significant load compared to the size of the city and it does not dispose of any pretreatment. It is therefore proposed that the factory's estimated average pollution load has to be added to the **current** domestic pollution load (estimated as 50 g BOD per capita per day) to evaluate the actual collected wastewater pollution in Soroca.

It is assumed, however, that in the mid-term (at least from year 2035) all industries in Soroca will install the necessary pretreatment facilities in order to comply with the discharge limits to the municipal sewerage network set in the Government Decision no. 950/2013. The industrial pollution load will therefore decrease considerably. For example, in the case of the Fabrica de brinceturi, the average pollution of 299 kg BOD/day (5000 PE) will decrease to 34 kg BOD/d (563 PE).

The estimation of the global pollution load for the WWTP in the mid-term, both domestic and non-domestic, once the industries have installed pre-treatments, can be estimated with the standard specific pollution load of 60 g BOD per capita per day.

6. Hydraulic Network Analysis and Recommendations

6.1. Wastewater network assessment with the Hydraulic Model

One of the main tools to perform an hydraulic assessment of a network is the hydraulic model. This paragraph reminds the principles of hydraulic modeling, details the methodology used for the model construction and presents the model conclusions for the current and the future situations.

6.1.1. Hydraulic modeling: principles and objectives

Hydraulic computer modelization is an informatic tool which is used to **simulate the dynamic performance of wastewater flow in the network**, from the domestic connection upstream to the outfall or the wastewater treatment plant downstream. Results obtained by simulation are more accurate than calculations by static methods. The modelisation has the following advantages:

- It takes into account the wave's propagation inside the network ;
- Water levels and flow visualisation everywhere and at all times in the modelised network ;
- The easy and quick modification of an event or a structure and their immediate integration in the calculations (accurate impact assessment of the modification) ;
- It takes into account complex hydraulic phenomena such as the downstream influence of main network overloading on the branches (with eventually the inversion of flow) ;

The model is a numeric representation of the wastewater network main structure. It plays a key role in the assessment of the existing wastewater network capacity and in the planification of future extensions.

GENERALS GOALS OF THE WASTEWATER NETWORK MODELIZATION :

- Identification and localization of hydraulic existing problems and bottlenecks of the network ;
- Performance assessment of many scenarios ;
- Optimization of the network rehabilitation and the renewal program ;
- Provision of a tool to determine the dimension of the network extensions needed.

6.1.2. INFOWORKS ICM Presentation

The software used to build the Soroca model is INFOWORKS ICM, developed by Innovyze, one of the most commonly used softwares. The software incorporates full interactive views of data using geographical plan views, long sections, spreadsheet and time varying graphical data.

Models can be built based on the GIS exports of wastewater networks.

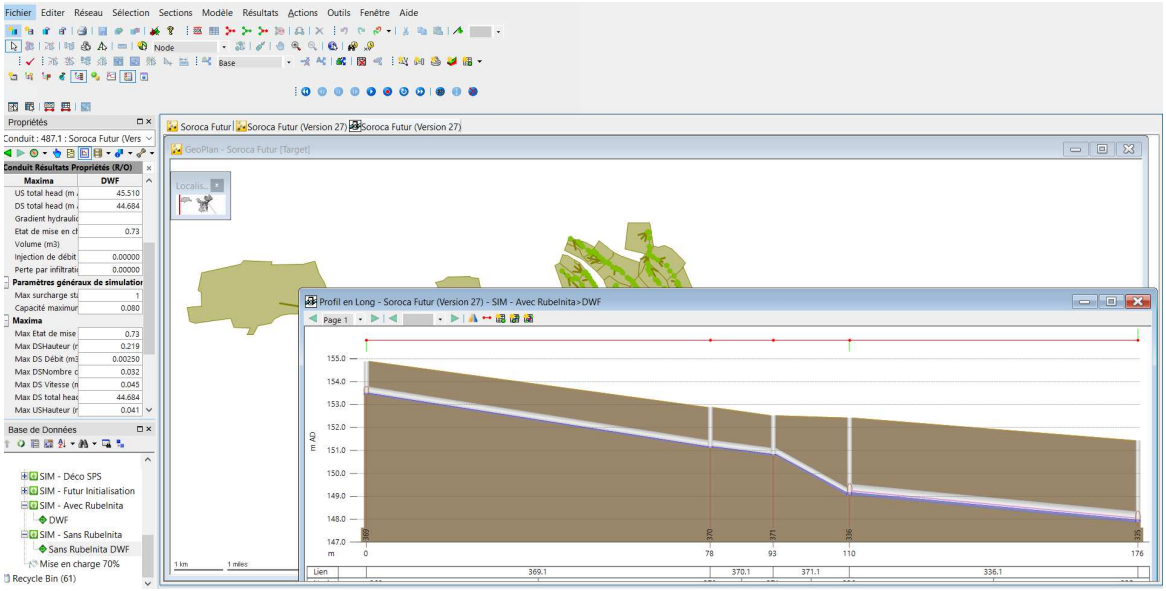


Figure 52: Illustration of INFOWORKS ICM

This software combines :

- Hydrologic and hydraulic computation engines ;
- Cartographic interface.

INFOWORKS ICM provides network views with overflow nodes when occurs and profile gradients to assess the network load. Thus, the software allows to :

- Perform a diagnostic of the current wastewater network (load of pipes, water velocity etc.);
- Perform predictive simulations with network extensions and new wastewater connections to assess the future network load;
- Determine the future dimensions of the network needed to prevent the overflows and overloads in the network.

After the completion of the project, the **model will remain as a valuable operational and planning tool** for SA “Regia Apa Canal Soroca”.

6.1.3. Modeling methodology: main steps

Each type of model (physical, mathematic, numeric) follows the same methodology:

- **First step : Data collection**

Sewer network data has been collected from SA “Regia Apa Canal Soroca”, Soroca municipality and from the topographic campaign performed in the frame of this project. Data needs to be processed in order to be integrated into the GIS software.

- **Second step : Model construction**

During this step, all data collected during the first step and needed for the calculation are transferred first, in the GIS Software and then in INFOWORKS ICM. The parameters required include ground elevation, manholes invert levels, pipe’s diameters, pipe’s materials, subcatchments delimitation and contributions.

- **Third step : Model calibration**

The model calibration has been based on the flow measurement campaign and on the customer database.

- **Fourth step : Diagnostic**

Once the model is realized and calibrated, the network diagnostic allows to visualize flow problems.

- **Fifth step : Simulation of future situation and definition of priority works**

During the last step, the future network condition based on the hypothesis is modelized and the reaction of the network is observed through the model to assess its capacity. **The target horizon considered in this study is the year 2065.**

6.1.4. Modeling methodology: Detailed approach

6.1.4.1. Model construction

Network

The part of the network integrated in the model has been defined based on the GIS provided by SA "Regia Apa Canal Soroca" and on the data collected through the topographic campaign. **Only the main sewer pipes have been modeled** (small pipes are not needed).

The map below shows the network used in the model.

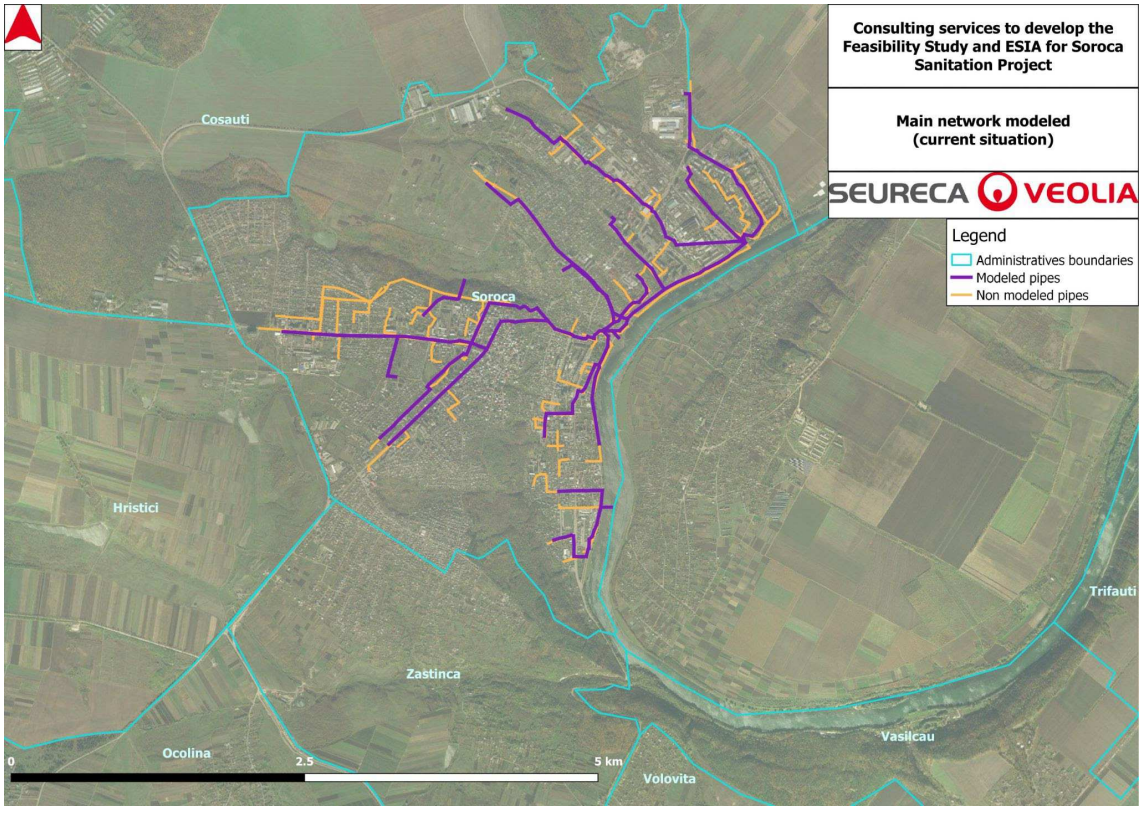


Figure 53: Main network integrated in the model (current situation)

Nodes

Nodes represent manholes. For each node, the following information have been entered:

Table 16: Nodes parameters entered in INFOWORKS ICM

ICM Parameter	Data entered
Node type	Manhole
Ground level	Topographic campaign data collected (mASL)
Invert level	Topographic campaign data collected (mASL)
Flooding area	0,1 ha (usually used for modeling)

When data were not available, some estimations have been made by interpolation, considering upstream and downstream nodes and the available digital elevation model.

Pipes

The pipes characteristics used come from the topographic campaign. For each pipe, the following information has been entered:

Table 17: Pipes parameters entered in INFOWORKS ICM

ICM Parameter	Data entered
Upstream node ID	Manhole ID
Downstream node ID	Manhole ID
Shape	Topographic campaign data collected (mASL)
Diameter	0,1 ha (usually used for modeling)
Upstream invert level	Upstream node invert level
Downstream invert level	Downstream node invert level

When data were not available, some estimations have been made considering upstream and downstream pipes and the slope.

Outfalls

The outfalls are the point where wastewater exits the network and flows into a water body or a WWTP. The following information has been entered:

Table 18: Outfalls parameters entered in INFOWORKS ICM

ICM Parameter	Data entered
Node type	Outfall
Ground level	Informatic elevation model (mASL)
Invert level	1 meter lower than the upstream node (mASL)

As no data were available for the outfalls, hypotheses based on field data and topographic campaign data have been made.

The figures below show the model built for the current situation and the future situation.

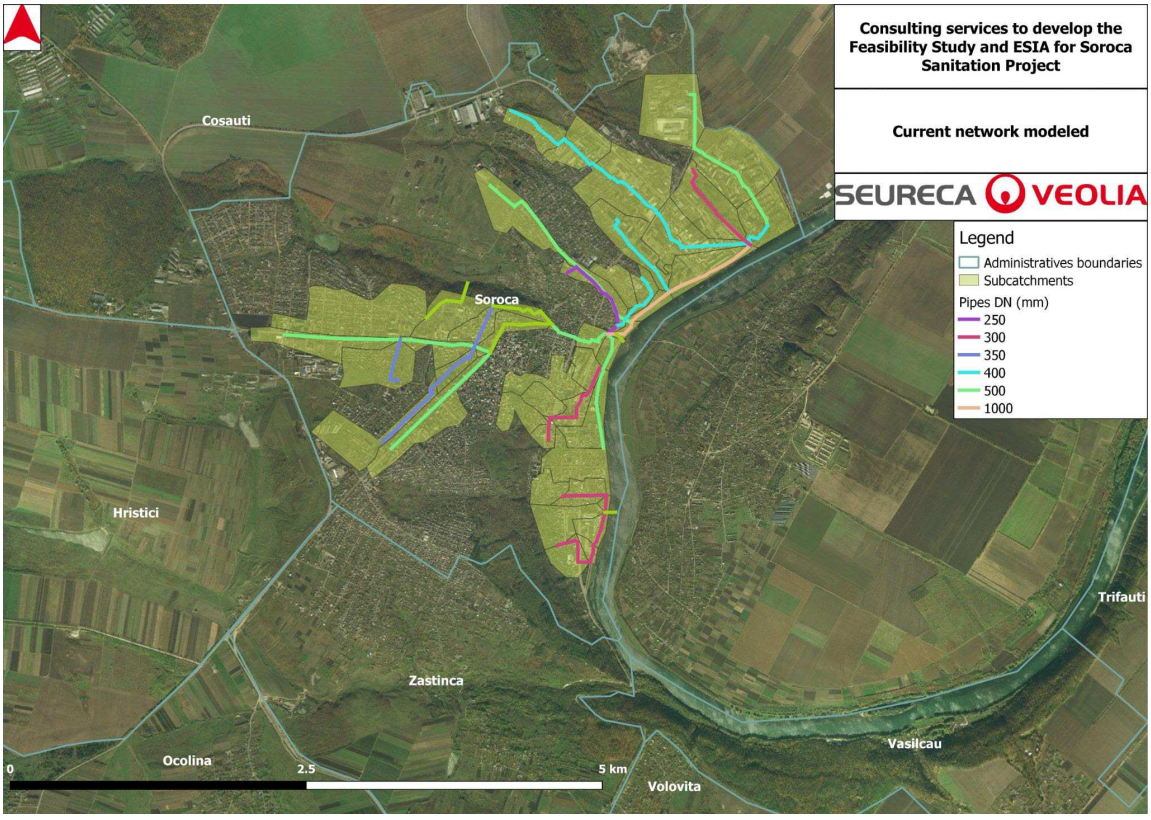


Figure 54: Current network modeled

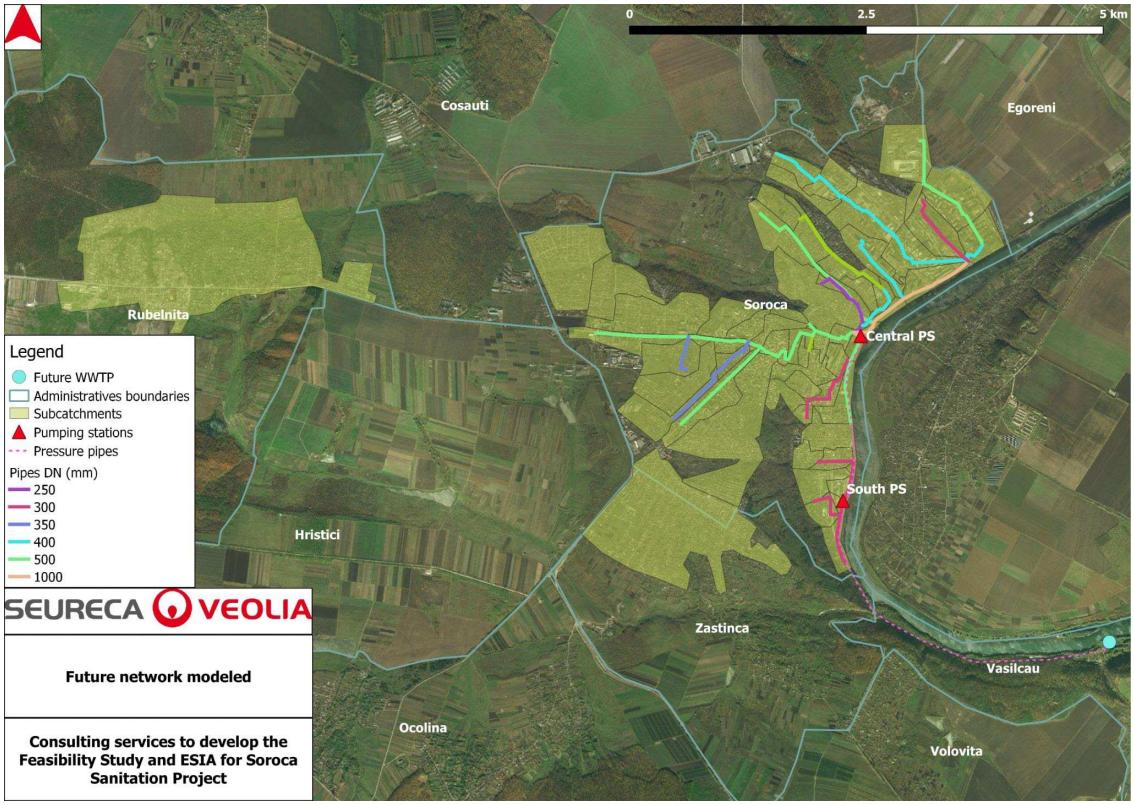


Figure 55: Future network modeled

6.1.4.2. Sewerage flows

To assess the capacity of Soroca network, the wastewater flow in the network is calculated following the formula below :

$$V_{wastewater} = (V_{domestic\ wastewater} + V_{non\ domestic\ wastewater}) \times 1,9 + V_{rainwater} + V_{infiltrations}$$

Where :

$V_{domestic\ wastewater}$ = Network linear x Connection rate x Number of inhabitants per connection x Daily consumption x Return rate
$V_{non\ domestic\ wastewater}$ = Volume of non domestic wastewater
$V_{rainwater}$ = Network linear x Rainwater rate per network linear
$V_{infiltrations}$ = Network linear x Infiltrations rate per network linear

Based on information provided and collected, the following parameters and volumes have been considered :

- **Network length :** the main network has been considered based on the information provided by SA “Regia Apa Canal Soroca”.
  - Current : 32,5 km
  - Future (2065) :

        - Extensions :
            - 68,7 km without Rublenita
            - 91 km with Rublenita

- **Connection rate :** the connection rate takes into account the total number of customers in Soroca: current and future. In the model, those customers have been affected with a pro-rata on the total pipe length. This approach allowed for the customers' density to be considered. (the extensions to new neighbourhoods have less density, with more individual houses, than in the center).

- **Number of inhabitants per connection :** the number of inhabitants for each customer account and connection correspond approximately to the average number of people living per household.
    - Current and future : 2,5 inhabitants per connection

- **Daily consumption :** For the model, the drinking water consumption for each inhabitant has been estimated at :
    - Current : 86 L/capita/day
    - Future (2065) : 104 L/capita/day

- **Return rate :** not all the water returns to the wastewater network as some volumes are used for activities such as garden irrigation or car wash. The return rate considered is :
    - Current and future : 80 %

- **Volume of non domestic wastewater :** the non domestic wastewater combines industrial and public services (budgetary institutions) discharges. For these volumes, the following hypotheses have been taken:
    - Current and future :
        - Public services discharges : 10 % of domestic wastewater
        - Economic agents discharges: Current discharge fixed at 137 m^3/day plus additional industrial discharges which evolve as a ratio of domestic wastewater (10 % of domestic wastewater)

- **Rainwater :** the rainwater has been estimated based on the flow measurement campaign extrapolated to the area of the urbanised city. For the model, the rainwater has been estimated as a constant in order to assess the capacity of the network. This rainwater flow has then been affected to the different catchments based on the network length.
    - Current and future : 36 m^3/h rainwater's extra volume

- **Infiltrations :** the infiltrations have been estimated based on the flow measurement campaign, and extrapolated based on the network length and condition. As the existing network will be renewed during the future years, the infiltration rate should decrease.
    - Current : 31,2 m^3/h
    - Future : 22,5 m^3/h

- **Peak Dry Weather Flow:** a coefficient of 1,9 has been used to calculate the peak daily flow .

With those volumes considered, it is possible to estimate the capacity of the network in the worst case scenario when a rain occurs at the peak of wastewater discharge.

6.1.5. Results of Hydraulic Model

The hydraulic model's results help to determine the current capacity of the network and the areas that would need improvement in the future in order to increase the capacity of the network.

6.1.5.1. Modelling of the current situation

The results of the model show a **large capacity of the network with less than 50 % capacity used in the downstream pipes near the main outfall** close to the old central pumping station. The current network is largely oversized for the current flows.

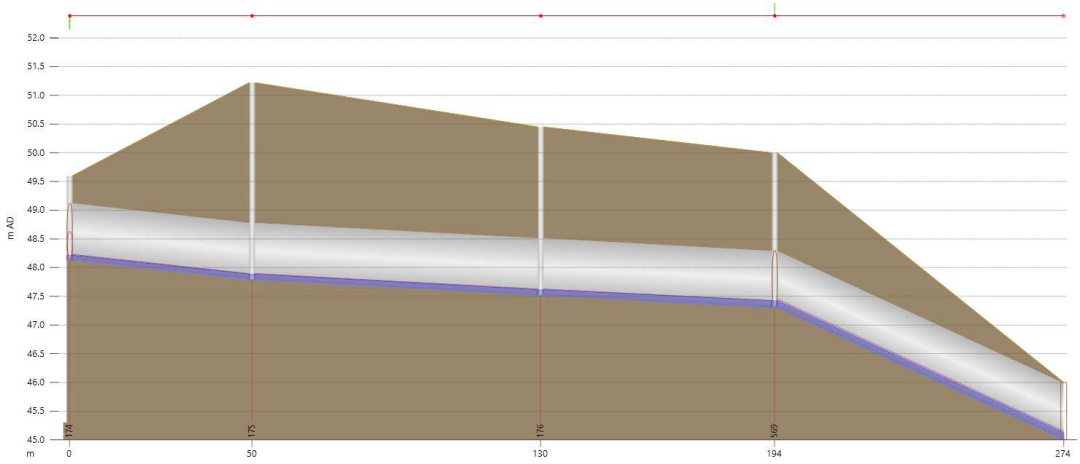


Figure 56: Example of profile gradient for the DN 1000 pipe filling before the outfall for the current situation

The current network model is shown below.

Figure 57: Map of the modelled current network

There are only two sections where the pipes are filled at more than 70 % :

- One DN 250 pipe in the street Alhionie, near the old central pumping station, because of the low slope and the influence of the DN 500 pipe downstream. As the network connections are not well known in this area with a lot of pipes' arrivals, it may not represent exactly the reality. However, this issue is minor and does not impact the assessment of the network condition;
- The pipe in the street Petru Rares, near the old south pumping station, with multiple reverse slopes and downstream influence of the pumping station no longer in operation with an outfall to the river on a higher elevation than the lowest elevation of the network. It causes a constant pipe's filling.

The map below shows the pipe loading with the current model.

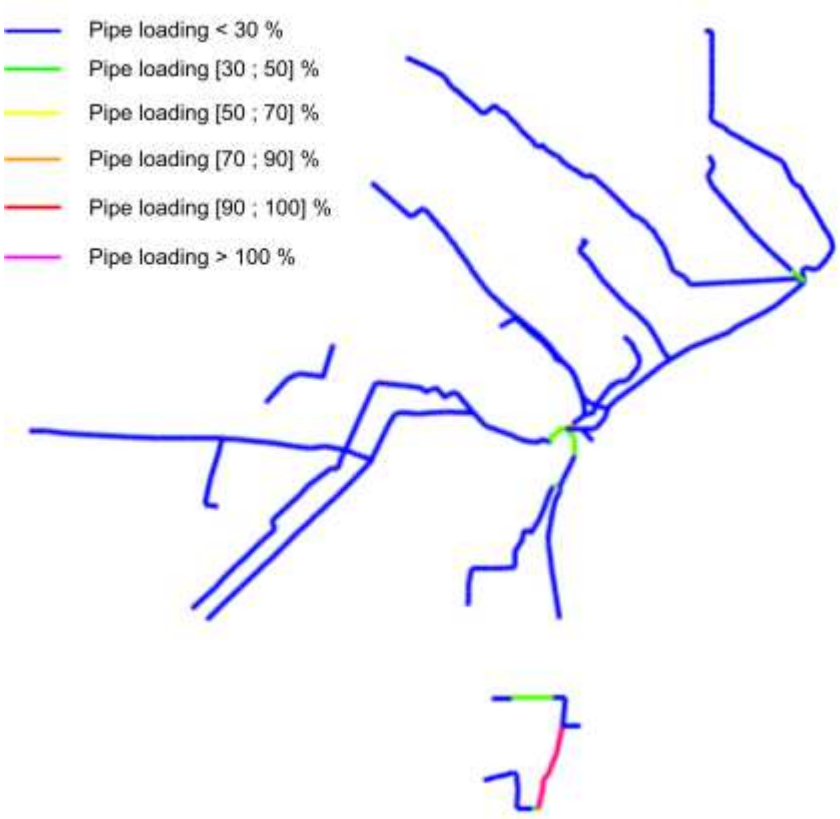


Figure 58: Current network loading modeled

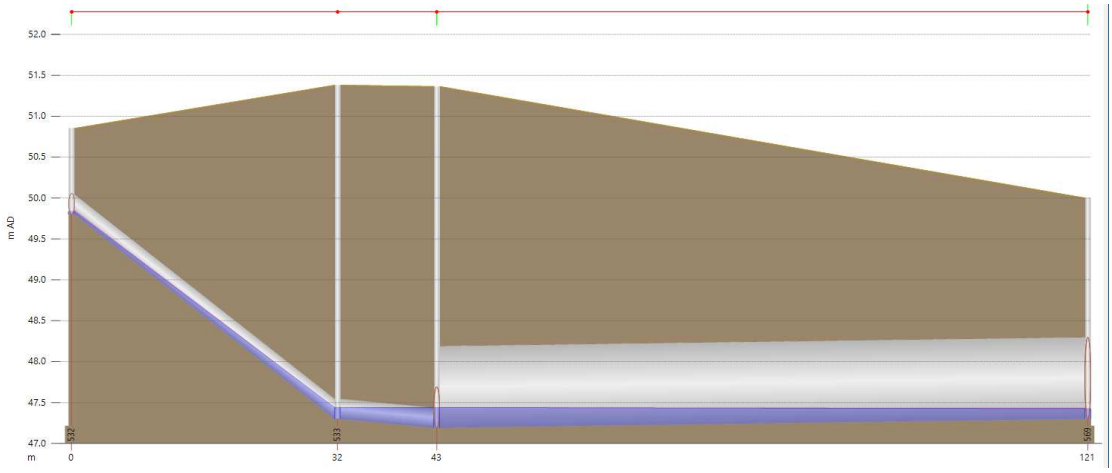


Figure 59: Profil gradient DN 250 pipe with almost 97 % of the capacity used from model in the street Alhionie

Figure 60: Map with the DN 250 pipe concerned by the capacity minor issue in the street Alhionie

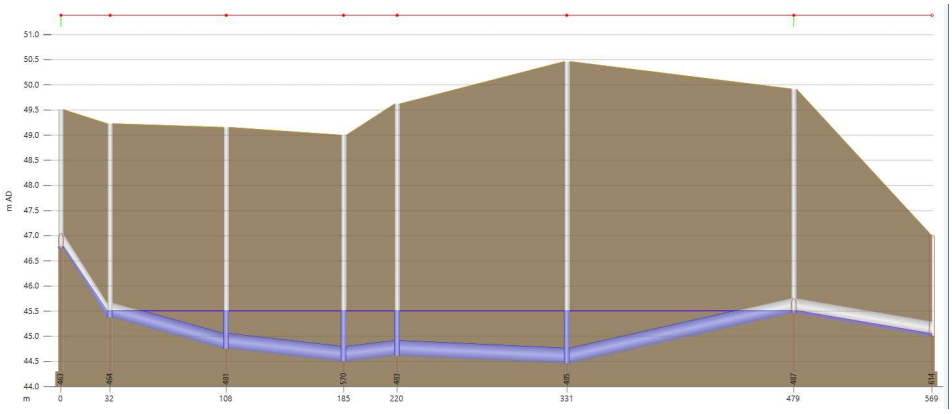


Figure 61: Profil gradient pipe filled with the reverse slopes in the street Petru Rares

Figure 62: Map with the pipe concerned by the reverse slope in the future configuration, street Petru Rares

6.1.5.2. Modelling of the Future Situation - Unchanged Design

Based on the work done with the GIS and based on the project criteria defined in the intermediate report, a network aiming at collecting the wastewater of 90% of the population in the future situation has been proposed and integrated in the model. In an initial step, the pipe's diameters were kept as of today (oversized for the current flow), only completed by required network extension, all in 200 mm.

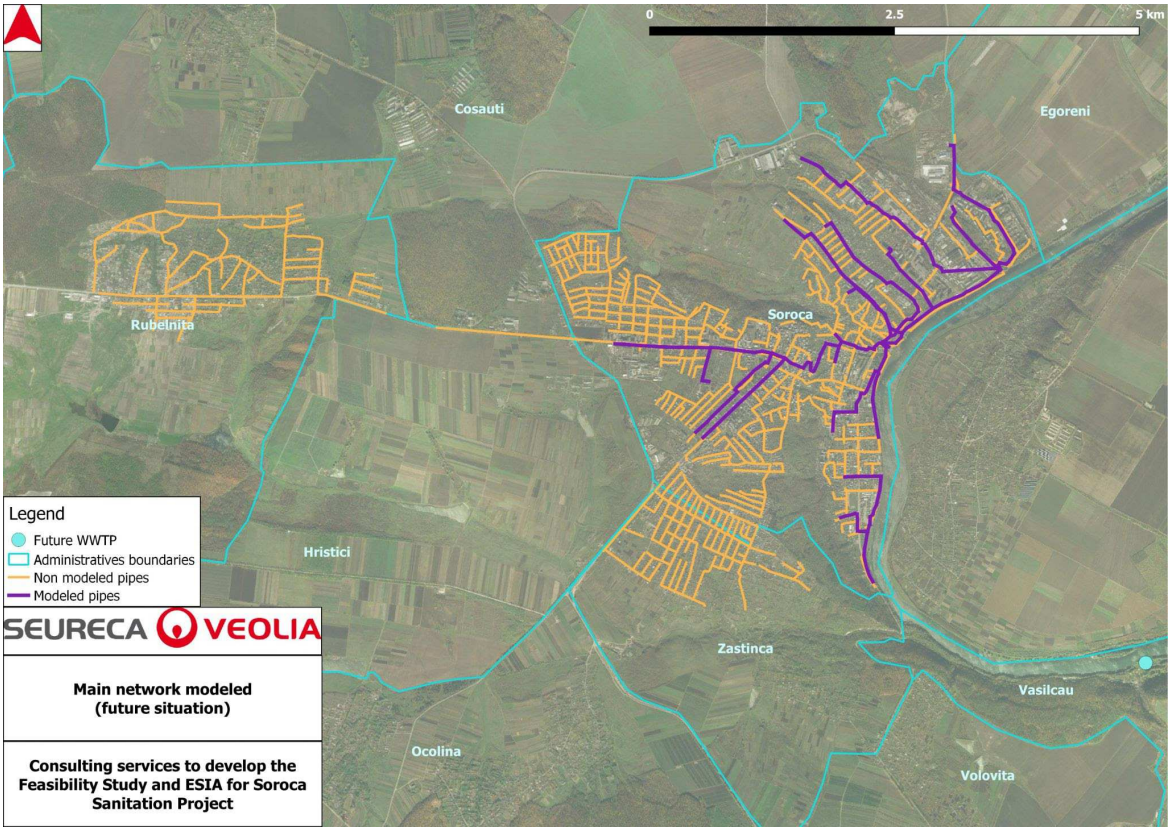


Figure 63: Main network integrated in the model (future situation)

The model with the future network and new pumping stations reveals no particular problems. The pipes near the main pumping station are loaded with less than 35 % of water. Only the pipe street Petru Rares is loaded at 73 % nearby the south pumping station because of a reverse slope. The results of pipe loading are presented below.

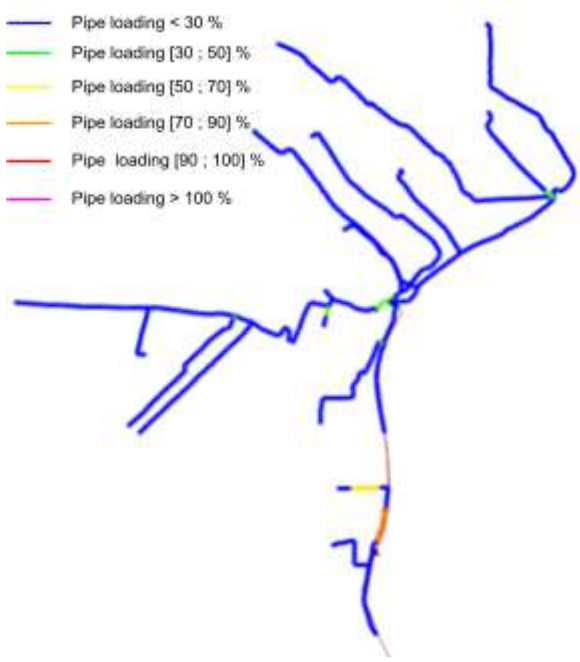


Figure 64: Pipes loading for the future situation in 2065

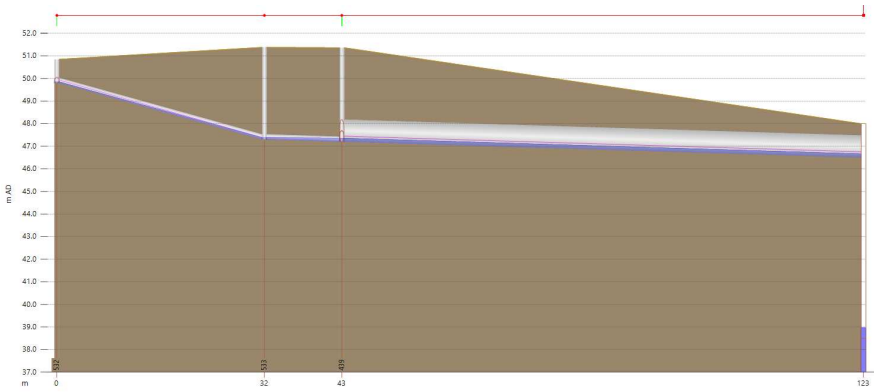


Figure 65: Profil gradient of the pipe before the main pumping station

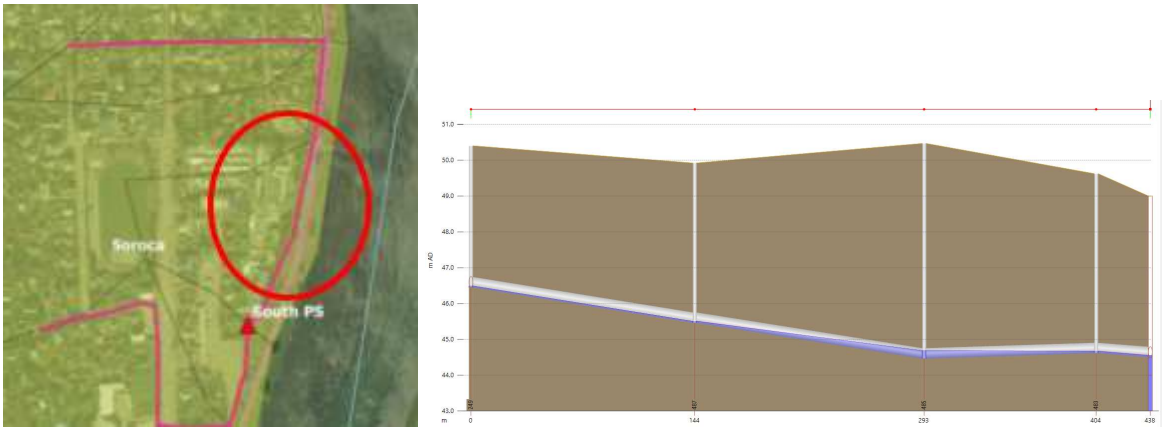


Figure 66: Pipe in the street Petru Rares with the reverse slope before the South Pumping Station: Map (left) and Profil gradient (right)

As a conclusion, it appears that the size of the existing network is sufficient to cope with the future flows and only structural rehabilitation is required. The water level remains very low in most of the major pipes, according to the model, it is possible to optimize the wastewater network and change the diameters of the pipes being replaced.

6.1.5.3. Modelling of the future situation with diameter optimisation (reduction)

The future model has been modified with a reduction of pipe diameters in order to prepare the wastewater network replacement plan and optimize the costs. As observed in the two previous sections, the current and the future networks are oversized and, in case of rehabilitation with identical diameters, the costs will be more important than with optimised diameters.

It is important to note that oversizing does not impact only the costs but also the operation of the system. Indeed a network with the correct pipe diameters will have higher velocities which is better for maintenance and self cleaning, reducing the risk of H_2S release.

The future network with pipe diameter reduction is presented below.

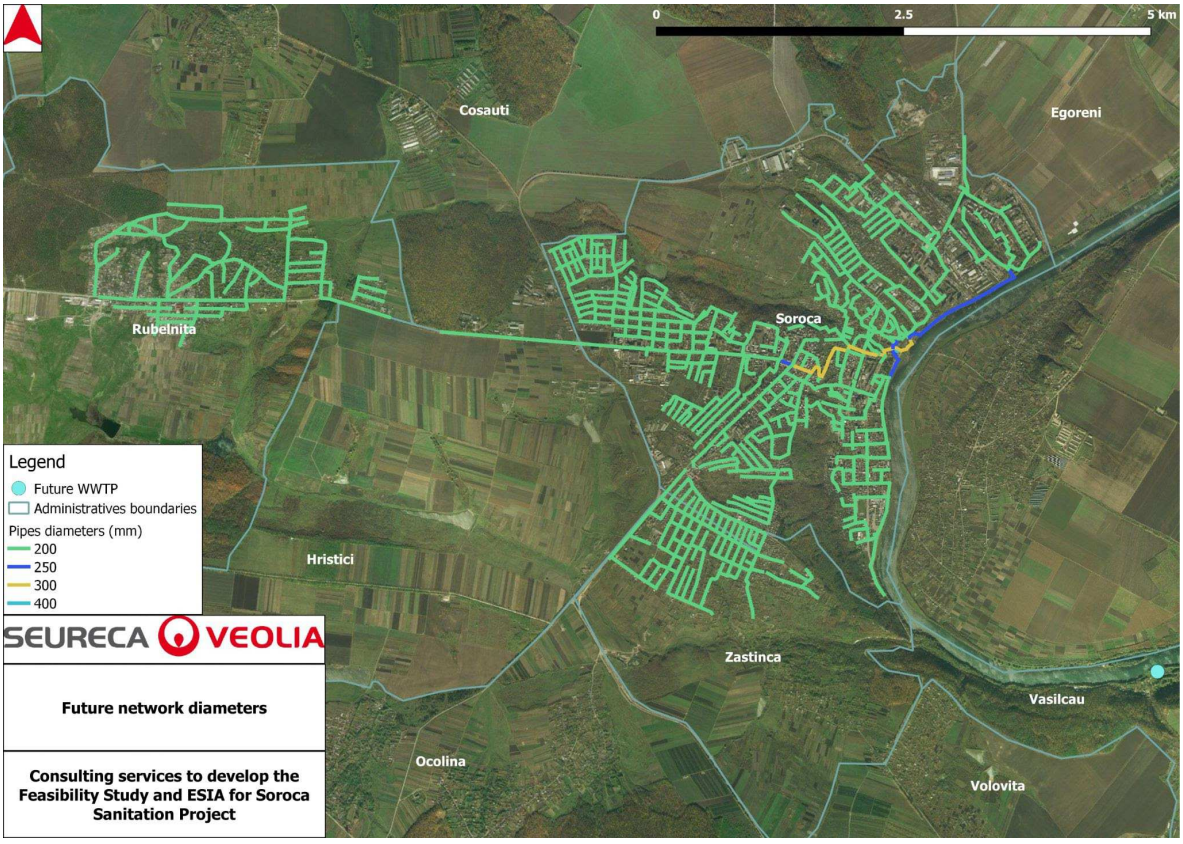


Figure 67: Future network diameters

The simulation performed with these diameters presents no issues. The only two problems come from the reverse slope noted in the previous section (street Petru Rares) and another reverse slope in the north east (street Dmitrie Cantemir) as visible in the figure under the model's map below.

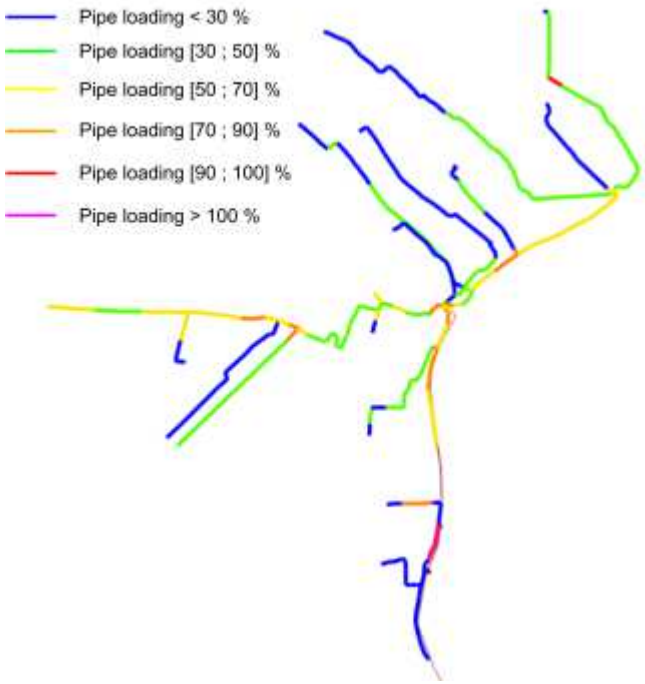


Figure 68: Pipes loading results for the future model with pipe reductions

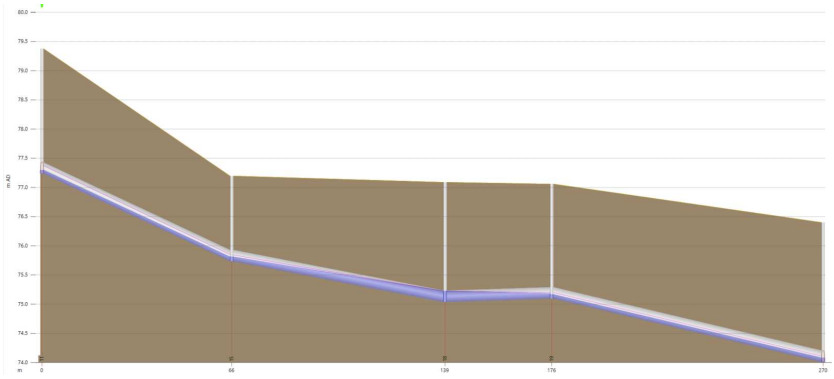


Figure 69: Reverse slope in the street Dmitrie Cantemir

For most of Soroca city, a rehabilitation with diameters of 200 mm is sufficient and only the downstream parts of the network will require 250 to 400 mm (not 300 to 1000 mm as of today).

It clearly appears that it is possible to renew the current network with smaller diameters to reduce the cost and reduce the risk of deposit.

However, for these replacements with pipe diameter reductions, it is necessary to plan the works and proceed from upstream to downstream of the network and prepare detailed study ahead of the works.

6.2. Future wastewater collection system : rehabilitation and extension

The previous section presented the hydraulic assessment of the network, in the current and future situations. Strong of this knowledge, the following section will present in more detail the required investments to be undergone to adapt the current network to the future situation.

6.2.1. Objectives and requirements of the future network

As of today, the wastewater network in Soroca collects about 42% of the wastewater discharged by the city (domestic and industrial).

For the wastewater collection and transfer to the treatment site, in order to meet the targeted coverage rates, the required investments will include both rehabilitation of existing and construction of new infrastructures to ensure the correct operation of the sewer network. This will include:

- **Gravity pipes renewal and extension:**
  - the construction of new pipes (network extension) in the areas currently without any network. The diameter of most of the extension pipes will be 200 mm.
  - rehabilitation of existing pipes will have to be undertaken, as many are in a poor structural condition (most of them could be replaced with 200 mm as seen in the previous section).
  - repair of existing pipes:
    - for example the broken gravity pipe in “Centru” sector, most of the time with similar diameters in the same location.
    - in other cases, like for the broken gravity pipe “Gipsy Hill”, rerouting of the existing pipes (thus changing the location and diameter) will be required.
  - New connection to the houses/buildings will also be required (for new but also for existing networks)
- **Pumping stations and pressure pipes rehabilitation, construction or reconstruction**
  - Several new pumping stations (rather small, only to pump a few houses/neighborhoods) will be required to pass the hilly topography of the city. Each station will be completed by a short length of pressure pipes to reach out to the closest gravity network.
  - The South Pumping Station will have to be rebuilt and its pressure pipe toward the main network rehabilitated.
  - The main Central Pumping Station will have to be rebuilt. A new pressure pipe will have to be constructed to send the pumped wastewater all the way up to the WWTP site.

Nota: It is important to remember that, for networks, the design criteria in terms of possible collected flow is always the final horizon 2065, no matter the date of the pipe laying. For the pumping stations, the infrastructure and civil work will be designed to meet the 2065 horizon but the pumps will first be installed for the estimated connection rate of 2035. This will be done in order to adapt the design and operation of the system to the reality of the connection rate actual increase. When required, additional pumps will be installed.

Nota: As previously explained, the design flow considered for the network is based on the peak dry weather flow and includes a provision for infiltration water and for stormwater. Indeed, although rain and infiltration flows should not be collected by the sewerage system, measures and on site

observation showed that these volumes exist. They are therefore considered in order to minimize the risk of overflow and pollution of the river and, when it happens, to control the overflow and protect health and safety of the operators and inhabitants. That is also why the South and Central pumping stations will be equipped with an overflow to the river in order to avoid any inondation in case of a heavy rain entering the system.

6.2.2. Short term plan 2025 : Network and Pumping Station Rehabilitation Programme

The short term plan includes urgent actions necessary to ensure the correct operation of the existing system (rehabilitation and recommissioning). The objective is that the wastewater discharged today is collected and sent to the future WWTP site.

The overview of the works planned for the short term is detailed below:

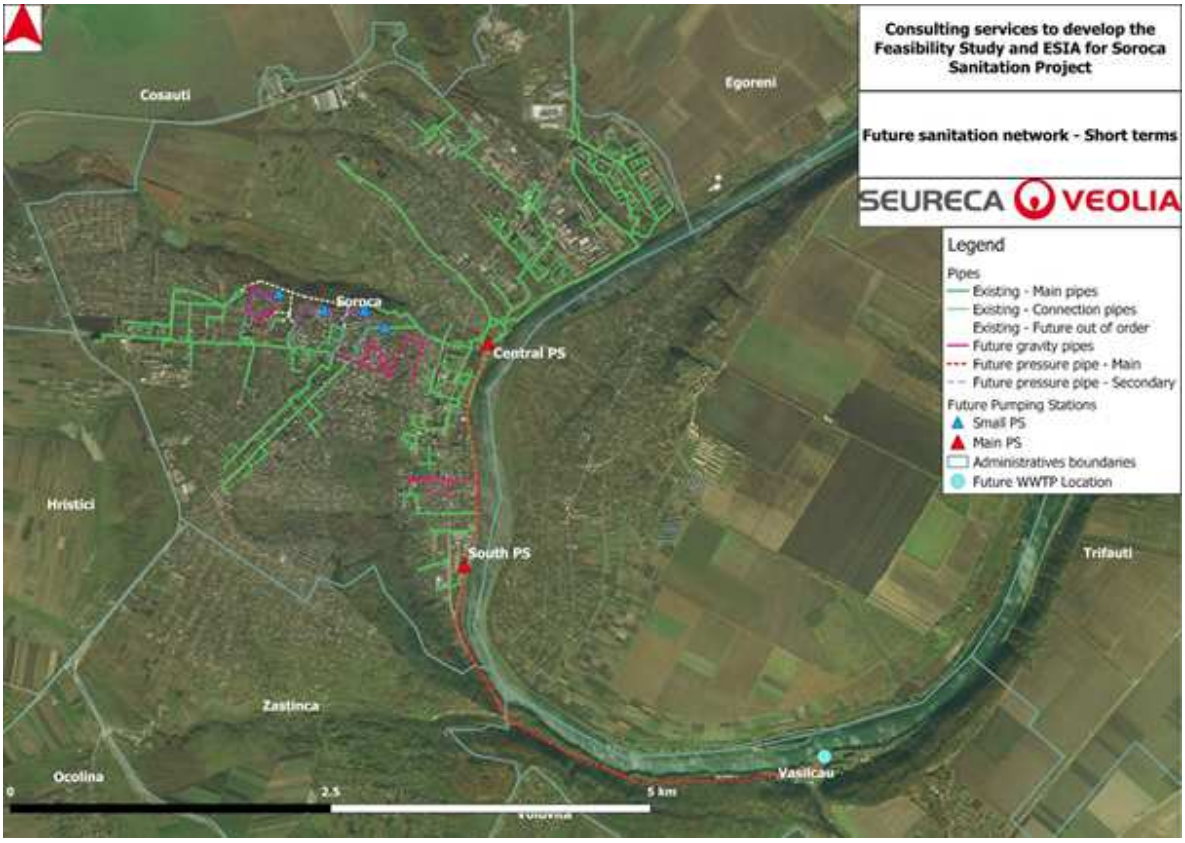


Figure 70: General overview of the short term plan - network

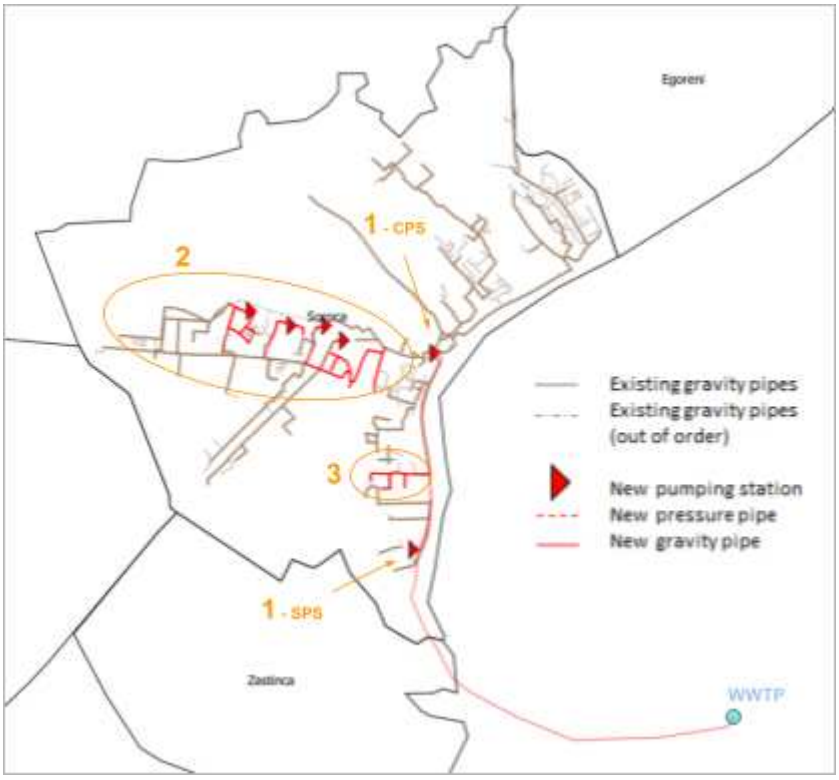


Figure 71: Detailed overview of the short term plan - network

The short term works include :

- The renewal of the 2 main pumping stations: 2 pumping stations (Central PS and South PS) will be constructed next to the existing ones and associated pressure pipes will be laid. The selection of the pumps will be done considering the future connection rate in 2035. However, the overall design of the pressure pipe and the pumping station will be designed in order to bring additional or larger pumps in the future if needed.

  - **South Pumping Station (SPS)**
    - Pumping from the SPS to the main network
    - Pumping station:
      1. Number of pumps: 1 + 1 (stand-by)
      2. Flow: 4,4 l/s
      3. TDH: 12 m
      4. Power: 1 kW
    - Pressure pipe to connect SPS with gravity network:
      1. Diameter: DN 90 (int.77 mm)
      2. Length: 0,83 km

  - **Central Pumping Station (CPS)**
    - Pumping from the CPS to the WWTP
    - Pumping station:
      1. Number of pumps: 2 +1 (stand-by)
      2. Flow: 36 l/s

3. TDH: 38 m
4. Unit power: 25 kW

- Pressure pipe to connect CPS with new Soroca WWTP:
  1. Diameter: DN 400 (int. 353 mm)
  2. Length: 5,8 km

A manual coarse screening (40 - 60 mm) will be installed upstream the lifting pumps to protect them from coarse debris.

An overflow to safely discharge stormwater and/or wastewater in case of dysfunctional operation of the pumping station. This overflow will be equipped with a manual coarse screen.

The Central and South Pumping Stations will be provided with a stand-by electric generator to ensure Category II reliability.

- The rerouting of the forest broken pipe in Gipsy hill (1.5 km gravity pipe DN200 and 1 km pressure pipe): as of today, the pipe is broken and wastewater overflows directly in a small stream towards the Nistru. Most of this pipe route is under private property, not accessible to SA "Regia Apa Canal". With the known constraints, the short term plan includes the **partial** rehabilitation of this pipe[13] with the construction of 2 small pumping stations in order to avoid laying of a new gravity pipe in the forest. However, detailed studies could be performed to propose an optimised solution. In general, it will be strongly recommended to lay public pipes under public roads/areas, in order to ensure easy access for maintenance.

- The rehabilitation of the broken gravity pipe in "Centru" sector (1,4 km DN500).

Summary of the short term plan

The characteristics of the short term plan works are as follows:

Table 19: Short term plan works

Works	Quantity
Gravity pipes reparation	2.9 km
Individual connections	194 u
Central Pumping Station	1 u
South Pumping Station	1 u
Local PS	2 u
Pressure pipe from CPS to WWTP DN400	5.8 km

[13] In the first version of this report, it was proposed the complete rehabilitation of this pipe (3 km gravity pipe, 2 km pressure pipe and 4 small PS). Due to the reduced available funds for the first phase, the revised investment plan only includes half of the planned works. The rest of the rehabilitation works will be done in a second phase, together with the rehabilitation of other parts of the network.

Pressure pipe from SPS to network DN90	0.8 km
Other pressure pipes in forest area	1 km

6.2.3. Medium And Long term plan

The medium and long term plans include the extension of the sewage network and the rehabilitation of the existing one. They aim at having a collection system fully operational for the final horizon.

A - Network extension

The following table provides a reminder of the baseline situation in terms of coverage and connections within Soroca:

Table 20: Current population wastewater coverage and connections in Soroca city

Connections	Population in 2020	Total connections in 2020	Active customers in 2020	Estimated population connected per district	Estimated population with active water and ww
Bujerauca	2 518	983	747	74%	1 868
Bujerauca Noua	4 282	54	41	2%	103
Centru	4 434	1 330	1 011	57%	2 528
Colegiul Agricol	2 737	543	413	38%	1 033
Dealul Romilor	3 271	145	110	8%	275
Dealul Sorocii	2 499	82	62	6%	155
Hidroinpex	4 072	414	315	19%	788
Soroca Noua si FAT	11 492	4 259	3 237	70%	8 093
TOTAL Soroca	**35 305**	**7 811**	**5 936**	**42%**	**14 840**

Considering the rather low current coverage ratio (42% in Soroca city), network extensions within the perimeter were proposed based on the current coverage rate within districts as well as the topography and the current urbanisation. Several pumping stations are included in the program, in order to avoid laying pipes in private or in non-accessible areas (this could be improved by future detailed studies as it is recommended to minimise the number of pumping stations).

The village of Zastinca being very close to Soroca (same urban area), the best option for wastewater collection is to build its sewer system connected to the Soroca network. **Zastinca has been therefore considered as a part of the agglomeration of Soroca to evaluate the future connection rate.**

Also, as per the conclusion of the sanitation solutions for villages presented in section 7.7.3, the village of Rublenita is big enough and close enough to Soroca to be worth connecting to the city and central system in the future.

An overview of the future wastewater network extension is shown below.

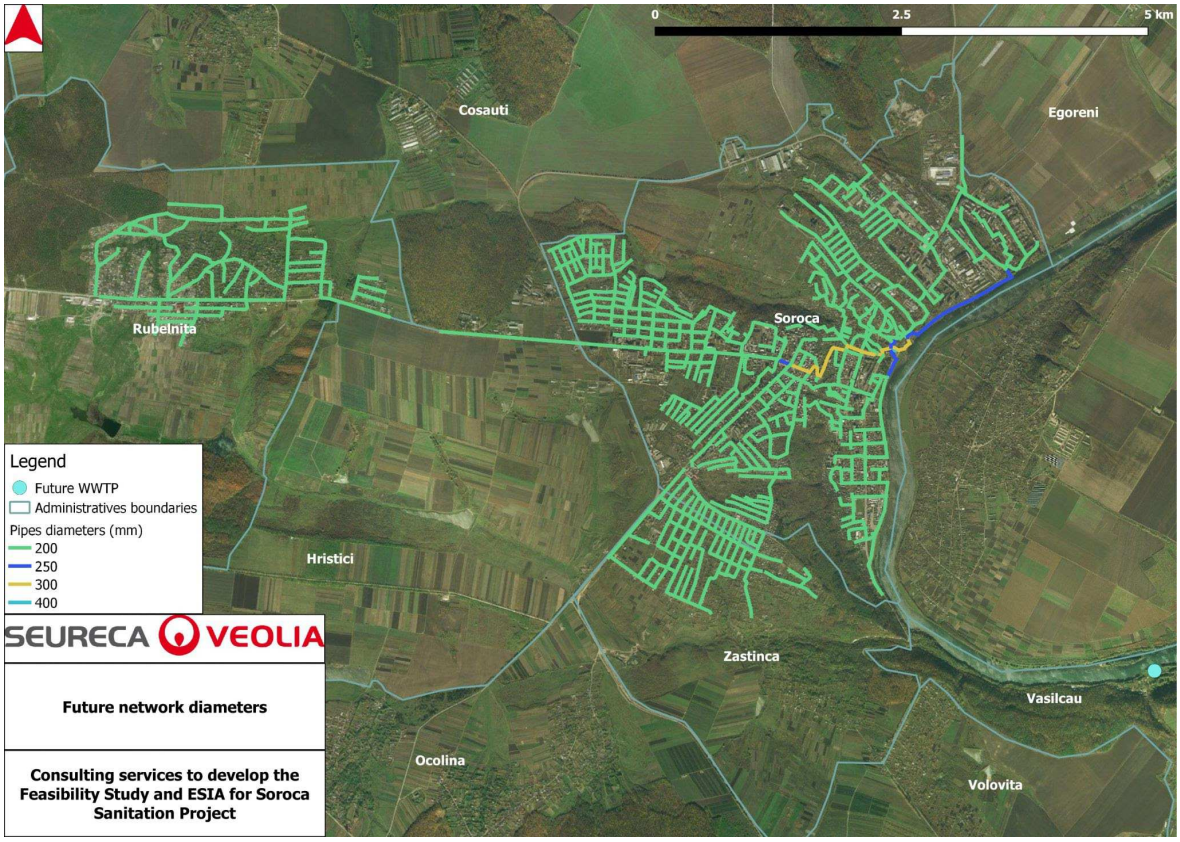


Figure 72: Complete sewer network extension at final horizon

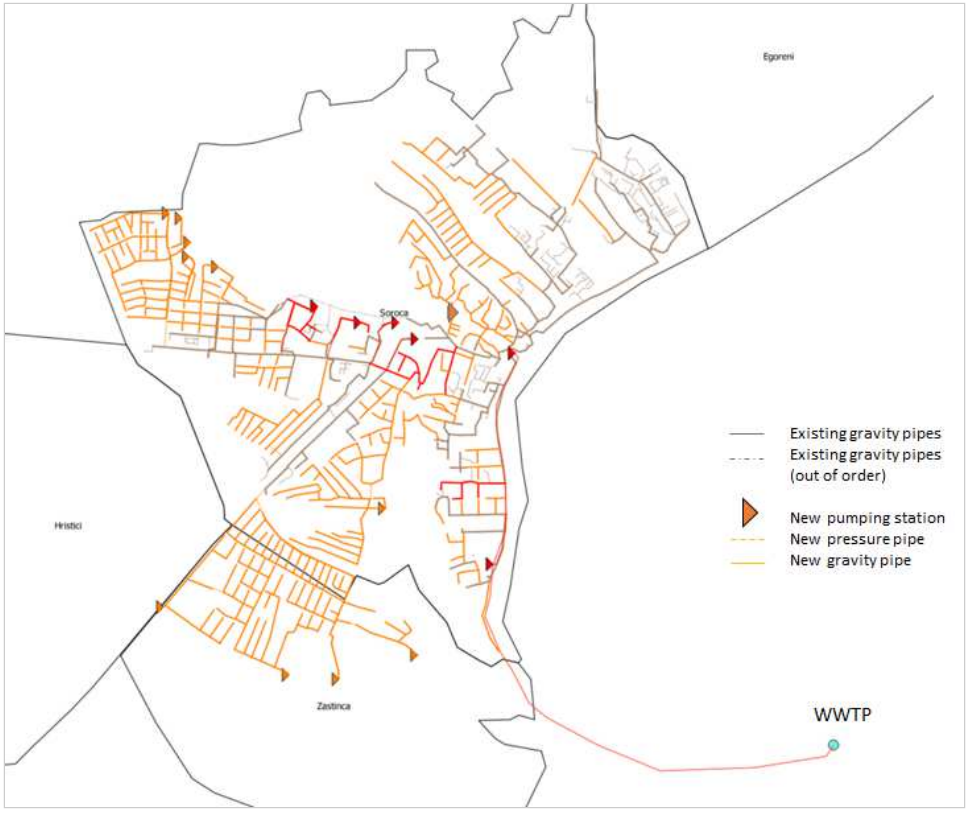


Figure 73: Detailed overview of network extension (in orange) in Soroca and Zastinca

The network extension will include a total of:

- 64.5 km gravity pipes in Soroca and Zastinca (and 20.7 km gravity pipes in Rublenita)
- 11 pumping stations in Soroca and Zastinca (and 5 pumping stations in Rublenita and 1 pumping station to connect to Soroca main network)
- 7.6 km pressure pipes in Soroca and Zastinca (and 1.6 km pressure pipes to connect Rublenita to the main network of Soroca).

Taking into account the estimated future wastewater flows and the Moldovan construction norms, which defines a minimum diameter for sewerage network in urban areas at **200 mm**, most of the gravity pipes will be designed with this diameter.

It should be noted that the important number of pumping stations is related to the difficulty of access for O&M activities to the private areas. The routing of the sewerage network is done through the roads, in public property, to avoid private areas.

In order to prioritize the extension of the network, a list of technical criteria is proposed to perform a multi-criteria analysis of the network as shown in the table below.

Table 21: Criteria for prioritization and ponderation

Criteria		Score
Combined with urgent works	YES	5
	NO	1
Area already supplied by drinking water	YES	3
	NO	1
Population density (1000 inhab/km²)	3 - 8	3
	2 - 3	2
	< 2	1
Connection by gravity to the existing network possible	YES	3
	NO	1

For each pipe, a score is given for every parameter and the total score is calculated (addition of all 4 criteria). Pipes with high scores will be laid in priority. The result of this multi-criteria analysis is presented below.

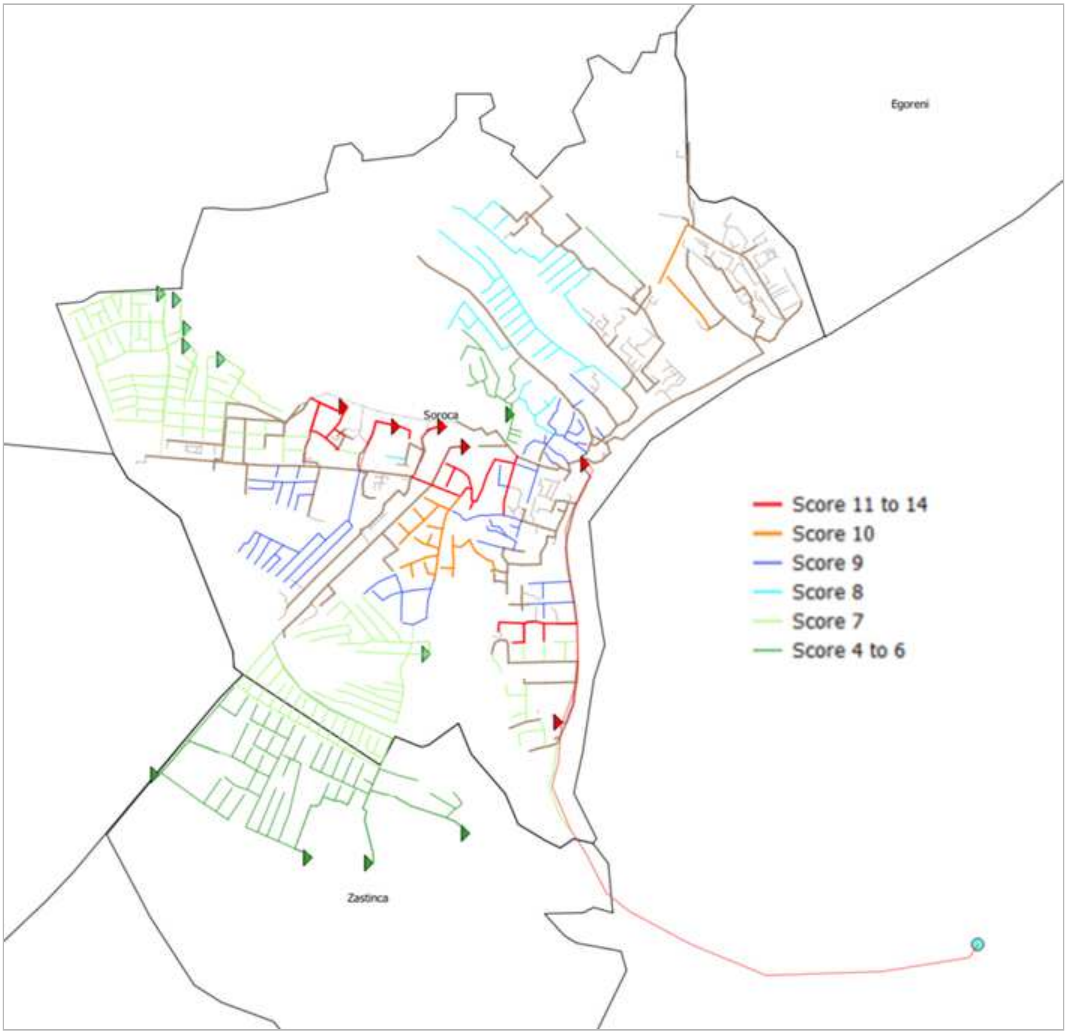


Figure 74: Sewerage network extensions - Priorities

The pipes with the highest score (score 11 to 14 in red) are the priorities for the short term investment.

According to this analysis, the next priority area will be located in Dealul Romilor and Soroca Noua (score 10 in orange), which correspond to highly populated areas, followed by Colegiul Agricol district, some areas of the Centru and the rest of Dealul Romilor (medium population density and possibility to connect by gravity).

The network extension will then be carried out in Bujerauca (score 8, light blue). Upstream networks that need pumping stations can be extended after that (score 7, light green).

The last area to be developed is Zastinca, only after the complete construction of the drinking water network. Rublenita will come after Zastinca, with the same requirement on drinking water connection.

This analysis can be completed or adjusted with social criteria and the city development strategy if required. As presented in section 3.1.3 the Soroca 2019-2021 Urban Revitalisation Plan targets the district “Dealul Romilor” as well as the adjacent section of the Colegiul Agricol district (the College itself and the Street Calea Baltului) as the priority area for urban development.

The length of networks that will be part of the medium term or the long term plan will depend on the target coverage rate required for 2035 and 2045/2065. In this final report, the following coverage rates have been proposed to evaluate the required investment (see Investment Plan section):

- Coverage rate of 47% in 2035,
- Coverage rate of 75% in 2045,
- Coverage rate of 90% in 2065.

B - Network rehabilitation

Since the network is in a very bad condition with structural risk and a lot of infiltration spots, the full replacement of the main existing network (31,2 km) will be necessary in the mid-long term. In order to define the priorities and identify the urgent replacement needs (for the medium term plan) and the less urgent (for the long term plan) it is recommended to carry out **camera inspections (CCTV).**

Therefore, it is proposed the purchase of a CCTV truck / CCTV equipment for SA “Regia Apa Canal Soroca” or the contracting of a specialized society, to perform the survey of the network and identify the most urgent rehabilitation needs: survey of approximately 10 km of the network in the mid term and another 20 km in the long term.

The rehabilitation works have been divided into 6 packages of 5.2 km which can be spread over time according to the available budget and other priority works established by the municipality in the different Soroca sectors (road repairs, etc.).

Figure 75: CCTV truck

It is important to note that, before running the camera along the pipes, a cleaning of the canalisations has to be carried out by SA “Regia Apa Canal Soroca”.

The medium term investment plan also includes the purchase of HSE equipment to equip the network O&M team (as well as the WWTP and Pumping Station unit), in particular the following:

- Individual Protective Equipment (boots, reflective jackets, helmets, etc.);
- Collective Protective Equipment to equip the intervention areas;
- Gas detectors and mechanical ventilation equipment;
- Etc.

Summary of the medium and long term plans

The characteristics of the Medium and Long term plans works are as follows :

Table 22: Medium and long term plans works

Works	Quantity
Extension works - Gravity pipes	85,1 km
Rehabilitation works - Gravity pipes	32,7 km
Connections	7 899 u
Local PS	13 u
Pressure pipes length	8.6 km
Camera inspection (CCTV)	30 km
HSE Equipment	-

6.2.4. COMMENT ON THE CONNECTION RATE

One of the key design criteria for the Feasibility Study for Soroca Sanitation Project is the wastewater flows that will be collected. This is directly related to the connection rate (i.e. the number of inhabitants discharging their wastewater into the central network).

However, the connection rate increase does not only rely on investment and network extension. **It also depends on the willingness of the population to connect and use the public services**.

There are several solutions to ensure that people will actually connect to the main system: make it compulsory by law, encourage it with subsidies or fully manage and bear the cost of the new connections.

In France, for example, connection to an existing network is a legal obligation (within 2 years from the construction). In other countries, especially when completely new systems are built, the private connections are included in the general works.

Legal framework regulating connections to the wastewater network

According to the current legal framework, the decision to connect to the water and sanitation network is left to the discretion of individuals (and the connection fee is currently borne by the customer).

In a context where substantial infrastructure investment needs to be financed and where environmental protection has been identified as a key challenge by the Government, it seems necessary to update the existing legal framework to **make it compulsory to perform the individual sewer connections to new or existing centralized sewer systems, when the network** is located in reasonable proximity to the house.

International best practices show that such legal obligation can help the operator recover the large fixed costs component of investment based on the principle of economies of scale. In the case of Soroca, it appears indeed risky to invest in extending the sewer network if there is no guarantee that the residents will connect and become customers.

The financial implications of connecting to the sewer network need to be addressed independently (subsidization, etc.) and hence, **the cost of connections will be included in the Feasibility Study investment planning.**

Two costs are differentiated:

- Connection in the public property: from the sewer network to the connection chamber situated next to the customer's boundary. It includes the connection chamber and 6 meters of pipe;
- Connection in the private property: An additional cost to subsidize the connection works in the private property (from the connection chamber to the wastewater outlet of the customer). This cost may be highly variable depending on the internal arrangement of the plumbing network, the number and location of soakpits, etc.

7. WASTEWATER TREATMENT AND DISPOSAL

7.1. REGULATORY FRAMEWORK

7.1.1. MAIN REGULATORY FRAMEWORK FOR WASTEWATER TREATMENT AND DISPOSAL

The European Council Directive 91/271/EEC of 21 May 1991 on Urban Wastewater Treatment, has been partially transposed into the Moldovan legislation by the **Government Decision no. 950 of November 25, 2013 "Requirements for collection, treatment and discharge of wastewater in the sewerage system and/or in water bodies for urban and rural localities"**, last amended on February 19, 2020.

This regulation sets the requirements for the operation of wastewater collection systems and wastewater treatment plants. In particular, it establishes the discharge limits or Maximum Allowable Concentrations (MAC) for:

- Industrial wastewater discharges into the municipal sewerage networks (Annex 1)
- Industrial and urban discharges into water bodies (Annex 2)
- Treated wastewater or effluent discharge from WWTPs (Annex 3)

Table 23: Discharge limits to sewerage networks and water bodies set in the GD 950/2013

No	Parameter	Unit	Annex 1. Limit value discharges into the sewerage networks	Annex 2. Limit value discharges into water bodies
1.	Temperature	C°	> 8 - < 30	30
2.	PH	-	6,5-8,5	6,5-8,5
3.	Suspended Solids	mg/l	350	35
4.	Biochemical Oxygen Demand (BOD5)	mg O2/l	225 *	25
5.	Chemical Oxygen Demand (COD)	mg O2/l	500 *	125
6.	Ammoniacal Nitrogen (NH4+)	mg/l	30	2
7.	Total Kjeldahl Nitrogen (TKN)	mg/l		10
8.	Nitrate (NO3-) 5)	mg/l		25
9.	Nitrite (NO2-) 5)	mg/l		1
10.	Sulphides and hydrogen sulphide (S2-)	mg/l	1	0,5
11.	Sulfite (SO3)2-	mg/l	2	1.0
12.	Sulfate (SO42-)	mg/l	400	400
13.	Phenols (C6H5OH)	mg/l	3	0,3
14.	Substances extractable with organic solvents (grease)	mg/l	25	10

15.	Petrol products	mg/l	2,5	0,5
16.	Total Phosphorus Ptot	mg/l	5	2
17.	Biodegradable active anion synthetic detergents	mg/l	2,5	0,5
18.	Total Cyanures (CN)	mg/l	1	0,4
19.	Free residual chlorine (Cl2)	mg/l	0,5	0,2
20.	Chloride (Cl -)	mg/l	300	300
21.	Fluoride (F-)	mg/l	1,5	1,5
22.	Fixed residue (Total Dissolved Solids)	mg/l		1500
23.	Arsenic (As+)	mg/l		0,1
24.	Aluminium (Al3+)	mg/l		5
25.	Calcium (Ca 2+)	mg/l		300
26.	Lead (Pb2+)2)	mg/l	0,2	0,12
27.	Cadmium (Cd2+) 2)	mg/l	0,2	0,1
28.	Total chromium (Cr3++Cr6+) 2)	mg/l	1,5	1
29.	Chromium (Cr3)	mg/l		0,9
30.	Hexavalent chromium (Cr6+) 2)	mg/l	0,2	0,1
31.	Total iron ionic (Fe2+,Fe3+)	mg/l		5
32.	Copper (Cu2+)	mg/l	0,2	0,1
33.	Nickel (Ni2+)	mg/l	0,8	0,5
34.	Zinc (Zn2+)	mg/l	1	0,5
35.	Mercury (Hg2+)	mg/l		0,05
36.	Silver (Ag+)	mg/l		0,1
37.	Molybdenum (Mo2+)	mg/l		0,1
38.	Selenium (Se2+)	mg/l		0,1
39.	Total manganese (Mn total)	mg/l		1
40.	Magnesium (Mg2+)	mg/l		100
41.	Cobalt (Co2+)	mg/l		1

Table 24: Discharge limits for WWTPs set in the GD 950/2013

Parameter	Concentration	Minimum of % reduction	Observation
BOD	25 mg/l O_2	70 –90	
COD	125 mg/l O_2	75	
TSS	35 mg/l	90	
TP	2 mg/l (10 000-100 000 PE) 1 mg /l (> 100 000 PE)	80	Average annual concentration
TN	15 mg/l (10 000-100 000 PE) 10 mg /l (> 100 000 PE)	70-80	Average annual concentration (or daily average < 20 mg/l N) for water temperature of at least 12°C during the operation of the biological reactor

Some adjustments were made on 13.04.2020 to the Government Decision No. 950/2013, in particular, the Annex no. 8 (Methodology on the delimitation of agglomerations) was introduced. According to this Annex no. 8, the following aspects and requirements have to be taken into account when delimiting agglomerations:

Agglomeration size	**Requirements for**	
	wastewater collection system (sewerage)	**wastewater treatment**
>10 000 PE	Provide a collection system	Apply advanced treatment
2 000 - 10 000 PE	Provide a collection system	Apply secondary treatment or equivalent
<2 000 PE	Without specific requirement	No specific requirements, but subject to "adequate treatment" in case of agglomerations with an existing collection system

With regards to wastewater collection and treatment in rural areas, “individual systems or other appropriate systems shall be used to ensure the same level of environmental protection when the installation of a wastewater collection system is not justified, either because it does not produce environmental benefits or because it requires high costs”.

The individual wastewater collection systems recommended by the European Commission's guidelines are mainly watertight tanks, where wastewater is collected and transported regularly to a treatment plant, septic tanks or individual wastewater treatment systems.

7.1.2. National Water Supply and Sanitation Strategy 2014 - 2030

The **National Water Supply and Sanitation Strategy 2014-2030** establishes the following criteria for planning centralized wastewater infrastructure:

- the volume of domestic wastewater for the localities ≤ 10,000 PE: 135 lpcd for urban areas and 75 lpcd for rural areas;
- the volume of domestic wastewater for the localities > 10 000 equivalent-inhabitant: 160 lpcd;
- domestic wastewater restitution factor, expressed as the ratio between water consumption and wastewater production: 100%;
- maximum coefficient of variation, defined as the ratio between the daily flow and the maximum hourly flow: 1/10.
- Per capita equivalent: 60 g DBO_5/day

Following discussions with the Client, the figures presented in the National Water Supply and Sanitation Strategy 2014 - 2030 are not considered realistic for this Feasibility Study. **Appropriate values for specific wastewater generation volume and return factor have been proposed for Soroca.**

7.1.3. Construction Standards and Codes of Practice

The design and construction of Wastewater Treatment Plants (WWTPs) in the Republic of Moldova must be carried out in accordance with the normative acts in force on the territory of the country. The legal and normative basis in the Republic of Moldova is in the process of adjusting to the legislation of the European Union. The main Moldovan Construction Norms (NCM) for WWTPs, which have replaced the soviet SNiP standards, are the following .

- **Normative in construction NCM G.03.02: 2015 - External sewerage networks and facilities (NCM G.03.02:2015 Rețele și instalații exterioare de canalizare),** approved by the Order of the Ministry of Regional Development and Construction No. 56 of 25.04.2016 that replaced СНиП 2.04.03-85: Sewerage. External networks and facilities. According to NCM G.03.02: 2015, for centralized sewerage systems, mechanical-biological treatment must be provided (point 4.2.6). For the treatment of wastewater from small localities, the use of prefabricated monobloc stations must be provided (point 4.2.8).

- **Normative in construction NCM G.03.01-2012 - Small municipal wastewater treatment plants (NCM G.03.01-2012 Stații de capacitate mică de epurare a apelor uzate comunale)**, approved by the Order of the Ministry of Regional Development and Construction No. 48 of 15.04.2013. This normative has as objective the problems that aim in particular at stations with low capacity for communal wastewater treatment up to 5,000 m3/day;

- **Code of Practice CP G.03.07:2016** Systems for natural biological treatment of communal wastewater in filters planted with macrophytes (phytofilters) (CP G.03.07:2016. Sisteme de epurare biologică naturală a apelor uzate comunale în filtre plantate cu macrofite (fitofiltre)).

7.1.4. Discussion of applicable standards

According to point 4 of Annex no. 8, “in the agglomerations with more than 10 000 PE, advanced treatment (Ntotal and Ptotal removal), must be carried out, and stricter conditions for discharged water in a sensitive area apply”.

Although the Government of the Republic of Moldova has not yet established the sensitive areas in the County and has not delimited the agglomerations, these changes in the legislation are to be taken into account in the WWTP development process for the municipality of Soroca.

However, the obligation to treat total nitrogen and phosphorus has a great influence in the design of the WWTPs, and in the investment and operational costs (the different alternatives for treating nitrogen and phosphorus, and the technical and financial considerations are explained later in this document). This is why in the frame of this study, the two possibilities, to treat and not treat nutrients, are studied.

The final discharge limits for the future Soroca WWTP will have to be coordinated and validated with the corresponding state authorities.

7.2. Wastewater Treatment Context in Moldova

7.2.1. General Overview

According to the last official published data[14], in 2018 over 1 million people in Moldova had access to centralized sewerage services, which represents 38.1% of the total population. In the urban areas there were 979.6 thousand people with access to centralized sewerage services, representing 64.1% of the country's urban population, and in rural areas 57.3 thousand people, representing 2,8% of the country's rural population.

In 2018 there were 126 localities in Moldova with a centralized sewerage system (53 municipalities and cities and 73 villages). This represents only 10.3% of the total number of centralized drinking water supplies (aqueducts). Out of the 126 centralized sewerage systems:

- 110 systems are operated
- 83 systems are equipped with wastewater treatment plants, out of which 73 are functional

The following figure shows the cumulative yearly volume of treated wastewater, which is rather stable since 2002, and the number of WWTPs, which has almost been reduced by 2 in the last 17 years.

[14] National Bureau of Statistics, Starea mediului în Republica Moldova Raport național în baza indicatorilor de mediu, 2015-2018, Agentia de Mediu, 2020

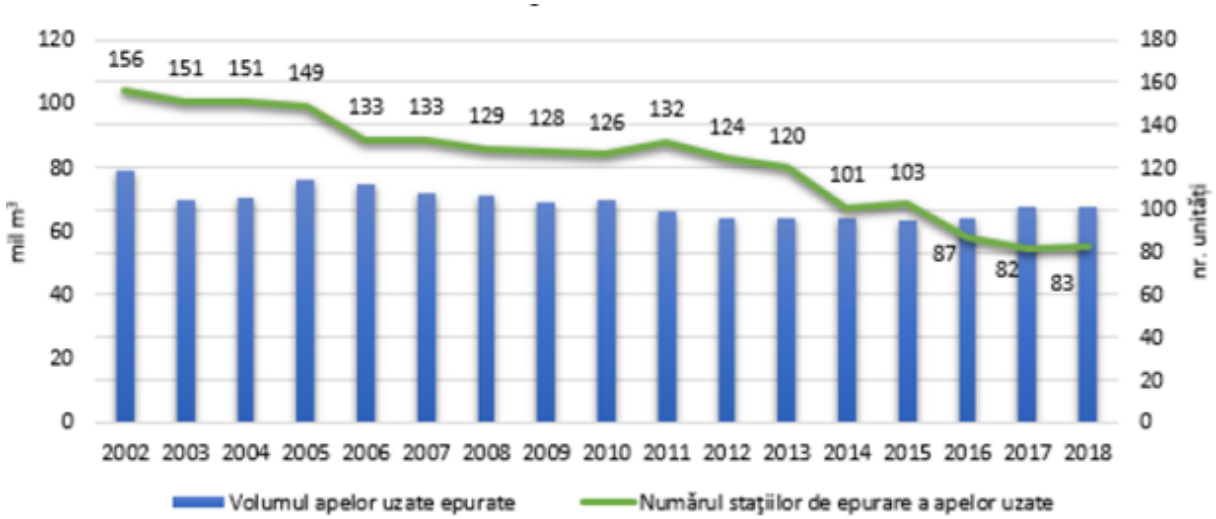


Figure 76: Evolution of annual volume of treated wastewater and number of WWTPs

In 2018, the volume of treated wastewater in 83 Wastewater Treatment Plants was estimated as follows:

- 66.6 million m3 - mechanical stage,
- 64.8 million m3 - biological stage.

At the same time, approximately 2.4% of the total volume of wastewater discharged had not been subjected to any treatment.

In practice, the existing Wastewater Treatment Plants are in rather poor condition and most of the existing facilities provide only mechanical treatment. The biological treatments have fallen out of use due to neglected maintenance during years and unaffordable operating costs. In general, treated wastewater is not up to discharge requirements. According to one World Bank Study[15] from 2008, only four existing WWTPs operated satisfactorily, viz. in Balti, Glodeni, Drochia and Floresti.

About 95% of the total volume of water supply and sewerage services are provided by 40 licensed supply and sewerage operators. Most of these operators are members of the "Moldova Apa-Canal" Association, whose purpose is to provide assistance to these enterprises in technical, scientific, commercial issues, etc., as well as defending their interests in central and local public administration bodies. This non-governmental association carries out a detailed analysis of the sector annually[16].

[15] Project Appraisal Document on a Proposed Credit in the Amount of SDR 8.6 Million (US$14.0 Million Equivalent) to Republic of Moldova for a National Water Supply and Sanitation Project (WB, 2008)
[16] www.amac.md
http://www.amac.md/public/files/documente/Culegeri_indicatori_financiari_2001-2019.2020.11.11.pdf

7.2.2. Treatment Technologies in Moldova

The general requirement for the existing WWTPs in Moldova is only carbon removal. The most typical wastewater treatment technologies are activated sludge and trickling filters, whereas drying beds (sludge platforms) are mostly applied for sludge treatment.

In the period 2000-2020, 36 wastewater treatment technologies were presented for ecological expertise, of which 8 were local, 24 imported and 1 using built Constructed Wetlands (CW) - for the city of Orhei - and 3 very small CW for public institutions.

In recent years, the construction or reconstruction works of the WWTPs with a capacity of more than 5,000 m^3/day have been very rare. Some of the most recent projects performed in Moldova are detailed below.

Chisinau WWTP

The Chisinau WWTP is the largest treatment plant in the country. With a design capacity of 435 000 m^3/day, it currently treats 142 000 m^3/d and an estimated pollution load of 700 000 Population Equivalent, considerably below its design capacity. This WWTP is based on primary settlers and activated sludge medium load, only for carbon removal The sludge treatment line initially included static thickeners, anaerobic digestion and drying beds, but the digesters had never been commissioned due to construction defaults. Since 2009, the WWTP had been using “geotubes” as a temporary solution to dewater sludge.

The sludge management of the plant, and the associated odours, has been a significant challenge. At the moment, this treatment plant is being rehabilitated[17] and a new sludge treatment facility is being built consisting of anaerobic digestion, mechanical dewatering by centrifuge, biogas use for production of electricity and thermal energy.

However, **this project does not foresee the upgrade of the plant to treat nitrogen and phosphorus.**

Cahul WWTP

A project of WWTP construction In the municipality of Cahul is being prepared (35.6 thousand inhabitants - according to the data of the National Bureau of Statistics for 2021 - which is similar in size to the municipality of Soroca). The feasibility study was elaborated by the company Posch & Partners Consulting Engineers in 2017. This Feasibility Study proposed the construction of the WWTP

[17] Program for the development of water supply and sewerage services in Chisinau, financed by loans from the European Bank for Reconstruction and Development, the European Investment Bank and the investment grant provided by the European Union Neighborhood Investment Facility. The total cost of the project is 24 million euros

in phases: At Phase I (for the period up to 2030) it was proposed to build two tranches of 16,000 PE each (total 32,000 PE), with further extension until Phase II up to 48,000 P.E. for 2050.

The feasibility study proposed the following treatment line:

- Fine screening
- Grit and grease removal
- Imhoff tanks
- Trickling filters (2 units) in Phase I. In Phase II, one additional aerobic trickling filter and 3 anoxic trickling filters will be required to cope with the increased hydraulic and pollution load.
- Secondary clarifiers (2 units). In Phase II, one additional clarifier will be required.

The sludge treatment line consists of:

- Stabilization in the Imhoff tanks
- Mechanical dehydration in screw presses
- Long storage in sludge platforms

At the stage of realization of the project by the company Fichtner Water & Transportation GmbH some modifications of the technological scheme of wastewater treatment have been proposed:

- The replacement of Imhoff tanks by rectangular sedimentation tanks, due to the low practice of applying Imhoff tanks for WWTP of such capacity, as well as for constructive, operational and environmental reasons,
- The installation of anaerobic digestion with the reuse of biogas by a Combined Heat and Power (CHP) unit
- The replacement of the sludge drying beds by sludge reed beds

Cantemir WWTP

The construction of WWTP with a capacity of 5,420 PE was recently completed in the city of Cantemir. The treatment line consists of:

- Preliminary treatment: Screening and grit chamber,
- Imhoff tanks,
- Trickling filters,
- Secondary clarifiers,
- Sludge drying beds (sludge platforms).

Orhei WWTP

A new WWTP was built in Orhei in 2013 based on Constructed Wetland technology. The capacity is 21 660 Population Equivalent and the design hydraulic load is 4 600 m^3/d.

The Orhei WWTP consists of:

- Preliminary treatment: Screening and grit chamber,
- Equalization tank with pre-aeration,
- Two stages of Constructed Wetland (4 lines in parallel):
    - Stage 1: French system reed bed with a surface area of 18.000 m^2
    - Stage 2: Vertical flow reed bed with a surface area of 17.000 m^2

- Final chlorination

The total gross area is about 5 ha.

Figure 77: Orhei new WWTP based on Constructed Wetland

7.2.3. Focus on Small WWTP

Regarding small WWTPs, the most frequently used technologies on the territory of the Republic of Moldova are bio-mechanical **prefabricated treatment plants** made of polyethylene (smaller capacities) or reinforced concrete.

These prefabricated WWTPs are mainly based on activated sludge SBR (Sequencing Batch Reactor) and fixed film technologies such as moving bed bioreactor (MBBR). Some installed technologies in Moldova are:

1. "TOPAS" from Boncom SRL based on activated sludge (from 5 to 300 PE - from 0,75 m^3/d up to 45 m^3/d)
2. "Monobloc-T" from Boncom SRL based on SBR (from 100 to 500 PE - from 22.5 - 750 m^3/day)
3. "Biofix-U" series developed by Technical University of Moldova with "Metioles" SRL - fixed biofilm and reactors with sequential working regime, lamellar settlers
4. MBBR (Moving Bed Bioreactor) from Aqua System Plus SA

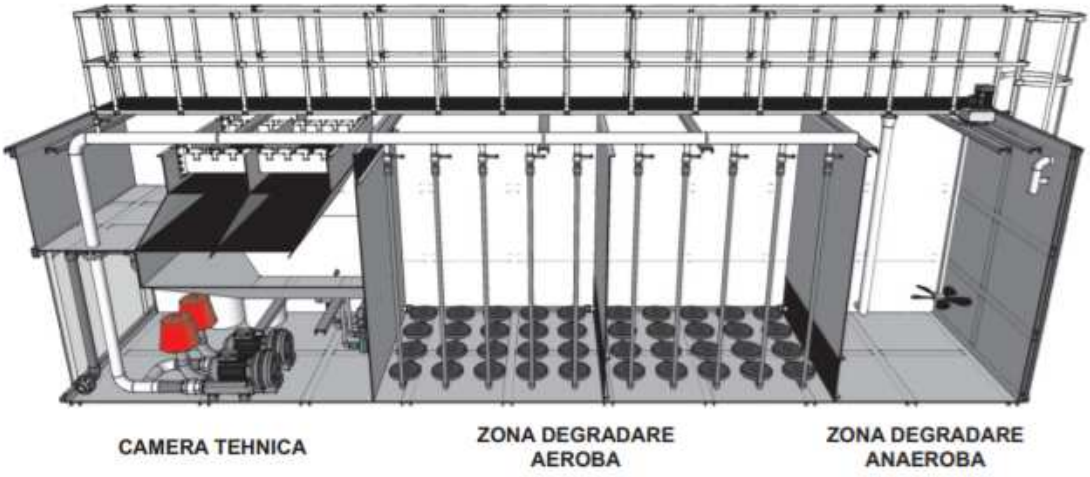


Figure 78: Prefabricated and containerized small WWTP from Aqua System Plus SA

A list of WWTPs recently built in Moldova is shown below.

Table 25: List of WWTPs built in Moldova during recent years

Locality	Population	Capacity (m^3/day)	Technology	Treatment requirements*
Cahul (ongoing project)	32,000	-	Primary clarifier + Trickling filter	C removal
Cantemir	5420	740	Imhoff Tank + Trickling filter	C removal
Orhei city	25,300	4600	Constructed Wetland	C, NH4, P removal
Căușeni city	21,500	2400	BIOFIX-U	C, NH4, P removal
Dondușeni city	9,100	700	BIOFIX-U	C, NH4, P removal
Călăraș city	14,400	1400	MBBR	C, NH4 removal
Măgdăcești village	7,000	350	MBBR	C, NH4 removal
Telenești city	6,900	350	MBBR	C, NH4 removal
Budești village		100	TOPAS-300	C, NH4 removal
Regional Sofia, Negrea, Balțata villages		200	BIOFIX-U	C, NH4, P removal
Goianul Nou village		100	Monobloc-T	C, NH4 removal

(*): According to supplier

During recent years, there has also been an effort to introduce extensive technologies in Moldova, mainly based on Constructed Wetlands (CW, also called Reed bed filters). Some of these CWs have been built for public institutions.

The Water and Sanitation Project in Moldova (ApaSan) (2008—2019), funded by the Swiss Agency for Development and Cooperation (SDC), co-funded by the Austrian Development Cooperation (ADC), and implemented by Skat Consulting Ltd., was aimed at developing and promoting sustainable models for water and sanitation services in rural areas of Moldova.

Table 26: List of small Constructed Wetland Plants built in Moldova during recent years (ApaSan, 2008–2019)

Locality	Population	Capacity (m^3/day)	Technology
Sărata-Galbenă	Retirement home (56 p)	5	Septic tank + CW
Negrea	School (82 children) + school kitchen (253 p)	5	Septic tank + CW
Rusca	43 households + prison (400 p)	30	Anaerobic Baffled Reactor + CW
Drăgușenii Noi	School (300 children) + >85 households	50	Two stage CW
Iurceni	130 households + institutions (300 p)	50	Two stage CW
Cristești	24 households + institutions (220 p)	50	CW + polishing pond

In 2016, a new Code of Practice in construction was issued in Moldova dealing with Systems of Communal Wastewater Natural Biological treatment in Reed Bed Filters (CP G.03.01:2016).

7.3. Wastewater Treatment Plant Location

7.3.1. Identification of Potential Sites For Soroca WWTP

The selection of the location of the future WWTP in Soroca is critical for the successful development of the project. The location of the WWTP should, ideally, fulfil the following criteria:

- Favourable location with regards to the sewerage network structure – minimization of network length and pumping to convey raw wastewater and to dispose of treated wastewater
- Availability of enough space for current and future space requirement – not only the future population and increase of sewer connection rate must be taken into account, but also the possible changes in effluent quality discharge, which may require WWTP upgrade
- Sufficient distance from existing or planned habitation areas is required to minimize impacts to the population such as noise and smell
- Ownership of the plot – it is preferable that the plot is owned by the municipality to not incur in additional costs for land acquisition
- Not exposed to climatic risks (flooding, landslide, etc.)
- Acceptable subsurface soil conditions - Soil bearing capacity, low groundwater table
- Easy access - The existence of access roads and utility services will reduce the cost of constructing these services
- Minimization of other environmental impacts - The presence of valuable ecological life or an aesthetic landscape

Following the interviews with Local Public Authorities and SA “Regia Apa Canal Soroca” and the field recognition, four possible sites were proposed:

- P1 - Egoreni: (cadastre code 78281050350). This site was proposed during the Global Environment Facility Trust Fund Project in 2010. It is situated inside the boundaries of Egoreni, at 1 km from the village, and 2.8 km from Soroca city;
- P2 - North Pumping Station: (cadastre codes 78011180328 and 78011180285 - partial): this site has been selected in the last Pre-feasibility study for the Construction of a WWTP in Soroca performed by RoAid in 2019 for the Municipality. It is situated in the industrial sector of Soroca Noua si FAT. Part of this plot is empty (no activities) and part is used as a car/bus depot;
- P3 - South Pumping Station (several plots): The Consultant proposed this site due to the optimal location with regards to the sewerage network;
- P4 - Forest (cadastre code not assigned - next to 78572100019): This site, located downstream of the city, has been identified by SA “Regia Apa Canal Soroca”. It currently belongs to Moldsilva.

Following the First Public Consultation held on the 21st June, and the fierce rejection from Egoreni village to install the WWTP in their administrative boundaries, two additional plots, distant from habitations, were added to the study:

- P5 - Plot next to the landfill (cadastre code 78011180600);
- P6 - Zastinca, proposed by the Client.

The location of these 6 sites is shown in the Figure below.

Figure 79: Overview of the location of studied WWTP sites

Besides, two other plots were also proposed by the Municipality of Soroca, but were not retained for detailed analysis:

- Plot next to the Vento SAX-46 Gas station, Str. Independenței, at the entrance of the city: this plot has only 0,51 ha. This area is not enough to construct the future WWTP
- Plot in Trifauti, 1,46 ha. This plot is situated on sloped terrain at an average elevation of 100 m.a.s.l. and is situated at 9,5 km from the CPS. These technical constraints make this plot less advantageous than the other proposed plots.

Figure 80: Additional sites not retained for the study of the WWTP location

The six selected sites have been evaluated and compared by means of technical, environmental and social criteria. The results of this evaluation are shown in the tables below, whereas the detailed description and photographic report are enclosed in Annex.

The following technical criteria are presented for each site:

- Available area in hectares
- Ownership: public or private
- Distance to habitations
- Length of the pressure network to be laid between the CPS and the WWTP site
- Technical constraints which have a significant impact on construction costs
- Other constraints that can incur additional costs

Regarding the social and environmental criteria:

- Impact to population
- Impact to natural environment
- Suitability of the site for the future upgrade / extension of the WWTP (Phase II)
- Sludge disposal suitability
- Other information

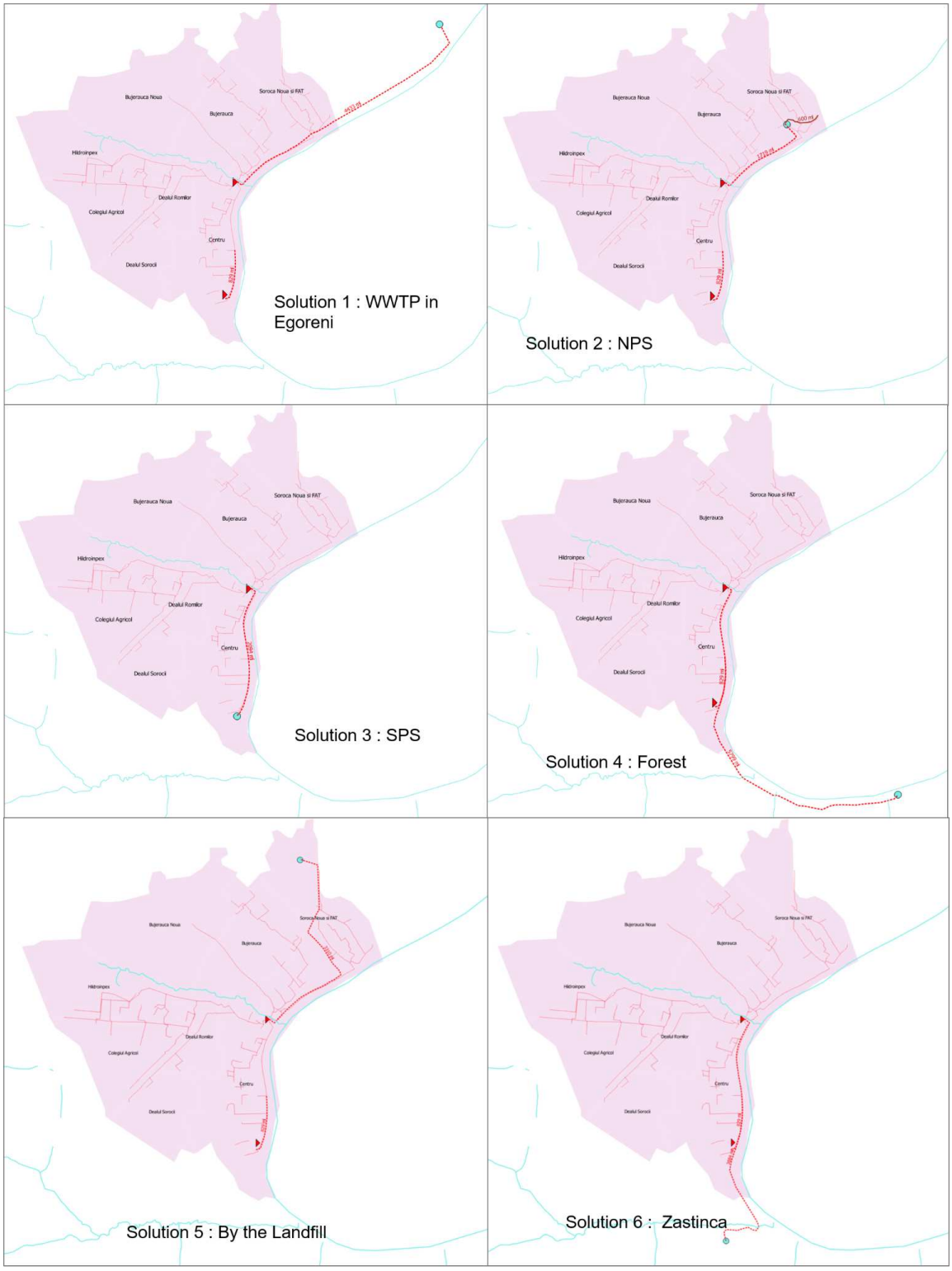
Site	Area (ha)	Ownership	Distance to habitation	Pressure network from CPS	Overcost for construction costs / Other associated costs
P1 - Egoreni	**10**	Public	**>400 m**	**4 km**	-
P2 – NPS	2	Public	**100 m (5 buildings, ~80 families)**	**1.3 km**	- Phase I: Indemnisation of families Phase II: Relocation of residential buildings. Expropriation of economic activities for future extension
P3 – SPS	**~0.8**	Public + **Private**	**< 100 m**	**2 km**	+++ Flood area. Not enough space for extensive sludge treatment Expropriation of nearby houses and relocation of Bus station.
P4 - Forest	2,14	Public, Moldsilva. Land use has to be modified	100 m (two private houses and camp sites)	**5,6 km**	+ Forest clearing and road construction Relocation of private houses or indemnisation
P5 - Landfill	2,6	Public	No	3,3 km - **85 m gradient** + 3 km gravity discharge	++ Earthworks, high gradient (10%), probably retaining walls will be needed Significant risks due to the vicinity of unofficial landfill (biogas, leachate…)
P6 - Zastinca	> 2	Public, Moldsilva. Land use to be modified	~175 m (one house)	3,9 km - **70 m gradient**	+++ Forest clearing, earthworks, high gradient (10%), retaining walls needed (high landslide risk) Relocation of private houses or indemnisation

Site	Impact to population	Impact to natural environment	Phase II	Sludge disposal	Other
P1 - Egoreni	Isolated from population, but firm rejection from Egoreni village Zavoiul Nistrului Eco Village in the surroundings (> 400 m)	Neutral Upstream of Soroca city	Enough area to build the extension and upgrade of WWTP	Very close to farm lands and close to landfill. Enough space to store sludge on site	The plot has been legally handed to Soroca municipality for the construction of the WWTP 10 years ago
P2 – NPS	Closeby housing with ~80 families Other social activities: water source, small lake and recreation activities Predominant wind goes to the Dniester	Industrial area, already "degraded" Upstream of Soroca city, but downstream of "Soroca beach"	Enough area to build the extension and upgrade of WWTP but Economic activities in the municipal plot shall probably be expropriated in Phase II	Close to farm lands and landfill	Part of Soroca noua sector can be diverted by gravity
P3 – SPS	Expropriation of nearby houses and relocation of Bus station. Close to a historical monument area (Memorial)	Downstream of the city	Small area to build an extension and upgrade	7 km from landfill Farm lands in the south	
P4 - Forest	2 Private houses close to the plot Recreation activities during summer (camp site)	Downstream of the city It respects the Protection Area of the Nistru (100 m) Natural, recreation area	Enough area to build the extension and upgrade of WWTP	10 km from landfill Farm lands in the south	Currently bad accessibility, road works and forest clearing needed Official deal (2020) signed between Soroca municipality and MoldSilva: this plot has been allocated to a future WWTP, but an ESIA is required by the Ministry of Environment and Public Properties Agency. Public plots handed to private residencies/ activities, little social rejection can be expected if mitigation measures are put in place (indemnisation)

P5 - Landfill	No impact	No impact Degraded area between landfill and industrial area	Enough area to build the extension and upgrade of WWTP	Very close to the landfill and to the farm lands in the North	Significant risks due to landfill vicinity (biogas, leachate), probably landslide (to be confirmed by geotechnical investigations)
P6 - Zastinca	Insignificant impact (only one house < 200 m)	Protected area “Bechirov lar", monument of nature, archaeological and paleontological interest (area of 46 hectares). High impact of wastewater discharge on the Bechirov stream	Enough area to build the extension and upgrade of WWTP, but new expensive works required for land preparation	10 km from landfill Farm lands in the south	Very significant landsliding risks Rocky subsoil expected (to be confirmed by geotechnical investigations)

7.3.2. TECHNICAL-ECONOMIC COMPARISON REGARDING NETWORK AND PUMPING STATIONS

A detailed techno-economic analysis has been performed on the location of the WWTP regarding the design and operation of the Pumping Stations.



A preliminary design has been done to compare the requirements in terms of energy (pumping) for the six locations.

Table 27: Technical comparison of network and pumping requirements of the identified sites

Solution comparison - Future 2045						
	Solution 1	Solution 2	Solution 3	Solution 4	Solution 5	Solution 6
	WWTP in Egoreni	WWTP North	WWTP Bus station	WWTP forest	WWTP Landfill	WWTP Zastinca
Length Main Pressure network	4,4 km	1,7 km	2,1 km	5,8 km	3,3 km	3,9 km
H geo	15 m	20 m	3 m	10 m	95 m	75 m
Length South Pressure network	0,83 km	0,83 km	-	0,83 km	0,83 km	0,83 km
H geo	2 m	2 m		2 m	2 m	2 m
Number of PS	2	2	1	2	3	2
Central PS						
Q max. (l/s)	76	49	73	76	69	76
Pumps	(2+1) x 34 KW	(2+1) x 18 kW	(2+1) x 13 kW	(2+1) x 34 kW	(2+1) x 101 kW	(2+1) x 85 kW
Total energy	68 kW	36 kW	26 kW	68 kW	202 kW	170 kW
Pressure pipe	4 435 ml - ND 400	1 720 ml - ND 315	2 095 ml - ND 400	5 800 ml - ND 400	3 310 - ND 400	3885 - ND 400
Air insufflation	YES	NO	NO	YES	NO	NO
South PS						
Q max. (l/s)	4,4	4,4	-	4,4	4,4	4,4
Pumps	(1+1) x 1 kW	(1+1) x 1 kW	-	(1+1) x 1 kW	(1+1) x 1 kW	(1+1) x 1 kW
Total energy	1 kW	1 kW	-	1 kW	1 kW	1 kW
Pressure pipe	830 ml - ND 90	830 ml - ND 90	-	830 ml - ND 90	830 ml - ND 90	830 ml - ND 90
Gravity pipe		600 ml - ND 315				
Other					Private PS for Fabrica de brinzeturi and Alfa-Nistru	

The location of the future WWTP has an important impact on the design of the Central Pumping Station. The graph below shows the cumulative energy costs of the Pumping Stations until 2045 for each solution:

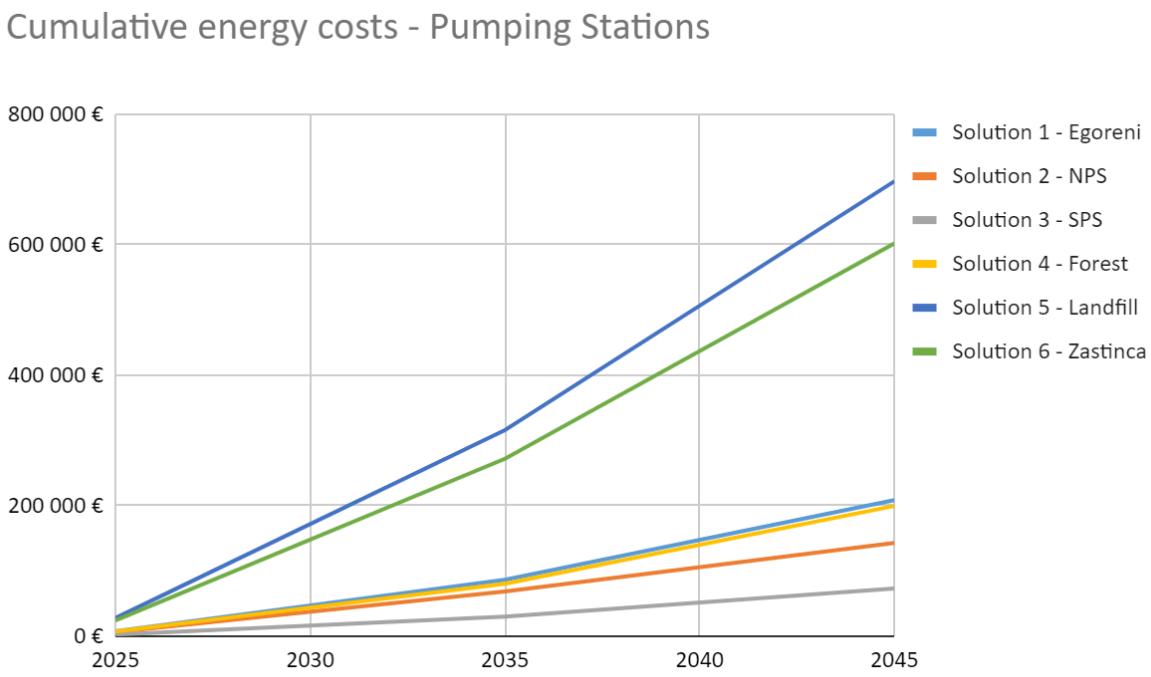


Figure 81: Cumulative energy costs of Pumping Stations of identified sites for the WWTP

It can be observed that the solutions 5 and 6, next to the landfill and in Zastinca, represent by far the highest investment and energy costs.

From the energy costs point of view, the solutions 2 and 3 (in the North Pumping Station and South Pumping Station, respectively) are the best ones. Annual costs for pumping amounts from 2600 and 6200 €/year for these two options, whereas solutions 5 and 6, which are not optimal regarding the topography (+75 / +95 m difference of elevation with CPS) will represent about 25 k€/year in 2025.

Also, the length of the network has to be taken into account. The risk of H_2S development increases with the length of the pressure pipe. If the contact time in the pipe is higher than 3h, air insufflation is recommended at the beginning of the pipe, in the Pumping Station. This is the case for solutions 1 and 4.

The length of the pressure pipe also increases the risk of leakages and involves more maintenance.

7.3.3. Comparison of WWTP Sites

The 6 sites are compared in the next table following the multicriteria analysis presented above:

- the green color represents that the criterion is fulfilled;
- the orange color represents that the site has some constraints concerning that criterion, but these constraints can be managed during the construction phase;
- the red color represents that the constraints are too significatif and the criterion cannot be conveniently fulfilled.

Table 28: Multicriteria comparison of identified sites for the WWTP

CRITERIA	P1 - Egoreni	P2 - NPS	P3 - SPS	P4 - Forest	P5 - Landfill	P6 - Zastinca
Minimize pumping = minimize OPEX (Favourable location with regards to topography and CPS)						
Minimize CAPEX (network - Favourable location with regards to CPS and Nistru; WWTP construction)						
Space availability						
Administrative status of the plot / Public and buildable plot						
Not exposed to climatic or other environmental risks (flooding, landslide, etc.)						
Acceptable subsurface soil conditions - Soil bearing capacity, low groundwater table	*			*		
Easy access						
Minimization of environmental impacts						
Distant from habitation areas						
Public acceptance		?	?	?		?

(*) GW (groundwater) table to be confirmed
(?) It means that public acceptance is currently not known.

According to the multicriteria analysis, the site **P2 situated close to the North Pumping Station**, is the plot that represents more advantages compared to the others: it is situated next to the Nistru, not far from the CPS and in an industrial area, where the WWTP could be easily integrated. The plot belongs to the municipality and although there are some ongoing economic activities, they could easily be displaced by the LPA to other areas of the city. Although the plot is situated upstream of Soroca city, it is downstream of “Soroca beach”, a recreational spot next to the Nistru.

The only critical issue of this plot is the distance to habitations, because there are several multi storey buildings next to it (~100 m). These buildings are separated from the plot by a vegetated area, but in theory, it would not comply with the minimum buffer zone which is required for the construction of WWTPs. The proximity of these residential buildings also creates high uncertainty about the public acceptance of the construction of the WWTP in this plot.

The site in Egoreni has also many advantages: it is located in the middle of the fields, next to the Nistru but distant from habitation areas (only one touristic camp site is situated at 400 m from the plot). There is however a strong rejection from Egoreni village, who does not accept the construction of the WWTP in their territory. Although the plot was legally handed to Soroca municipality 10 years ago to construct the WWTP (Global Environment Facility Trust Fund Project, 2010), the administrative status of the plot is not clear, both Soroca and Egoreni claim the title of the plot.

Protection or Buffer Zone of WWTPs - Distance to habitations

According to the NCM G.03.02-2015, the WWTPs have to respect a minimum buffer or protection zone with respect to the distance to habitations. In the case of the future Soroca WWTP (design flow< 5,000 m3/d), this buffer zone is set at 200 m, if drying beds are used for sludge treatment, or 150 m if mechanical treatment is used.

This distance can be reduced by a maximum of 25%, if the wind direction is favorable.

Tabelul 3.1

Denumirea instalaţiilor	Zona de protecţie sanitară, în m, pentru debitul de calcul al instalaţiilor , mii m³/d			
	Până la 0,2	>0,2÷5	>5÷50	>50÷280
Instalaţii pentru epurarea mecanică şi biologică cu platforme pentru uscarea nămolurilor fermentate, precum şi platforme izolate de uscare a nămolurilor.	150	200	400	500
Instalaţii pentru epurarea mecanică şi biologică cu tratarea termomecanică a nămolurilor în încăperi închise	100	150	300	400
Câmpuri de filtrare	200	300	500	-
Câmpuri de irigare	150	200	400	-
Iazuri biologice	200	200	300	300
Staţii cu şanţuri de oxidare	150	-	-	-
Staţii de pompare	15	20	20	30

A detailed Net Present Value comparison has been performed to evaluate the economic viability of the 6 sites. The hypothesis and detailed calculations of this assessment are found in Annex.

Table 29: NPV comparison of identified sites for the WWTP

	P1: Egoreni	P2: NPS	P3: SPS	P4: Forest	P5: Landfill	P6: Zastinca
Capital Expenses (Phase I) Million EUR	7,1	6,8	7,6	7,9	8	8,4
Capital Expenses (Phase II) Million EUR	2,3	2,3	2,6	2,3	2,6	2,8
Cumulated OPEX (2025-2045) Million EUR	2,18	2,11	2,04	3,36	3,86	3,76
NPV (EUR/m3)	0,51	0,49	0,54	0,58	0,61	0,63
NPV (EUR/pe)	20,93	20,25	22,21	24,07	25,24	26,20
Difference with NPS	3%	0%	10%	19%	25%	29%

It is observed that the most **cost-effective** sites are the plots situated at the **North Pumping Station and Egoreni**, due to the fact that they do not present significant technical constraints to build the WWTP and due to the lower pumping costs.

The sites situated at the landfill and Zastinca are the least recommendable solutions from an economic point of view.

7.3.4. Conclusions of Site Selection for the WWTP

Taking into account the techno-economic, environmental and social criteria, the optimum options to construct the WWTP are the plots situated upstream of Soroca, next to the North Pumping Station and Egoreni. Both sites have however insurmountable obstacles which make the construction of the WWTP not viable: The NPS Plot is located too close to a densely populated neighborhood and Egoreni Plot has administrative and political impediments.

The next **preferred and recommended option would be Plot 4 in the Forest of Vasilcau**. It is the only plot where exclusion criteria have not been identified, and although it is the site which is situated further away from the CPS (5,8 km), it has several advantages:

- Space availability
- It is located downstream of the city
- It is close to the Nistru, but at sufficient distance of the Nistru Protection Zone (100 m) and it is not subject to floods[18]
- Public use: the plot currently belongs and is managed by Moldsilva, but there are ongoing discussions between this Authority and the Municipality to exchange this plot for another one in Soroca
- There are only three or four private residences in the buffer zone of this plot (<200 m). Some of them, however, offer touristic activities in the area.

[18] According to more recent information, **part** of the plot situated below the topographic line of 50 m, would be subject to flooding (1% probability flooding - once every 100 years).

The drawbacks from the site are the additional investment required to clear the forest and build the access road, and the relocation or indemnisation of the closest private houses and economic activities (camp sites).

More detailed information on the social aspects of this plot are found in the ESIA and ESMP report.

7.4. Wastewater Treatment: Review of Possible Treatment Options

7.4.1. Objectives of Wastewater Treatment

Domestic wastewater is a complex by-product containing different kinds of gas, solid, particular and dissolved pollution. The two main reasons justifying the need for wastewater collection and treatment are:

- The protection of public health
- The protection of the environment

The types of pollutants found in wastewater and the associated harmful effects are summarized below.

Type of pollutants	Harmful effects
Solid scraps – macroscopic waste	Esthetical – scattering of plastic in the environment – damage or clogging of other processes downstream
Sand	Rapid wearing of pumps of other equipment (in the sludge treatment mainly)
Grease	Additional loading on downstream biological treatment – favorable factor for bulking in activated sludge
Suspended solids	Prevent sun light to get into the bulk of water and aerobic plants to grow
Carbonaceous pollution (BOD_5, COD)	Consumes by oxidation the oxygen of the receiving water body – creates anaerobic condition and prevents development of superior forms of life (shells, fishes)
Nutrient (nitrogen and phosphorus)	As very efficient fertilizers, it can trigger algae bloom – dead algae accumulate in the bottom of the water body, and their decomposition creates anaerobic conditions preventing other forms of life (fish) to develop.
Pathogenic germs (bacteria, virus, worms)	May contaminate people who get in contact with the water through direct reuse (irrigation), bathing or fish farming.

Wastewater treatment aims at reducing or transforming these pollutants by means of **mechanical, biological or physicochemical** processes. Conventionally there are four treatment steps in a sewage treatment plant:

1. **Preliminary treatment:** Removal of heterogeneous and bulky materials that are carried in the sewerage networks, to protect downstream equipment
2. **Primary treatment:** Elimination of part of suspended solids
3. **Secondary or biological treatment:** It uses a wide variety of microorganisms, mainly bacteria, to convert biodegradable organic material into simple products and additional biomass (sludge).
4. **Tertiary treatment:** Additional treatment depending on the final destination of treated wastewater: advanced removal of suspended matter, disinfection, removal of phosphorus, etc.

7.4.2. Wastewater Treatment Technologies

7.4.2.1. Preliminary Treatment

The preliminary treatment or pre-treatment comprises the following steps:

- Screening for the extraction of coarse suspended solids (large floating materials, plastics, rocks, wood, fibers, etc.);
- Grit removal for the precipitation of sand and gravel;
- Grease removal (sometimes combined with the grit removal unit) for the extraction of fats, oils and greases by flotation;
- Treatment of by-products: scraps from screening, grit washing, grease concentration;
- Equalization tank (optional): its purpose is to buffer the inlet flow variation to the WWTP and the strength of wastewater (blending).

Preliminary treatment is one of the major odor generation areas of the wastewater treatment plants and specific odor treatment units are normally associated with this area.

There are many technical options for screens and grit and grease removal units, but they are all based on the same principles. The main process involves the choice of the bar spacing for the screening, which depends on the nature of the network and on the type of treatment implemented downstream. The typical configuration is a coarse screening of 40 to 50 mm followed by a fine screening of 20 mm.

In case of a pure separative sewerage network, fine screening alone can be considered.

7.4.2.2. Primary Treatment

Primary treatment is used for settling of suspended solids, commonly in primary clarifiers, although anaerobic treatments such as septic tanks, Imhoff tanks, Upflow Anaerobic Sludge Blanket (UASB) reactors, Anaerobic Baffled Reactors (ABR) and anaerobic ponds also serve this purpose. In these processes, besides the settling of suspended solids, a part of the carbonaceous pollution is removed.

The most typical primary treatment technology is a radial settler with a scrapping bridge. The efficiency is around 40-50% of total suspended solids removal. This large amount of fresh sludge has to be further treated to reduce its water content and fermentability.

An interesting variant to primary settlers, relevant for small communities, consists in combining primary settling and anaerobic sludge digestion. This process is called an Imhoff tank. It consists of a top compartment, which serves as a settling basin, and a lower compartment in which the settled solids are anaerobically stabilized, producing biogas (CH_4 and CO_2). Scum and gas vent chambers are located at the sides of the tank. The desludging operation is performed several times per year, instead of the daily production of a conventional settler, and the produced sludge is partially stabilized.

The advantages of an Imhoff tank compared to a primary settler are the simple operation and maintenance, which do not require highly skilled supervision (no electromechanical equipment). The disadvantages are the lower treatment efficiency and the possible production of odours. To avoid nuisance, the Imhoff tanks may be covered and odour treatment units can be provided. Unlike other anaerobic processes, biogas cannot be recovered in an Imhoff tank.

Another low-cost technology, similar to the Inhoff tank, but with higher removal efficiencies, is the ABR. It consists of an improved septic tank with a series of vertical baffles that direct the wastewater under and over the baffles as it passes from the inlet to the outlet. Since the development of this technology in the early 1980s, much research has been carried out with the ABR, mostly at laboratory or very small scale. It is mostly applied in tropical and subtropical areas of developing countries in small size, decentralized WWTPs.

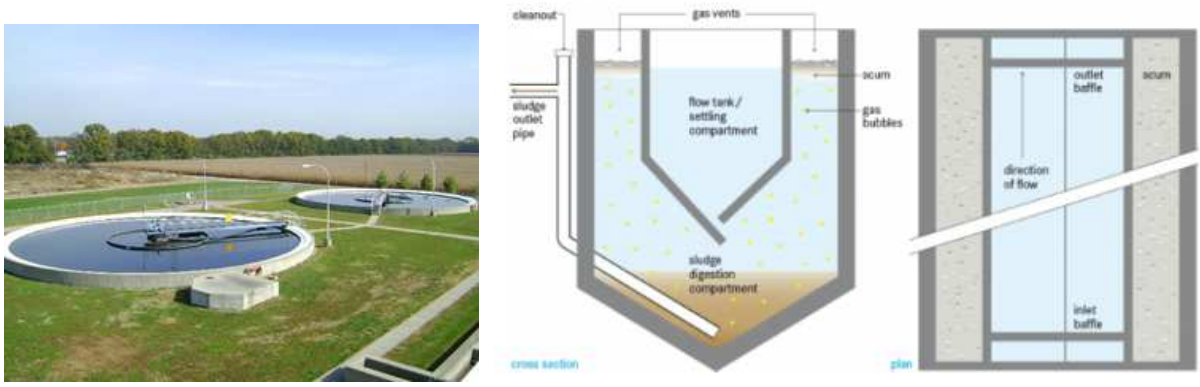
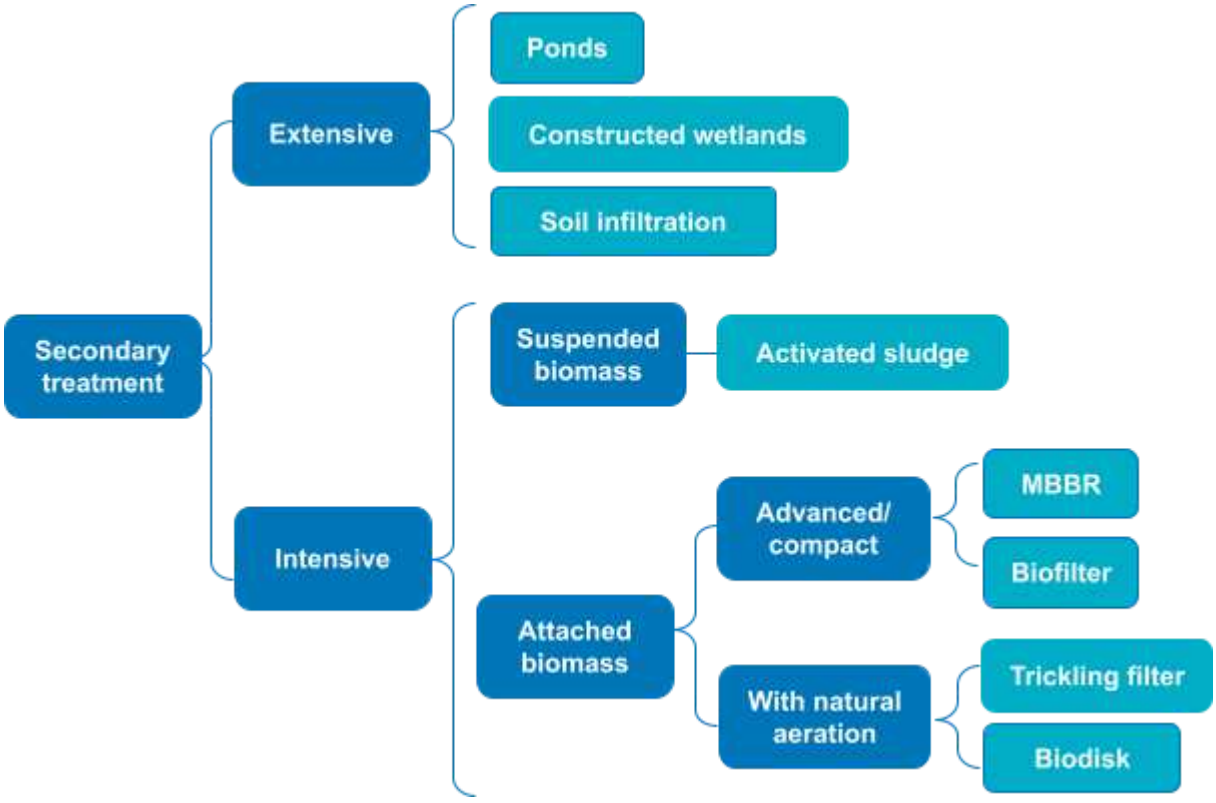


Figure 82: Conventional radial settler (left) and Imhoff tank (right)

7.4.2.3. Secondary Treatment

The secondary treatment or biological treatment can be designed for removal of only carbonaceous pollution, or for carbonaceous pollution and nitrogen removal. Nitrogen treatment is not an independent stage which can be added to a biological treatment, but a special configuration of the whole biological treatment.

The biological treatment basically consists in reproducing in a closed tank or pond, the biological natural phenomena occurring in the environment in order to control them. Based on this principle, many configurations and schemes are possible, as shown in the figure below.



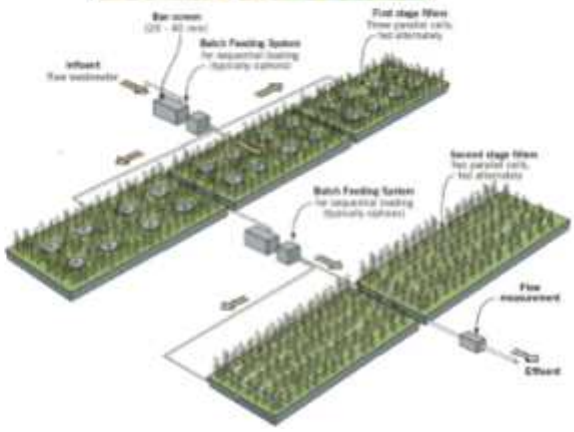
Extensive treatments consist in reproducing the natural biological oxidation of pollution in a delimited area, so that it does not compete with the natural equilibrium of the environment. The shape of the basins and their arrangements are designed in order to enhance the efficiency of the biological activity, but this activity is not forced by any (or almost any) mechanical means.

Three main kinds of treatments follow this principle: waste stabilization ponds, constructed wetlands and soil infiltration.

Secondary intensive treatments normally comprise an aerated reactor followed by a solid/liquid separation step (clarifier, membranes) to remove and concentrate the biomass produced from the organic compounds' treatment. Aerobic reactors use either suspended growth processes (activated sludge) or fixed-film processes (trickling filter, biodisk, MBBR, etc).

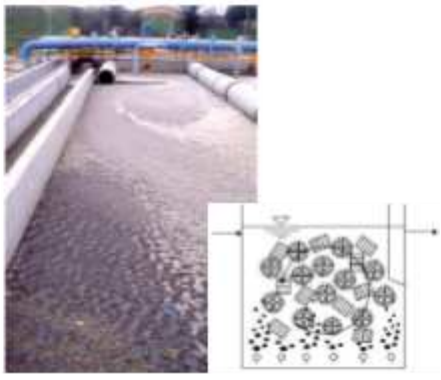
These technologies are briefly described hereunder.

Ponds

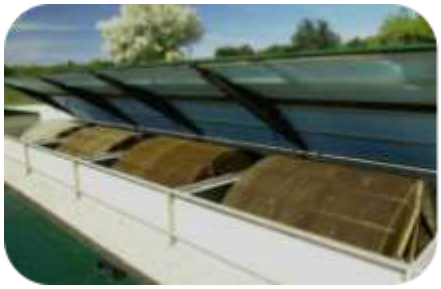


Constructed Wetland

Activated sludge



MBBR (Moving Bed Biofilm Reactor)



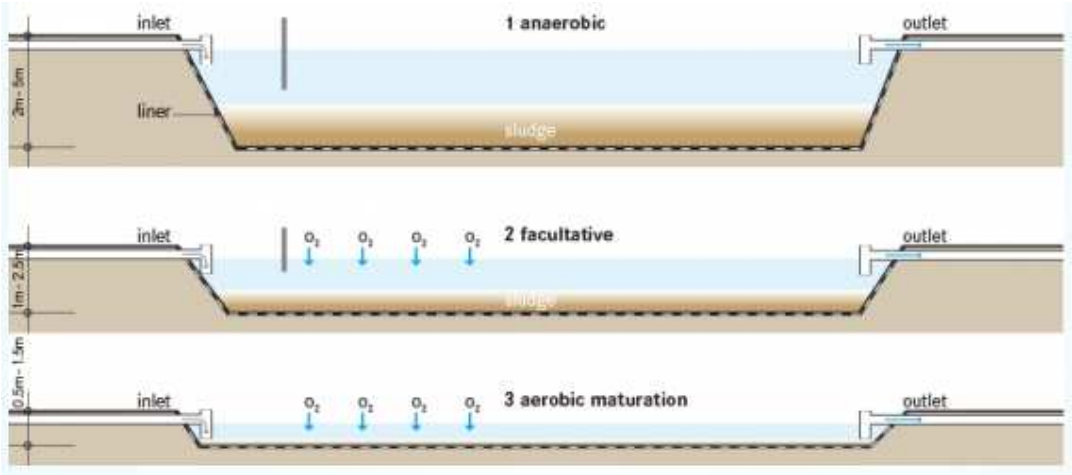
Biodisk

Trickling filter

Waste Stabilization Pond

Waste stabilization ponds (WSP) consist of one or more series of different types of ponds, anaerobic, facultative and maturation. Since sunlight and ambient temperature are key factors in their process performance, they are particularly suited to warm climates.

Typical design includes an anaerobic pond (as primary treatment) followed by a facultative pond for TSS and BOD removal, and several maturation ponds for pathogen removal as tertiary treatment. The final effluent quality depends largely on the size and number of maturation ponds.



This process requires high space requirements and is mostly suited for warm climates (efficiency decreases in cold climates). In addition, this treatment process does not allow consistent nitrogen and phosphorus removal.

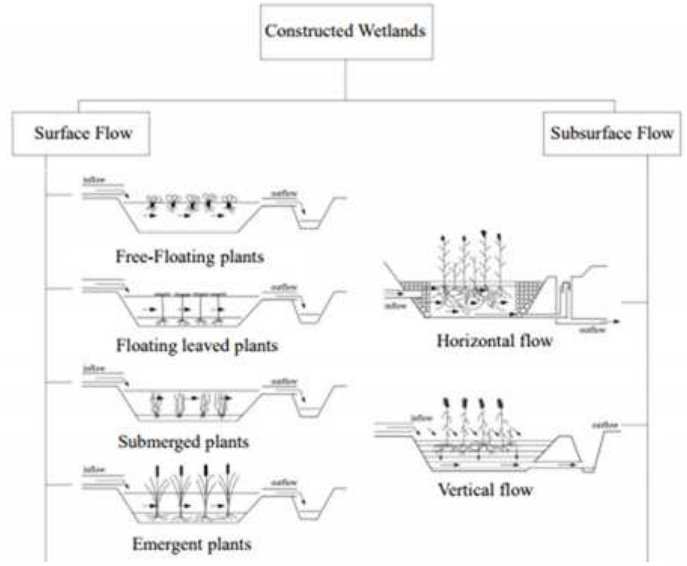
Aerated lagoon

An aerated pond is a modified extensive technology where mechanical aerators are added to reduce space requirements compared to conventional ponds. This technology is typically designed with a minimum 4-day detention time, a depth of 3 - 4 m and the needed specific space is about 1,5 to 3 m²/PE. Aerated lagoons are typically followed by a settling pond, for the sedimentation of the produced sludge, and maturation ponds, to increase efficiency.

Constructed Wetland

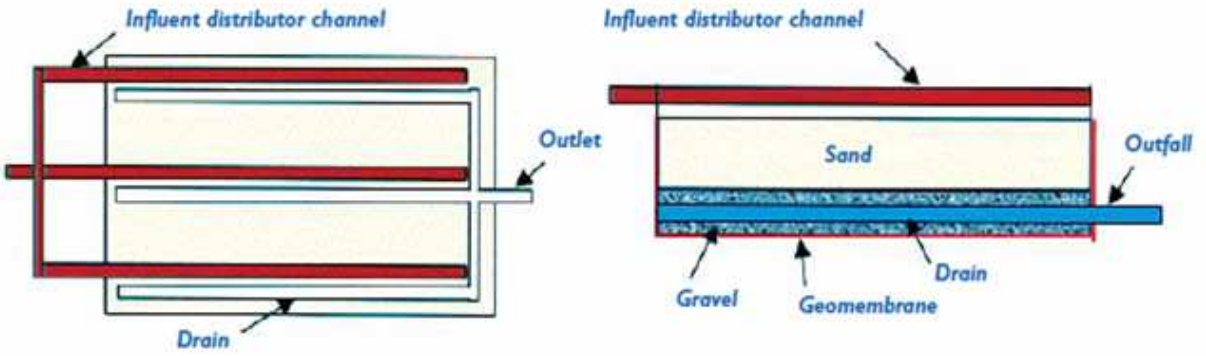
Constructed wetlands (CW) are engineered systems for wastewater treatment, which utilize the natural processes involving wetland vegetation, soil and microbes. Constructed wetlands are typically classified according to the hydrology (surface flow or subsurface flow) and flow path (horizontal or vertical). CWs may be combined in hybrid or combined systems to utilize the specific advantages of the different systems and achieve higher removal efficiencies.

For instance, the “french system” uses a series of vertical flow CWs with 2 stages, without requiring primary treatment. Other enhanced design approaches have been developed to improve nitrogen removal by combining one or two stages of several parallel vertical flow filters followed by 2 or 3 horizontal or vertical flow beds in series (VSSF-HSSF system).



Soil - Infiltration

This technology uses an engineered soil (granular filter) to infiltrate pre-treated wastewater. The biomass attached to the soil allows mainly to oxidize organic matter, nitrify ammoniacal nitrogen (formation of nitrates) and also to reduce pathogens.



Activated sludge

The principle of activated sludge is to grow a free biomass in an aerated tank. The biomass is separated from the treated effluent in a secondary settler or clarifier. One portion of this biomass or sludge is permanently recycled in the aerated tank, to maintain a required biomass concentration, and the rest is sent to the sludge treatment.

Activated sludge can be designed to treat only carbon (high or medium load) or to treat carbon and nitrogen (low load or extended aeration). If Nitrogen treatment is required, there are several configurations (recycling of mixed liquor, sequential aeration, step feeding, oxidation ditches…). All these configurations are only variations of the same principle.

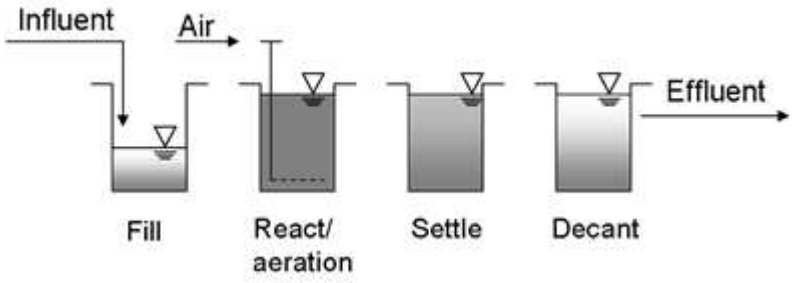
Activated sludge is a very efficient process. It is the most common way of treating carbonaceous and nitrogenous pollution of domestic effluents worldwide. The two main limitations are:

- High energy consumption, mainly for forced aeration
- Monitoring requirements: oxygen levels, sludge age, sludge settleability, sludge recirculation rate, etc.
    - The proper separation of the biomass from the treated effluent (basic condition for a good functioning) depends on the quality of the biomass and its aptitude to settle. If the loading conditions (kgBOD_5/kg of biomass/d) in the aeration tanks vary or are not well controlled, the quality of the biomass can rapidly decay and it becomes impossible to settle ("bulking").

Sequencing Batch Reactor

Sequencing Batch Reactors (SBR) are based on the activated sludge process. However, aeration and sedimentation are conducted in the same tank. Under special frame conditions this process allows the reduction of construction costs compared to the conventional activated sludge extended aeration process.

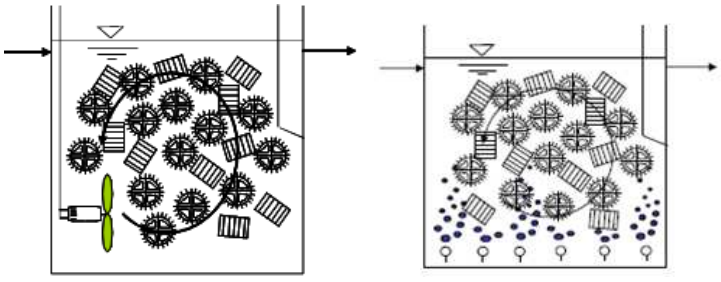
However, the handling of the SBR process needs a higher qualification of the operation staff and additional storage tanks. In general, SBRs need constant wastewater flows and load conditions and could be used for industrial wastewater treatment facilities.



MBBR

The Moving Bed Biofilm Reactor or MBBR is a biological treatment process for carbonaceous removal and/or nitrogen removal. The use of a support for biofilm growth enables a high biomass concentration to be maintained in the biological tank without any sludge recirculation, and without incurring settlement problems in the clarifier due to bulking sludge.

The support, generally referred to as carrier or media, is typically made of plastic, of a density lower or equal to that of water, allowing the support to be put in suspension in the reactor either by mechanical means (in an anoxic zone) or by the aeration system (in an aerobic zone). The carriers are retained in the reactor either using a screen or a sieve.



Compared to low load activated sludge, sludge production in MBBR is higher and sludge is not stabilized. Aeration (and energy) requirements are also higher than activated sludge, typically 20-30% higher.

MBBR is a very interesting solution when space is not available and a compact technology is required.

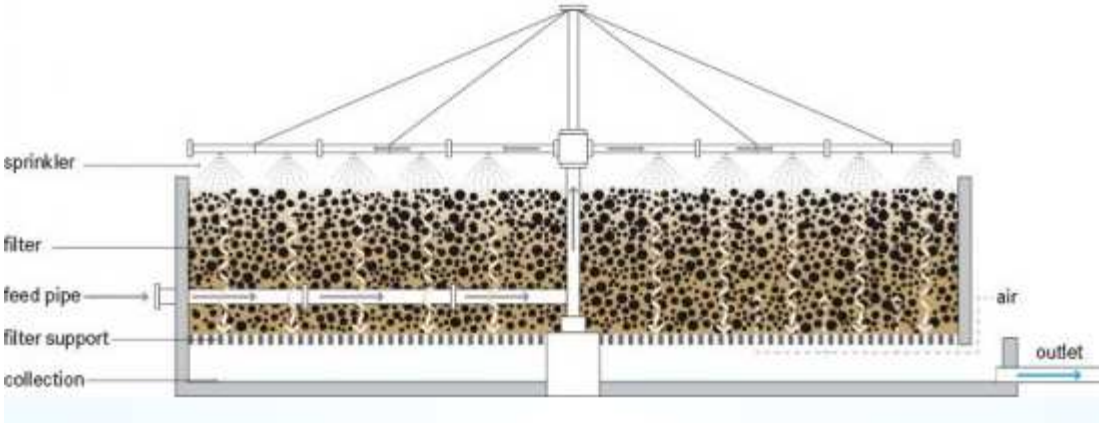
Biodisc or Rotary Biological Contactor (RBC)

It consists of a biomass media in the form of disc, usually plastic, that is partially immersed in the wastewater. A living biomass attaches and grows on the media. When the discs are set in rotation, they lift a film of wastewater into the air and bacteria are exposed to oxygen. When immersed, bacteria are fed with dissolved organic matter from wastewater. Any excess biomass is sloughed-off as the media is rotated through the wastewater. This prevents clogging of the media surface and maintains a constant microorganism population.

Compared to a conventional activated sludge process, energy consumption and operational requirements are lower, which make it well adapted for small WWTPs. Although simple in operation, it is very important to guarantee a reliable and robust mechanical design and construction to avoid failures, which increases the investment costs.

Trickling filter

A trickling filter is a fixed-growth biofilm treatment system where the wastewater “trickles” through a media on which a biofilm grows. The wastewater is distributed at the top of the filter with the use of rotating distributor arms that can be either hydraulically or electrically driven. Oxygen is provided to the system through ventilation openings at the bottom of the filter through which air can freely flow. There are various types of media such as rocks or plastic packed media.



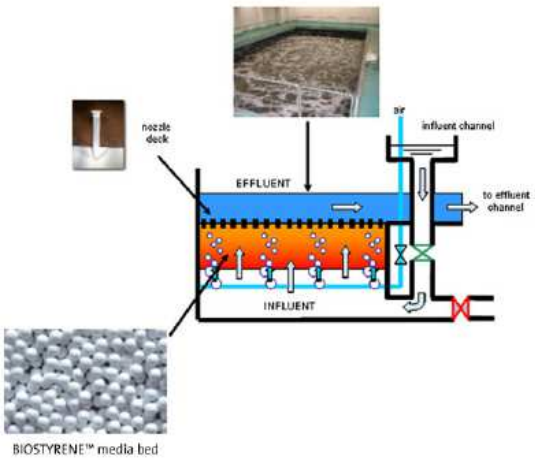
The trickling filters, as they use attached biomass, are very flexible to mass load variation with the condition that the system is designed with hydraulic recirculation. The new designs with plastic materials suffer from less operating problems than the old design with rock materials. Compared to

activated sludge, they consume less energy because they do not require forced aeration and the operational and monitoring requirements are lower.

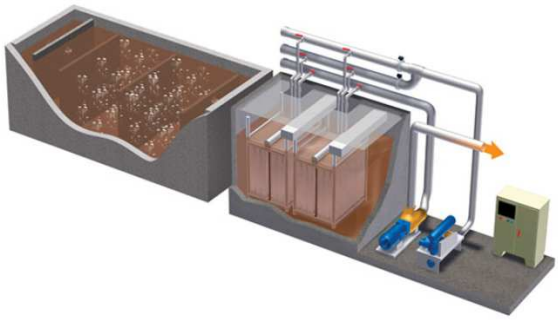
Advanced compact treatment technologies

Other advanced treatment technologies, such as aerated biofilters and Membrane Bioreactors (MBR), cannot be recommended to Soroca due to the very high investment and operational costs compared to conventional technologies. These are very efficient technologies which achieve a high quality effluent, but require high operational skills and are not suitable for small-medium size WWTPs.

A Biological Aerated Filter (BAF) combines filtration with biological carbon reduction, nitrification or denitrification. Wastewater and air are injected through a media on which biomass grows. Backwashing is needed in order to remove excess biological sludge. The high bacteria population leads to a very compact and efficient treatment.



Membrane Bioreactor (MBR) systems consist of a bioreactor and membrane filtration in the same unit, therefore eliminating the need for secondary clarification. The solid-liquid separation is achieved through membrane filtration. MBR has a very reduced space requirement (approximately 5 to 10 times smaller than conventional activated sludge plants with tertiary treatment).



7.4.2.4. Treatment of Nitrogen

Nitrogen in Wastewater

Nitrogen in wastewater is mostly in organic form and in reduced form (ammonia). The sum of organic nitrogen and ammonia is called Total Kjeldahl Nitrogen or TKN. The main sources of nitrogen are human excrement (urea) and household and industrial food waste. Nitrogen compounds, especially ammonia, are an indicator of water pollution since they exert a demand for oxygen, ammonia (in non-ionic form - NH_3) is toxic to aquatic organisms and together with phosphorus is the cause of eutrophication of water bodies. Furthermore, nitrates are a source of contamination if the recipient water body is used for the production of drinking water (the recommended limit for drinking water is 50 mg/L Nitrate (or 11 mg/L as $N\text{-}NO_3$).

On the other hand, nitrogen is an essential nutrient for plants and is used as a fertilizer in agriculture.

The biological treatment of nitrogen is done in two steps:

- First step: **nitrification** – consisting of the oxidation of ammonia (NH_4) and organic nitrogen in nitrate (NO_3). This process requires the growth of a specific biomass, autotrophic and aerobic. As the growth kinetic of the autotrophic biomass is slower than the kinetic of the aerobic heterotrophic biomass (which oxidize the carbonaceous pollution), this nitrifying bacteria can grow only when the carbonaceous pollution has been completely consumed (competitive growth of bacteria).
- Second step: **denitrification** – consisting of the transformation of nitrate (NO_3) into gas nitrogen (N_2). This step is performed by heterotrophic anoxic biomass. As it is heterotrophic, the denitrifying biomass requires carbonaceous substratum to grow.

This nitrification and denitrification process scheme requires a very accurate control of aeration, in order to create suitable **aerobic and anoxic conditions**. These can be obtained in an activated sludge process and in other advanced attached growth processes such as biofilters and MBBR.

The efficient removal of total nitrogen with extended processes or processes using natural aeration (trickling filters or biodiscs) is difficult to obtain. They are usually applied for carbon removal, although nitrification can also be achieved if correct conditions are set. For example, the following figure shows the operation of a trickling filter for carbon and ammonia removal: In the upper section BOD is consumed by heterotrophic bacteria. Nitrifiers cannot compete due to their slow growth and lower metabolic rate. With increasing depth of the trickling filter, when BOD is already removed (BOD<20 mg/l), nitrifying bacteria can develop and ammonia is converted to nitrate.

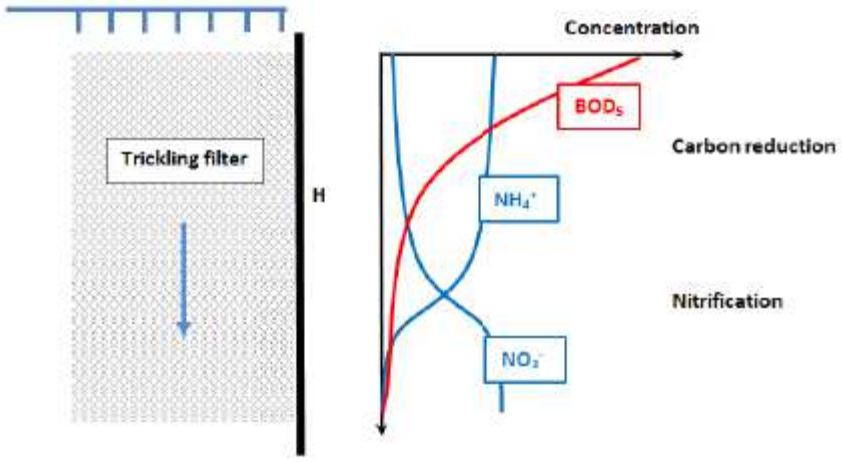


Figure 83: Nitrogen removal in trickling filter

The combination of trickling filters for BOD removal and nitrification with an anoxic system allows for integrated denitrification. However, this solution represents a higher degree of complexity, capital and operational costs than simple carbon removal trickling filters' plants.

7.4.2.5. Tertiary Treatment

It refers to treatment processes downstream of secondary treatment such as additional solids removal (coagulation, flocculation and clarification, filtration), disinfection for pathogen elimination, salts or micropollutants removal.

Phosphorus removal can be performed by chemical or biological treatment:

- Chemical treatment consists in precipitating the phosphorus with a metallic salt (generally: ferric sulfate or ferric chloride) and removing it by settling. It can be done in the primary, secondary or tertiary treatment.
- Biological treatment is based on a complex behavior of some aerobic bacteria, which in anaerobic conditions tend to store phosphate as a potential source of oxygen. This process can only be implemented with activated sludge.

7.4.2.6. Sludge Treatment

Sludge is produced in the primary and secondary treatment stages: primary sludge is composed of suspended solids brought with the water, and biological sludge, which is composed of excess biomass coming from the biological treatment of dissolved pollution. The solid content of primary and secondary sludge varies considerably, depending on the wastewater treatment process and on the operational procedures.

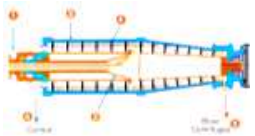
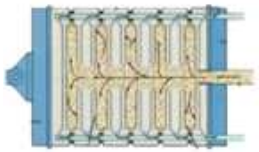
Sludge treatment has several objectives:

- Reducing its water content, by thickening, dewatering and/or thermal processes;
- Stabilization, that is, reduction of its fermentability or biological activity, by chemical (mainly lime), thermal or biological processes (anaerobic or aerobic digestion);
- Reduction of pathogens.

Thickening is a process that reduces sludge volume and increases solid content by removing a portion of the liquid fraction - water. Thickening can produce typically up to 4-6% of solids (Dry Matter). Sludge thickening technologies include gravity thickening, dissolved air flotation, centrifuge, gravity belt thickener and rotary drum thickener. Thickening technologies require polymer conditioning.

Dewatering is a process that further reduces the water content of sludge, making it easier to handle. Main dewatering technologies are presented below.

Table 30: Sludge mechanical dewatering technologies

PROCESS	CENTRIFUGE	BELT FILTER	PLATE FILTER PRESS	DRYING BED
View				
Description	Mechanical device composed of a rotating body that projects the sludge at the periphery through the coriolis forces. Internal baffles allow the collection of the thickened sludge on the side wall towards the discharge point while the concentrate is collected to the opposite end.	Dynamic continuous thickening. The raw sludge is spread between 2 belts and further pressed by circulating between rolls. Pressure is controlled by adjustment of the cylinder's position. Excess free water is filtered through the belts and is collected underneath.	Batch process. The raw sludge is generally dosed with ferric chloride and polymer or lime and then pumped into the compression chambers (plates). Hydraulic force is then applied to further press the sludge. Final cake is then manually or automatically dismantled from the plate and collected underneath.	A sludge drying bed is a solar drying process. It is composed of a bed of gravel/sand layers which is used as a filter media. **Planted drying beds** use the same principle of drying beds, but it takes advantage of plants. Sludge is also mineralized.
Advantages	Continuous operation, automatic Compact, small footprint, lower odor generation. Can be used also for thickening. Good performance	Continuous operation Small footprint Lower investment cost Simple operation	Very high performance Good sludge consistency Robust	Simplicity No energy consumption No chemical consumption Very efficient in summer
Limitations	High maintenance requirements Noise High energy and chemical consumption (polymer)	Lower performance Water consumption Medium -high maintenance and staff requirement	Intermittent operation Medium-high maintenance cost, High chemical consumption and increased volume of sludge if lime used High staff requirement	Large footprint Non continuous operation - Sludge handling – staff requirement Odor nuisance in summer Lower performance during winter
Cost	Capex: ++ Opex: +	Capex: + Opex: +	Capex: ++ Opex: ++	Capex: + (depends on land cost) Opex: - (only manpower)

Mechanical dewatering technologies can achieve a Dry Matter content higher than 20% DM (80% moisture content) with chemical dosage.

Chemical conditioning (polymer) is required for all alternatives. Belt filters require in general less chemical and energy than a centrifuge or filter press, but performance is lower (~18% DM). Filter press has the highest performance of these technologies (more than 30% DM), but requires more staff to operate and chemical consumption is higher, since it also requires lime.

Note on natural dewatering processes

In a sludge drying bed, part of the water is drained through the sand and gravel bed and part is evaporated. Performance is variable throughout the year depending on local climatic conditions, but enough dryness can be obtained if drying beds are designed and operated correctly (limited hydraulic surface load per batch and enough retention time).

Similar to drying beds, a **planted drying bed or sludge reed bed** is a system of a filter layer of sand and gravel with a drainage system, where water is partially evaporated and partially drained. Sludge volume is reduced, and sludge is stabilized. Plants, commonly reeds, are planted in the sand layer, which has the following advantages:

- It enhances the evaporation by evapotranspiration;
- Heavy metals and nutrients are partially absorbed;
- Oxygen is transferred to the sludge layer and sludge is mineralized (dry matter is reduced by 30 – 50 %);
- Sludge reed beds are prone to be better accepted by the public due to enhanced aesthetics and reduced nuisance (odors).

A sludge reed bed is in operation for approximately 5 to 10 years and achieves a mineralized sludge with a dry matter content of 30-40% (70-60% moisture). Before emptying, a drying and resting period of several months without addition of fresh sludge should be respected in order to well mineralise sludge and reduce pathogens.

Dimensioning is done according to sludge characteristics (quality and quantity) and local climatic conditions. The recommended applied ratio in continental climate such as in Soroca is:

- Surface load: 50 to 70 kg DM/m^2/year (which represents a footprint of approx. 0.25 m^2/pe);
- Number of filters: a minimum of 8 – 10 basins are recommended in order to achieve the required ratio between loading and resting periods.

The main limitation of this process compared to conventional drying beds is a certain complexity in the design and failures in the operation of the system due to the empirical operation:

- The sludge reed bed needs a long start-up period to allow plants to acclimatise and ensure plant growth;
- The sludge load needs to be adapted to the needs of the plant;
- Feeding and resting periods have to be adapted to the sludge height in order to guarantee enough mineralization.

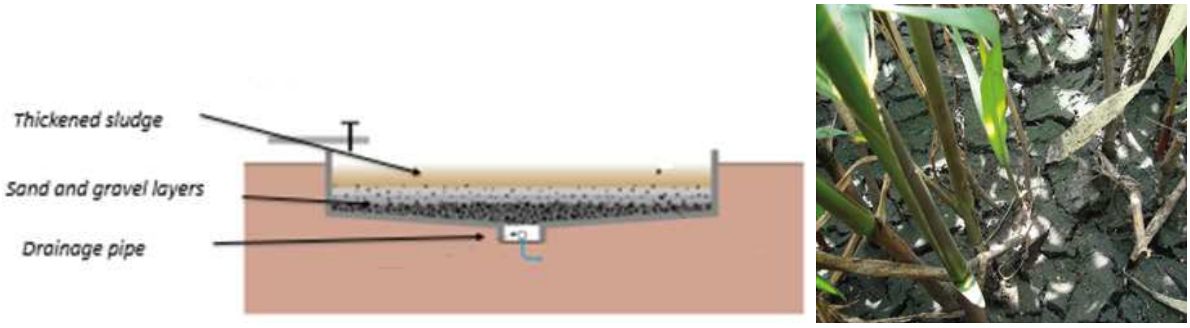


Figure 84: Drying bed (left) and Planted drying bed (right)

The following table shows the performance and characteristics of both processes for the local conditions in Soroca.

Table 31: Comparison between Drying bed and Planted Drying bed for sludge treatment

Parameter	Drying bed	Planted Drying bed
Loading	20 - 30 kg DM/m2/cycle Cycles: 30 - 40 days	50 kg DM/m2/year
Feeding frequency	Once a day	1 - 3 times a week, depending on weather conditions and plant specie
Desludging	After each cycle	Every 5 to 10 years
Final dryness	depending on weather conditions and cycle duration (20-40%)	>30% (long storage)
Dry matter reduction	-	30-50%
Plant acclimatisation **Plant harvesting**	NA	Plant to be irrigated with wastewater during start-up period and sludge feeding load has to be reduced
Plant harvesting	NA	Once or Twice per year

Mechanical or extensive sludge treatment in Soroca?

A mechanical sludge option can be proposed as an alternative to drying beds if nuisances may present a limitation for drying beds at the selected WWTP location. A mechanical treatment can be implemented inside a building where odours can be better managed. The disadvantage is the increased operational costs (energy, chemicals, repair and maintenance) compared to the conventional drying beds for a small-medium size WWTP such as Soroca. According to the NCM G.03.02:2015, mechanical sludge treatment is recommended for larger WWTPs' capacity *"sludge mechanical treatment will be provided, as a rule, at treatment plants with a capacity of 20 000 m^3/d or higher. With a proper justification, it can also be provided for treatment plants from 5 000 m^3/d".*

Figure 85: Sludge mechanical treatment based - Centrifuge

A CAPEX-OPEX estimation of both options is presented below for Soroca WWTP (19 000 PE). The following hypotheses are applied:

- Sludge production: 761 kg DM/day
- Organic loading rate drying beds: 200 kgDM/m2/year
- Polymer consumption centrifuge to obtain 25% dryness: 8 kg/T DM
- Maintenance and renewal centrifuge: 2,5% costs (without building)
- Maintenance and renewal drying bed: 0,5% costs
- Sand renewal for drying beds: Once per year; 10 cm
- Electricity: 0,086 EUR/kWh
- Financial assumptions: interest return rate of 5% for 20 years

Table 32: Financial comparison between centrifuge and drying bed for Soroca WWTP

1.CAPEX	Centrifuge	Drying Bed
Centrifuge Polymer preparation unit and dosing pumps Piping and valves Ventilation Electrical, automation and control Skips for storage (2 x 20 m3)	282 000	
Building	45 000	
Sludge drying bed 1400 m2 (including associated drainage pipes, valves, gravel and sand)		280 000
Bobcat		125 000
TOTAL CAPEX (EUR)	327 000	405 000

2. OPEX	Centrifuge	Drying Bed
2.1 Chemicals, consumables		
Polymer 8 kg/TDS	8 700	
Sand (10 cm renewal once per year)		4 200
Diesel for bobcat		100
2.2 Equipment Renewal	7 100	2 100
2.3 Electrical consumption	1 500	
TOTAL OPEX (EUR)	17 300	6 400
FINANCIAL COMPARISON	Centrifuge	Drying Bed
Interest Return Rate %	5%	5%
PERIOD (YEARS)	20	20
ANNUAL COST (EUR)	43 539	38 898

The annual operating costs for mechanical sludge treatment represent around 2.7 times the costs for drying beds. If both operating and investment costs are considered (NPV IRR=5%, 20 years), the mechanical treatment is approx. 10% more expensive.

The conventional drying bed is a well known technology in Moldova, which is implemented in most of the WWTPs. Due to the simplicity to operate and the lower maintenance required, **it is the preferred option for Soroca.**

Planted drying beds could also be applied in Soroca for sludge treatment. However, it is quite a new technology, there is no experience in Moldova, and it would need the implementation of a pilot project before large-scale.

7.4.3. Selection of a Wastewater Treatment Technology

7.4.3.1. Key factors for Technology Selection

Some key factors need to be taken into account for the process selection of Soroca WWTP:

- **Ease of operation and maintenance:** There is currently a general lack of qualified staff in SA "Regia Apa Canal Soroca" to operate a WWTP; the current staff is not familiar with the maintenance of sophisticated processes, complex electromechanical equipment, or with the operation of biological wastewater treatment plants. It is expected that O&M skills will improve in the future thanks to training and capacity building and that the financial situation of SA "Regia Apa Canal Soroca" will ameliorate, but in the short-medium term, robust and simple technical options should be preferred over advanced technologies;

- **Operational costs:** Currently there are very few expenses for the sewerage system (no energy consumption, no treatment plant, no sludge disposal costs). SA "Regia Apa Canal Soroca" will have to face an increase in expenses due to the construction and operation of new pumping stations and the new WWTP. Technical solutions requiring fewer staff, less spare parts and lower energy consumption should be preferred to keep expenses as low as possible;
- **Process reliability and flexibility:** The WWTP will be receiving domestic and non-domestic wastewater, but also septage sludge coming from the individual sanitation systems. The biological process needs to be robust and flexible to accept shock loads.
- **Phasing:** The WWTP needs to be designed and planned in several phases to cope with the future sewerage extension and the increase of the coverage ratio. The biological process needs to be easily extended.

7.4.3.2. Evaluation and Selection of Technologies

Intensive or extensive technology?

A first comparison is done between extensive and intensive technologies and its application for Soroca WWTP is discussed.

Table 33: Advantages and limitations of extensive technologies compared to intensive technologies.

Criteria	Extensive technologies	Intensive technologies
Construction costs	Generally lower capital costs. Costs depend mainly on land acquisition cost and may increase depending on type of soil	Higher capital cost
Operating costs	>50% less operating costs due to reduced power requirement and lower sludge production	High operating costs: energy consumption, sludge production, personnel, maintenance of electromechanical equipment
Ease of Operation and Maintenance	Simpler operation and maintenance	Skilled operators needed
Performance, flexibility and reliability	Less reliability and performance Not recommended for treating non-domestic wastewater Limited nitrogen removal	Higher performance and process reliability Very high nitrogen removal for specific intensive treatments More effective in treating high concentrated effluents and flexibility to load variations
Environmental and social footprint	Very large footprints are needed Risk of bad smells when bad operated and maintained Good aesthetics, landscape integration (constructed wetlands)	Small footprint

Application to Soroca

Extensive technologies are simpler and less expensive to operate than intensive techniques, in particular concerning energy, specialised manpower and the costs for treatment and disposal of sludge. Nevertheless, the use of extensive technologies have several drawbacks which are discussed below:

- Availability of space: Very large footprints are required (a minimum of 1,5 to 3 m^2/PE for constructed wetlands and aerated ponds, and more than 10 m^2/PE for ponds and infiltration-percolation), which means **a minimum of 4,5 hectares for a future WWTP of 30 000 PE.** After the research of available land for the WWTP location, only the Egoreni site has enough space to consider extensive treatment technologies, which limits the options to construct the WWTP.

  Nota: If the Constructed Wetland is combined with a primary treatment where part of the suspended solids and organic matter is removed, the space requirement would decrease. It has been estimated that a WWTP combining ABR (Anaerobic Baffled Reactor) - which has a high BOD removal efficiency (> 60%) - with CW will require approx. 2,2 ha for a 19 000 PE WWTP and 3,2 ha for a 29 000 PE.

- Efficiency and operational flexibility: Extensive technologies are less efficient and flexible than intensive technologies, as the technologies are based on natural reactions, there is little room for improvement and human intervention. Besides, **they cannot easily be upgraded to treat total nitrogen.**

- Public acceptance: The lessons learnt during the previous feasibility study in Soroca (Global Environment Facility Trust Fund Project, 2010-2012), show that extensive technologies can be rejected because of “low reliability” and “bad opinion” by the population (founded or not).

- The return of experience from the Orhei WWTP does not give confidence to SA “Regia Apa Canal Soroca” (see below).

Return of Experience of Constructed Wetland WWTP in Orhei

A new WWTP was built in Orhei in 2013 based on Constructed Wetland technology, with a design capacity of 21 660 Population Equivalent and a design hydraulic load of 4 600 m3/d.
This plant has been in operation since 2013 and presents satisfactory results according to the operator Apa Canal Orhei (TSS outlet = 28 - 32 mg/l; BOD outlet = 16 mg/l). Quite a lot of information has been published about this site, which presents the success of this type of extensive technology in medium-size WWTPs.

However, there are some operational issues which, unfortunately, reveal some unclear points about the efficiency and suitability of this technology:

1. The WWTP has been working at 25% of capacity - around 1000 m^3/d - since its commissioning. Neighboring villages have not been connected to the sewer network yet, and a large part of the city and the main industrial site (a juice factory), are still connected to the old WWTP (based on trickling filters). The operator uses the whole Constructed Wetland area to treat 25% of the flow. This results in underloading the reed beds and it has allowed him not to remove sludge in all these years. This situation shows that the applied design loads (organic and hydraulic) have not been completely “approved” in the Moldovan context.

2. Since the beginning of the operation, the plant has suffered from some freezing problems during winter time. These problems “could be solved by defining specified operational strategies for the coldest periods”, as indicated by the constructor. However, these strategies have not been implemented in the plant, the basins freeze and according to the information collected onsite, the WWTP is not used in winter, all the flow is treated in the old WWTP.

3. The CW Plant is not treating agro-food industrial discharges as it was supposed to do. The discharges from industries still go to the old WWTP. The operator wants to rehabilitate his old WWTP, because he does not trust that the CW can treat the industrial discharges.

Due to this return of experience in the operation of the WWTP, there is not a clear consensus on the efficiency and reliability of Constructed Wetland technology for medium-size cities in Moldova. In particular, the operator SA “Regia Apa canal Soroca”, showed reluctance in the suitability of this type of extensive technology for Soroca, where climatic conditions and agro-food discharges are similar to Orhei.

Extensive technologies can be, however, a very good option for small WWTPs in rural areas for small populations where the removal of nitrogen and phosphorus is not required, because of the lower investment and operation costs. The publication of the Code of Practice dealing with Systems of Communal Wastewater Natural Biological treatment in Reed Bed Filters (CP G.03.01:2016) provides useful guidelines and backs-up the utilization of this technology in rural areas.

The following table shows the comparison for the main intensive biological technologies and the Constructed Wetland technology.

Criteria	Constructed Wetland	Biodisc	Trickling filter	Activated sludge (low load)	SBR	MBBR
Construction costs	Low - moderate (depending on cost of land and type of soil)	Moderate-high	Moderate	Relatively high	Relatively high	High
Operating costs	Very low operational costs Very low sludge production	Low operational costs Low sludge production	Low operational costs Low sludge production	High energy costs (aeration) and staff O&M requirements	High energy costs (aeration) and staff O&M requirements	Higher energy costs (~20% higher energy consumption than AS) Staff O&M requirements
Ease of O&M	Very easy to operate	Easy to operate	Easy to operate New material fillings (plastic) suffer from less operating problems such as vector and odor problems than the rock materials	Complex operation, operating tasks include: Monitoring of oxygen levels and sludge age, sludge recirculation. Skilled personnel	Complex operation Skilled personnel	Less complex operation (no sludge age monitoring) Skilled personnel
Performance and flexibility	Very limited system flexibility Limited nutrient removal Lower process efficiency than AS	Limited system flexibility and nutrient removal Lower process efficiency than AS	Limited nutrient removal Lower process efficiency than AS	High process efficiency and nutrient removal	High process efficiency and nutrient removal Higher degree of automation required for optimum operation	High process efficiency and nutrient removal
Reliability	Generally reliable, self-adjusting systems	Robust and resistant to shock loads	Robust and resistant to shock loads	Average resistance to shock loads (depending on type of AS)	Lower resistance to shock loads	Robust and resistant to shock loads
Other	Large footprint requirement Low social acceptance in Soroca	Adapted to small WWTPs	It requires primary treatment	It does not require primary treatment Sludge is partially stabilised if long sludge age	Lower footprint Sludge is partially stabilised if long sludge age	Very compact, lower footprint Sludge is not stabilised

The main advantages of trickling filter technology over activated sludge, SBR or MBBR, is the lower operational costs and operational and maintenance requirements. This is considered a **critical factor to guarantee sustainability and durability** of the WWTP over time. Although the technology is not as efficient and flexible as technologies with forced aeration, the optimised design of trickling filters with new plastic fillings and high recirculation rates achieves a high degree of treatment reliability. Besides, the trickling filters are adapted to future changes in flow and wastewater concentration. The biological treatment uses attached biomass and it can work with both concentrated and diluted effluents.

The main limitation of trickling filters is that they are less adapted than the other technologies to treat total nitrogen. A target of 15 mg/l total nitrogen, as required by the regulation, is challenging and it would need local pilot testing to ensure proper design and operation.

If only carbon treatment (or partial treatment of nitrogen - nitrification) is accepted in a first phase, then the most suitable process to local conditions is the trickling filter. This would allow to prioritize the construction of the WWTP:

- The first phase aims at tackling an environmental problem by treating wastewater to an acceptable level for discharge. It also aims at strengthening the capacities and technical skills of the staff;
- The second phase aims at upgrading the treatment plant to treat total nitrogen, meet regulatory compliance requirements, and cope with possible increase in loads and flows due to the sewerage network extension.

If the full treatment of nitrogen is imposed from now, according to the Moldovan regulation, then the most recommendable solution would be the low load activated sludge, due to its reliability and high efficiency.

On the other hand, a hybrid solution consisting of anaerobic primary treatment (Imhoff tank or ABR) followed by Constructed Wetlands could be proposed as the option with the least operational and investment costs. This solution will however not guarantee the treatment of nitrogen and phosphorus up to the required limits.

7.4.3.3. Pre-design and Net Present Value Comparison

The Net Present Value (NPV) of the pre-selected technologies is calculated in order to evaluate the total life-cycle cost of these options for the period 2025 to 2045:

- Option A: Trickling filter (only Carbon Treatment)
- Option B: Constructed Wetland (only Carbon Treatment)
- Option C: Trickling filter with un upgrade in second phase to treat Nitrogen
- Option D: Activated Sludge low load

Option A. Trickling filter

The water treatment line is composed of:

- Pre-treatment: Screening and combined grit and grease removal tank
- Imhoff tank
- Intermediate pumping station
- Trickling filter
- Secondary clarifier

The sludge from the secondary clarifier is recirculated to the Imhoff tank. From the Imhoff tank, sludge is extracted and treated directly in drying beds.

This WWTP only treats Carbon.

Option B. Constructed Wetland

The water treatment line is composed of:

- Pre-treatment: Screening and combined grit and grease removal tank
- Anaerobic Baffled Reactor (ABR)
- Intermediate pumping station
- Constructed Wetland

The sludge from the ABR is extracted and treated directly in drying beds.

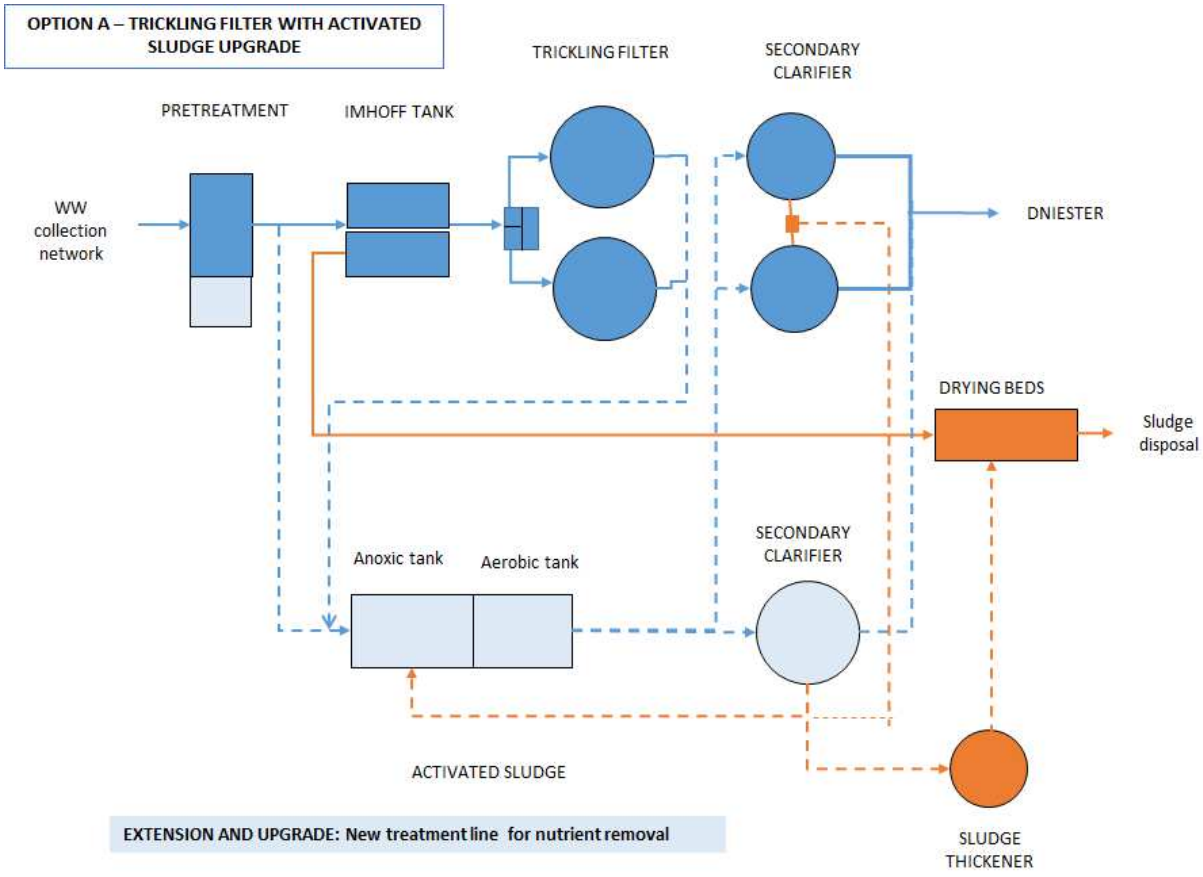
This WWTP only treats Carbon.

Option C. Trickling filter and upgrade to treat nitrogen

For this option, it is considered that the Trickling Filter WWTP will be upgraded during a second construction phase to treat nitrogen. Several options may be available for this upgrade:

- A complete activated sludge treatment train can be implemented in parallel to the trickling filters: the organic loading to the existing trickling filters is decreased, allowing organic removal and nitrification to occur. The treated effluent from the trickling filter is then recycled in the head of the activated sludge, where it is mixed with part of the raw effluent, allowing denitrification. The split between activated sludge and trickling filter will depend on the COD and Nitrogen loads: the ratio of COD/N has to be over 10 to allow for an advanced nitrate removal (NO_3<10 mg/l). Compared to a full activated sludge treatment, the aerated zone to be built would be much smaller and the global energy consumption lower.
- Addition of denitrifying reactors and additional trickling filters for nitrification. The denitrifying reactors could be based on submerged anaerobic filters or anoxic MBBR tanks. Several recirculation loops would be required to achieve correct conditions in the anoxic reactor (COD/N ratio) and in the nitrifying trickling filters.

The second treatment scheme is challenging from an operational point of view, and there are no track records of its implementation in medium-size plants, the first option is selected for the comparison, as shown below.



Option D. Activated sludge low load

A conventional low load activated sludge treatment plant includes:

- Pre-treatment: Screening and combined grit and grease removal tank
- Biological tank of activated sludge low load
- Secondary clarifier

The sludge treatment line includes the following steps:

- Sludge static thickener
- Drying bed

Hypothesis for calculation of Net Present Value (NPV)

- Location of WWTP: P4 - Forest
- Evolution of flows and lows

Parameter	Unit	2025 - 2035	2045
Total population	inh	36 826	36 313
Connected population	**%**	**47%**	**75%**
Connected population	in	17 308	27 235
WW discharge ratio	**LPCD**	**72**	**76**
Total flow (domestic + non-domestic)	**m3/d**	**2 243**	**6536**
Pollution load	**kg BOD/d**	**1 142**	**2 139**
Population Equivalent	**PE**	**19 039**	**28 900**

- Construction phases:
  - Phase I - 2023: Construction of WWTP at horizon 2035
  - Phase II - 2035: Construction of extension of WWTP at horizon 2045

	Electricity (kWh/kg BOD rem)	Sludge Production (kg TSS/kg BOD rem)	Maintenance and renewal (% Capex)	Staff
Trickling filter	0,5	0,7	1%	14 people
Constructed Wetland	0,2	0,23	0,25%	10 people
Trickling filter + AS Phase II	1,2	0,77	1%	16 people
Activated sludge	1,9	0,84	1,5%	16 people

Unitary costs for Operational Expenses

- Electricity: 1,83 MLD/kWh
- Sludge disposal in Landfill: 212 MLD/m3
- Exchange rate: 1MDL = 0,047 EUR

OPEX includes electricity from WWTP and pumping stations, renewal and maintenance, sludge disposal cost in landfill and personnel cost.

Nota: Additional costs for phosphorus removal are not included because it is considered that the chemical consumption would be the same for all options.

The comparison of the NPV for a period of 20 years and a discount rate of 3 and 5% is shown below.

Table 34: NPV for selected technologies

WWTP in Forest	Option A: Trickling filter	Option B: Constructed Wetland	Option C: Trickling filter + upgrade	Option D: Activated sludge
Capital Expenses (Phase I)	7,9	5,3	7,9	9,5
Capital Expenses (Phase II)	2,3	2	4,5	4,6
Cumulated OPEX (2025-2045)	3,36	1,54	4	5,7
NPV (EUR/m3) - DR 5%	0,58	0,38	0,66	0,80
NPV (EUR/pe) - DR 5%	24,07	15,87	27,34	33,14
Difference with Option A Trickling filter		-34,1%	13,6%	37,7%
NPV (EUR/m3) - DR 3%	0,62	0,41	0,73	0,88
NPV (EUR/pe) - DR 3%	25,75	16,97	29,99	36,29
Difference with Option A. Trickling filter		-43,4%	16,3%	40,7%

It can be observed that the option with Activated sludge low load has a NPV 38 - 40% higher than the option of Trickling filter for carbon removal. The construction of a first phase with only carbon removal followed by the upgrade, would allow keeping the expenses of the treatment plant to a minimum during the first years of operation.

On the other hand, the Constructed Wetland solution is between 34 - 43% less expensive than the Trickling Filter.

7.4.3.4. Conclusion on Technology Selection

Taking into account the main selection criteria (ease of operation and maintenance, operational costs, process reliability and flexibility, phasing for future extension - upgrade), the preferred solution by the consultant is Trickling Filter technology. This technology has moderate operation and maintenance costs, provides high reliability and robustness for medium size plants and requires low-moderate personnel skills.

Although the Constructed Wetland technology would be more advantageous than the Trickling Filter from an economic point of view, it is not the preferred option for Soroca due to several factors:

- Large footprint requirement, which makes it difficult to integrate in the topography in Soroca and in the identified plots (this technology could eventually be built in the selected Plot in the Forest by combining it with a primary treatment, but only for the first phase capacity. Additional land should be obtained by the Municipality for future extensions);
- Limitation to perform a process upgrade and guarantee nitrogen and phosphorus removal to required limits;
- Social rejection from the beneficiary to this type of extensive treatment.

7.5. Recommendations for On-site Sanitation Systems

7.5.1. Introduction

The most extended system of on-site sanitation in the study area is soak pit latrines. This is one of the simplest solutions for individual sanitation, where wastewater is directly infiltrated into the soil, without any pretreatment. Septage sludge accumulates and degrades in the pit, which needs to be emptied more or less regularly.

The soak pit system cannot be considered an adequate solution due to several reasons:

- Lack of pre-treatment stage of wastewater;
- Groundwater pollution;
- Lack of maintenance (irregular emptying of the pits);
- Uncorrect management of septage (the disposal point of most of the septage produced in the study area is not known).

The improvement of on-site sanitation systems needs to cover all these aspects, from the design of on-site systems, to the management of septage and effluent.

The groundwater analyses of the villages of the study area show a significant pollution with faecal bacteria and high nitrate concentration, originating probably from natural nitrification of ammonia in the ground. The source of this pollution may be farm activities (animals' manure, fertilizers…) but also on-site sanitation systems.

The performance of on-site sanitation systems depends on the type of system used, the soil characteristics, the groundwater level and the population density. For effective wastewater treatment, favourable soil characteristics and geology must exist for treatment and subsequent disposal of treated wastewater into the environment. In areas with high water tables, low permeable soils, very sloped areas, other advanced options should be taken in consideration, instead of simple soak pit latrines.

To avoid contamination of drinking water sources and other problems, soil absorption systems must be situated at prescribed distances from wells, surface waters and springs, property boundaries and building foundations. These regulations may restrict the feasibility of on-site systems' installation.

7.5.2. Improvement of On-site Sanitation Systems

The first step to improve the current on-site sanitation systems is to upgrade the existing pit latrines with more advanced treatment solutions. There are several options depending on the degree of performance:

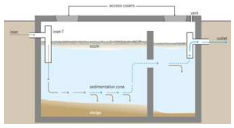
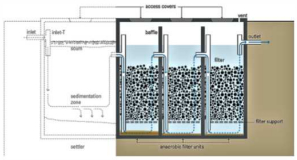
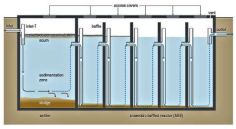
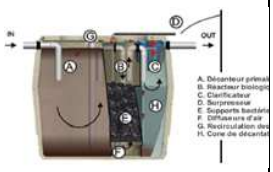
1. **Septic tank followed by a soil adsorption area:** A septic tank is the most simple pre-treatment for on-site or decentralized sanitation solutions. It is a watertight chamber made of concrete, fibreglass, PVC or plastic, which provides primary treatment (settlement of suspended solids and anaerobic digestion of biodegradable organics). Organic matter is typically reduced up to 50%.

2. **Septic tank with anaerobic filter followed by a soil adsorption area:** The septic tank effluent is further treated by an anaerobic filter made of different types of media (coconut husk media, textile media, sand, etc.) designed at low hydraulic load, so that it does not require backwashing as biological activity regulates the clogging level.

3. **Anaerobic Baffled Reactor followed by a soil adsorption area:** The ABR is an improved septic with higher efficiency, which depends mainly on the number of chambers and on the ambient temperature.

4. **Small WWTP** based on mechanical aeration systems such as SBR, fixed film bioreactor, etc. or natural systems such as Constructed Wetland.

Table 35: Different options of wastewater treatment for on-site solutions

Septic tank	Septic tank + anaerobic filter	Anaerobic Baffled Reactor	Small treatment facility (SBR, fixed film, CW, etc.)
			
BOD_5= 15-25% TSS = 60-70% Fecal coliforms= 90%	BOD_5= 50-80% TSS = 50-80% Fecal coliforms= 1-2 logs	BOD_5= 70-95% TSS = 60-90% Fecal coliforms= 90%	BOD_5= 90-95% TSS = 90-95% Fecal coliforms= 90%

In the first three options, the effluent is still malodorous, contains significant dissolved organic content and pathogenic organisms and cannot be discharged into the environment. The effluent has to be further treated by subsoil infiltration, such as a soak pit or a grid of perforated buried pipes in trenches (leach field or soil adsorption field).

The effluent from small WWTPs can be further treated by a polishing filter to reduce microorganisms, by soil filtration or directly discharged into the environment.

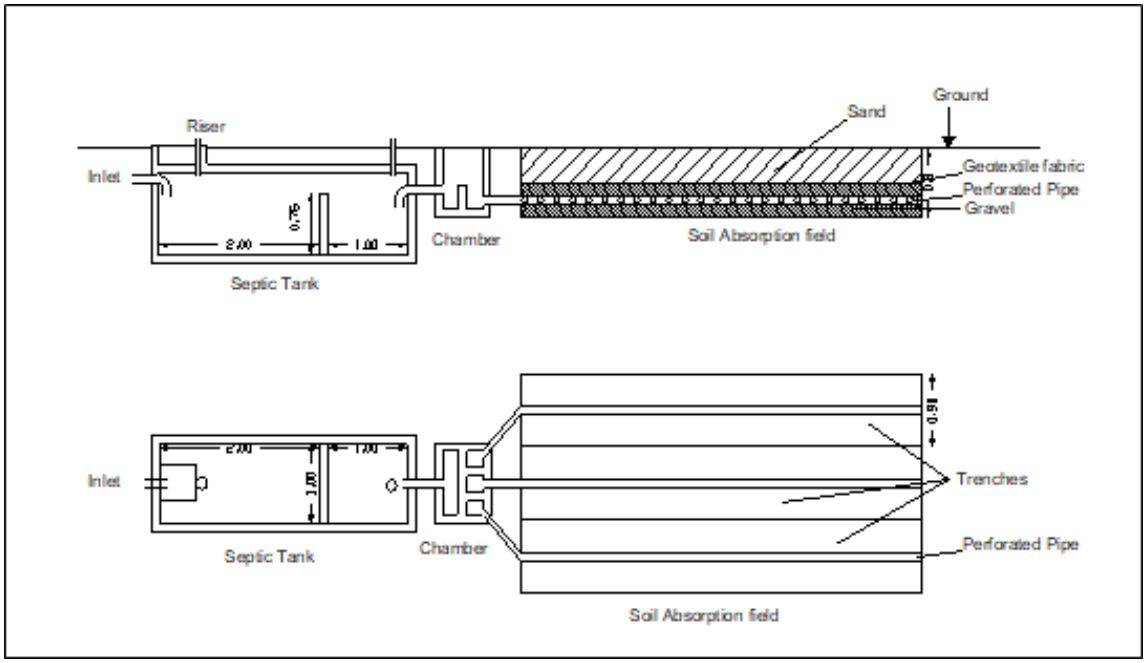


Figure 86: Septic tank with soil adsorption system

The design and construction of the soil adsorption system (area) depends on the following criteria:

- The soil characteristics (type, permeability, depth, etc.)
- The depth of the water table
- The proximity of wells, springs or other water sources
- The groundwater quality and vulnerability (exploitation of groundwater for drinking water)
- The density of on-site sanitation facilities
- The type of pretreatment

Typically, the area occupied by a leaching field in an individual house is over 20 m^2. Common horizontal separation distances from various objects are shown in the following table and figure.

Table 36: Typical horizontal separation between soil adsorption systems and other objects

Object	Typical horizontal separation
Water supply wells Surface waters, springs	15 – 30 m
Boundary of property	1.5 – 3 m
Building foundations	3 – 6 m

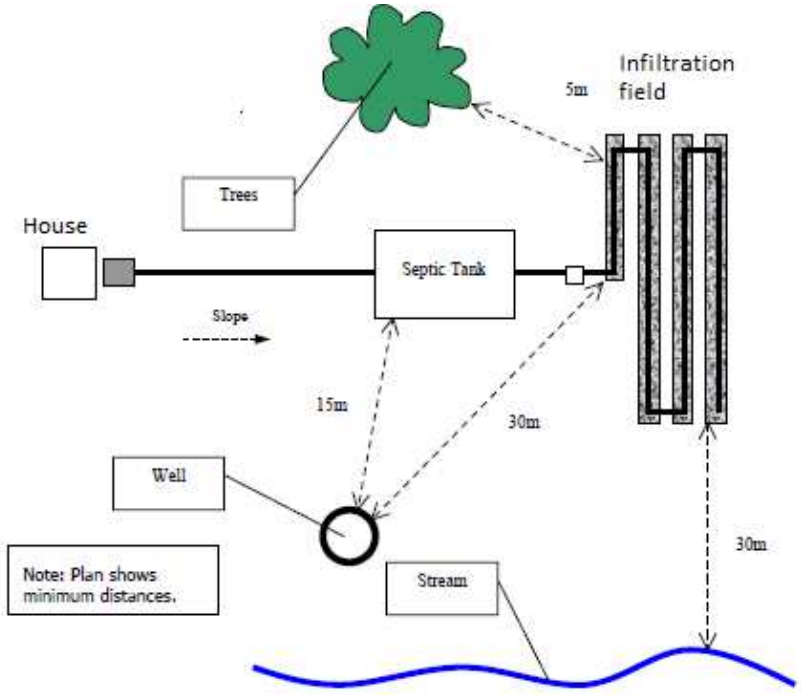


Figure 87: Example of plan location of an on-site sanitation system (source: OXFAM Technical Briefs Septic Tanks and Drainfields)

The cost of a simple septic tank for an individual house (3-4 persons - 2000 L) is around 12 - 15 000 Lei whereas the cost for the soil absorption field is highly variable depending on the type of soil and the excavation and works required.

It is recommended that new houses which are connected to drinking water piped supply, are provided with septic tanks with an appropriate soil adsorption system. Regarding existing houses, there are two main constraints at household level which may hinder the rehabilitation of on-site systems, finance and the availability of space for locating the system.

Ecosan toilets

The use of Ecosan toilets (Urine Diverting Dry Toilets) is being promoted in Moldova by several NGOs and international projects (ApaSan 2008-2019). This system is an improved sanitation solution for dry pits, because it reduces smells and it allows the separate disposal of by-products (urine and faeces) in an easier and safer way.

Since the system does not use water and does not require much space to be implemented, it is a good option for households where a septic tank and soil infiltration system cannot be implemented. However, whereas this system has given promising results in schools, where it has improved the sanitary conditions and represents an invaluable educational tool, the implementation in households is not popular yet.

7.5.3. Septage Management Options

On-site sanitation systems must be easily accessible for periodic emptying of the accumulated sludge (typically every 3 to 4 years). Sludge must be disposed of in an approved facility (see below).

Legal framework for septage collection, treatment and disposal

According to the HG 950/2013, fecal sludge from septic tanks or other similar installations will be treated in wastewater treatment plants. The discharge of faecal sludge into surface water bodies is prohibited.

The existing options for septage treatment and disposal from on-site sanitation systems are as follows:

1) **Direct land application** based on either surface or subsurface application. Surface application methods include spray irrigation, ridge and furrow irrigation, vacuum truck or farm tractor spreading. Subsurface application methods include techniques such as subsurface injection and tank truck or farm tractor with plow and furrow cover;

2) **Co-treatment at existing Wastewater Treatment Plant**: Septage can be disposed of and treated in a WWTP, either in the wastewater line (septage is disposed of in the plant headworks) or directly in the sludge treatment.

3) **Independent WWTP to treat septage:** this can be adopted in situations where there is no WWTP available or land to handle septage. An independent WWTP can be based on different processes such as activated sludge, waste stabilization lagoon, constructed wetland, aerobic or anaerobic digestion, etc. The high concentrations and septicity of the septage need to be taken into account to design it.

The option of co-treatment in the future WWTP is the preferred option for Soroca and surrounding villages, since direct land application of sludge is not permitted in Moldova, according to the current legal framework, and there are neither experiences, nor design norms in the country for independent WWTPs treating only septage.

The average concentration of septage is at least 20 times higher than wastewater, therefore, the WWTP must be designed to treat the peak loads of septage. According to best French Operational Practices, the organic load (BOD, COD) of the septage disposed of in the WWTP must be lower than 20% of the organic design load, and the septage flow must be below 3%. Other strategies include:

- Independent receiving facility for septage which includes screening, grit removal
- Flow equalization tank with mixers: the effluent is then intermittently fed to the WWTP to avoid organic peaks
- Implementation of an appropriate odor control unit
- Measure discharge septage (weight of vacuum truck) or flow, to accurately follow volumes of disposed septage

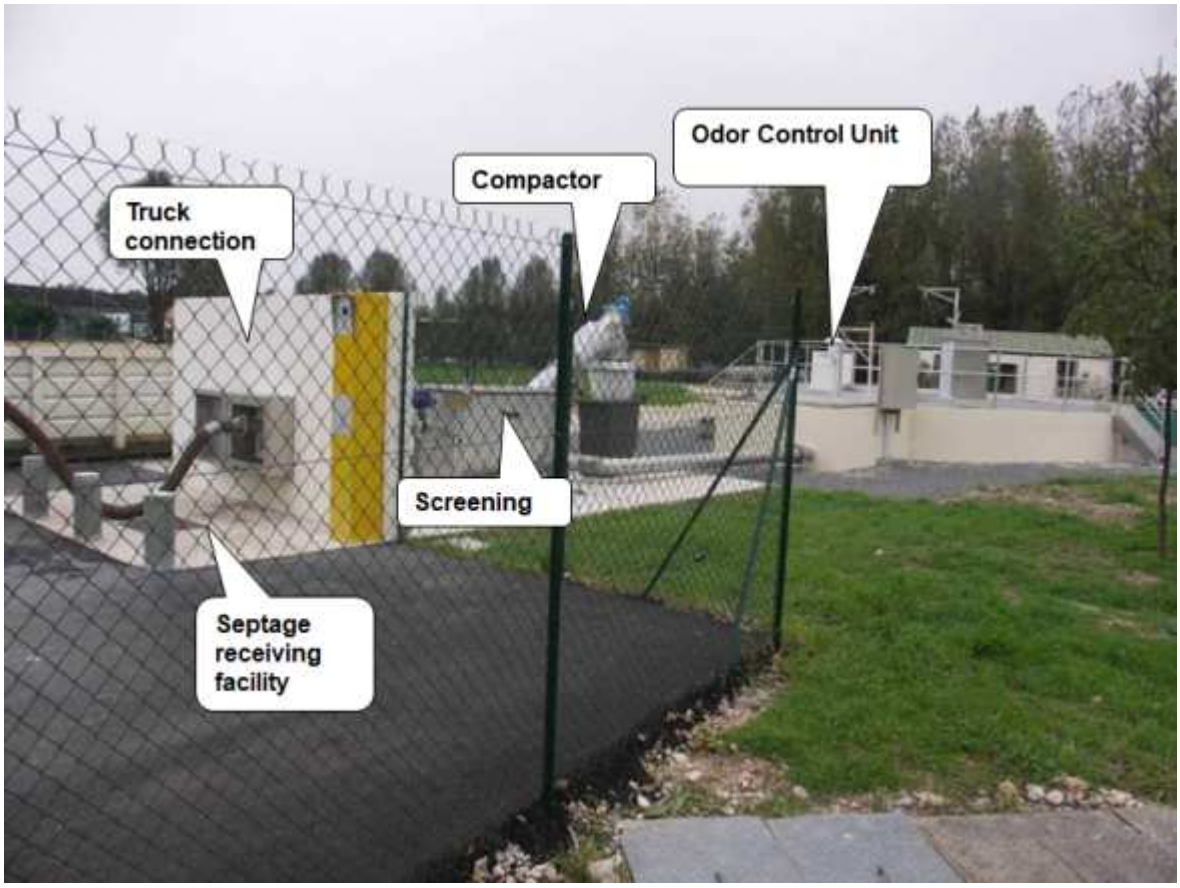


Figure 88: Septage sludge treatment facility in WWTP

7.6. General Design of the Soroca Wastewater Treatment Plant

7.6.1. Main Design Criteria

Wastewater Characteristics

The design of a Wastewater Treatment Plant is based on the incoming peak hydraulic load (generally represented as the maximum hourly wastewater flow rate) and on the incoming pollution load.

The characteristics of the wastewater to be treated by Soroca WWTP have been estimated based on various assumptions presented in the previous sections for the current situation and the evolution in time from 2025 to 2045:

- The population will decrease at an annual rate of 0.14%;
- The drinking water consumption will gradually increase by +2.74%/year until 2025 and thereafter by +0.5%/year to target a domestic water consumption of about 100 liter/capita/day by 2065;
- The agglomeration served by a central sewer system and connected to the WWTP includes the town of Soroca and Zastinca,

- The coverage rate targets 47% of total population in 2035 and 75% in 2045;
- Wastewater flow rate generated by the inhabitants, budgetary institutions and economic agents: 80% return ratio of drinking water consumption,
- Additional flows expected from budgetary institutions: 10% of domestic wastewater
- Additional flows expected from economic agents: 10% of domestic wastewater flow. + fixed baseline of 137 m^3/d.
- Pollution load: In 2025, it is estimated that a specific value of 50 g BOD/capita/day represents the domestic pollution in Soroca, including the pollution from commercial and institutional agents, to which it is added the pollution load from the main industrial site (Fabrica de brinceturi).

  From 2035, a standard value of 60 g BOD/capita/day is used to estimate both the domestic and non-domestic pollution load of the city (budgetary and economic agents). In fact, it is considered that from 2035, the industries will have their own pre-treatment facilities and will comply with the discharge limits to the sewer network.
- Infiltration to the sewer network: It has been estimated at 31 m^3/h in 2025 and it reduces 20% in 2035 (25 m^3/h) and an additional 10% in 2045 (22,5 m^3/h),
- Peak hourly flow (Peak Flow Factor) is calculated with the conventional formula

  $PFF = 1.5 + \frac{2.5}{\sqrt{ADF\ (l/s)}}$ where ADF= Average Daily Flow (without infiltration)
- Storm water flow: due to the condition of the sewer network and the elevated intrusion of rainwater, a flow of 36 m^3/h has been included in the design of the Central Pumping Station and in the WWTP. Higher rain flows will be discharged to the river at the main Pumping Stations by means of storm water overflows and will not be treated at the WWTP,
- Septage discharge from on-site sanitation systems will be accepted in the WWTP (maximum of 10% of domestic design load at horizon 2035, which represents 19 vacuum trucks per week of 3,8 m3 capacity). For the estimation of the WWTP capacity at horizon 2025, it is considered the acceptance of one vacuum truck per day.

All these assumptions and associated calculations are presented below.

Table 37: Wastewater characteristics Soroca WWTP

Parameter	Unit	Current situation 2025	Phase I 2035	Phase II 2045
Total population (Soroca and Zastinca)	inh	37 348	36 826	36 313
Connected population	%	40%	47%	75%
Connected population	**inh**	**14 939**	**17 308**	**27 235**
Water consumption	lpcd	86	90	95
Wastewater return factor	%	80%	80%	80%
Specific wastewater discharge ratio	lpcd	69	72	76
Wastewater flows				
Domestic	m3/d	1 028	1 246	2 070
Budgetary institutions	m3/d	103	125	207
Economic agents	m3/d	240	262	344
Infiltration	m3/d	749	600	540
Septage	m3/d	3,8	10	10
Total daily flow	m3/d	2 123	2 243	3 171
Dry weather peak factor		2	1,99	1,91
Dry weather peak flow	m3/h	146	161	232
Storm water	m3/h	36	36	36
Wet weather peak flow	m3/h	182	197	268
Specific Pollution loads				
BOD5	g PE	50	60	60
COD	g PE	100	120	120
TSS	g PE	60	65	65
TKN	g PE	10	11	11
TP	g PE	2	2	1,8
Pollution loads - Sewerage network				
Load BOD5	kg/d	747	1 038	1 634
Load COD	kg/d	1 494	2 077	3 268
Load TSS	kg/d	896	1 125	1 770
Load TKN	kg/d	149	190	300
Load TP	kg/d	30	31	49
Additional Industrial Pollution loads - Fabrica brinceturi				
Load BOD5	kg/d	299		
Load COD	kg/d	448		
Load TSS	kg/d	52		
Load TKN	kg/d	28		
Load P	kg/d	7		
Septage Pollution loads - Vacuum truck				

Load BOD5	kg/d	38	104	104
Load COD	kg/d	57	156	156
Load TSS	kg/d	46	125	125
Load TKN	kg/d	3,8	10,4	10,4
Load TP	kg/d	0,6	1,6	1,6
Total Pollution loads				
Load BOD5	kg/d	1 084	1 142	1 738
Load COD	kg/d	1 999	2 233	3 424
Load TSS	kg/d	994	1 250	1 895
Load TKN	kg/d	181	201	310
Load TP	kg/d	38	33	51
Concentration wastewater Average Dry Weather				
Concentration BOD	mg/l	511	509	548
Concentration COD	mg/l	942	996	1 080
Concentration TSS	mg/l	468	557	598
Concentration TKN	mg/l	85	90	98
Concentration TP	mg/l	18	15	16
Concentration wastewater during Peak Wet Weather Flow				
Concentration BOD	mg/l	248	242	270
Concentration COD	mg/l	458	473	533
Concentration TSS	mg/l	228	265	295
Concentration TKN	mg/l	41	43	48
Concentration TP	mg/l	9	7	8
Population equivalent - 60g	**Unit**	**18 065**	**19 039**	**28 966**

Treated Wastewater Characteristics

The Phase I of the plant will be designed to only treat carbon pollution. During Phase II, the WWTP will be extended and upgraded to treat nitrogen and phosphorus.

Table 38: Treated wastewater quality parameters

Parameter	Phase I (mg/l)	Phase II (mg/l)	Observations
BOD5	25	25	
COD	125	125	
TSS	35	35	
TN		15	Average annual concentration (or daily average < 20 mg/l N) for water temperature of at least 12°C during the operation of the biological reactor
TP		2	Average annual concentration

7.6.2. Proposed Phasing

The average daily flow rate to be treated in Soroca is expected to increase from around 2 200 m3/d in in 2035 to 3200 m3/d in 2045, whereas the load of pollutants is expected to increase from 19 000 to 29 000 population equivalent respectively due to the increase of the sanitation coverage rate and the expected increase in water consumption.

It is proposed that the WWTP is designed for operating over the period 2025-2045, with the following phasing:

- **Phase I (2025 - 2035): Construction of two treatment trains for an average daily flow rate of 2 200 m3/d and daily BOD load of 1142 kg (19 039 Population-Equivalent) which is the estimated flow and load for the horizon 2035 for a coverage rate of 47%. The WWTP will be designed to treat only Carbon pollution.**
- **Phase II (2036 - 2045): extension of the WWTP with a third treatment train to cope with the increasing coverage rate of the sewer system (estimation of 3 200 m3/d and 1 738 kg/d at horizon 2045), and upgrade of the WWTP to treat nutrients (total nitrogen and phosphorus). This extension and upgrade of the WWTP will have to be adjusted and scheduled depending on the real evolution of wastewater volumes (coverage rate)**

7.6.3. WWTP Location

The WWTP will be located in the commune of Vasilcău, in the South-east of Soroca, on the right bank of the Nistru river. The plot is currently occupied by the forest, has a total surface of 2,14 ha and is situated between the Nistru and the village of Inundeni. The plot has a light gradient towards the Nistru and the natural ground elevation varies from 46 to 58 m.a.s.l.

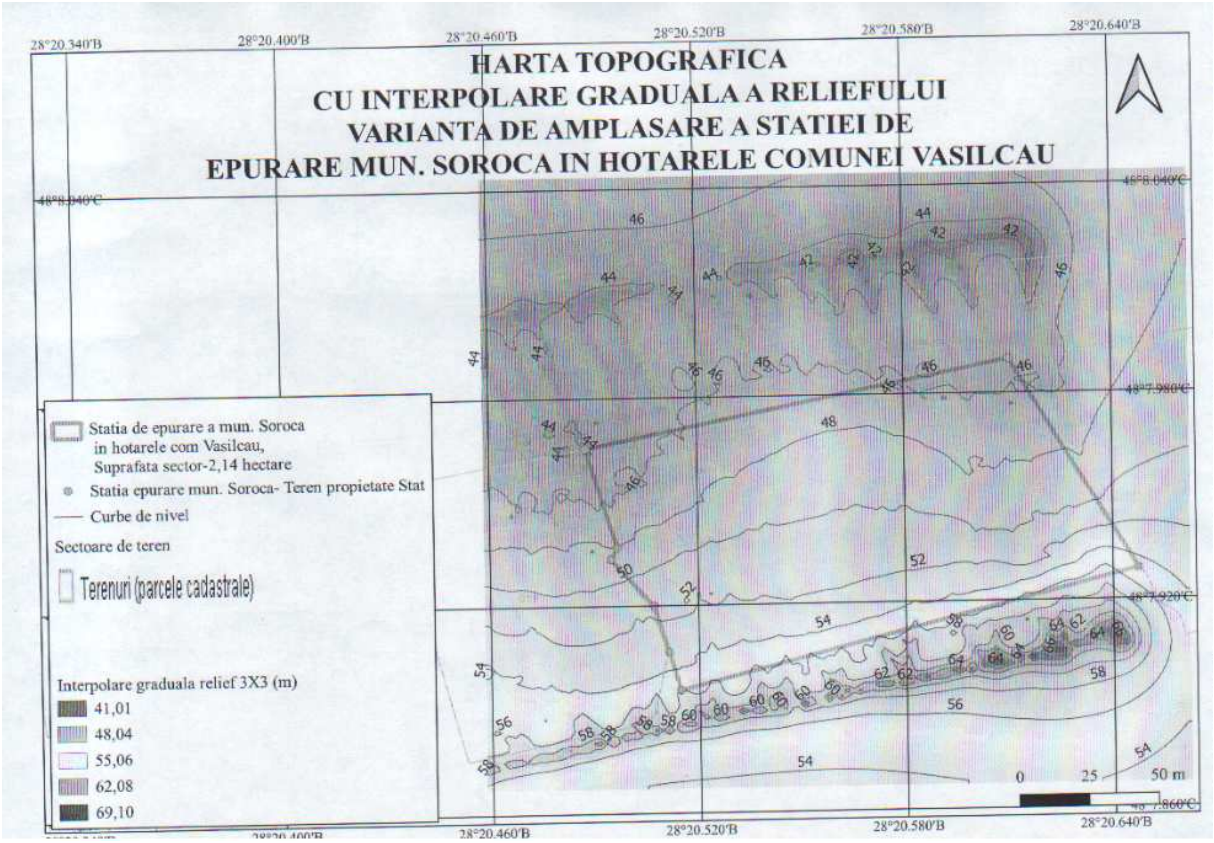


Figure 89: Location of the plot assigned for the WWTP in the commune of Vasilcău

Based on satellite images and confirmed by local residents, the plot was not subject to flooding during the last events registered in Soroca in 2008 and 2020[19]. However, the 1% probability flood is established in the south of Soroca at a ground level of 50 m.a.s.l. (source: General Urban Plan Soroca, 2011), so it should be considered that there is a risk of flooding in part of the plot. Taking into account this risk, a preliminary layout of the WWTP has been proposed (refer to the layout drawing in Annex).

A complete geotechnical study will be required during the preliminary studies to confirm the flooding risks, the groundwater table of the area, the type of soil and provide optimum design for civil works against flooding (creation of an elevated platform, containment structures, etc.) and optimised layout.

The road accessing the future WWTP, which is currently a gravel road of 4-5 m width, will be upgraded after the installation of the pressure pipe serving the WWTP to an asphalt road with shoulders and culverts in accordance with international standards.

[19] The flow of the Nistru is regulated by the Novodnestrovsk hydropower dam located in Ukraine (around 125 km upstream of Soroca). According to the Operating Regulations of the power plant, the maximum discharge flow from their 1st accumulation lake CHE-1 is 2600 m3/s (depending on the inlet flow into the lake, the value may increase). This flow was not exceeded in 2020 but was exceeded in 2008 by 800 m3/s where heavy rains hit both Ukraine and Moldova.

7.6.4. Description of WWTP Main Components

The water treatment line will comprise the following steps:

- Inlet works for degassing the H_2S and other dangerous gas
- Screening
- Combined grit and grease removal tank
- Imhoff tank
- Intermediate pumping station
- Trickling filter
- Secondary clarifier

The sludge from the secondary clarifier will be recirculated to the Imhoff tank. From the Imhoff tank, sludge will be extracted and treated directly in drying beds.

This treatment line is very suitable for a medium size community such as Soroca. The use of Imhoff tank as primary treatment minimizes the volume of sludge to be treated, and reduces the operation costs (man hours, electricity costs etc).

In order to allow easy maintenance and flexibility, the plant will be designed in two parallel independent treatment trains. The trains will be interconnected between the pretreatment and the Imhoff tanks, and downstream the Imhoff tanks (See PFD drawing attached).

Access roads and gates will be implemented to allow for easy access to the various works within the WWTP premises.

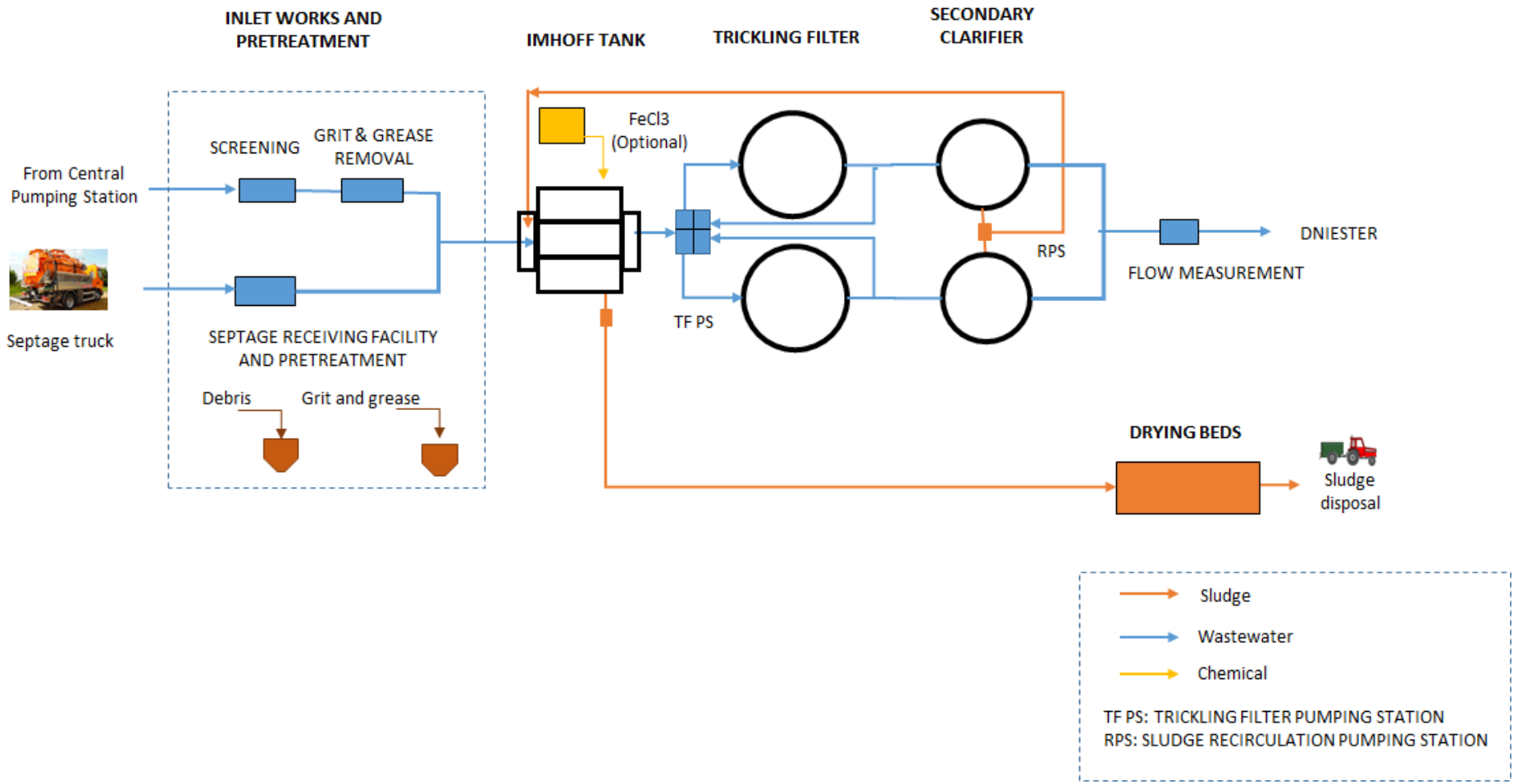


Figure 90: WWTP Process Flow Diagram

Inlet works - Pre treatment

Wastewater will arrive from the Central Pumping Station to the inlet structure by means of a pressure pipe DN400. The inlet structure and pre-treatment will be housed inside a technical building. It will comprise the following components:

- **Degassing chamber** for removing the over-dissolved toxic gas (such as H_2S) from the raw water in a closed and vented compartment.
- **Fine screening** (bar spacing between 6 - 10 mm): The purpose of the fine screening is to protect the electro-mechanical equipment located downstream (pumps, pipes, etc.) against small-size floating objects or scraps liable to clog or to damage them. Wastewater will be conveyed to two parallel channels (one in service, one in standby) fitted with automatic fine screens.
- **Grit and grease removal:** After fine screening, wastewater will go through a grit and grease removal tank. The purpose of this treatment step is to remove the mineral particles of diameter greater than 0.2 - 25 mm and to remove part of the grease. The grit and grease removal will be based on an aerated longitudinal or circular tank. An inclined screw installed within the grit trap will convey grit and discharge it into a container. The grease will be collected on the surface of the tank and discharged into a grease collection tank. A separation efficiency of 90 % of grit particles of size 0.20 - 0.25 mm can be expected. The containers for screening debris, grit and grease will be located on the ground floor of the technical building.
- A **reception facility for septage sludge**: A specific facility will be dedicated to the reception and pre-treatment of septage sludge collected from septic tanks prior to their discharge into the wastewater treatment line. Septage will be discharged by the trucks into a tank fitted with fine screening. A screw conveyor will remove the screening from the tank, press and dewater the screening debris before dropping them into a container. Septage will be afterwards stored in a homogenization tank with a mixer, and regularly pumped into the primary treatment of the WWTP in such a way that the extra load of the septage is smoothened during the day and does not disrupt the WWTP process. The volume of this tank will store the equivalent of 3 days of septage discharge i.e. at least 30 m^3.

The equipment in the pre-treatment stage (screens, screws, tanks) will be made of stainless steel and protected against corrosion. The inlet structure and pre-treatment will be permanently vented, and the polluted air will be transferred to the odour treatment line. Air sensors (H_2S, CH_4) will be installed for security.

The truck's reception platform, debris, grit and grease containers will be installed on the ground level of the building whereas the screening and grit and grease removal units will be installed on the first level, at a sufficient height to feed by gravity the following treatment step - Imhoff tank.

Imhoff tanks

Pre-treated wastewater will be distributed to three Imhoff tanks. Imhoff tanks are designed for solid-liquid separation and sludge stabilisation. They consist of a top compartment, which serves as a settling basin, and a lower compartment in which the settled solids are anaerobically stabilized,

producing biogas (CH_4 and CO_2)[20]. The gas is deflected by baffles to the gas vent channels at the sides of the tank to prevent it from disturbing the settling process. The gas transports sludge particles to the water surface, creating a scum layer.

The liquid fraction will remain only some hours in the tank and the effluent from the Imhoff tank will be odourless. Gases produced in Imhoff tanks may, however, generate odours locally, typically hydrogen sulfide (CH_4) and ammonia (NH_4). The formation of these gases can be reduced by a correct operation (regular scum removal, etc.) and by the addition of ferric chloride ($FeCl_3$) to precipitate H_2S.

Sludge, which is partially stabilized, will be extracted from the digestion zone by pumping and sent to sludge treatment (drying beds). The volume of the digestion compartment will be designed for a minimum storage of 3 months. The extraction rate of sludge will depend on the temperature and the degree of stabilization of sludge. Normally, it will be preferable to extract small quantities more frequently (once every two or four weeks) than perform a complete emptying every 3 months.

The volume of the digestion compartment will be designed for a specific production of 50 litres (primary and secondary sludge) per population equivalent in 3 months. The Imhoff tank will be built partially underground with reinforced concrete. The total water depth is estimated at 8 m.

The expected efficiency in the Imhoff tanks is:

- BOD removal efficiency: 30%
- TSS removal efficiency: 40%

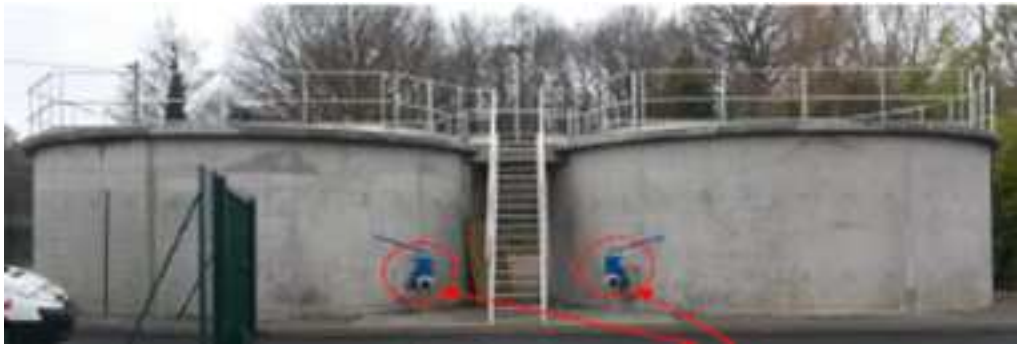


Figure 91: Imhoff tanks

Distribution chamber and Intermediate Pumping Station

Wastewater from Imhoff tanks will be collected in a distribution chamber which also receives the recirculation of the trickling filters. From this chamber, wastewater will be pumped to the trickling filters.

Trickling filters

The biological treatment will consist of trickling filters, which is a fixed-bed biological reactor.

The wastewater will be distributed at the top of the filters with the use of rotating distributor arms. Wastewater will percolate through the plastic media and oxygen will be provided to the system through ventilation openings at the bottom of the filter. The biomass, which grows on the surface of the plastic

[20] The organic load in domestic wastewater is not high enough for the economical collection and usage (or flaring) of biogas.

media, will absorb the organic matter. The attached biomass will continue to grow and will "slough off" periodically and travel with the treated effluent to the secondary clarifier, where it will be separated from the treated wastewater.

The trickling filters are designed with two basic parameters:

- The mass load (kg $BOD_5/m^3/d$)
- The hydraulic load (m^3/m^2 filter/h)

In order to get a final BOD_5 concentration less than 25 mg/L, even during winter, the mass load shall be limited to 0.4 $kgBOD_5/m^3/d$ (assuming a packing material developing 100 - 150 m^2/m^3 of specific surface). This will require a minimum filter volume of 2000 m^3.

Two trickling filters will be constructed with a 15,2 m diameter and a plastic filling height of 5,5 m.

The trickling filters will be provided with recirculation to improve wetting of the filter material, to avoid clogging and to ensure a good shearing and washing off of the excess biomass. Treated effluent, which is collected at the bottom of the filter, will be diverted to the distribution chamber and to the secondary clarifier. A recirculation ratio of 2.1 will be applied to keep a hydraulic load (m^3/m^2 filter/h) above 0.8 $m^3/m^2/h$, which corresponds to a unitary flow of 145 m^3/h per filter.

Trickling filters will be provided with enough ventilation slots to ensure natural ventilation during the different periods of the year. The rotating distributors will be motor driven to allow for optimum speed control and avoid any operational problems (clogging, odours, etc.).

Secondary clarifiers

Each trickling filter will be followed by a secondary clarifier of circular type with a scrapping bridge. The hydraulic load on secondary clarifiers after the trickling filter will be limited to 1.2 m/h at Wet Weather Peak Flow (minimum 10,2 m diameter and 3.5 m depth). Settled sludge from both clarifiers will be collected in a sludge chamber equipped with two pumps (1 + 1 in stand-by) which will transfer the biological sludge to the Imhoff tank for stabilization.

Treated effluent will be led by gravity to the disposal point in the Nistru. Before discharge, the treated effluent flow will be measured via a venturi or Parshall flume.

Figure 92: Trickling filter and secondary clarifier

Sludge treatment

A rough estimation of the sludge production can be done, based on a standard effluent composition and the following hypotheses.

Primary sludge

It is considered that 40% of the raw wastewater TSS will settle in the Imhoff tanks. This sludge will contain 65% of volatile solids (organic), which will be destroyed by anaerobic digestion with an efficiency of 40%. Then, primary sludge production will be:

1250 kg TSS/d x 40 % x [65% x 60% + 35%] = 370 kg TSS/d

Secondary sludge

Secondary excess sludge will be approximately 0.72 g/g BOD_5, with 80% of volatile solids. This sludge will be recycled in the Imhoff tank and partially digested. Then, the final production will be:

800 kg BOD/d x 0.72 g TSS/g BOD x [80% x 60% + 20%] = 392 kg TSS/d

The total sludge production will then be 762 kg TSS/d = 278 ton DM/year

Sludge will be extracted from Imhoff tanks and pumped to the drying beds. Drying beds will be composed of a bed of gravel/sand equipped with perforated pipes. The liquid part of sludge (leachate) will infiltrate through the bed, will be collected by the drainage pipes and will be pumped back into the Imhoff tanks.The solid fraction will remain on the filter surface and will be dried by natural evaporation.

During each sludge extraction, sludge will be disposed of uniformly in a layer of 20 - 30 cm to allow for effective percolating and evaporation. Anaerobic sludge from Imhoff tanks will dry rapidly and present low odour potential. Frost in winter and hot summer climate are very favorable to rapid natural drying.

When the sludge will be dried (moisture content lower than 80%), it will be removed from the drying beds by mechanical means (bobcat or similar) and sent for disposal in landfill or further storage and reuse in agriculture.

With an annual mass loading of 200 kg DM/m^2/year, a total surface of 1 390 m² of drying beds will be required.

Figure 93: Drying bed

Odour treatment

The pretreatment (degassing chamber, screening, grit and grease removal, septage receiving facility) will be housed in a vented building, and the air will be treated by means of biological filtration so that no odour will be perceptible at the boundaries of the site.

The addition of $FeCl_3$ can be performed inside the Imhoff tank to precipitate H_2S or when sludge is extracted and pumped to the drying beds.

7.6.5. Other Works

Power supply

The plant will require a power supply of approximately 103 kVA. The project will include the connection to the medium voltage grid through the implementation of MV cells, transformer and LV cells

An emergency generator (50 kVA) and fuel storage tanks will be provided to guarantee the continuous operation of the WWTP for 24 hours in case of a power failure. The capacity of the fuel storage tank will be of minimum 155 litres.

Administrative building, laboratory and workshop

An administrative building will be built to support the administrative and operation activities of the WWTP. It will include a control room (to host the SCADA), office, rest room and toilets, warehouse and laboratory.

The laboratory room will be fully equipped for routine monitoring and analysis of standard wastewater and sludge parameters. The following analyses will be performed:

- Raw and treated wastewater - 3 measurements per week: TSS, BOD_5, COD, temperature, pH, conductivity
- Raw and treated wastewater - once per month: NH_4, NO_3, TP, alkalinity
- Sludge analysis - once per fortnight or each time drying beds are filled up: Dry matter, TSS

Legal monitoring as required per Government Decision 950/2013 will be outsourced to an external laboratory (12 samples per year, parameters BOD, COD, TSS, TN, TP).

The workshop will be fully equipped for routine maintenance of the electromechanical equipment of the plant.

7.6.6. Expected Performance

Wastewater

The process implemented will guarantee the following quality criteria for the treated wastewater:

- **BOD_5 < 25 mg/L**
- **COD < 125 mg/L**
- **TSS < 35 mg/L**

Sludge

The dryness of the dewatered sludge at the drying beds will vary between 20 to 40% according to climatic conditions. The production of sludge will be about 23 ton dry matter (DM) per month in 2035, which corresponds to a volume of 70 m^3 per month for an average dryness of 30%.

Electricity consumption and Greenhouse Gas Emissions

The operation of the new pumping stations and the WWTP will be responsible for increasing the indirect Greenhouse Gas emissions (GHG) in Soroca due to the electricity consumption. The pumping is responsible for 37% of the electrical consumption of the sanitation system (network + WWTP).

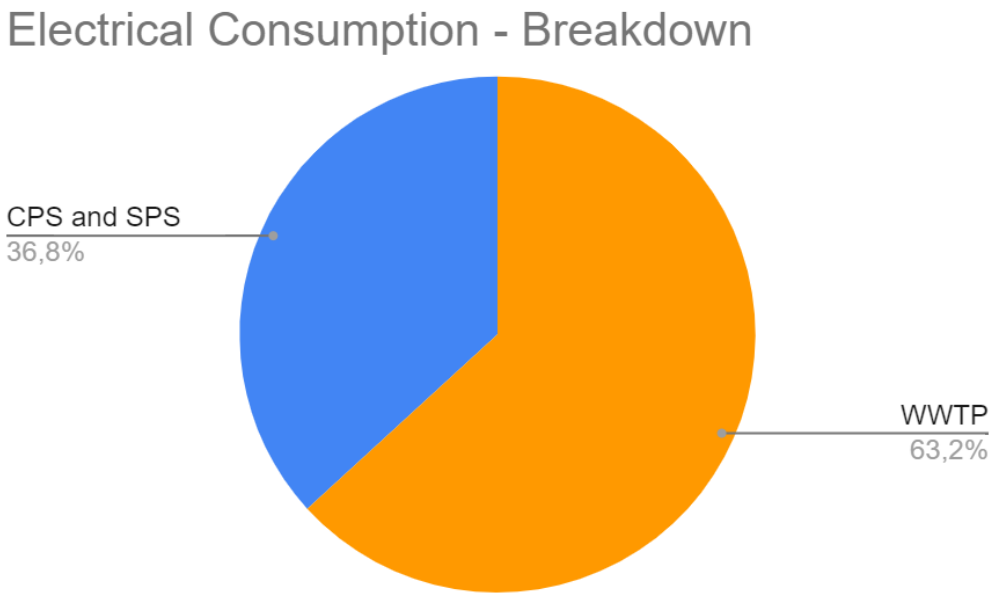


Figure 94: Electrical consumption breakdown in Soroca Sanitation System

The carbon footprint of the operation of main pumping stations (Central and South) and of the WWTP is estimated at 217 tonnes CO_2eq per year (horizon 2035).

Table 39: Electrical Consumption and GHG emissions of sanitation system in Soroca

Item	Electrical Consumption (kWh/year)
WWTP	234 923
Central and South PS	136 828
Total	**371 751**
GHG emission	**217 t CO2e**

Note: Emission Factor Power Grid Moldova: 0,583 kg CO2e / kWh

The energy consumption and carbon footprint can be reduced by applying energy efficiency measures for pumping (selection of efficient pumps and motors, monitoring of mechanical and hydraulic performance, maintenance of sewer network to reduce head losses, etc.).

7.6.7. SCADA System

In order to monitor and control the Pumping Stations and the WWTP installations, it is recommended to install a medium level of automation together with a Supervisory Control and Data Acquisition (SCADA).

A SCADA system is composed of different levels :

- Level 0 - It is the field level with devices such as flow and temperature instruments, control elements (valve, motor contactor). The field device duty is to send field information and execute commands from the Program Logic Controller (PLC). They are hardwired to the PLC input/output cards using 4-20mA or 0-24VDC or 0-48VDC signals.
- Level 1 - It contains the industrialized input/output (I/O) modules and the Program Logic Control that is the brain of the system. PLC monitors the information received from level 0 and sends commands to the control elements according to its internal program.
- Level 2 - It is the supervision level where all the data can be displayed on a screen to inform, alarm the operator about the status of the process and the equipement. At this level the operator has the possibility to send setpoints to the PLC to adjust its control sequences and control loops.

Each main pumping station (Central and South Pumping Stations) shall have their own PLCs to control the pumps according to the wastewater level. A local HMI (Human Machine Interface) will be installed on the control panel door to visualize the level, the alarms and adjust the level setpoint.

In case of PLC failure, it should be possible to bypass the PLC and operate manually the pump from the Auto/0/Manu selector switches in front of the electrical panel :

- In “Auto”, the pump is controlled by the PLC,
- In “0”, pump is stopped,
- In “Manu” position Pump starts.

At the WWTP, a main PLC will control the equipment of the Plant and connect to the supervision composed of the SCADA workstations. The PLC should collect all the signals from the site (instruments, various status) including signals from local equipment control panels (ex. automatic screen, etc.). Depending on the site arrangement, the signals shall be connected directly to the PLC via inrack I/O cards or via remote I/O cards installed in dedicated panels.

For the equipment controlled by the main PLC, it should be possible to bypass it in case of failure. The operator should be able to operate manually the equipment from the Auto/0/Manu selector switches in front of the electrical panel(s):

- In “Auto”, the equipment is controlled by the PLC,
- In “0”, equipment is stopped,
- In “Manu” position, the equipment starts.

The supervision should be composed of 2 workstations with dual screen configuration. On each workstation, a SCADA software shall be installed communicating in real time with the PLC and having the following main characteristics :

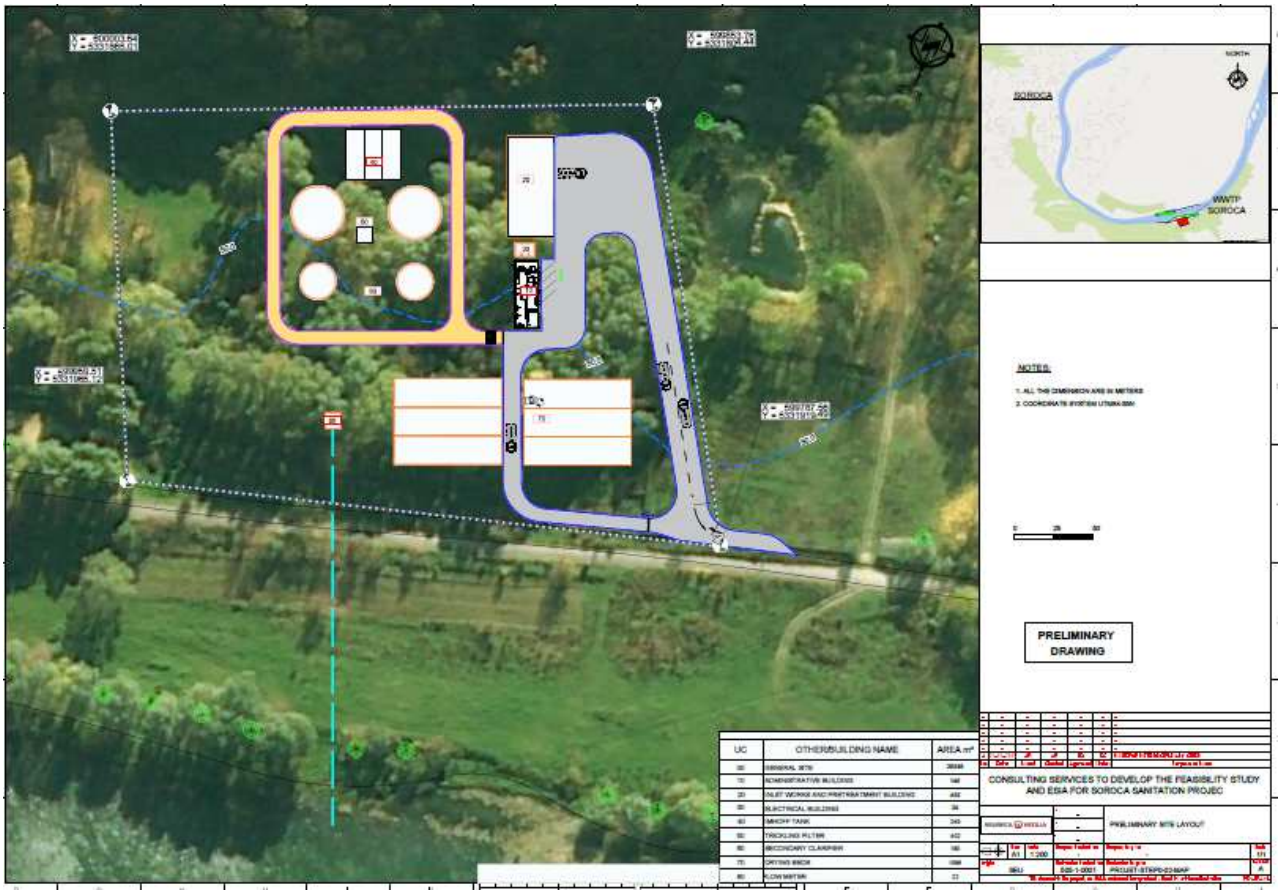
- Graphical display of the entire plant,
- Process Setpoints adjustment,
- Alarm management,
- Trend curves of the process data and status,
- Report generation including process data and equipment running times to facilitate the maintenance,
- Data Storage and archiving (internal or external).

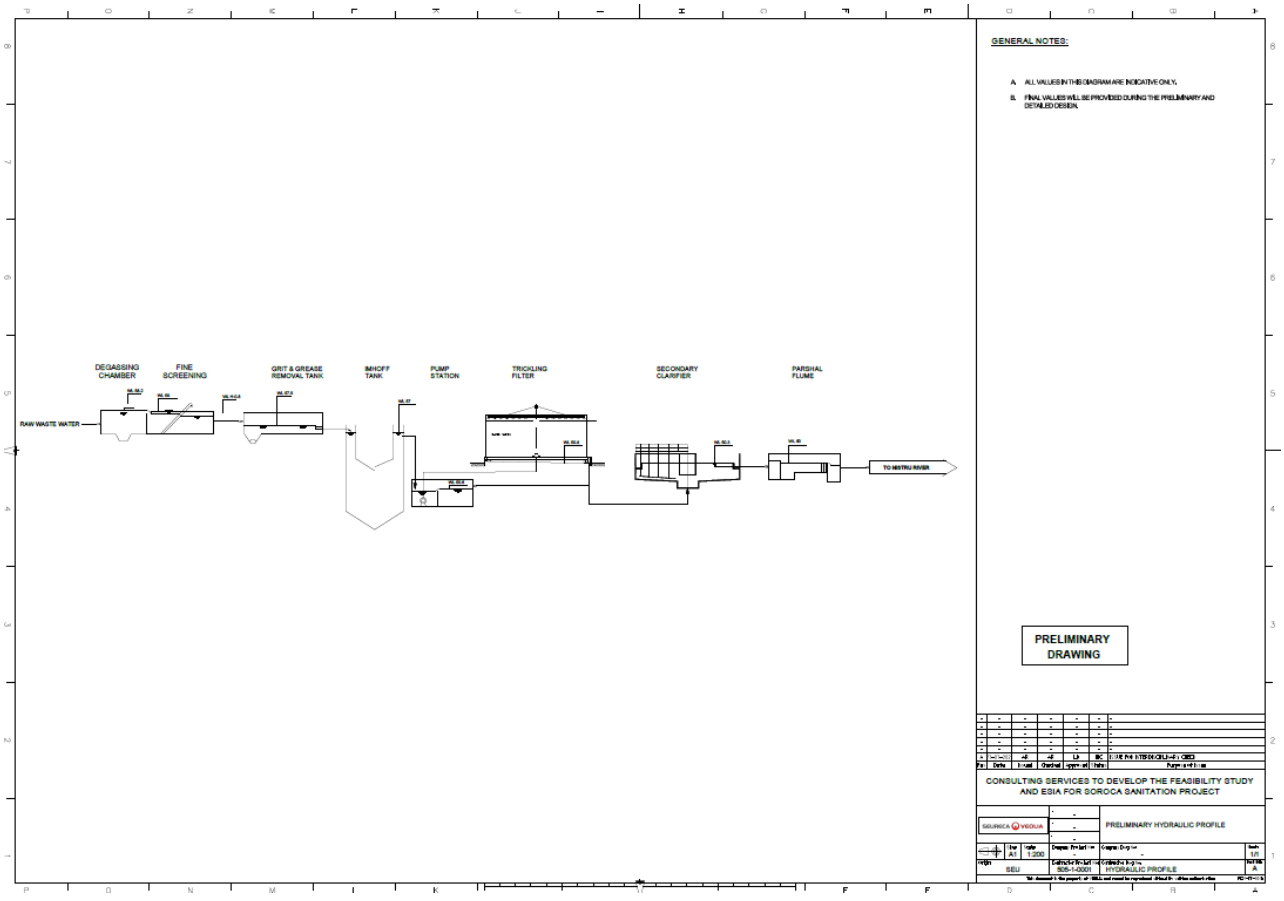
The two workstations should have the same configurations so if one worskations fails, the other can be used to supervise the plant.

The SCADA of the WWTP will be equipped with maintenance and reporting tools, and the values of laboratory analyzes will be stored in an open database.

7.6.8. DRAWINGS

The general Layout and the preliminary hydraulic profile are enclosed below and in Annex.




GENERAL NOTES:
A ALL VALUES IN THIS DIAGRAM ARE INDICATIVE ONLY.
B FINAL VALUES WILL BE PROVIDED DURING THE PRELIMINARY AND DETAILED DESIGN.
DEGASSING CHAMBER
FINE SCREENING
GRIT & GREASE REMOVAL TANK
IMHOFF TANK
PUMP STATION
TRICKLING FILTER
SECONDARY CLARIFIER
PARSHAL FLUME
RAW WASTE WATER
TO NISTRU RIVER
PRELIMINARY DRAWING
CONSULTING SERVICES TO DEVELOP THE FEASIBILITY STUDY AND ESIA FOR SOROCA SANITATION PROJECT
PRELIMINARY HYDRAULIC PROFILE
HYDRAULIC PROFILE

7.7. Sanitation Solutions for Villages

7.7.1. Context

In rural localities the level of development of centralized sewerage systems is much lower than in urban localities in Moldova. There are some existing sewer systems, but they are rarely connected to an operating treatment plant. The several hundred WWTPs built in rural areas during the Soviet era, based mainly on activated sludge technology, are no longer operated due to high operational costs (energy, maintenance) and the lack of skilled labor (ApaSan, 2019).

The lessons learnt from recent projects[21] performed in Moldova and Romania about the sanitation situation in rural areas are the following:

- The actual production of wastewater in Moldovan rural households remains low (less than 30 liters per person per day on average), even when a drinking piped water supply is available. This is due to several reasons:
  - Water supply systems do not work properly all year long, mostly due to droughts in the summer months and pipes freezing in the winter months;
  - Water use and disposal habits: Wastewater producing infrastructures (flush toilets, bathrooms, washing machines, kitchen sinks, etc.) are not systematically present in rural households, mainly in households with ageing population, which is typically the case in rural areas;
- Many rural inhabitants have already developed a solution for greywater disposal (reuse in gardens, disposal in yards or fields, etc.), which does not encourage them to invest for the few remaining wastewater.
- Even in rural areas where centralized sewerage systems have been built, the level of connection to networks is quite low. This is due to permanent or temporary migration of the population, low income level, etc.
- Some LPA give a high priority to sewer infrastructure projects, but it is grounded more in political reasons than in a real need from the population. Only a few beneficiaries tend to connect to a centralized sewer system without external incentives.
- While the construction of the WWTP and main sewer lines are typically financed by international or national donors, private connections to the network have to be done by households themselves, which prevents many residents from connecting to centralized sewerage systems.

Example of Sanitation projects in rural context - Village of Roşu in the district of Cahul

The realisation of the sewerage system in the locality of Rosu was financed through the programme “Modernisation of Local Public Services in the Republic of Moldova". In the period 2013-2015, the design "Sewerage of the village Rosu, Cahul Rayon with connection to the sewerage system of the Cahul city" has been elaborated, consisting of:

- 22.5 km of sewerage networks (15 km of gravity sewerage network and 7.5 km of sewerage networks under pressure);

[21] (ISPA, ENV SOP: Sectoral Operational Programme Environment) (GIZ/MLPS Modernization of Local Public Services) ApaSan- Swiss Water and Sanitation Project Moldova

- Installation of 4 sewage pumping stations.

Potential beneficiaries of this project are 3,700 inhabitants of Rosu village with about 1,100 service connections. Wastewater is collected and pumped into the sewerage system of Cahul town, Apa Canal Cahul manages the system.

In a subsequent project "Connection of individual houses to the centralized sewerage system in Rosu, Cahul Rayon", with financial support from the Romanian Government and population contribution, around 335 service connections to the sewerage network were installed in the period from May 2018 and April 2019, allowing about 577 households to connect to the system (Investment costs around EUR 775,000). The beneficiary is looking for additional funding to complete the project.

Following the implementation of these projects, practically all the population of Rosu locality can in theory connect to the sewerage system. However, up to 30/04/2021 only 221 connections are in operation.

7.7.2. Presentation of Villages of the Study Area

The villages that are currently under SA “Regia Apa Canal Soroca” mandate are shown in the table and figure below. These 6 villages are a representative sample of other rural localities found in the district of Soroca (population, topography, socio-economic context).

The main demographic and topographic characteristics are presented: number of population, connected households and population to water services (source: Soroca Diagnostic Utility Report, WB, 2021), estimated water consumption per capita, estimated population density (in urbanised area) and distance to Soroca (from the lowest point of the village to Soroca sewer network).

Table 40: Villages description

Admin unit	Locality	Pop.	HHs connected	Conn. pop.	Coverage ratio WS %	LPCD	Density (inh/km^2)	Dist. to Soroca km
village Egoreni	Egoreni	1 078	389	972	90	65	891	7,7
commune Regina Maria	Regina Maria	674	155	387	57	69	1148	24,2
	Lugovoe		0	0				
commune Bulboci	Bulboci	1 959	246	615	31	58	825	32,6
	Bulbocii Noi		0	0				
village Hristici	Hristici	1 240	359	898	72	64	1095	17,5
village Zastînca	Zastînca	2 308	486	1 215	53	55	1065	4,19
commune Rublenița	Rublenița	3 781	920	2 300	61	55	1311	5,8
	Rublenița Nouă		0	0				

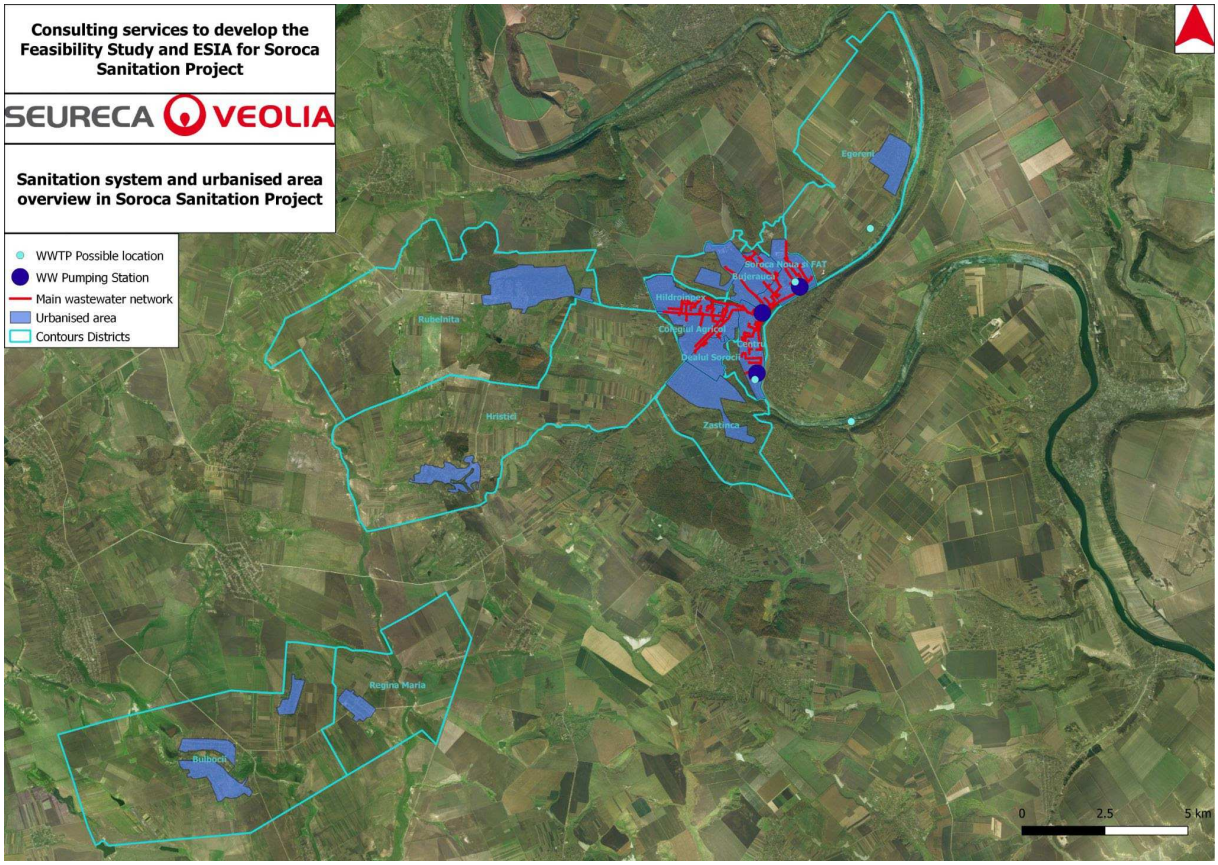


Figure 95 : Sanitation system and urbanised area in Soroca Sanitation Project

The population varies between 674 and 3 800 inhabitants and the water coverage ratio varies from 31% (Bulboci) to 90% (Egoreni). The estimated water consumption per capita (source: SA “Regia Apa Canal Soroca” database) varies from 55 to 69 lpcd. None of the villages has a sewer network, all households, budgetary institutions and economic agents use on-site sanitation solutions, mainly pit latrines with soil infiltration.

The existing sanitation solutions for rural areas are presented below and their suitability is discussed for these villages. The findings are valid for other rural localities of the district.

7.7.3. Overview of Sanitation Solutions for Villages

Different sanitation options can be proposed for the rural localities of Soroca:

- Improved on-site sanitation, as presented in section 7.5
- Construction of a central sewer system with a decentralized small WWTP, serving one or several villages
- Construction of a central sewer system and connection to Soroca WWTP

Small WWTPs can be based on bio-mechanical prefabricated treatment plants or on extensive technologies such as the Constructed Wetlands. The choice between these technologies should be analysed case-by-case, but the construction of constructed wetlands, as long as there is space

available, is recommended due to the lower construction and operating costs and the simpler operation and maintenance requirements.

The different sanitation solutions have to be assessed depending on different regulatory, social, techno-economic and environmental criteria:

- Regulatory
- Population
- Physical environment: vulnerability of groundwater
- Topography
- Distance to Soroca

Regulation

According to the existing regulation (GD No. 950/2013), the agglomerations with less than 2000 population equivalent do not have any specific requirement regarding wastewater collection system and treatment, but “individual systems or other appropriate systems shall be used to ensure the same level of environmental protection when the installation of a wastewater collection system is not justified, either because it does not produce environmental benefits or because it requires high costs”.

For agglomerations over 2000 Population Equivalent, a wastewater collection system and a wastewater treatment system based on secondary treatment is required.

In our case, based on the size of the agglomeration, **Zastinca, Rublenita and Bulboci should be prioritised for the construction of a central sewer system.**

Population and social acceptance

The number of inhabitants (permanent or temporary) and population density directly influences the specific cost of the sewer network. Also, the areas with strong population densities relying on on-site sanitation systems have a greater impact on the environment and it is more probable that groundwater is affected by discharges from individual systems.

The socioeconomic status of the population and their way of life (water consumption), on the other side, defines the willingness of the population to invest and connect to a central sewer network. Specific surveys need to be performed in each village to understand the willingness of the population to have access to sewered sanitation.

Physical environment: vulnerability of groundwater

The density of households and on-site sanitation systems may impact on the groundwater because of the cumulative loading, particularly of nitrate. This should be taken into account especially where the vulnerability of the groundwater is high. In the evidence of high nitrate levels in groundwater sources used for human consumption by the population, a sewer system should be preferred over on-site sanitation systems.

However, the origin of the pollution and the relative contribution of the domestic wastewater should be investigated in each particular case before final decision, in order to justify the construction of a central sewer system.

As indicated in the assessment section, the analyses of groundwater sources performed in Soroca villages by the National Agency for Public Health show that the villages of Egoreni, Rublenita, Rublenita Noua and Zastinca suffer from more groundwater pollution than Regina Maria and Bulboci.

Topography

The complexity of a sewer network depends on the topography of the village. Villages with many hills and valleys, such as Hristici, are less suitable to construct a central sewer network due to higher costs on pumping to bring wastewater to a central point.

Decentralized Vs Centralised Solution?

The possibility to connect some of the localities to the existing central sewer network of Soroca and to the future WWTP can also be a solution for some of the villages. The location of the WWTP in the south of Soroca makes it possible for some of the small villages of the area to connect directly to the WWTP, such as Volovita, Alexandru cel Bun, Inundeni and Ruslanovca.

However, the very small size of these localities, the low water consumption per capita, and associated wastewater discharge, and the relative long distances to Soroca to pump a small volume of wastewater makes it preferable to treat on-site rather than connect to the central WWTP.

Table 41: Comparison decentralized Versus Decentralized WWTP

Decentralized WWTP	Centralized WWTP
+ It may respond better to rural areas where low connectivity is expected (low volumes of wastewater are collected) + Small WWTPs are considered viable if low-medium level technologies are implemented (robust, efficient, easy to operate and maintain) - Some poor performances can be expected mainly due to their managing - Additional O&M requirements	+ Treatment is more efficient in larger WWTPs + Economies of scale can be obtained in O&M staff - Operational problems in the network with H_2S formation due to long retention times, blockages, etc. depending on the location of the village with regards to Soroca network / WWTP. - High energy consumption for pumping relatively small volumes to the central WWTP

According to the above criteria, the following diagram tree shows a decision aid tool to select the recommended on-site sanitation system for villages.

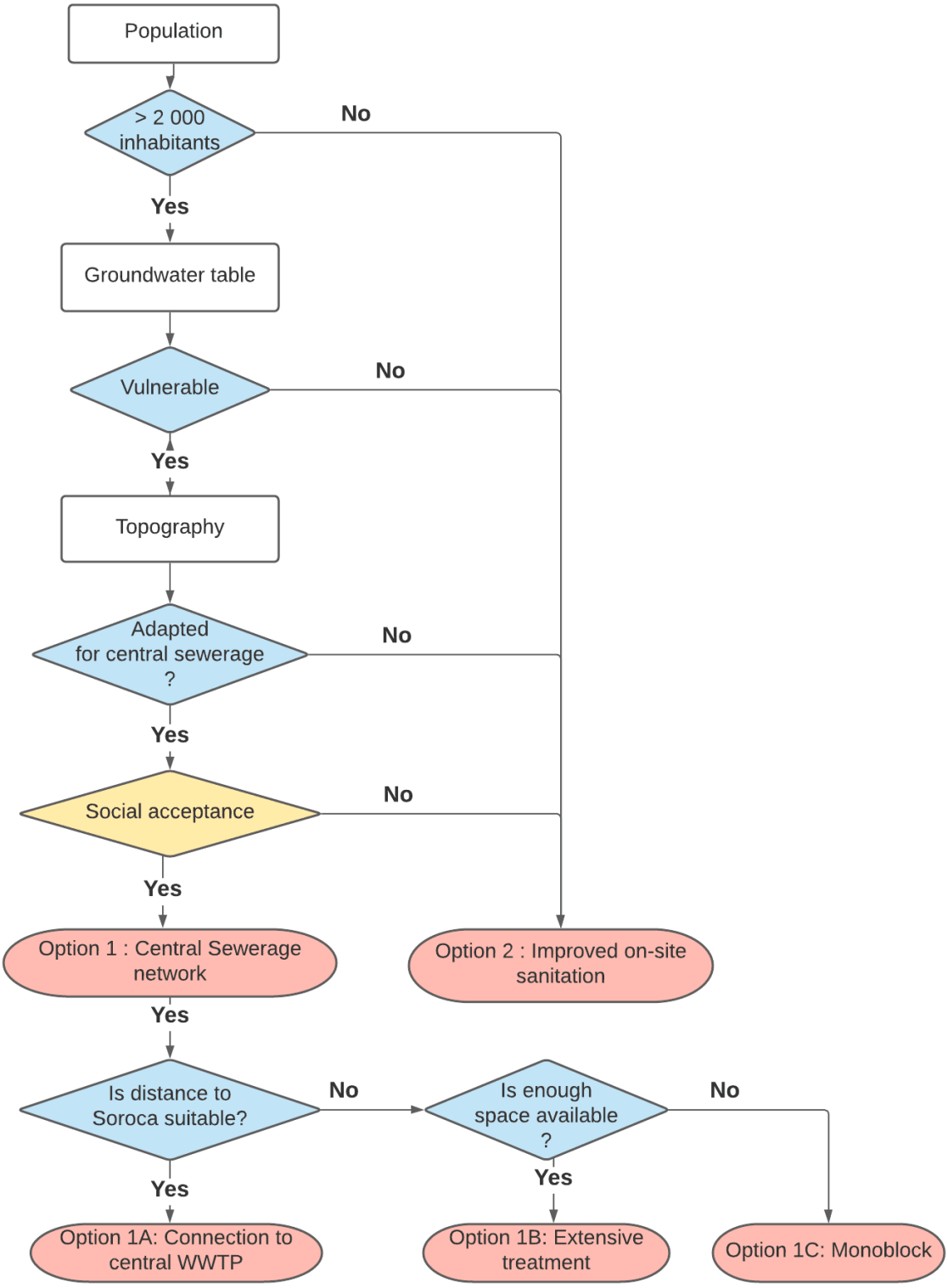


Figure 96: Decision aid tool for sanitation solutions for villages

Table 42: Criteria for selection sanitation solutions for villages

Locality	Pop. > 2000	GW pollution	Topo-graphy (**)	Dist. to Soroca km	Recommended solution
Egoreni	No	Yes	Yes	7,7	Consider central sewer and WWTP after investigation on the origin of nitrate in groundwater
Regina Maria	No	No	Yes	24,2	On site sanitation
Bulboci	*Yes (*)*	No	Yes	32,6	Central sewer and WWTP
Hristici	No	Yes	No	17,5	Consider central sewer and WWTP after investigation on the origin of nitrate in groundwater
Zastînca	Yes	Yes	Yes	4,19	Central sewer and WWTP
Rublenița	Yes	Yes	Yes	5,8	Central sewer and WWTP

(*) Bulboci population is almost 2000 population
(**) Topography adapted to central sewer system

For the particular cases of Egoreni and Hristici, where the population is around 1000 inhabitants and where the groundwater is already strongly polluted with nitrates, the final decision should be made only after a detailed investigation on the impact of nitrate pollution to drinking water sources and on the origin of nitrate: it is likely that the contribution of the domestic wastewater infiltration is marginal compared to the pollution from agricultural origin (fertilizer and manure).

According to this, it would be recommended to build a central sewer system in Zastinca, Rublenita and Bulboci.

Bulboci being far from Soroca (32 km), it is not recommended to connect its network to the WWTP of Soroca.

In the case of Zastinca and Rublenita, due to the larger populations and the shorter distance to Soroca, both options, either to connect the village to Soroca sewer network or to build a decentralized small WWTP seem technically suitable. An economic comparison is done for the case of Rublenita.

Rublenita / Zastinca : Centralized Versus Decentralized Treatment

The layout of the main network in Rublenita is shown in the figure below. It would consist in:

- Gravity network (150 mm): 20 694 m
- Pressure network (40/50 mm): 1 558 m
- Small Pumping stations: 5

Figure 97: Sewer network in Rublenita village

Three options are compared:

- Option A: Decentralized WWTP based on bio-mechanical treatment
- Option B: Decentralized WWTP based on Constructed Wetland
- Option C: Centralized WWTP in Soroca

The following hypotheses are considered in the techno-economic comparison:

- Number of sewer connections per km: 48[22]
- Average water consumption (rural): 60 lpcd
- Wastewater discharge ratio: 80%
- Population per connection: 2,5 people
- Small WWTP - Energy: 1,5 kWh/d per 6 PE
- Small WWTP - CW: Inlet pumping
- Unit costs

Gravity network - 150	90	EUR/m
Pressure network - 90	60	EUR/m
Pressure network - 50	45	EUR/m
Small PS	10000	EUR
PS to Soroca (>20kW installed)	50000	EUR
Small WWTP - Prefabricated	1000	EUR/m3/d
Small WWTP - CW	700	EUR/m3/d
Electricity	1,83 0,086	MDL/kWh EUR/kWh

[22] This is the current average number of water connections per km in rural areas managed by SA “Regia Apa Canal Soroca”

Note: Operational costs only include the main post of energy consumption (forced aeration in case of the bio-mechanical WWTP, pumping from the village to Soroca, inlet pumping for Constructed Wetland).

Table 43: Techno-economic comparison of sanitation solutions in Rublenita village

Central sewerage network	Option A. Decentralized Prefab WWTP	Option A. Decentralized CW WWTP	Option B. Centralized
Population (inh)	3781	3781	3781
Gravity network (m)	20 694	20 694	20 694
Connections	993	993	993
Connected population (inh)	2484	2484	2484
Percentage (%)	66%	66%	66%
Small pumping stations	5	5	5
Pressure pipe (m)	1558	1558	1558
Pressure pipe to Soroca (m)			5848
Daily wastewater (m3/d)	119	119	119
Small WWTP capacity (m3/d)	179	179	
Investment costs (EUR)			
Gravity pipe	1 862 500	1 862 500	1 862 500
Pressure pipe	70 200	70 200	421100
Pumping stations	50 000	50 000	100 000
Small WWTP	179000	120 000	
Total	2 161 700	2 102 700	2 383 600
Operational costs (EUR/year)			
Small WWTP - energy	19 495	51	
Pumping station to Soroca			3 554
Operational costs (EUR) - 10 years	194 955	510	35 539
Total CAPEX + OPEX 10 years	2 356 655	2 103 210	2 419 139

It can be observed that about 80% - 90% of main investment costs are related to the construction of the sewer network in the village. The total costs for the three options, investment costs and operational costs during 10 years, are very similar; given the degree of accuracy at feasibility stage, the differences are not meaningful to favor one or other option.

As the centralized solution will be easier to manage, it is recommended to connect Rublenita to Soroca in the mid-long term.

7.7.4. Conclusion

The recommended technical options for the sanitation of the villages under SA “Regia Apa Canal Soroca” are summarized in the table below.

Table 44: Recommend solutions for the sanitation of the villages

Locality	Recommended solution
Egoreni	Investigate the origin of nitrates in groundwater. On site sanitation if it is confirmed that the main source of groundwater pollution is agriculture and/or nitrate pollution does not represent a significant impact on the population If not, build a central sewer network, an independent WWTP based on Constructed Wetland and disposal in the Nistru
Regina Maria	On site sanitation
Bulboci	Build a central sewer network with an independent WWTP based on Constructed Wetland. Treated water to be disposed of in the Căinări river
Hristici	Investigate the origin of nitrates in groundwater. On site sanitation if it is confirmed that the main source of groundwater pollution is agriculture and/or nitrate pollution does not represent a significant impact on the population If not, build a central sewer network with an independent WWTP based on Constructed Wetland if space is available
Zastînca	Build a central sewer network and connect to Soroca WWTP
Rublenița	Build a central sewer network and connect to Soroca WWTP

The recommended sanitation solutions have as a prerequisite the willingness of the population to have access to improved sanitation solutions and namely sewered sanitation. When planning for sanitation solutions for villages, it should be mandatory to perform a specific survey in each village to correctly estimate the number of connections and provide support measures such as financial subsidies, health and environmental sensibilisation, etc. to motivate the population to improve their sanitation conditions.

7.8. Wastewater Reclamation and Reuse Strategy in Soroca

7.8.1. Types of Water Reuse Applications

Water reclamation is the process of converting wastewater into water that can be reused for a variety of purposes. Reclaimed water or treated wastewater can be reused as a source of water for multiple activities which do not require potable quality. The major types of reuse applications can be grouped into the following categories:

A. **Agriculture**: irrigation of food crops and non-food crops, trees, etc.
B. **Industrial:** process water, make-up water for cooling towers, boilers, etc.
C. **Urban or municipal:** green areas irrigation, street cleaning, ornamental or recreational use, fire protection and non-potable domestic uses such as toilet flushing, etc.
D. **Environmental and recreational:** enhancement of river flows, wetlands, irrigation of golfs, groundwater recharge, etc.
E. **Potable reuse:** direct or indirect

Each of these applications and its potential implementation in Soroca is further discussed in the following sections.

Wastewater reuse is currently not a common practice in the Republic and Moldova, there are no official, planified experiences on this topic.

7.8.1.1. Agriculture

Agriculture is Moldova's third largest water consuming sector (10%), after heating / hot water supply (71%) and drinking water (15%)[23].

Wastewater irrigation can provide a regular volume throughout the year, together with nutrients and organic matter that can benefit the plants and soil. It enables the preservation of groundwater or surface water resources which can be assigned to drinking water uses instead. More specifically, it represents an advantageous option in peri-urban areas, where large volumes of wastewater are produced and must be disposed of.

Uncontrolled reuse in agriculture, however, may impact soil structure and permeability as well as present health risks (diseases). Indeed, wastewater contains a number of compounds that may have harmful effects if they are not well controlled such as, for instance:

- **Salinity and specific ions:** The control of Total Dissolved Solids (or conductivity) and the concentration of certain parameters (sodium, chloride) in reclaimed water is needed for agricultural applications. Excessive salinity may damage crops and cause soil permeability problems. Some ions that can be found in higher concentrations in wastewater, such as boron, are also toxic for some crops.

[23] *MWSS Project: Environmental and Social Management Framework, 2021*

- **Suspended solids and biodegradable matter:** although beneficial for the soil and crops, high concentrations of suspended solids and organic compounds can cause plugging of irrigation systems as well as biofouling in storage and distribution systems.
- **Pathogens:** The potential health risks through transmission of an infectious disease by a pathogen is the main concern associated with reuse of reclaimed water in any of its usages. Depending on the level of human exposure in a reuse application, an increasing level of treatment and disinfection will be required. This risk exists for the people in direct contact with the wastewater during the irrigation process (workers), but also for the people who will consume the agricultural products, especially when they are eaten raw.
- **Nutrients**: The presence of nitrogen and phosphorus in wastewater is beneficial, because farmers can save fertilizer. However, excessive nitrogen in irrigation can damage crops and possibly pollute aquifers or surface water through runoff.

Application to Soroca

Agricultural land around Soroca represents a potential user of large volumes of treated wastewater. Irrigation areas are found in the North of Soroca (Egoreni, Cosauti), in the West (Hristici) and in the South (Zastinca, Volovita).

The most common crops that are cultivated in Soroca district are cereal crops (wheat, barley, corn), sunflower, sugar beet, fruits, legumes and vegetables. Based on the assessment performed as part of this study, irrigation is mainly used in some vegetables and orchards. Farmers use available water sources close to their fields such as groundwater (although not very suitable for irrigation, due to high saline content), surface water (ponds, creeks or directly the Nistru river). Also, some fields which are situated next to the Soroca-Balti Aqueduct, directly buy water to Aqva Nord for irrigation at 6 MLD/m^3.

Figure 98: Orchard irrigated with drinking water from Soroca - Balti Aqueduct

Raw wastewater in Soroca has a slight to moderate saline content (1250 - 1580 mg/l as Total Dissolved Solids and 251 - 400 mg/l of chlorides, according to historical analysis; 411 - 745 mg/l as

Total Dissolved Solids and 47 - 120 mg/l of chlorides, according to the wastewater quality campaign performed in June 2021). Standard mechanical and biological treatments of WWTPs do not remove salinity to a great extent, and treated wastewater will have similar concentrations.

According to the general classification of irrigation water quality standards prepared by the Food and Agriculture Organization of the United Nations (FAO, 1992), the use of slight to moderate saline waters (TDS = 450 - 3000 mg/l, Cl= 140 - 350 mg/l) will require some degree of restriction on use and the implementation of mitigation measures to reduce potential negative effects on soil, plants and irrigation systems (selection of suitable tolerant plants and appropriate irrigation methods, improvement of soil structure by the use of calcium amendments, etc.).

In conclusion, treated wastewater could eventually be used for agriculture irrigation in Soroca, but a more detailed approach case-by-case should be done to validate the use of treated wastewater in each plot depending on the type of crop, type of soil and treated wastewater salinity.

7.8.1.2. Industrial Uses

Reclaimed water can be reused in several industrial applications. Water quality requirements will differ from one industrial process to another, but in general good quality will be required. Industrial reuse has to be studied **case-by-case**, since specific limits for process water are normally required.

Many industries requiring high purity water dispose of advanced water treatment technologies such as membranes, ion exchange, advanced oxidation, etc. to treat fresh water. This fresh water could be in some cases replaced by reclaimed water by adjusting the advanced water treatment, which could represent both economic and environmental benefits. The feasibility of such projects will depend on the cost and reliability of reclaimed water supply compared to fresh water.

Major industrial uses of reclaimed water include cooling, boiler feed, washing and as an ingredient in industrial products. Industrial sites situated next to populated areas that generate large volumes of wastewater effluent are potentially suitable clients for industrial reuse.

Application to Soroca

In Soroca, the agro-food industries (dairy, meat and canned vegetables) are the main economic agents consuming water. The main water usages in these industries are for cleaning, washing (products, machines, etc.) and cooling. The use of reclaimed water in the agro-food industries requires a treated wastewater of very high quality, totally free of bacteria and microorganisms. The necessity to have an advanced treatment in the WWTP, such as ultrafiltration membranes, and the increased monitoring, would substantially raise the production cost for reclaimed water. Besides, these industries are not located close to the future WWTP and would require the laying of dedicated distribution pipes with considerable impact on the investments.

7.8.1.3. Urban Uses

Urban uses include both municipal and domestic uses such as fire protection, public or private green areas irrigation, street cleansing or toilet flushing in residential, administrative or commercial buildings.

Municipal uses do not require drinking water quality, but generally demand a quite high water standard to avoid nuisance (odour) or sanitary risks to the nearby public.

A double distribution network would be needed for some of these municipal applications, which represents a high investment cost for a city. Some applications can however be done through tankers, which would only need the setup of a reclaimed water supply point close to the city.

Application to Soroca

In Soroca, there are no municipal irrigation systems for watering green areas. Water tankers, which pump water directly from the Nistru, are used to supply non-potable water. Some private houses, which can afford it, dispose of private irrigation systems for their plots, but they usually use groundwater from the privately-owned wells. In conclusion, urban uses in Soroca are not currently identified as reclaimed reuse opportunities in Soroca.

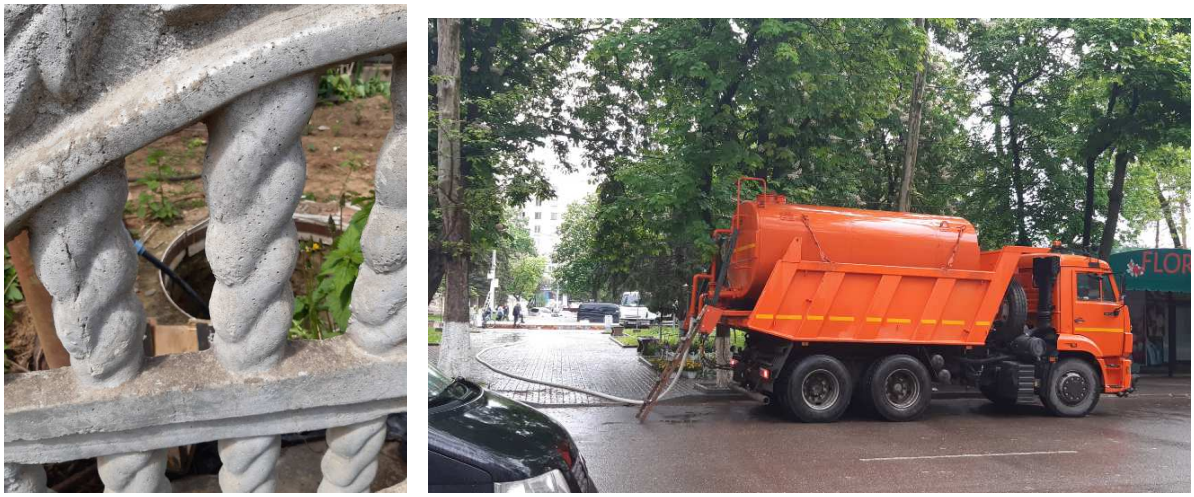


Figure 99: Well with pump system in private house (left); Fountain in Soroca city being filled up with truck (right)

7.8.1.4. Environmental and Recreational Uses

Reclaimed water can be used in applications such as enhancement of river flows, creation and maintenance of wetlands, or for recreational activities such fishing, boating, swimming.

Application to Soroca

In Soroca, the Nistru river represents the central recreational area of the city. Citizens go for a walk on the newly built promenade along the Nistru, fish on the river banks and enjoy the “Soroca beach” during summer, a leisure area north of the city.

Figure 100: Soroca beach (right) and fisherman on the banks of the Nistru (right)

Currently, the discharge of non-treated wastewater to the Nistru has a significant negative impact on the main tourist attraction of the city, the Soroca Fortress (Cetatea Soroca). The rehabilitation of the Central Pumping Station and the construction of the new WWTP should solve this issue and substantially improve the quality of life of both residents and visitors. The conventional treatment of the WWTP (mechanical and biological) will achieve a wastewater quality apt for discharge into the Nistru river. Additional treatment such as disinfection would only be necessary depending on the prevailing uses of the Nistru downstream of the discharge point, such as bathing, potable water supply or irrigation.

7.8.1.5. Potable Use

Direct potable reuse refers to mixing directly treated wastewater with drinking water. Some well-known cases exist in Windhoek (Namibia) and Singapore, places which suffer from severe water shortage.

Indirect potable reuse is the reuse of treated wastewater which is placed into a water body such as a lake, river or aquifer, which is itself used as a source of drinking water.

Indirect potable reuse may occur unintentionally, when wastewater, treated or not, infiltrates into an aquifer, but also, it can be developed by using Managed Aquifer Recharge. In this case, advanced tertiary treatments and monitoring of treated wastewater are used in order to avoid any potential degradation of groundwater and minimise the need for any advanced treatment at the point of abstraction.

Either indirect or direct potable reuse schemes are not considered potential applications in Soroca.

7.8.2. Reclaimed Water Quality and Wastewater Treatment

In accordance with good practices, the secondary effluent from a conventional WWTP is not acceptable for most reuse applications. The need to ensure health and environmental safety when reusing treated wastewater requires the implementation of additional and complementary tertiary

treatments in the WWTP in order to further reduce suspended solids, pathogens, dissolved solids and/or trace constituents.

Primary and secondary treatments generally remove about 95% TSS and 90% DBO_5 of raw wastewater, but only 1 - 2 log of pathogen microorganisms[24] (90% or 99% reduction). Disinfection of wastewater is therefore required to reduce health risks associated with reclaimed water reuse. However, pathogen inactivation - either chemical or physical - can only be guaranteed if turbidity and suspended solids content of the secondary effluent is low. Hence, the implementation of additional tertiary treatments (typically filtration) is generally recommended in order to obtain a safe effluent.

The treatment level required for reclaimed water depends on the end usage. This concept "Fit-for-Purpose" is graphically represented below and illustrates that water treatment technologies offer a range of increasing water quality, and selecting the right level of treatment should be dictated by the end application of the reclaimed water for achieving economic efficiency and environmental sustainability (USEPA, 2012).

Figure 101: Different treatment levels depending on water reuse application

A number of countries, where water reuse is significantly implemented, have produced their own legal frameworks, regulations, or guidelines for water reuse applications. At European level, Regulation 2020/741 on minimum requirements for water reuse for agricultural irrigation was published on 25th of May 2020 and will enter into force on 26th June 2023. This regulation aims at stimulating and facilitating water reuse in the EU by harmonising minimum water quality and monitoring requirements, setting risk management provisions to assess and address potential health and environmental risks and defining permitting and public communication requirements.

The EU regulation on water reuse only applies to agricultural irrigation, other applications such as irrigation of green areas or industrial reuse are not considered.

The reclaimed water quality classes, the permitted uses and irrigation methods for each class, and the minimum requirements for water quality according to these new European standards are shown in the following tables.

[24] *Pathogen microorganisms include bacteria, virus, protozoa and helminths. Raw wastewater contains on average 10^6 - 10^8 bateria and 10^5 - 10^6 viruses.*

Table 45: Classes of reclaimed water quality and permitted agricultural use and irrigation method (European Regulation 2020/741)

Minimum reclaimed water quality class	Crop category (*)	Irrigation method
A	All food crops consumed raw where the edible part is in direct contact with reclaimed water and root crops consumed raw	All irrigation methods
B	Food crops consumed raw where the edible part is produced above ground and is not in direct contact with reclaimed water, processed food crops and non-food crops including crops used to feed milk - or meat-producing animals	All irrigation methods
C	Food crops consumed raw where the edible part is produced above ground and is not in direct contact with reclaimed water, processed food crops and non-food crops including crops used to feed milk - or meat-producing animals	Drip irrigation** only
D	Industrial, energy and seeded crops	All irrigation methods***

(*) If the same type of irrigation crop falls under multiple categories, the requirements for the most stringent category shall apply.
(**) Drip irrigation is a micro-irrigation system capable of delivering water drops or tiny streams to the plants and involves dripping water onto the soil or directly under its surface at very low rates (2-20 litres/hour) from a system of small diameter plastic pipes fitted with outlets called emitters or drippers.
(***) In the case of irrigation methods which imitate rain, special attention should be paid to the protection of the health of workers or bystanders. For this purpose, appropriate preventive measures shall be applied.

Table 46: Reclaimed water quality requirements for agricultural irrigation (EU Regulation 2020/741)

Reclaimed water quality class	Indicative technology target	Quality requirements				
		E. coli (cfu/100 ml)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Other
A	Secondary treatment, filtration, and disinfection	≤10	≤10	≤10	≤5	*Legionella* spp.: <1,000 cfu/l where there is risk of aerosolization Intestinal nematodes (helminth eggs): ≤1 egg/l for irrigation of pastures or forage
B	Secondary treatment, and disinfection (*)	≤100	≤25	≤35	-	
C	Secondary treatment, and disinfection	≤1,000			-	
D	Secondary treatment, and disinfection	≤10,000			-	

Note: Quality target B usually requires prior filtration besides disinfection to guarantee the bacteria indicator.

7.8.3. Conclusions on potential Wastewater Reuse in Soroca

Currently, the major potential wastewater reuse application in Soroca is agricultural irrigation. However, and in our opinion, it is not relevant to consider it at this stage due to a number of limitations detailed below:

- **Reclaimed water quality:** According to historical wastewater analysis, treated wastewater will have a slight to moderate saline content in Soroca (raw water average values: 1400 mg/l as Total Dissolved Solids and 300 mg/l of chlorides). These high values may not be appropriate for some crops or types of soil. Besides, the use of saline irrigation water would require the implementation of mitigation measures to reduce potential negative effects on soil, plants and the irrigation system, such as selecting suitable tolerant plants and leaching salts via appropriate irrigation methods.
- **Water reuse costs and financing:** The cost for implementing a water reuse project includes a number of additional components such as the additional water treatment processes at the WWTP, the distribution network and storage tanks as well as the water quality monitoring and system maintenance. The cost-effectiveness is directly related to the volume of reclaimed water produced (the more water produced, the lower relative costs) but also the volume of reclaimed water sold which strongly depends on the location of the WWTP with regards to the potential users (the investment costs for water storage and the distribution network are in general the principal expenditure of most water reuse projects).
- **Water resources availability:** Although it is recognised that Moldova is highly vulnerable to climate change related hazards such as droughts and erratic weather patterns, the availability of water resources such as the Nistru river, the Soroca-Balti aqueduct and other semi-permanent surface waters in Soroca, is an obstacle for the development of water reuse nowadays.
- **Public perception and acceptability:** Public perception is critical to the success of any water reuse project. Communication and public participation plays an important role in understanding benefits and risks of water reuse and it increases public willingness to accept and pay for it. There are currently no experiments in Moldova on water reuse and the prior implementation of small-scale pilot water reuse projects would be necessary in order to increase awareness and promote water reuse in the future.

7.9. Sludge Reuse Strategy in Soroca

7.9.1. Introduction

There are three technical options for the disposal of sludge:

- Dumping, either in a dump site (informal) or a sanitary landfill;
- Reuse in agriculture, either as direct reuse of dried sludge, or as compost;
- Destruction by incineration, either in a dedicated incineration unit, in a co-incineration unit with domestic waste, in a cement factory or partial elimination by wet air oxidation. Ashes from incineration can be sent to the landfill or used as construction material.

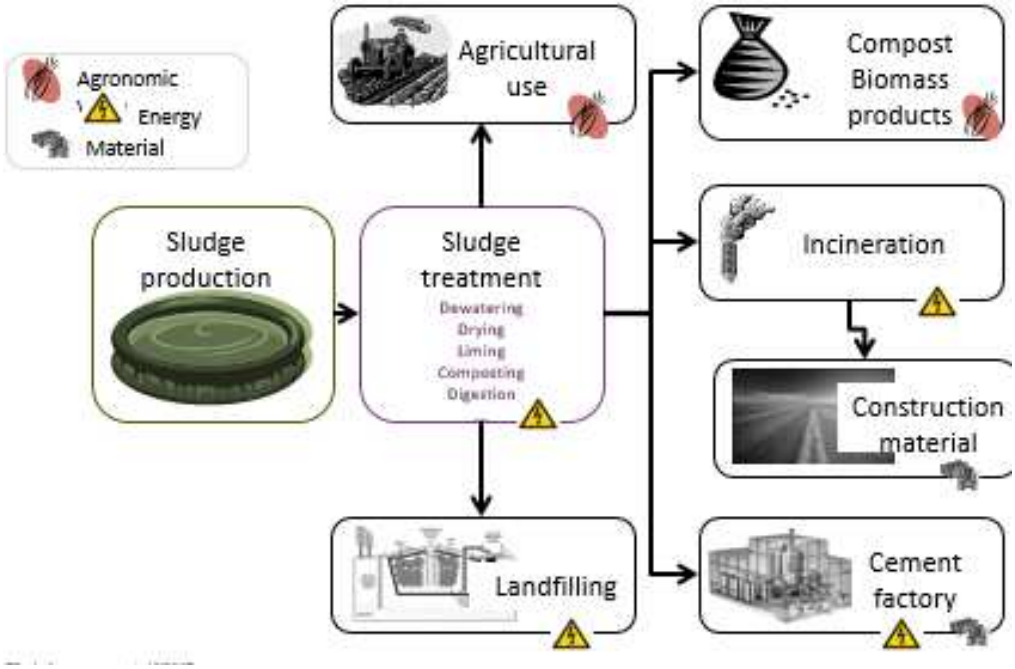


Figure 102: Sludge treatment and disposal routes

7.9.2. Sludge Disposal Routes in Europe And Neighboring Countries to Moldova

Sewage sludge disposal routes in Europe are in coherence with the waste hierarchy introduced by the Waste European Framework Directive in 2008, which indicates an order of preference for action to reduce and manage waste, i.e., prevention, minimisation, reuse, recycling, energy recovery and, landfilling as final and undesired option.

Sludge disposal routes include:

- agriculture,
- landfill,
- incineration or co-incineration with domestic waste water (with final disposal of ashes in landfill),
- composting.

In general, the reuse of sewage sludge in agriculture is the most favoured route for sludge management in European countries. The amount of sludge disposed of in landfills has decreased in the last years since the regulation makes it compulsory for member states to reduce the amount of biodegradable waste sent to final disposal and, therefore, of sludge, which is a biodegradable waste.

Incineration and co-incineration are very common in some western European countries (Netherlands, Germany, Austria, Belgium), but they require high investment costs and are not always welcomed by citizens.

Biological treatment of sludge through anaerobic digestion and/or co-digestion with other organic waste has been applied, especially in northern Europe.

As far as Moldova's neighboring countries are concerned, in Ukraine, only 3 to 5% of sewage sludge is used in agriculture, which is regulated by DSTU 7359: 2013 "Wastewater. Requirements for wastewater and its byproducts for irrigation and fertilization". The low level of sewage sludge utilization is mainly due to imperfect legislation and outdated treatment plant equipment.

In Romania, sludge disposal routes are: 22% in agriculture, 2% incinerated, and the rest 64% deposited in landfills (EurEau survey, 2016). The usage of sludge in agriculture is reported to stay stable or to decrease in time. Even though the usage of sewage sludge was widely promoted in Romania, and farmers were initially enthusiastic, in time, the interest in reusing sludge as fertilizer has been reducing.

7.9.3. Overview of Sludge Disposal Routes And Reuse in Moldova

In Moldova, sludge from WWTPs is commonly stored for a long time in the available WWTP drying beds and is subsequently disposed of in landfills. Sometimes, sludge is reused by closeby farmers, but this is randomly practiced.

Sludge reuse has been studied in Chisinau WWTP (Experiments conducted during the years 2014 - 2015 in the experimental fields of the Institute of Genetics, Physiology and Plant Protection of Academy of Sciences of Moldova), and some publications have been done on the subject. Other sludge reuse experiences exist in the country (example of Orhei just below), but sludge reuse is done sporadically, not in a planified and controlled way in the country.

According to Apa Canal Orhei (personal communication, May 2021), the Municipality of Orhei uses part of the dried sludge from the old WWTP as fertilizer for the city's green areas.

Sometimes local farmers are also willing to take the sludge from the WWTP.

Figure 103: Drying bed in the old WWTP in Orhei

7.9.4. Moldovan Regulatory Framework on Sludge Reuse

The **Governmental Decision on the approval of the Technical Regulation "Soil protection measures in agricultural practices" no 1157 from 13.10.2008** transposes the European Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of soil, when sewage sludge is used in agriculture (86 / 278 / EEC).

Sludge may only be used in agriculture in accordance with this Regulation. The sludge defined in the Regulation "sludge from septic tanks and similar installations for the treatment of wastewater, sludge from other treatment plants, treated sludge - sludge treated by a biological, chemical or thermal process, by long-term storage or by any other appropriate process" can be used in agriculture as

fertilizer after the issuance of approval by the State Sanitary - Epidemiological Service based on toxic-hygienic and sanitary-chemical expertise of the preparatory forms of sewage sludge.

Article 36 indicates that the sludge needs to be treated before being used in agriculture, and when using sludge, users must take into account the nutritional needs of plants and not allow the possibility of altering the quality of soils and surface and groundwater. Beside that, sludge users must keep records of information relative to:

1. the quantities of sludge, purchased and consumed;
2. the composition and characteristics of the sludge compared to the parameters specified in the Technical Regulation.
3. the treatment processes to which the sludge was subjected;
4. the names and addresses of the sludge suppliers and their place of use.

Information on treatment methods and the results of sludge analyses shall be communicated at the request of the competent authorities.

The sludge analysis, at least once every six months, must include the following parameters:

- dry matter, organic matter;
- pH;
- total nitrogen, phosphorus and potassium (mobile forms);
- cadmium, copper, nickel, lead, zinc, mercury, chromium (total forms).

Also, sewage sludge users must ensure that the content of heavy metals in the soil does not exceed the limit values established in this Technical Regulation. The soil analysis must include the following parameters:

- pH;
- cadmium, copper, nickel, lead, zinc, mercury, chromium,
- nitrate content (the permissible concentration of 130 mg / kg must be observed);
- presence of viable helminth eggs.

The following table shows the different Maximum Admissible Concentrations set in the Regulation.

Table 47: Maximum admissible concentrations of sludge and soil

Parameter	Annex 1. MAC in soil (mg/kg of DS)	Annex 2. MAC in sludge (mg/kg of DS)	Annex 3. Max application rate (kg/ha/yr)
Cadmium	3	40	0.15
Copper	150	1750	12
Nickel	75	400	3
Lead	300	1200	15
Zinc	300	4000	30
Mercury	1,5	25	0.1
Chromium	-	-	-

7.9.5. Sludge Reuse Assessment in Soroca

Thorough research has been made in the study area in order to identify the largest farmers, to enquire about the main types of cultures and soils and the acceptability of reusing sludge as fertilizer.

In this context, the Association of Agricultural Producers "Teragronord" was contacted. This association welcomed the idea of sewage sludge reuse as natural fertilizer and mentioned the importance of informing the farmers on the value of its usage, as currently the information is not spread and not all companies, farmers and individuals know the benefits. The Association also offered the contacts of the largest farmers in order to participate in a survey regarding the availability to receive and reuse sewage sludge.

Below are presented the outputs of the survey.

Company/Description	**Scripta Prim SRL** Company founded in 1999 having an area of activity cultivation of cereals (excluding rice), leguminous plants and oilseeds. Also, other activities (unlicensed) are indicated: ● Cereal, technical and fodder plants ● Vegetables, fruits and increasing nursery production ● Raising animals ● Wholesale of raw agricultural products and live animals ● Other shipping and transport activities
Geolocation	The fields are in Stoicani village, Soroca district (18 km South from Soroca city)
Ha of Land	Approx. 1000 ha
Types of cultures	Wheat, barley, corn, sunflower, fruit orchard.
Type of soils	Not know
Irrigation	Uses water for the irrigation of orchards. Not connected to water, uses water from a nearby lake.
Type of irrigation	Manually with tractor
Interest and desire to reuse treated effluent / sludge	He does not know too much information on the benefits of sludge use as fertilizer. If more information is available, the interest would increase. For the time being, he could not say if he is interested in reusing sludge or not.

Company/Description	**CAP Alexandru Gusacinschi** Manages fields that are given by individuals, citizens for rent.
Geolocation	The fields are in Cainarii Vechi village, Soroca district (25 km from Soroca city)
Ha of Land	Approx. 900 ha
Types of cultures	Wheat, barley, corn, sunflower.
Type of soils	Majority chernozem
Irrigation	No irrigation
Type of irrigation	No irrigation
Interest and desire to reuse treated effluent / sludge	**Interested** in the usage of sludge waste as fertilizer. Any natural and organic fertilizer is welcome

Company/Description	**Diamax Agro SRL** Founded in 2002, has as its main activity cultivation of cereals (excluding rice), leguminous plants and oilseeds. Also, other activities (unlicensed) are indicated ● Cultivation of cereal, technical and fodder plants ● Vegetable cultivation, fruit growing and increasing nursery production" ● Raising animals ● Wholesale of raw agricultural products and live animals ● Other shipping and transport activities
Geolocation	The fields are situated in Egoreni village, Soroca district (5 km from Soroca city)
Ha of Land	Approx. 600 ha
Types of cultures	Sunflower, Wheat, barley, corn, peas, perennials, colza. Orchard (apples)
Type of soils	Sandy
Irrigation	No irrigation
Type of irrigation	No irrigation
Interest and desire to reuse treated effluent / sludge	**Interested** in the usage of sludge waste as fertilizer. Any natural and organic fertilizer is welcome. Knows information on the sludge use.

Company/Description	**GT Vitalie Bacalim** Cereals (excluding rice), leguminous plants and oilseeds.
Geolocation	The fields are in Baxanii village, Soroca district (22 km from Soroca city)
Ha of Land	Approx. 780 ha
Types of cultures	Sunflower, Wheat, barley, corn, peas, perennials.
Type of soils	Majority chernozem
Irrigation	No irrigation
Type of irrigation	No irrigation
Interest and desire to reuse treated effluent / sludge	**Interested** in the usage of sludge waste as fertilizer. Any natural and organic fertilizer is welcome. Knows information on the sludge use.

Company/Description	**Agrostoc Prim SRL** Main activity is cultivation of cereals (excluding rice), leguminous plants and oilseeds.
Geolocation	The fields are situated in Visoca and Darcauti village, Soroca district (35 km from Soroca city)
Ha of Land	Approx. 1100 ha
Types of cultures	Cereals, perennials, wheat, barley, corn, peas, sunflower and soybeans
Type of soils	Neutral, Chernozem Brun
Irrigation	No irrigation
Type of irrigation	No irrigation
Interest and desire to reuse treated effluent / sludge	"I heard something but I did not document the quality, the composition. **I am interested in using it on a pilot plot** and then depending on the results, to use more".

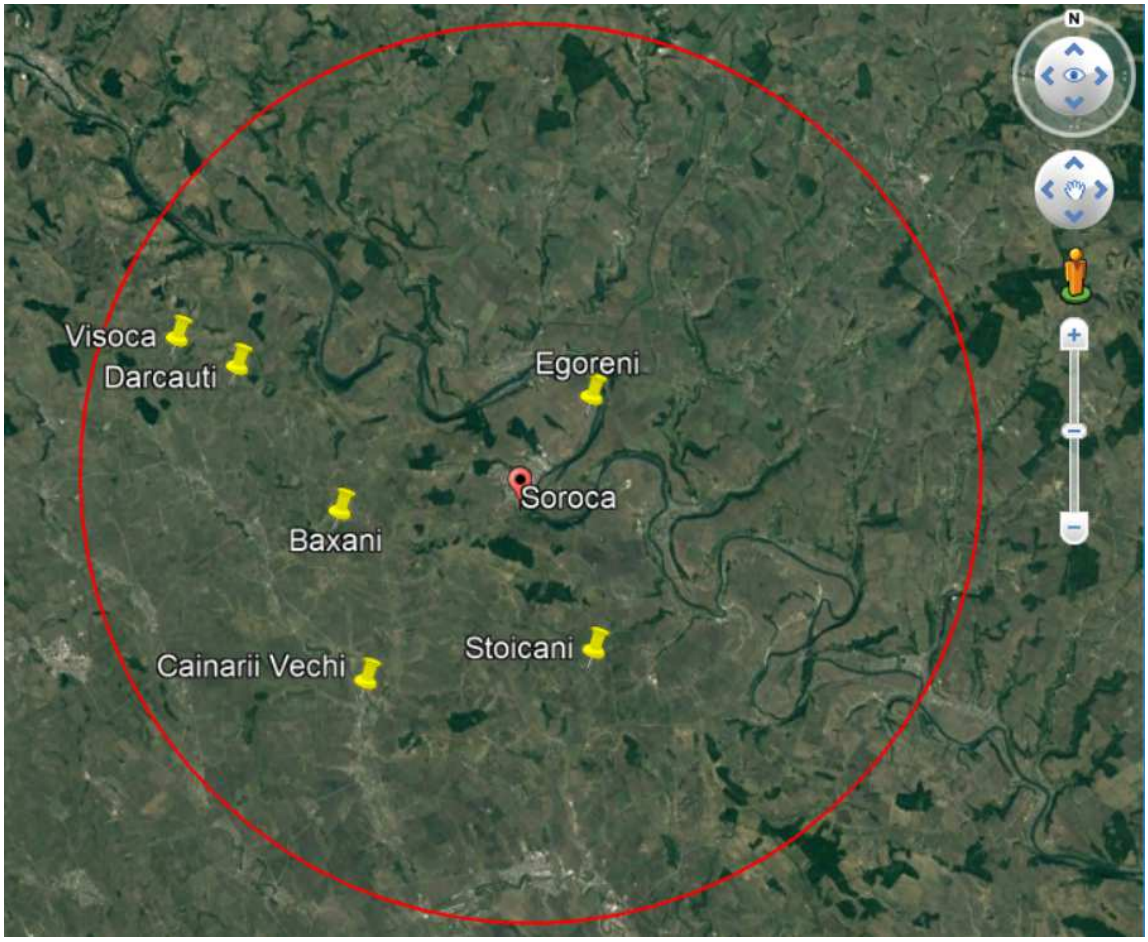


Figure 104: Location of consulted farmers during the sludge reuse survey (”Teragronord” Association) - 35 km rayon from Soroca

It can be concluded from this survey that most farmers would be interested in using sewage sludge from the future Soroca WWTP as fertilizer on their lands. Still, they mentioned that rigorous monitoring and control needs to be established in order to guarantee the quality of the sludge and avoid any harmful impact from heavy metals or other dangerous chemicals.

7.9.6. Conclusions of Sludge Disposal and Reuse in Soroca

Sewage sludge is rich in nutrients such as nitrogen and phosphorus and contains valuable organic matter that is useful when soils are depleted or subject to erosion. Sludge can be used as fertiliser or as an organic soil amendment, thus reducing the need for other agricultural amendments.

All sludge types (liquid, semi-solid, solid or dried sludge) can be spread on land. The use of each of them induces practical constraints on storage, transport and spreading itself. Dried sludge (>20% DS) is typically used because it can be handled with available farm vehicles (tractors), stored on piles and spread using the same equipment as for solid mineral fertilizer or animal manure.

Landspreading is influenced by culture types, soil occupation, sludge characteristics, accessibility of the field and meteorological conditions, but it is commonly performed twice a year, after harvesting (typically at the end of summer), or before ploughing and sowing (in spring). Sludge storage capacity

must therefore be available on the WWTP premise or on the farmlands, because sludge production in a WWTP, which depends on the inlet pollution load to the plant, is more or less constant throughout the year.

Besides sludge storage, transport is the other aspect to be taken into account, which may represent significant costs depending on the distance from the WWTP.

Application to Soroca WWTP

- Sludge characteristics and production

It can be expected that the sludge produced in the future WWTP will comply with the required quality standards as set in the Government Decision 1157/2008 since there are no large industrial companies which may discharge heavy metals into wastewater.

The sludge treatment line based on drying beds will produce sludge with a total dryness higher than 20%.

Regarding sludge production, a peak production can be expected in summer, because septage disposal from on-site systems in the WWTP is more frequent in spring-summer, and main industries have their peak production in summer.

- Sludge storage and disposal:

After sludge treatment in the WWTP, sludge can be stored either in the WWTP or in a storage facility near the fields. As far as the spreading areas are concerned, ideally the agricultural zone should be flat, divided in large fields and close to the WWTP (less than 50 km).

Average sludge load for landspreading can be estimated between 2 to 3 t DM/ha (during 10 years) or 1 t DM/ha/year if spreading is done every year. A WWTP of 30 000 Population Equivalent, producing around 500 t DM/year of sludge, will serve to enrich between 160 and 500 ha of farmland (depending on the types of crops and fertilization plan). Due to the extensive availability of agricultural land in the district of Soroca,and in particular near the future location of the WWTP in the areas of Zastinca, Volovita, Vasilcau and Trifauti, sludge reuse is a promising option for sludge disposal in Soroca.

If Local Public Authorities, the WWTP Operator and farmers agree on such a utilization, then the supply chain must be defined to maximize the use of this sludge. Since nowadays this product is unknown to agricultural stakeholders, it is highly recommended to set up an information program towards potential users. A back-up option for sludge disposal, in case this agricultural use is eventually not possible or not accepted, needs to be prepared.

The second option for sludge disposal in Soroca is landfilling. Soroca's waste landfill[25] is located in the North of the city, on the road to Cosauti, and the fee for waste disposal amounts for 212 MLD/m^3.

[25] The landfill is not a sanitary landfill, but an informal dumpsite and no conditions exist for acceptance of sludge. A minimum dryness of 20% has been proposed as the target for the sludge produced in the WWTP is in solid state and can be shovelled by mechanical means and transported.

8. Resilience of the Sanitation Infrastructure

8.1. Objective of this Section

The objective of this section is to analyze the resilience of main components of the sanitation infrastructure towards possible damage that may arise from main environmental hazards, namely flooding, droughts and high winds, which are likely to become worse with climate change and they directly affect water and wastewater infrastructure.

The main components of the sanitation infrastructure in Soroca include:

- Wastewater collection network,
- Pumping Stations (Main PS and small lift stations)
- Wastewater Treatment Plant
- Treated wastewater outfall
- Chemical and fuel storage tanks
- Power supply
- On-site sanitation systems

At this stage of the Feasibility Study, the resilience assessment consists of a high-level hazard screening in the study area and in particular for the systems' components. Then, possible failures due to these hazards are identified and described and finally, selected mitigation measures to reduce these failures are presented.

8.2. Identification of Hazards in Soroca

8.2.1. Flooding

Floods are one of the most dangerous meteorological phenomena. The main causes leading to catastrophic floods in Soroca are:

- torrential rains with high intensity;
- incorrect regulation of the DHPC (Dniester Hydropower Complex) in Ukraine and exceedance of the maximum allowed flow (2600 m^3/s).

Seasonal floods are possible on the Nistru River. The surface of the area flooded in the region of Soroca city can be 23 km^2, with an affected population of about 10 thousand people (Soroca General Urban Plan, 2011). On the territory of Soroca town, there are 21 water basins (lakes, ponds) of which 1 ("Ivancenko") presents a partial danger to the north-eastern sector of the city.

The stormwater network of the city is practically missing, only some sectors have independent storm sewers. During rainy events, some low parts of the city are flooded, creating difficulties in transport

and communications. The central sewer network of the city is also negatively affected, since rainwater infiltrates it.

According to the Strategic Framework for Adaptation to Climate Change in the Nistru River Basin (refer to ESIA Report, § 5), the 2021-2050 period will show a noticeable increase in temperature all over the year and an annual decrease of precipitation in Soroca region, as compared to historic records. Also, on the basis of modelling forecast in temperature and precipitation changes for the next decades, it has been established that the annual stream flow of the Nistru River will decrease by 10% in the DHPC area and by 20% in the Soroca area for 2021-2050 as compared with 1971-2000 period. However, even if the average precipitation and runoff of the Nistru is supposed to decrease during next decades, the frequency and intensity of extreme events (e.g. droughts, floods, and heavy rains) will increase and are identified as a significant risk in Soroca.

The Soroca General Urban Plan (2011) presents the areas of the city which are subject to flooding from the overflow of Nistru river (probability of occurrence of 1% per year) and sets the limit of flooding at a level of 50 m in the city.

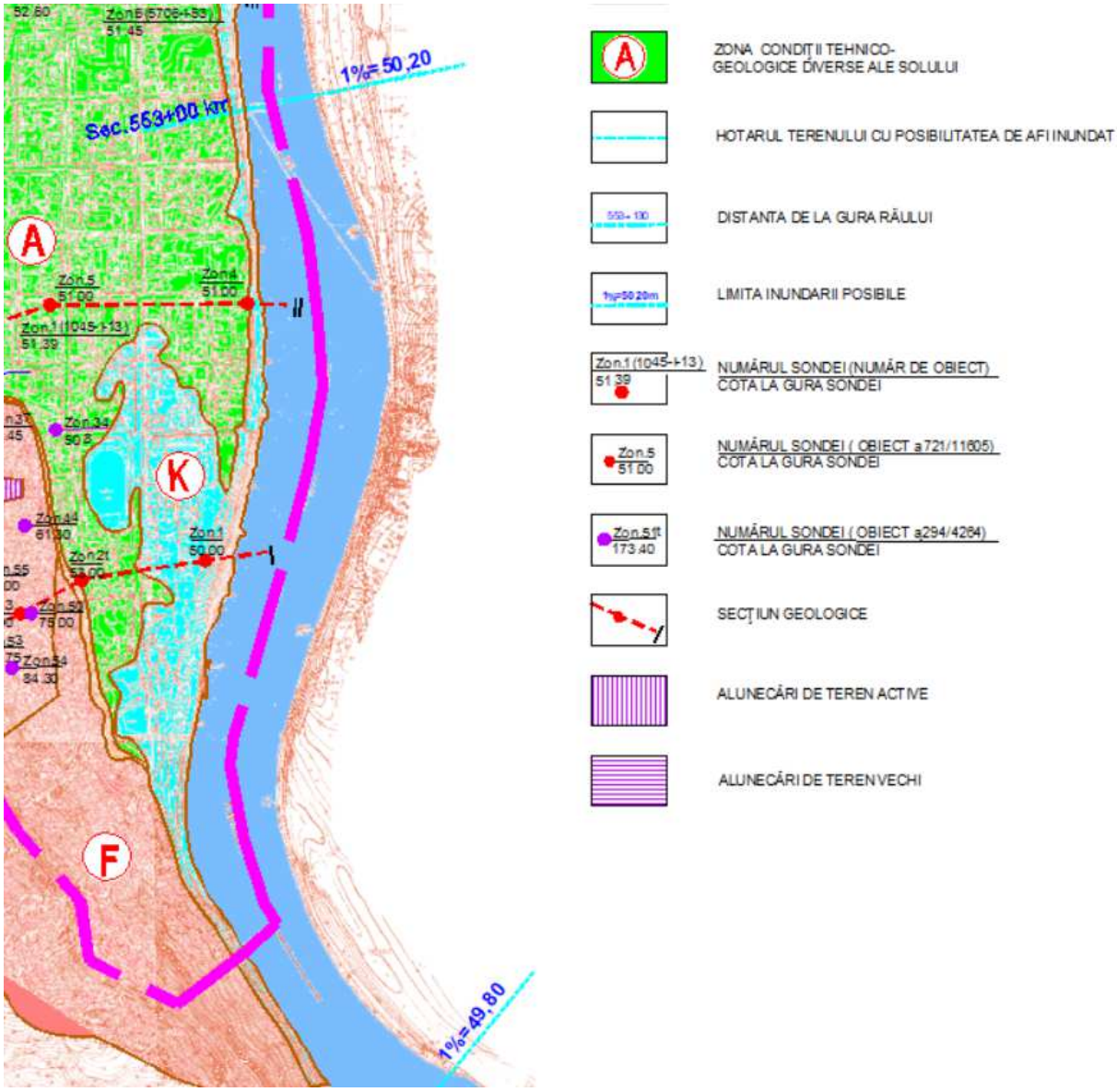


Figure 105: Overview of the south of the city of Soroca which is subject to flooding (K area)

The following figures show the location of the main Pumping Stations and the WWTP with regards to the flooding areas in Soroca.

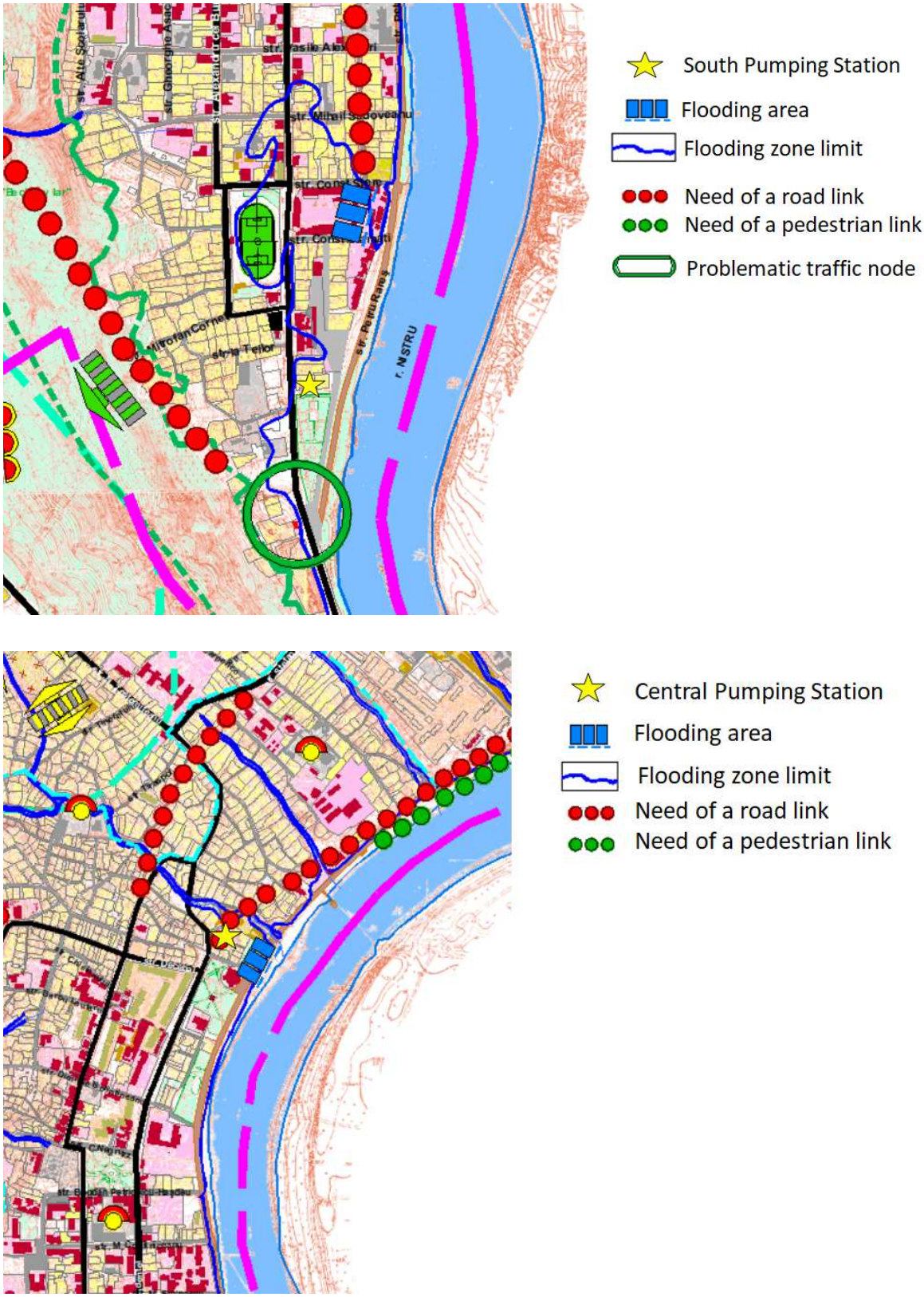


Figure 106: Location of Central and Pumping Station with regards to flooding areas in Soroca

It can be observed that the South Pumping Station will be located in an area which is subject to flooding.

With regards to the WWTP, it will be located in the commune of Vasilcău, in the South-east of Soroca, on the right bank of the Nistru river. The natural ground elevation of the plot varies from 46 to 58 m.a.s.l. and the plot may be subject to partial flooding[26].

Flooding is considered to be the main environmental hazard in Soroca.

8.2.2. Droughts

Drought is characterized by high surface air temperature of the soil over a long time in combination with the lack of sufficient rainfall for plant development. In the Republic of Moldova, droughts occur periodically with an interval of 3-5 years. Drought leads to considerable agricultural production losses (from 10 to 50%). Also, lowering groundwater and surface water levels can lead to difficulties in supplying drinking water to the population that do not rely on SA “Regia Apa Canal” central supply.

The lowering of groundwater levels in Soroca may reduce the infiltration of water into the sewers, which may bring uncertain effects on the wastewater quality (more concentrated, corrosive wastewater).

Drought may also increase soil subsidence. Depending on its composition, the soil will swell and shrink with moisture changes. If the soil movements are very pronounced, they can cause serious damage to property structures.

8.2.3. High winds

Storms with wind speeds greater than 27–34 m/s can cause damage to trees, roofs of houses, breakage of electricity lines and wired communication.

The wind regime in Soroca is characterized by the predominance of the north-western wind origin, and the average annual wind speed is 4.4 m/sec with intensifications in February - March, and November. In July and August, dry, hot winds blow.

High winds have not been identified as a probable risk in Soroca which may affect the sanitation infrastructure. Damage can result from concurrent flooding during heavy storms.

8.3. Identification of Possible Damages and Proposal of Mitigation Measures

The following tables show the different types of damage sustained by the Soroca sanitation system’s main components from floods and drought, and the proposed risk mitigation options.

[26] Based on Landsat satellite images and confirmed by some local residents, the plot was not subject to flooding during the last events registered in Soroca in 2008 and 2020. However, the 1% probability flood is established in the south of Soroca at a ground level of 50 m.a.s.l., so it is considered that there is a risk of flooding in part of the plot.

Table 48: Damages due to flooding and proposed mitigation options

Component of sanitation system	Possible damages / failures due to flooding	Proposed Mitigation options
Wastewater collection network	• Floods can cause overflow of the sewer network and sewage can back up and flood streets and houses. Sewers can experience physical damage, clogging, etc.	• The existing network will be rehabilitated in the next few years to correct infiltration of clear water and rainwater. • A new stormwater drainage network needs to be laid in most parts of the city.
Central Pumping Station	• Sewage can back up, flooding houses, businesses and streets. Damage on electromechanical equipment.	• An overflow shall be built in the Pumping Station to discharge flow larger than design pumping capacity
South Pumping Station	• Sewage can back up, flooding houses, businesses and streets. Damage on electromechanical equipment.	• An overflow shall be built in the Pumping Station to discharge flow larger than design pumping capacity. • Pumps will be of submersible type preferably. • Electrical components (motors, instrumentation, etc.) will be protected against inundation (location above design flood elevation, waterproof elements, etc.)
Small Pumping Stations	• Sewage can back up, flooding houses, businesses and streets. Damage on electromechanical equipment.	• Install submersible pumps or waterproof pump motors. • Elevate pump stations above the design flood level
Wastewater Treatment Plant	• Floodwaters can wash out drying beds (sludge treatment) and damage electro-mechanical equipment (pumps, motors, electrical power and controls). Buildings and treatment structures can be inundated. • Floods in the city can alter the quality of wastewater entering the WWTP with high solids due to the run-off.	• The maximal flow that arrives at the WWTP is limited by the Central Pumping Station capacity. The Central Pumping Station will have an overflow. • The WWTP layout will be designed in order to reduce flooding risks. The plot will be prepared against flooding (elevation of ground level above flood elevation, elevated platforms, containment structures, etc.). Main electromechanical equipment will be located above the flood elevation limit.

Chemical storage tanks	• Spill of chemicals into the environment. If the access to the WWTP is interrupted for a prolonged period, chemicals would not be available.	• Chemical storage tanks will be located inside the technical building above the flood elevation limit. • In our case, the use of chemicals is not considered essential to have additional storage installed in case of an emergency.
Fuel storage tanks	• Without fuel, emergency operation of the generator could be disrupted.	• The fuel storage tanks in the WWTP and in the main PS will be located above the flood elevation limit. Larger tanks can be installed to provide additional storage in case of an emergency.
Treated wastewater outfall	• Floodwaters can submerge and clog outfalls with debris or sediment and erode their • foundations. Clogged outfalls can cause sewer backups.	• A check valve will be installed at the outfall pipe. • The outfall will be reinforced against the impact of floating debris, erosion and siltation.
Power supply	• Floods can cause power outages that can affect or shut down the WWTP. Flood water can enter backup generators and render them useless	• A power generator will be installed in the WWTP and in the main Pumping Stations (Central and South). The power generator in the WWTP and in the main PS will be located above the flood elevation limit.
On-site sanitation systems	• Pits can overflow due to the increase of the groundwater level or to the infiltration of surface drain water.	• Soak Pits shall be avoided in areas with high groundwater tables. • Existing systems based on soak pits need to be improved by installing water-tight septic tanks and infiltration field

Table 49: Damages due to drought and proposed mitigation options

Component of sanitation system	Possible damages / failures due to drought	Proposed Mitigation options
Wastewater collection network and Pumping Stations	• Sediments can accumulate with slower flows; corrosive wastewater may damage pipes. • Higher detention times in the network increase the formation of H2S, which is a health and safety hazard. • Sewer pipes and pumping stations may suffer from soil subsidence, creating breaks and damage on the infrastructure.	• Monitor pumping flows in Central Pumping Station to detect short and long term evolution of wastewater flows. • Monitor H2S concentration and provide correct HSE equipment for the operators. • Protect equipment against corrosion. • Geotechnical studies of the areas where buried pipes are laid are required during the detailed design phase.
Wastewater Treatment Plant	• Drought may create raw wastewater with higher concentrations of pollutants and more corrosive, damaging equipment and reducing the efficiency of the biological treatment. • Soil subsidence may negatively affect infrastructure (breaks, damage, collapse).	• Monitor raw wastewater quality regularly in the WWTP to detect short and long term trends. • Full geotechnical study of the plot is required during the detailed design phase.

Nota: Other sanitation components such as on-site sanitation systems, chemical and fuel storage tanks are not affected by drought.

9. Assessment of SA "Regia Apa Canal Soroca" Sanitation Organisation and staff

This section presents the analysis and recommendations regarding SA "Regia Apa Canal Soroca":

- strategy and objectives
- organisation
- performance monitoring
- human resources
- industrial monitoring

9.1. Strategic vision and Objectives of SA "Regia Apa Canal"

The lack of financial capacity as well as the numerous changes of Administrator over the recent years has hindered the development of SA "Regia Apa Canal Soroca"'s long term vision. Since 2019, the Company's management has stabilised under a new Director who has demonstrated initiative and commitment to the improvement of the utility.

Apart from the content of its founding documents, SA "Regia Apa Canal Soroca" does not have a formalised strategic framework or business plan to guide its vision but has defined a number of strategic objectives:

- Minimise water losses
- Develop and implement GIS systems;
- Implement a SCADA system on the main drinking water networks;
- Extend the sewerage network;
- Construct the wastewater treatment plant.

For 2021, SA "Regia Apa Canal Soroca" has developed an action plan which lists 17 priority actions aimed at improving the utility's performance. Among others, the following topics can be highlighted:

- *Institutional strengthening* with actions focusing on the completion of the asset transfer, the finalisation of the Bulboci service delegation contract, the review of the legal and institutional framework around the operation of the Egoreni wells;
- *Financial performance* with actions targeting the tariff review and end of the bank account freezing;
- *Operational performance* with actions related to the reduction of non-revenue water and in particular commercial losses via the reduction of unauthorised consumptions and improvement of the metering performance;
- *Governance* with the improvement of the utility's performance monitoring and compliance as well as the elaboration of a reporting framework for the service delegation contract.

9.2. Organizational Chart and Sanitation activities within SA "Regia Apa Canal Soroca"

SA "Regia Apa Canal Soroca" Staff macro figures

Based on SA "Regia Apa Canal Soroca" staff data, a number of key figures can be pointed out:

- Total staff: 113
- Average age : 49,4 years
- 19% of staff > 60 years old
- Feminisation rate : 17%

The overall age of staff requires the implementation of a knowledge retention strategy. In particular, the difficulties encountered by the utility in digitalising the technical information related to the water and wastewater infrastructure have been hindering the knowledge saveguard and transfer and the HR person needs to elaborate a dedicated plan.

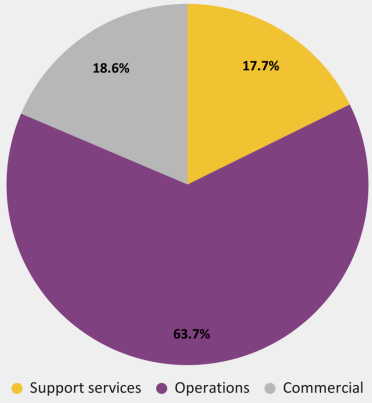


Figure 107 SA "Regia Apa Canal Soroca" 2020 staff distribution among key company functions

The utility recently revised its organisational structure and the chart overleaf illustrates the 2021 approved version.

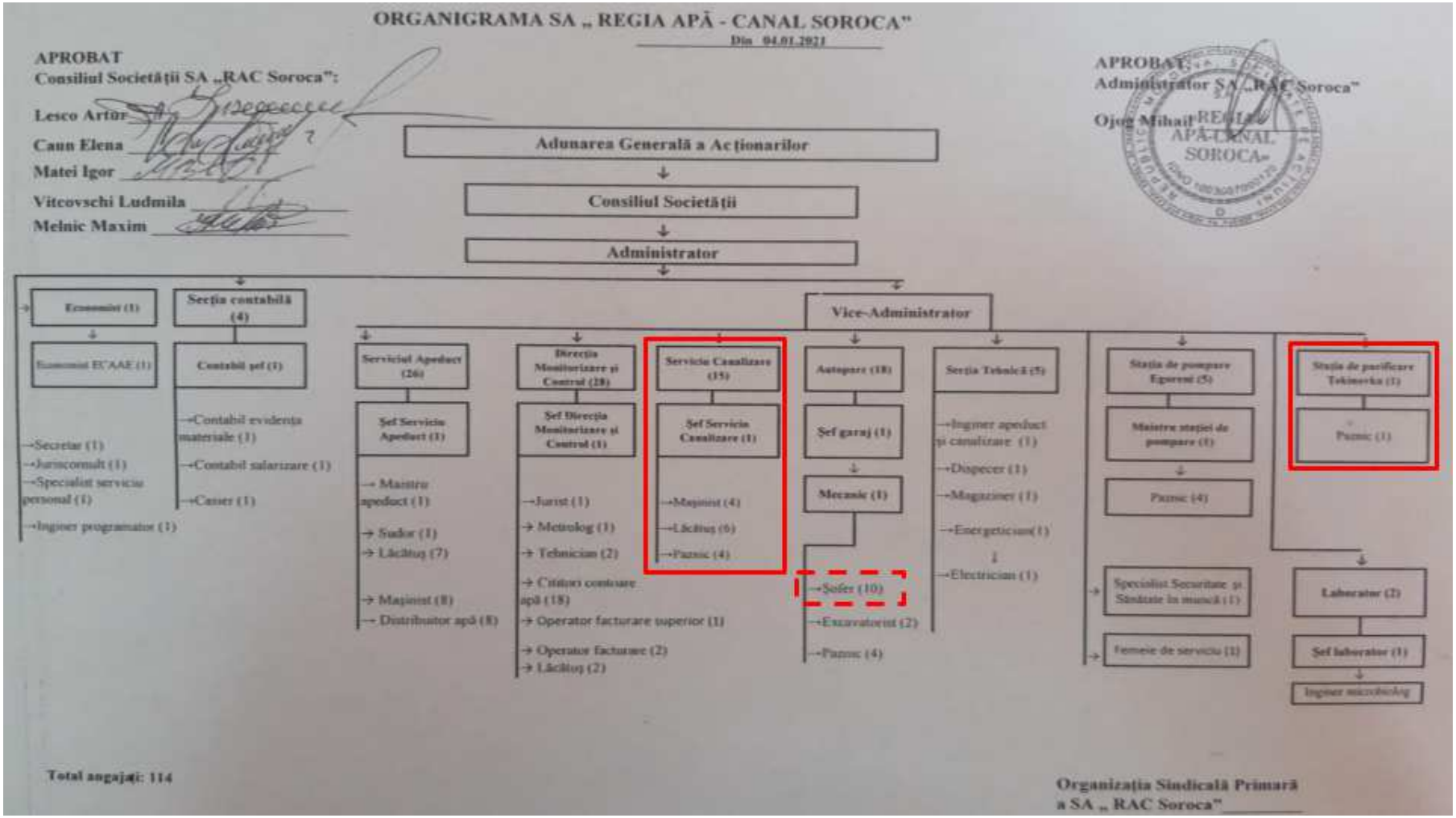


Figure 108: SA “Regia Apa Canal Soroca” 2021 Organisational Chart with emphasis on sanitation-related team

Sanitation-related activities (in red on the chart overleaf) are currently performed by the i) Sanitation service, ii) the team in charge of the Tekinovka WWTP and iii) part of the Garage team (driver dedicated to the flushing truck) but the delivery of sanitation services is heavily dependant on other teams which support both water and sanitation activities, in particular:

- **Technical Section** which is expected to provide support to both water and sanitation teams in terms of design, pump management, in addition to managing the store of spare parts;
- **Monitoring and Control Directorate** which is in charge of customer management and relations including billing and revenue collection of sanitation services;
- **Laboratory** which, in principle, should cover both water and sanitation activities but currently solely focuses on water (the utility does not monitor wastewater quality today);
- Etc.

Out of the 17 positions authorised within the organisational structure for sanitation O&M-related activities, 15 are currently staffed:

- Sanitation service:
  - **1 Service head**;
  - 6 technicians (Lacatus) mainly in charge of operating the system;
  - 4 operators (*Masinists*) in charge of basic maintenance activities;
  - 4 security guards in charge of the security of the various sites (pumping stations);
- Garage service:
  - 1 driver dedicated to the flushing truck;
- Old Tsekinovka WWTP site (in Ukraine):
  - 1 security guard.

Sanitation O&M activities are carried out under the supervision of the Service Head who has the knowledge of what needs to be done. However, O&M activities would strongly benefit from the elaboration of **standard operating procedures to ensure the homogeneous quality of service** delivered by the team and to align current practices with international standards. Moreover, there are no design standards nor templates for connections which, although they fall under the responsibility of the technical engineer, do not appear to be standardised.

The level of digitization of the information and digitalisation of processes within the O&M is rather low with no GIS in place (although it was reported that an ongoing initiative was ongoing for the setup of a GIS system for the water perimeter), no hydraulic model, no operating SCADA, etc.

There is a basic tracking of network intervention which will need to be enhanced and interfaced with the GIS once it is in place. According to the Utility Diagnosis and Performance Improvement Plan (2021), 313 failures were registered on the sewerage networks in 2019, which is typical of an **old and unmaintained network**. Maintenance is currently solely performed in the form of corrective maintenance (repairs) and there are no **preventive maintenance activities** reported by the teams. It will be essential for the team to start performing preventive maintenance on the rehabilitated and new assets in order to preserve their lifespan.

Operational reporting is performed on a monthly basis, at the request of the Economist who centralises key indicators but i**ndicators are not proactively followed** within the sanitation team which lacks a strategic vision and SMART objectives for its activities. Moreover, the use of the

indicators within the team remains basic and does not serve the continuous improvement of O&M practices (no mitigation measures nor improvement action plan).

It must be highlighted that the sanitation service team **does not measure the wastewater volumes** at the outlet points nor does it follow the volumes brought by the vacuum tanks and discharged at the central station. The volumes recorded and currently reported to ANRE and other stakeholders are solely based on wastewater return ratio estimates calculated from the water consumption volumes.

Given its financial constraints and seizure of its bank account, SA "Regia Apa Canal Soroca" has been having difficulties to ensure the timely procurement of all the required materials. There is **no procurement plan nor any procurement department** and the utility procures its materials on an ad-hoc basis whenever cash is available. Although forced by the context, operating in such a reactive manner does not support the smooth delivery of water and sanitation services and is likely to generate delays in repair and maintenance activities which may, in time, endanger the continuity and safety of service.

9.3. Performance monitoring and reporting

It is the financial department (more specifically the Economist) which centralises the data regarding the Utility's performance monitoring.

The economist maintains a number of dashboards to track the Utility's performance on its various processes (HR, finance, operations, commercial, etc.) based on data supplied by the various departments on a monthly basis:

- Purchased water
- Water sales in volume and Lei
- Water cost recovery in Lei/m3
- Wastewater volumes and Lei
- Wastewater cost recovery in Lei/m3
- Total cost recovery

The service delegation contract signed between SA "Regia Apa Canal Soroca" and the Municipality lists a number of KPIs with targets provided up to 2015 which have not been updated and are not specifically followed up.

Overall and based on the discussion held with SA "Regia Apa Canal Soroca" teams during the field mission, it would be beneficial to ground the utility management on the notion of performance through:

- Incentivising the teams on performance with the allocation of specific KPIs and the definition of their calculation for each business process;
- Systematising the bottom-up but also top-down communication of the performance monitoring in order to build the entire company's commitment to the Utility's performance;
- Using the monitoring to not only look at past performance but also project future trends to improve decision-making.

It is strongly recommended that the Utility builds the capacity of the Financial team (only one Economist and one accountant at the moment) in order to be able to dedicate more time to performance monitoring and in particular develop the **Utility's Business Plan**. This strategic

document should provide a vision for the utility's priorities in the short, mid and long term and be based on a strong excel financial model to assess the impact of various scenarios and priority measures on the Utility's overall performance.

It is our understanding that SA "Regia Apa Canal Soroca" is expected to monitor and report on the following information to its external stakeholders:

- Wastewater quality to the Environmental agency;
- Drinking water quality to Apelei Moldovei;
- Cost/revenue reporting to ANRE to support tariff review requests;
- No specific reporting is currently communicated to the Municipality.

9.4. Recommendations on Organization and Staff of SA "Regia Apa Canal Soroca"

The current organisational structure does not support the good performance of sanitation activities which are lacking leadership.

Indeed, due to the very horizontal organisational structure, the sanitation activities are not centralised under one unit and the reporting lines are therefore not clear as some individuals are under the supervision of the Service head and others directly under the supervision of the Vice-Administrator. For the smooth operations of wastewater activities, **it is highly recommended that they all be supervised by the Sanitation Service Head in charge of providing the strategic vision and responsible for the achievement of targets**.

Despite the Head of service who seems to have a good understanding of the system and sanitation infrastructure, the rest of the team's knowledge and expertise is very basic. It is therefore crucial that the rehabilitation of the infrastructure be considered as an opportunity to **digitalise and centralise** all the information on the existing assets as well as properly document the new investments.

Moreover, the service is in dire need of **engineering support** to design the new wastewater connections and it is essential that this expertise be readily available within the Utility's technical team (it is currently outsourced to external engineers).

The absence of staff working on wastewater quality monitoring is a critical issue and will need to be addressed .

The 2021 organisational chart appears more efficient than the previous organisational structure which was very complex and lacked efficiency in reporting lines. However, in line with international best practices and with the objectives of facilitating sanitation operations, a number of recommendations could be made to further **improve the current organisational structure**:

- **Harmonize the level of services** (services, direction, section, teams, etc.) into Departments which may in turn be subdivided into services;
- **Further streamline reporting lines** by allocating site management to the teams concerned (Tsekinovka WWTP under the sanitation service, Egoreni pumping station under the water service, etc.);

- **Expand the duties of the Technical Section to cover Planning and Design** as the planning of infrastructure has been identified as a key missing function of SA "Regia Apa Canal Soroca"'s operations (not having the means to self-finance infrastructure development does not mean that infrastructure requirements should not be identified and precisely planned for as these are prerequisites to obtain external financing);
- **Create one single Financial Management and Accounting Department** comprising the team of the Economist and Accountant and staff the vacant positions to support this central function of the Company;
- **Setup of a new laboratory** within the WWTP premises to be dedicated to wastewater quality monitoring;
- Setup of an **emergency response team** to cover both water and wastewater activities in order to improve crisis management. Tentatively consider 4 individuals with a rotational mobilisation programme and specific procedures. The team can be composed of existing staff who may hence be working extra-hours in case of emergency, and remunerated accordingly;
- **Create a Procurement Department** which, in accordance with good international practices, should be independent from the Financial department (the entity who buys should be different from the one who pays). This department will be in charge of centralising the procurement requirements from the various teams, manage procurement and purchases throughout the year and supervise the store (storekeeper to be moved to that new team).

The Utility Diagnosis and Performance Improvement Plan (WB, 2020) also reported a number of vulnerabilities that need attention, including:

- The age of the Head of the Aqueduct Service is 59 years old and it would be good to introduce an engineer who would ensure the continuity of the service;
- The Occupational Safety and Health Specialist is also close to retirement age 61 years;
- 61-year-old Microbiologist Engineer.

The Utility Diagnosis Report indicated a staffing ratio of 7,2 which is above international standards (around 5 staff/1000 connections). Although majoritarily composed of low-skilled staff, SA "Regia Apa Canal Soroca" **must improve its staffing efficiency**. The selection of technologies relying on a number of automated processes combined with the increase of the utility's wastewater connections should support this improvement over the coming years.

The existing sanitation team currently does not hold the necessary competencies to operate and maintain the new infrastructure that is recommended within this Feasibility Study. Additional staff will be required but also, the capacity of the existing staff will need to be enhanced. To that effect, it must be highlighted that the company does not have a **staff capacity building / training strategy** and that training is performed ad-hoc without consistency with the utility's strategic vision. It is highly recommended that the Utility HR person performs a competency mapping of all staff in order to identify competency gaps and consistently develop/prioritise the capacity building programme.

Also, it is highly recommended that SA "Regia Apa Canal Soroca" be supported by a Technical Assistance Contract over a couple of years to structurally improve their capacity in delivering their assigned duties in terms of operational but also commercial and financial performance.

It is proposed that the new team be structured according to the following logic with a optimum number of **26 dedicated staff**:

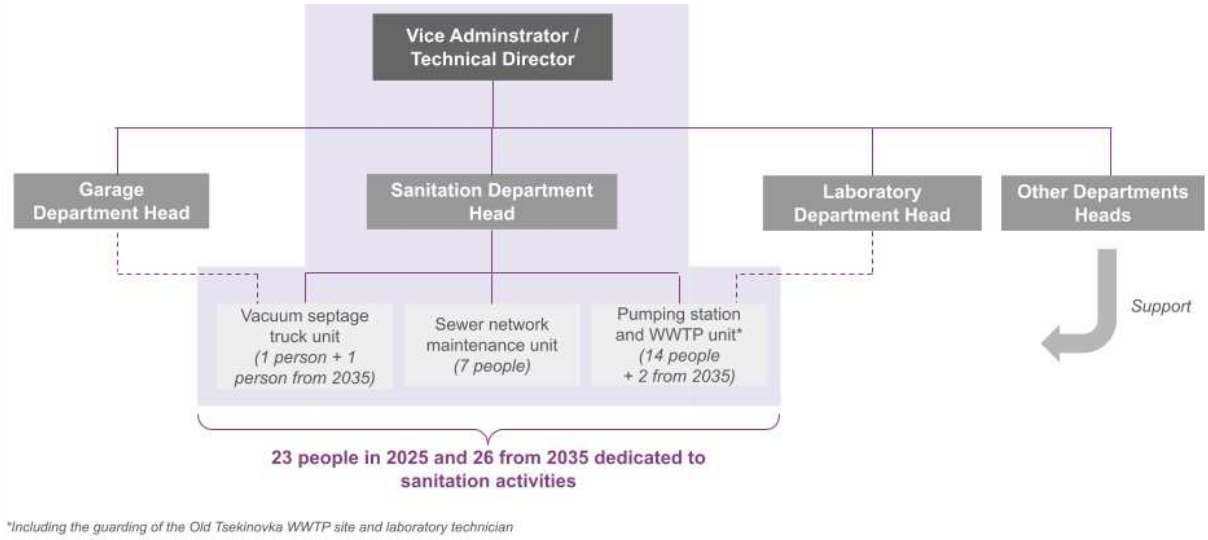


Figure 109: Proposed future organisation of the SA “Regia Apa Canal Soroca” sanitation team

Focus on the Sewer network maintenance unit

To maintain the lifespan of the new and rehabilitated sewer network, a new maintenance unit team will need to be dedicated to network operation and maintenance activities as detailed below:

Position	Staff number
Network Manager	1
Operator (corrective maintenance)	2
Operator (preventive maintenance)	2
Driver (flushing truck)	2
Total number	**7**

The sewer network maintenance unit will work closely with the electromechanical technicians within the WWTP and Pumping station unit who will be mutualised.

The purchase of HSE equipment will be necessary for the sewer network maintenance unit to perform its activities. In particular, they should be equipped with individual PPE with gas detectors, adequate outfits with helmets etc as well as mechanical ventilation equipment, surface signalisation equipment for interventions, etc.

The two drivers will work in shifts with the existing sewer flushing trucks within the utility.

It will be necessary to ensure the allocated staff are sufficiently experienced and trained on the following topics to perform their duties including:

- Corrective and preventive maintenance of pumps;

- Emergency response;
- Sewer pipe flushing;
- CCTV Sewer inspections;
- Sewer flow measurement;
- Performance monitoring;
- HSE including interventions in confined spaces;
- Etc.

As mentioned before, it is key that the Utility team be staffed with a competent Technical Engineer in charge of supporting the network team and in particular on the design of sewer connections.

Focus on the Septage vacuum truck unit

For consistency in the implementation of sanitation improvement activities, it is proposed that the septage vacuum truck unit be moved under the supervision of the Sanitation Department Head who will be in charge of achieving the general sanitation targets in terms of coverage as well as service quality. The septage vacuum truck unit will receive support from the Garage Department.

The team will be composed of 1 driver/truck operator and then 2 when the second truck is purchased (2035).

Focus on the Pumping station and WWTP unit

The operation and maintenance of the new pumping stations and WWTP infrastructure will require a specific team to operate and maintain the system at its expected performance. The following table shows the anticipated staff number and position required for the efficient running of the plant based on trickling filter technology and medium degree of automation.

	WWTP and PS Phase 1			Additional for WWTP Phase 2
Position	**Shift 1**	**Shift 2**	**Shift 3**	
Plant Manager	1			
Operations supervisor				1
Laboratory technician	1			1
Electrical/Instrument technician	1			
Mechanical technician	2	1		
Operator	2	2	1	
Guard	1	1	1	
Total number	**14**			**2**

It is also anticipated that the WWTP staff will have to be reinforced by two additional persons (process engineer and laboratory technician profiles) to be recruited if the treatment plant is upgraded for nitrogen removal.

It will be necessary to ensure the allocated staff are sufficiently experienced and trained on the following topics to perform their duties including:

- Corrective and preventive maintenance of pumps;
- Energy management;
- Wastewater quality sampling and monitoring;
- Laboratory analysis;
- Performance monitoring;
- Etc.

It is strongly recommended that a dedicated capacity building / technical assistance project be organised to support SA “Regia Apa Canal Soroca”’s transformation and reorganisation to adequately operate the new infrastructure.

Focus on the Laboratory

SA “Regia Apa Canal Soroca” currently manages a laboratory which is responsible for verifying the quality of the drinking water delivered to the consumers according to the normative requirements (Government Decision 934/2007 on the “State Register of Natural, Drinking Mineral Waters and Bottled Non-Alcoholic Beverages”, Law no. 182 of 19.12.2019 regarding the quality of drinking water). The laboratory is certified for water quality control according to 9 parameters[27] (7 chemical and 2 bacteriological parameters).

Figure 110: SA “Regia Apa Canal Soroca” laboratory

The laboratory is located next to the Water Reservoir no 1. (Centura Soroca, Bujerauca sector) and has one office, a sterilizing room, a microbiological analysis room and a chemical analysis room. The laboratory team is composed of two persons, the head of the laboratory and a microbiologist engineer. The laboratory equipment has recently been replaced through the project "Empowering the citizens of

[27] Odour/Taste, Colour, Turbidity, pH, free and combined chlorine, ammonia, nitrite, iron, Escherichia coli, Enterococci

the Republic of Moldova" (2019-2021), funded by the European Union and implemented by the German Agency for International Cooperation (GIZ).

IN-HOUSE AND OUTSOURCED WATER QUALITY MONITORING

A new laboratory will be set up inside the WWTP with one person dedicated to the analysis of wastewater quality and responsible for performing regular and basic wastewater quality monitoring (mainly BOD, COD, TSS, conductivity, temperature, pH, alkalinity, TN, TP, sludge dry matter).

However, it is recommended to continue working with the accredited laboratory in Otaci (Agenția de Mediu Nord) or other accredited laboratory for the legal wastewater quality measurements (BOD, COD, TSS, TN, TP, 12 samples per year, according to GD 850/2013). In the mid term, it is recommended to invest into setting up an accredited wastewater laboratory within Soroca, which would be responsible for monitoring not only the wastewater in the WWTP, but also from the sewer network and industries.

Support from other departments

It is assumed that some of the existing personnel of SA “Regia Apa Canal Soroca” will support sanitation operations at large, in particular those within support services such as administrative personnel, IT Engineer, technical engineer, commercial agents, etc. and as such, it is the performance improvement of the entire utility that should be sought to support both water and sanitation service delivery simultaneously.

9.5. FOCUS ON INDUSTRIAL DISCHARGE MONITORING

9.5.1. LEGAL FRAMEWORK

Industrial wastewater is defined as *“wastewater which results from commercial or industrial production processes”.* The conditions for the organisation, management, regulation and monitoring of industrial wastewater in the Republic of Moldova are addressed by the following main law and regulation:

- The **Law on water supply and wastewater public services no. 303 of 2013**
- The **Government Decision no. 950 of November 25, 2013 "Requirements for collection, treatment and discharge of wastewater in the sewerage system and/or in water bodies for urban and rural localities",** last amended on February 19, 2020.

The discharge of industrial wastewater into public sewerage systems is carried out on the basis of a **wastewater collection agreement and/or discharge authorization** issued by the operator who manages and operates the sewerage system, who controls the quality of water received and supplies the contract for the provision of the public sewerage service.

The wastewater collection agreement or the contract includes the conditions and indicators for industrial wastewater discharge in terms of **composition and volume** established by the operator, which are subsequently coordinated with the environmental bodies of local public authorities (State

Ecological Inspectorate) and approved by the central bodies in the field of water and environmental protection (Apele Moldovei).

In order to renew or to obtain an authorization for the discharge of industrial wastewater into the public sewerage network, the economic agent (consumer) will submit an **application** to the operator with the following information:

a. the flows and Maximum Allowable Concentrations of the pollutants from the wastewater discharged at the control point;
b. wastewater discharge restrictions at certain hours;
c. measures to standardize the flows and concentrations of pollutants from wastewater discharged into the public sewerage system;
d. the obligation to install **meters** for measuring and recording the volumes of wastewater discharged into the public sewerage system and to maintain them in working order;
e. the obligation of the consumer to inform the operator about all own accidents that may disturb the proper functioning of the public sewerage system;
f. the obligation of the consumer to elaborate the plan to combat the accidental pollution of the wastewater, including to endow with means and materials for intervention, or to conclude a pre-contract with a specialized unit for interventions in case of accidental pollution of the wastewater discharged in public sewerage system;
g. designation of quality control points for wastewater discharged into the public sewerage system and frequency of sampling of wastewater.

The **wastewater discharge authorization** into the public sewerage system, annexed to the **contract** for the provision of the public sewerage service, shall be issued by the operator to the consumer and shall include:

a. the name of the act (Wastewater collection agreement);
b. the date of issuing the agreement;
c. the name of the operator;
d. the name of the consumer to whom the respective act is issued;
e. the requirements of the operator regarding the quality of the wastewater discharged in the public sewerage networks;
f. Maximum Allowable Concentrations of pollutants from consumer wastewater;
g. the conditions for accepting the wastewater from the consumer, which include requirements regarding:
    - the need for pre-treatment / treatment of industrial wastewater or part of it at the consumer's pre-treatment / treatment plant;
    - pre-treatment of industrial wastewater in common with other consumers, in treatment plants of the group of enterprises (if such exists);
    - maximum reuse of treated wastewater to ensure technological processes with technological water or for other uses;
    - implementation of new technologies that offer the possibility to reduce water consumption or wastewater flow, as well as their degree of pollution;
    - the use of closed water supply systems or the repeated and successive use of water in the technological processes of the enterprise;
    - recovery of useful substances contained in industrial wastewater;
    - treatment and use of sludge resulting from technological processes and pre-treatment of industrial wastewater;

h. the term of validity of the agreement for taking over the wastewater;
i. the name, surname and signature of the person in charge of the authorized / designated operator with the right to sign the wastewater collection agreement.

The Maximum Allowable Concentrations (MAC) of wastewater discharged into the public sewerage system is determined for each consumer according to the methodology established in Annex 6 of the GD 950/2013, which takes into account the percentage of domestic and non-domestic wastewater in the locality, the treatment efficiency of the WWTP and the discharge limit established for the WWTP into the water body. In the case of absence of this estimation, the MAC are established in Annex 1 of the GD 950/2013. Industrial clients have the obligation to **pre-treat wastewater** so that it complies with the established MAC at the discharge point.

The operator is responsible for monitoring the industrial wastewater quality discharged into the public sewerage system at the control point established by him. The periodicity of sampling of industrial wastewater is set by the operator for each individual consumer depending on their form of the activity, the monthly and annual wastewater flows, the impact on sewerage networks, etc. with a minimum frequency of **once a year**. The analyses need to be performed in accredited laboratories in Moldova.

If exceedances of the quality parameters are found in relation to the established MAC, the operator will calculate additional payments to the consumer. calculation of additional payments according to Annex 7 of the GD 950/2013.

9.5.2. Current Practices in Soroca

SA “Regia Apa Canal Soroca” keeps individual contracts with non-domestic consumers on the provision of the public water supply and sewerage service. The discharged wastewater volume is estimated as a percentage of the supplied drinking water volume (which is metered), depending on the type of activity and industrial process. This discharge ratio is approved by Apele Moldovei.

Nowadays, the industries do not have specific meters for wastewater discharge to correctly evaluate and monitor their discharge volumes and SA “Regia Apa Canal Soroca” keeps no database that compiles and analyses the monthly and annual wastewater volumes for economic agents.

Regarding wastewater quality monitoring, this is not performed by SA “Regia Apa Canal Soroca”. Some industries regularly perform analysis, but there is no obligation of reporting to the operator and SA “Regia Apa Canal Soroca” keeps no records on expected or actual industrial wastewater quality from economic agents.

In general, economic agents in Soroca do not have pre-treatment facilities[28], or when existing, its performance is not known.

No accredited laboratory for wastewater analysis exists in Soroca.

[28] One exception is the Alfa Nistru facility which has a pre-treatment and where wastewater quality monitoring is regularly performed.

9.5.3. RECOMMENDATIONS

The current industrial wastewater management scheme by SA “Regia Apa Canal Soroca” is poorly developed and not well adapted to the future implementation of a WWTP. Moreover, industries do not comply in general with the legal requirements set in the Moldovan legislation on wastewater quality discharged into the public sewer network.

It is recommended that the provisions and requirements from the existing legal framework are followed by both economic agents and the sewer network operator in order to correctly manage the industrial wastewater discharges in Soroca.

Some short-term measures for industries include:

- The implementation of a **pre-treatment** to guarantee that the industrial wastewater discharged in the public sewer network complies with the Maximum Allowable Concentrations set in the Regulation. Depending on the type of industry or economic activity, the pre-treatment requirement will vary from a simple grease separator (for restaurants), oil or hydrocarbons separator (for garages, car washing) to a complete mechanical and biological treatment (for Fabrica de brinzeturi and Debut Sor, mainly).

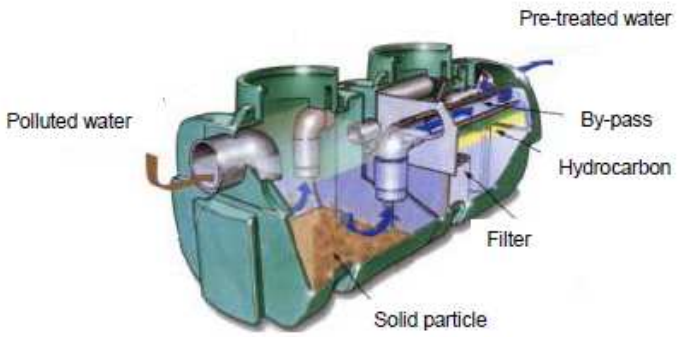


Figure 111: Hydrocarbons removal tank

- The diversion and separate treatment and disposal of most polluted effluents from the wastewater discharge into the public sewer network;
- The provision of an equalization tank to homogeneize wastewater effluents and smooth the discharge into the sewer;
- The installation of meters to correctly evaluate the wastewater discharge;
- The regular monitoring of the discharged wastewater quality.
- The performance of detailed studies for the largest industries for reducing their pollution load and increasing the water efficiency of their industrial activities (water recycling options, operational habits, cost-effective pre-treatment requirements, etc.).

Some short-term measures for SA “Regia Apa Canal Soroca” will include:

- Establish a clear **classification** of the industrial customers that takes into account their respective weight in the total industrial pollution load in order to prioritize and rationalize the efforts made on monitoring and controlling the industrial wastewater discharges. Most of the economic agents, such as hotels, supermarkets, small shops, coffee shops, etc. can be assimilated to “domestic customers” and a light monitoring will be required. On the other hand,

some institutional customers, such as hospitals, should also require a tailored monitoring program similar to the industrial sites;

- To digitize and improve the monitoring of largest consumers (economic agents and budgetary institutions) by means of a specific database which includes the discharged volumes, wastewater quality, etc.

According to the regulation, the responsibility for measuring and analyzing the wastewater discharges to the sewerage network is on the side of SA “Regia Apa Canal Soroca”, which will require a lot of additional workload and operating expenses. Since there is no accredited wastewater laboratory in Soroca, industrial wastewater samples’ analysis needs to be externalized. It is recommended that in the mid term, the wastewater laboratory of the WWTP will be accredited to perform the routine control analyses for industries.

Finally, a strong collaboration between the industrial customers, SA “Regia Apa Canal Soroca” and Local Public Authorities is required in order to develop synergies and a sound strategy that will encourage industrial customers to reduce their pollution load and comply with the legislation, whilst optimizing expenses:

- On the one hand, the environmental authorities should be more active in collaborating with SA “Regia Apa Canal Soroca” and controlling illegal discharges to the sewer network and to the water bodies. For example, the installation of pre-treatment units by the economic agents is not sufficient, but the correct maintenance and cleaning of the units is required to guarantee the unit performance;
- On the other hand, largest industries/polluters could dispose of a procedure of “self-monitoring” that would place the responsibility of measuring, sampling and/or analysing the industrial effluents into their own hands, so that SA “Regia Apa Canal Soroca” would only check the data provided by the customers from time to time by additional measurements. This procedure would significantly reduce the workload of SA “Regia Apa Canal Soroca” while giving more responsibility to the industrial customers, thus raising their awareness about water savings and pollution reduction.

10. Developing Soroca's Sanitation Infrastructure - Investment Strategy

The previous sections presented the recommendations for the infrastructure and organisation required to reach a level where wastewater will be safely collected and treated before its discharge into the environment.

This section summarizes all the recommendation and price them in 3 investments plans:

- short term: aiming at improving the sewerage system for the current situation
- medium term: aiming at strengthening the Utility's capacities and increasing the coverage rate of the sewerage system
- long term: aiming at increasing the sewerage system's capacity

This section presents:

- the summary of the investments needs
- the investment plan
- the procurement plan

NOTA: the investment plan is obviously highly dependent on the design criteria and project objectives selected in the previous phases of the project. The Investment Plan has been reviewed from the first draft version according to the new project criteria (coverage rate of 47% in 2035, 75% in 2045 and 90% in 2065).

10.1. List of identified investment needs

As discussed in the previous sections, the identified investment needs to improve the sanitation in Soroca are summarized as follows:

- Rehabilitation / reconstruction of main pumping stations;
- Construction of a WWTP in two stages:
    - the first stage will treat the estimated wastewater volume and load at horizon 2035. The process will be based on carbon treatment.
    - The second stage will cover the future coverage rate in year 2045 and it will also take into account the upgrade of the WWTP to treat N and P;
- Rehabilitation of existing main sewerage network and extension of the network to increase the area of the city covered by the sewerage network:
    - The rehabilitation phasing will be supported by performing camera inspections (CCTV);
    - The extensions will include gravity pipes, but also small pumping stations and pressure pipes to connect areas which cannot easily be connected by gravity.
- Connection of new customers in new but also rehabilitated sections of the network;
- Reinforcement of onsite systems management with the purchase of a new vacuum truck;
- Improvement of SA "Regia Apa Canal Soroca" HSE equipment;
- Capacity building / technical assistance to improve SA "Regia Apa Canal Soroca"

The priority works for the **short term (2023 - 2025)** will include the construction and commissioning of the WWTP and main pumping stations, but also the partial rehabilitation of critical parts of the network.

For the **mid-term (2025 - 2035),** the priority will be given to the rehabilitation of the sewerage network, to the connection of new customers to increase the coverage rate and to the reinforcement of SA "Regia Apa Canal" capacities (see below).

For the **long term (>2035)**, new extensions and rehabilitations will be planned and the WWTP will be upgraded and extended according to the evolution of the coverage rate.

Focus on the Technical Assistance / Capacity building (Mid-term measures)

As part of the mid-term measures, we strongly recommend implementing a 2 to 3-years technical assistance / capacity building programme. Indeed, once it receives the mandate to operate and maintain the new equipment, the utility will need to substantially build its capacities to adequately operate and maintain the new assets. As such, the technical assistance programme should enable the utility to:

- Support the utility in developing its corporate leadership, business vision and change management;
- Identify operational performance improvement levers and support the implementation of dedicated action plans to reduce OPEX costs;
- Streamline its current O&M practices to align with international best practices and standards to improve the quality of service;
- Streamline commercial activities to reduce commercial losses and optimise revenues on both water and sanitation;
- Enhance revenue collection to ensure the utility is able to collect the cash necessary to perform its activities;
- Support the utility in undergoing its **digital transformation** across its activities in order to improve performance and quality of service (from customer management to O&M activities, financial management, etc.)
- Train the staff across the organisation, in the various activities directly or indirectly related to sanitation, to perform their duties efficiently;
- Etc.

Such technical assistance programmes typically spread over 2 to 3 years and are organised according to the following sequence:

1. Detailed assessment of the utility maturity by business process including;
2. Support to the definition of the utility's vision and long term strategy including elaboration of a corporate business plan to project and monitor the key drivers affecting the utility's viability
3. Elaboration of the performance improvement action plan and capacity building programme;
4. Support to implementing the action plan:
    a. Support to reorganisation of the utility and recruitment for vacant positions;
    b. Development of policies, standard operating procedures and monitoring frameworks for each business process;
    c. Support to the implementation of key performance leverage activities such as NRW reduction, customer database update, software setup, laboratory accreditation, etc.
    d. Staff training and capacity building;
    e. Etc.

To maximise the impact of such a technical assistance support, it is recommended to have it address both water and sanitation activities to integratively cover the entire utility perimeter.

10.2. Investment Plan

The components of the complete investment plan (short, medium and long term) and the associated investment costs are shown in the tables below. The unitary costs' assumptions are presented in Annex.

NOTA: These costs do not include VAT. A 15% employer's rate is included in the final lump sum.

Table 50: Components of the Investment Plan for the improvement of sanitation in Soroca

Component	Short term <2025	Medium term 2025 - 2035	Long term > 2035
On-site systems management			
New vacuum truck		Vacuum truck 3,8 m3 capacity	
HSE Equipment			
HSE Equipment		Gas detectors, overalls, etc	
Wastewater collection system			
Pumping stations and pressure networks - New			
Central Pumping Station	New pumping station (2 + 1 pumps 36 l/s; Power = 50 kW)		Extension - new pump
South Pumping Station	New pumping station (1 + 1 pumps 4.4 l/s - 1 kW)		Extension - new pump
Small pumping stations	2 PS to pump wastewater from the forest to main sewer	2 PS to pump wastewater from the forest to main sewer	
Pressure network to feed the WWTP	5,8 km Diam = 400 mm		
Pressure network from SPS to gravity sewer	0,83 km Diam = 90 mm		
Small pumping stations Dealul Sorocii and Hydroinpex			6 small PS
Small pumping stations Bujerauca and Zastinca			5 small PS
Pressure pipes for small PS in Soroca			7,6 km

Pumping stations Rublenita + pressure pipe to Soroca			New PS (1 + 1 pumps 10 l/s; Power = 30 kW) and 5 small PS 1,6 km to connect to Soroca
Replacement / rehabilitation of existing network			
Replacement of existing critical parts (Dealul Romilor and Centru)	1,4 km Diam = 500 mm 1,5 km Diam = 200 mm	1,5 km Diam = 200 mm	
Pressure pipes from forest sector to main sewer	1 km	1 km	
Phase 1 - rehabilitation		5,2 km	
Phase 2 - rehabilitation		5,2 km	
Phase 3 - rehabilitation			5,2 km
Phase 4 - rehabilitation			5,2 km
Phase 5 - rehabilitation			5,2 km
Phase 6 - rehabilitation			5,2 km
New extensions of sewerage system - Gravity pipes			
Dealul Romilor - Score 10			3,9 km
Colegiul agricol, Dealul Romilor and Centru - Score 9			10,9 km
Bujerauca and Bujerauca noua - Score 8			8 km
Dealul Sorocii and Hydroinpex Ph1 - Score 7			10 km
Dealul Sorocii and Hydroinpex Ph2 - Score 7			16,9 km
Bujerauca - Score 4/6			2 km
Zastinca - Score 4/6			12,8 km
Rublenita - Score 4/6			20,7 km
Individual connections			
Individual connections in existing and rehabilitated networks (densification)			
Individual connections - Public network	194 connections	797 connections	1394 connections
Individual connections - Private network	194 connections	797 connections	1394 connections
Individual connections in new networks (extensions)			

Individual connections - Public network			5708 connections
Individual connections - Private network			5708 connections
Services to support rehabilitation program			
Camera inspection CCTV		10 km	20 km
WWTP			
New Soroca WWTP	Capacity 19 000 PE - 2243 m3/d (peak flow 197 m3/h) - 47% coverage rate		First extension and upgrade for N and P treatment for 29 000 PE - 3171 m3/d (peak flow 268 m3/h) - 75% coverage rate in 2045 Second extension for 36 000 PE - 4173 m3/d (peak flow 340 m3/h) - 90% coverage rate in 2065
Access road	Rehabilitation and upgrade of access road (3 km)		
Connection of the new WWTP to the power grid	Medium voltage 100 kVA - 2,5 km and transfo		
Technical Assistance			
Technical Assistance / Capacity Building		Technical Assistance / Capacity Building Programme (2 to 3 years)	

Table 51: Investment Plan for the improvement of sanitation in Soroca

Component	Short term <2025	Medium term 2025 - 2035	Long term > 2035
On-site systems management			
Vacuum truck		125 000 €	
HSE Equipment			
HSE Equipment		50 000 €	
Wastewater collection system			
Pumping stations and pressure networks - New			
Central Pumping Station	150 000 €		30 000 €
South Pumping Station	40 000 €		5 000 €

Small pumping stations	30 000 €	30 000 €	
Pressure network to feed the WWTP	580 000 €		
Pressure network from SPS to gravity sewer	49 800 €		
Small pumping stations Dealul Sorocii and Hydroinpex			90 000 €
Small pumping stations Bujerauca and Zastinca			75 000 €
Pressure pipes for small PS in Soroca			342 000 €
Pumping stations Rublenita			196 000 €
Replacement / rehabilitation of existing network			
Replacement of existing critical parts (Dealul Romilor and Centru)	176 400 €		
	157 500 €	157 500 €	
Pressure pipes from forest sector to main sewer	45 000 €	45 000 €	
Phase 1 - rehabilitation		600 600 €	
Phase 2 - rehabilitation		600 600 €	
Phase 3 - rehabilitation			600 600 €
Phase 4 - rehabilitation			600 600 €
Phase 5 - rehabilitation			600 600 €
Phase 6 - rehabilitation			600 600 €
New extensions of sewerage system - Gravity pipes			
Dealul Romilor - Score 10			409 500 €
Colegiul agricol, Dealul Romilor and Centru - Score 9			1 144 500 €
Bujerauca and Bujerauca noua - Score 8			840 000 €
Dealul Sorocii and Hydroinpex Ph1 - Score 7			1 050 000 €
Dealul Sorocii and Hydroinpex Ph2 - Score 7			1 774 500 €
Bujerauca - Score 4/6			210 000 €
Zastinca - Score 4/6			1 344 000 €
Rublenita - Score 4/6			1 863 000 €
Individual connections			
Individual connections in existing and rehabilitated networks (densification)			
Individual connections - Public network	106 865 €	438 350 €	766 700 €
Individual connections - Private network	58 290 €	239 100 €	418 200 €
Individual connections in new networks (extensions)			
Individual connections - Public network			3 139 400 €
Individual connections - Private network			1 712 400 €
Services to support rehabilitation program			
Camera inspection CCTV		200 000 €	400 000 €

WWTP			
New Soroca WWTP	5 500 000 €		4 500 000 €
Access road	762 000 €		
Connection of the new WWTP to the power grid	65 000 €		
Technical Assistance			
Technical Assistance / Capacity Building		800 000 €	
TOTAL EUR (without VAT)	**7 720 855 €**	**3 286 150 €**	**22 712 600 €**

The following table summarizes the investment needs for the three horizons and includes an Employer's rate of 15% which should be taken into account in the final budget.

Table 52: Summary of investment Plan for the improvement of sanitation in Soroca

Component	Short term <2025	Medium term 2025 - 2035	Long term > 2035
On-site systems management (vacuum truck)		125 000 €	
HSE Equipment		50 000 €	
Pumping stations and pressure networks - New	849 800 €	30 000 €	738 000 €
Replacement / rehabilitation of existing network	378 900 €	1 403 700 €	2 402 400 €
New extensions of sewerage system - Gravity pipes	- €	- €	8 635 500 €
Individual connections	165 155 €	677 450 €	6 036 700 €
Services to support rehabilitation program		200 000 €	400 000 €
WWTP	6 327 000 €	- €	4 500 000 €
Technical assistance / Capacity building		800 000 €	
TOTAL EUR (without VAT)	**7 720 855**	**3 286 150**	**22 712 600**
Employers' rate (detailed studies, tender preparation and supervision)	15%	15%	15%
TOTAL EUR (without VAT)	**8 878 983**	**3 779 073**	**26 119 490**
TOTAL US$ (without VAT) with Employer's rate	**10 565 990**	**4 497 096**	**31 082 193**

Additionally, **a budget of 490 000 US$** has been estimated in the short term plan for the **Environmental and Social Management** of the Soroca Sanitation Project (refer to ESIA and ESMP Draft Report). The total budget for Phase I of Soroca Sanitation Project, including the ESIA mitigation measures, will account for **11,09 Million US$**.

In total, a budget of **46,6 Million US$** will be required to align Soroca with the local and national sanitation strategies at horizon 2045, and with the more ambitious target of 90% coverage rate in the agglomeration of Soroca (Soroca city and the largest neighboring villages) by 2065. This budget can be divided up into:

- 11,1 MUS $ in the short term,
- 4,5 MUS$ in the mid-term
- and 31,1 MUS$ in the long term.

In the short term, the investment for the construction of the new WWTP amounts for 82% of the budget, whereas in the long term, the highest investment (80%) will be required for the network.

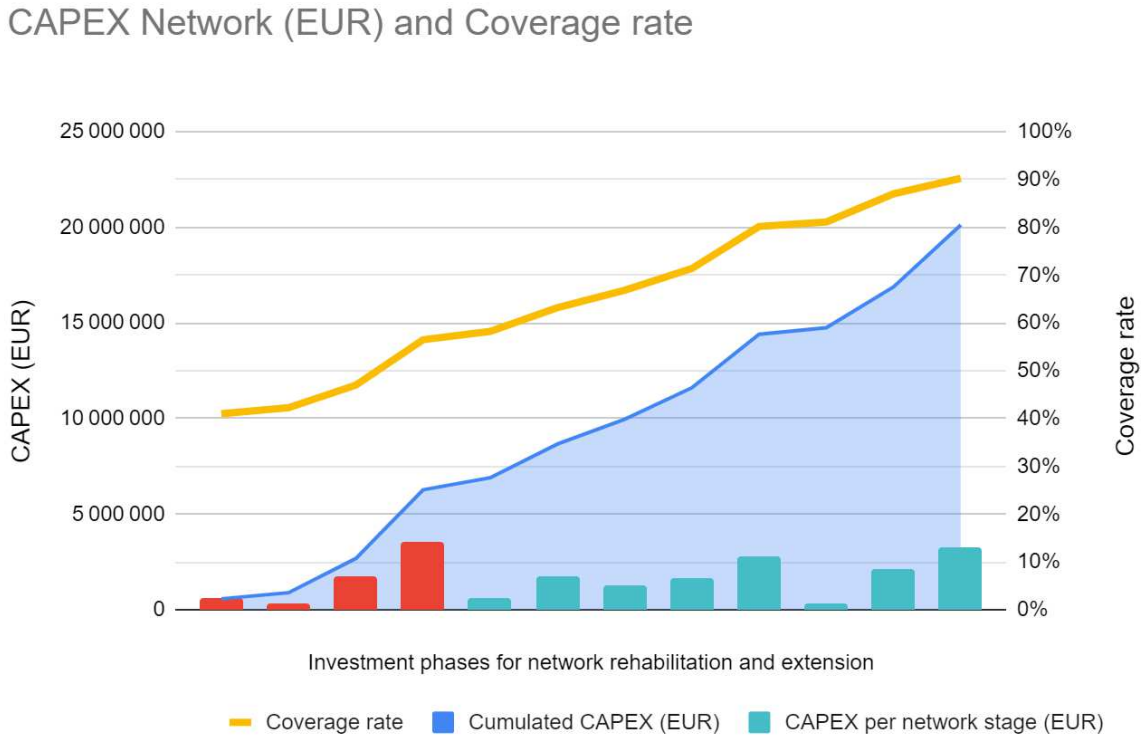
Figure 112: Investment needs at the three horizons and evolution of the coverage rate

10.2.1. Focus on the rehabilitation and extension of the network

The following table and figure detail the different stages to be followed in the rehabilitation and extension of the network to reach the intermediate coverage rates of 47% in 2035 and 75% in 2045 for the agglomeration Soroca and Zastinca, and a final coverage rate of 90% at horizon 2065 for the agglomeration Soroca, Zastinca and Rublenita.

Investment phase	Sector for extension / rehabilitation	Priority	Length (km)	PS	New customers	Total Customers	Connected Population	Coverage rate	Inhabitants	CAPEX (EUR)	Cumulated CAPEX (EUR)
Short term < 2025	Existing network in forest, centru Scores 11 and 14 (part 1)	Score 11/14	2,9	2 small PS	194	6 127	15 318	41%	37 348	574 055	574 055
Medium term 2025 - 2035	Existing network in forest, centru Scores 11 and 14 (part 2)	Score 11/14	1,5	2 small PS	101	6 228	15 570	42%	36 826	317 925	891 980
	Phase 1 and Phase 2 Rehabilitation in Soroca*		10,4		697	6 925	17 312	47%	36 826	1 793 480	2 685 460
Long term 2035 - 2065	Phase 3 to 6 Rehabilitation in Soroca*		20,8		1 394	8 318	20 796	56%	36 826	3 586 960	6 272 420
	Dealul Romilor	Score 10	3,9		261	8 580	21 449	58%	36 826	631 605	6 904 025
	Colegiul agricol, Dealul Romilor and Centru	Score 9	10,9		730	9 310	23 275	63%	36 826	1 765 255	8 669 280
	Bujerauca and Bujerauca noua	Score 8	8		536	9 846	24 615	67%	36 826	1 295 600	9 964 880
	Dealul Sorocii and Hydroinpex Ph 1	Score 7	10	2 small PS	670	10 516	26 290	71%	36 826	1 649 500	11 614 380
	Dealul Sorocii and Hydroinpex Ph 2	Score 7	16,9	4 small PS	1 132	11 648	29 120	80%	36 313	2 796 955	14 411 335
	Bujerauca	Score 4/6	2	1 small PS	134	11 782	29 455	81%	36 313	338 900	14 750 235
	Zastinca	Score 4/6	12,8	4 small PS	858	12 640	31 599	87%	36 313	2 132 960	16 883 195
	Rublenita	Score 4/6	20,7	5 small PS + 1 big PS	1 387	14 027	35 067	90%	38 854	3 237 865	20 121 060

* Priorisation will be given according to critical areas + CCTV results



~~Figure 113~~: Evolution of coverage rate according to the different stages of network rehabilitation and extension

10.3. Procurement Plan

The short term investment plan, to be financed by the World Bank loan, includes nine components.

Table 53: Procurement Plan

#	Project components	Contents
1	Reconstruction of gravity pipe in “Centru” sector and connections	Piping Civil works
2	Rerouting of gravity pipe in “Gipsy Hill” sector (Dealul Romilor) and connections	Piping Civil works
3	Construction of the new Central Pumping Station	Electromechanical equipment Electrical equipment Civil works
4	Construction of the new South Pumping Station	Electromechanical equipment Electrical equipment Civil works
5	Construction of 2 pumping stations on new pipe	Electromechanical equipment

	for “Dealul Romilor” sector.	Electrical equipment Civil works
6	New pressure pipe to connect the new WWTP	Piping Civil works
7	New WWTP	Process Electromechanical equipment Electrical equipment Civil works
8	Connection of the new WWTP to the power grid	Electrical line / substation
9	Rehabilitation and upgrade of the access road to the WWTP	Civil work

10.3.1. Packaging into Contracts

The definition of the best number of packages is a trade-off between two opposite objectives:

- A fine division in many different packages better matches with the characteristics of the market, and therefore enables better competition and results in lower costs; it also avoids chains of subcontracts with piling of margins.
- The bundling of the works in few packages only (or even only one) enables a better control of the time schedule and a transfer of responsibilities (in terms of quantities and performances) to the contractor. It is then much safer for the Employer, but results in higher total cost.

Actually, the advantage of bundling the works in one contract is significant only if there are some interactions (performances or limits of supply) between the various kinds of works which are merged together in one contract.

On the other hand, the involvement of the Employer (or of the PIU) will be all the more important as the number of different packages is high.

Therefore, it is proposed to organize the short term investment plan in 4 packages:

Table 54: Organisation of the short investment plan in packages

Package	Content
Package 1	Gravity pipes & Pressure pipes (until inlet of the WWTP)
Package 2	Pumping stations
Package 3	WWTP
Package 4	Electrical line / electrical substation

10.3.2. Procurement approach and contractual procedure

10.3.2.1. Project Implementation Unit (PIU)

A Project Implementation Unit shall be implemented to assist the company in the procurement phase, and to supervise the implementation of the works. The exact scope of work of the PIU will depend on the selected procurement procedures for each package, especially its involvement in the detailed design of the works. It will at least include the following:

- preparation of the tender documents for each package (including basic, preliminary or detailed design, according to the selected procurement procedure).
- assistance to the client during all the purchasing procedures;
- costs control;
- time schedule control;
- work supervision.

10.3.2.2. Potential types of contractual procedures

Three types of contractual procedure can be considered:

- Direct procurement of goods or small works (procurement and construction contract, based on design and bills of quantities defined by the PIU);
- Design and Build contract (D&B - for civil works), or Engineering, Procurement and Construction contract (EPC - for plants);
- Design, Build and Operate (DBO) contract (for plants).

The general features and application fields of each procedure is summarized below:

Table 55: Types of contractual procedures

Procedure	Characteristics	Advantages - usual fields of application	Limits and drawbacks
Direct procurement of goods - direct procurement of works - (BoQ based contract)	The Employer defines in detail the good(s) to be supplied ("shopping list", with technical specifications) or the works to be built (bills of quantities.) The supplier/ contractor only takes responsibility on the quality of the goods he supplied or works he builds. Payments are adjusted on real quantities	Supply of one piece of equipment Replacement / rehabilitation of worn out equipement Rehabilitation of civil works	The Employer takes the full responsibility of the design and of the quantities. Not possible if the Employer cannot mobilize the required skilled staff (maybe subcontracted to a consulting company). Generally it results in a longer implementation period.
Design and built contract (D&B) or Engineering, Procurement and Construction contract (EPC)	The contract is based only on preliminary design, general specifications and performance guarantees.	Adapted to water and wastewater treatment plants, especially when there are process performance stakes.	As the final cost would be higher than for direct procurement, it is not adapted for simple works, with no real risk on

	The contractor takes over the full responsibility of the quantities and of the performances.	Allows a good competition between specialized contractors, as they have a margin for optimization of the design. Allows to impose a tight time schedule.	performances and quantities, and no margin for process optimization. Allows a better control of the time schedule.
Design Build and Operate (DBO)	Combination of the D&B contract with a period of operation and maintenance of the plant (generally around 10 years)	Adapted to complex process plants, when the Employer cannot mobilize in time skilled staff. It also allows to transfer to the Contractor the responsibility of the performances on a longer period	Interesting only if the project is large and complex enough to interest companies specialized in O&M.

Between the BoQ based contract and the real D&B contract, all the intermediate solutions can be considered. It depends on the degree of detail of the design done by the Employer and attached to the contract. A contract can still be considered as a D&B contract, even if the Employer has imposed a preliminary design with a relatively high level of detail.

Therefore, the procurement plan must state the level of involvement of the Employer in the technical definition of each package, and not only the type of contractual procedure.

Funding and Applied Legislation for Water Supply and Sewerage Infrastructure in Moldova

Investments in water supply and sewerage (WSS) infrastructure in the Republic of Moldova are provided from several sources, ensuring compliance with relevant legislation:

No.	Source of funding	Applied legislation
1.	Local and central public administration budgets	Law 131 of 03.07.2015 on public procurement
2.	Own sources of WSS service operators	Law 74 of 21.05.2020 on procurement in the energy, water, transport and postal services sectors[1]
3.	Financial sources of donors and development partners	According to the specific procedure of an international organization[2]

[1] Law 74 of 21.05.2020 is in force since 26.06.2021.
[2] According to Article 5, letter m) of Law 131 of 03.07.2015 on public procurement.

10.3.2.3. Recommended contractual procedures for Short-term works

Package 1: Networks

For reconstruction of pipe, the exact scope of works must preferably be defined in detail by the Employer, as the need for rehabilitation can hardly be objectively and clearly defined on the basis of performances only.

Likewise, for the new pipe, there is no real interest for the Employer to transfer the responsibility of the design to the contractor.

However, the procedure will still be a **Design and Built** but within **a frame defined by the Employer**.

The PIU (or a consultant company) will be in charge of designing:

- the exact layout of the pipes;
- the nominal diameters and pressure class;
- the pipes materials and characteristics;
- a generic method of laying (standard section).

The Contractor will still remain responsible for the detailed design of singularities, the exact schedule of works and finally the quantities.

Package 2 (Pumping stations) and Package 4 (Electrical line)

Like for the pipelines, as there is no real process stake and margin for optimization, the recommended procedure for pumping stations and the electrical line to the WWTP would be a **Design and Build Contract**, based on preliminary design done by the PIU (or a consultant company).

This preliminary design shall define for the pumping stations:

- type and number of pumps;
- pumps characteristics (nominal flow and head);
- pumps and motors specification (technologies, material, minimum efficiency);
- internal dimension of the pumping chamber;
- electrical single lines diagram.

The contractor will take the responsibility of the detailed Civil Works design (fundation, reinforcement, framework, etc.) and of the detailed arrangement of piping and fittings.

Package 3: Wastewater Treatment Plant

For the WWTP, the **D&B contract** is again the most adapted procedure, but the question can be raised to add an O&M period (DBO procedure).

For the D&B part, it is also recommended to impose a preliminary design, so that the choice of the process, the main design criteria and the general layout remain fully controlled by the Employer - the Contractor being responsible for the detailed design and taking over the risk on performances and quantities.

The subcontracting of the O&M for a long period of time must be considered in line with the potential offer. The fact is that no large international company, specialized in O&M of wastewater facilities, are currently active in Moldova. Given the small size of the Soroca project, and the limited turn over to be expected for an O&M service, it is very unlikely that it would interest international operators.

Then the risk with a DBO procedure would be to get offers from D&B contractors only, which would have set up a team of freelance operators for the O&M period, but without all the background in plant operation and maintenance (centralized technical support department, for instance) which make this kind of contract really profitable for the Employer.

The interest of adding an O&M period also depends on the selected process.

- **Trickling filters (or equivalent):** The trickling filters are considered easy to operate, with few mechanical equipment to maintain; an O&M contract would not bring any significant advantage;
- **Activated sludge:** In this case, it is much more important to have on site a skilled process specialist to monitor the process parameters (sludge age, MLSS concentration, etc). The activated sludge also involves more electromechanical equipment (large blowers for instance) and is more demanding in terms of maintenance. Therefore, an O&M contract period is more relevant in this latter case

One major stake of this project will be the taking over of the new plant by the Employer and its sustainable operation and maintenance.

A DBO procedure would be a possible solution to insure these objectives, but it is very unlikely that, given the size of the project and the state of the market for O&M of WWTP, this solution actually meets the expectations.

In addition, if the process Imhof tank + trickling filters is eventually selected (as it is recommended), the real advantage of a full O&M contract is questionable.

Another solution, much more adapted to the situation of Soroca, would be to have a **D&B contract, with strong requirements in terms of training and know-how transfer**. For instance, the inclusion of a **process specialist** and a **maintenance engineer** during a 2-years technical assistance could be a satisfactory solution.

10.3.3. Conclusion

The recommended procurement strategy is summarized below.

Table 56: Recommended procurement strategy for Soroca Sanitation Project

Package	Procurement procedure	Design level included in the scope of the PIU
1. Gravity and pressure pipes	D&B contract	Preliminary design Technical specifications of the pipes
2. Pumping stations	D&B contract	Basic design Technical specifications
3. WWTP	D&B + 2 years of technical assistance to O&M	Basic design Technical specifications Schedule of performance guarantees
4. Electrical line	D&B	Basic design Technical specifications

10.3.4. Time Schedule

A tentative time schedule for the implementation phase of the short-term measures is proposed hereafter.

Item / Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Q1	Q2	Q3	Q4	Q5	Q6
Selection of the PIU consultant																														
Preliminary studies																														
Package 1 - Network																														
Preparation of tender																														
Contractor selection																														
Detailed design																														
Construction																														
Package 2 - Pumping stations																														
Preparation of tender																														
Contractor selection																														
Detailed design																														
Construction																														
Commissioning and operation																														
Package 3 - WWTP																														
Preparation of tender																														
Contractor selection																														
Detailed design																														
Construction																														
Commissioning and operation																														
Package 4 - Electrical connection																														
Preparation of tender																														
Contractor selection																														
Detailed design																														
Construction																														

11. Financial Analysis and Impact on the Tariffs

The investment plan and the recommended new system will have an important impact on Apa Canal, its organisation, its operation and its expenditures. This section details the impact of the proposed investments on the sanitation tariffs in Soroca.

11.1. SA "Regia Apa Canal Soroca" Financial analysis of existing Sanitation activities

The following section will look into the current financial situation of SA "Regia Apa Canal Soroca" in terms of sanitation revenue and costs.

11.1.1. Sanitation tariffs

The current tariffs for water and sanitation services in Soroca are as follows:

SA„Regia Apă-Canal Soroca"

Tariffs for the provision of water supply and sewerage service

Nr	Name and date of the document	Tarriffs (lei/m³)								
		Population		Budgetary institutions		Economical agents		Self-employed economical agents	others	
		Water	Sewerage	Water	Sewerage	Water	Sewerage	Sewerage	Water	Sewerage
1	Decision of the city council nr.4/8 date 15.09.2011; Decision of the city council nr.22/2 din 11.07.2017	15,26	1,60		3,30	35,20		51,80-Alfa Nistru SA; Comtiras SRL; Sorvismax SRL 38,50-Customs office		
2	Decision of the city council nr.26/10 date 06.03.2013			40,94			23,0			
3	Decision of the city council nr.7/4 date 10.11.2011								32,0-District Hospital 13,67-PA(public association) Soarta	3,0-District Hospital 6,84-PA (public association) Soarta

Administrator of SA Regia Apă Canal Soroca Ojog Mihail

Figure 114: Current applicable tariffs per customer category in Soroca

Cross-subsidization in current tariff

We note that the wastewater tariff varies significantly between customer categories as **Economic agents are billed 14 times more than domestic agents**. We note that this follows the principle of cross-subsidization between customer categories but, although it is quite legitimate for large industrials which discharge a heavily polluted wastewater, it is not fair to the average shop/restaurant which discharges a wastewater comparable in terms of pollution to the one of domestic or budgetary institutions.

In line with the national tariff methodology prepared by the National Energy Regulatory Agency (ANRE), the water and sanitation consumption tariff calculation is based on the full-cost recovery approach. The tariff should cover the following:

- Operational costs composed of basic and variable costs for water and sanitation;
- Infrastructure costs in the form of amortisation (for water and sanitation).

We note that, to date, tariffs cannot cover the cost of amortisation as the ownership of infrastructure assets has not yet been transferred to SA "Regia Apa Canal Soroca" due to the absence of legal ownership documentation. For the sanitation component, the impact of amortisation in cost-recovery is considered insignificant as most assets date back from the Soviet time and their current value is probably close to zero. This Feasibility Study will however take into consideration the amortisation cost for the new infrastructure (network rehabilitation/extension and the new WWTP).

As far as operational costs are concerned, in 2020, 83% of the total water and sanitation basic costs requested by the Utility to ANRE were approved and considered applicable for tariff. For 2020 sanitation costs specifically, **87% of the total cost coverage amount requested was approved by ANRE** with mainly "Operation and Maintenance costs" and "Administrative & Distribution costs" being cut down by half.

In addition to the consumption-based services, AC Soroca also provides a number of auxiliary services related to sanitation which fees are either regulated by ANRE (excl. VAT):

- **Connection fees:** regulated by ANRE (official announcement of 23/02/2021) at 69,44 MDL for both domestic and non-domestic customers;
- **Resiliation fee:** regulated by ANRE at 80,06 MDL;
- **Reconnection fees:** regulated by ANRE at 40.08 MDL;

or at the discretion of SA "Regia Apa Canal Soroca" (excl. VAT):

- **Emptying individual septic tank**: 376.26 MDL per trip within a distance of 7 km from the city;
- **Curing** : 440.49 MDL per trip within a distance of 7 km from the city.

11.1.2. Billing of wastewater services

The current computation wastewater tariff computation depends on the customer category :

- **Domestic customers**' wastewater bill is calculated applying the tariff to the volume of water consumed in the period as it is based on the assumption that domestic customers discharge 100% of their water consumption as wastewater;

- **Non-Domestic customers** :

    - **Institutions/budget** customers' wastewater bill follows the same principle as domestic customers;

    - **Economic agents**' wastewater bills had so far been calculated based on the assumptions that their wastewater discharge depends on their business process (typically between 50% and 90%). As such, economic agents are required to obtain Apele Moldovei's approval on their specific wastewater discharge ratio which then forms part of their contract and serves to compute the wastewater component of their monthly bill.

A recent amendment to the water bill was passed indicating that starting from 1st March 2021, wastewater billing of non-domestic customers would assume a discharge ratio of 100% which will contribute to the increase of wastewater revenues.

Cross-subsidization between customer categories is strongly influencing the current tariff but applying the same tariff to the small businesses and large industrials within the Economic agent customer category weighs down on the economy. The **principle of the "polluter pays"** is surely key to the definition of wastewater tariffs but the cost relative to treating effluents from small businesses (wastewater quality comparable to the domestic population) and large industrials (discharging highly polluting contaminants) cannot be compared. It is the entire wastewater tariff structure that should be rethought under the leadership of ANRE at national level.

However, the heavy structural cross-subsidization must be put in perspective with the wastewater billing computation method which allocates a partial discharge ratio to non-domestic customers. Moreover, the Utility reported that **a new tariff computation method was to be implemented in the course of 2021 whereby all wastewater customers would be charged based on an assumed discharged ratio of 100%**.

THE IMPACT OF NRW ON THE BILLING OF WASTEWATER SERVICES

The calculation of the wastewater bills is tied to the water consumption volume and therefore, the performance of water meters is central to the billing and recovery of wastewater service costs. The Utility's current NRW level is as high as at 39% (Indicators reported to ANRE for 2020) and while precise water balance data is not available, it is highly likely that a substantial part of the unbilled water can be attributed to "commercial losses" for the following reasons:

- Under-usage of the macro-zoning approach : a zoning of the network was installed with the objective of narrowing down on critical zones but the information collected from the zone meters do not seem to be analysed or used to develop a prioritised NRW reduction strategy;
- Undermetering : Meters are purchased by customers who therefore choose low quality types which have a tendency to get blocked and undercount;
- Customer database update : the customer database presents a number of connections without any consumption which are likely to be inactive which suggests that the customer database may not be up to date and that customers may also be receiving water and not be billed.

Improving the coverage of wastewater costs requires the reduction of NRW which should receive critical attention in the coming years.

11.1.3. CURRENT WASTEWATER REVENUE

The sanitation revenue billed and collected by SA "Regia Apa Canal Soroca" are composed of two main streams :

- **Revenue related to water consumption and wastewater collection** (volume-based) with tariffs regulated by ANRE;
- **Revenue related to auxiliary services** with tariffs either regulated by ANRE or at the discretion of the Utility.

According to the sales reported to ANRE, the SA "Regia Apa Canal Soroca" wastewater revenue over the past 3 years evolved as follows:

Table 57: SA "Regia Apa Canal Soroca" wastewater revenue and average tariff (2018 - 2020)

	2018	2019	2020
Utility Wastewater revenue (Lei/year)	2,609,500	2,871,400	2,803,700
Average tariff (Lei/m3)	**5,40**	**5,63**	**6,98**

The average tariff is quite high due to the weight of economic agents who are charged 14 times more than domestic customers.

Based on the data analysis from the past 3 years, it must be noted that while wastewater is mainly generated by domestic customers, it is economic agents which contribute to most of the wastewater revenue.

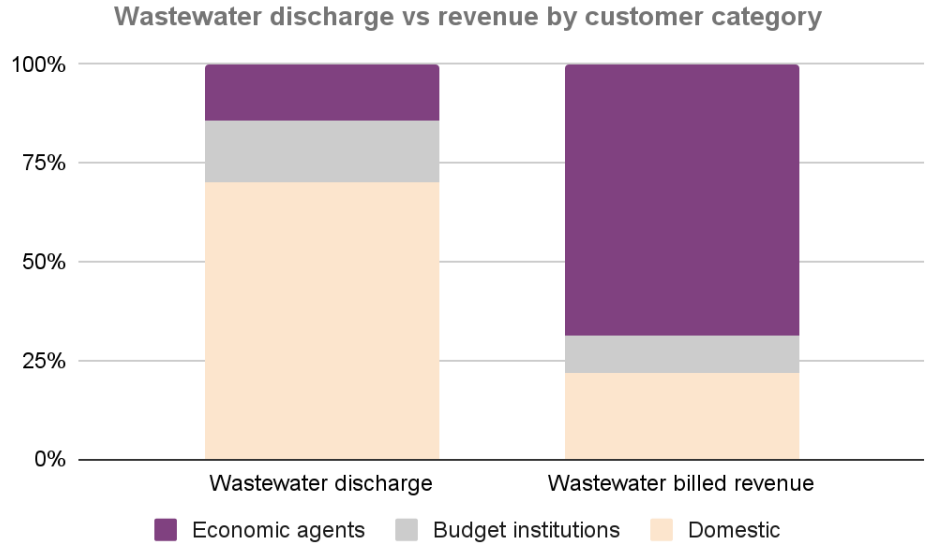


Figure 115: Current wastewater discharge and revenue by customer category

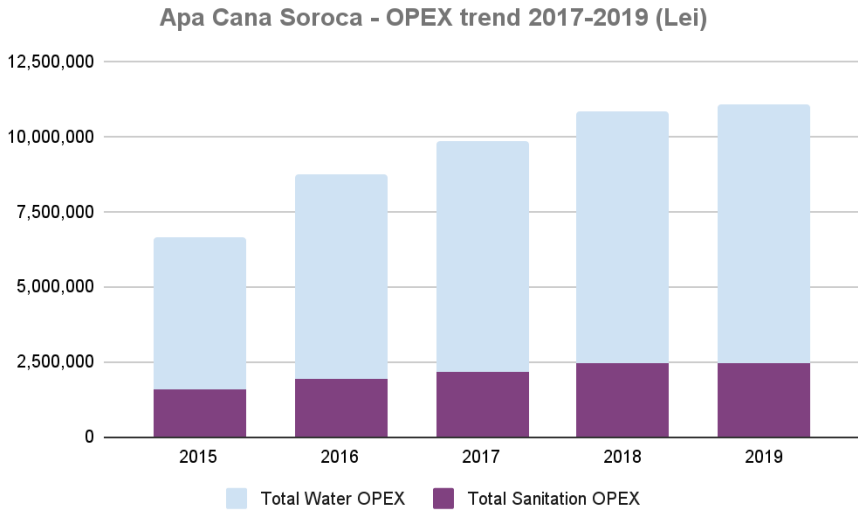
Economic agents must indeed be carefully managed as they discharge 15% of the wastewater currently collected by the utility (according to the utility's estimates) but represent 70% of the total wastewater revenue in Soroca. This application of the Pareto Law will be heightened with the new billing calculation method where all economic agents will be billed according to a 100% wastewater return ratio. As such, it is recommended that the utility strengthens the capacity of the commercial team dedicated to large customers in order to ensure they are billed correctly, in time and the corresponding revenue collected (customer support, targeted payment reminders, etc.).

11.1.4. Current Sanitation Costs in Soroca

Due to financial constraints, SA "Regia Apa Canal Soroca" has not been able to invest into its sanitation infrastructure in recent years, hence, there is no recent existing data on infrastructure costs and the analysis of the current situation will focus on Operational Costs only (OPEX).

The following cost analysis is based on the cost computation sheets prepared by SA "Regia Apa Canal Soroca" for 2015-2019 which was submitted to ANRE in 2020 as part of their tariff review request documentation.

Since 2015, **sanitation operational costs (OPEX) have increased by 53%** but remained within the **same proportion of total OPEX costs for water and sanitation (about 22%)**.



The sanitation OPEX costs are composed of several cost categories.

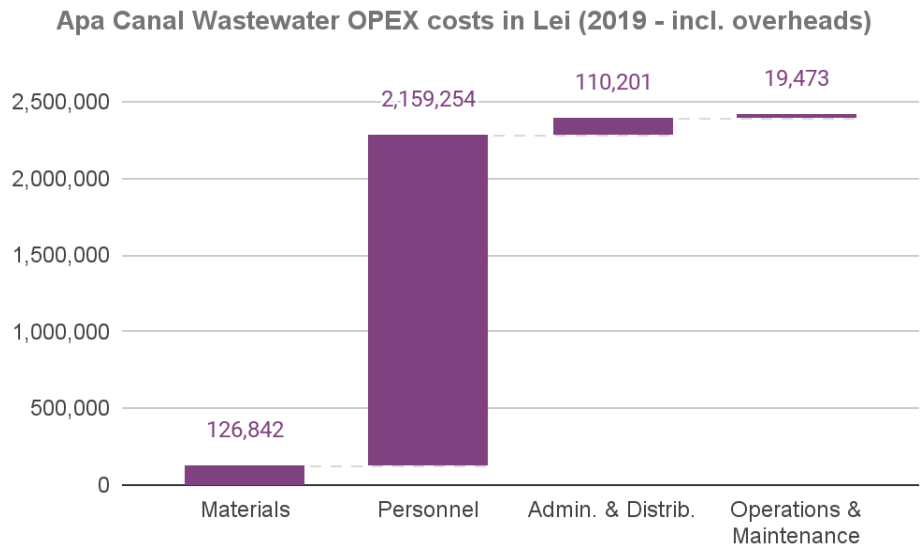


Figure 116: Wastewater OPEX Costs in Soroca (2019) including overheads

The following elements are worth noting:

- On average over the last 5 years, **personnel costs** have been accounting for **89% of total costs** for a team of 20 to 25 people. Over the last 3 years and with the arrival of the new Director, the sanitation team was rationalised and personnel costs **reduced by 13%**;
- **75% of the material costs is for the purchase of fuel** for the two flushing and septic pumper trucks;
- Due to the lack of financial resources, **operation and maintenance costs have been particularly low** (1% of total sanitation OPEX costs) which has led to the gradual degradation of the sewer network.

11.2. Impact of future recommendations on the cost structure

11.2.1. Impact on sanitation OPEX

The new infrastructure will substantially impact the cost of operations. The various OPEX costs have been projected using a number of assumptions based on existing data extracted from the Company as well as the consulting team's expertise as follows:

- **Fixed costs:**
  - **Staff** : assuming an average annual salary of 89,362 Lei/year in 2020 for the members of the O&M team based on existing data;
  - **Laboratory** : covering both regular basic in-house analyses as well as monthly compulsory analyses outsourced to a certified laboratory for about 75,000 Lei/year;
  - **Maintenance and repair** : in line with international standards, an annual assumption of 1% of WWTP and network corresponding CAPEX as well as 2% of pumping stations corresponding CAPEX was used;

- **Administrative** : in line with existing data from SA "Regia Apa Canal Soroca", an amount equivalent to 4,136 Lei/staff in 2020 was assumed for administrative costs.

- **Variable costs:**
  - **Energy, chemicals and sludge disposal**: estimated to be about 2.1 Lei/m^3 for the first phase of the WWTP/Pumping station construction (until 2035) and then increase to 3.1 Lei/m^3;

- **Costs dedicated to the septage vacuuming activity:**
  - **Fuel & maintenance of septage vacuum truck:** based on existing data from SA "Regia Apa Canal Soroca", a cost of about 100 Lei/m3 collected was assumed for the fuel and maintenance of the septage vacuum truck;
  - **Staff** : assuming an average annual salary of 89,362 Lei/year in 2020 for the driving team based on existing data.

The graph below illustrates the projected evolution of OPEX costs over the period.

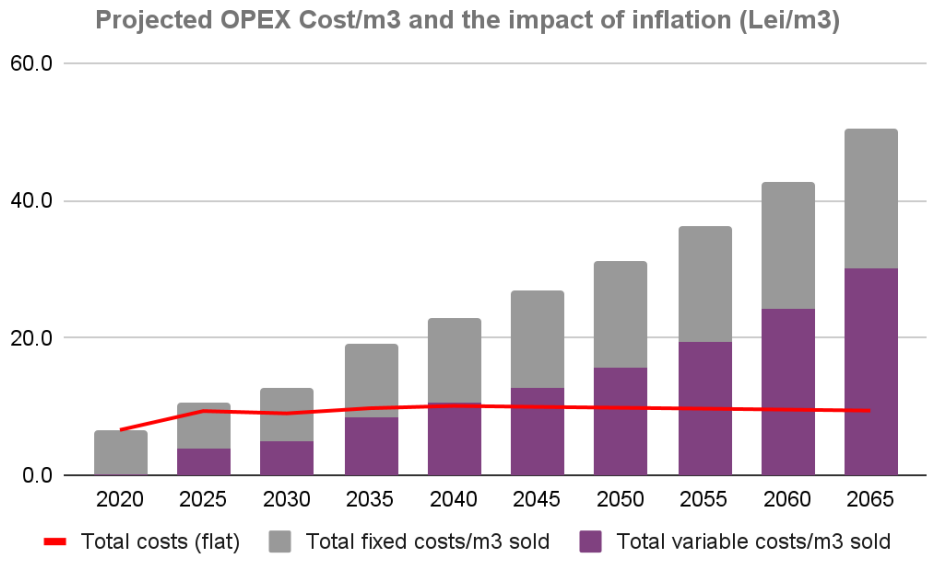


Figure 117: Projected wastewater OPEX Lei/m3 and the impact of inflation on the cost of service

The assumption of an annual inflation rate of 5% (based on an average of the previous years - National statistics) heavily impacts the operational cost of service (OPEX) projections and the tariff will need to be regularly adjusted to follow the inflation rate. **With inflation, the total OPEX cost of the centralised sewer system is expected to be multiplied by x4 by 2045 and by x7.5 by 2065**.

However, as illustrated on the above-graph (red line), if inflation is excluded, **flat COPEX costs only increase between 2025-2040 (multiplied by x1.5 by 2045 compared to 2020)**, mainly due to the operation of the new WWTP and pumping stations which generate variable costs (energy, chemicals, disposal, etc.). After 2040, economies of scale start to kick in and the flat OPEX cost/m3 starts to reduce over the remaining period.

It is worth noting that while the current cost of sanitation operations is currently **99% fixed costs** (salaries and basic maintenance as the wastewater collected is not processed), this ratio will gradually

reduce to about **40% fixed costs** by the end of the project period (2065). Reducing the proportion of fixed costs is necessary for the utility's long-term sustainability as it grows its customer base. As such, it is again emphasised that the utility should benefit from a capacity building programme to streamline its processes and improve its overall staff efficiency.

11.2.2. Cost recovery of centralised sanitation and impact on tariffs

According to the national legal framework, the water and sanitation tariffs should be set according to the principle of **full cost recovery** to enable the Company to operate and renew its infrastructure in the long-run. As such, tariffs should cover:

- The cost of operations (OPEX);
- The cost of infrastructure (CAPEX depreciation);
- The cost of the financing of infrastructure development (interest from loans).

As the newly developed assets will be property of the Local Public Authority (transmitted by delegation contract under the management of SA "Regia Apa-Canal Soroca"), depreciation should be in their accounting books and should therefore be computed in the tariff calculations. It must be noted that the depreciations of existing assets are currently not part of the tariff computation as their ownership has not been fully transferred to the utility. Existing assets are assumed fully depreciated today but it is necessary that the ownership of future assets be allocated to the Company to enable them to apply for full cost-recovery tariffs.

Similarly, the cost of infrastructure financing, if financed through loan, should be consolidated in the utility's costs and be covered by the tariff. Several scenarios have been studied in this feasibility study and these forecasts are based on **an assumption that only 50% of the mid/long-term CAPEX will be financed through loan and the rest will be financed through grants or government subsidies**. The budget of 11M USD allocated by the World Bank for the first phase of the investment plan has been projected as grant as is therefore not generating financial costs.

The table below presents the projected costs for the various components:

Table 58: Project cost recovery based on current tariff

	Unit	2020	2025	2035	2045	2065
OPEX cost (basic cost of service)	MLD/m3	6.6	10.5	18.7	26.4	49.6
Depreciation	MLD/m3		7.8	9.8	13.6	15.6
Financial cost	MLD/m3		0.0	2.8	7.5	10.8
Full cost of service	**MLD/m3**	**6.6**	**18.3**	**31.4**	**47.6**	**76.1**
2020 average tariff (flat)	MLD/m3	7.0	8.2	7.5	6.5	4.8
2020 average tariff (inflated)	MLD/m3	7.0	10.4	15.2	21.0	39.7
Basic cost coverage ratio (OPEX only)	**MLD/m3**	**106%**	**78%**	**40%**	**25%**	**10%**
Full cost coverage ratio	**MLD/m3**	**106%**	**45%**	**24%**	**14%**	**6%**

The average tariff/m3 has been computed and projected as a consolidation of the volumes discharged by the different customer categories and their respective current tariff. It must be highlighted that **the**

current average tariff (mainly due to the high commercial tariff) covers 106% of the basic cost of service (OPEX only). However, the projections clearly indicate that the current tariff (without inflation) **would only cover about 10% of the basic cost of service, and 6% of the full cost of service by 2045**. Consequently, it appears necessary to urgently increase the wastewater tariff in order to :

- cover the additional operational costs which will be generated by the new infrastructure;
- follow the relatively high inflation trend.

The graph below illustrates the projections for the cost recovery (basic and full) of the centralised sanitation activities within SA "Regia Apa Canal Soroca":

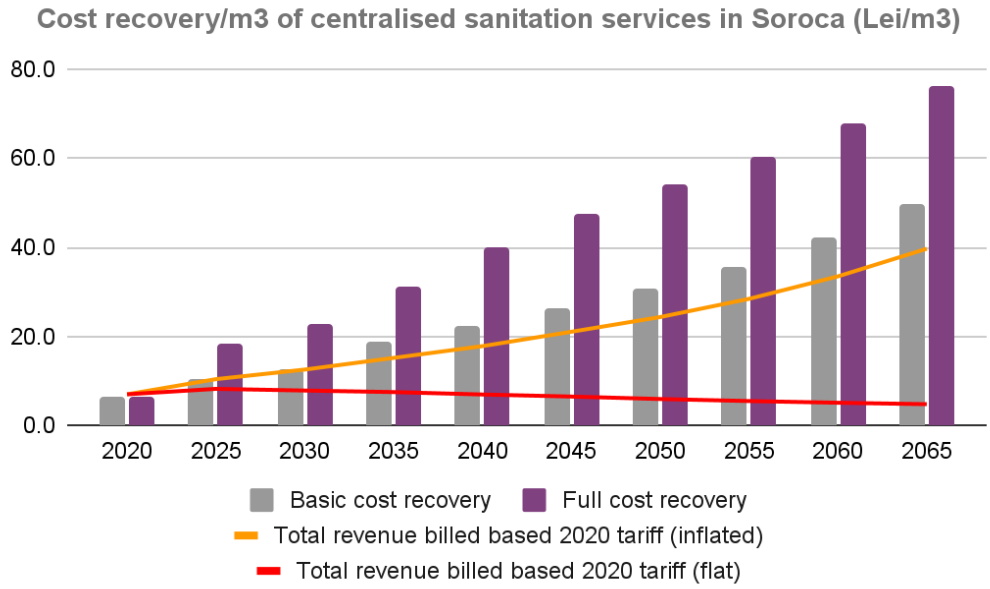


Figure 118: Projected cost recovery/m3 of centralised sanitation in Soroca (Lei/m3)

The above graph clearly illustrates the scissor effect of inflation which must be understood in order to put into perspective the tariff increment recommended in this study. Indeed, the graph clearly shows that **inflation is responsible for half of the cost increment**. As such, **if the average wastewater tariff increases in line with inflation, it would cover, by 2045 only 80% of the operational cost and 50% of the full cost of service respectively**.

IMPACT OF THE PROPOSED INVESTMENT ON THE TARIFF

If the proposed investment options are to be implemented and SA "Regia Apa Canal Soroca" is to be financially viable, **the 2020 tariff for centralised sanitation needs to be increased by:**

- **For basic cost recovery (OPEX only), today's tariff needs to be multiplied by X1.3 by 2025 and by x4 by 2045;**
- **For full cost recovery : x2.2 by 2025 and x7 by 2045.**

It must be highlighted that this study solely focuses on sanitation activities and the cost of service calculated above only covers the specific sanitation team and activities However, there are a number of support activities within SA “Regia Apa Canal Soroca” which are not directly dedicated to water or wastewater but need to be covered by the tariff as they indirectly contribute to the performance of water and sanitation services (e.g. commercial services, human resources, finance, information technology, etc.). When applying to ANRE for tariff reviews, SA “Regia Apa Canal Soroca” will, as per the approved calculated methodology, spread its overhead costs over its projected water and sanitation costs to apply for cost recovery tariffs that include the utility’s overhead.

11.2.3. Cost recovery of onsite sanitation and impact on tariffs

It is expected that a large number of the population in the coverage area, especially in the villages will remain with onsite sanitation solutions. SA “Regia Apa Canal Soroca” ‘s mandate to provide safe sanitation services also includes septage removal. In line with the assessment made on current practices (section 4.5.2), there is room for SA “Regia Apa Canal Soroca” to increase this activity. Making **better use of the existing functioning septage vacuum truck** is essential but a **second truck** has also been included in the second phase of the Investment plan in order to boost the utility’s capacity to respond to the market demand.

For projection purposes, it is assumed that SA “Regia Apa Canal Soroca” will **triple its collected septage by 2030 (purchase of a new truck and optimised use of the fleet)**. This assumption takes into account the current context and in particular the available volumes and the competitive environment within Soroca.

50% of the cost of the septage vacuuming activity are variable costs. The projected OPEX costs of decentralised sewer system for SA “Regia Apa Canal Soroca” include:

- Collection:
  - Staff costs with the 2 drivers;
  - Fuel and repair costs (about 47 Lei/m3 collected);
- Treatment
  - Contribution to the WWTP OPEX (with a corrective factor of 5 to account for the fact that the cost of treating septage is higher than treating wastewater).

The current fee applied to septage vacuuming depends on the size of the truck and was set at an average of 58 Lei/m3 in 2020. In 2020, the fee **only covers about 30% of the current OPEX cost for septage vacuuming. This remains stable over time as the OPEX costs are majoritarily variable (fuel and treatment contribution)**

In addition to following inflation, the current tariff will need to be multiplied by 3 to cover the operational cost and by 4.5 to cover the full cost of service.

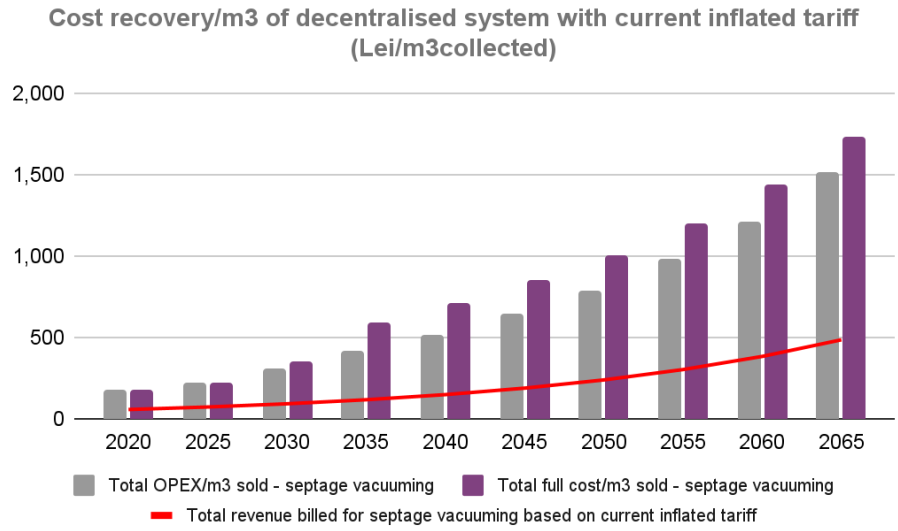


Figure 119: Projected cost recovery/m3 of decentralised sewer system in Soroca

For this activity to be streamlined and adequately managed by the utility, **the tariffs must be revised and increased to cover the cost of operations**. However, the **unlawful competition from illegal economic agents in Soroca presents a major problem** and enforcement of the legal framework on this aspect needs to be enhanced or all customers will go to the cheaper service provider.

It is interesting to compare the cost of onsite sanitation with centralised sewer system.

Table 59: Comparison of cost service for centralised and onsite sanitation

	Unit	2020	2025	2035	2045	2065
Centralised sewerage - Basic cost of service	MLD/m3	6.6	10.5	18.7	26.4	49.6
Centralised sewerage - Full cost of service	MLD/m3	6.6	18.3	31.4	47.6	76.1
Onsite sanitation - Basic cost of service	MLD/m3	182	224	418	643	1,511
Onsite sanitation - Full cost of service	MLD/m3	182	226	422	649	1,519
Average cost of service - Centralised (full cost recov.)	**MLD/month/ household**	**54.3**	**150.9**	**259.1**	**389.2**	**620.3**
Average domestic monthly cost of service - Onsite sanitation (full cost recov.)	**MLD/month/ household**	**5.8**	**7.2**	**13.4**	**20.6**	**48.1**

The above table shows that all costs included, **onsite sanitation is still about 10 times cheaper than centralised sanitation**. However, with the objective of protecting groundwater and the environment, as well as recovering the cost of the new infrastructure investment, customers must be encouraged to switch to the centralised sewer system whenever possible. In challenging socio-economic context, the following elements are **prerequisites for the success of the project**:

- **a change of the legal framework** to make it compulsory for customers to connect if the sewer network passes in reasonable distance from their plot location;

- **the financing of individual connection through grants** in order to avoid the extra cost discouraging customers;
- **a review of the centralized sewer system** to propose further cross-subsidization between customer categories and reduce the average domestic bills.

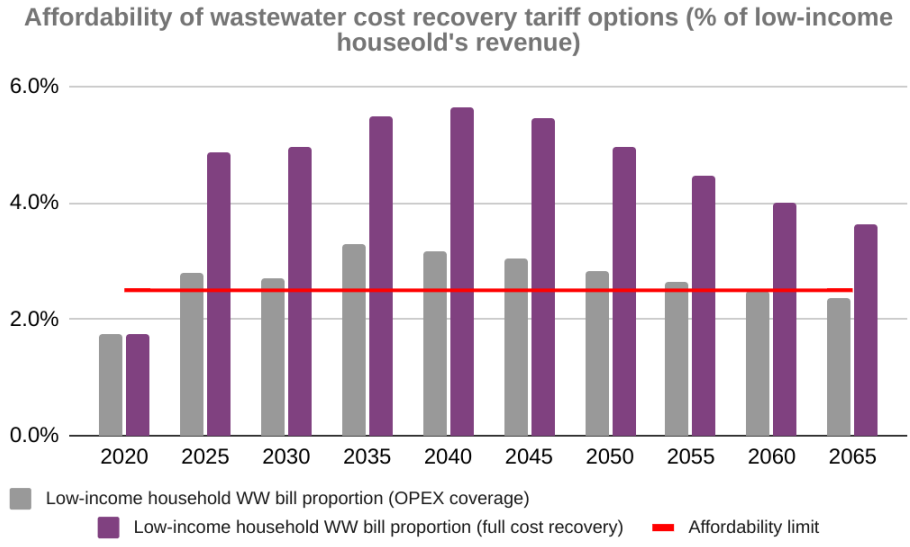
11.2.4. TARIFF REVIEW AND SERVICE AFFORDABILITY

According to the National Strategy and international best practices, the customers' ability to pay shall be taken into account and national guidelines refer to the necessity of ensuring the water and sanitation bill does not surpass 3-5% of the average household income.

In general, the current Moldovan legislation does not provide requirements for social affordability of water and wastewater services. Nevertheless, such requirements need to be developed in particular as part of the set of criteria used by ANRE to approve tariffs. Indeed and in line with the UN Sustainable Development Goals[29], if "universal and equitable access to safe and affordable drinking water and sanitation for all" is to be achieved by 2030, supporting low-income households in accessing this primary service is key. Whether a social tariff is setup, financed through a cross-subsidization system between customer categories or services to low-income families are directly subsidized through public financing, the issue needs to be addressed at national level.

In Soroca, **today's domestic water + wastewater average monthly bill (excluding connection fees) amounts to 15.26 Lei/m3 which corresponds to 4.5% of the average poorest household income[30] and is within standards**.

With the new infrastructure, the inevitable increase of the cost of wastewater service in Soroca brings concerns with regards to affordability. The graph below projects the wastewater cost-recovery tariff affordability over the period:



**Assuming low-income households' revenue follow the inflation trend*

Figure 120: Projected affordability of wastewater cost recovery tariff options

[29] *https://www.un.org/sustainabledevelopment/water-and-sanitation/*
[30] *Assuming an average household income of the poorest residents in rural areas of 1548.8 MLD/month/capita (source: "Improvement of water supply in the district of Soroca: financial Model findings" presentation, WB 2020)*

The above graph shows that, if the revenue of low income households follows the inflation trend, an **average tariff set for basic cost recovery (OPEX only) remains close to the affordability ceiling**. As projections are done with average costs, a dedicated tariff study could easily ensure that the domestic tariff is below the affordability ceiling by allocating a higher tariff to economic agents (as is already the case).

However, an **average tariff set for full cost recovery is rather far above the affordability limit.** In that case, two options could be explored in a subsequent tariff study :

- **A specific tariff is set for low-income households** which can be identified from the City social records (6% of the Soroca population depends on social assistance[31]) and subsidised from the Municipal budget as part of a social support programme. Based on our experience of similar projects, this option is the most acceptable and easier to implement in the short-run;

A FURTHER TARIFF STUDY TO ACCOUNT THE AFFORDABILITY

For the purpose of this project and sanitation tariff projections, conclusions were made based on an average tariff but it is highly recommended that **a future specific tariff study looks into the setup of a social tariff for low-income households**.

- The **cross-subsidization between customer categories** could be maximised with the cost of service heavily borne by non-domestic customers but this presents a risk of acceptability from the city's economic agents;
- **Investments should primarily be financed through grants** and loans paid out of the national budget without directly weighing on the population of Soroca, including connection costs to reduce the opportunity cost of connection for low-income households and lighten the average cost recovery tariff.

[31] *SA "Regia Apa Canal Soroca"'s reporting to ANRE, 2019*

12. ANNEXES

1. Manhole Forms for Flow and Wastewater Quality Measurement Campaign
2. Wastewater Quality in Soroca 2018 - 2021
3. Fact Sheet Industries
4. Photographic Report of WWTP Potential Sites
5. NPV Comparison for Plots and NPV Comparison for Technologies
6. Individual Sewerage Connections
7. Cost Assumptions
8. Plans
   - Soroca wastewater network current situation
   - Soroca customer spatial repartition current situation
   - WWTP Preliminary Layout
   - WWTP Preliminary Hydraulic Profile

12.1. Manhole Forms for Flow and Wastewater Quality Measurement Campaign

MANHOLE FORM ID: **SOROCA**

Catchment : 1 Visit Date : **07-15.06.2021** Install Date : **07-06-2021**
Street : Alhionie Un-Install Date : **15-06-2021**

Environment

Characteristics

X = 48°09'44.278"
Y = 28°18'15.493"
(in WGS-84 UTM)
Ground = 87.00 m
Invert = 84.73 m
(read on the planchettes of ALRCMD)
Depth = 2.69 m
(measured on site with a ruler)

Equipment Installation

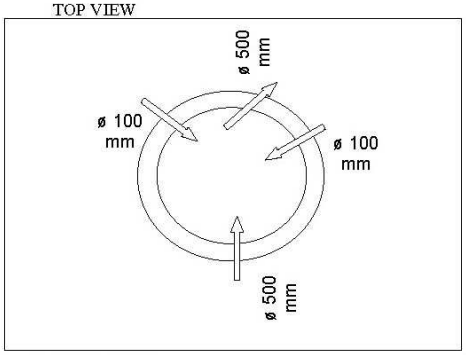
(SENSORS: (V) 38608 & (H) #16020)
Type: MainFLO NS: 65104
Heigth: 97.6 mm
Speed: 0.29 m/s
Flow: 7.71 L/s
INITIAL QUALITY OF SIGNAL: 77%

	Material	Type	Dimension	Observation
Manhole	Concrete	Circular	ø 1500 mm	Clean, No Deposits
Main Pipe	Concrete	Circular	ø 500 mm	Slightly Curved in the Downstream Section
Main Pipe	PVC	Circular	ø 100 mm	private connection
Other Pipe	PVC	Circular	ø 100 mm	private connection

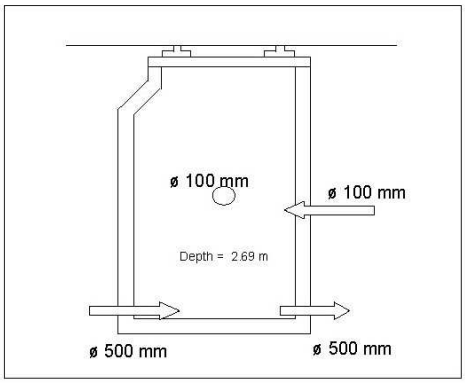
Remarks/Comments : Debris very often adhered to the sensor.

Layout of the Manhole

TOP VIEW



PROFILE VIEW



GIS Extract

Picture of the Manhole

MANHOLE FORM SAMPLER AS950 — ID: SOROCA

Catchment : ---------- **Visit Date :** 07-14.06.2021 **Install Date :** 07/06/2021
Street : Alhionie **Un-Install Date :** 14/06/2021

Environment

Characteristics

X = 48°09'45.570"
Y = 28°18'21.669"
(in WGS-84 UTM)

Ground = 78,00 m
Invert = 73,80 m
(read on the planchettes of ALRCMD)

Depth = 4,20 m
(measured on site with a ruler)

Equipment Installation

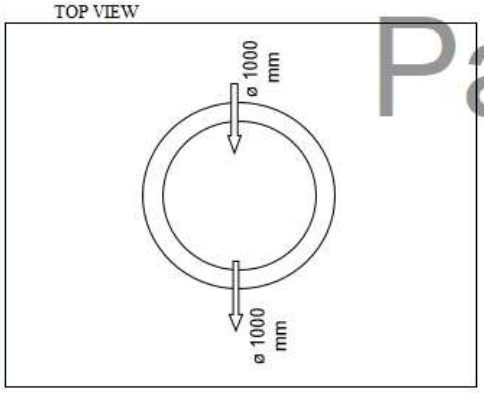
Sampler: AS-950
Sample type: composite 24 hours
Sampling schedule: one sample per hour, 24h
Sample volume: 200 ml
V for laboratory: 3 L
Sampler tube length: 7,5 m
D tube: 10 mm

	Material	Type	Dimension	Observation
Manhole	Concrete	Circular	ø 1500 mm	Not clean
Main Pipe	Concrete	Circular	ø 1000 mm	Deposits 40-50см

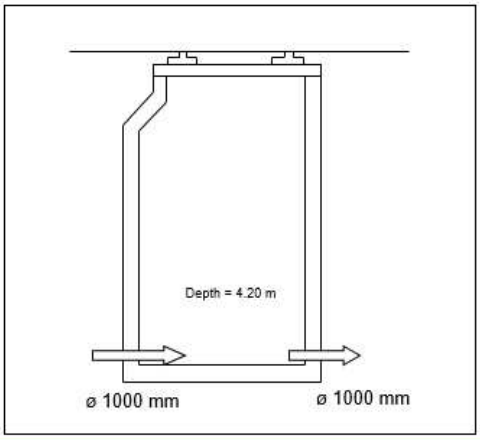
Remarks/Comments : in manhole H_2S, the filter clogged during the rain, from 7-11.06.2021, two or three times a day

Layout of the Manhole

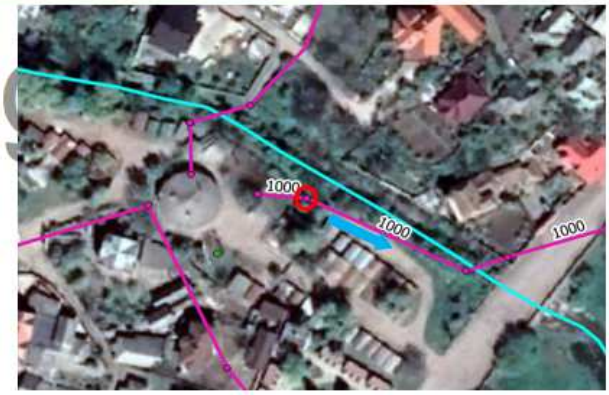
TOP VIEW



PROFILE VIEW



GIS Extract



Picture of the Manhole

12.2. WASTEWATER QUALITY IN SOROCA 2018 - 2021

Rezultatele analizelor probelor de apă efectuate la deversarea în r.Nistru de la SPC şi SPS a SA"Regia Apă-Canal" Soroca pe parcursul a.2018 conform contractului № 070043 din 22.03.2018

№	Data	Locul prelevării	pH	Subs. susp.	CCO	CBO_5	O_2	NH_4^+	NO_2^-	NO_3^-	Prod. petr.	Rez. fix.	CT	Dur.
1	27.03.18	devîrsare de la SPC	6,78	229,0	339,1	151,2		32,35	0,385	4,6		1474,0	297,0	9,3
		devârsare de la SPS	6,93	161,0	239,4	116,2		24,13	0,305	5,0		1250,0	251,1	8,6
2	20.06.18	devîrsare de la SPC	6,7	224,0	361,0	170,0		29,06	0,374	4,2		1504,0	330,2	9,8
		devârsare de la SPS	6,98	173,0	210,6	90,3		21,93	0,32	4,7		1335,0	287,6	8,7
3	18.09.18	devîrsare de la SPC	6,63	244,0	539,3	228,8		40,03	0,4	4,4		1548,0	400,6	10,4
		devârsare de la SPS	6,88	219,0	359,5	143,5		30,16	0,362	5,0		1370,0	351,0	9,8
4	18.12.18	devîrsare de la SPC	6,68	258,0	499,7	225,3		40,57	0,387	3,8		1582,0	393,0	10,3
		devârsare de la SPS	6,9	212,0	339,8	130,9		29,61	0,32	4,1		1373,0	332,8	9,6
	media 2018	**devîrsare de la SPC**	**6,7**	**238,8**	**434,8**	**193,8**		**35,5**	**0,387**	**4,3**		**1527,0**	**355,2**	**10,0**
		devârsare de la SPS	**6,92**	**191,3**	**287,3**	**120,2**		**26,46**	**0,327**	**4,7**		**1332,0**	**305,6**	**9,2**
		CMA	**6,8-8,5**	**35,0**	**125,0**	**25,0**		**2,0**				**1500,0**	**300,0**	

ex: V.Şamrai

Rezultatele analizelor probelor de apă efectuate la deversarea în r.Nistru de la SPC şi SPS a SA"Regia Apă-Canal" Soroca pe parcursul a.2019 conform contractului № 046 din 15.03.19

№	Data	Locul prelevării	pH	Subs. susp. mg/dm³	CCO mg/dm³	CBO_5 mgO_2/l	O_2 mgO_2/l	NH_4^+ mg/dm³	NO_2^- mg/dm³	NO_3^- mg/dm³	Prod. petr. mg/dm³	Rez. fix. mg/dm³	CT mg/dm³	Dur. mg/dm³
1	20.03.19	devîrsare de la SPC	6,33	236,0	340,9	169,5		33,95	abs	abs		1497,0	322,2	10,3
		devîrsare de la SPS	6,48	219,0	481,3	200,3		38,23	abs	abs		1475,0	343,4	9,8
2	22.05.19	devîrsare de la SPC	6,38	274,0	481,3	196,0		38,8	abs	abs		1500,0	362,1	9,8
		devîrsare de la SPS	6,53	245,0	361,0	141,5		26,4	abs	abs		1456,0	323,1	9,5
3	9.09.19	devîrsare de la SPC	6,38	250,0	441,2	188,7		32,87	0,411	3,7		1544,0	294,3	9,8
		devîrsare de la SPS	6,73	199,0	401,1	182,1		29,1	0,372	4,4		1422,0	290,7	8,9
4	25.11.19	devîrsare de la SPC	6,4	323,0	538,5	235,3		31,79	0,372	2,3		1637,0	311,6	9,5
		devîrsare de la SPS	6,53	274,0	398,9	191,9		28,56	0,321	3,1		1579,0	286,8	9,2
	media 2019	**devîrsare de la SPC**	**6,37**	**270,8**	**450,5**	**197,4**		**34,35**	**0,392**	**3,0**		**1544,5**	**322,6**	**9,9**
		devîrsare de la SPS	**6,57**	**234,3**	**410,6**	**179,0**		**30,57**	**0,347**	**3,8**		**1483,0**	**311,0**	**9,4**
		CMA	**6,5-8,5**	**35,0**	**125,0**	**25,0**		**2,0**				**1500,0**	**300,0**	

ex: V.Şamrai

AGENŢIA DE MEDIU NORD

Rezultatele analizelor probelor de apă efectuate la deversarea în r.Nistru de la SPC şi SPS a SA"Regia Apă-Canal" Soroca pe parcursul a.2021 conform contractului № 101 din 15.02.2021

№	Data	Locul prelevării	pH	Subs. susp. mg/dm³	CCO mg/dm³	CBO_5 mgO_2/l	O_2 mgO_2/l	NH_4^+ mg/dm³	NO_2 mg/dm³	NO_3 mg/dm³	Prod. petr. mg/dm³	Rez. fix. mg/dm³	CT mg/dm³	Dur. mg/dm³
1	31.03.2021	devîrsare de la SPC	6,48	253,0	560,7	219,7		35,95	0,41	3,1		1366,0	276,5	9,2
		devârsare de la SPS	6,7	219,0	420,5	175,8		28,43	0,383	3,9		1261,0	269,4	8,9
2		devîrsare de la SPC												
		devârsare de la SPS												

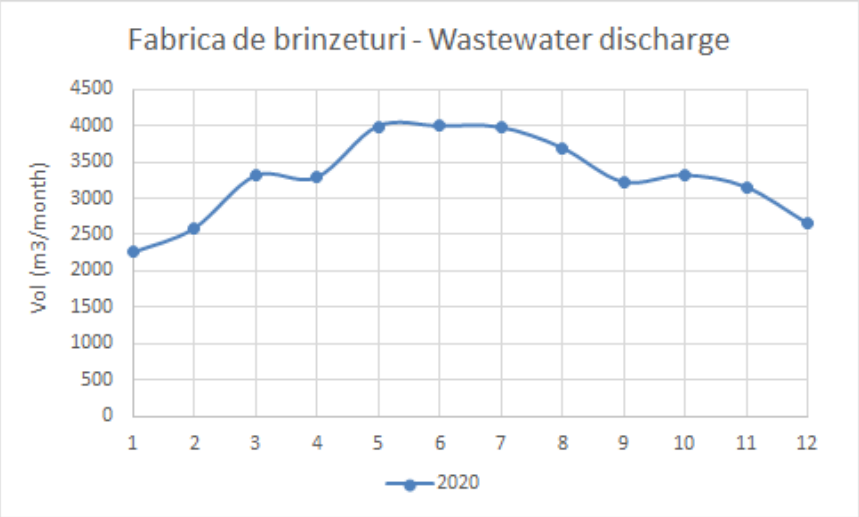
Rezultatele analizelor probelor de apă efectuate la deversarea în r.Nistru de la SPC şi SPS a SA"Regia Apă-Canal" Soroca pe parcursul a.2020 conform contractului № 95 din 18.03.2020

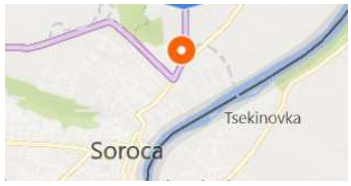
№	Data	Locul prelevării	pH	Subs. susp. mg/dm³	CCO mg/dm³	CBO_5 mgO_2/l	O_2 mgO_2/l	NH_4^+ mg/dm³	NO_2 mg/dm³	NO_3 mg/dm³	Prod. petr. mg/dm³	Rez. fix. mg/dm³	CT mg/dm³	Dur. mg/dm³
1	26.05.2020	devîrsare de la SPC	6,43	190,0	400,5	175,8		30,98	0,351	2,5		1256,0	247,9	9,1
		devârsare de la SPS	6,6	177,0	340,5	154,2		26,09	0,311	3,6		1226,0	233,7	9,4
2	7.07.2020	devîrsare de la SPC	6,68	232,0	499,4	191,3		33,7	0,351	3,2		1376,0	276,9	8,9
		devârsare de la SPS	6,53	210,0	379,5	169,3		28,81	0,297	3,5		1358,0	266,3	8,6
3	8.09.2020	devîrsare de la SPC	6,4	256,0	420,5	188,4		29,89	0,419	4,1		1398,0	304,5	9,1
		devârsare de la SPS	6,58	219,0	360,8	165,7		23,37	0,365	4,3		1384,0	279,7	8,9
4	17.11.2020	devîrsare de la SPC	6,53	339,0	521,0	216,7		32,2	0,5	3,9		1433,0	304,9	9,0
		devârsare de la SPS	6,6	254,0	400,8	185,7		29,89	0,392	4,4		1369,0	287,2	9,2
	media 2020	**devîrsare de la SPC**	**6,51**	**254,3**	**460,4**	**193,1**		**32,2**	**0,405**	**3,4**		**1365,8**	**283,6**	**9,0**
		devârsare de la SPS	**6,6**	**215,0**	**370,4**	**168,7**		**27,04**	**0,341**	**4,0**		**1334,3**	**266,7**	**9,0**
		CMA	**6,8-8,5**	**35,0**	**125,0**	**25,0**		**2,0**				**1500,0**	**300,0**	

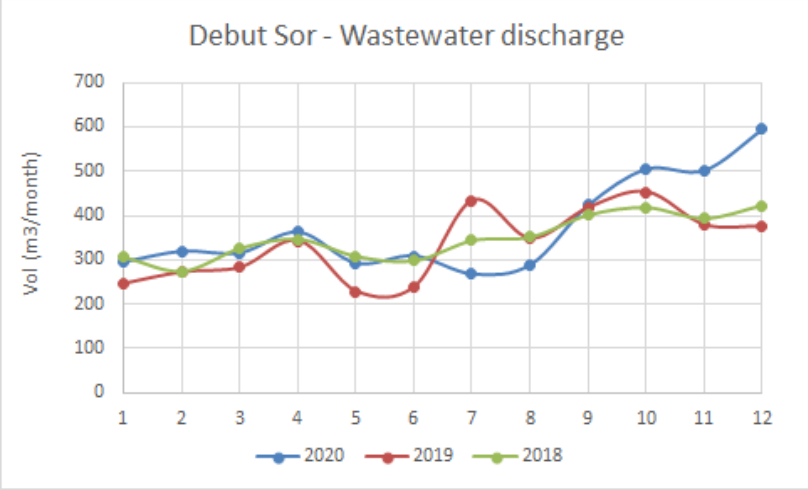
12.3. Fact Sheet Industries

1. Fabrica de brînzeturi din Soroca" SA (Alba) - dairy industry
2. Alfa-Nistru SA - Canned vegetable and fruits
3. Debut-Sor SRL - Production of sausages
4. Uniform CSM - Textile production (sport clothes)
5. Nou Stil - Textile production (professional clothes, cars upholstery)
6. Ermo group - Textile production - jackets

Name	FACT SHEET ÎM ”Fabrica de brînzeturi din Soroca” SA (Alba)
Activity	Production of dairy products: cheese, milk, sour cream, kefir, butter and yoghurt drinks (Yoli).
Location	Industrial area "Soroca Nouă" , 48.17945794596075, 28.31369345143885 Stefan cel Mare street, 133 SOROCA
Production	Approx. 120 people According to the company webpage the capacity of production is: - Fresh dairy products: 80 tons/day - Hard cheese: 7 tons/day - 25 collected trucks of milk per day Seasonal production: peak season in May – September
Water source	Apa Canal water supply
Water consumption	Average = 167 m3/day ; peak = 190 m3/day; Yearly average = 46 300 - 56 000 m3/year
Water usages	Cooling system (20%), production (10%), washing, cleaning, rinsing

Wastewater discharge	One discharge point into the municipal sewerage network Wastewater accounts for 70% of water consumption ~32,400 - 40,000 m3/y 
Wastewater characterisation	Analyses are performed twice a year by a national/regional laboratory. No information is given of wastewater quality
Pre-treatment facilities	Not existing
Forecast	Depends on the availability of milk in the region

<table>
<tr><th>Name</th><th>FACT SHEET Alfa-Nistru SA</th></tr>
<tr><td>Activity</td><td>Production of canned vegetables and fruits, juices, concentrates
(Green beans, maiz, cucumber, tomatoes, apples, etc.)</td></tr>
<tr><td>Location</td><td>Industrial area "Soroca Nouă"
48,17744, 28,31391
  </td></tr>
<tr><td>Production</td><td>Approx. 150 people in 3 shifts
Seasonal production, mainly from May to November (agricultural season)
Mainly international market</td></tr>
<tr><td>Water source</td><td>Own well, internal laboratory to control water quality</td></tr>
<tr><td>Water consumption</td><td>Approx. 28,000 m3/year</td></tr>
<tr><td>Water usages</td><td>Cooling system (29%), production (20%), washing of raw vegetables, rinsing of cans</td></tr>
<tr><td>Wastewater discharge</td><td>One discharge point into the municipal sewerage network
Wastewater accounts for 51% of water consumption ~14,000 m3/year</td></tr>
<tr><td>Wastewater characterisation</td><td>Analyses are performed by Agentia du Nord before and after pretreatment four times a year (average results)
<table><tr><td>Parameter</td><td>Raw WW</td><td>Pre-treated</td></tr><tr><td>BOD (mg O2/l)</td><td>76,9</td><td>54,5</td></tr><tr><td>COD (mg/l)</td><td>170</td><td>115</td></tr><tr><td>TSS (mg/l)</td><td>168</td><td>70</td></tr><tr><td>TDS (mg/l)</td><td></td><td>794</td></tr></table></td></tr>
<tr><td>Pre-treatment facilities</td><td>Screening (2 mm) + Settling tanks
 </td></tr>
<tr><td>Forecast</td><td>Very dependent of the market fluctuations but also the agro-climatic conditions
Expected growth: +15% in 3 years</td></tr>
</table>

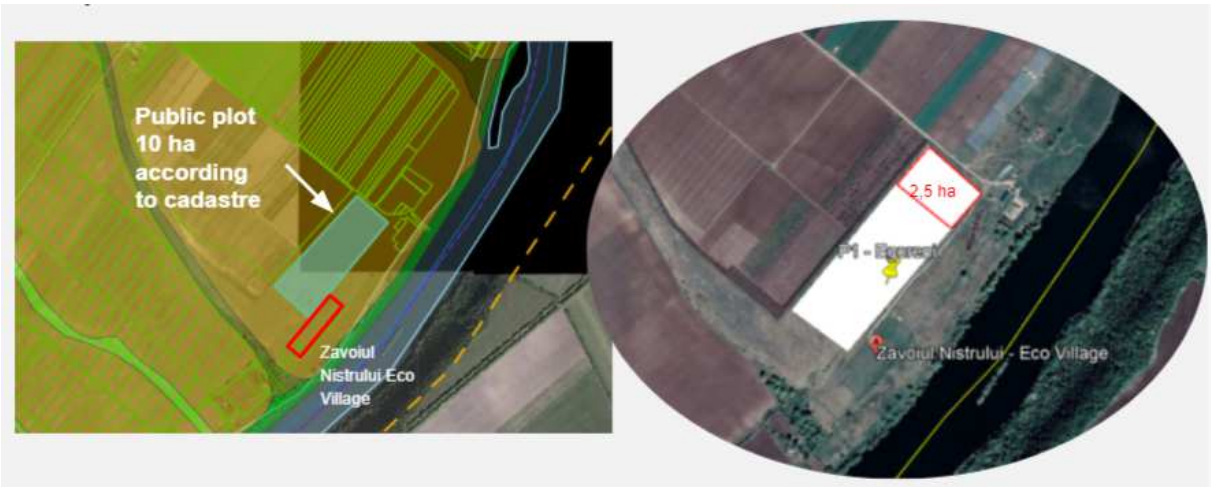
Name	FACT SHEET Debut-Sor SRL
Activity	Production of sausages
Location	Industrial area “Bujerauca”
Production	112 people National market
Water source	Drinking water Apa Canal
Water consumption	6000 m3/year (average from last 3 years)
Water usages	Production (30%), cleaning, cooling of products
Wastewater discharge	One discharge point into the municipal sewerage network Wastewater accounts for 70% of water consumption ~4,250 m3/year (average from last 3 years) 
Wastewater characterisation	Not known
Pre-treatment facilities	Grease trap (removal once per week with truck)
Forecast	Estimation of +10/15% increase of water consumption

Name	FACT SHEET Uniform CSM	FACT SHEET Nou Stil
Activity	Textile production (sport clothes)	Textile production (professional clothes, cars upholstery)
Location		
Production	250 people	1000 people 100% exports
Water source	Drinking water Apa Canal	Drinking water Apa Canal
Water consumption	Approx. 100 m3/month	Approx. 190 m3/month
Water usages	Mainly domestic use (workers), cleaning, iron	Mainly domestic use (workers), cleaning, iron
Wastewater discharge	One discharge point into the municipal sewerage network	One discharge point into the municipal sewerage network Wastewater accounts for 90% of water consumption ~ 170 m3/month
Wastewater characterisation	Not known, assimilable to domestic	Not known, assimilable to domestic
Pre-treatment facilities	No	No
Forecast	Unknown	Unknown

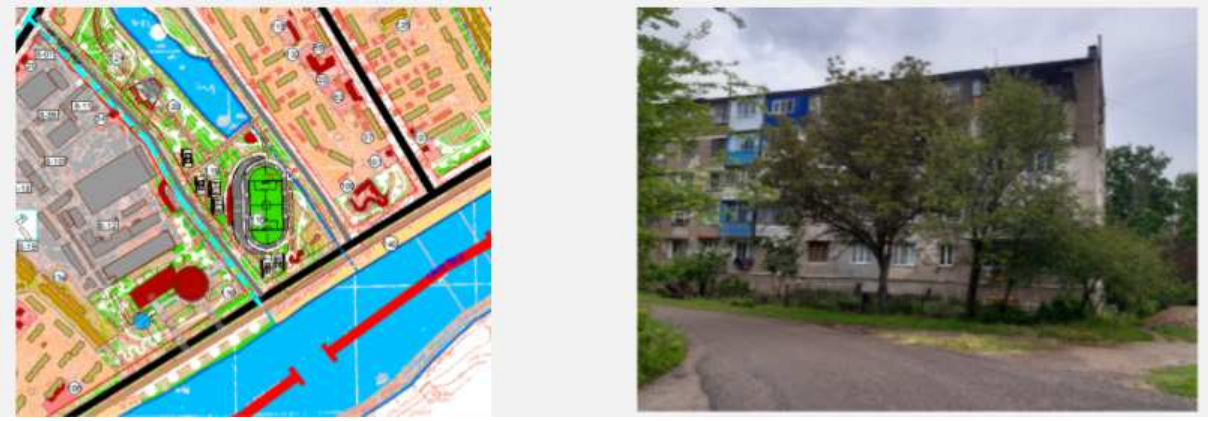
Name	FACT SHEET Ermo Group
Activity	Textile production (jackets)
Location	
Production	400 people
Water source	Drinking water Apa Canal
Water consumption	Approx. 200 m3/month
Water usages	Mainly domestic use (workers), cleaning, iron
Wastewater discharge	Watertight cesspit, emptied twice per week Wastewater accounts for 70% of water consumption ~ 140 m3/month
Wastewater characterisation	Not known, assimilable to domestic
Pre-treatment facilities	No
Forecast	Unknown

12.4. Photographic Report of WWTP Potential Sites

PLOT 1. EGORENI



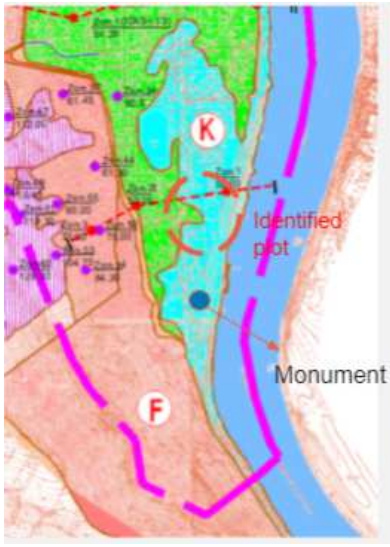
PLOT 2. NORTH PUMPING STATION



In the last Soroca General Urban Plan (2010), this plot was allocated to a Sport complex, but this is no longer in the plans of the Municipality.

Closest residential building ~100 m from plot boundaries

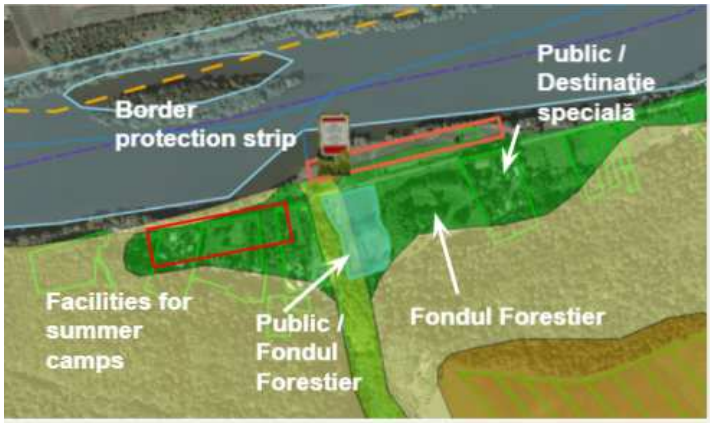
PLOT 3. SOUTH PUMPING STATION

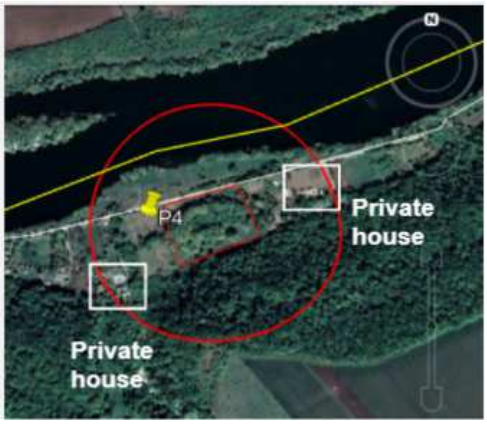


ZONA CONDIŢIONAL FAVORABILĂ PENTRU CONSTRUCŢII DIN CAUZA POSIBILITĂŢII INUNDĂRII CAUZATE DE VIITURILE PE R. NISTRU.
GEOMORFOLOGIC COINCIDE CU BAZA PANTEI DE DREAPTA ŞI LUNCA VĂII R. NISTRU ÎN LIMITA COTELOR 49.80-50.70M-
DUPĂ NECESITATE CONSTRUCŢIILE NOI POT FI AMPLASATE NUMAI PE TERASAMENTE, MAI SUS DE LINIA POSIBILELOR INUNDAŢII CU PROBABILITATEA 1%.

Flood area, new constructions are conditioned: they must be placed only on earthworks above the line of possible floods (level 49,8 - 50,2 m) with a probability of 1%

PLOT 4. FOREST



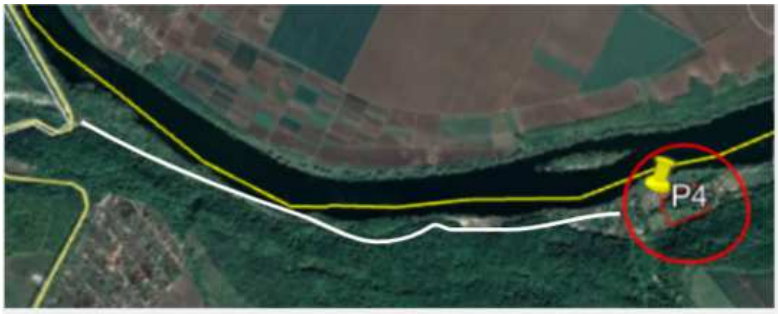


Private activities (Hanul Verde) > 200 m from plot boundary

Only two private houses in the buffer zone

Flat plot, but not subject to flooding

Other constraints: Forest clearing and preparation of the access road

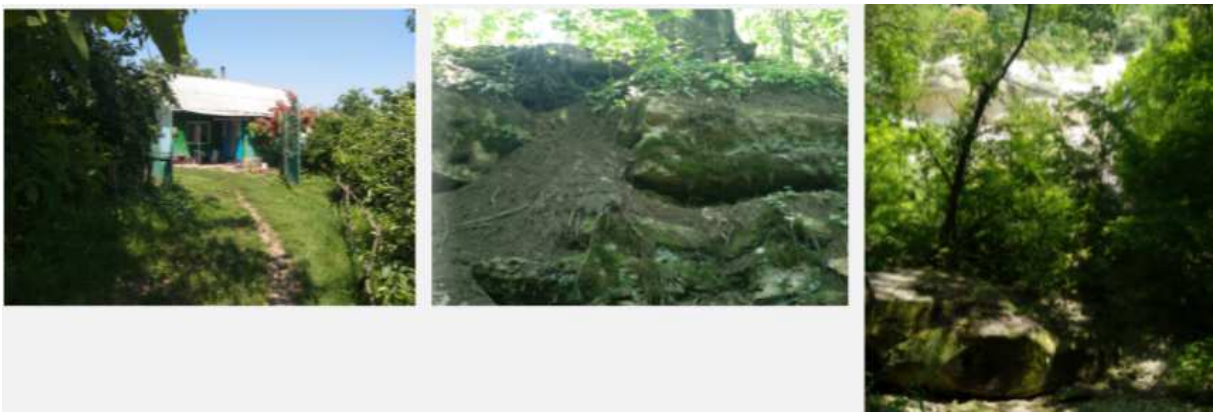


PLOT 5. LANDFILL

PLOT 6. ZASTINCA

Local constraints:

- Private house < 200 m
- Rocks
- Ravine Rîpa "Bechirov Iar" (46 ha): Protected area (geological and paleontological nature monument) managed by Moldsilva next to the plot
- Significant risk of landsliding



Ariile Naturale Protejate de Stat
Identification of the protected area in the register (orange) ≠ location of Bechirov ravin
Bechirov Iar
Plot

Road to
Zastinca?
Traces of landsliding in
the selected plot (in red)
are observed
Degraded soil
according to
cadastre

12.5. NPV Comparison for Plots and NPV Comparison for Technologies

NPV Plot 1: Egoreni with Trickling Filter (carbon removal) - Discount rate 5%

NPV Plot 2: NPS with Trickling Filter (carbon removal) - Discount rate 5%

NPV Plot 3: SPS with Trickling Filter (carbon removal) - Discount rate 5%

NPV Plot 4: Forest with Trickling Filter (carbon removal) - Discount rate 5%

NPV Plot 5: Landfill with Trickling Filter (carbon removal) - Discount rate 5%

NPV Plot 6: Zastinca with Trickling Filter (carbon removal) - Discount rate 5%

NPV Plot 4: Forest with Constructed Wetland - Discount rate 5%

NPV Plot 4: Forest with Trickling Filter with upgrade for nitrogen removal - Discount rate 5%

NPV Plot 4: Forest with Activated sludge Low Load - Discount rate 5%

P1: Egoreni Trickling Filter																						
Year	**2023**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**Total**
WWTP																							
Flow (m3/year)		815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	848 917	882 789	916 661	950 533	984 405	1 018 277	1 052 149	1 086 021	1 119 893	1 153 765	18 978 905
Load (kg BOD/year)		416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	440 738	464 645	488 553	512 460	536 368	560 275	584 183	608 090	631 998	655 905	10 068 343
Population equivalent		19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	20 125	21 217	22 308	23 400	24 492	25 583	26 675	27 767	28 858	29 950	459 742
Sludge production (ton/year)		924	924	924	924	924	924	924	924	924	924	924	977	1 030	1 083	1 136	1 189	1 242	1 295	1 348	1 401	1 454	22 318
Sludge production (m3/year)		840	840	840	840	840	840	840	840	840	840	840	888	936	985	1 033	1 081	1 129	1 177	1 225	1 274	1 322	20 289
Electricity (kWh/year)		197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	209 350	220 706	232 062	243 419	254 775	266 131	277 487	288 843	300 199	311 555	4 782 463
Pumping Stations																							
Electricity (kWh/year)		94 026	94 026	94 026	94 026	94 026	94 026	94 026	94 026	94 026	94 026	94 026	102 725	111 425	120 124	128 823	137 523	146 222	154 921	163 621	172 320	181 019	2 453 011
Capital Expenses																							
Central PS	173 000											30 000											
South PS	46 000																						
Pressure network	568 000																						
WWTP	6 325 000											2 300 000											
Total CAPEX	**7 112 000**											**2 330 000**											
Operational Expenses																							
Electricity WWTP (EUR/year)		17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	18 006	18 983	19 960	20 936	21 913	22 890	23 867	24 843	25 820	26 797	411 340
Electricity PS (EUR/year)		8 087	8 087	8 087	8 087	8 087	8 087	8 087	8 087	8 087	8 087	8 087	8 835	9 584	10 332	11 080	11 828	12 577	13 325	14 073	14 821	15 569	210 983
Sludge disposal (EUR/year)		8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 850	9 330	9 810	10 290	10 770	11 250	11 730	12 210	12 690	13 170	202 162
Maintenance and renewal (EUR/year)		55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	1 355 000
Staff (EUR/year)		56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	1 186 500
Total OPEX		**88 486**	**88 486**	**88 486**	**88 486**	**88 486**	**88 486**	**88 486**	**88 486**	**88 486**	**88 486**	**88 486**	**110 691**	**112 896**	**115 101**	**117 306**	**119 511**	**121 716**	**123 921**	**126 126**	**128 331**	**130 536**	**2 175 485**
Total annual cost	7 112 000	88 486	88 486	88 486	88 486	88 486	88 486	88 486	88 486	88 486	88 486	2 418 486	110 691	112 896	115 101	117 306	119 511	121 716	123 921	126 126	128 331	130 536	11 621 485
Net present value	7 112 000	80 260	76 438	72 798	69 331	66 030	62 885	59 891	57 039	54 323	51 736	1 346 704	58 702	57 020	55 366	53 739	52 142	50 576	49 040	47 536	46 064	44 624	9 624 242
	0,51	**EUR/m3**																					
	20,53	**EUR/pe**																					

P2: North Pumping Station Trickling Filter																						
Year	**2023**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**Total**
WWTP																							
Flow (m3/year)		815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	848 917	882 789	916 661	950 533	984 405	1 018 277	1 052 149	1 086 021	1 119 893	1 153 765	18 978 905
Load (kg BOD/year)		416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	440 738	464 645	488 553	512 460	536 368	560 275	584 183	608 090	631 998	655 905	10 068 343
Population equivalent		19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	20 125	21 217	22 308	23 400	24 492	25 583	26 675	27 767	28 858	29 950	459 742
Sludge production (ton/year)		924	924	924	924	924	924	924	924	924	924	924	977	1 030	1 083	1 136	1 189	1 242	1 295	1 348	1 401	1 454	22 318
Sludge production (m3/year)		840	840	840	840	840	840	840	840	840	840	840	888	936	985	1 033	1 081	1 129	1 177	1 225	1 274	1 322	20 289
Electricity (kWh/year)		197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	209 350	220 706	232 062	243 419	254 775	266 131	277 487	288 843	300 199	311 555	4 782 463
Pumping Stations																							
Electricity (kWh/year)		72 884	72 884	72 884	72 884	72 884	72 884	72 884	72 884	72 884	72 884	72 884	75 396	77 908	80 420	82 932	85 444	87 956	90 468	92 980	95 492	98 004	1 668 716
Capital Expenses																							
Central PS	138 000											20 000											
South PS	46 000																						
Pressure network	256 000																						
Gravity network	73 000																						
WWTP	6 325 000											2 300 000											
Total CAPEX	**6 838 000**											**2 320 000**											
Operational Expenses																							
Electricity WWTP (EUR/year)		17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	18 006	18 983	19 960	20 936	21 913	22 890	23 867	24 843	25 820	26 797	411 340
Electricity PS (EUR/year)		6 269	6 269	6 269	6 269	6 269	6 269	6 269	6 269	6 269	6 269	6 269	6 485	6 701	6 917	7 133	7 349	7 565	7 781	7 997	8 213	8 429	143 526
Sludge disposal (EUR/year)		8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 850	9 330	9 810	10 290	10 770	11 250	11 730	12 210	12 690	13 170	202 162
Maintenance and renewal (EUR/year)		55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	1 355 000
Staff (EUR/year)		56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	1 186 500
Total OPEX		**86 668**	**86 668**	**86 668**	**86 668**	**86 668**	**86 668**	**86 668**	**86 668**	**86 668**	**86 668**	**86 668**	**108 341**	**110 013**	**111 686**	**113 359**	**115 032**	**116 705**	**118 378**	**120 050**	**121 723**	**123 396**	**2 112 028**
Total annual cost	6 838 000	86 668	86 668	86 668	86 668	86 668	86 668	86 668	86 668	86 668	86 668	2 406 668	108 341	110 013	111 686	113 359	115 032	116 705	118 378	120 050	121 723	123 396	11 270 028
Net present value	**6 838 000**	**78 610**	**74 867**	**71 302**	**67 906**	**64 673**	**61 593**	**58 660**	**55 867**	**53 206**	**50 673**	**1 340 123**	**57 455**	**55 564**	**53 723**	**51 931**	**50 188**	**48 493**	**46 846**	**45 246**	**43 692**	**42 183**	**5 310 801**
	0,49	**EUR/m3**																					
	20,25	**EUR/pe**																					

P3: South Pumping Station Trickling Filter																							
Year	**2023**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**Total**
WWTP																							
Flow (m3/year)		815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	848 917	882 789	916 661	950 533	984 405	1 018 277	1 052 149	1 086 021	1 119 893	1 153 765	18 978 905
Load (kg BOD/year)		416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	440 738	464 645	488 553	512 460	536 368	560 275	584 183	608 090	631 998	655 905	10 068 343
Population equivalent		19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	20 125	21 217	22 308	23 400	24 492	25 583	26 675	27 767	28 858	29 950	459 742
Sludge production (ton/year)		924	924	924	924	924	924	924	924	924	924	924	977	1 030	1 083	1 136	1 189	1 242	1 295	1 348	1 401	1 454	22 318
Sludge production (m3/year)		840	840	840	840	840	840	840	840	840	840	840	888	936	985	1 033	1 081	1 129	1 177	1 225	1 274	1 322	20 289
Electricity (kWh/year)		197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	209 350	220 706	232 062	243 419	254 775	266 131	277 487	288 843	300 199	311 555	4 782 463
Pumping Stations																							
Electricity (kWh/year)		32 598	32 598	32 598	32 598	32 598	32 598	32 598	32 598	32 598	32 598	32 598	35 851	39 105	42 359	45 612	48 866	52 120	55 373	58 627	61 881	65 134	863 503
Capital Expenses																							
Central PS	138 000											20 000											
South PS																							
Pressure network	241 000																						
WWTP	7 274 000											2 530 000											
Total CAPEX	**7 653 000**											**2 550 000**											
Operational Expenses																							
Electricity WWTP (EUR/year)		17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	18 006	18 983	19 960	20 936	21 913	22 890	23 867	24 843	25 820	26 797	411 340
Electricity PS (EUR/year)		2 804	2 804	2 804	2 804	2 804	2 804	2 804	2 804	2 804	2 804	2 804	3 084	3 363	3 643	3 923	4 203	4 483	4 763	5 043	5 322	5 602	74 270
Sludge disposal (EUR/year)		8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 850	9 330	9 810	10 290	10 770	11 250	11 730	12 210	12 690	13 170	202 162
Maintenance and renewal (EUR/year)		55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	1 355 000
Staff (EUR/year)		56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	1 186 500
Total OPEX		**83 203**	**83 203**	**83 203**	**83 203**	**83 203**	**83 203**	**83 203**	**83 203**	**83 203**	**83 203**	**83 203**	**104 939**	**106 676**	**108 413**	**110 149**	**111 886**	**113 622**	**115 355**	**117 096**	**118 832**	**120 569**	**2 042 771**
Total annual cost	7 653 000	83 203	83 203	83 203	83 203	83 203	83 203	83 203	83 203	83 203	83 203	2 633 203	104 939	106 676	108 413	110 149	111 886	113 622	115 359	117 096	118 832	120 569	12 245 771
Net present value	7 653 000	75 467	71 874	68 451	65 192	62 087	59 131	56 315	53 633	51 079	48 647	1 466 266	55 652	53 879	52 148	50 461	48 815	47 212	45 652	44 132	42 654	41 216	10 212 963
	0,54	**EUR/m3**																					
	22,21	**EUR/pe**																					

P4: Forest Trickling Filter																						
Year	2023	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	Total
WWTP																							
Flow (m3/year)		815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	848 917	882 789	916 661	950 533	984 405	1 018 277	1 052 149	1 086 021	1 119 893	1 153 765	18 978 905
Load (kg BOD/year)		416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	440 738	464 645	488 553	512 460	536 368	560 275	584 183	608 090	631 998	655 905	10 068 343
Population equivalent - 60g		19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	20 125	21 217	22 308	23 400	24 492	25 583	26 675	27 767	28 858	29 950	459 742
Sludge production (ton/year)		924	924	924	924	924	924	924	924	924	924	924	977	1 030	1 083	1 136	1 189	1 242	1 295	1 348	1 401	1 454	22 318
Sludge production (m3/year)		840	840	840	840	840	840	840	840	840	840	840	888	936	985	1 033	1 081	1 129	1 177	1 225	1 274	1 322	20 289
Electricity (kWh/year)		197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	209 350	220 706	232 062	243 419	254 775	266 131	277 487	288 843	300 199	311 555	4 782 463
Pumping Stations																							
Electricity (kWh/year)		87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	96 580	105 962	115 345	124 727	134 109	143 491	152 873	162 255	171 637	181 019	2 347 179
Capital Expenses																							
Central PS	173 000											30 000											
South PS	46 000																						
Pressure network	725 000																						
WWTP + road	6 925 000											2 300 000											
Total CAPEX	**7 869 000**											**2 330 000**											
Operational Expenses																							
Electricity WWTP (EUR/year)		17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	18 006	18 983	19 960	20 936	21 913	22 890	23 867	24 843	25 820	26 797	411 340
Electricity PS (EUR/year)		7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	8 307	9 114	9 921	10 728	11 535	12 342	13 149	13 956	14 763	15 569	201 881
Sludge disposal (EUR/year)		8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 850	9 330	9 810	10 290	10 770	11 250	11 730	12 210	12 690	13 170	202 162
Maintenance and renewal (EUR/year)		55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	1 355 000
Staff (EUR/year)		56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	1 186 500
Total OPEX		**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**166 663**	**168 926**	**171 190**	**173 454**	**175 718**	**177 981**	**180 245**	**182 509**	**184 772**	**187 036**	**3 356 882**
Total annual cost	7 869 000	144 399	144 399	144 399	144 399	144 399	144 399	144 399	144 399	144 399	144 399	2 474 399	166 663	168 926	171 190	173 454	175 718	177 981	180 245	182 509	184 772	187 036	13 555 882
Net present value	7 869 000	130 974	124 737	118 797	113 140	107 753	102 622	97 735	93 081	88 648	84 427	1 377 838	88 385	85 319	82 345	79 461	76 665	73 955	71 329	68 786	66 323	63 938	11 065 259
	0,58	**EUR/m3**																					
	24,07	**EUR/pe**																					

P5: Next to Landfill Trickling Filter																						
Year	2023	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	Total
WWTP																							
Flow (m3/year)		815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	848 917	882 789	916 661	950 533	984 405	1 018 277	1 052 149	1 086 021	1 119 893	1 153 765	18 978 905
Load (kg BOD/year)		416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	440 738	464 645	488 553	512 460	536 368	560 275	584 183	608 090	631 998	655 905	10 068 343
Population equivalent		19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	20 125	21 217	22 308	23 400	24 492	25 583	26 675	27 767	28 858	29 950	459 742
Sludge production (ton/year)		924	924	924	924	924	924	924	924	924	924	924	977	1 030	1 083	1 136	1 189	1 242	1 295	1 348	1 401	1 454	22 318
Sludge production (m3/year)		840	840	840	840	840	840	840	840	840	840	840	888	936	985	1 033	1 081	1 129	1 177	1 225	1 274	1 322	20 289
Electricity (kWh/year)		197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	209 350	220 706	232 062	243 419	254 775	266 131	277 487	288 843	300 199	311 555	4 782 463
Pumping Stations																							
Electricity (kWh/year)		343 606	343 606	343 606	343 606	343 606	343 606	343 606	343 606	343 606	343 606	343 606	361 818	380 030	398 241	416 453	434 665	452 876	471 088	489 300	507 511	525 723	8 217 374
Capital Expenses																							
Central PS	250 000											50 000											
South PS	46 000																						
Pressure network	437 000																						
Gravity network	290 000																						
WWTP	6 958 000											2 530 000											
Total CAPEX	7 981 000											2 580 000											
Operational Expenses																							
Electricity WWTP (EUR/year)		17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	18 006	18 983	19 960	20 936	21 913	22 890	23 867	24 843	25 820	26 797	411 340
Electricity PS (EUR/year)		29 554	29 554	29 554	29 554	29 554	29 554	29 554	29 554	29 554	29 554	29 554	31 120	32 686	34 253	35 819	37 385	38 952	40 518	42 085	43 651	45 217	706 776
Sludge disposal (EUR/year)		8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 850	9 330	9 810	10 290	10 770	11 250	11 730	12 210	12 690	13 170	202 162
Maintenance and renewal (EUR/year)		55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	1 355 000
Staff (EUR/year)		56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	1 186 500
Total OPEX		166 453	166 453	166 453	166 453	166 453	166 453	166 453	166 453	166 453	166 453	166 453	189 476	192 459	195 522	198 545	201 568	204 592	207 615	210 638	213 661	216 684	3 861 778
Total annual cost	7 981 000	166 453	166 453	166 453	166 453	166 453	166 453	166 453	166 453	166 453	166 453	2 746 453	189 476	192 499	195 522	198 545	201 568	204 592	207 615	210 638	213 661	216 684	14 422 778
Net present value	7 981 000	150 977	143 788	136 941	130 420	124 209	118 295	112 662	107 297	102 187	97 321	1 529 328	100 483	97 225	94 049	90 956	87 944	85 012	82 160	79 387	76 692	74 073	11 602 407
	0,61	EUR/m3																					
	25,24	EUR/pe																					

P6: Zastinca Trickling Filter																							
Year	**2023**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**Total**
WWTP																							
Flow (m3/year)		815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	848 917	882 789	916 661	950 533	984 405	1 018 277	1 052 149	1 086 021	1 119 893	1 153 765	18 978 905
Load (kg BOD/year)		416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	440 738	464 645	488 553	512 460	536 368	560 275	584 183	608 090	631 998	655 905	10 068 343
Population equivalent		19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	20 125	21 217	22 308	23 400	24 492	25 583	26 675	27 767	28 858	29 950	459 742
Sludge production (ton/year)		924	924	924	924	924	924	924	924	924	924	924	977	1 030	1 083	1 136	1 189	1 242	1 295	1 348	1 401	1 454	22 318
Sludge production (m3/year)		840	840	840	840	840	840	840	840	840	840	840	888	936	985	1 033	1 081	1 129	1 177	1 225	1 274	1 322	20 289
Electricity (kWh/year)		197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	209 350	220 706	232 062	243 419	254 775	266 131	277 487	288 843	300 199	311 555	4 782 463
Pumping Stations																							
Electricity (kWh/year)		295 448	295 448	295 448	295 448	295 448	295 448	295 448	295 448	295 448	295 448	295 448	311 557	327 666	343 775	359 884	375 993	392 102	408 210	424 319	440 428	456 537	7 090 400
Capital Expenses																							
Central PS	250 000											50 000											
South PS	46 000																						
Pressure network	505 000																						
Gravity network	35 000		*1,2 Works in forest																				
WWTP	7 526 750											2 737 000											
Total CAPEX	**8 362 750**											**2 787 000**											
Operational Expenses																							
Electricity WWTP (EUR/year)		17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	18 006	18 983	19 960	20 936	21 913	22 890	23 867	24 843	25 820	26 797	411 340
Electricity PS (EUR/year)		25 411	25 411	25 411	25 411	25 411	25 411	25 411	25 411	25 411	25 411	25 411	26 797	28 183	29 568	30 954	32 339	33 725	35 110	36 496	37 881	39 267	609 845
Sludge disposal (EUR/year)		8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 850	9 330	9 810	10 290	10 770	11 250	11 730	12 210	12 690	13 170	202 162
Maintenance and renewal (EUR/year)		55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	75 000	1 355 000
Staff (EUR/year)		56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	1 186 500
Total OPEX		**162 310**	**162 310**	**162 310**	**162 310**	**162 310**	**162 310**	**162 310**	**162 310**	**162 310**	**162 310**	**162 310**	**185 153**	**187 995**	**190 837**	**193 680**	**196 522**	**199 364**	**202 207**	**205 049**	**207 891**	**210 734**	**3 764 847**
Total annual cost	8 362 750	162 310	162 310	162 310	162 310	162 310	162 310	162 310	162 310	162 310	162 310	2 949 310	185 153	187 995	190 837	193 680	196 522	199 364	202 207	205 049	207 891	210 734	14 914 597
Net present value	8 362 750	147 220	140 210	133 533	127 175	121 119	115 351	109 858	104 627	99 645	94 900	1 642 286	98 190	94 950	91 796	88 727	85 742	82 840	80 020	77 281	74 621	72 039	12 044 880
	0,63	**EUR/m3**																					
	26,20	**EUR/pe**																					

P4: Forest Constructed Wetland																						
Year	2023	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	Total
WWTP																							
Flow (m3/year)		815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	848 917	882 789	916 661	950 533	984 405	1 018 277	1 052 149	1 086 021	1 119 893	1 153 765	18 978 905
Load (kg BOD/year)		416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	440 738	464 645	488 553	512 460	536 368	560 275	584 183	608 090	631 998	655 905	10 068 343
Population equivalent - 60g		19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	20 125	21 217	22 308	23 400	24 492	25 583	26 675	27 767	28 858	29 950	459 742
Sludge production (ton/year)												3 388										4 051	7 439
Sludge production (m3/year)		0	0	0	0	0	0	0	0	0	0	3 080	0	0	0	0	0	0	0	0	0	3 683	6 763
Electricity (kWh/year)		79 198	79 198	79 198	79 198	79 198	79 198	79 198	79 198	79 198	79 198	79 198	83 740	88 283	92 825	97 367	101 910	106 452	110 995	115 537	120 080	124 622	1 912 985
Pumping Stations																							
Electricity (kWh/year)		87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	96 580	105 962	115 345	124 727	134 109	143 491	152 873	162 255	171 637	181 019	2 347 179
Capital Expenses																							
Central PS	173 000											30 000											
South PS	46 000																						
Pressure network	725 000																						
WWTP + road	4 330 000											2 035 500											
Total CAPEX	**5 274 000**											**2 065 500**											
Operational Expenses																							
Electricity WWTP (EUR/year)		6 812	6 812	6 812	6 812	6 812	6 812	6 812	6 812	6 812	6 812	6 812	7 202	7 593	7 984	8 375	8 765	9 156	9 547	9 937	10 328	10 719	164 536
Electricity PS (EUR/year)		7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	8 307	9 114	9 921	10 728	11 535	12 342	13 149	13 956	14 763	15 569	201 881
Sludge disposal (EUR/year)		0	0	0	0	0	0	0	0	0	0	30 688	0	0	0	0	0	0	0	0	0	36 699	67 387
Maintenance and renewal (EUR/year)		9 325	9 325	9 325	9 325	9 325	9 325	9 325	9 325	9 325	9 325	9 325	13 750	13 750	13 750	13 750	13 750	13 750	13 750	13 750	13 750	13 750	240 075
Staff (EUR/year)		41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	41 500	871 500
Total OPEX		**65 137**	**65 137**	**65 137**	**65 137**	**65 137**	**65 137**	**65 137**	**65 137**	**65 137**	**65 137**	**95 825**	**70 759**	**71 957**	**73 155**	**74 352**	**75 550**	**76 748**	**77 945**	**79 143**	**80 341**	**118 237**	**1 545 379**
Total annual cost	5 274 000	65 137	65 137	65 137	65 137	65 137	65 137	65 137	65 137	65 137	65 137	2 161 325	70 759	71 957	73 155	74 352	75 550	76 748	77 945	79 143	80 341	118 237	8 884 879
Net present value	5 274 000	59 081	56 268	53 588	51 036	48 606	46 291	44 087	41 988	39 988	38 084	1 203 507	37 525	36 343	35 189	34 062	32 962	31 890	30 846	29 828	28 838	40 419	7 294 426
	0,38	**EUR/m3**																					
	15,87	**EUR/pe**																					

P4: Forest Trickling Filter with Upgrade in 2035																						
Year	**2023**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**Total**
WWTP																							
Flow (m3/year)		815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	848 917	882 789	916 661	950 533	984 405	1 018 277	1 052 149	1 086 021	1 119 893	1 153 765	18 978 905
Load (kg BOD/year)		416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	440 738	464 645	488 553	512 460	536 368	560 275	584 183	608 090	631 998	655 905	10 068 343
Population equivalent - 60g		19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	20 125	21 217	22 308	23 400	24 492	25 583	26 675	27 767	28 858	29 950	459 742
Sludge production (ton/year)		924	924	924	924	924	924	924	924	924	924	924	1 075	1 133	1 191	1 250	1 308	1 366	1 424	1 483	1 541	1 599	23 534
Sludge production (m3/year)		840	840	840	840	840	840	840	840	840	840	840	977	1 030	1 083	1 136	1 189	1 242	1 295	1 348	1 401	1 454	21 394
Electricity (kWh/year)		197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	197 994	502 441	529 695	556 950	584 204	611 459	638 714	665 968	693 223	720 477	747 732	8 428 799
Pumping Stations																							
Electricity (kWh/year)		87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	96 580	105 962	115 345	124 727	134 109	143 491	152 873	162 255	171 637	181 019	2 347 179
Capital Expenses																							
Central PS	173 000											30 000											
South PS	46 000																						
Pressure network	725 000																						
WWTP + road	6 925 000											4 500 000											
Total CAPEX	**7 869 000**											**4 530 000**											
Operational Expenses																							
Electricity WWTP (EUR/year)		17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	17 029	43 215	45 559	47 903	50 247	52 592	54 936	57 280	59 624	61 968	64 312	724 961
Electricity PS (EUR/year)		7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	8 307	9 114	9 921	10 728	11 535	12 342	13 149	13 956	14 763	15 569	201 881
Sludge disposal (EUR/year)		8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	8 370	9 735	10 263	10 791	11 319	11 847	12 375	12 903	13 431	13 959	14 487	213 172
Maintenance and renewal (EUR/year)		55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	55 000	94 130	94 130	94 130	94 130	94 130	94 130	94 130	94 130	94 130	94 130	1 546 304
Staff (EUR/year)		56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	56 500	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	1 321 500
Total OPEX		**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**144 399**	**225 387**	**229 066**	**232 745**	**236 424**	**240 103**	**243 783**	**247 462**	**251 141**	**254 820**	**258 499**	**4 007 818**
Total annual cost	7 869 000	144 399	144 399	144 399	144 399	144 399	144 399	144 399	144 399	144 399	144 399	4 674 399	225 387	229 066	232 745	236 424	240 103	243 783	247 462	251 141	254 820	258 499	16 406 818
Net present value	7 869 000	130 974	124 737	118 797	113 140	107 753	102 622	97 735	93 081	88 648	84 427	2 602 880	119 527	115 694	111 954	108 309	104 756	101 297	97 929	94 652	91 466	88 368	12 567 747
	0,66	**EUR/m3**																					
	27,34	**EUR/pe**																					

P4: Foreet Activated Sludge																						
Year	2023	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	Total
WWTP																							
Flow (m3/year)		815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	815 045	848 917	882 789	916 661	950 533	984 405	1 018 277	1 052 149	1 086 021	1 119 893	1 153 765	18 978 905
Load (kg BOD/year)		416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	416 830	440 738	464 645	488 553	512 460	536 368	560 275	584 183	608 090	631 998	655 905	10 068 343
Population equivalent - 60g		19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	19 033	20 125	21 217	22 308	23 400	24 492	25 583	26 675	27 767	28 858	29 950	459 742
Sludge production (ton/year)		1 109	1 109	1 109	1 109	1 109	1 109	1 109	1 109	1 109	1 109	1 109	1 172	1 236	1 300	1 363	1 427	1 490	1 554	1 618	1 681	1 745	26 782
Sludge production (m3/year)		1 008	1 008	1 008	1 008	1 008	1 008	1 008	1 008	1 008	1 008	1 008	1 066	1 124	1 181	1 239	1 297	1 355	1 413	1 470	1 528	1 586	24 347
Electricity (kWh/year)		752 378	752 378	752 378	752 378	752 378	752 378	752 378	752 378	752 378	752 378	752 378	795 531	838 684	881 837	924 990	968 143	1 011 296	1 054 449	1 097 602	1 140 755	1 183 909	18 173 358
Pumping Stations																							
Electricity (kWh/year)		87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	87 198	96 580	105 962	115 345	124 727	134 109	143 491	152 873	162 255	171 637	181 019	2 347 179
Capital Expenses																							
Central PS	173 000											30 000											
South PS	46 000																						
Pressure network	725 000																						
WWTP + road	8 507 000											4 600 000											
Total CAPEX	9 451 000											4 630 000											
Operational Expenses																							
Electricity WWTP (EUR/year)		64 712	64 712	64 712	64 712	64 712	64 712	64 712	64 712	64 712	64 712	64 712	68 424	72 135	75 847	79 558	83 270	86 982	90 693	94 405	98 116	101 828	1 563 091
Electricity PS (EUR/year)		7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	7 500	8 307	9 114	9 921	10 728	11 535	12 342	13 149	13 956	14 763	15 569	201 881
Sludge disposal (EUR/year)		10 043	10 043	10 043	10 043	10 043	10 043	10 043	10 043	10 043	10 043	10 043	10 619	11 196	11 772	12 348	12 924	13 500	14 076	14 652	15 228	15 804	242 594
Maintenance and renewal (EUR/year)		85 070	85 070	85 070	85 070	85 070	85 070	85 070	85 070	85 070	85 070	85 070	131 070	131 070	131 070	131 070	131 070	131 070	131 070	131 070	131 070	131 070	2 246 470
Staff (EUR/year)		70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	1 470 000
Total OPEX		237 325	237 325	237 325	237 325	237 325	237 325	237 325	237 325	237 325	237 325	237 325	288 420	293 515	298 609	303 704	308 798	313 893	318 988	324 082	329 177	334 271	5 724 036
Total annual cost	9 451 000	237 325	237 325	237 325	237 325	237 325	237 325	237 325	237 325	237 325	237 325	4 867 325	288 420	293 515	298 609	303 704	308 798	313 893	318 988	324 082	329 177	334 271	19 805 036
Net present value	9 451 000	215 261	205 011	195 248	185 951	177 096	168 663	160 631	152 982	145 697	138 759	2 710 309	152 955	148 245	143 636	139 130	134 728	130 429	126 234	122 143	118 155	114 271	15 236 534
	0,80	EUR/m3																					
	33,14	EUR/pe																					

12.6. Individual Sewerage Connections

The construction of individual sewerage connections must follow the requirements set in the Moldovan Construction Norms **NCM G.03.02: 2015 - Networks and external sewerage installations** regarding:

- Minimum speed for all types of canals and pipes (> 0.7 m/s)
- Minimum slope for the sewer connection (0.008 for a diameter of 150 mm and 0.007 for a diameter of 200 mm)
- Minimum distance from existing underground constructions
- The installation of manholes or chambers for the change of direction, the connection and the intersection of pipes
- The installation of visiting manholes at the connection and unloading points
- etc.

The laying depth of the pipes is established based on topographic, geological and hydrogeological conditions and on technical-economic considerations (depending on the laying of the consumer's internal networks), ensuring the longitudinal slope, taking into account the protection against frost and possible degradation due to mechanical stresses. The minimum laying depth of the connecting pipes is 0.7 m from the ridge of the pipe to the surface of the ground or the projected elevation. The maximum laying depth of the sewer pipes can be done at a depth of 8-10 m by open digging, but in practice the designers do not go deeper than 4.2 m.

The connecting pipes are typically made of PVC or PP. The connecting manholes/chambers are made of HDPE, PP or reinforced concrete. The diameter of the manhole/chamber with circular section is adopted depending on the diameter of the pipes on which it is placed and the depth. The diameter may vary from 700 to 1500 mm.

Figure 121: HDPE chamber, Rosu village, 2018

In accordance with the normative acts in force, for sewerage networks, the **delimitation point** is the connection chamber to the public network in the sense of wastewater drainage.

The **Connection chamber** is an underground construction that ensures the connection and collection of wastewater from the consumer's internal sewerage installations in the public sewerage network.

The **Wastewater control chamber** (for industrial consumers) is a special underground construction for wastewater sampling. The connection chamber can also serve as a wastewater control chamber.

Given that the connecting chamber is part of the public sewerage system, it is installed on public land, but as close as possible to the border of private property. An example of a sewer connection is shown in the figure below.

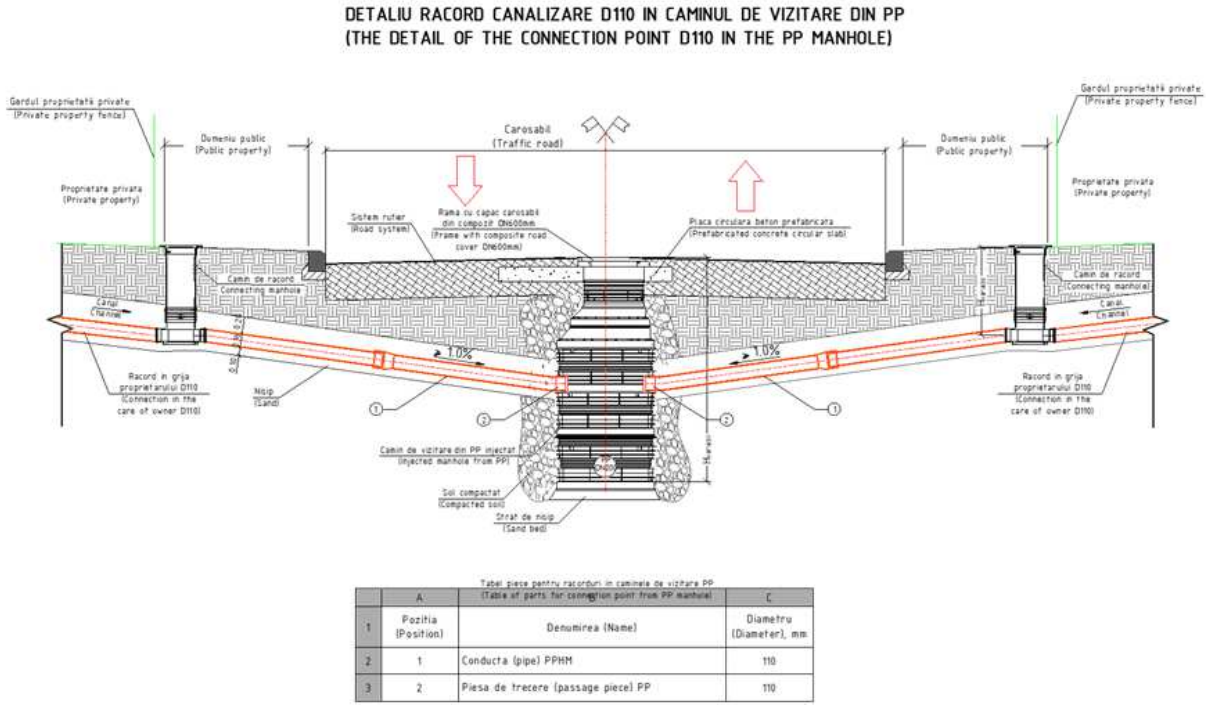


Table pieces pentru racorduri in caminele de vizitare PP
(Table of parts for connection point from PP manhole)

	A	B	C
1	Pozitia (Position)	Denumirea (Name)	Diametru (Diameter), mm
2	1	Conducta (pipe) PPHM	110
3	2	Piesa de trecere (passage piece) PP	110

Figure 122: Example of connection to the street network (injected manhole from PP)

In situations when the street sewer collector is at a higher level than the customer's internal networks, individual pumps are used (see Figure below). Such applications are rarely used and are not to the liking of consumers. Legislation does not regulate exactly this type of connection, but given the technical conditions and the customer's responsibility for the installed pump, the pumped manholes are usually installed on the customer's private property.

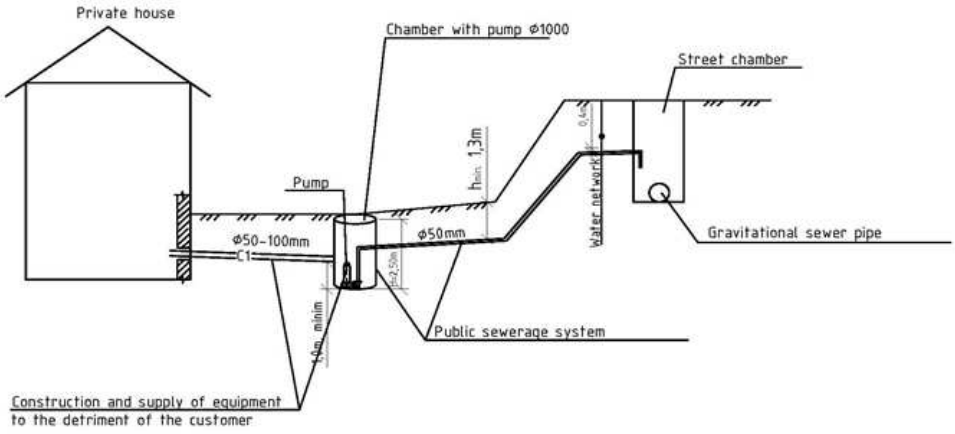


Figure 123: Example of connection to the street network by pump

12.7. Cost Assumptions

Investment costs -Assumptions			
Item	**Unit**	**Cost (EUR)**	**Cost (MLD)**
Individual connection - public property Manhole + 6 m on average	u	550	11 702
Individual connection - private property	u	300	6 383
Gravity sewerage network - 200/315	EUR/m	105	2 234
Gravity sewerage network - 400/500	EUR/m	126	2 681
Gravity sewerage network - 150 Rural	EUR/m	90	1 915
Pressure network - 315/400	EUR/m	100	2 128
Pressure network - 90/110	EUR/m	60	1 277
Pressure network - 40/50	EUR/m	45	957
Gravity sewerage network - Rehabilitation	EUR/m	116	2 457
Central Pumping Station - Phase I 2 + 1 pump, 36 l/s Punit= 25 kW	u	150 000	3 191 489
Central Pumping Station - Extension Phase II	u	30 000	638 298
South Pumping Station - Phase I 1 + 1 pump, 4.4 l/s Punit= 1 kW	u	40 000	851 064
South Pumping Station - Extension Phase II	u	5 000	106 383
Small pumping station - Soroca	u	15 000	319 149
Rublenita main Pumping Station 1 + 1 pumps 10 l/s; Power = 30 kW	u	50 000	1 063 830
Small pumping station - rural	u	10 000	212 766
Road construction to access WWTP (paved road, international standards)	EUR/km	254 000	5 404 255
WWTP - 19 000 PE	u	5 500 000	117 021 277
Extension and upgrade WWTP in Phase II	u	4 500 000	95 744 681
Electric line - MV	EUR/km	18 000	382 979
Transfo MV/LV	EUR	20 000	425 532
Vacuum truck 3,8 m3	EUR	125 000	2 659 574
Camera inspection	EUR/km	20 000	425 532

Operational costs - Assumptions			
Item	**Unit**	**Cost (EUR)**	**Cost (MLD)**
Electricity	kWh/m3	0,086	1,83
Sludge disposal in Landfill	MLD/m3	10	212
Slaked lime Ca(OH)2	MDL/ton	215	4580
Polymer for sludge treatment	MDL/ton	3888	82720
Ferric Chloride FeCl3	MDL/ton	212	4500
Fuel	MDL/L	0,80	17
Maintenance and renewal for WWTP	Percentage over total investment	1%	
Maintenance and renewal for PS	Percentage over total investment	2%	
Laboratory, analysis	EUR/year	3500	74 468

Exchange rate		
1 MDL =	0,047	EURO
1 EURO =	1,19	US$
Employer’s rate	15%	

The employer's rate includes detailed studies (geotechnical, preparation of offers, etc.) and supervision

12.8. PLANS

- Soroca wastewater network current situation
- Soroca customer spatial repartition current situation
- WWTP Preliminary Layout
- WWTP Preliminary Hydraulic Profile

Cosauti

Egoreni

Soroca

Hristici

Zastinca

0 1 2 km

Legend

Wastewater direction

Discharge points

Pumping stations

Central

North

South

Pipes

Main pipes

Connections

Catchments

1

2a

2b

3

4

Districts

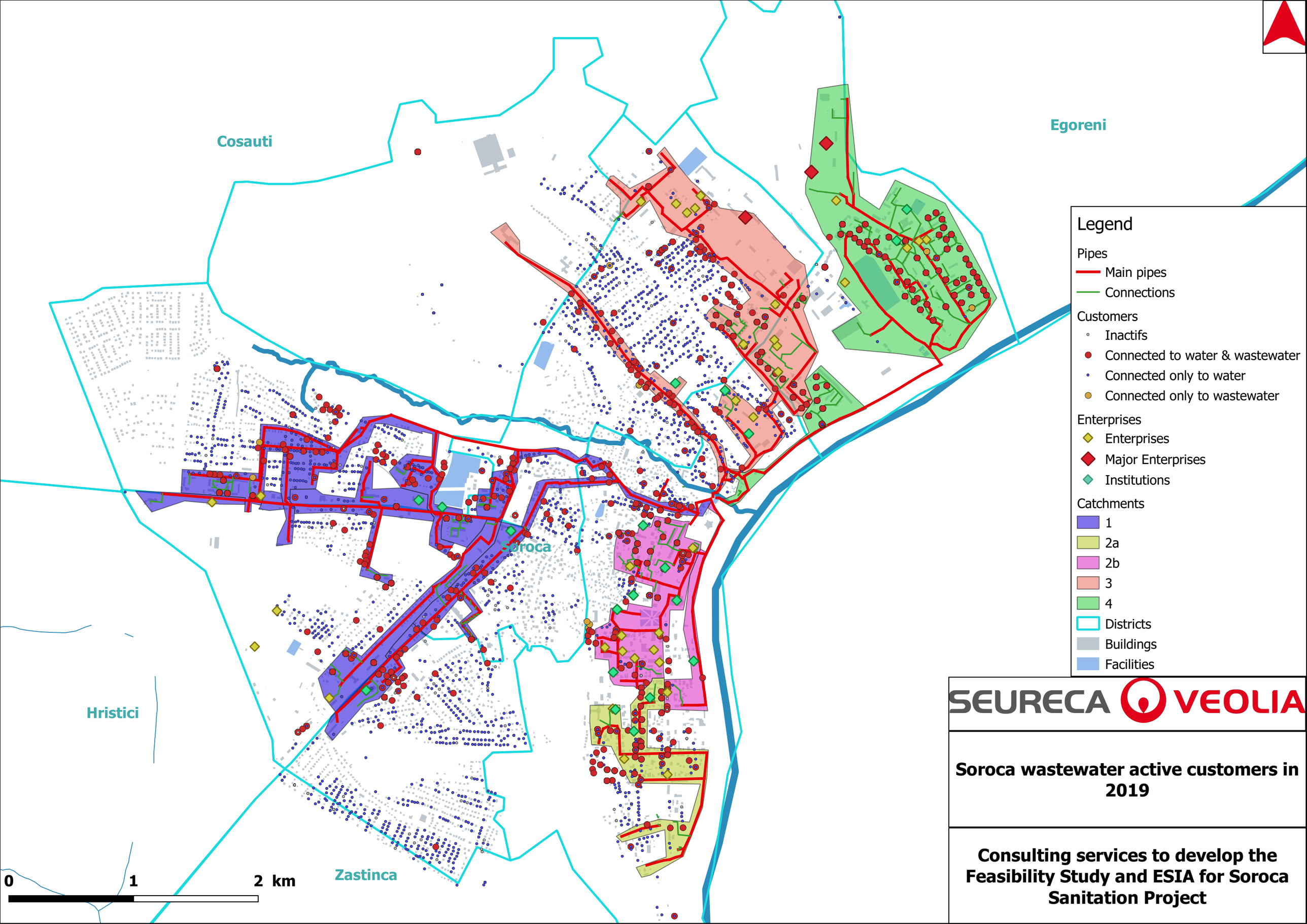
Buildings

Facilities

SEURECA VEOLIA

Soroca wastewater network current situation

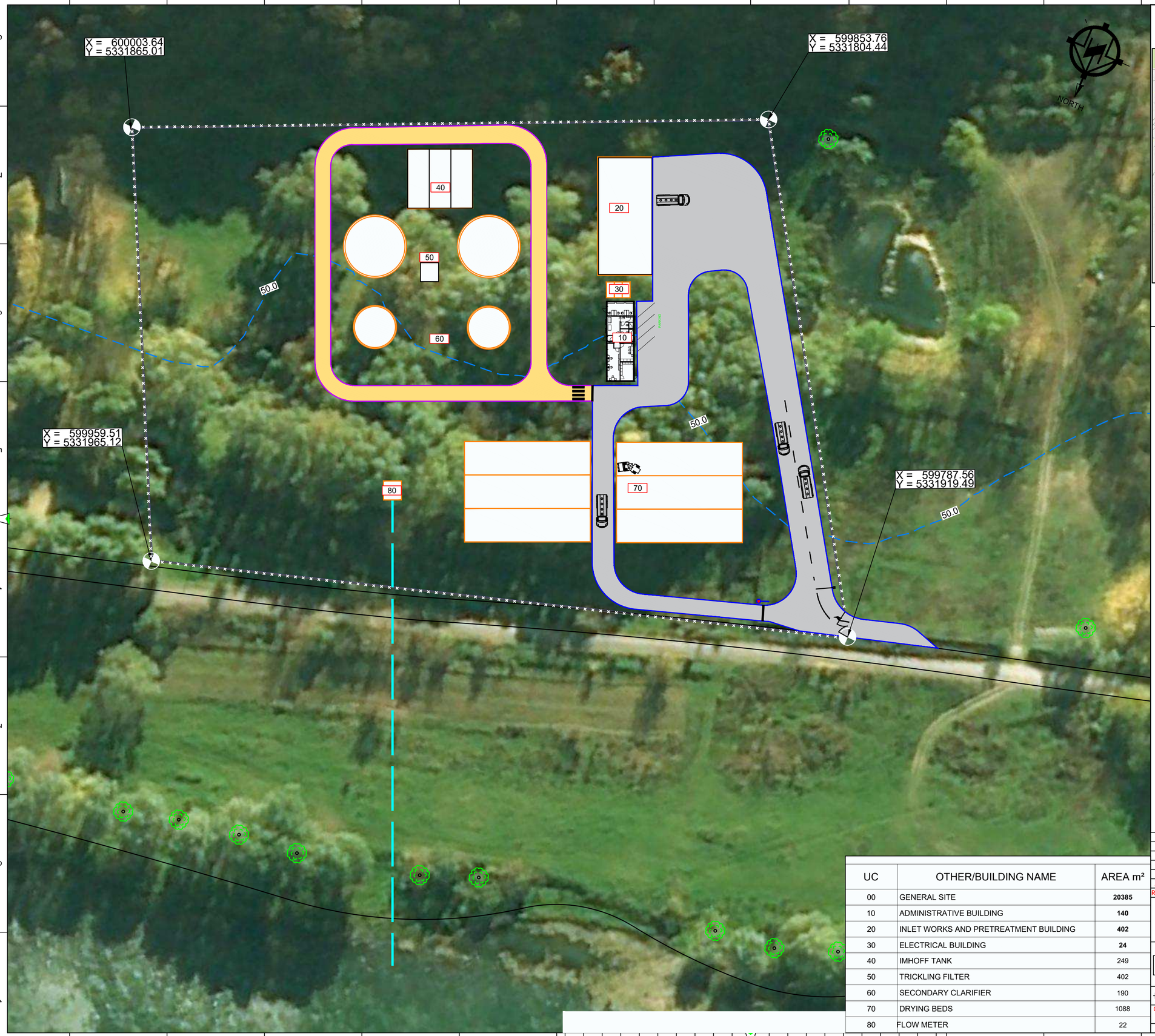
Consulting services to develop the Feasibility Study and ESIA for Soroca Sanitation Project

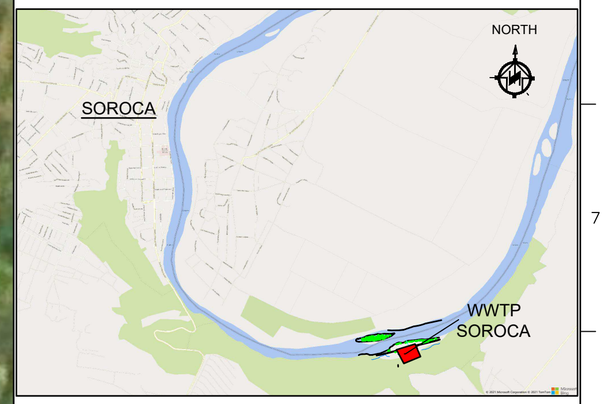


SEURECA VEOLIA

Soroca wastewater active customers in 2019

Consulting services to develop the Feasibility Study and ESIA for Soroca Sanitation Project





NOTES:

1. ALL THE DIMENSION ARE IN METERS
2. COORDINATE SYSTEM UTM84-35N

0 25 50

PRELIMINARY DRAWING

UC	OTHER/BUILDING NAME	AREA m²
00	GENERAL SITE	**20385**
10	ADMINISTRATIVE BUILDING	**140**
20	INLET WORKS AND PRETREATMENT BUILDING	**402**
30	ELECTRICAL BUILDING	**24**
40	IMHOFF TANK	249
50	TRICKLING FILTER	402
60	SECONDARY CLARIFIER	190
70	DRYING BEDS	1088
80	FLOW METER	22

Rev	Date	Issued	Checked	Approved	Status	Purpose of issue
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
A	27-07-2021	AR	AR	LD	IDC	ISSUE FOR INTERDISCIPLINARY CHECK

CONSULTING SERVICES TO DEVELOP THE FEASIBILITY STUDY AND ESIA FOR SOROCA SANITATION PROJEC

SEURECA VEOLIA

PRELIMINARY SITE LAYOUT

Size:	Scale:	Company Project No:	Company Dwg No:	Sheet:
A1	1:200	-	-	1/1
Origin: SEU		Contractor Project No: 505-1-0001	Contractor Dwg No: PROJET-STEP0-02-MAP	Revision: A

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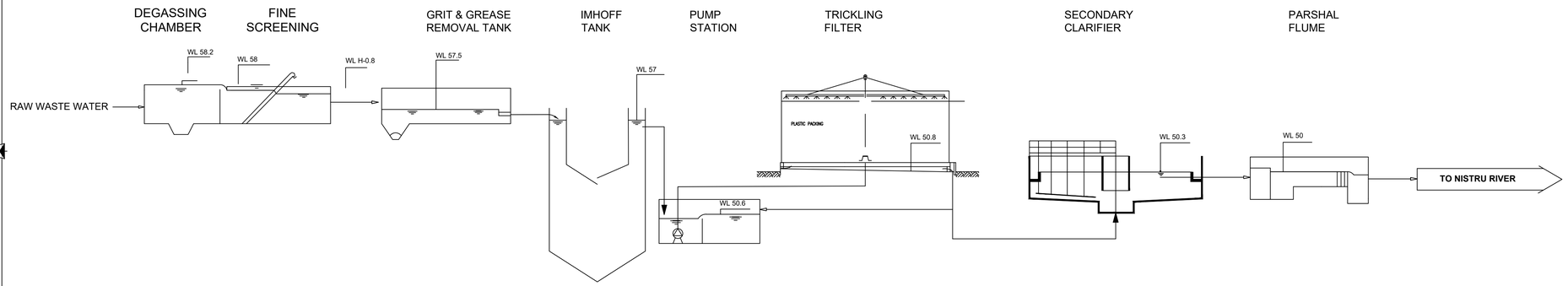
Format A1



GENERAL NOTES:

A. ALL VALUES IN THIS DIAGRAM ARE INDICATIVE ONLY.

B. FINAL VALUES WILL BE PROVIDED DURING THE PRELIMINARY AND DETAILED DESIGN.

PRELIMINARY DRAWING

Rev.	Date	Issued	Checked	Approved	Status	Purpose of issue
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
A	27-07-2021	AR	AR	LD	IDC	ISSUE FOR INTERDISCIPLINARY CHECK

CONSULTING SERVICES TO DEVELOP THE FEASIBILITY STUDY AND ESIA FOR SOROCA SANITATION PROJECT

SEURECA VEOLIA

PRELIMINARY HYDRAULIC PROFILE

Size:	Scale:	Company Project No:	Company Dwg No:	Sheet:
A1	1:200	-	-	1/1
Origin: SEU		Contractor Project No: 505-1-0001	Contractor Dwg No: HYDRAULIC PROFILE	Revision: A

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