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APA CANAL CHISINAU

CHISINAU WATER SUPPLY & SEWAGE TREATMENT - FEASIBILITY STUDY

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Potable Water Network – Investment Program - FINAL

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LIST OF ABBREVIATIONS AND ACRONYMS

ACC	Apa Canal Chişinău
CAPEX	Capital Expenses
EBRD	European Bank for Reconstruction and Development
HDPE	High-Density Polyethylene
IR	Inception Report
LLI	Linear Leakage Index
LRI	Linear Repair Index
TLIP	Long Term Investment Programme
MDL	Moldovan Leu
ND	Nominal Diameter
OPEX	Operation Expenses
PIP	Priority Investment Programme
PIU	Project Implementation Unit
ToR	Terms of Reference
WWTP	Wastewater Treatment Plant

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1. INTRODUCTION

The objective of this report is to present the future investments to be implemented for the water supply network. The definition of the investments is a long process, resulting from data collecting, the measurement campaign and the hydraulic model presented in previous reports. Indeed, the measurement campaign and the construction of the model lead to a good knowledge of the current situation of the water supply network. This knowledge then enables the definition of measures to improve the situation and therefore the definition of the future investments.

The present report is organized as follow:

- A quick summary of the principal objectives and findings of the measurement campaign and of the hydraulic model
- The technical explanation of the recommendations to implement in the future on the water supply network, as
    - The new organization of the network
    - The extensions to the villages and the urban zones,
    - The rehabilitation needs for the pipe, the tanks and the pumps
    - The emergency plan in case of unavailability of the water intake on the Nistru.
    - The possibility of generating energy by installing turbines
- The design of the solutions and recommendations proposed. This part gives the technical characteristics and the quantities for all the solutions proposed.
- The last part estimates the costs for the recommendation and gives the final assessment of the investment proposed.

2. MEASUREMENT CAMPAIGN AND HYDRAULIC MODEL

The objectives of the measurement campaign are to give a first analysis of the flows on the network and to enable the calibration of the hydraulic model. Once the model is calibrated, several objectives will be achieved: a global knowledge of the network, the definition and tests of the future situation and the tests of the scenarios for the improvement of the current situation.

For the measurement campaign on the water supply network, the network was divided into 33 hydraulic entities presented in the Table 1 (a hydraulic entity is a zone where it is possible to control the inflow and the outflow). And the measurement campaign was carried out in 6 steps to be able to assess all the hydraulic entities.

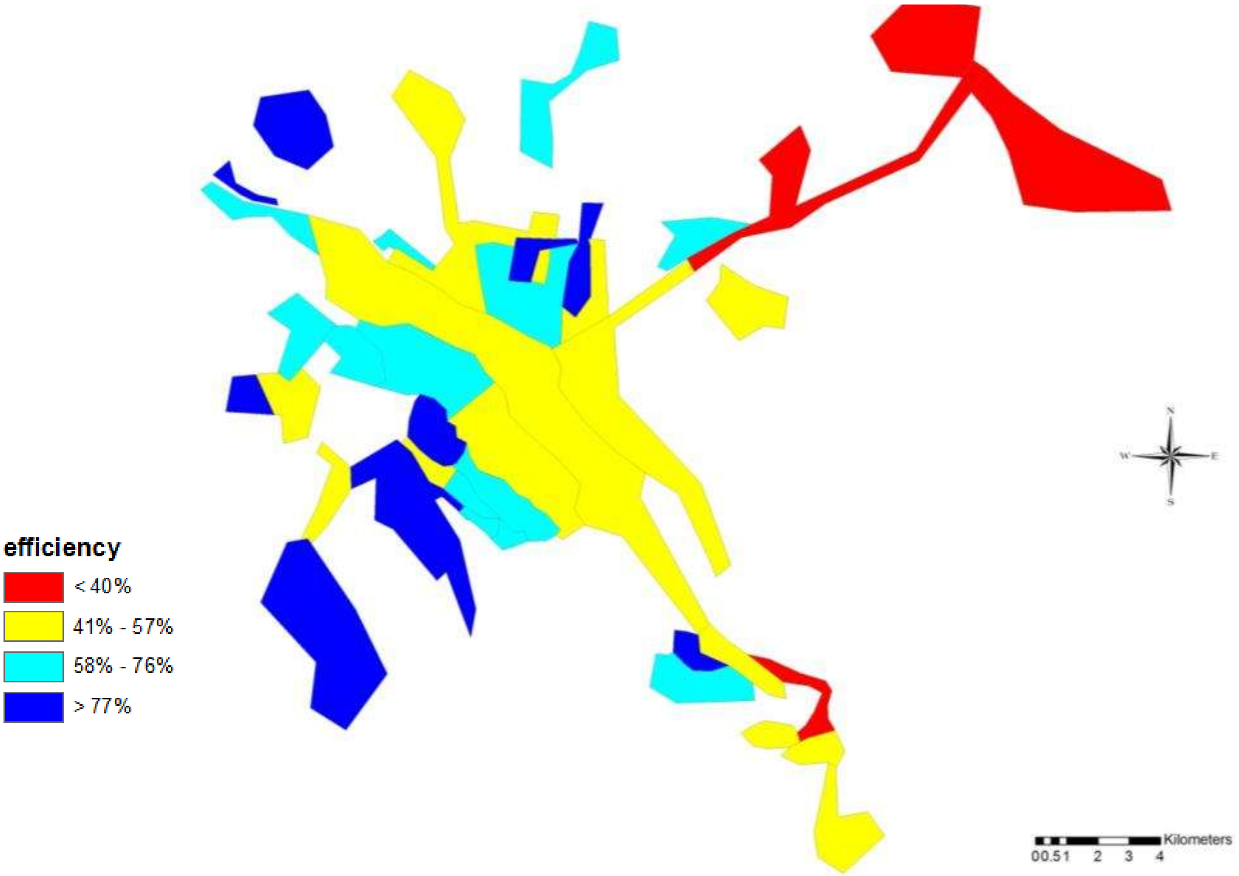
Table 1: hydraulic entities for the study area

Campaign N°	In Chisinau city	Campaign N°	In the suburbs disserved by ACC
1	Zone 1	3	Airport
4	Zone 2 Oţel	3	Codru PS to Airport
4	Zone 2 Doina	3	Codru PS to Sîngera
4	Zone 2 Tohatin, Vostoc and Independenţa	3	Codru PS to MDK
2	Zone 3 Buiucani	6	Coloniţa and Maximovca
2	Zone 3 Independenţa	6	Coşerniţa
2	Zone 3 Valea Dicescu	3	Dobrogeah
2	Zone 3 Rîscani	5	Durleşti -Cartuşa
2	Zone 3 Ciocana	5	Durleşti -Gribov
4	Zone 3 Universita Agrara	3	Ialoveni
1	Zone 4 Buiucani	6	SAN to Tohatin
5	Zone 4 Telecentru	3	Sîngera
5	Zone 4 Independenţa	6	Stauceni and Goianul Nou
6	Zone 4 Ciocana	6	Tohatin
5	Zone 4a Botanica	6	Vadul Lui Voda
5	Zone 4a Telecentru	1	Vatra
5	Zone 4a Schinoasa		

Pressure and flow measurements were therefore undertaken for each hydraulic entity during the summer 2011, thanks to the collaboration ACC. These measurements gave us a good local knowledge of the network operation and enable to perform hydraulic analyses for each entity. Different results were obtained through these analyses for each hydraulic entity:

- Average and peak volume into supply
- Water losses, as well as the corresponding linear leakage index and the efficiency of the network
- Dissipated energy in each regulating valve
- Hydraulic energy transferred to the water

Figure 1: Network efficiency for all the hydraulic entity



The Figure 1 above is an example of the results we got from the measurement campaign: a geographical distribution of the network efficiency. The campaigns highlighted the zones with

- **Important leakages** (such as the Zone 1, Zone 2, Zone 2 Oţel, Zone 2 Doina, Zone 3 Ciocana and Zone 3 Independenţa);
- **Low network efficiency** (such as Vadul Lui Voda, Coşerniţa, SAN to Tohatin and Codru PS to Sîngera PS);
- **High leakage linear index** (such as Coloniţa, Zone 3 Ciocana, Zone 3 Independenţa and Zone 4A Botanica);
- **High hydraulic energetic ratio** (such as Zone 4A Telecentru, Zone 4A Schinoasa, Durleşti-Gribov and Durleşti-Cartuşa).

In addition, the measurement campaigns enabled the assessment of the efficiency of the pumping stations and therefore the definition of the rehabilitation needs (described in the following section 4.3.3 Identification of pumping station rehabilitation needs) and of the potential location to recover hydraulic energy instead of dissipating it (proposition explained in the section 4.5 Potential for hydro power generation).

The second objective for the measurement campaign is to use the collected data in the calibration of the hydraulic model. Indeed, the hydraulic model is built in order to reproduce the behaviour of the water supply network. However, as long as the modelled data is not verified against the reality, the model cannot be considered as fully reproducing the reality – i.e. it is not calibrated.

Once the flows and pressures modelled recreate exactly the measured data, it is possible to consider that the local knowledge obtained through the measurement campaign has lead to a global knowledge of the network. The model indeed is able to point out the current black spots of the network, as the locations where the pressure is too low or too high and the pipes where the head loss generated is important. The few recommendations following this diagnosis are presented in the Report Water Supply Network – Hydraulic Model and are summarized in the next section.

In the same way, the calibrated model enables the assessment of the water loss reduction if the pressure regulation (proposed in the section 4.2 Improvement of the operation) is implemented.

The calibrated model for the current situation can then model the future situation. Indeed, thanks to the result of the water demand study, the evolution of the water demand is known at a very fine scale, as well as the evolution of the population connected to ACC's network.

This future model enables the design of the transformations proposed in the transmission mains (explained in the section 3 : Design solutions for transmissions mains) or of the network extensions described in the section 4.3.1 Expansion of the network.

3. DESIGN SOLUTIONS FOR TRANSMISSIONS MAINS

3.1. VARIANTS

According to the production scheme, there are three options for the splitting of production between STA and the wells. For the normal operation conditions, the proposed production schemes are:

- Option 1: Balişevschi, Ghidighici and Petricani well fields are mobilized daily at their minimum capacity to maintain in good operating conditions the whole production system. On the other hand, Ialoveni well field is operated at high capacity to supply Ialoveni city, the Zones 4a (even during the peak day) and sometimes part of the Zones 4.
- Option 2: Ialoveni well field is operated at a lower capacity to supply Ialoveni City only (even during the peak day at the horizon 2035). All the other well fields are decommissioned. There is no emergency plan in case the raw water intake in Nistru River is temporarily unusable.
- Option 3: The ground water sources are mobilized at their minimum capacity to maintain in good operating conditions the whole production system. And Ialoveni well field is operated at low capacity to supply Ialoveni City (even during the peak day at the horizon 2035) and part of Zone 4a Schinoasa and Zone 4a Telecentru.

The Option 2 maintains the current organization of the network: supply of Ialoveni City by Ialoveni well field; Zones 4 and 4a by STA. The energetic ratio of the delivered water is therefore unchanged.
The only projected investment is a package treatment plant at Ialoveni well field.

In options 1 and 3, it is proposed to adapt and rehabilitate the well fields of Balişevschi, Ghidighici and Petricani in order to include them in an emergency plan.
In order to implement the Emergency plan (see § 4.4), new pumping stations should be created to transfer the produced water from the well fields to the distributions Zones. For example, for Ialoveni well fields, the maximum extracted volume for emergencies will be 20 900 m^3/d and 96% will be transferred to Chişinău City. For this emergency transfer the produced water needs to be pumped from Ialoveni well field to Schinoasa tank. From Schinoasa tank, water will then be pumped to the Zone 4a Schinoasa but also to the Zones 4a Telecentru and Botanica, by inversing the current organization. Part of this water will supply as well Telecentru tank and pumping station to supply the Zones 4 of Telecentru and Independenţa and also, Zone 3 Valea Dicescu and part of Zone 2.
Investments due to the emergency plan include:

- New pumps to replace the old ones in Ialoveni pumping station to supply Schinoasa tank,
- New pumps in Schinoasa pumping station to supply Zone 4a Telecentru and Botanica.

In the Option 1 the utilisation of the transfer facilities from Ialoveni to Chişinău City -to be implemented for the emergency plan- will be optimum. It is proposed to use them to supply the Zones 4a (even during the peak day) and sometimes part of the Zones 4 with water produced by Ialoveni well field. It must be noticed that it is cheaper to pump water from Ialoveni to Zones 4a and 4 than from STA: the difference of hydraulic energy by delivered m^3 is around 0.16 kWh.

Option 3 is based on a treatment facility in Ialoveni designed on the maximum demand of Ialoveni City (peak day at the 2035 horizon) and on the use of a new pumping system to transfer the remaining water to Chişinău City -when Ialoveni's demand is not maximum.

3.2. COSTS ESTIMATES

The costs of projected facilities to transfer produced water from Ialoveni well field to Chişinău City are estimated to:

- New pumps in Ialoveni pumping station to supply Schinoasa tank: 6.1 M Lei,
- New pumps in Schinoasa pumping station to supply Zone 4a Telecentru and Botanica: 0.4 M Lei (to be renew once before 2035)

The maximum pumping electric consumption is obtained for option 2. It is 1.1% lower for option 1 and 0.4% for option 3. The energetic gain by comparison with option 2 is around:

- 0.59 M Lei / year for option 1
- 0.22 M Lei / year for option 3

The cost of the treatment facilities are estimated in the report on the Water treatment and resumed in the Table 2. In the same way, the cost for the rehabilitation, decommissioning and creation of new well fields (necessary for the operation of the emergency plan) are described in the report on the Groundwater resources and resumed below.

3.3. EVALUATION OF VARIANTS

An economical comparison of the three options has been performed considering the costs assessed for the treatment plants. The result is presented in the table below:

Table 2: Economical comparison of variants

Variants	Energy gain per year (M Lei)	Investment costs (M Lei)		
		Transfer from Ialoveni to Chişinău City	Treatment of ground water	Decommissioning, Rehabilitation and creation of wells
Option 1	0.59	6.9	27.15	41.92
Option 2	0	0	7.68	2.57
Option 3	0.22	6.9	19.33	41.92

The calculated net present value (25 years – discount rate = 5%) of option 1 and 3 are 6 times higher than option 2. The net present values of options 1 is 4% higher than the one of option 3. The difference is zero with a discount rate of 1.5% only.

Option 2 is the most economical one. The difference between the option 2 and the two other options represents the effort to secure a minimum supply regarding the high risk of pollution or flood of Nistru River.

3.4. PREFERRED OPTION

The risk of pollution or flood of Nistru River is the most important risk to be considered for the water supply in Chişinău. To secure a minimum supply in regard to this risk, the Option 3 is the more economical solution. It is therefore considered as the preferred option.

The preferred option can be described as follows: in case the raw water intake in Nistru River is temporarily unusable, some water will be provided by the 4 existing well fields of Ialoveni, Balisevschi, Ghidighici and Petricani even if the quality of the ground water is poor. But to produce their maximum capacity, the wells need to be rehabilitated. Considering Ialoveni well field, the most economical solution is to implement a package treatment plant designed for the demand of Ialoveni City (5 000 m3/day for the peak day of 2035 horizon). The remaining capacity of this proposed treatment plant will be transferred to Schinoasa tank using the transfer facilities to be implemented for the emergency plan (as this investment should be made anyway).

3.5. PROPOSED DESIGN FOR THE TRANSMISSION MAINS

The proposed production scheme including an emergency plan is based on the split of the production between STA and the 4 well fields of Ialoveni, Balişevschi, Ghidighici and Petricani: SAN will be decommissioned.
The 4 well fields will operate continuously and will produce on a daily basis only a part of their total capacity. Therefore the daily production will maintain in good operating conditions the whole production system. Given the poor quality of the groundwater, the production of drinking water from all these sources for permanent supply will be treated thanks to package treatment plants. The adopted strategy proposes to treat H_2S and NH_4. To meet the standard for TDS and SO_4 (it concerns Balişevschi, Ghidighici and Petricani well fields), it is proposed to dilute the water in the reservoirs.

3.5.1. SHUTDOWN OF SAN

Before SAN will be decommissioned, the water distribution between Vadul Lui Voda and Tohatin has to be modified. It is proposed to supply Tohatin tanks from Zone 2. The main ND800 between Tohatin tanks and Zone 2 will be used in the reverse direction. To increase the flow to Tohatin tanks, two valves have to be opened:

- The valve located next to the crossing of str. Mesterul Manole and str. Vadul lui Voda between the ND1200 (outlet Vostoc) coming from STA and the ND600 supplying the ND800 to Tohatin tanks.
- The valve located at the crossroad of the streets Vadul Lui Voda, Milescu-Spataru and Transnistria, between the ND1200 (outlet Independenţa or Spataru) coming from STA and the ND400 supplying the ND800 to Tohatin tanks.

A new pumping station with a low Total Head (around 1 bar) will be also implemented on this ND800, 250 meters upstream Tohatin tanks to increase the flow to Tohatin when the pressure on the Zone 2 will be too low.
The operation of the current Tohatin pumping station will be maintained to supply Tohatin City and Coloniţa tank.

The main ND800 between Tohatin tanks and Vadul Lui Voda will also be used in the reverse direction to supply Vadul Lui Voda, Coşerniţa and localities alongside this ND800. For this purpose, new pumps have to be implemented in Tohatin Pumping station to be able to get over the point of the highest elevation on the route of the transmission pipe (the altitude of this point is 172m while the altitude of the reservoir is 160m).
SAN and the treated water pumping stations Treapta II and IIA will be by-passed and replaced by pressure reducer valves to maintain on the delivery networks of Vadul Lui Voda and Cosernita a constant pressure lower than 6 bars.

In case of incident on the ND800, the reservoir "Upper Vadul Lui Voda" will be preserved. A chlorination unit will be added in the tank to mitigate the high residence time of the water in the ND800 and to ensure a good quality of the water in Vadul Lui Voda, Coşerniţa and Balabaneşti.

3.5.2. DILUTION IN THE RESERVOIRS OF PETRICANI AND GHIDIGHICI

Production from Balişevschi, Ghidighici and Petricani well fields will be treated and mixed with the water from the network in the storage tanks before being pumped to the water supply network of Zone 1.
The water production system of Balişevschi is already following this organization: water coming from wells is mixed with the water from the network of Zone 2. As STA is supplying the water supply network of Zone 2 with water with low TDS and sulphate concentrations, the dilution rate is 2.38.
Petricani and Ghidighici well fields are located in the North West part of Chişinău; their production can be diluted with the water from the network of Zone 1 but the mixed water is pumped to the network of Zone 1. To avoid diluting the water from wells with already mixed water, the following organisations are proposed:

- In Petricani: two pipes of the Zone 1's network are connected to the production system of Petricani; it is proposed to pump the mixed water in the pipe connected to the north part of the Zone 1. The second pipe will be used to supply the Petricani's tanks with the water from the south part of the zone 1 (coming from STA). As shown on the figure below, one pipe connecting the 2 pipes will be closed.

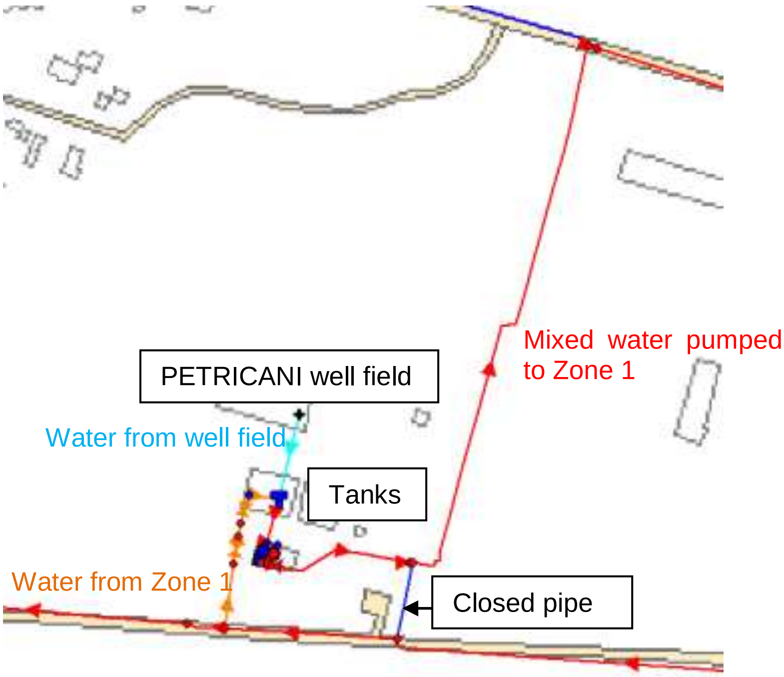


Figure 2: Connecting pipes of the Petricani production system

- In Ghidighici Pumping station: it is proposed to deliver the mixed water only to the North West part of the network (towards Vatra city). To constrain the flow to this direction, a check valve has to be installed on a bypass coming from Zone 1, allowing the water to be pumped to Chişinău city in case of emergency.

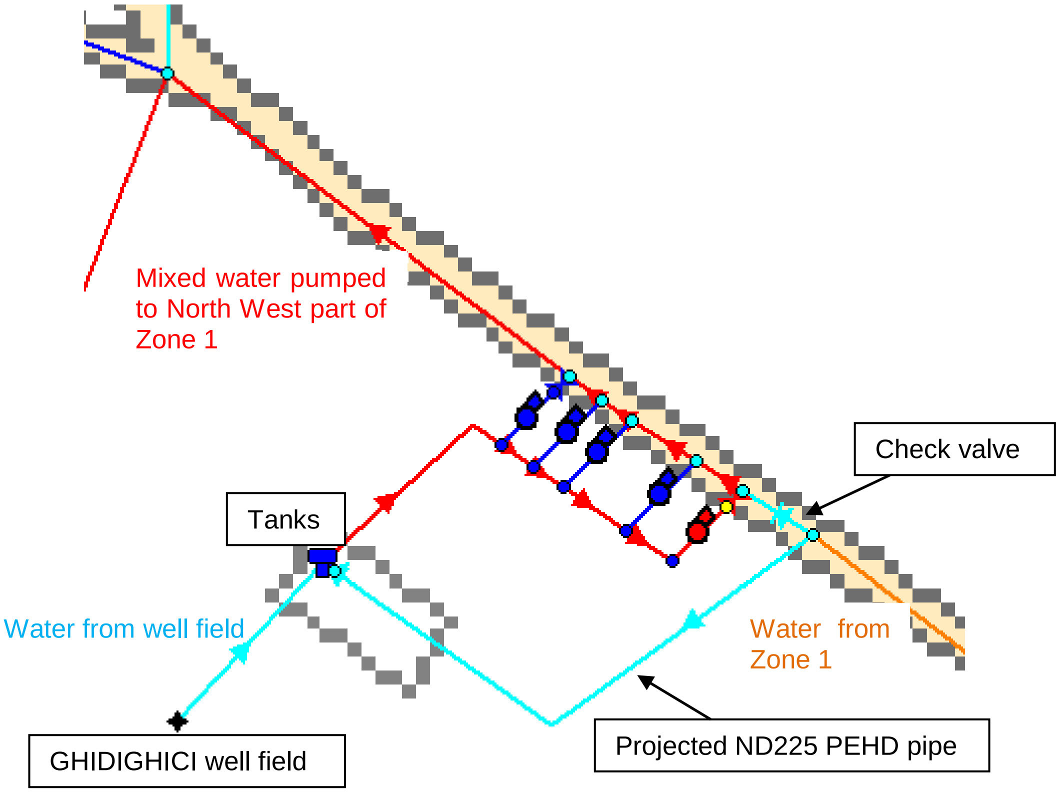


Figure 3: Connecting pipes of the Ghidighici production system

3.5.3. SUPPLY OF SCHINOASA TANK AND DURLEŞTI

To supply Schinoasa tank from Ialoveni, new pumps with a high Total Head (165m) have to be installed at Ialoveni pumping station. The currently closed valve located on the transfer main ND500/400 between Ialoveni PS and Chişinău will be opened to allow transfer to Schinoasa tank. This main will not be used to supply Ialoveni City. A new pipe ND300 will be laid to supply directly Ialoveni City as it is shown on the figure below.

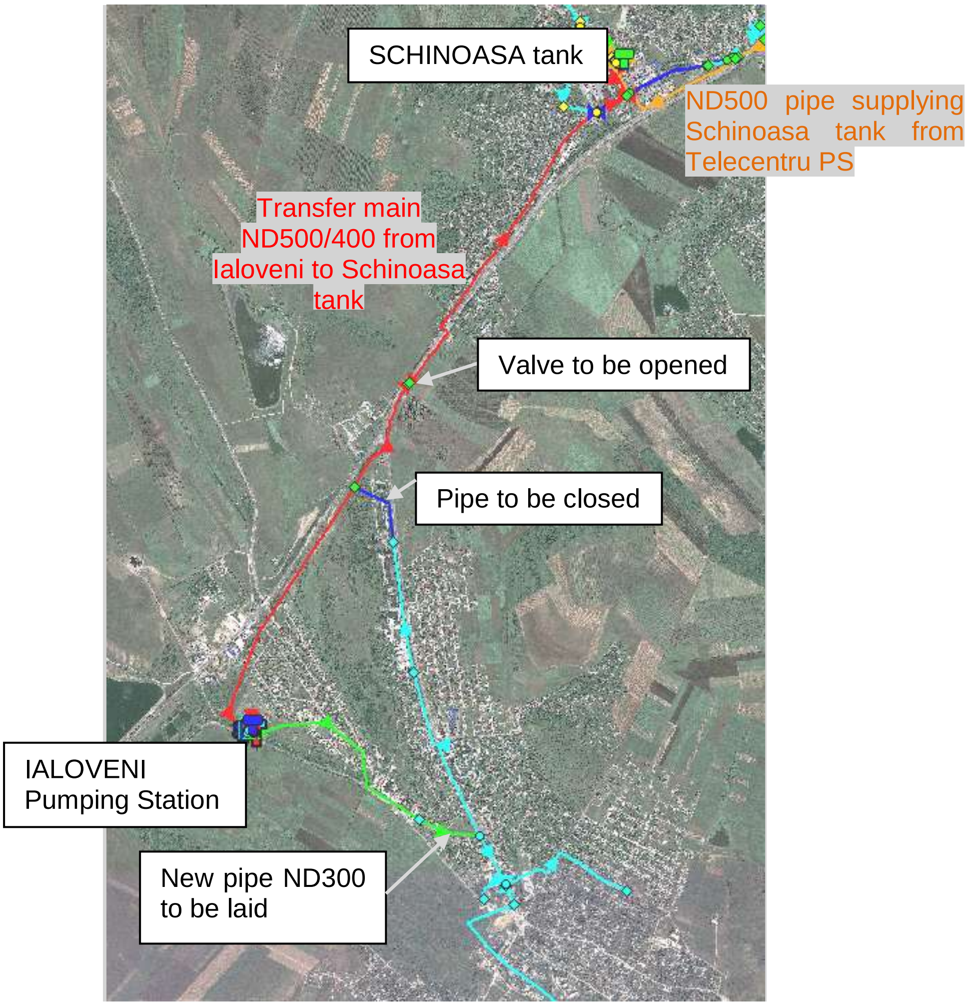


Figure 4: Proposed design for the transfer between Ialoveni and Schinoasa tank

Schinoasa tank will then be supplied by Ialoveni PS and Telecentru PS.

ACC has already scheduled to implement a new ND300 to connect the distribution Zones of Durleşti (Durleşti-Cartuşa and Durleşti-Gribov) to Schinoasa Pumping Station as it is shown on the Figure 5 below. The design of new pumps will be adapted to the projected demand of Durleşti and Zone 4a Schinoasa. The pumping stations and the tanks of Gribov and Cartuşa will be held in reserve (to maintain a second means of supply of Durleşti if the supply from Schinoasa is temporarily interrupted) and a by-pass of Cartuşa PS will be implemented. It must be noticed that in this projected configuration, the energetic ratio for the water supplied to Durleşti will be lower than the present one by 0.16 kWh/m^3.

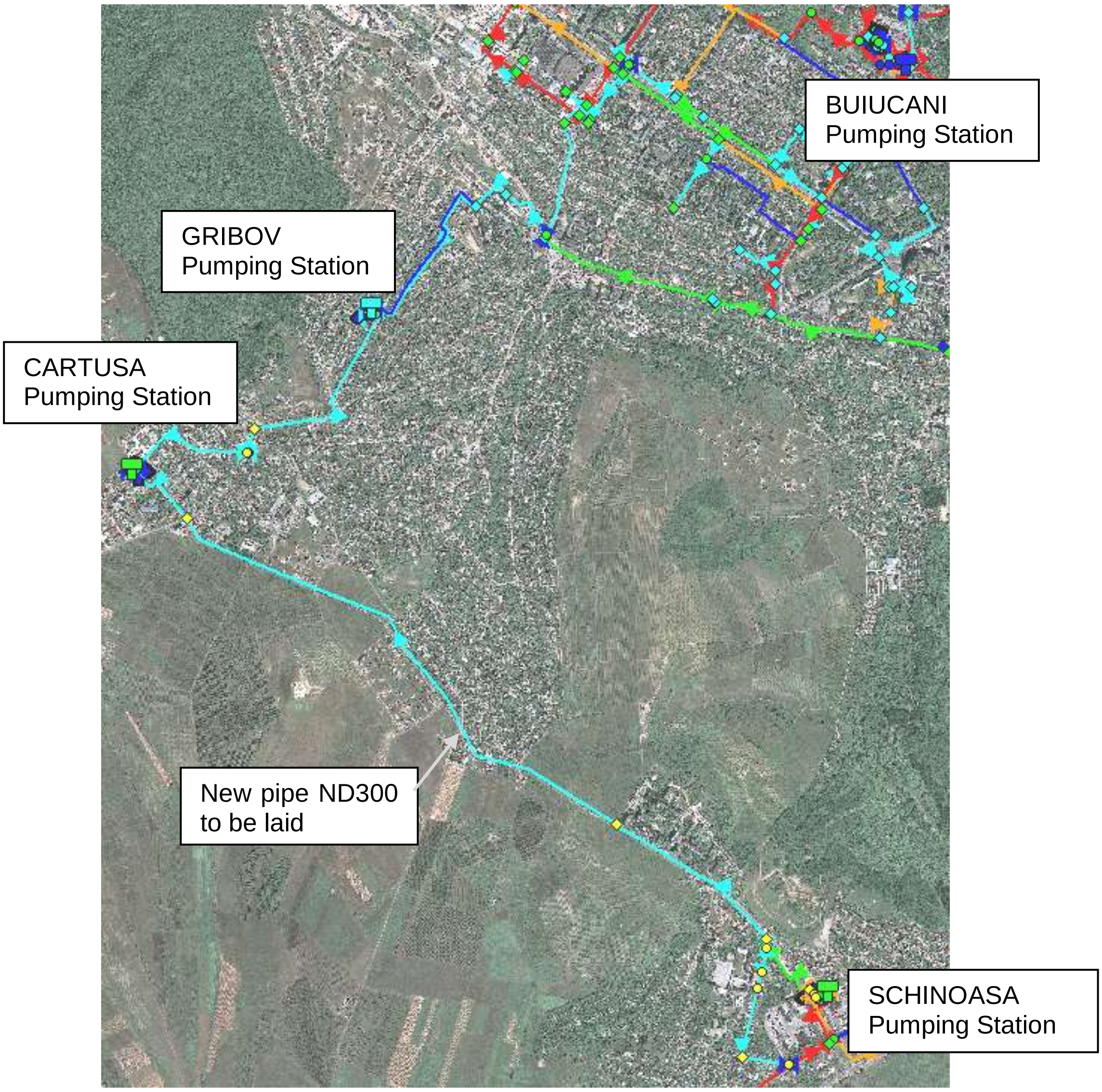


Figure 5: Projected transfer between Schinoasa Pumping Station and Durlesti

3.5.4. SUPPLY OF SOUTH EAST DISTRIBUTION ZONES

Codru pumping station is supplied by a 6000 m^3 tank located at a low elevation (around 40m only). This tank is filled by gravity from Zone 1 via a ND500/400/500 transfer pipe and a high level of energy is lost in the upstream regulation valve. This pumping station supplies then three tanks: Sîngera (elevation = 118m), Codru reservoir MDK (elevation = 82m) and Aeroport (elevation = 98m). Considering that Zone 1 is supplied by STA (elevation = 163m) via Zone 2, it is possible to supply those 3 tanks by gravity from Zone 2. Consumed energy by Codru PS will be saved (around 775 MWh in 2010).

To implement this solution, the ND500/400/500 transfer pipe has to be connected to Zone 2 instead of Zone 1 by manipulating valves. The pressure on the ND500/400/500 transfer pipe will then increase by more than 5 bars and reaches around 12 bars upstream Codru PS what will be enough to supply directly the 3 tanks (Codru PS will be by-passed). Unfortunately, the high pressure cannot be accepted by a part of the current ND500/400/500 transfer pipe. This part located upstream Codru PS (700 meters) has to be replaced by a ND400 before the implementation of the new configuration.

4. DESIGN SOLUTION FOR DISTRIBUTION NETWORK

4.1. DESIGN CRITERIA

4.1.1. OBJECTIVES (PRESSURE AND QUALITY)

The design of the network has to ensure for the future a good quality of service. Two objectives are to be taken into account:

- At each point of the network, the minimum pressure –at the peak hour generally- has to be high enough to ensure the supply of water to all consumers. The minimal pressure must be of 1 bar at the bottom of the buildings and of 0.4 bars for each floor. The minimal pressure to be supplied to a 5-floor building is therefore 30m.
- At each point of the network, the quality of the water has to be ensured. In Chişinău, the only limiting factor is the concentration of SO_4^{2-}. Indeed, the water extracted from the wells in Ghidighici, Petricani or Balişevschi contains a high quantity of SO_4^{2-}. A dilution is therefore needed in the reservoirs of the three pumping stations to lower the concentration below the admissible threshold of 250 mg/L of SO_4^{2-}. The production and dilution flows are described in the Table 3 below

Table 3: quality of the groundwater sources

Well fields	SO_4^{2-} (mg/L)	routine production flow (m^3/d)	dilution flow (m^3/d)
Ialoveni	250	2 090	0
Balişevschi	678	850	2 021
Petricani	443	1 130	1 881
Ghidigici	497	790	1 084

4.1.2. PEAK FACTORS

The network is designed for the peak consumption, meaning for the consumption at the peak hour of the peak day.

The peak consumption is calculated as shows the following equation:

$$C_{peak} = \alpha \times \beta \times C_{average}$$

where C_{peak} is the peak flow (m^3/h)
$C_{average}$ is the average flow of the year (m^3/h)
α is the peak factor of the peak day ($C_{peak\ day} = \alpha \times C_{average}$)
β is the hourly peak factor

The peak factors were obtained through the measurement campaign and are summarized in the Table 4.

Table 4: Peak factors for the water consumption

Zone	Daily peak factor	Hourly peak factor
Chişinău	1.36	1.66
Outer area	1.94	2.01
Total	1.40	1.66

Contrary to the consumption, it has been assumed that the physical water losses are not following a seasonal pattern.

4.2. IMPROVEMENT OF THE OPERATION

4.2.1. SOLUTIONS TO EXISTING BLACK SPOTS

During the diagnosis of the water supply network through the hydraulic model, a few black spots appear in Chişinău city. These black spots should disappear if a few actions are taken (fully explained in the report on the drinking water network model):

- Rehabilitation of the pipe street Lomonosov to supply the zone 3 Independenta by the pumping station Valea Dicescu, currently undergoing,
- Rehabilitation of the pipe at the crossroad of the streets Grenoble and Trajan to recreate a loop on the zone 3 Valea Dicescu, planned in the pipe rehabilitation program,
- Plan site survey to find the singularities that create high head loss in Chişinău city, especially the one on the street Pogdorenilor

4.2.2. PRESSURE REGULATION

In order to improve the operation of the network, especially the leakage rate, the management of the pressure is critical. By reducing the pressure, the water lost for each existing leak will be reduced[1], and the number of new leaks will drop.

In order to reduce the pressure in the network, several solutions have been studied:

- Change the pressure set at the outlet of the pumping stations.
- Isolate a part of the network and supply it by a pressure Zone with a lower piezometry;

[1] The water loss for one leak is described by the equation :

$$Water\ losses = Water\ losses\ (night) \times \left(\frac{Pressure}{Pressure\ (night)}\right)^{1.15}$$

- Isolate a part of the network and install a pressure reducer;

These solutions have been modelled for the peak day of the year 2015, with the new organization of the network (Schinoasa supplied by Ialoveni and SAN stopped)

The most important point when trying to reduce the pressure is to know the critical points of each Zone. The monitoring of the pressure at these points ensures then that problems of low pressure do not arise (around 40 pressure sensors will have to be installed on the network at the critical points). The current critical points are shown on the map below. They take into account the altitude of the ground, as well as the number of floors of each building.

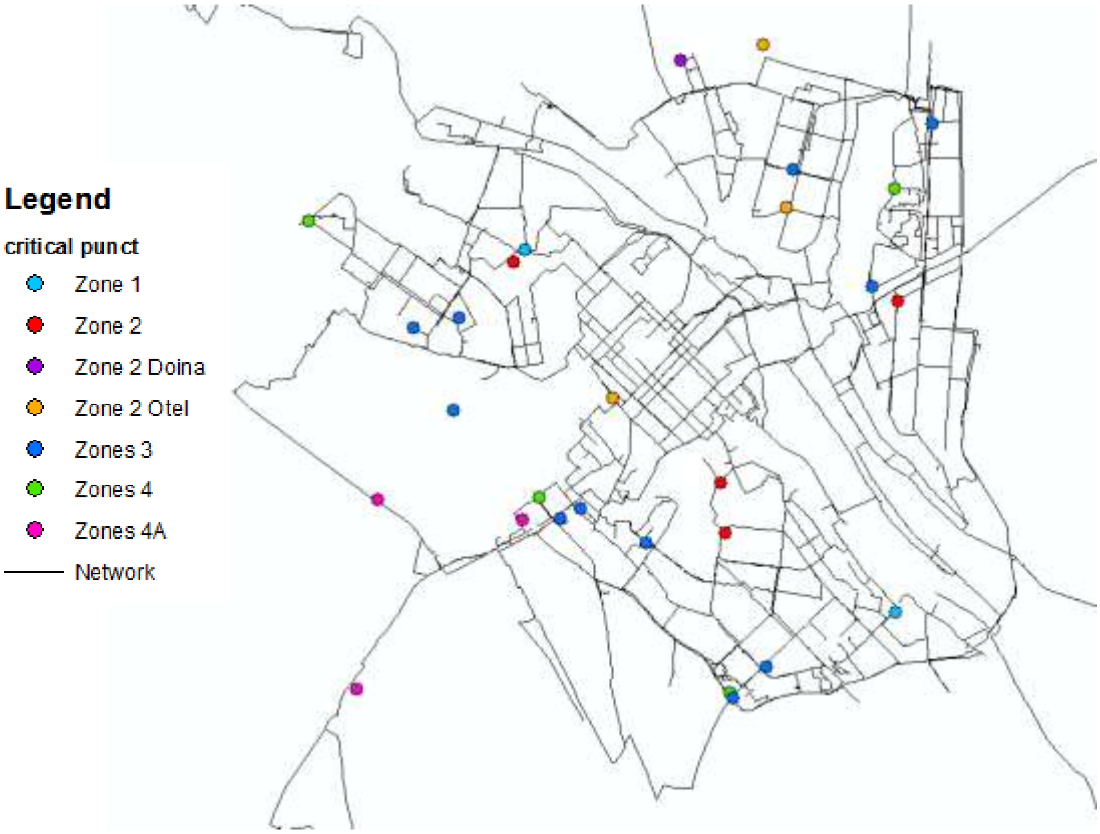


Figure 6: Critical points of the network of Chişinău

If an elevated building (or a small group of elevated buildings) is located in a zone where the other buildings have a low number of floors, it is sometimes more economical to adapt the pressure on the network to the low buildings and to implement a booster pump on the connection pipe of the elevated building. A picture of an up to date booster pump is given below.

Currently, Apa Canal already regulates the pressure by using several methods:

- Controlling the pressure at the outlets of the pumping stations, thanks to variable speed drives. The set pressure generally changes during the day to adapt the pressure to the consumption of the peak hour.

- Apa Canal uses as well pressure reducers in some place in Chişinău municipality, to reduce the pressure in a village (as in Bîc and Codru) or in a building (as the one on the street Izmail).
- The last method used to regulate the pressure on the network is to throttle valves. This is done at the outlet of the pumping station of SAN or on the outlet Oţel of the Water Treatment Plant. On this outlet, the regulation is performed right after the reservoir, controlling the pressure on the inlet pipe of Balişevschi pumping station. The piezometry maintained in the Zone is therefore optimal. However, the regulation by the valve enables air to enter the network and to deteriorate greatly the steel pipes downstream the regulation valve. The regulation cannot be displaced anymore, because of the poor condition of the pipe that would break down if the pressure were higher. It would be interesting but highly costly to replace this system.
- The regulation upstream the reservoir is performed as well by throttling valves. The implementation of appropriate system for this regulation will be addressed in the paragraph on the rehabilitation of the reservoirs that will consider solutions to modernize the regulation upstream the tanks.

Figure 7: Booster pump

4.2.3. IMPLEMENTATION OF PRESSURE REDUCTION

In most of the pumping station, the set pressure at the outlet corresponds to the objective piezometry to reach in the Zone (set by the objective piezometry at the critical points). And it is difficult to reduce the set pressures, at the exception of the Zone 3 Buiucani. Indeed, in this Zone, the pressure is 10m higher than required at the critical points (the 5-floor building on the street I. Pelivan, and the 9-floor buildings on the street Alba Iulia (on the Figure 8 below)). The pressure could therefore be reduced by 10m during the day. This could easily be implemented if no problem arises in the private sector, where the network is undersized -leading to the apparition of low pressure problems.

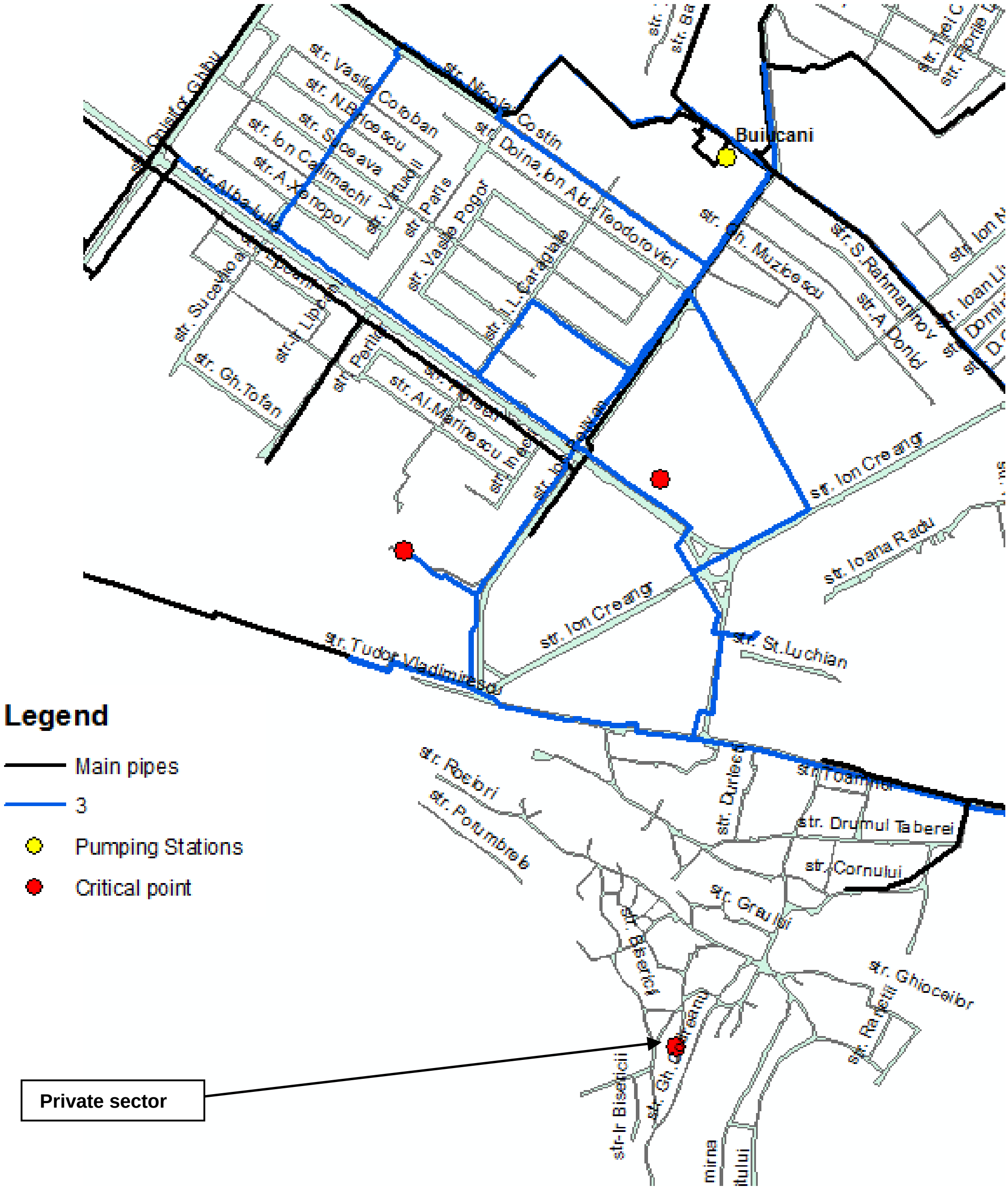


Figure 8: Critical points in the Zone 3 Buiucani

The easiest way to reduce the pressure on the network is to isolate parts of the network and install a pressure reducer. The different solutions that can be exploited are described below.

Part of the network of Valea Dicescu can be isolated (north of the Zone) by closing two valves, as presented on the Figure 9 below, and a pressure reducer installed (the piezometry will be 188m instead of 200m). The critical point is indicated in red on the network and corresponds to one building of 5 floors on the street Mitropolit G. Grosu.

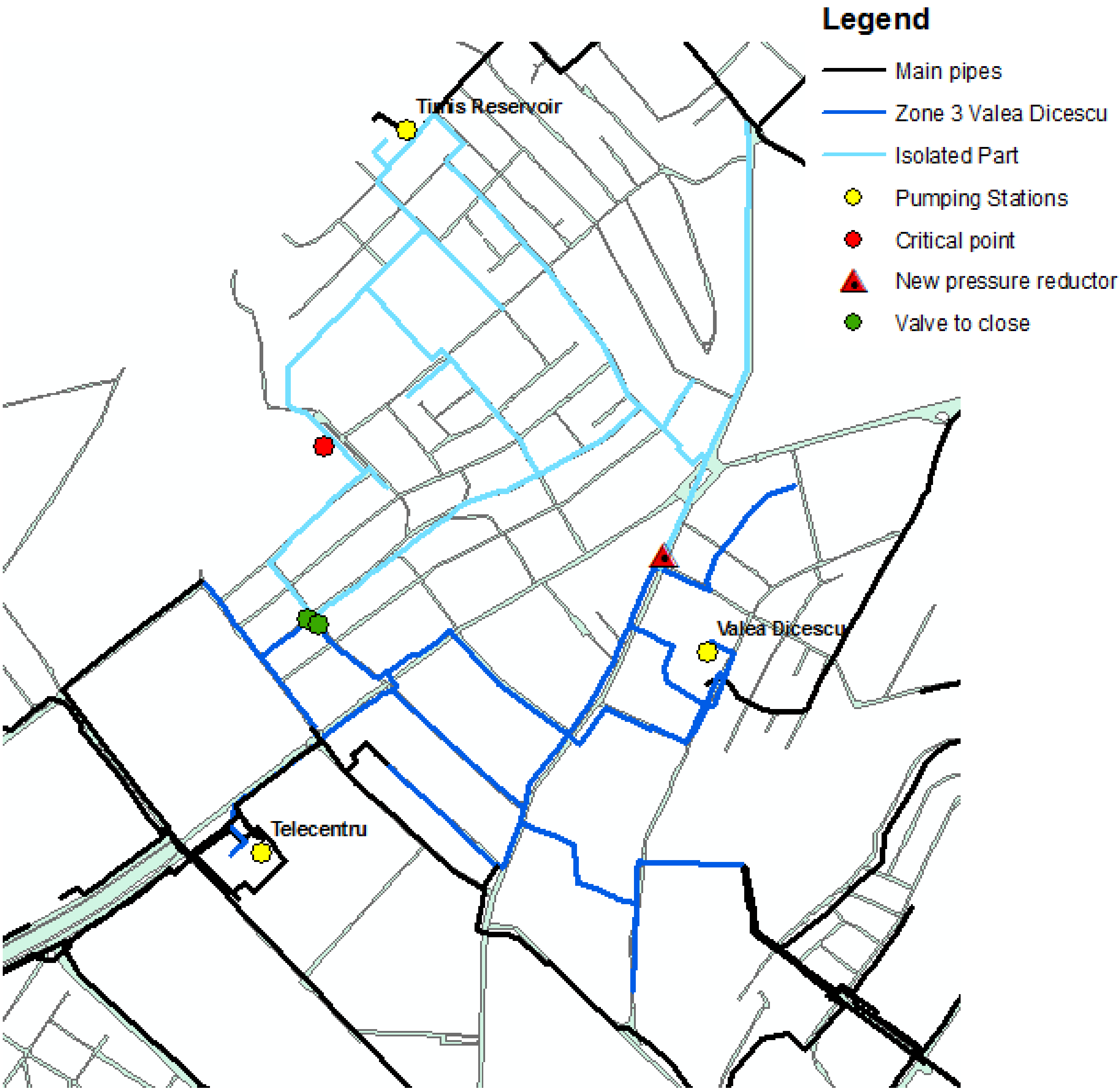


Figure 9: Pressure Reduction in the Zone 3 Valea Dicescu

In the Zone 4A Schinoasa, part of the network can be isolated and the pressure reduced, in the private sector near the pumping station. This reduction will have to wait for the new organization to be implemented (the pumping station of Schinoasa supplied by the pumping station of Ialoveni), otherwise, pressure problems would appear at the critical point (situated on the network between Ialoveni and Chişinău). The piezometry can be reduced from 265m to 250m, with a monitoring of the pressure at the critical point on the street Zodiac.

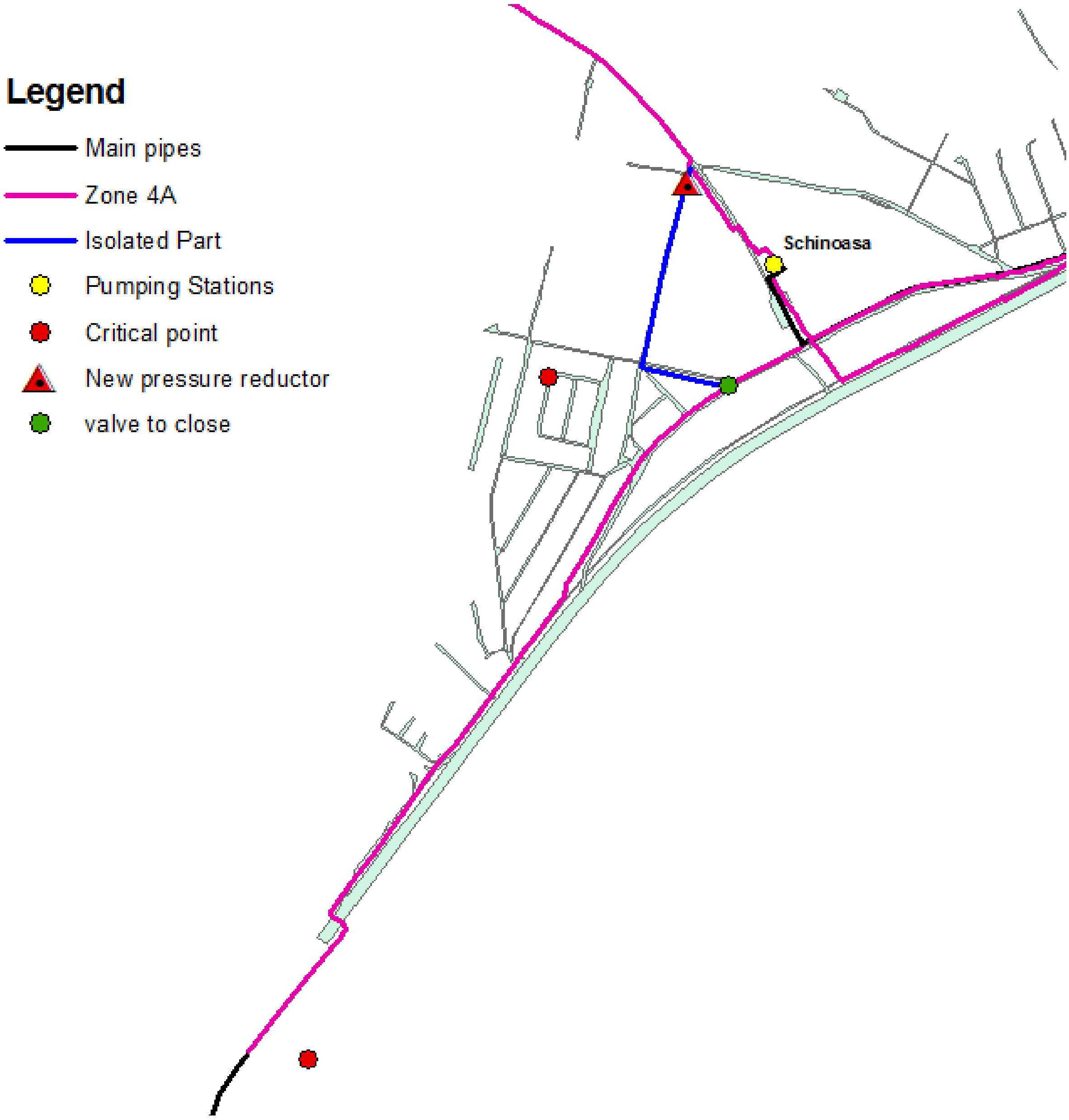


Figure 10: Isolated Network in the Zone 4A Schinoasa

The same process enables the isolation of a part of the Zone 2 Ciocana, in the industrial park. A pressure reducer has to be installed at the entrance of the Zone and the piezometry reduced from 160m to 135m. The figure below indicates the valves to close as well as the critical point (with a 9-floor building), where the pressure has to be monitored.

Figure 11: Reduction of pressure in the industrial Zone

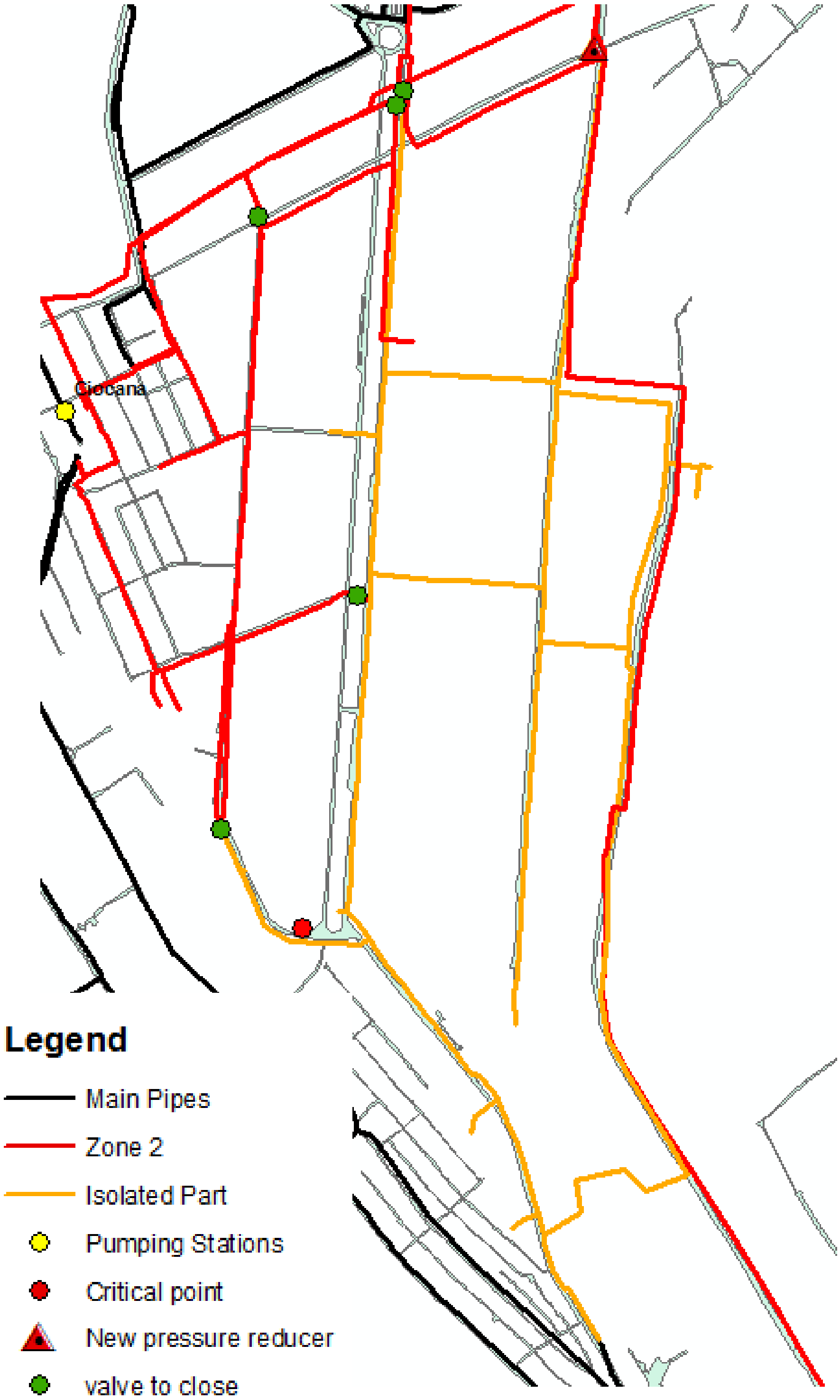
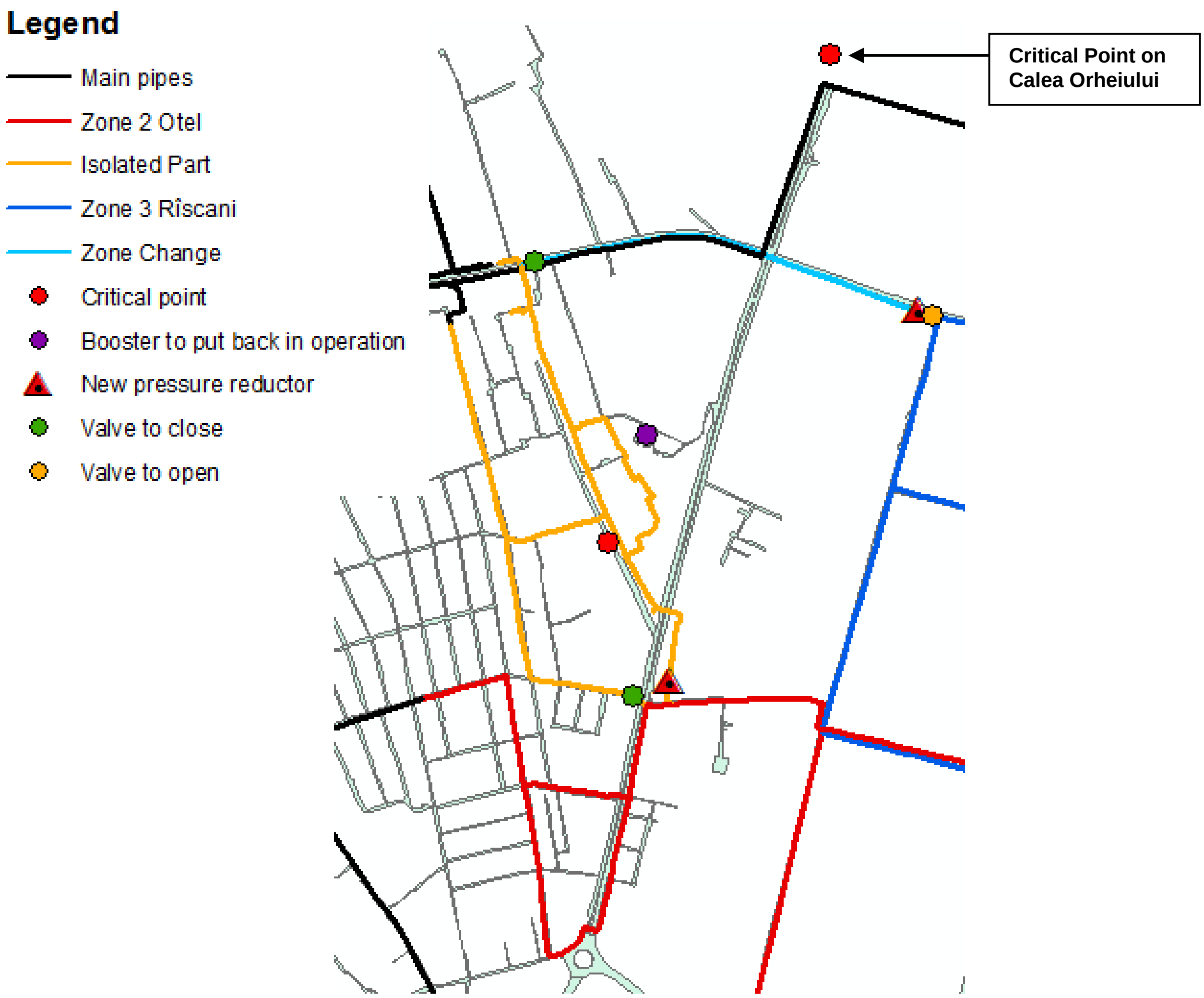


Figure 12: Reduction of pressure in the Zone 2 Oţel



In Rişcanovka, the organization will remain as it is now, with one part supplied by the outlet Oţel and one part supplied by the outlet Doina. On the outlet Oţel, it is possible to isolate a part of the network and to install a pressure reducer that will reduce the piezometry from 135m to 119m. In order for this reduction to be effective, one booster has to be operational again (the booster Calea Orheiului 113/3) and a part of the network has to be put on the pressure Zone 3 (with another pressure reducer) in order to supply the critical point at the north of the Street Calea Orheiului.

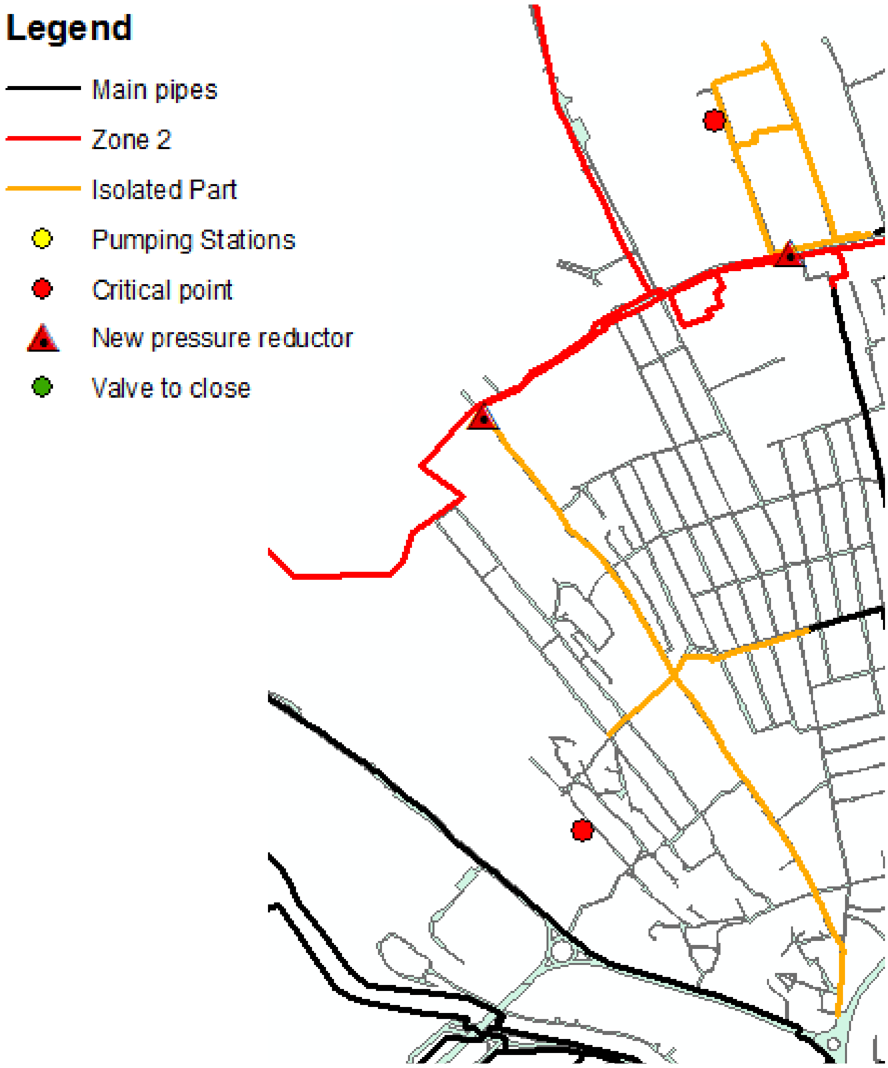
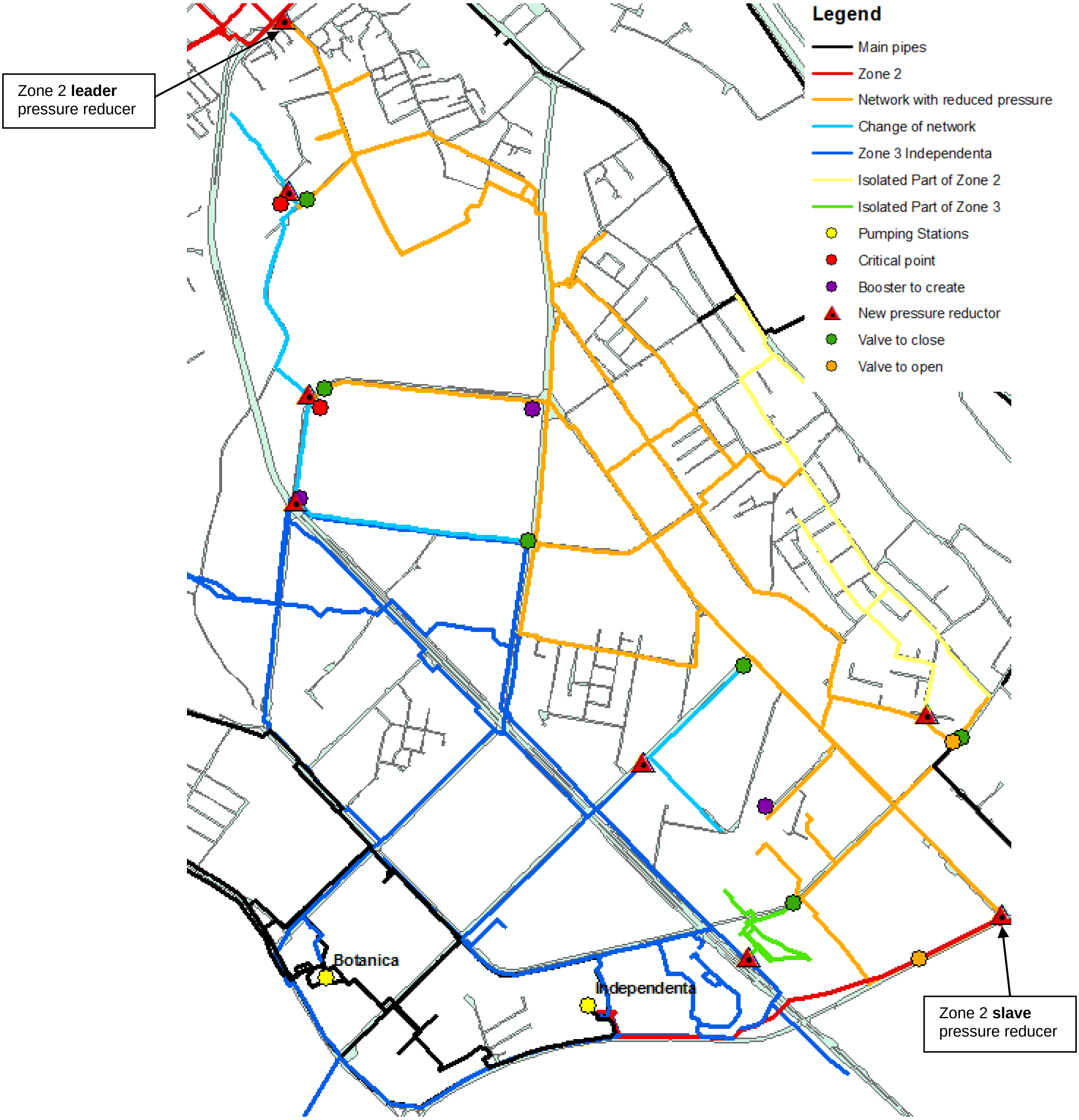


Figure 13: Reduction of the pressure on the outlet Doina

In the same way, two parts of the Zone 2 Doina can be isolated and pressure reducers installed. To control the pressure, the monitoring should be done at the two critical points. For the pressure reducer installed on the street Pogdorenilor, the pressure reduction is 65m, while the pressure reduction on the street Socoleni is 35m.

The Figure 14 below explains the proposed organization for the Zone 2 and Zone 3, in the sector Botanica. The first objective is to reduce the pressure in the Zone 2.
In order to do so, two pressure reducers are installed at both entries of the Zone: one reducer called the "leader", as it is the one imposing the piezometry in the Zone and the other one, called the "slave", that supports the first one, and enables to preserve the right piezometry during the peak hours. The piezometry imposed by both is around 130m, instead of 155m.

Figure 14: Pressure reduction in the Zone 2 in Botanica



The reduction of pressure is therefore high and to mitigate this reduction at the critical points, two solutions are proposed:

- Parts of the network are passed on the Zone 3 Independenţa -with the implementation of pressure reducers to maintain the current piezometry.
- Boosters are installed for two buildings, one with 10 floors on the street Transdafirilor and one with 9 floors on the street Cernauţi.

Hence, the pressure is reduced in the whole Zone and maintained at the current critical points of the Zone.
Moreover, two parts of the network can be isolated, presented on the map above:

- A portion of the Zone 2 near the street Cetatea Alba. The piezometry is reduced from 130m to 100m.
- A portion of the Zone 3 between Boulevard Dacia and street Burebista. The piezometry is reduced from 185m to 170m.

The last part of the network that can be isolated is situated in the Zone 1 (south of Chişinău). As the pumping station of Codru will be bypassed and the suburbs in the south will be supplied by the Zone 2, this action does not affect the supply of the suburbs. The piezometry can be reduced from 110m to 90m.

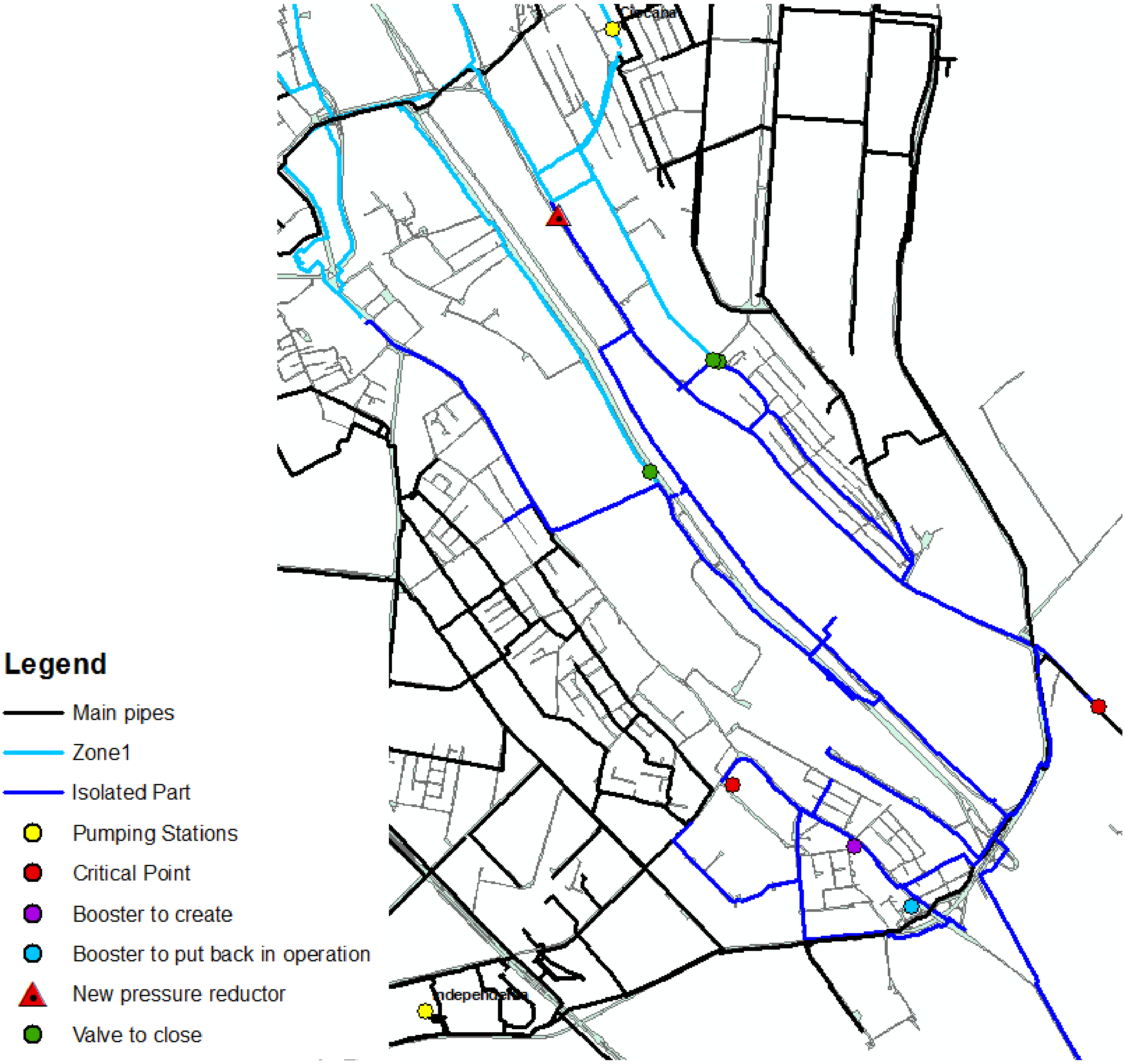


Figure 15: Pressure Reduction in the Zone 1

This reduction of pressure can be performed if the booster Muncesti 406/1 is put back into operation to supply a 9-floor building and if another booster is created on Muncesti street to supply three 10-floor buildings. The pressure will then be monitored at the two critical points indicated on the Figure 15 above.

The last method to reduce the pressure is to change the pressure Zone of a part of a network. In Ciocana, the part of the network supplied by the Zone 3 Ciocana near the street Spataru can be supplied by the Zone 2, as long as the elevation of the building is below 113m (as shown in the Figure 16).

In the same way, part of the network that is today supplied by the Zone 4 Ciocana can be supplied by the Zone 3 Ciocana.

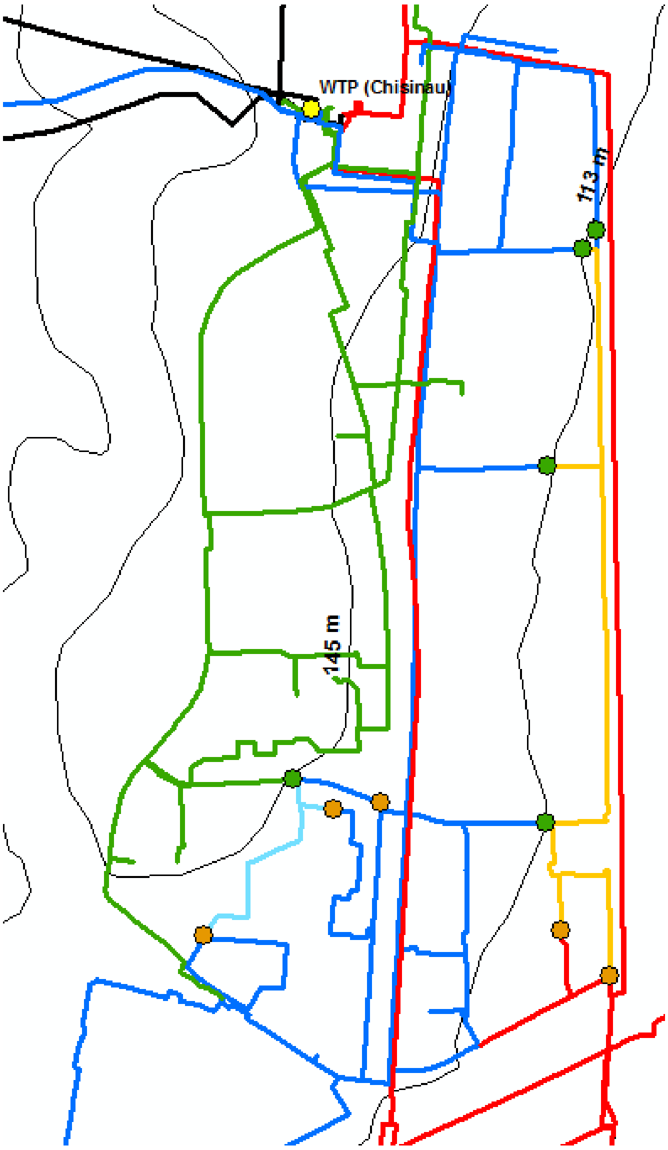
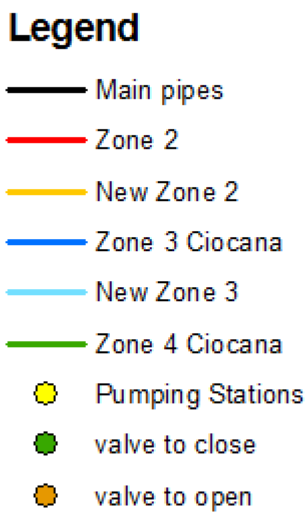


Figure 16: Pressure Reduction in Ciocana



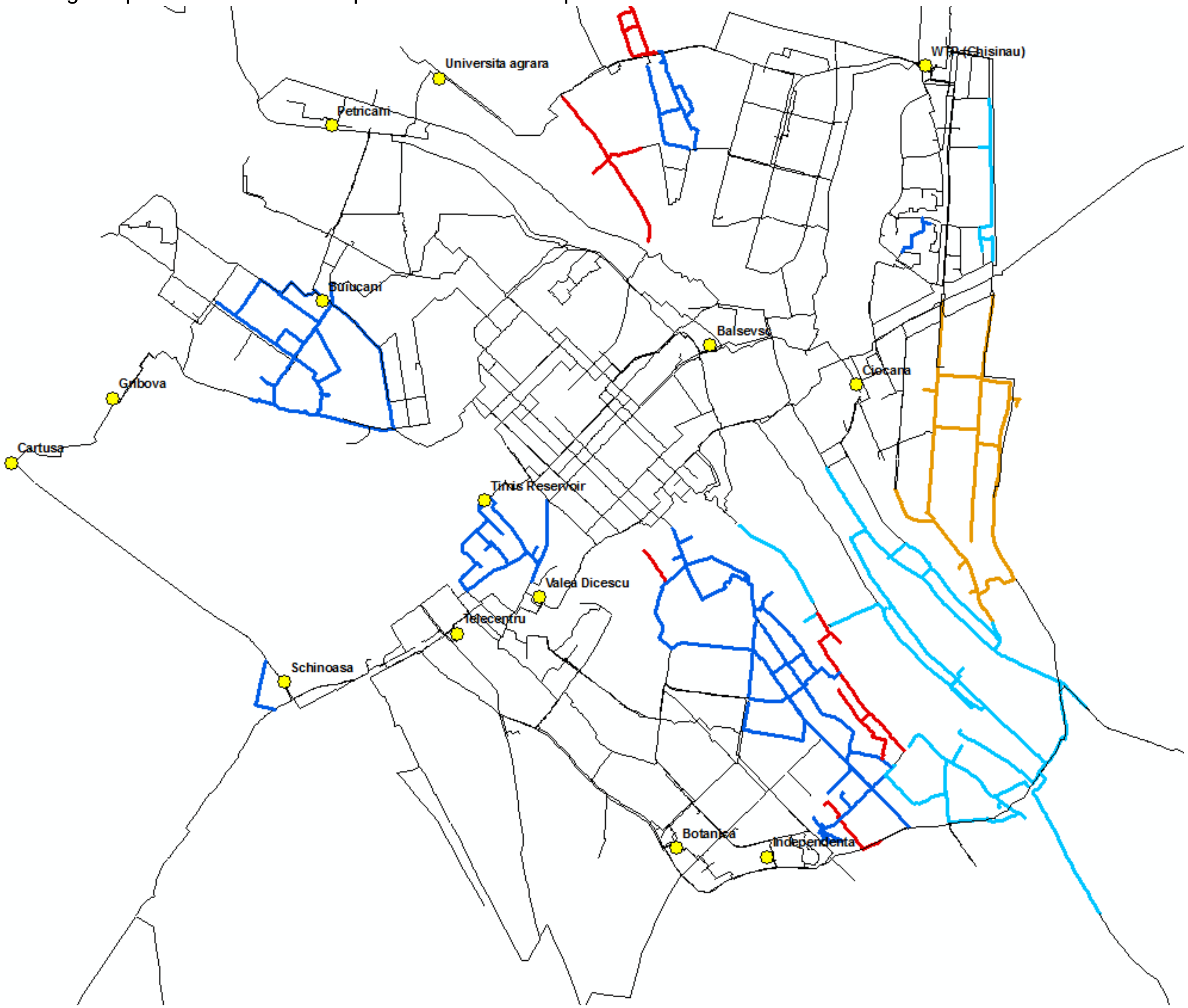
To summarize, the implementation of the proposed pressure reduction can be made by

- Installing 16 pressure reducers on the network
- Creating 3 boosters
- Putting 2 boosters back in operation

4.2.4. EXPECTED RESULTS

The summary of the results concerning the pressure reduction is presented in the map below.

Figure 17: Pressure reduction on the network of Chişinău



Legend

Network

Pressure reduction (m)

- 0
- 10 - 15
- 16 - 20
- 25 - 30
- 35 - 55
- Pumping Stations

4.2.5. IMPACT ON REDUCING WATER LOSSES

This reduction of the pressure will lead to a reduction of the water loss. The physical water losses can be **reduced by 10%** if the proposed organization is implemented.

Each proposition does not have the same efficiency and the Table 5 below shows the participation of the projects to the total reduction of water losses

Table 5: Technical Interest to implement the proposed solution

Zone	% of total water loss reduction	Hydraulic Energetic ratio (kWh/m^3)	Implementation
Zone 1	11%	0.51	1 pressure reducer; 1 booster to create & 1 booster back in operation
Zone 2 in Botanica	23%	0.49	8 pressure reducers and 2 boosters to create
Zone 2 in Ciocana	13%	0.49	1 pressure reducer
Zone 2 Doina	18%	0.48	2 pressure reducers
Zone 2 Oţel	0.5%	0.48	2 pressure reducers & 1 booster back in operation
Zone 3 Valea Dicescu	1.5%	0.68	1 pressure reducer
Zone 3 Buiucani	3.5%	0.52	-
Zone 3 Ciocana	27%	0.56	-
Zone 4 Ciocana	1%	0.57	-
Zone 4A Schinoasa	1.5%	0.82	1 pressure reducer
Total	100%	0.52	

The Table 5 shows that the regulation of the pressure does not have the same efficiency in all the Zones. Indeed, in the Zone 2 Oţel, the pressure is already well regulated. Even if the reduction of pressure would not affect greatly the water losses, it would decrease the number of new leakages. In addition, if the regulated zone is large enough, flow meters will be implemented upstream the pressure reducers. They will allow to perform the water balance of the regulated zones and to follow the Minimum Night Flows. Through the implementation of 8 new flow meters, the flow of 7 new hydraulic entities will be measured.

Finally, some projects are easy to implement and could reduce greatly the water losses, as

- The change of pressure for the Zones 3 and 4 in Ciocana,
- The reduction of pressure in the industrial area, supplied by the Zone 2 in Ciocana.
- The reduction of pressure in the Zone 2 Doina

For example, by implementing these three propositions, the total water losses could be reduced by 6%, and it would be reduced by 10% if all the projects were implemented. This reduction of water losses represents an electrical energetic gain of around 2 000 MWh/year (3% of the total electrical consumption of the whole pumping stations).

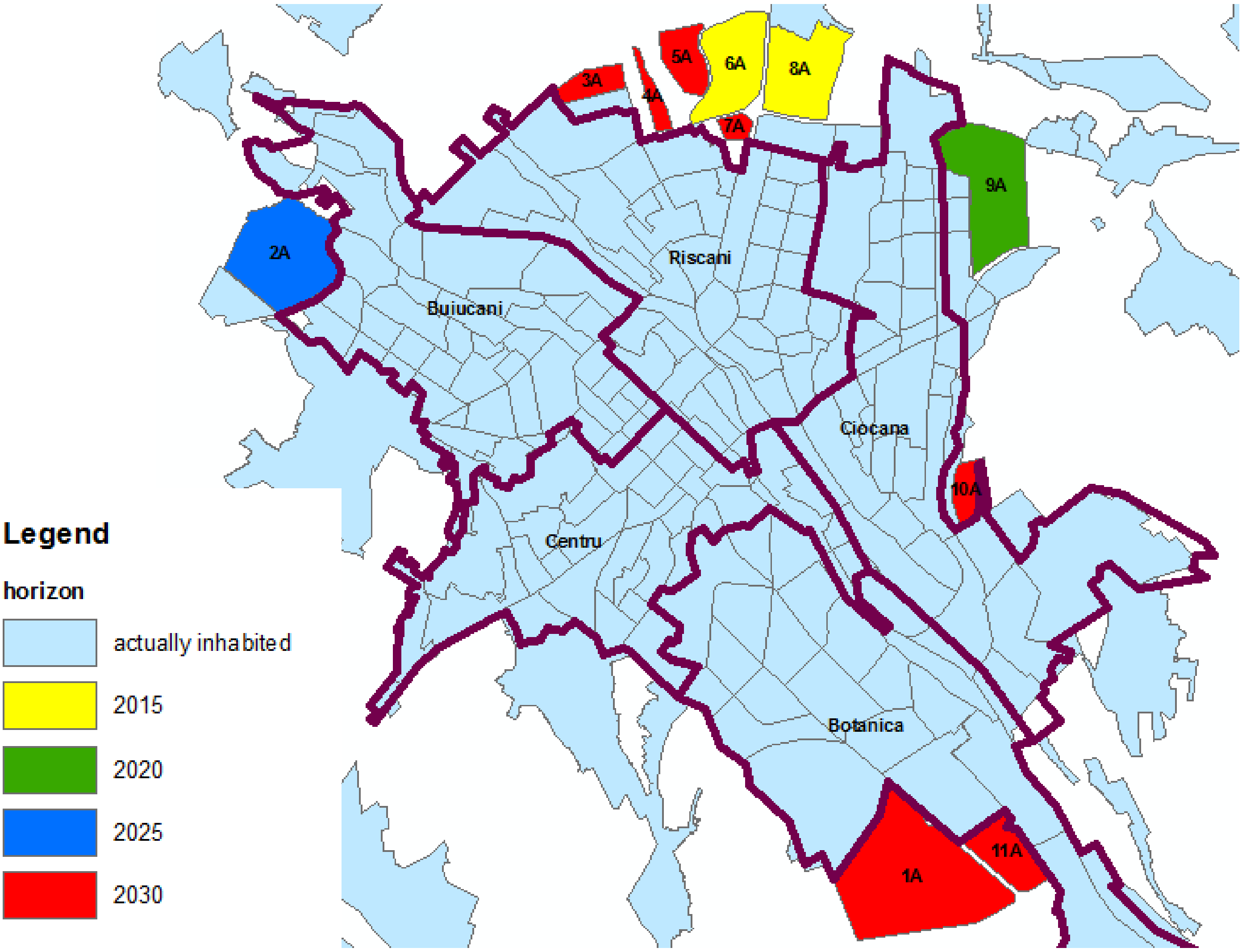
4.3. PROGRAMME FOR GROWTH AND REHABILITATION

4.3.1. EXPANSION OF THE NETWORK

4.3.1.1. Expansion of the network to new territories

The new territories correspond to 11 uninhabited areas in Chişinău that will be developed in the future. The Figure 18 shows the localisation and the code of these new territories, as well as the horizon of development. For example, in 2015, the Zones 6A and 8A will begin to develop while the Zone 7A will develop in 2030.

Figure 18: New Territories in Chişinău



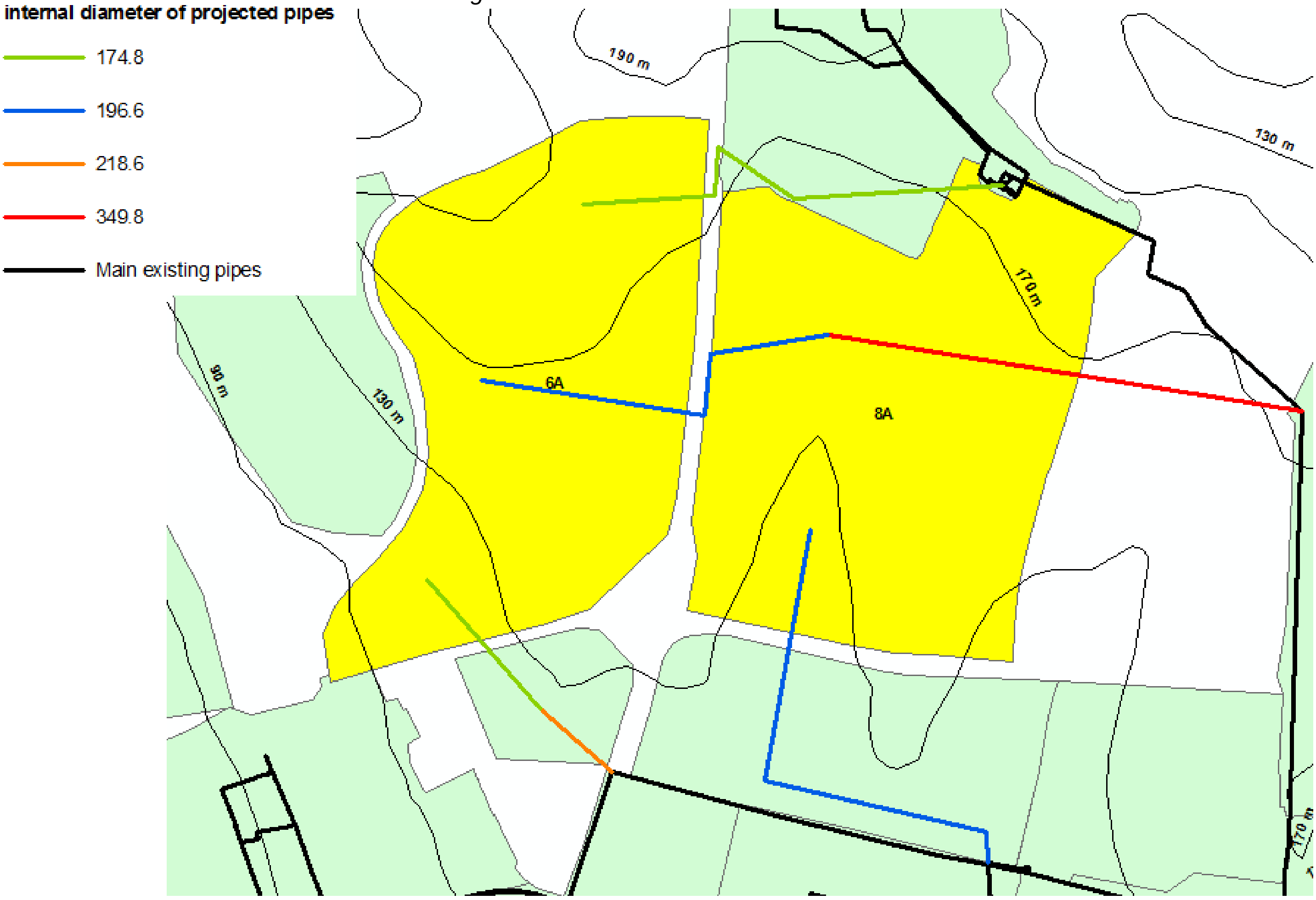
For each territory, the extension of the primary and the secondary network has been designed through the model of the peak day of 2035, meaning that it took into account the peak flow of the next 25 years. The description of the extension will be described below in a chronologic order; and a summary of the pipes, pumps and pressure reducers needed is given at the end.

The organization of the urban extension zones described below allows giving an estimation of the investments necessary in the future to supply these expansion zones.

The Zones 6A and 8A are topographically comprised between less than 90m and 185m. The Figure 19 below describes the resulting division of these two areas in several pressure Zones, as well as the diameter of the pipes supplying the areas (effective in 2015):

- The first pressure Zone (for the points where the elevation is below 130m), should be supplied by the outlet Doina from the Water treatment plant. This Zone will therefore belong to the hydraulic entity “Zone 2 Doina”
- The second pressure Zone will supply the points situated between 130m and 170m of the two Zones. It will be connected to the pipe linking the water treatment plant and the pumping station Stauceni. This pipe belongs to the pressure Zone 4 and to a new hydraulic entity “Water Treatment plant PS to Stauceni PS”
- The third pressure Zone supplies the area above 170m in the area 6A. The pipe will be connected to the outlet of Stauceni Pumping Station.

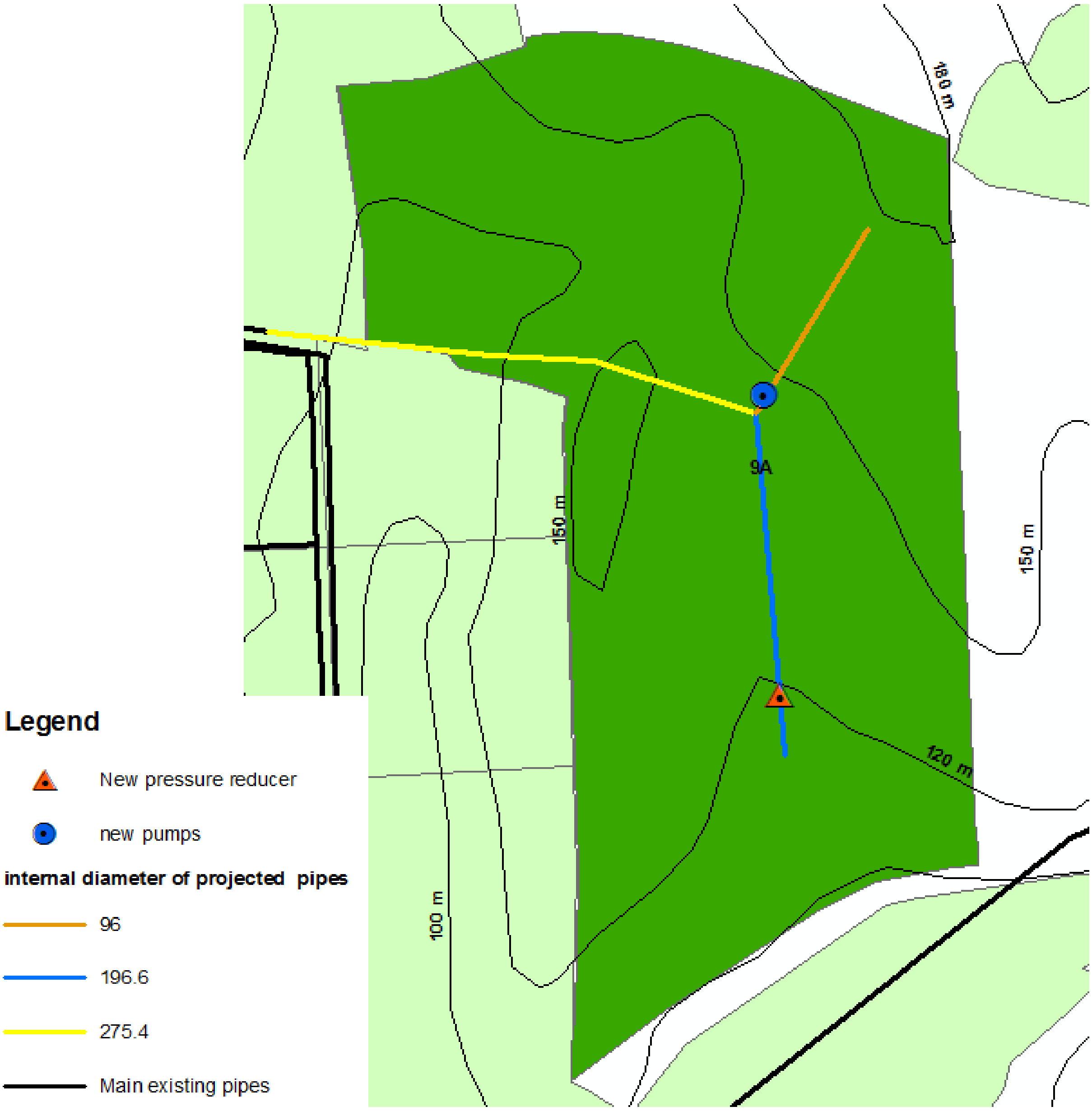
Figure 19: extensions for the Zone 6A and 8A and their diameter.



The Zone 9A will be developed in 2020. The topography of the Zone varies from 100m to 180m. The Figure 20 below describes the organisation of the network supplying this Zone. Three pressure Zones are created:

- For the area comprised between 130m and 160, the pipe is connected to the Zone 3 Ciocana.
- For the area below 130m, the pressure will be too high and a pressure reducer should be implemented. The pressure should at least be reduced by 20m.
- For the area between 160m and 180m, a pumping system is needed to supply the inhabitant. The pumping system should be able to supply an average daily flow of 108 m^3/d (from 1.5 m^3/h to 7m^3/h) with a head of 20m.

Figure 20: Extensions for the Zone 9A



The Zone 2A will be developed in 2025. The Zone will be supplied by water coming from the Zone 4 Buiucani. As the altitudes of the Zone are comprised between 100m and 200m, a pumping system will be needed to supply the area above 160m (corresponding to the way the Zone 4 Buiucani is organized). The organization of the area is described in the Figure 21 below. The pumping system should be chosen for it to be able to supply an average daily flow of 1 152m^3/d (encompassing flows from 12m^3/h to 90m^3/h) and a head of 40m.

Figure 21: Extension for the Zone 2A, near Buiucani

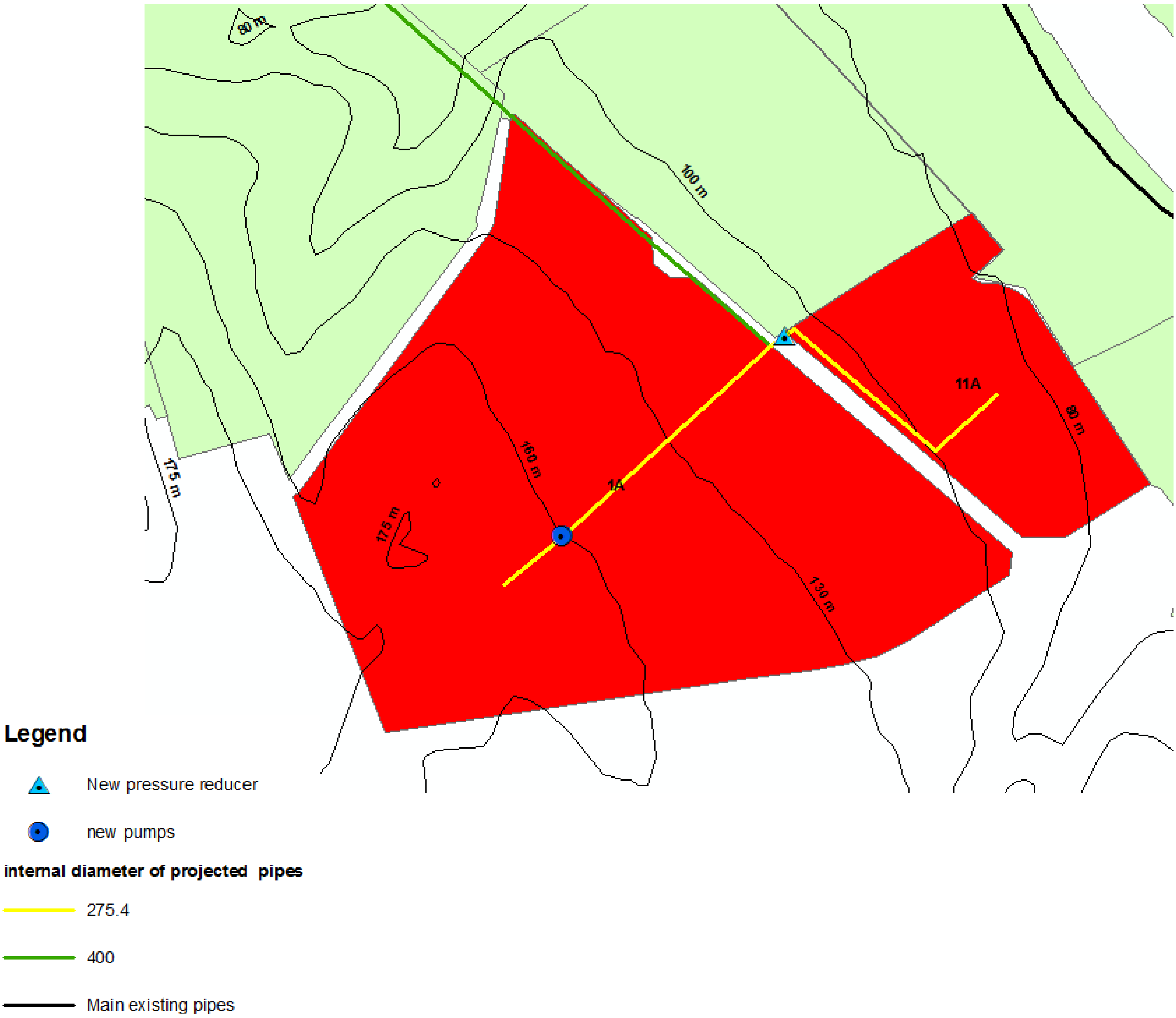
In 2030, the remaining Zones will start their development.

- The Zone 10A (altitudes between 80 and 100m) will be supplied by water coming from the gravitational outlet Independenţa from the Water Treatment Plant by a pipe with an internal diameter of 196.6mm.
- The Zones 1A and 11A, in the south of Botanica will be connected to the “Zone 3 Independenţa”. A pipe of 400mm will be laid in continuation of the existing one on the boulevard Dacia (see Figure 22 below).

The Zone 1A will then be divided into two areas. For the altitudes below 150m, the area will be supplied directly by the pressure Zone 3 Independenţa. A pumping system will be needed to reach the elevations above 150m. The pumping system should be able to supply a head of 15m for an average daily flow of 2 760 m3/d (encompassing flows from 50m3/h to 190m3/h).

The altitudes of the Zone 11A vary from 80m to 100m. A pressure reducer is therefore necessary at the inlet of the Zone to maintain a piezometry of 140m in the Zone, corresponding to a pressure reduction of 30m.

Figure 22: organization of the extension Zones 1A and 11A



- The Zones 3A, 4A, 7A, at the north of Chişinău will be supplied by the gravitational outlet Doina from the water treatment plant (see Figure 23).

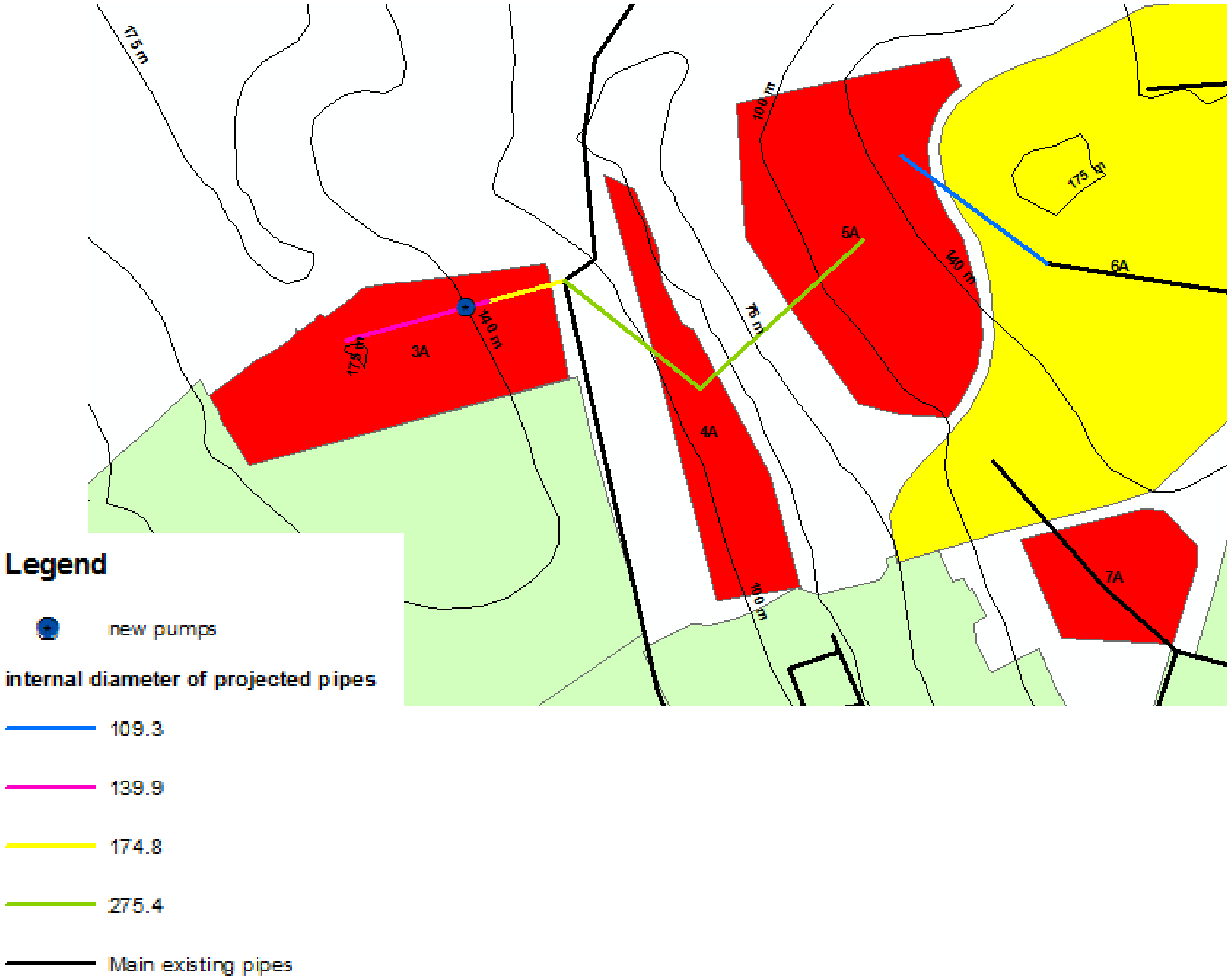
The altitudes of the Zone 7A vary from 115m to 135m and the whole Zone can be supplied by the Zone 2 Doina

The altitudes of the Zone 4A vary from 80m to 105m and the whole Zone can be supplied by the Zone 2 Doina.

The altitudes of the Zone 3A vary from 115m to 175m. The area with an altitude below 140m will be supplied by water coming from the Zone 2 Doina. A pumping system should then be implemented to supply the area above 140m. The pumping system should be able to supply a head of 35m for a daily average flow of 528m3/d (encompassing flows from 9 m3/h to 35m3/h)

- The Zone 5A will be divided in two pressure Zones. The lowest one (altitudes below 130m) will be connected to the Zone 4A and will therefore be supplied by the Zone 2 Doina. The area with altitudes between 130m and 175m will be connected to the Zone 6A and will therefore be supplied by the pipe connecting the water treatment plant and the pumping station of Stauceni.

Figure 23: organization of the extension Zones 3A, 4A, 5A and 7A



The Table 6 summarizes the investments needed to supply the future urban expansion Zones of Chişinău. The material of the pipes is the PEHD and the internal diameters are described here.

Table 6: Summary of investment for urban extension areas

Horizon	Zones	internal diameter (mm)	Length of the pipe (m)	Comments
2015	Zones 6A and 8A	174.8	1730	
		174.8	420	
		196.6	1300	
		196.6	1460	
		218.6	550	
		349.8	1545	
2020	Zone 9A	65.5	185	
		196.6	1110	Install a pressure reducer with a set pressure of 20m
		275.4	930	
2025	Zone 2A	218.6	700	
		275.4	1215	
2030	Zone 10A	196.6	550	
	Zones 1A and 11A	275.4	1090	Install a pressure reducer with a set pressure of 30m for the Zone 11A
		275.4	1420	
		400	940	
	Zone 3A	139.9	605	
		174.8	635	
	Zone 4A	275.4	745	
	Zone 5A	109.3	550	
		275.4	500	
	Zone 7A	-	-	Pipe already laid in 2015 to supply the Zone 6A

The characteristics of the pumps to install are summarized in the Table 7 below. The installed power corresponds to 3 identical pumps: Two working on a daily basis and one back up pump.

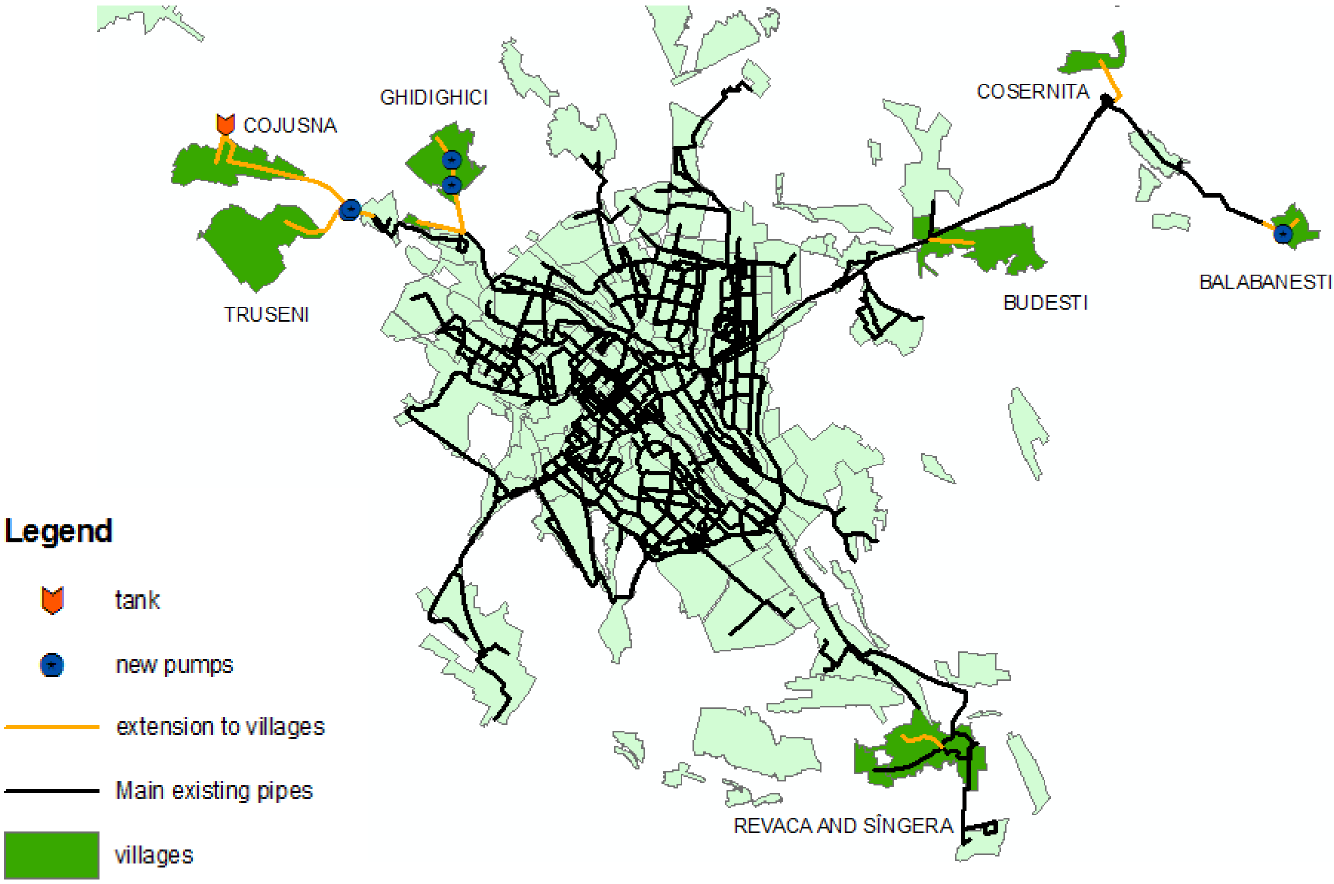
Table 7: Summary of the pumping system to install to supply the urban extensions

Extension	Flow max (m^3/h)	Head max (m)	Efficiency (%)	Installed power (kW)
2A 200m	88.39	40	56%	26.0
3A 170m	35.05	35	43%	11.8
9A 180m	6.85	20	43%	1.3
1A 170m	188.45	15	63%	18.2

4.3.1.2. Expansion of the network to the suburbs

In the same way, some suburbs are planned to be connected to ACC's network in the future. Interviews were performed in every village of the study area and the villages identified to be connected to ACC's network in the future are presented in the Figure 24, as well as the solutions that are developed below.

Figure 24: Extensions to villages



- The well of Sîngera will be closed before 2015 and the part of the network today supplied by this well will be connected to the network of Sîngera supplied gravitationally by the reservoirs of Sîngera Pumping Station. The internal diameter and the length of the pipes are summarized in Table 8.
- The city of Revaca will be supplied by the network of ACC before 2015 as well. The pipe of 180 mm has already been laid and only the connections to the houses are missing.
- The well in Vatra city will be closed before 2015 and the part of Vatra that is nowadays supplied by this well will be connected to the network of ACC at the pumping station of Ghidighici.

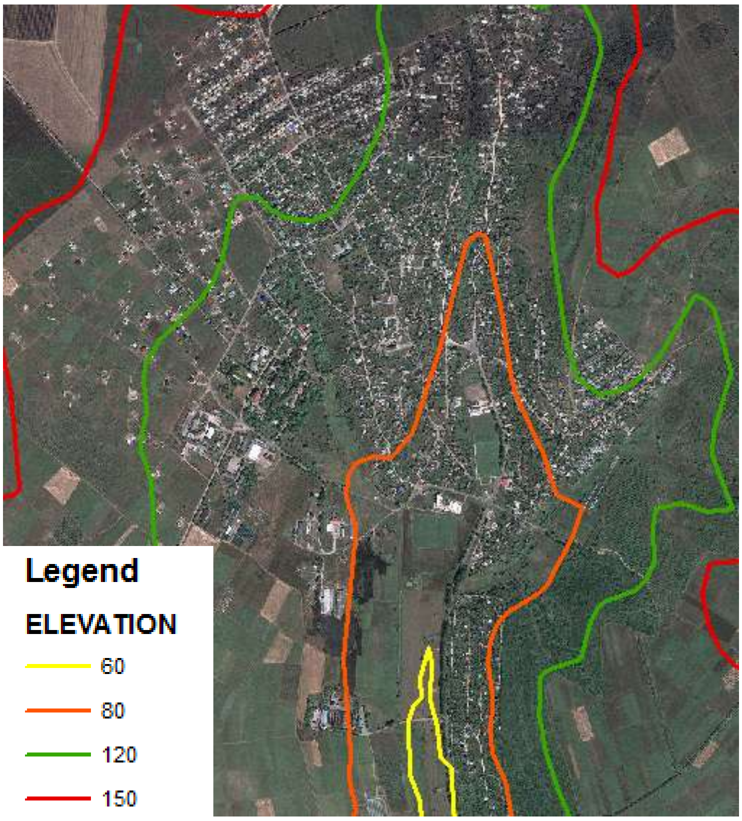
- The wells of Ghidighici will be as well stopped before 2015 and the city connected to the main network of ACC at the pumping Station of Ghidighici. The altitudes of the city of Ghidighici vary from 60m to 150m. The city is therefore divided into three pressure Zones (see Figure 25 below):

Below 80m, the city is supplied by the water coming directly from Ghidighici Pumping Station.

Between 80m and 120m, one pumping system has to be installed. The pumps should supply a head of 45m for an average daily flow of 20 m3/h (encompassing flows from 3 to 55m3/h).

To supply the part of the city above 120m, another pumping system should be installed. The pumping system should supply a head of 35m and an average daily flow of 5m3/h (encompassing flows from 1 to 13m3/h).

Figure 25: Contour lines in Ghidighici city



- The pipe connecting Truşeni city to Vatra city will be laid before 2015 and the city will be completely connected to the network in 2030 (actually, about 43% of the city is connected to a network). The wells that currently supply the city will be closed in the future. A pumping system has to be installed that should be able to supply a head of 140m and an average daily flow of 45m^3/h (encompassing flow from 10 to 75m^3/h).

- In the same way, the city of Cojuşna will be connected to the network of Chişinău before 2015. A reservoir exists in the city of Cojuşna, located at the highest point (around 140m). A pumping system must be installed between Vatra and this reservoir. The pumping system should be able to supply a head of 70m for a flow of 55m^3/h. The connecting pipe should be 174.8mm. And the pipe in the village connecting the reservoir to the consumers should have an internal diameter of 218.6 mm.

- The city of Balabaneşti will as well be connected to the network of ACC. The 300mm pipe supplies the Waste Water Treatment Plant and the same pipe should supply Balabaneşti. The village should be divided in two pressure Zones:

The part of the city below 50m will be supplied directly by gravity via the pipe coming from Vadul Lui Voda.

For the part of the city between 50 and 120m, a pumping system should be implemented, with a capacity of 70m and an average daily flow of 12m3/h (ranging from 4 to 29m3/h)

- For the city of Coşerniţa, the diameter of the current pipe is not enough to supply the forecasted growing population of the city and should be replaced before 2015.
- The city of Budeşti will be connected to the network of ACC before 2020.

The Table 8 summarizes the pipes of the transfer network to be laid in order to supply the suburbs, while the Table 9 summarizes the power to install for the supply of the villages.

Table 8: Summary of the investments to connect the suburbs

Horizon	Village	diameter (mm)	length (m)	Comment
2015	Sîngera	65.5	1700	Part of the network already exists
	Revaca	-	-	Connections need to be performed
	Ghidighici 80m	196.6	1975	Part of the network already exists
	Ghidighici 120m	174.8	765	
	Ghidighici 150m	109.3	555	
	Vatra	96	1945	The network already exists
	Coşerniţa	174.8	1600	Rehabilitation of an existing transfer pipe under sized
	Cojuşna	174.8	6163	Presence of a reservoir.
		218.6	1090	
	Truşeni	196.6	2415	Part of the network already exists
	Cojuşna & Truşeni	275.4	710	
	Balabaneşti 50m	174.8	845.3	The network already exists
	Balabaneşti 120m	139.9	655	
2020	Budeşti	196.6	1306.46	The network already exists

Table 9: Summary of the pumping system to implement for the villages

Extension	Flow max (m^3/h)	Head max (m)	Efficiency (%)	Installed power (kW)
Ghidighici 120m	55.13	45	51%	19.9
Ghidighici 150m	13.34	35	43%	4.4
Cojuşna Reservoir 152m	54.06	70	51%	30.4
Truşeni	73.35	140	56%	75.5
Balabaneşti	28.6	70	43%	19

4.3.2. IDENTIFICATION OF PIPE REHABILITATION NEEDS

The assessment of the current situation based on ACC data showed that the network's efficiency is thought to be around 61% and the linear leakage index around 47m^3/day/km for the drinking water network and 84m^3/day/km for the technological water network.

Those values are very high and show that both networks are in poor condition. In France, Veolia ranks urban network within the "Very Poor" category when the linear leakage index is higher than 16m^3/day/km.

The measurement campaign performed on the drinking water network last summer confirmed these values. Based on an analysis of the night flows delivered to the 36 distribution Zones and a comparison between delivered flows and consumption, more precise indicators have been calculated for each Zone (see chapter 5.6 of the Report Potable Water Supply Network – Measurement Campaign – Summer 2011).

Concerning Chişinău City, the average efficiency of the drinking water network is around 63% while the linear leakage index is around 48 m^3/day/km. Seven distribution Zones are more concerned by physical losses:

Table 10: Efficiency of the Drinking Water Network in the 7 Most Critical Zones

Zone	Average delivered flow (m^3/d)	Water losses (m^3/d)	Network efficiency (%)	Length of the network (km)	Linear leakage index ($m^3/d/km$)
Zone 2 - Tohatin, Vostoc and Independenţa	38 788	18 744	52%	274	68
Zone 2 - Doina	11 446	5 226	54%	73	71
Zone 3 - Independenţa	14 985	5 510	63%	59	94
Zone 3 - Ciocana	15 378	7 253	53%	36	203
Zone 3 - U.Agrara	519	186	64%	3	70
Zone 4 - Independenţa	8 309	2 579	69%	41	63
Zone 4A - Botanica	938	317	66%	4	82
TOTAL	**90 364**	**39 816**	**56%**	**489**	**81**
% of the total Chişinău City	51%	60%		35%	

The distribution Zones outside Chişinău City represent only 9% of the total average flow delivered by ACC, the average efficiency is lower (around 50% only) but the linear leakage index is better (around 22m^3/day/km). Four of them are supplied by networks with very bad performance indicators (efficiency lower than 35%): Codru to Sîngera, Coşerniţa, Coloniţa and Vadul lui Voda.

Such bad efficiencies are mainly due to the high brittleness of the network and its service connections: over the last 5 years, an average of 13 400 leaks were found and repaired every year. Around 68% occur on mains (32% on service connections).

The main reasons of the brittleness of the network are:

1. **Corrosivity of soil:** clay soils are corrosive; they destroy concrete and metal in civil works, pipes, fittings etc... In consequence, steel pipes unprotected against corrosion are very fragile. Leakages due to corrosion pits are very common in Chişinău.

2. **Interruption of the water supply** during electrical shortages or sudden pumping events (such phenomena have been observed during the measurement campaign) generates water hammers and depressurisation of the network. It also leads to pipe bursts and pollution infiltration (lower water quality and public health hazards).

3. **Pipe repair practices:** wood cones are plugged into the pipe to obstruct the leaking surface and backfill compaction is not carried out. It is estimated that the recurrence rate of repaired leaks that re-appear during the year is around 30%.

To illustrate the previous point, a burst repaired by plugging several wood cones still leaking after ACC intervention is given on the following picture:

Figure 26: Repair on a pipe using wood cones

4.3.2.1. Replacement of the pipelines

The technical performance of a potable water system has three axes which are the level of water losses, the continuity of service and the quality of the distributed water. In the short term, improved operating practices can reduce the number of leaks. But, in the long term, the aging of the network will deteriorate the performances. For the time being, although 98% of the network is younger than 50 years, its condition is very poor. It should be considered that a lifespan of 50 years is a maximum.

ACC has identified pipelines which need to be rehabilitated because they are too brittle, difficult to maintain or strategic. The list and map is given in Annex.

The main characteristics of the identified pipelines to be rehabilitated are given in the following table:

Table 11: the Linear of the identified pipelines to be rehabilitated by Diameter and Material

Nominal Diameter	Material										
	Concrete	Iron	Iron then Steel	Romanian Iron	Steel	Steel + Iron	Steel + PE	Steel 80% Iron 20%	PE Ascim	Unknown	Total (m)
63					50				55		105
100,76,63,32					1 500						1 500
100		3 000		380	4 971		200			1 000	9 551
150					1 090	1 140					2 230
180					360						360
200	800				7 685	1 373					9 858
250										200	200
300		1 220	1 450		11 147	10 556		1 460		1 500	27 333
400					1 200	932				1 120	3 252
500		800			6 686	1 242					8 728
600					2 910						2 910
800					3 800						3 800
1200	12 560										12 560
Total (m)	13 360	5 020	1 450	380	41 399	15 243	200	1 460	55	4 270	82 387

Most of the pipelines to be rehabilitated are oversized and can be replaced by new pipelines with a lower internal diameter (around 75%). The internal diameter of the new pipelines has been calculated using the model. The results are given in the following table. For example, 82% of the ND600 existing pipelines can be replaced by HDPE pipe with ND400 and 18% by cast iron pipe with ND500.

Table 12: Characteristics of the new pipelines replacing the pipelines to be rehabilitated

Nominal Diameter of the existing pipe	Nominal Diameter and Material of the projected pipe														
	ND 63 HDPE	ND 110 HDPE	ND 125 HDPE	ND 160 HDPE	ND 180 HDPE	ND 200 HDPE	ND 225 HDPE	ND 250 HDPE	ND 315 HDPE	ND 300 CAST IRON	ND 400 HDPE	ND 400 CAST IRON	ND 500 CAST IRON	ND 800 CAST IRON	ND 1000 CAST IRON
63	100%														
100,76,63,32		100%													
100		100%													
150			100%												
180					100%										
200			10%	3%	10%	54%	23%								
250							100%								
300						32%	2%	24%	27%	10%	5%				
400								31%	33%		14%	22%			
500									52%		15%	19%	14%		
600											82%		18%		
800													100%		
1200												7%		22%	71%

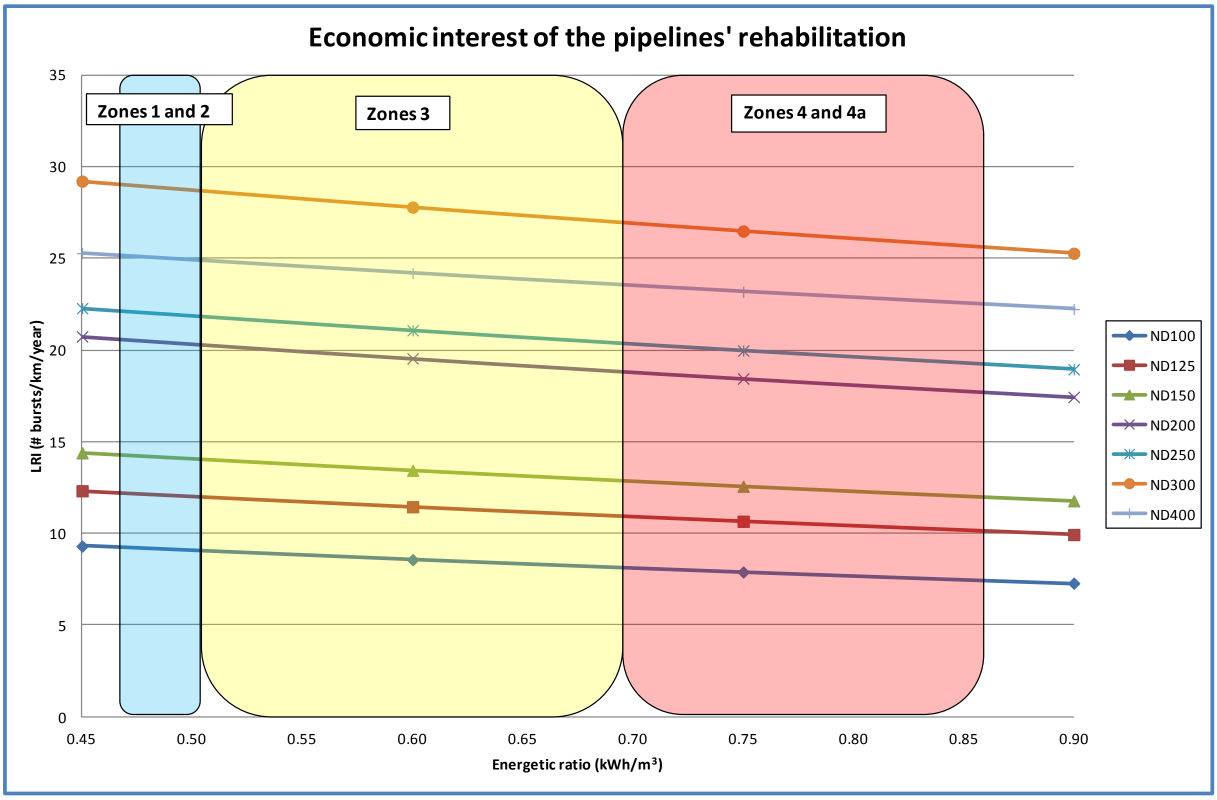
To prioritize the rehabilitation programme, the following parameters have been taken into account: material, diameter, Linear Leakage Index, operational status, if considered as strategic by ACC, if surroundings of the pipelines could be damaged by a leakage, if the pipeline is difficult to maintain (if laid under a building, for example), if the rehabilitation represents an economical interest.

To estimate the economical interest of the rehabilitation of a pipe, the cost of the replacing pipeline has been compared to the actualized operation cost of the existing pipeline for the next 50 years (lifespan of a new pipeline). The operation costs correspond to the cost of repairs and of the water losses due to the leakages, with a discount rate of 5% for the actualization.

The economical interest depends therefore on the diameters of the existing and the projected pipelines (the cost of repairs differs according to diameters), the marginal cost of the water (depends on the Zone to which the water is delivered) and the Linear Repair Index (LRI).

The figure below presents the minimum LRI that a pipe has to obtain to justify that its replacement has an economical interest. For example, for a ND100 pipeline located on Zone 3, its replacement is economically interesting if more than 8 leaks occur per year and per km.

Figure 27: Minimum LRI to obtain an economical interest through the rehabilitation of pipelines



The previous figure shows that:

- The economical interest to rehabilitate the tertiary network (ND ≤ 150 mm) is obtained if the LRI of the existing pipeline is higher than 11 bursts/km/year.
- Concerning the secondary network (ND between 200 mm and 400 mm), it is obtained if the LRI of the existing pipeline is higher than more or less 23 bursts/km/year.

- The location of the existing pipeline is not a preponderant factor to determine the economical level of LRI. The difference between the minimum LRI to obtain an economically interesting rehabilitation is only 17% higher when the pipeline is located in a distribution Zone with the highest energetic ratio than in a distribution Zone with the lowest energetic ratio.

Considering ACC's programme, the rehabilitation of 20% of the proposed pipelines represents an economical interest as shown in the following table:

Table 13: Economical interest of the ACC's rehabilitation pipelines programme

Nominal Diameter of the existing pipe	Economic interest	
	No	Yes
63	52%	48%
100,76,63,32	100%	0%
100	29%	71%
150	33%	67%
180	100%	0%
200	65%	35%
250	100%	0%
300	84%	16%
400	100%	0%
500	100%	0%
600	100%	0%
800	100%	0%
1200	100%	0%
TOTAL	80%	20%

If the economical interest is found for the tertiary network, it is not for the secondary and primary network.

In order to estimate the programme for rehabilitation of the next 25 years, it is proposed to complete the ACC's programme with the existing pipelines which represent the highest economical interest (it means with the highest LRI).

The real Linear Repair Index by Diameter and Material calculated through number of repairs recorded between 2006 and 2010 is given in the following table:

Table 14: The Linear Repair Index by Diameter and Material

Nominal Diameter	LRI (# bursts / km / year)					
	steel	cast iron	concrete	asbestos cement	PE	TOTAL
50	-	-	-	-	1.4	1.4
63	-	-	-	-	1.2	1.2
75	-	-	-	-	1.1	1.1
90	-	-	-	-	0.3	0.3
100	8.6	4.8	-	0.0	-	7.4
110	-	-	-	-	0.1	0.1
125	78.5	-	-	-	0.2	1.0
150	20.8	6.6	-	10.0	-	13.0
160	-	-	-	-	0.0	0.0
180	-	-	-	-	0.1	0.1
200	21.2	4.9	-	1.0	0.1	9.5
225	-	-	-	-	0.0	0.0
250	5.2	1.1	-	-	0.0	1.8
300	15.0	1.4	-	0.1	-	4.5
315	-	-	-	-	0.0	0.0
350	4.9	-	-	-	-	4.9
400	11.6	1.2	-	1.4	0.0	4.3
500	3.8	0.9	0.2	0.0	-	2.4
600	4.1	0.4	-	0.0	-	2.2
630	-	-	-	-	0.0	0.0
700	0.3	-	-	-	-	0.3
800	3.1	0.7	0.0	-	-	2.9
900	0.4	0.0	-	-	-	0.3
1000	0.9	3.3	0.0	-	-	0.5
1200	0.4	-	0.0	-	-	0.3
1400	0.0	-	-	-	-	0.0
TOTAL	**9.2**	**2.9**	**0.0**	**0.5**	**0.4**	**5.0**

The most brittle pipes are:

- Pipes made of steel with a Nominal Diameter between 100 and 400 mm (especially ND150 and ND200, the LRI of ND125 steel pipes is high but their total length is not significant). They represent 30% of the total network but 70% of the total repairs operated on pipes.
- The second category of pipes with a high rate of repairs is pipes made of iron with a Nominal Diameter between 100 and 200 mm (around 17% of total length and of total repairs).

In 2011, the brittleness of these two categories has increased. Their condition is more and more critical; it is high time to initiate their replacement.
57% of the pipelines proposed by ACC are included in one of both categories. The

remaining 43% of ACC's rehabilitation pipelines programme represents 2% of the total network.

The average LRI of the pipes made of steel with a Nominal Diameter between 100 and 200 mm (total length = 412 km) is higher than the "economical" LRI. Their rehabilitation has therefore an economical interest.

With a Linear Repair Index higher than 20 repairs/km/year, **the steel pipes with a Nominal Diameter of 150 and 200 mm have to be rehabilitated in priority**. Their total length is around 120km.

ACC should start rehabilitating the oldest pipes (70% of steel pipes are older than 20 years) located in the seven distribution Zones with the highest Linear Leakage Index and the worst efficiency. We estimated roughly that about 35% of the concerned steel pipes are located in the seven Zones mentioned above.

The urgent rehabilitation phase should therefore concern around:

120 x 0.7 x 0.35 ~ 30 km

Considering that a lifespan of 50 years is a maximum, the annual rate of replacement of the current network should not be less than 1/50 = 2%. In the next 25 years, half of the current network should be rehabilitated (922 km). The proposed rehabilitation programme of pipelines for the next 25 years is:

1. Priority programme: the oldest steel pipes with a Nominal Diameter of 150 and 200 mm located in the seven distribution Zones with the highest Linear Leakage Index and the worst efficiency: **30 km**
2. The remaining steel pipes with a Nominal Diameter of 150 and 200 mm and the steel pipes with a Nominal Diameter of 100 mm: **382 km**
3. The pipes made of steel with a Nominal Diameter between 250 and 400 mm: **122 km**
4. The pipes made of iron with a Nominal Diameter between 100 and 200 mm: **290 km**
5. The remaining 43% of the ACC's rehabilitation pipelines programme not included in the four categories above: **36 km**
6. A complementary programme of strategic pipelines to be defined by ACC in 10 or 20 years: **62 km**. It should include the ND800 between Tohatin and SAN due to its poor state. As it will be used in reverse with a lower flow, it could be replaced by a new pipe with a lower diameter (300 mm).

4.3.2.2. Replacement of the service connections

32% of the repairs (around 4 250 repairs per year) are due to leakages on the service connections (around 121 350 units). The ratio of repair per connection is very high:

4 250 / 121 350 = 3.5 repairs / 100 connections

In France, performance indicators show that the annual ratio of repair per connection is around 1 repair / 100 connections. It means that **in Chişinău the rate of interventions is 3.5 times higher.**

Around 90% of service connection bursts appear on steel service connections. **These steel connections have to be replaced in priority.** They are mainly connected to the steel and cast iron pipes.

The ones which are connected to the steel pipes that should be rehabilitated during the urgent phase will be replaced simultaneously. This should represent around 2 000 connections.

In the same way, the annual rate of replacement of existing connections should not be less than 2% per year = 2 430 units/year. In priority, the connections of the rehabilitated pipes have to be replaced. It will represent an economical interest because the unit cost for the connection replacement is lower, as the excavation will be already done.

ACC is in charge only of the investments concerning the connections for blocks which should represent more or less half of the existing connections. The connections for individual houses should be replaced as well but will be invoiced to the customers.

4.3.2.3. Impact on reducing water losses

Physical water losses will be impacted by the rehabilitation programme. The MTU's normative approach estimates that:

- 45% of water losses are due to hidden losses and
- 55% to repaired bursts (average estimated on the last 5 years).

It can be considered that **half of the hidden losses** of the current network will disappear when half of the current network will be abandoned to be replaced by new network.

Concerning the physical losses due to repaired bursts, the most brittle pipes (pipes made of steel with a Nominal Diameter between 100 and 400 mm and pipes made of iron with a Nominal Diameter between 100 and 200 mm) and their service connections represent around **87%** of the total repaired bursts. It can be considered that physical losses due to reparations on these brittle pipes and their connections will disappear when they will be abandoned.

In conclusion, the rehabilitation programme of the next 25 years should reduce the physical water losses due to the current network by:

$$87\% \times 55\% + 50\% \times 45\% \sim 70\%$$

4.3.3. Identification of pumping station rehabilitation needs

The results of the measurement campaign performed on the water supply network (see chapter 5.3 of the Report Potable Water Supply Network – Measurement Campaign – Summer 2011) reveal that a number of pumping stations of the raw and drinking water systems of Apa Canal Chişinău operate with a poor efficiency, such as PS Schinoasa, Airport, Botanica and Ialoveni.

This global analysis is a first step to performance enhancement but is not sufficient to identify the actions to be implemented for energy saving.

Hence, some of the pumping stations that operate with low performance are small facilities with low flow rate. For this reason, they are only small sources of energy saving even after rehabilitation (e.g. Airport, Botanica). On the contrary, large pumping facilities with a high efficiency may provide important sources of energy saving: Indeed, the gain of only some percentage units of efficiency is converted to a large amount of energy spared and to a quick financial gain.

Another parameter to be considered is the payback time of investments. Indeed, aside from small operational adjustments, any program of performance improvement is based on an investment plan. Payback time is the time after which the rehabilitation investment will be fully reimbursed only by operational savings. For example, replacing a pump of low performance by a new one with high efficiency would cost 100.000 lei but would save 20.000 lei per year: the payback time would be 5 years.

The notion of payback time has to be compared to the typical forecasted lifetime of a new piece of equipment. Usually, it is considered that properly maintained electromechanical equipment can achieve a lifetime of 5 up to 30 years or more according to its size or power. For example, the replacement of a large piece of equipment that would have a payback time of 5 years but a forecasted lifetime of 30 years is still a source of savings. On contrary, a payback time of 4 years compared to a forecasted lifetime of 10 years is less interesting.

In brief, the pumping facilities to be rehabilitated can be sorted with the following indicators:

- Current efficiency
- Potential gain of efficiency
  - ➢ Ratio between the current efficiency and the typical efficiency of new equipment
- Payback time
  - ➢ Ratio between the yearly energy gain and the cost of investment
- Investment urgency indicator
  - ➢ Ratio between the payback time and the typical lifetime
- Financial gain indicator
  - ➢ Product of the investment urgency indicator and the average flow rate.

Finally, the financial gain indicator is the synthesis of all other parameters: gain of efficiency, payback time, forecasted lifetime and flow rate (i.e. energy consumption). It is the root of the proposed classification for pumping stations rehabilitation.

Table 15: Water supply pumping stations - Results of the data analysis

Localisation	Average flow rate (m^3/d)	Current efficiency (%)	Target efficiency (%)	gain (kWh/y)	Energy gain (%)	Financial gain (lei/year)	Investment cost (lei)	Payback time (years)	Forecasted lifetime (years)	Investment urgency indicator	Gain indicator
Gribov PS	749	54%	56%	3 187	2%	4 549	160 000	35.2	10	1	0
Ghidighici PS	2 520	**46%**	62%	78 395	26%	104 847	190 000	**1.8**	10	20	1
Ghidighici wells	2 520		62%	72 137	26%	96 478	180 000	**1.9**	10	19	1
Balişevschi PS	2 925	50%	62%	75 420	19%	100 604	210 000	**2.1**	15	**26**	2
Ialoveni PS	2 024	**32%**	66%	316 316	51%	426 291	380 000	**0.9**	15	**60**	**4**
Ialoveni wells	2 024		66%	251 478	51%	338 910	330 000	**1.0**	15	**55**	**3**
Buiucani Z3 PS	7 327	**43%**	67%	84 171	36%	112 335	140 000	**1.2**	10	**29**	**6**
Buiucani Z4 PS	10 873		70%	531 451	38%	709 273	510 000	**0.7**	20	**100**	**32**
U. Agrara PS	519	60%	No expected gain								
Valea Dicescu PS	15 276	71%	No expected gain								
Independenţa Z3 PS	14 985	51%	74%	287 315	31%	383 711	360 000	**0.9**	15	**57**	**25**
Independenţa Z4 PS	9 247		68%	353 649	26%	472 301	480 000	**1.0**	20	**71**	**19**
Botanica PS	938	**39%**	56%	10 659	30%	14 178	140 000	9.9	10	4	0
Telecentru Z4 PS	3 074	54%	63%	28 991	15%	38 674	150 000	**3.9**	10	9	1
Telecentru Z4a PS	7 433		67%	148 904	20%	198 639	370 000	**1.9**	15	**29**	**6**
Schinoasa PS	1 991	**38%**	62%	94 481	39%	125 898	160 000	**1.3**	10	**28**	2
STA Z3 PS	19 856	71%	74%	30 030	4%	39 985	420 000	10.5	15	5	3
STA Z4 PS	6 429		No expected gain								
Tohatin PS to Tohatin	683	**42%**	56%	18 861	24%	26 451	140 000	5.3	10	7	0
Tohatin PS to Coloniţa	1 057		59%	53 650	28%	75 238	180 000	**2.4**	10	15	0
Aeroport PS	341	**26%**	43%	21 312	39%	29 677	140 000	**4.7**	10	8	0
Cartuşa PS	335	**42%**	51%	3 002	17%	4 165	140 000	33.6	10	1	0

Localisation	Average flow rate (m^3/d)	Current efficiency (%)	Target efficiency (%)	gain (kWh/y)	Energy gain (%)	Financial gain (lei/year)	Investment cost (lei)	Payback time (years)	Forecasted lifetime (years)	Investment urgency indicator	Gain indicator
Sîngera PS	575	**45%**	No expected gain								
Codru PS	6 574	51%	66%	251 036	23%	334 996	440 000	**1.3**	20	**55**	**11**
Stauceni PS	1 378	58%	62%	8 708	7%	12 011	180 000	15.0	10	2	0
Treapta IIa raw water	170 084	69%	75%	1 021 343	9%	1 369 880	7 380 000	5.4	30	**20**	**100**
Treapta IIa treated water	31 326	61%	74%	464 269	17%	622 703	490 000	**0.8**	20	**91**	**84**
Treapta II raw water	170 084	75%	No expected gain								
Treapta II treated water	31 326	70%	74%	186 758	6%	250 490	2 870 000	11.5	25	8	**7**
Treapta I raw water	201 410	78%	No expected gain								
Balişevschi wells	585	**40%**	43%	2 658	6%	3 543	140 000	39.5	10	1	0
Sat. Ghidighici wells	347	**47%**	51%	9 934	8%	13 833	170 000	12.3	10	3	0
Sîngera wells	35	**32%**	44%	3 734	28%	5 316	140 000	26.3	10	1	0
Vatra wells	27	**23%**	44%	4 579	47%	6 410	140 000	21.8	10	2	0

The results presented in the previous table lead to the following classification:

1. High gain indicator:
   - Treapta IIa raw water
   - Treapta IIa treated water
2. Medium gain indicator:
   - Buiucani Z4
   - Independenta Z3
   - Independenta Z4
   - Codru PS
3. Low gain indicator:
   - Treapta II treated water
   - Telecentru Z4a
   - Buiucani Z3
   - Ialoveni PS and wells

All the other pumping stations have a very low or null gain indicator.

The results presented in the previous table are based on a "business as usual" scenario when the design and the operation of the drinking water network is not modified compared to the current situation. However, water demand will decrease and significant modifications are recommended in the near future to optimize the Chişinău's network. These modifications affect the previous calculations especially through the following facts:

- The shutdown of the Statia de Apa Nistru (SAN) water treatment plant lead to the shutdown of the treated water pumping stations Treapta II and IIa.
- Shutdown of Codru PS.
- The expected production from Ialoveni well field under normal condition will concern the supply of the Zone 4a - Schinoasa. The existing pumping station of Telecentru supplying this Zone will be impacted.
- The expected production from Ialoveni well field under normal condition and for the emergency plan will impact the design of the pumps of the production system of Ialoveni.

Considering the proposed classification for pumping stations rehabilitation presented in the paragraph above and the proposed operations that will impact the design of pumping stations, the rehabilitation urgent programme should include the replacement of pumps (complete pumping groups, electrical boards, variable frequency drive if required and adaptation of hydraulic equipments) of the following pumping stations:

- Treapta IIa raw water

- Buiucani Z4
- Independenta Z3
- Independenta Z4
- Buiucani Z3

It is worth pointing out that ACC also proposed some recommendation to improve the routine operation. For example, ACC intends to regularly adapt the pumping regimes and the pump impeller diameters for the “Nistru” line pumping stations (I, II, IIa), in function of the seasonal variations of the water demand. This methodology is the most valuable considering existing equipment and does not require heavy investment. However, energy gains on a mid- and long-term view are not optimized and existing equipment is getting out-aged and difficult to maintain. For this reason, if funding is available, implementing the proposed investment plan is more relevant economically.

The second step (before 2015) of the rehabilitation programme of the pumping stations will concern the pumps impacted by the projected production scheme:

- The pumping stations linked to the well fields (Ghidighici, Petricani, Balişevschi and Ialoveni) and
- The pumping stations of Schinoasa and Telecentru.

The long term programme of replacement of pumps has been based on the estimated lifespan of pumps:

Table 16: Water supply pumping stations – Lifespan of pumps

Power of the pump	Estimated lifespan
Lower than 22 kW	10 years
Between 22 and 75 kW	15 years
Between 75 and 200 kW	20 years
Between 200 and 500 kW	25 years
More than 500 kW	30 years

4.3.4. IDENTIFICATION OF TANK REHABILITATION NEEDS

The reservoirs were visited during their cleanup and interviews with ACC’s engineers were conducted in order to assess the state of the reservoirs. The main defects found in the reservoirs are described below:

- **The tightness of the reservoirs**: the deterioration of the reservoirs roofs' waterproofing elements allows rain water to penetrate.
- **The strength of bearing elements**:

The prefabricated panels from the roofs of the affected reservoirs show pronounced corrosion. The reinforcing steel rods are attacked by chlorine vapours and are subject to corrosion, so they do not comply with the regulations regarding the quality of constructions.

Plastered surfaces are detached from the walls and the pillars of the reservoirs.

The partition walls within the reservoirs are damaged and missing. In the case of reservoirs with a big volume, the missing of partition walls causes the water to hammer against the walls, which can lead to the building's resistance reduction. Technologically speaking, this fact has a negative influence on the quality of water disinfection during the chlorination process.

- **The wear degree of pipes and fittings:**

The suction and discharge pipes are made of steel. The physical degradation is visible. A hit with the hammer would make a hole.

The access scales of the reservoirs are in an advanced degree of corrosion. They are a danger for the health of operating staff.

The assessment of the current condition of the tanks is given in the following table (green colour means that the state is good, dark red that the state is poor).

Table 17: Water supply tanks – Condition assessment

Name of the localisation	Tank number	Volume (m^3)	Wear degree of pipes and fittings				strength of bearing elements			TOTAL
			Scale	Pipes, tubes	Valves	Chlorination system	Physical condition of tank roof	Physical condition of tank bottom	Physical condition of tank walls	
Airport	1	300	yellow	green	yellow	green	green	green	green	yellow
	2	1 000	yellow	green	green	green	green	green	green	yellow
	3	300	yellow	green	green	green	green	green	green	yellow
Balişevschi	1	2 000	yellow	green	green	green	green	green	green	yellow
	2	2 000	yellow	green	green	green	green	green	green	yellow
Buiucani	1	3 000	yellow	green	green	green	orange	green	green	red
	2	5 000	yellow	orange	orange	green	green	green	green	orange
	3	6 000	yellow	green	yellow	green	red	green	green	red
Botanica	1	2 000	yellow	orange	green	green	green	green	green	orange
	2	5 000	yellow	green	green	green	green	green	green	yellow
Cartuşa	1	500	yellow	green	green	green	orange	orange	green	red
	2	500	yellow	green	green	green	orange	green	green	orange
Ciocana	1	3 000	yellow	yellow	yellow	green	orange	green	green	red
	2	3 000	yellow	yellow	yellow	green	orange	green	green	red
	3	10 000	yellow	orange	yellow	green	green	green	green	orange
Codru	1	6 000	yellow	green	green	green	red	green	green	red
Codru Reservoirs	1	600	yellow	yellow	green	green	green	green	green	yellow
	2	600	yellow	orange	green	green	green	green	green	orange
Coloniţa	1	500	yellow	green	yellow	green	green	green	green	yellow
	2	500	yellow	green	green	green	green	green	green	yellow
	3	500	yellow	green	green	green	green	green	green	yellow
Ghidighici	1	2 000	yellow	red	orange	yellow	orange	green	orange	red
	2	2 000	yellow	green	yellow	green	orange	green	orange	red
Gribova	1	250	yellow	green	green	green	green	green	green	yellow
	2	250	yellow	green	green	green	green	green	green	yellow
Independenţa	1	10 000	yellow	green	green	green	green	green	green	yellow
	2	10 000	yellow	green	green	green	green	green	green	yellow
Ialoveni	1	1 000	yellow	red	orange	green	orange	green	green	red
	2	1 000	yellow	red	orange	green	orange	green	green	red

Name of the localisation	Tank number	Volume (m^3)	Wear degree of pipes and fittings				strength of bearing elements			TOTAL
			Scale	Pipes, tubes	Valves	Chlorination system	Physical condition of tank roof	Physical condition of tank bottom	Physical condition of tank walls	
Schinoasa	1	6 000								
Sîngera	3	3 000								
	3a	3 000								
Stauceni	1	3 000								
Telecentru	1	5 000								
	2	3 000								
Tohatin	1	10 000								
	2	3 000								
	3	3 000								
Valea Dicescu	1	3 000								
	2	6 000								
	3	2 000								
STA Chişinău	1	5 000								
	2	5 000								
	3	10 000								
	4	10 000								
	5	10 000								
	6	10 000								
STA Nistru Treapta II	1	1 000								
	2	1 000								
	3	1 000								
Upper VLV	1	1 500								
Lower VLV	1	1 000								
SP Petricani	1	3 000								
	2	3 000								
SP Burcuta	1	600								
	2	600								
	3	600								

Codru, Cartuşa, Gribov and tanks localised in SAN are in poor condition. However, when the new production scheme will be adopted in 2014/2015, they will be decommissioned because they will be needless (except for the tank "Upper Vadul Lui Voda" that needs to be rehabilitated). In the same way, the Burcuta pumping station and Botanica tanks will be maintained stopped, no rehabilitation works are proposed.

It can be noticed that:

- Condition of three tanks is very poor: Tohatin #1, STA #5 and #6 (STA #6 is already decommissioned). Their capacity is 10 000 m^3 each and they supply by gravity the Zone 2. They need heavy investments to be rehabilitated (higher than 2 M MDL).
- 17 tanks are in poor condition and they need more than 0.5 M MDL to be rehabilitated.

To optimize the rehabilitation costs of the tanks, it is proposed to adapt the stored volumes to the delivered flows by hydraulic entities and to rehabilitate tanks only if they are necessary to maintain a stored capacity higher than 50% of the peak demand for the next 25 years. It is therefore proposed to decommission the 3 following tanks:

- **Buiucani #1**: the peak flow pumped by Buiucani pumping station should never be more than 20 000 m^3/day. It is proposed to decommission tank #1 of Buiucani pumping station. The total stored capacity at Buiucani will then be 11 000 m^3 which will represent 55% of the maximum peak daily flow.
- **Ghidighici #1**: according to the proposed production scheme, under normal condition, the diluted production of Ghidighici well field will be around 1 875 m^3/day. It is proposed to decommission tank #1 of Ghidighici pumping station. The total stored capacity at Ghidighici will be 2 000 m^3 what will represent 107% of the daily flow under normal condition.
- **Telecentru #2**: the peak flow pumped by Telecentru pumping station should decrease in the future. In 2015, it will be lower than 10 250 m^3/day and the tank #2 of Telecentru pumping station could be decommissioned. The total stored capacity at Telecentru will be 5 000 m^3 what will represent 50% of the maximum peak daily flow.

It could be possible to decommission as well 1 or 2 tanks (#1 and #3 for example) in Valea Dicescu PS as the peak flow pumped by this pumping station should never be more than 6 500 m^3/day and as the total stored capacity is 11 000 m^3 which represents 170% of the maximum peak daily flow. However, the transmission main "Independenţa" coming from STA, situated on the streets Spataru, Transnistria and Industriala and supplying the pumping station of Independenţa is brittle and, by experience, ACC knows the repairs take time. In case of a burst on this transmission main, the water would be supplied to the zones 3 and 4 Independenţa through the pumping station of Valea Dicescu and Telecentru. The volume of the tanks in Valea Dicescu should therefore be higher than 50% during the time of the repair as long as the risk of burst on the transmission main "Independenţa" is high.

The tank rehabilitation programme has to be, at first, focused on the tanks supplying Zone 2 by gravity. Although it should not be necessary to rehabilitate tank #6 of STA to maintain a sufficient level of stored volume (this tank will remain decommissioned), the two others need a quick rehabilitation, to avoid their shutdown:

1. **The tank #5 of STA**: the roof is not waterproof, the partition walls collapsed and the bottoms and the walls of the reservoir have cracks.
2. **The tank #1 of 10 000 m^3 in Tohatin Pumping Station**: the reinforced steel rods of the roof are completely corroded and the reservoir is at risk to crumble.

It is proposed to rehabilitate during an urgent phase the tank #5 of the water treatment plant in order to maintain on this production site the best ratio of stored volume compared to the production flow.

The tank #1 of Tohatin pumping station and the other tanks -which have been identified as necessary to maintain a minimum ratio of 50% of stored volume compared to the peak demand by hydraulic entity- will be rehabilitated in the next 10 years.
During those works, some adaptations and modernizations will be carried out. They will

mainly concern the chlorination systems, the regulation of the upstream flows (valves operated manually will be replaced by automatic systems) and safety of installations.

Through these investments, the Chişinău's water supply system will be equipped with a storage capacity of 157 800 m^3 (including the stored volumes of Cojuşna City which is part of the study area and should be supplied by the ACC resources from 2015). It will represent 54% of the total targeted production capacity: 290 000 m^3/day including 9 700 m^3/day of "technical water".

4.4. EMERGENCY PLAN IN CASE OF INOPERABILITY OF THE RAW WATER INTAKE IN NISTRU RIVER

4.4.1. ORGANIZATION BASIS

In case of pollution of the Nistru or of problem with the water intake in Vadul Lui Voda, the available water resources will switch to groundwater sources and will therefore be 63 600 m^3/d (the distribution of the groundwater resources is explained in the Table 18).

Table 18: Capacity of the well fields

Well fields	Capacity of well fields (m^3/d)
Ialoveni	20 900
Ghidighici	7 900
Petricani	11 300
Balişevschi	8 500
WTP	15 000
Total	**63 600**

This production capacity corresponds to 34% of the current volume supplied by the network of ACC in Chişinău city (with the exception of Tohatin, Coloniţa, Cruzeşti, Vadul Lui Voda and Coşerniţa). The cities of Coloniţa, Tohatin, Cruzeşti, Coşerniţa and Vadul Lui Voda will be supplied by a well to be implemented in the North-East suburbs of Chişinău. The concerned volume is 1 850m^3/d.

The following paragraphs explain how to supply this water to the city. Indeed, if the water from the Nistru is unavailable, then the normal operation of the network and the pumping stations does not function and another one has to be implemented.

The ground hypothesis is that **each entity of the network will be supplied 34% of the current delivered volume**. As the network will be supplied only part of the day, the water losses will be lower and the real percentage of the demand satisfy will be 45% instead of 34%.

The delivery of water will be performed in three phases to be able to supply the whole city:

- 1st phase (represented by  in the figures below)
- 2nd phase (represented by  in the figures below)
- 3rd phase (represented by  in the figures below)

- Some entity can be supplied anytime (represented by  in the figures below), as long as the reservoir is at the end of the supply chain
- Some entity will be supplied all the time (represented by  in the figures below). Valves will have to be closed alongside the transfer to ensure every consumer to have water.

The supply is therefore stopped during the night in order to fill the reservoirs. Hence the transfers of water will be performed for 24 hours and the valves alongside these transfers will have to be closed and opened on a daily basis to ensure a proper supply of each entity (as shown on the Figure 28 below).

In the schematic figures below the volume written corresponds to the transfer of water for one day.

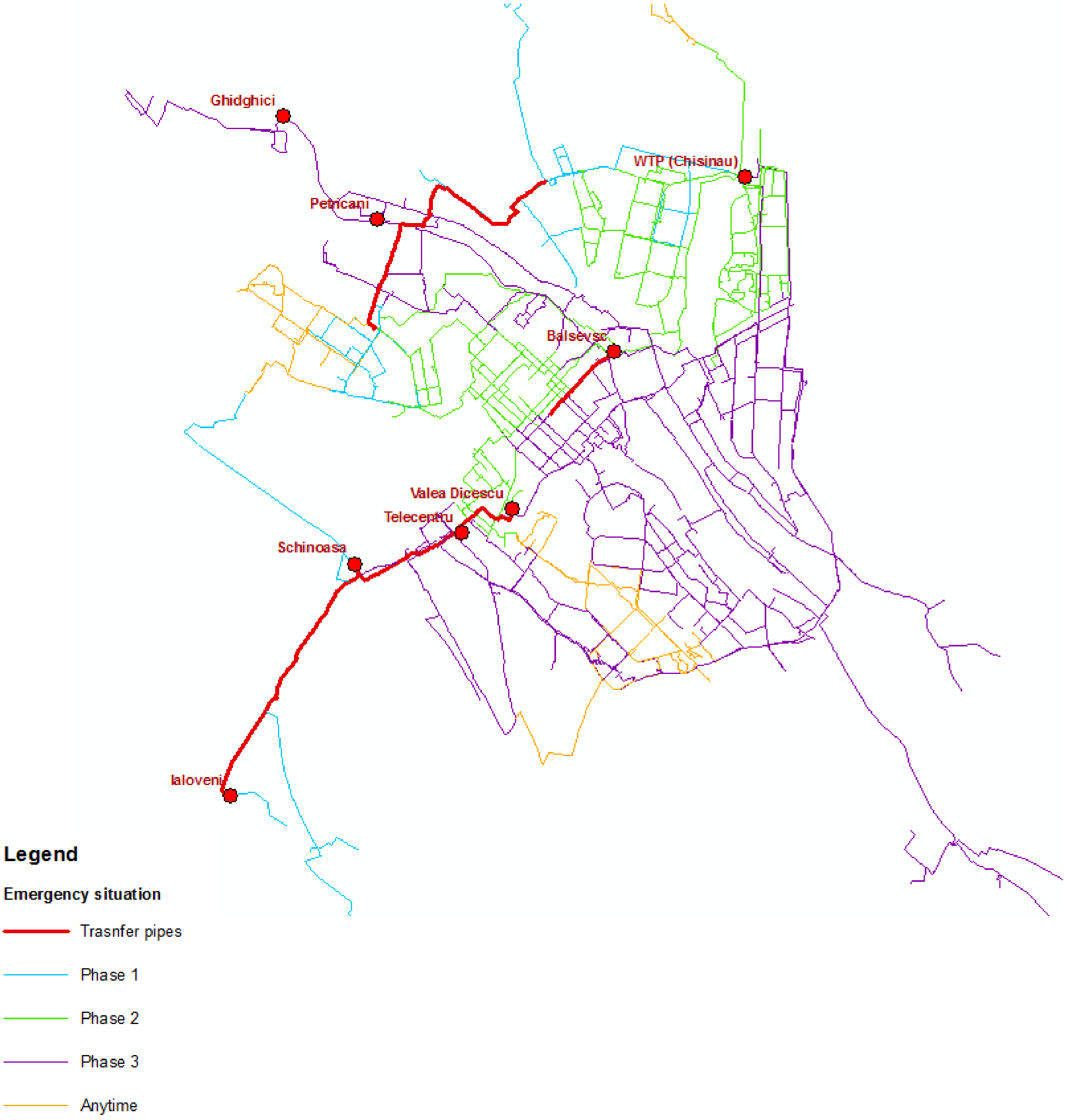


Figure 28: Supply of the city in case of emergency

4.4.2. IALOVENI WELL FIELDS

The well field of Ialoveni produces 20 900m^3/d. The organization scheme of the network dependent on Ialoveni well fields is presented in the Figure 29.

Water is extracted from Ialoveni well fields (870m^3/h) and transferred to Schinoasa reservoir during the whole duration of the emergency situation. For this transfer, pumps that currently do not exist have to be built in Ialoveni pumping station.

From Schinoasa reservoir, the water is then transferred to Telecentru reservoir, through the pipes used today to supply the reservoir of Schinoasa from the pumping station of Telecentru. The pumping station of Schinoasa will therefore operate in a different way than usually and new pumps need to be implemented. However, this way to operate will be easy to implement as this station was designed to work this way. New pumps should nevertheless be built.

The transfer of water from Schinoasa to Telecentru will be performed for the whole duration of the emergency situation. Connecting valves will have to be closed alongside the pipe on şos Hîncesti to ensure the transfer. The supply of Telecentru's reservoir should be easy by opening and closing valves at the crossroad Sprîncenoaia and Hîncesti (in order to use the former inlet of the reservoirs). These valves will be then opened to allow the supply of the Zones 4A Telecentru and Botanica and of the Zone 4 Independenţa. Schinoasa PS will then transfer water to the reservoir of Independenţa through the pipes of the Zone 4 Independenţa. A connection has therefore to be built in Independenţa PS between the pipes of the Zone 4 Independenţa and the reservoir.

In the same way, water will be transferred all the time from Telecentru Pumping station to Valea Dicescu reservoirs. The supply of the Zone 3 Valea Dicescu will be performed at one moment of this transfer. For this transfer, the pumps normally used to supply the zone 4A Telecentru will be used and a connection established in Valea Dicescu PS between the transfer pipe from the Zone 3 and the reservoir.

Then the water will be pumped from Valea Dicescu to the Zone 2. Connections will have to be established between the delivery pipe in Valea Dicescu pumping station and the inlet pipe from the Zone 2.

The remaining water extracted from Ialoveni wells will be used to supply the city of Ialoveni, Durleşti and the Zone 4A of Schinoasa. The Zone 3 of Independenţa can be supplied anytime, using the water from the reservoir and therefore the pumps normally used for the supply of the Zone 4 Independenţa.

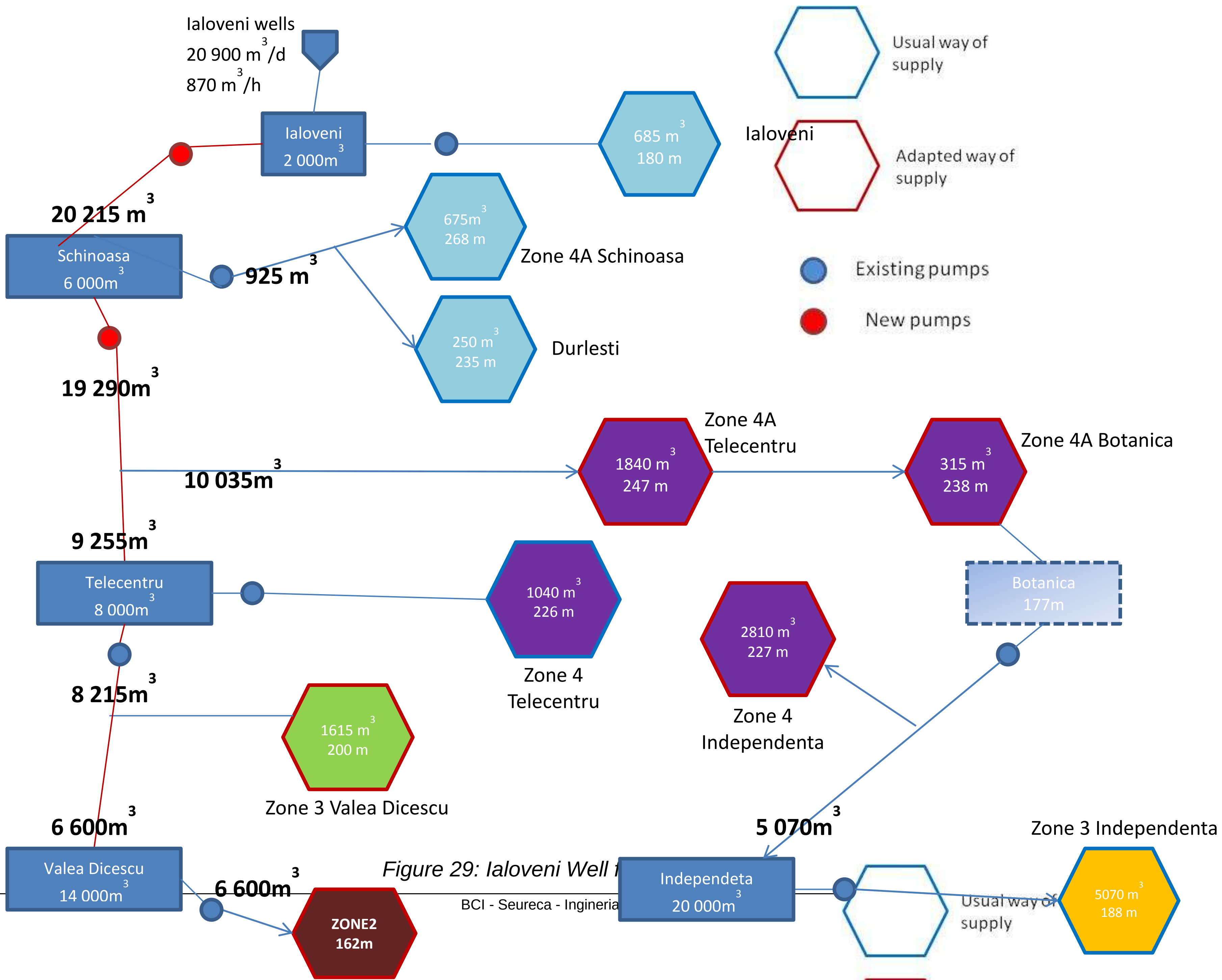


Figure 29: Ialoveni Well f

Table 19: Characteristics of the pumping systems dependent on Ialoveni well fields for the emergency plan

#	Pumping station	Required Capacity (m^3)	Required Flow (m^3/h)	Working hours	Head (m)	Efficiency (%)	Required Power for emergency plan (kW)	Comment	Installed Power for normal conditions (kW)
1	Ialoveni PS to Ialoveni City	685	114	6.0	101	59%	53	Existing. To be replaced in the next few years.	74
2	Ialoveni PS to Chişinău	20 215	842	24.0	165	70%	542	New Pump. Working 24h	
3	Schinoasa PS to Z4A Telecentru	19 290	804	24.0	30	70%	94	New Pump. Working 24h	
4	Schinoasa PS to Z4A Schinoasa and Durlesti	925	121	7.6	48	59%	27	Existing. To be replaced in the next few years.	27
5	Telecentru PS to Z4 Telecentru	1 040	173	6.0	35	62%	27	Existing. To be replaced in the next few years.	30
6	Telecentru PS to Z3 VD	8 215	342	24.0	13	66%	18	Use the pumps for the zone 4a to be replaced in the next few years.	119
7	Valea Dicescu PS to Z2	6 600	275	24.0	42	65%	49	Existing.	175
8	Botanica							Not working in case of emergencies	
9	Independenţa	5 070	720	7.0	60	70%	168	Use the pumps for the zone 4 to be replaced in the next few years.	233

The Table 19 above shows the characteristics of the pumping system in case of emergency in the different pumping stations supplied by Ialoveni well field.

One pumping stations has to be implemented especially for the emergency plan (# 3):

- Schinoasa PS to Z4a Telecentru

One pumping system has to be oversized for the particular condition of the emergency plan (#2):

- Ialoveni PS to Chişinău.

4.4.3. PETRICANI AND GHIDIGHICI WELL FIELDS

In case of emergency, the well field of Petricani will produce 11 300m^3/d and Ghidighici 7 900m^3/d .These two well fields will be used to supply the city of Vatra, the Zone 1, and the north of Chişinău, as indicated in the Figure 30.

In Ghidighici, the water is extracted from the wells and pumped into the Zone 1 for 24 hours. In the Zone 1, several small zones have to be defined and have to be isolated daily to ensure every consumer to have water.

During the night, the pumping station of Petricani transfers water to Buiucani reservoirs, using the transfer pipe from the Zone 2 Doina. To allow this transfer, new pumps have to be installed in Petricani pumping station and a connection needs to be established between the pumping station and the transfer pipe: 500m of a pipe with a diameter of 600mm.

The connecting valves have to be closed alongside the transfer. The water is then pumped to supply successively the Zone 2 Doina, the pumping station of Universita agrara (and the Zone 3 Universita agrara) and the Zone 3 Buiucani through the pumping station of Buiucani.

Part of the water supplying the Zone 2 Doina will come by gravity from the reservoirs of the water treatment plant. The Zone 4 Buiucani can be supplied anytime as long as the reservoirs of Buiucani are full.

Figure 30: Petricani and Ghidighici well fields

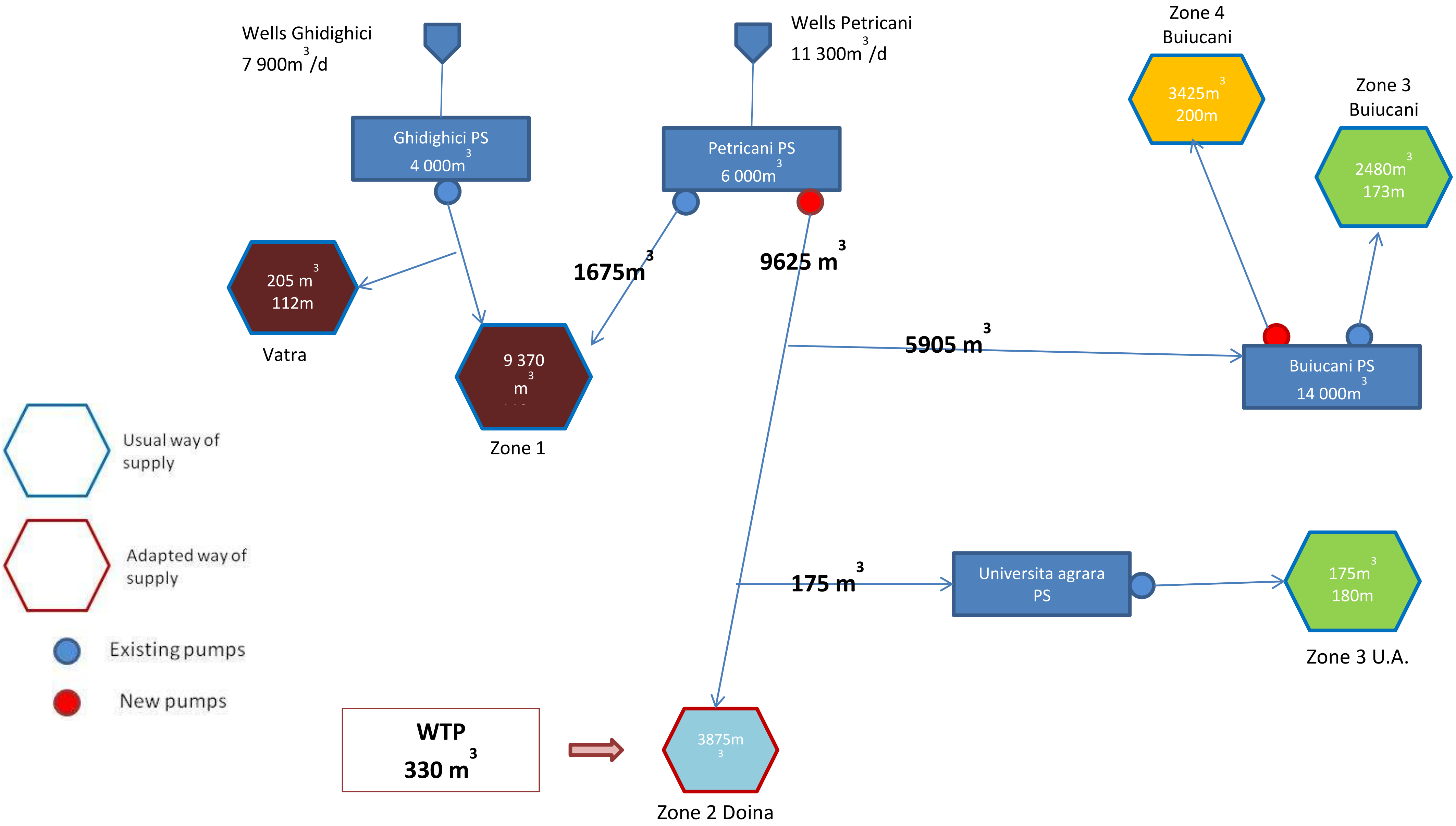


Table 20: Characteristics of the pumping systems dependent on Petricani and Ghidighici well fields for the emergency plan

#	Pumping station	Required Capacity (m³)	Required Flow (m³/h)	Working hours	Head (m)	Efficiency (%)	Required Power for emergency plan (kW)	Comment	Installed Power for normal conditions (kW)
1	Ghidighici PS to Zone 1	7 900	329	24.0	70	66%	96	Existing. To be replaced in the next few years. Working 24h	*36*
2	Petricani PS to Zone 1	1 675	279	6.0	70	65%	82	Existing. To be replaced in the next few years.	*30*
3	Petricani PS to Zone 2	9 625	401	24.0	120	66%	197	New pump. Working 24h	
4	Buiucani PS from Buiucani tanks to Zone 4	3 425	571	6.0	97	68%	221	New pump	
5	Buiucani PS from Buiucani tanks to Zone 3	2 480	413	6.0	60	66%	102	Use the pumps for the zone 4 under normal condition to be replaced in the next few years.	187
6	Universita agrara	175	29	6.0	18	43%	3	Existing.	6

The Table 20 above shows the characteristics of the pumping system in case of emergency in the different pumping stations supplied by Ghidighici and Petricani well field.

Two pumping stations have to be oversized for the particular conditions of the emergency plan (# 1 and # 2):

- Ghidighici PS to Zone 1
- Petricani PS to Zone 1

Two pumping stations have to be implemented especially for the emergency plan (# 3 and # 4):

- Petricani PS to Zone 2
- Buiucani PS from Buiucani tanks to Zone 4

Buiucani PS will be operated as follow:

- Under normal conditions, pumps will be supplied directly by the inlet pipe from Zone 2. They need a low head (22 m for Zone 3 and 60 m for Zone 4);
- In case of emergency, pumps will be supplied by Buiucani tanks with a higher head (60 m for Zone 3 and 97 m for Zone 4).

It must be noticed that the pumps to supply Zone 4 directly from Zone 2 will be able to supply Zone 3 if they receive the water from Buiucani's tanks. It means that even under normal conditions, the Buiucani tanks could be used.

4.4.4. WTP AND BALIŞEVSCHI WELL FIELDS

In case of emergency, the well field of Balişevschi can produce 8 500m^3/d and the future well field of the WTP will produce 15 000m^3/d.

These two well fields will supply the Zones 2 as well as the pressure Zones 3 and 4 currently supplied by the pumping station of the water treatment plant: the Zones 3 Ciocana and Rîscani, the Zone 4 Ciocana and the city of Stauceni (as indicated in the Figure 31.)

In the first phase, the WTP will supply by gravity the Zone 2 Doina.

Then the WTP will supply in the usual way the Zones 3 Ciocana and Rîscani, the Zone 4 Ciocana and the reservoir of Stauceni. And finally the Zone 2 will be supplied by gravity. No changes have to be done in the WTP, except the work connected to the implementation of the new well field.

The pumping station of Balişevschi will supply successively the Zone 2 Oţel and the Zone 2, using the transfer pipe of the Zone 2 Oţel and opening/closing the transit valves in the centre (on the street V. Alecsandri). New pumps need therefore to be installed and the former organization of the pumping station rehabilitated (formerly the pumping station pumped water in the “special network”, in fact the network of the Zone 2 Oţel). The piezometry will be the same as today.

Figure 31: Balişevschi and WTP Well fields

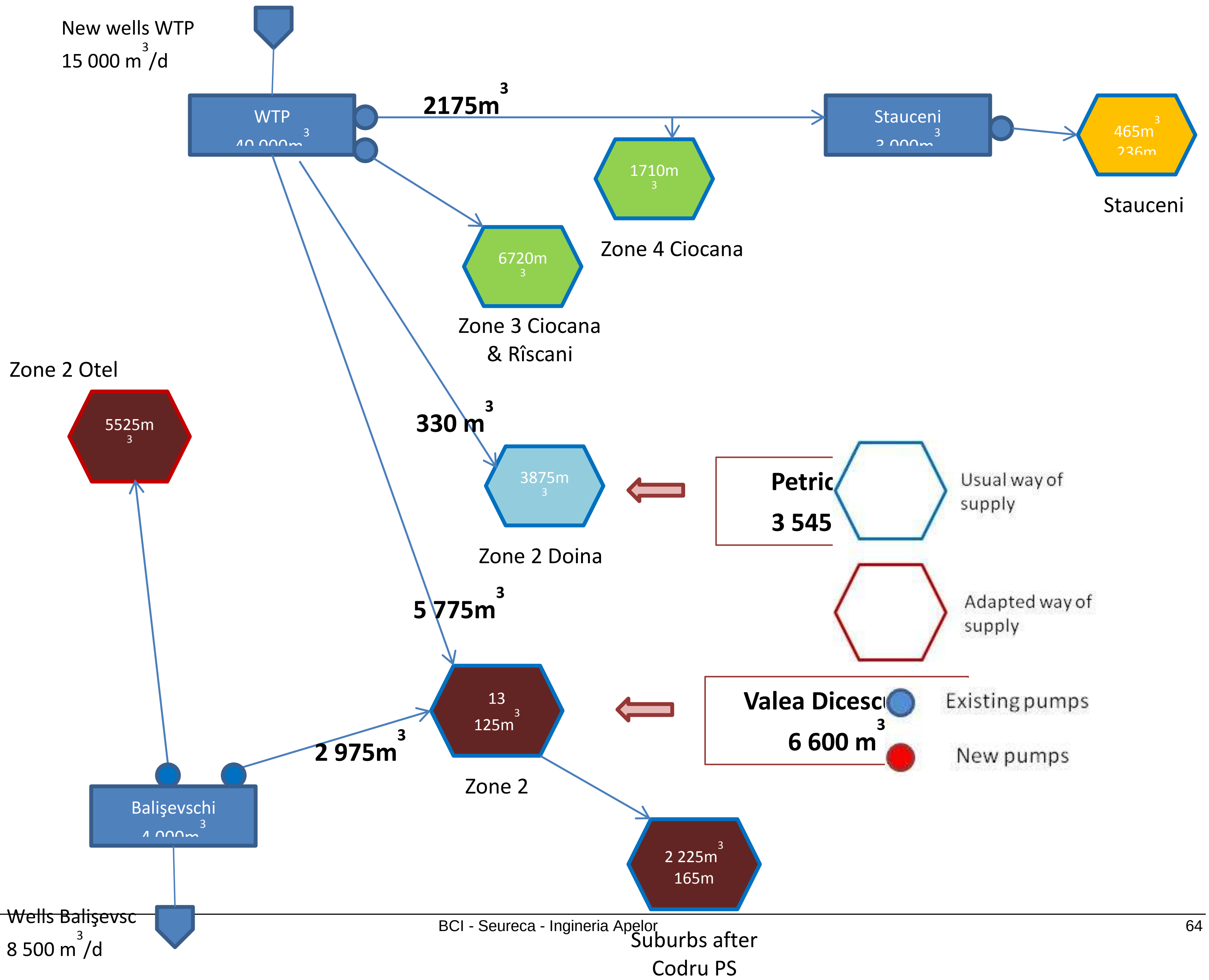


Table 21: Characteristics of the pumping systems dependent on Balişevschi and WTP well fields

#	Pumping station	Required Capacity (m^3)	Required Flow (m^3/h)	Working hours	Head (m)	Efficiency (%)	Required Power for emergency plan (kW)	Comment	Installed Power for normal conditions (kW)
1	STA Z4 PS	2 175	363	6.0	37	66%	55	Existing.	58
2	STA Z3 PS	6 720	1 120	6.0	34	74%	141	Existing.	148
3	Stauceni PS	465	78	6.0	54	56%	21	Existing.	31
4	Balişevschi PS to Zone 2	8 500	354	24.0	125	66%	184	Existing. To be replaced in the next few years. Working 24h	*55*

The Table 21 above describes the characteristics of the pumping systems in case of emergency. One pumping stations have to be overdesigned for the particular conditions of the emergency plan (# 4): Balişevschi PS to Zone 2.

4.5. Potential for hydro power generation

The potential for hydro power generation along the Chişinău drinking water network has been assessed based on the head loss reduction and associated averaged flow rate at various locations as presented in the Table 22 below.

The Payback time for each location has been estimated on the basis of the realistic hypotheses summarized in Table 23. Selling price of electricity has been taken equal to the current purchase price of electricity (0.088 €/kWh corresponds to 1.45 MDL/kWh with an exchange rate of 16.5 MDL/€) although in most countries "green" energy is very often purchased at a higher price than the usual market price.

Table 22: Main hypotheses for payback time calculations

Hypotheses		
Approval of Health authorities	-	OK
Total yield (mechanical & electrical)	-	72%
Electricity selling price	€/kWh	0.088
OPEX of one pump-turbine	€/year	5,000

Table 23: Identification of relevant locations where turbines could be installed

Location	Dissipated energy	Available power	CAPEX	Available energy	Potential revenues	Payback time
	kWh/d	kW	€	kWh/year	€/year	years
Downstream Ciocana reservoirs	223	9	29 563	58 505	5 141	209.2
Upstream Codru reservoir	1 006	42	80 794	264 317	23 228	4.4
Upstream Gribov reservoirs	31	1	17 031	8 159	717	No financial gain
Upstream Telecentru reservoirs	241	10	30 786	63 418	5 573	53.7
Downstream Ialoveni PS	121	5	22 886	31 682	2 784	No financial gain
Downstream Codru PS	387	16	40 307	101 666	8 934	10.2
Upstream Airport reservoirs	38	2	17 505	10 064	884	No financial gain
Upstream Sîngera reservoirs	5	0	15 297	1 195	105	No financial gain
Upstream Balişevschi reservoirs	482	20	46 525	126 647	11 130	7.6
Upstream Independenţa reservoirs	225	9	29 706	59 078	5 192	154.9
Upstream Valea Dicescu reservoirs	765	32	65 047	201 057	17 669	5.1
Upstream Buiucani reservoirs	348	15	37 782	91 521	8 043	12.4
Upstream Ciocana reservoirs	3 422	143	238 872	899 366	79 035	3.2
On the outlet Otel of the WTP	1 854	77	136 305	487 322	42 825	3.6
Downstream Gribov PS	67	3	19 415	17 736	1 559	No financial gain
Upstream Cartuşa reservoirs	10	0	15 638	2 562	225	No financial gain
Upstream Schinoasa reservoir	131	5	23 552	34 358	3 019	No financial gain
Upstream Stauceni Reservoir	42	2	17 761	11 093	975	No financial gain
Outlet to Coşerniţa in SAN	9	0	15 594	2 386	210	No financial gain
Outlet to Vadul Lui Voda in SAN	314	13	35 512	82 401	7 241	15.8
TOTAL	9 720	405	935 879	2 554 532	224 490	

This evaluation is based on a "business as usual" scenario when the design and the operation of the drinking water network is not modified compared to the current situation. It shows that only three locations display a payback time shorter than 5 years.

However, significant modifications are recommended in the near future to optimize the Chişinău's network. These modifications affect the previous calculations especially through the following facts:

- Codru PS will not be used any longer
- The pipe at the outlet of the WTP will need to be changed so that it is pressure resistance enough. The CAPEX of implementing a pump-turbine station at the outlet of the WTP will then significantly increase compared to the previous calculations where it was accounting only for the pump-turbines and direct ancillaries.

The only place where a power generator has to be implemented is at Ciocana reservoir. For more than 15 years, ACC has studied this solution. To optimise the investment, Veolia has developed a solution based on standard equipments: a centrifugal pump coupled with an asynchronous motor operating in reverse. The technical principles are explained on the following figure.

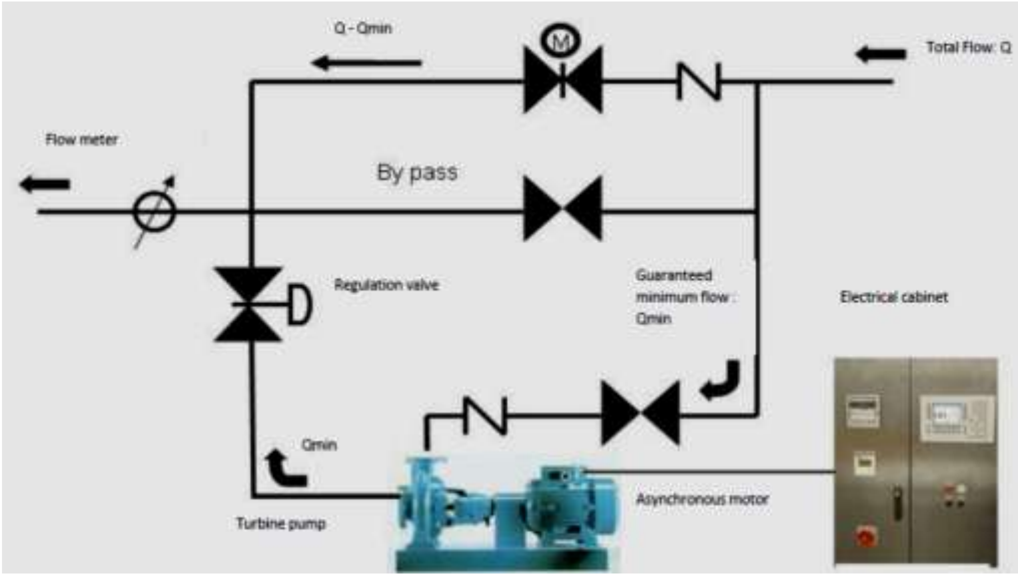


Figure 32: Principles of the hydro power generation through centrifugal pump

Based on the flow measurements performed upstream the Ciocana reservoirs and the future production scheme, it has been assessed that the minimum flow filling the Ciocana reservoirs will decrease from 900 and 450m^3/h between 2015 and 2035. As the lifespan of a centrifugal pump is 15 years, the equipments have to be designed for a flow of 560m^3/h (minimum flow estimated for 2030 -considering that the implementation will be done in 2015). With a head difference around 30m, the generated power will be 33kW (efficiency around 72%). This new facility will generate 290 000 kWh/year, which would bring revenues estimated at 20 500 €/year after the payback periods (around 4 years) when considering a total OPEX of 5 000 €/year.

It is worth reminding here that producing and selling electricity is subject to the approval of the authorities and to the technical feasibility of the connection to the grid. There is no guarantee that these two conditions can be fulfilled in a near future in Moldova, which makes the practical implementation of the following evaluation highly uncertain.

The most direct way of utilizing this energy potential would consist in coupling pump-turbines to electrical devices on the same site to avoid any electricity transit through the national grid and associated administrative procedures. Unfortunately, in Ciocana site, there are not such electrical devices.

5. DESIGN: QUANTITIES AND CAPACITIES

5.1. IMPROVEMENT OF THE CURRENT DISTRIBUTION

The supply of Ialoveni City, Durleşti and South East distribution Zones will be modified:

- A new ND300 pipeline should be laid by ACC to connect directly the distribution network of Ialoveni to Ialoveni pumping station. It was decided that the Ialoveni City Hall will purchase the pipes and ACC will install the network.
- A new ND300 pipeline should be laid by ACC in 2012 to connect directly the distribution network of Durleşti to Schinoasa pumping station. A tender has been carried out and the contractor selected. The work will be performed during 2012, by the Capital Constructions Directorate of Chişinău.
- The Codru pumping station supplying the South East distribution Zones will be by-passed. The upstream transfer pipeline will be partially replaced (700 m) by a ND400. This new pipeline will be extended to by-pass the Codru pumping station. It will be connected to the 3 existing delivery pipes to Airport tank, to Sîngera tank and to Codru MDK tank.

5.2. ADAPTATION OF THE WATER DISTRIBUTION SYSTEM TO THE NEW PRODUCTION SCHEME

The proposed production scheme including an emergency plan is based on the split of the production between STA and the 4 well fields of Ialoveni, Balişevschi, Ghidighici and Petricani. The ground water sources are mobilized, under normal conditions, at their minimum capacity to maintain in good operating conditions the whole production system. Given the poor quality of the groundwater, the production of drinking water from these sources for permanent supply will be treated thanks to package treatment plants. The adopted strategy proposes to treat H_2S and NH_4. To meet the standard for TDS and SO_4 (it concerns Balişevschi, Ghidighici and Petricani well fields), the water will be diluted in the reservoirs. This new production scheme needs some new facilities on the network:

- SAN and the treated water pumping stations Treapta II and IIa will be by-passed and replaced by pressure reducer valves. Around 100 meters of HDPE ND315 has to be laid to by-pass the abandoned facilities and two pressure reducers ND100 have to be installed.
- Ghidighici well field's production will be diluted with the water from the network of Zone 1 and mixed water will be pumped only to the North West part of the network. Around 100 meters of HDPE ND225 has to be laid to fill the Ghidighici's tank with water from the network and ND300 check valve has to be installed on the pipe coming from Zone1.

A new pumping station will be implemented to supply Tohatin tanks from Zone 2. The capacity of this pumping station will be adapted to the demand when the pumps will be changed every 10 years (lifespan of the pumps). Two pumps will deliver the maximum flow; one spare pump will be also installed. The technical characteristics of the pumps to be implemented in the next 25 years are given in the following table.

Table 24: Expected capacity of the projected pumping station to supply Tohatin tanks from Zone 2

Horizon	#	Flow by pump	Total Head	efficiency	Installed power
		m^3/h	m	%	kW
2014	2 + 1	169	10	66%	21
2024	2 + 1	142	10	65%	18
2034	2 + 1	113	10	63%	15

In the same way, a new pumping station will be implemented to get over the high point on the route from Tohatin to Vadul Lui Voda (the highest point is situated at 177). The capacity of the pumping station will also be adapted during the rehabilitation every 10 years. The technical characteristics are given in the Table 25.

Table 25: Expected capacity of the projected pumping station to supply Vadul Lui Voda from Tohatin tanks

Horizon	#	Flow by pump	Total Head	efficiency	Installed power
		m^3/h	m	%	kW
2014	2 + 1	182	20	66%	45
2024	2 + 1	165	20	66%	41
2034	2 + 1	146	20	65%	37

The pumping capacities of the 4 well fields of Ialoveni, Balişevschi, Ghidighici and Petricani to deliver the mixed water to the water distribution system have to be modified. The required designs depend on the emergency plan.

5.3. EMERGENCY PLAN

The Table 26 below summarizes the 7 pumping systems to implement for the emergency plan to operate correctly. To optimise the investments, two new pumps will deliver the maximum flow and no spare new pump will be installed. The best existing pumps will be maintained and they will be used as spare pumps.

Table 26: Pumping systems to implement for the emergency plan

Pumping stations	Lifespan	Stages		#	Flow by pump	Head	efficiency	Installed power
		1	2		m^3/h	m	%	kW
Petricani PS to Zone 1	15	2014	2029	2	140	55	65%	64
Petricani PS to Zone 2	20	2014	2034	2	201	120	66%	197
Ghidighici PS	15	2014	2029	2	165	54	66%	74
Balişevschi PS	20	2014	2034	2	177	125	66%	184
Buiucani Z4 PS from Buiucani tanks	20	2014	2034	2	285	97	68%	221
Ialoveni PS to Chişinău	25	2014		2	421	165	70%	542
Schinoasa PS to Z4a Telecentru	15	2014	2029	2	402	30	70%	94

Moreover, a connecting pipe of 600mm has to be laid between Petricani Pumping Station and the transfer pipe of Doina (500m) and some works has to be planned in the pumping stations of Valea Dicescu, Telecentru, Independenţa, Ialoveni and Schinoasa to be able to implement the emergency plan.

5.4. PRESSURE REDUCTION ON THE NETWORK

In order to improve the operation of the network, especially the leakage rate, the reduction of the pressure is critical. Some reorganisations are proposed on the water supply network to reduce the water losses by 10%. 10 distribution Zones are concerned.

The facilities described in the below table and the monitoring of the pressure at the critical points (around 40 pressure sensors will have to be installed on the network) lead:

- To reduce the flow of the leaks,
- To limit the number of new leaks,
- To improve the lifespan of the current network.

As the reduction of the losses is a critical issue, the implementation of the required facilities has to be scheduled in the next few years.

Table 27: Facilities to be implemented on the network to reduce the pressure on the existing network

Zone	Pressure reducer		Valve to close		Booster		Instrumentation		
	Diameter	#	Diameter	#	# to create	# back in operation	Flow meter Diameter	#	# Pressure sensor
Zone 1	ND200	1	ND400	1	1	1	ND200	1	2
			ND300	2					
Zone 2 in Botanica	ND200	4	ND500	1	2		ND200	3	16
	ND150	1	ND300	4			ND150	1	
	ND100	3	ND200	1					
Zone 2 in Ciocana	ND150	1	ND600	1			ND150	1	2
			ND400	1					
			ND300	3					
Zone 2 Doina	ND100	2							4
Zone 2 Oţel	ND200	1	ND500	1		1	ND200	1	4
	ND100	1	ND300	1					
Zone 3 Valea Dicescu	ND125	1	ND300	2			ND125	1	2
Zone 3 Buiucani									
Zone 3 Ciocana			ND500	2					
			ND400	1					
			ND300	1					
Zone 4 Ciocana			ND300	1					
Zone 4A Schinoasa	ND100	1	ND150	1					2

5.5. REHABILITATION OF WATER SUPPLY SYSTEM

5.5.1. REHABILITATION OF THE CURRENT NETWORK

In the next 25 years, half of the current network has to be rehabilitated (922 km). The pipelines rehabilitation programme is divided in 6 components as shown on the table below.

Table 28: Length of the pipelines to be rehabilitated by diameter

Rehabilitation Programme pipelines	Diameter of the existing pipes (mm)											Total (km)
	100	150	200	250	300	350	400	500	600	800	1200	
1 - Priority programme		18	12									30
2 - Steel Pipes ND 100 to 200	290	55	37									382
3 - Steel Pipes ND 250 to 400				27	64	4	27					122
4 - Iron Pipes ND 100 to 200	126	90	74									290
5 - ACC's programme not included in the four categories above	1		1		4		1	9	3	4	13	36
6 - Strategic pipes to be defined	2		1		7		3	15	5	12	17	62
Total (km)	420	162	125	27	75	4	32	24	8	11	35	922

5.5.2. REHABILITATION OF THE EXISTING PUMPS

Eleven existing pumping stations are operated with a poor performance. For them, the implementation of new pumps adapted to the current working conditions would generate an economical gain. However, all of them will not be rehabilitated:

- Three pumping stations will be decommissioned in the next few years.
- Three pumping stations are concerned by the new production scheme. The implementation of new pumps is therefore scheduled in the next few years.
- Five pumping stations will maintain the same working conditions in the future. It is scheduled to implement new pumps as soon as possible (they are comprised in the emergency programme).

Moreover, based on the economical gains, the future organisation of the water distribution system and the lifespan of the pumps, new pumps have to be implemented during the next 25 years (presented in the Table 29). To optimise the investments, two new pumps will deliver the maximum flow and no spare new pump will be installed. The best existing pumps will be maintained and they will be used as spare pumps.

Table 29: Existing water supply pumping stations – Capacity of the new pumps

Pumping stations	Lifespan	Stages			Stage 1					Stage 2					Stage 3				
		1	2	3	#	Flow by pump	Head	efficiency	Installed power	#	Flow by pump	Head	efficiency	Installed power	#	Flow by pump	Head	efficiency	Installed power
						m^3/h	m	%	kW		m^3/h	m	%	kW		m^3/h	m	%	kW
Treapta IIA raw water	30	2014			2	5 032	48	75%	1747										
Buiucani Z3 PS	10	2014	2024	2034	2	296	22	68%	52	2	238	22	67%	42	2	173	22	66%	32
Buiucani Z4 PS	20	2014	2034		2	400	60	70%	187	2	406	60	70%	190					
Independenţa Z3 PS	15	2014	2029		2	568	47	74%	198	2	581	47	74%	202					
Independenţa Z4 PS	20	2014	2034		2	291	100	68%	233	2	200	100	66%	164					
Balişevschi	15	2014	2029		2	180	68	66%	100	2	360	68	66%	100					
Ialoveni PS to Ialoveni City	20	2014	2034		2	186	101	66%	154	2	187	101	66%	155					
Telecentru Z4 PS	10	2014	2024	2034	2	100	35	63%	30	2	80	35	62%	24	2	58	35	59%	18
Telecentru Z4a PS	15	2014	2029		2	262	56	67%	119	2	205	56	66%	94					
Schinoasa PS	10	2014	2024	2034	2	61	48	59%	27	2	47	48	56%	22	2	34	48	56%	16
Tohatin PS to Tohatin	10	2017	2027		2	45	51	56%	23	2	40	51	56%	20					
Aeroport PS	10	2017	2027		2	17	40	43%	9	2	15	40	43%	8					
Sîngera PS	10	2017	2027		2	19	55	43%	14	2	18	55	43%	12					
Botanica PS	10	2017	2027		2	35	25	56%	9	2	28	25	51%	8					
U. Agrara PS	10	2017	2027		2	14	18	43%	3	2	10	18	43%	2					
Tohatin PS to Coloniţa	15	2020	2035		2	40	83	56%	32	2	32	83	56%	26					
Stauceni PS	15	2020	2035		2	100	54	63%	46	2	101	54	63%	47					
STA Z3 PS	15	2021			2	588	34	74%	148										
STA Z4 PS	15	2021			2	277	37	67%	83										
Valea Dicescu PS	20	2022			2	393	73	70%	224										
Treapta I raw water	30	2027			2	4 244	66	75%	2026										
Treapta II raw water	30	2027			2	4 244	63	75%	1934										

5.5.3. REHABILITATION OF THE TANKS

With the exception of Petricani tanks, the non-working tanks will remain stopped. On the other hand, 3 tanks will be decommissioned in the next years because they are in a poor state and inessential to maintain a stored capacity higher than 50% of the peak demand.

The remaining 39 tanks will be rehabilitated. Some need civil works and all of them need some equipment renewal and modernisation:

- Piping replacement,
- Fittings replacement and modernisation as the upstream regulation valves,
- Chlorination systems.

The rehabilitation and modernisation works are scheduled between 2014 and 2021 as shown on the table below:

Table 30: Rehabilitation works of the tanks

Site	TYPE OF WORKS	Horizon
Ialoveni	Construction works	2014
	Fittings	
Tohatin	Construction works	2014
	Fittings and rehabilitation of the chlorination system	
Valea Dicescu	Construction works	2014
	Fittings and implementation of a chlorination system	
STA Chişinău	Construction works	2014
	Fittings	
Ghidighici	Construction works	2014
	Fittings	
Upper Vadul Lui Voda	Construction works	2014
	Fittings and implementation of a chlorination system	
Telecentru	Construction works	2016
	Fittings and rehabilitation of the chlorination system	
Buiucani	Construction works	2021
	Fittings and rehabilitation of the chlorination system	
Ciocana	Construction works	2017
	Fittings and implementation of a chlorination system	
Schinoasa	Construction works	2019
	Fittings and rehabilitation of the chlorination system	
Airport	Fittings and implementation of a chlorination system	2015
Balişevschi	Fittings	2015
Petricani	Fittings	2015
Codru MDK	Fittings and implementation of a chlorination system	2020
Coloniţa	Fittings and implementation of a chlorination system	2018
Independenţa	Fittings and implementation of a chlorination system	2018
Sîngera	Fittings and implementation of a chlorination system	2015
Stauceni	Fittings and implementation of a chlorination system	2018

5.6. EXPANSION OF THE NETWORK

5.6.1. EXPANSION OF THE NETWORK INSIDE CHIŞINĂU CITY

Even if the population will decrease in Chişinău City during the next 25 years, some urban areas will continue to grow. The distribution network will follow the urban expansions and will be extended. The length of the projected network and the number of new connections has been estimated according to the evolution of the served population. The current ratios of 2.19 meters of network per inhabitant and 6.6 inhabitants per connection have been used in urban areas.

Model has shown that, in the next 25 years, the existing primary and secondary network will always remain enough sized to supply all the current urban areas of

Chişinău City even if some are growing. The network expansion in those urban areas concerns only the tertiary network.

Table 31: Distribution network expansion and number of new connections in Chişinău City

Zones	#	Horizon 2010	2015	2020	2025	2030	2035	TOTAL
Botanica	Population served by ACC resources via ACC's network	170 989	169 455	164 709	155 022	145 380	135 015	
	New inhabitants to be connected		1 639	1 410	945	804	699	5 498
	Expansion of the distribution network (m)		3 590	3 088	2 070	1 762	1 531	12 041
	New connections (units)		248	214	143	122	106	833
Buiucani	Population served by ACC resources via ACC's network	110 491	108 206	104 225	97 588	90 955	84 070	
	New inhabitants to be connected		154	250	298	40	0	741
	Expansion of the distribution network (m)		337	547	653	87	0	1 623
	New connections (units)		23	38	45	6	0	112
Centru	Population served by ACC resources via ACC's network	93 227	92 018	88 833	83 244	77 480	71 389	
	New inhabitants to be connected		0	0	0	0	0	0
	Expansion of the distribution network (m)		0	0	0	0	0	0
	New connections (units)		0	0	0	0	0	0
Ciocana	Population served by ACC resources via ACC's network	119 344	127 315	127 905	123 694	114 737	104 704	
	New inhabitants to be connected		7 971	589	0	0	0	8 561
	Expansion of the distribution network (m)		17 457	1 291	0	0	0	18 748
	New connections (units)		1 208	89	0	0	0	1 297
Rîscani	Population served by ACC resources via ACC's network	137 261	134 234	128 944	120 167	110 903	101 156	
	New inhabitants to be connected		109	99	72	59	47	386
	Expansion of the distribution network (m)		239	217	158	129	103	845
	New connections (units)		17	15	11	9	7	58
TOTAL	Population served by ACC resources via ACC's network	631 312	631 228	614 616	579 714	539 456	496 334	
	New inhabitants to be connected	0	9 873	2 348	1 315	903	746	**15 186**
	Expansion of the distribution network (m)	0	21 623	5 143	2 881	1 977	1 633	**33 257**
	New connections (units)	0	1 496	356	199	137	113	**2 301**

5.6.2. EXPANSION OF THE NETWORK IN THE CURRENTLY SERVED SUBURBS

In the next 25 years, the distribution network of some currently served suburbs by the ACC's network of Chişinău will be extended. The length of the projected network and the number of new connections has been estimated according to the evolution of the served population. The current ratios of 3.85 meters of network per inhabitant and 2.4 inhabitants per connection have been used.

Model has shown that the existing primary and secondary network will remain enough sized with the exception of Coşerniţa. The diameter of the current transfer pipe is not enough to supply the forecasted growing population of the city and should be replaced before 2015 by a ND200 HDPE (1.6 km).

Table 32: Length of projected distribution network and number of new connections of the suburbs currently served by Chişinău City's network

Suburbs	#	Horizon 2010	2015	2020	2025	2030	2035	TOTAL
Durleşti	Population served by ACC resources via ACC's network	16 319	16 731	16 499	16 271	16 045	15 867	
	New inhabitants to be connected		412	0	0	0	0	412
	Expansion of the distribution network (m)		1 588	0	0	0	0	1 588
	New connections (units)		172	0	0	0	0	172
Codru	Population served by ACC resources via ACC's network	14 399	14 417	14 508	14 600	14 692	14 766	
	New inhabitants to be connected		18	91	92	92	74	367
	Expansion of the distribution network (m)		70	351	353	355	286	1 414
	New connections (units)		8	38	38	38	31	153
Vadul lui Voda	Population served by ACC resources via ACC's network	4 544	4 561	4 399	4 243	4 092	3 975	
	New inhabitants to be connected		18	0	0	0	0	18
	Expansion of the distribution network (m)		68	0	0	0	0	68
	New connections (units)		7	0	0	0	0	7
Dumbrava	Population served by ACC resources via ACC's network	167	231	294	355	417	416	
	New inhabitants to be connected		64	62	62	61	0	249
	Expansion of the distribution network (m)		246	240	238	237	0	960
	New connections (units)		27	26	26	26	0	104
Vaduleni	Population served by ACC resources via ACC's network	399	480	535	562	560	559	
	New inhabitants to be connected		81	55	26	0	0	163
	Expansion of the distribution network (m)		313	211	102	0	0	627
	New connections (units)		34	23	11	0	0	68
Coloniţa	Population served by ACC resources via ACC's network	3 392	3 417	3 407	3 397	3 386	3 378	
	New inhabitants to be connected		25	0	0	0	0	25
	Expansion of the distribution network (m)		98	0	0	0	0	98
	New connections (units)		11	0	0	0	0	11
Cruzeşti	Population served by ACC resources via ACC's network	1 275	1 436	1 600	1 679	1 674	1 670	
	New inhabitants to be connected		160	164	79	0	0	403
	Expansion of the distribution network (m)		617	632	305	0	0	1 553
	New connections (units)		67	68	33	0	0	168
Cheltuitor	Population served by ACC resources via ACC's network	221	286	321	355	354	353	
	New inhabitants to be connected		65	35	35	0	0	135
	Expansion of the distribution network (m)		251	134	133	0	0	518
	New connections (units)		27	14	14	0	0	56
Tohatin	Population served by ACC resources via ACC's network	2 194	2 310	2 303	2 296	2 289	2 283	
	New inhabitants to be connected		116	0	0	0	0	116
	Expansion of the distribution network (m)		446	0	0	0	0	446
	New connections (units)		48	0	0	0	0	48
Hulboaca	Population served by ACC resources via ACC's network	921	1 230	1 379	1 528	1 523	1 520	
	New inhabitants to be connected		309	150	149	0	0	607
	Expansion of the distribution network (m)		1 189	576	572	0	0	2 337
	New connections (units)		129	62	62	0	0	253
Goianul Nou	Population served by ACC resources via ACC's network	445	536	598	627	625	624	
	New inhabitants to be connected		91	61	30	0	0	182
	Expansion of the distribution network (m)		351	236	114	0	0	701
	New connections (units)		38	26	12	0	0	76
Stauceni	Population served by ACC resources via ACC's network	7 011	7 054	7 033	7 012	6 991	6 975	
	New inhabitants to be connected		43	0	0	0	0	43
	Expansion of the distribution network (m)		166	0	0	0	0	166
	New connections (units)		18	0	0	0	0	18
Ialoveni	Population served by ACC resources via ACC's network	14 597	16 400	16 755	17 046	17 046	17 046	
	New inhabitants to be connected		1 803	356	290	0	0	2 449
	Expansion of the distribution network (m)		6 942	1 369	1 117	0	0	9 428
	New connections (units)		751	148	121	0	0	1 020
Maximovca	Population served by ACC resources via ACC's network	734	1 075	1 429	1 782	1 782	1 782	
	New inhabitants to be connected		341	354	353	0	0	1 048
	Expansion of the distribution network (m)		1 312	1 363	1 359	0	0	4 034
	New connections (units)		142	148	147	0	0	437
Floreni	Population served by ACC resources via ACC's network	968	1 527	2 079	2 630	3 704	3 704	
	New inhabitants to be connected		559	552	551	1 074	0	2 737
	Expansion of the distribution network (m)		2 153	2 127	2 120	4 136	0	10 536
	New connections (units)		233	230	229	448	0	1 140
Coşerniţa	Population served by ACC resources via ACC's network	746	1 052	1 353	1 516	1 516	1 516	
	New inhabitants to be connected		305	301	164	0	0	770
	Expansion of the distribution network (m)		1 175	1 158	630	0	0	2 963
	New connections (units)		127	125	68	0	0	321

Suburbs	#	Horizon						TOTAL
		2010	2015	2020	2025	2030	2035	
TOTAL	Population served by ACC resources via ACC's network	68 332	72 744	74 492	75 898	76 697	76 433	
	New inhabitants to be connected	0	4 412	2 181	1 829	1 228	74	9 724
	Expansion of the distribution network (m)	0	16 986	8 396	7 042	4 727	286	37 437
	New connections (units)	0	1 838	909	762	512	31	4 052

5.6.3. EXPANSION OF THE NETWORK TO FUTURE URBAN AREAS

In the next 25 years, the water supply network will be extended to the future urban areas of Chişinău City. The length of the projected network has been estimated according to the evolution of the population in the future urban areas. The current ratio of 2.19 meters / inhabitant has been used.

Table 33: Length of the projected network of the future urban areas

Zone	Surface (ha)	Population					Total length of the water supply network (m)				
		2015	2020	2025	2030	2035	2015	2020	2025	2030	2035
1A	433.68	0	0	0	11 615	23 230	0	0	0	25 437	50 873
2A	252.67	0	0	11 370	13 528	13 528	0	0	24 900	29 625	29 625
3A	48.20	0	0	0	1 291	2 582	0	0	0	2 828	5 655
4A	28.07	0	0	0	2 148	4 296	0	0	0	4 704	9 408
5A	70.41	0	0	0	5 388	10 775	0	0	0	11 799	23 598
6A	160.53	1 971	7 293	9 032	8 597	8 597	4 316	15 972	19 780	19 780	19 780
7A	20.39	0	0	0	1 560	3 120	0	0	0	3 417	6 834
8A	166.02	2 718	5 748	9 966	9 486	9 486	5 953	12 588	21 826	21 826	21 826
9A	246.90	0	801	13 894	13 224	13 224	0	1 755	30 428	30 428	30 428
10A	51.73	0	0	0	1 385	2 770	0	0	0	3 033	6 067
11A	102.71	0	0	0	7 858	15 717	0	0	0	17 210	34 419
Total	**1 581**	**4 689**	**13 843**	**44 262**	**76 080**	**107 325**	**10 270**	**30 315**	**96 934**	**170 086**	**238 512**

The projected primary and secondary networks have been designed through the model. The breakdown of the projected network of the future urban areas by diameter and horizon is given in the following table.

Table 34: Breakdown of the extension of the network by diameter and horizon

Length of Network (m)	2015	2020	2025	2030	2035
Tertiary network	3 247	21 063	85 763	151 882	220 308
ND 110 HDPE	0	188	188	188	188
ND 125 HDPE	0	0	0	550	550
ND 160 HDPE	0	0	0	604	604
ND 200 HDPE	2 154	2 154	2 154	2 788	2 788
ND 225 HDPE	2 772	3 880	3 880	4 433	4 433
ND 250 HDPE	553	553	1 255	1 255	1 255
ND 315 HDPE	0	933	2 150	5 902	5 902
ND 400 HDPE	1 544	1 544	1 544	1 544	1 544
ND 400 CAST IRON	0	0	0	940	940
TOTAL (m)	**10 270**	**30 315**	**96 934**	**170 086**	**238 512**

The number of new connections to implement in the next 25 years in the future urban areas of Chişinău is also estimated based on the current ratio: around 6.6 inhabitants per connection.

Table 35: Number of new connections of the future urban areas

#	Horizon					TOTAL
	2015	2020	2025	2030	2035	
Population	4 689	13 843	44 262	76 080	107 325	
New inhabitants	4 689	9 154	30 419	33 402	31 245	108 909
New connections	710	1 387	4 609	5 061	4 734	16 501

To deliver an adequate pressure on the projected network, 4 pumping stations and 2 pressure reducers will be implemented. The technical characteristics of the required facilities to be implemented in the next 25 years are given in the following table. Two pumps will deliver the maximum flow; one spare pump will be also installed. The lifespan of the pumps is 10 years, they will be changed regularly.

Table 36: Facilities to be implemented on the network to reduce the pressure on the extensions of the network

Zone	Horizon	Facility's Description	Technical characteristics
1A	2030	PS to supply the area above 150 m	2 + 1 pumps - 94 m3/h by pump at 15 m - 18 kW installed
2A	2025	PS to supply the area above 160 m	2 + 1 pumps - 44 m3/h by pump at 40 m - 26 kW installed
3A	2030	PS to supply the area above 140 m	2 + 1 pumps - 17.5 m3/h by pump at 35 m - 12 kW installed
9A	2020	PS to supply the area above 160 m	2 + 1 pumps - 3.5 m3/h by pump at 20 m - 1.3 kW installed
		PR to supply the area below 130 m	Pressure reducer ND100
11A	2030	PR to supply the area below 100 m	Pressure reducer ND200

5.6.4. CONNECTION OF SUBURBS TO ACC'S NETWORK

In the future, some suburbs are planned to be connected to ACC's network because they are currently supplied by groundwater and the best way to supply them with potable water (in accordance with the standards) is to connect their distribution network to Chişinău's network. As the water quality is an important issue, the implementation of the required facilities has to be scheduled in the next few years. Most of the concerned suburbs are served by ACC (Part of Sîngera and Vatra currently supplied by groundwater, Ghidighici Village, Coşerniţa, Balabaneşti, Budeşti, Revaca) but two suburbs are not: Cojuşna and Truşeni.

The projected transfer mains have been designed through the model.

Table 37: Breakdown of the transfer mains by diameter and suburbs to be connected

Mains diameter	Ghidighici	Revaca and Sîngera	Vatra	Balabaneşti	Budeşti	Cojuşna and Truşeni	TOTAL (m)
ND 110 HDPE	0	1 699	1 945				3 644
ND 125 HDPE	555						555
ND 160 HDPE	0			655			655
ND 200 HDPE	765			845		6 164	7 774
ND 225 HDPE	1 975				1 306	2 415	5 697
ND 250 HDPE						1 090	1 090
ND 315 HDPE						710	710
TOTAL (m)	**3 295**	**1 699**	**1 945**	**1 500**	**1 306**	**10 379**	**20 124**

In the next 25 years, the distribution network served by the ACC's resources will be extended in the concerned suburbs. The length of the projected network and the number of new connections has been estimated according to the evolution of the served population: 3.85 meters / inhabitant and around 2.4 inhabitants per connection.

Table 38: Length of projected distribution network and number of new connections of the suburbs to be connected to Chişinău City's network

Suburbs	#	Horizon						TOTAL
		2010	2015	2020	2025	2030	2035	
Ghidighici	Population served by ACC resources via ACC's network	3 210	4 126	4 629	5 128	5 113	5 101	
	New inhabitants to be connected		916	502	499	0	0	1 918
	Expansion of the distribution network (m)		3 528	1 933	1 922	0	0	7 383
	New connections (units)		382	209	208	0	0	799
Revaca and Sîngera	Population served by ACC resources via ACC's network	6 867	8 964	9 070	9 176	9 285	9 372	
	New inhabitants to be connected		2 098	105	107	108	88	2 506
	Expansion of the distribution network (m)		8 076	406	411	417	338	9 648
	New connections (units)		874	44	45	45	37	1 044
Vatra	Population served by ACC resources via ACC's network	3 315	3 339	3 230	3 126	3 025	2 946	
	New inhabitants to be connected		0	0	0	0	0	0
	Expansion of the distribution network (m)		0	0	0	0	0	0
	New connections (units)		0	0	0	0	0	0
Balabaneşti	Population served by ACC resources via ACC's network	612	2 110	2 104	2 099	2 099	2 099	
	New inhabitants to be connected		0	0	0	0	0	0
	Expansion of the distribution network (m)		0	0	0	0	0	0
	New connections (units)		0	0	0	0	0	0
Budeşti	Population served by ACC resources via ACC's network	80	82	4 656	4 642	4 629	4 618	
	New inhabitants to be connected		0	0	0	0	0	0
	Expansion of the distribution network (m)		0	0	0	0	0	0
	New connections (units)		0	0	0	0	0	0
Cojuşna and Truşeni	Population served by ACC resources via ACC's network	0	5 168	8 880	11 152	14 845	14 826	
	New inhabitants to be connected		1 754	3 712	2 272	3 694	0	11 431
	Expansion of the distribution network (m)		6 751	14 291	8 747	14 220	0	44 009
	New connections (units)		731	1 547	947	1 539	0	4 763
TOTAL	Population served by ACC resources via ACC's network	14 083	23 789	32 568	35 323	38 995	38 962	
	New inhabitants to be connected	0	4 768	4 319	2 878	3 802	88	**15 855**
	Expansion of the distribution network (m)	0	18 356	16 630	11 080	14 637	338	**61 040**
	New connections (units)	0	1 987	1 800	1 199	1 584	37	**6 606**

To transfer and to deliver an adequate pressure to the suburbs' water supply network, 5 pumping stations are required. Their technical characteristics are given in the following table. Two pumps will deliver the maximum flow; one spare pump will be also installed. The lifespan of the pumps is 10 years, they will be changed regularly.

Table 39: Capacity of the required pumping stations to connect and supply the suburbs

Suburb	Facility's Description	Technical characteristics
Ghidighici	PS to supply the area above 80 m	2 + 1 pumps - 27.6 m3/h by pump at 45 m - 20 kW installed
	PS to supply the area above 120 m	2 + 1 pumps - 6.7 m3/h by pump at 35 m - 4.4 kW installed
Cojuşna	PS to supply the reservoir of Cojuşna	2 + 1 pumps - 27 m3/h by pump at 70 m - 30 kW installed
Truşeni	PS to supply Truşeni	2 + 1 pumps - 37 m3/h by pump at 140 m - 75 kW installed
Balabaneşti	PS to supply the area above 50 m	2 + 1 pumps - 14 m3/h by pump at 70 m - 19 kW installed

5.7. HYDRO POWER GENERATOR AT CIOCANA RESERVOIRS

A turbine pump will be implemented upstream Ciocana reservoirs to generate 33 kW:

- Flow: 560 m3/h
- Head: 30 m

This turbine pump has been designed on the expected minimum flow filling Ciocana reservoirs in 2030. Its implementation has been scheduled in 2015. Its replacement should come 15 years after.

6. COST ESTIMATES

6.1. UNIT COSTS

The cost estimates for construction and installation works were calculated using the resources method in accordance with the estimate rules in force in Republic of Moldova. The prices for materials, valves and accessories, flow-meters and other goods groups were applied based on the price lists of goods providing companies CIF Chişinău. The main unit costs are given below.

6.1.1. PIPES

For 10 years, ACC has chosen to lay, for secondary and tertiary network (diameters smaller than 300 mm), pipes made of HDPE and for primary network pipes made of ductile iron. This choice is widely used in Western Europe; it has been assumed that this choice is maintained in the future. The following unit costs have been calculated considering that only 20% of the tertiary network (diameters smaller than 100 mm) will be laid under an asphalt road (80% for the secondary and primary network).

Table 40: Unit cost of potable water pipes according to type of material and diameter

Diameter and type of material	Internal diameter (mm)	MDL VAT exclusive / meter
ND 63 HDPE SDR 17	54.9	**420**
ND 75 HDPE SDR 17	65.5	**511**
ND 90 HDPE SDR 17	78.6	**564**
ND 110 HDPE SDR 17	96	**642**
ND 125 HDPE SDR 17	109.3	**997**
ND 160 HDPE SDR 17	139.9	**1 184**
ND 180 HDPE SDR 17	157.3	**1 312**
ND 200 HDPE SDR 17	174.8	**1 453**
ND 225 HDPE SDR 17	196.6	**1 667**
ND 250 HDPE SDR 17	218.6	**1 897**
ND 315 HDPE SDR 17	275.4	**2 628**
ND 400 HDPE SDR 17	349.8	**3 802**
ND 300 DUCTILE IRON	300	**4 541**
ND 400 DUCTILE IRON	400	**5 944**
ND 500 DUCTILE IRON	500	**7 949**
ND 600 DUCTILE IRON	600	**10 229**
ND 800 DUCTILE IRON	800	**13 392**
ND 1000 DUCTILE IRON	1000	**16 514**
ND 1200 DUCTILE IRON	1200	**19 852**
ND 1400 DUCTILE IRON	1400	**21 488**

In the same way, the unit cost of a 12 meters HDPE connection has been estimated to 16 313 MDL VAT exclusive. The replacement of a connection when replacing the main pipe has a positive impact on the unit cost: it has been assumed that the price of the excavation works is greatly reduced. In this case, the considered unit cost is 11 200 MDL VAT exclusive.

6.1.2. PUMPING STATIONS

Veolia performs a permanent bench mark on the pump's costs. The Veolia experts have concluded that the current costs of electro-mechanical equipments for pumping stations including installation, hydraulic fittings, electricity and control panel are the followings:

Table 41: Unit cost of potable water pumps

Power (kW)	Cost (MDL VAT exclusive)
15	**66 528**
18	**72 576**
18.5	**72 576**
21	**78 624**
30	**96 768**
35	**105 840**
37	**108 864**
45	**127 008**
55	**148 176**
75	**181 440**
90	**211 680**
110	**241 920**
130	**272 160**
132	**272 160**
150	**332 640**
160	**362 880**
190	**544 320**
200	**695 520**
225	**1 663 200**
250	**1 814 400**
300	**2 116 800**
320	**2 268 000**
350	**2 570 400**
400	**2 872 800**
500	**3 326 400**
600	**3 780 000**
630	**3 931 200**
750	**4 384 800**
800	**4 838 400**
1100	**7 862 400**

They have also estimated that the implementation of a speed drive represents an extra cost of 50%.

The cost of civil works of the projected pumping stations has been estimated as follow:

Table 42: Unit cost of civil works for new pumping stations

Cost of the electromechanical equipments (MDL VAT exclusive)	Cost of the civil works (MDL VAT exclusive)
Lower than 160 000 MDL	**135 000**
Between 160 000 and 330 000 MDL	**194 000**
Higher than 330 000 MDL	**0.6 x Cost of equipments**

6.2. CAPITAL COSTS ESTIMATES

The following costs have been estimated:

Table 43: Water Supply CAPEX

Improvement of the current distribution

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
On-going project in Ialoveni	ND 300 DUCTILE IRON	422	1 916	120
On-going project in Durleşti	ND 300 DUCTILE IRON	2 652	12 043	753
TOTAL			13 959	872

Adaptation of the water distribution system to the new production scheme

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
By-pass of SAN facilities	ND 315 HDPE SDR 17	100	263	16
	ND100 pressure reducer	2	86	5
	Manhole for pressure reducer	2	87	5
New PS from Zone 2 to Tohatin	Stage 1: Pumps 169 m3/h vs 10 m	3	272	17
	Stage 2: Pumps 142 m3/h vs 10 m	3	272	17
	Stage 3: Pumps 113 m3/h vs 10 m	3	272	17
	ND 300 Check valve	1	13	1
	Civil works	1	194	12
New PS from Tohatin tanks to VdV	Stage 1: Pumps 182 m3/h vs 20 m	3	381	24
	Stage 2: Pumps 165 m3/h vs 20 m	3	327	20
	Stage 3: Pumps 146 m3/h vs 20 m	3	327	20
	ND 400 HDPE SDR 17	100	380	24
Ghidighici dilution	ND 225 HDPE SDR 17	100	167	10
	ND 300 Check valve	1	13	1
TOTAL			3 055	190

Emergency plan

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Petricani PS to Zone 1	Stage 1: Pumps 140 m3/h vs 55 m	2	311	19
	Stage 2: Pumps 140 m3/h vs 55 m	2	311	19
Petricani PS to Zone 2	Stage 1: Pumps 201 m3/h vs 120 m	2	653	41
	Stage 2: Pumps 201 m3/h vs 120 m	2	653	41
Ghidighici PS	Stage 1: Pumps 165 m3/h vs 54 m	2	339	21
	Stage 2: Pumps 165 m3/h vs 54 m	2	339	21
Balişevschi PS	Stage 1: Pumps 177 m3/h vs 125 m	2	612	38
	Stage 2: Pumps 177 m3/h vs 125 m	2	612	38
Buiucani Z4 PS from Buiucani tanks	Stage 1: Pumps 285 m3/h vs 97 m	2	712	44
	Stage 2: Pumps 285 m3/h vs 97 m	2	712	44
Ialoveni PS to Chisinau	Pumps 421 m3/h vs 165 m	2	6 076	380
Schinoasa PS to Z4a Telecentru	Stage 1: Pumps 402 m3/h vs 30 m	2	397	25
	Stage 2: Pumps 402 m3/h vs 30 m	2	397	25
Connection Petricani PS to Transfer pipe of Doina (Zone 2)	ND 600 DUCTILE IRON	500	5 115	320
TOTAL			17 238	1 077

Pressure reduction on the network

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Pressure reduction on Zone 1	ND200 Pressure reducer	1	95	6
	Manhole for pressure reducer	1	55	3
	ND400 Valve to be replaced	1	23	1
	ND300 Valve to be replaced	2	26	2
	Booster to create	1	160	10
	Booster back to operation	1	53	3
	ND200 Flow meter	1	68	4
	Pressure sensor	2	22	1
Pressure reduction on Zone 2 in Botanica	ND200 Pressure reducer	4	381	24
	ND150 Pressure reducer	1	84	5
	ND100 Pressure reducer	3	129	8
	Manhole for pressure reducer	8	437	27
	ND500 Valve to be replaced	1	44	3
	ND300 Valve to be replaced	4	53	3
	ND200 Valve to be replaced	1	9	1
	Booster to create	2	319	20
	ND200 Flow meter	3	203	13
	ND150 Flow meter	1	55	3
	Pressure sensor	16	176	11
Pressure reduction on Zone 2 in Ciocana	ND150 Pressure reducer	1	84	5
	Manhole for pressure reducer	1	55	3
	ND600 Valve to be replaced	1	95	6
	ND400 Valve to be replaced	1	23	1
	ND300 Valve to be replaced	3	39	2
	ND150 Flow meter	1	55	3
	Pressure sensor	2	22	1
Pressure reduction on Zone 2 Doina	ND100 Pressure reducer	2	86	5
	Manhole for pressure reducer	2	109	7
	Pressure sensor	4	44	3
Pressure reduction on Zone 2 Oţel	ND200 Pressure reducer	1	95	6
	ND100 Pressure reducer	1	43	3
	Manhole for pressure reducer	2	109	7
	ND500 Valve to be replaced	1	44	3
	ND300 Valve to be replaced	1	13	1
	Booster back to operation	1	53	3
	ND200 Flow meter	1	68	4
	Pressure sensor	4	44	3
Pressure reduction on Zone 3 Valea Dicescu	ND125 Pressure reducer	1	63	4
	Manhole for pressure reducer	1	55	3
	ND300 Valve to be replaced	2	26	2
	ND125 Flow meter	1	45	3
	Pressure sensor	2	22	1
Pressure reduction on Zone 3 Ciocana	ND500 Valve to be replaced	2	88	6
	ND400 Valve to be replaced	1	23	1
	ND300 Valve to be replaced	1	13	1
Pressure reduction on Zone 4 Ciocana	ND300 Valve to be replaced	1	13	1
Pressure reduction on Zone 4A Schinoasa	ND100 Pressure reducer	1	43	3
	Manhole for pressure reducer	1	55	3
	ND150 Valve to be replaced	1	7	0
	Pressure sensor	2	22	1
Critical points on the network	Pressure sensor	40	882	55
TOTAL			4 830	302

Rehabilitation of the current network

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
1 - Priority programme	ND150 existing steel pipes	17 827	17 772	1 111
	ND200 existing steel pipes	12 173	17 942	1 121
2 - Steel Pipes ND 100 to 200	ND100 existing steel pipes	290 490	186 628	11 664
	ND150 existing steel pipes	54 563	54 393	3 400
	ND200 existing steel pipes	37 257	54 914	3 432
3 - Steel Pipes ND 250 to 400	ND250 existing steel pipes	26 570	44 169	2 761
	ND300 existing steel pipes	63 960	146 703	9 169
	ND350 existing steel pipes	3 760	8 561	535
	ND400 existing steel pipes	27 390	63 116	3 945
4 - Iron Pipes ND 100 to 200	ND100 existing cast iron pipes	126 250	81 110	5 069
	ND150 existing cast iron pipes	89 880	89 600	5 600
	ND200 existing cast iron pipes	73 440	108 244	6 765
5 - ACC's programme not included in the four categories above	Existing pipes with diameter between 100 and 1200 mm	35 343	224 646	14 040
6 - Strategic pipes to be defined	Existing pipes with diameter between 100 and 1200 mm	62 490	375 415	23 463
TOTAL			1 473 211	92 076

Rehabilitation of the existing connections for blocks

(the connections for individual houses will be replaced as well but will be invoiced to the customers)

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Urgent programme for connections	Existing steel connections	1 000	11 200	700
Rehabilitation of steel connections	Existing steel connections	29 338	328 580	20 536
TOTAL			339 780	21 236

Rehabilitation of the existing pumps (Emergency Plan)

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Buiucani Z3 PS	Pumps 296 m3/h vs 22 m	2	270	17
Buiucani Z4 PS	Pumps 400 m3/h vs 60 m	2	623	39
Independenţa Z3 PS	Pumps 568 m3/h vs 47 m	2	647	40
Independenţa Z4 PS	Pumps 291 m3/h vs 100 m	2	745	47
Treapta II a raw water	Pumps 5032 m3/h vs 48 m	2	10 919	682
TOTAL			13 204	825

Rehabilitation of the existing pumps (stage 1)

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Balişevschi	Pumps 360 m3/h vs 68m	2	412	26
Ialoveni PS to Ialoveni City	Pumps 186 m3/h vs 101 m	2	547	34
U. Agrara PS	Pumps 14 m3/h vs 18 m	2	181	11
Valea Dicescu PS	Pumps 393 m3/h vs 73 m	2	717	45
Botanica PS	Pumps 35 m3/h vs 25 m	2	181	11
Telecentru Z4 PS	Pumps 100 m3/h vs 35 m	2	190	12
Telecentru Z4a PS	Pumps 262 m3/h vs 56 m	2	462	29
Schinoasa PS	Pumps 61 m3/h vs 48 m	2	181	11
STA Z3 PS	Pumps 588 m3/h vs 34 m	2	529	33
STA Z4 PS	Pumps 277 m3/h vs 37 m	2	368	23
Tohatin PS to Tohatin	Pumps 45 m3/h vs 51 m	2	181	11
Tohatin PS to Coloniţa	Pumps 40 m3/h vs 83 m	2	194	12
Aeroport PS	Pumps 17 m3/h vs 40 m	2	181	11
Sîngera PS	Pumps 19 m3/h vs 55 m	2	181	11
Stauceni PS	Pumps 100 m3/h vs 54 m	2	251	16
Treapta I raw water	Pumps 4244 m3/h vs 66 m	2	13 557	847
Treapta II raw water	Pumps 4244 m3/h vs 63 m	2	12 569	786
TOTAL			30 882	1929

Rehabilitation of the existing pumps (stage 2)

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Balişevschi	Pumps 180 m^3/h vs 68m	2	412	26
Ialoveni PS to Ialoveni City	Pumps 187 m3/h vs 101 m	2	550	34
Buiucani Z3 PS	Pumps 238 m3/h vs 22 m	2	236	15
Buiucani Z4 PS	Pumps 406 m3/h vs 60 m	2	629	39
U. Agrara PS	Pumps 10 m3/h vs 18 m	2	181	11
Independenţa Z3 PS	Pumps 581 m3/h vs 47 m	2	658	41
Independenţa Z4 PS	Pumps 200 m3/h vs 100 m	2	571	36
Botanica PS	Pumps 28 m3/h vs 25 m	2	181	11
Telecentru Z4 PS	Pumps 80 m3/h vs 35 m	2	181	11
Telecentru Z4a PS	Pumps 205 m3/h vs 56 m	2	399	25
Schinoasa PS	Pumps 47 m3/h vs 48 m	2	181	11
Tohatin PS to Tohatin	Pumps 40 m3/h vs 51 m	2	181	11
Tohatin PS to Coloniţa	Pumps 32 m3/h vs 83 m	2	157	10
Aeroport PS	Pumps 15 m3/h vs 40 m	2	181	11
Sîngera PS	Pumps 18 m3/h vs 55 m	2	181	11
Stauceni PS	Pumps 101 m3/h vs 54 m	2	252	16
TOTAL			5131	319

Rehabilitation of the existing pumps (stage 3)

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Buiucani Z3 PS	Pumps 173 m3/h vs 22 m	2	194	12
Telecentru Z4 PS	Pumps 58 m3/h vs 35 m	2	181	11
Schinoasa PS	Pumps 34 m3/h vs 48 m	2	181	11
TOTAL			557	35

Rehabilitation of the tanks

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Rehabilitation of the tanks of Ialoveni	Construction works	2	932	58
	Fittings		1 836	115
Rehabilitation of the tanks of Tohatin	Construction works	3	4 045	253
	Fittings and rehabilitation of the chlorination system		859	54
Rehabilitation of the tanks of Valea Dicescu	Construction works	3	2 502	156
	Fittings and implementation of a chlorination system		819	51
Rehabilitation of the tanks of STA Chisinau	Construction works	5	12 631	789
	Fittings		814	51
Rehabilitation of the tanks of Ghidighici	Construction works	1	510	32
	Fittings		148	9
Rehabilitation of the tanks of Upper Vadul Lui Voda	Construction works	1	561	35
	Fittings and implementation of a chlorination system		489	31
Rehabilitation of the tanks of Telecentru	Construction works	1	940	59
	Fittings and rehabilitation of the chlorination system		449	28
Rehabilitation of the tanks of Buiucani	Construction works	2	1 112	69
	Fittings and rehabilitation of the chlorination system		653	41
Rehabilitation of the tanks of Ciocana	Construction works	3	996	62
	Fittings and implementation of a chlorination system		798	50
Rehabilitation of the tanks of Schinoasa	Construction works	1	1 112	69
	Fittings and rehabilitation of the chlorination system		292	18
Rehabilitation of the tanks of Airport	Fittings and implementation of a chlorination system	3	564	35
Rehabilitation of the tanks of Balişevschi	Fittings	2	265	17
Rehabilitation of the tanks of Petricani	Fittings	2	265	17
Rehabilitation of the tanks of Codru MDK	Fittings and implementation of a chlorination system	2	768	48
Rehabilitation of the tanks of Coloniţa	Fittings and implementation of a chlorination system	3	568	36
Rehabilitation of the tanks of Independenţa	Fittings and implementation of a chlorination system	2	425	27
Rehabilitation of the tanks of Sîngera	Fittings and implementation of a chlorination system	2	425	27
Rehabilitation of the tanks of Stauceni	Fittings and implementation of a chlorination system	1	292	18
TOTAL			36 071	2 254

Expansion of the network in Chisinau City

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Expansion in Botanica in the next 25 years	Distribution network	12 041	5 635	352
	Connections	833	13 589	849
Expansion in Buiucani in the next 25 years	Distribution network	1 623	760	47
	Connections	112	1 827	114
Expansion in Centru in the next 25 years	Distribution network	0	0	0
	Connections	0	0	0
Expansion in Ciocana in the next 25 years	Distribution network	18 748	8 774	548
	Connections	1 297	21 158	1 322
Expansion in Rîscani in the next 25 years	Distribution network	845	395	25
	Connections	58	946	59
TOTAL			53 084	3 318

Expansion of the network in the currently served suburbs

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Expansion in Durleşti in the next 25 years	Distribution network	1 588	743	46
	Connections	172	2 806	175
Expansion in Codru in the next 25 years	Distribution network	1 414	662	41
	Connections	153	2 496	156
Expansion in Vadul lui Voda in the next 25 years	Distribution network	68	32	2
	Connections	7	114	7
Expansion in Dumbrava in the next 25 years	Distribution network	960	449	28
	Connections	104	1 697	106
Expansion in Vaduleni in the next 25 years	Distribution network	627	293	18
	Connections	68	1 109	69
Expansion in Coloniţa in the next 25 years	Distribution network	98	46	3
	Connections	11	179	11
Expansion in Cruzeşti in the next 25 years	Distribution network	1 553	727	45
	Connections	168	2 741	171
Expansion in Cheltuitor in the next 25 years	Distribution network	518	242	15
	Connections	56	914	57
Expansion in Tohatin in the next 25 years	Distribution network	446	209	13
	Connections	48	783	49
Expansion in Hulboaca in the next 25 years	Distribution network	2 337	1 094	68
	Connections	253	4 127	258
Expansion in Goianul Nou in the next 25 years	Distribution network	701	328	21
	Connections	76	1 240	77
Expansion in Stauceni in the next 25 years	Distribution network	166	78	5
	Connections	18	294	18
Expansion in Ialoveni in the next 25 years	Distribution network	9 428	4 412	276
	Connections	1 020	16 639	1 040
Expansion in Maximovca in the next 25 years	Distribution network	4 034	1 888	118
	Connections	437	7 129	446
Expansion in Floreni in the next 25 years	Distribution network	10 536	4 931	308
	Connections	1 140	18 597	1 162
Expansion in Coşerniţa in the next 25 years	ND 200 HDPE SDR 17	1 600	2 325	145
	Distribution network	2 963	1 387	87
	Connections	321	5 236	327
TOTAL			85 946	5 372

Expansion of the network to future areas

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Expansion in zones 6A and 8A in the next 25 years	ND 200 HDPE SDR 17	1 512	2 197	137
	ND 200 HDPE SDR 17	219	319	20
	ND 225 HDPE SDR 17	1 463	2 439	152
	ND 200 HDPE SDR 17	423	614	38
	ND 250 HDPE SDR 17	553	1 049	66
	ND 400 HDPE SDR 17	1 544	5 870	367
	ND 225 HDPE SDR 17	1 308	2 181	136
	Distribution network	32 579	15 247	953
	Connections	2 878	46 957	2 935
Expansion in zones 9A in the next 25 years	ND 225 HDPE SDR 17	1 109	1 848	116
	ND 315 HDPE SDR 17	933	2 452	153
	ND 110 HDPE SDR 17	188	121	8
	Stage 1: Pumps 3.5 m3/h vs 20 m	3	272	17
	Stage 2: Pumps 3.5 m3/h vs 20 m	3	272	17
	Civil works	1	194	12
	ND100 Pressure reducer	1	43	3
	Manhole for pressure reducer	1	55	3
	Distribution network	28 199	13 197	825
	Connections	2 105	34 341	2 146
Expansion in zones 2A in the next 25 years	ND 315 HDPE SDR 17	1 217	3 197	200
	ND 250 HDPE SDR 17	455	863	54
	ND 250 HDPE SDR 17	248	470	29
	Stage 1: Pumps 44 m3/h vs 40 m	3	272	17
	Stage 2: Pumps 44 m3/h vs 40 m	3	272	17
	Civil works	1	194	12
	Distribution network	1 046	489	31
	Connections	2 050	33 437	2 090
Expansion in zones 1A, 3A, 4A,5A, 7A, 10A and 11A in the next 25 years	ND 225 HDPE SDR 17	553	921	58
	ND 315 HDPE SDR 17	1 419	3 728	233
	ND 315 HDPE SDR 17	195	512	32
	ND 315 HDPE SDR 17	867	2 277	142
	ND 315 HDPE SDR 17	29	76	5
	ND 400 DUCTILE IRON	940	5 587	349
	ND 200 HDPE SDR 17	634	921	58
	ND 160 HDPE SDR 17	604	715	45
	ND 315 HDPE SDR 17	745	1 958	122
	ND 315 HDPE SDR 17	499	1 312	82
	ND 125 HDPE SDR 17	550	549	34
	Pumps 94 m3/h vs 15 m	3	272	17
	Pumps 17.5 m3/h vs 35 m	3	272	17
	Civil works	2	388	24
	ND200 Pressure reducer	1	95	6
	Manhole for pressure reducer	1	55	3
	Distribution network	158 468	74 163	4 635
	Connections	9 468	154 454	9 653
TOTAL			417 117	26 070

Connection and expansion of the network of suburbs to ACC's network

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Expansion in Ghidighici village in the next 25 years	ND 125 HDPE SDR 17	555	553	35
	ND 200 HDPE SDR 17	765	1 112	69
	ND 225 HDPE SDR 17	1 975	3 292	206
	Stage 1: Pumps 27.6 m3/h vs 45 m	3	272	17
	Stage 2: Pumps 27.6 m3/h vs 45 m	3	272	17
	Stage 3: Pumps 27.6 m3/h vs 45 m	3	272	17
	Stage 1: Pumps 6.7 m3/h vs 35 m	3	272	17
	Stage 2: Pumps 6.7 m3/h vs 35 m	3	272	17
	Stage 3: Pumps 6.7 m3/h vs 35 m	3	272	17
	Civil works	2	388	24
	Distribution network	7 383	3 455	216
	Connections	799	13 034	815
Expansion in Revaca and Sîngera in the next 25 years	ND 110 HDPE SDR 17	1 699	1 091	68
	Distribution network	9 648	4 515	282
	Connections	1 044	17 031	1 064
Expansion in Vatra in the next 25 years	ND 110 HDPE SDR 17	1 945	1 249	78
Expansion in Balabaneşti in the next 25 years	ND 160 HDPE SDR 17	655	776	48
	ND 200 HDPE SDR 17	845	1 228	77
	Stage 1: Pumps 14 m3/h vs 70 m	3	272	17
	Stage 2: Pumps 14 m3/h vs 70 m	3	272	17
	Stage 3: Pumps 14 m3/h vs 70 m	3	272	17
	Civil works	1	194	12
Expansion in Budeşti in the next 25 years	ND 225 HDPE SDR 17	1 306	2 177	136
Expansion in Cojuşna and Truşeni in the next 25 years	ND 200 HDPE SDR 17	6 164	8 956	560
	ND 225 HDPE SDR 17	2 415	4 026	252
	ND 250 HDPE SDR 17	1 090	2 068	129
	ND 315 HDPE SDR 17	710	1 866	117
	Stage 1: Pumps 27 m3/h vs 70 m	3	272	17
	Stage 2: Pumps 27 m3/h vs 70 m	3	272	17
	Stage 3: Pumps 27 m3/h vs 70 m	3	272	17
	Civil works	1	194	12
	Stage 1: Pumps 37 m3/h vs 140 m	3	396	25
	Stage 2: Pumps 37 m3/h vs 140 m	3	396	25
	Stage 3: Pumps 37 m3/h vs 140 m	3	396	25
	Civil works	1	235	15
	Distribution network	44 009	20 596	1 287
	Connections	4 763	77 699	4 856
TOTAL			170 188	10 637

Hydro power generation

Name of the project	Facilities	Length (m) or number	Cost (10^3 MDL)	Cost (10^3 Euros)
Hydro power generator at Ciocana reservoirs	centrifugal pump coupled with an asynchronous motor	1	408	26
TOTAL			408	26

GRAND TOTAL	2 663 635	166 477

ANNEX

ACC REHABILITATION PIPELINES PROGRAMME

The list of the proposed pipelines is presented in the table below. The prioritization factor is based on a multi-criteria analysis: 10 for the highest priority, 0 for the lowest. The economical interest is the ratio between the operational cost of the existing pipe over the next 50 years (actualization rate = 5%) and the investment to replace the pipe. Beyond 100%, the replacement is economically interesting.

4 colour codes were used:

- Group 1 & 2: Steel pipes with a Nominal Diameter between 100 and 200 mm
- Group 3: Pipes made of steel with a Nominal Diameter between 250 and 400 mm
- Group 4: pipes made of iron with a Nominal Diameter between 100 and 200 mm
- Group 5: remaining 43% of the ACC's rehabilitation pipelines programme not included in the previous categories

Nr d/o		Denumirea unităţii administrativ-teritoriale	Location	Existing diameter (mm)	Length (m)	Existing material	ND and material of the projected pipe	Cost of the new pipe (CAPEX in MDL)	Economical interest factor	Prioritization factor
SERA-1 Râşcani										
1	2	municipiul Chişinău	Reparaţia capitală a apeductului Bd.Moscova22pînă la nr.14	300	1150	Oţel	ND 300 CAST IRON	4 371 876	92%	**7.7**
2	7	municipiul Chişinău	Stramutarea apeductului tranzit din blocurile locative bd.Moscova, 15/1, 17/1, 15/2, 15/3	63	50	Oţel	ND 63 HDPE	20 986	153%	**6.8**
				100	180	Oţel	ND 110 HDPE	115 643	102%	**6.1**
				180	360	Oţel	ND 180 HDPE	472 191	53%	**3.4**
3	10	municipiul Chişinău	str.Puşkin de la str.Cosmonauţilor pînă la str.Columna	300	280	Oţel + Fonta	ND 200 HDPE	406 922	23%	**3.8**
4	12	municipiul Chişinău	str.Badiu de la str.Teodoroiu pînă la str.8 Martie	300	800	Oţel + Fonta	ND 200 HDPE	1 162 634	55%	**4.1**
5	18	municipiul Chişinău	str.Doga de la str.Florării pînă la str.Aerodromului	500	886	Oţel	ND 400 HDPE	4 023 010	33%	**4.1**
6	23	municipiul Chişinău	str.Cosmonauţilor de la str.Puşkin pînă la str.B.Bodoni	500	310	Oţel	ND 315 HDPE	814 688	13%	**3.2**
				150	80	Oţel + Fonta	ND 125 HDPE	79 751	23%	**2.5**
				100	230	Oţel	ND 110 HDPE	147 766	19%	**2.6**
7	24	municipiul Chişinău	str.B.Bodoni de la str.Ierusalim pînă la str.Columna	300	540	Oţel + Fonta	ND 200 HDPE	784 778	50%	**3.9**
8	26	municipiul Chişinău	str.Studenţilor de la str.Florilor pînă la str.C.Orhei	400	507	Oţel + Fonta	ND 250 HDPE	961 956	16%	**3.0**
9	27	municipiul	str.Moscovei,22-28	200	135	Oţel	ND 200	196 195	91%	**5.3**

Nr d/o		Denumirea unităţii administrativ-teritoriale	Location	Existing diameter (mm)	Length (m)	Existing material	ND and material of the projected pipe	Cost of the new pipe (CAPEX in MDL)	Economical interest factor	Prioritization factor
		Chişinău					HDPE			
				100	84	Oţel	ND 110 HDPE	53 967	660%	**8.7**
10	28	municipiul Chişinău	str. Doga intersectie cu str. Aerrodromului pina la VPI	500	370	Oţel	ND 400 HDPE	1 680 038	53%	**4.5**
11	29	municipiul Chişinău	bd.Moscovei,13 pînă la piața Total cu Trecerea str. M. Basarab	500	294	Oţel + Fonta	ND 315 HDPE	772 639	25%	**3.5**
12	30	municipiul Chişinău	Str-la I Florării după UNION Fenosa	200	415	Oţel	ND 200 HDPE	603 117	119%	**6.6**
13	31	municipiul Chişinău	str.Albișoara de la str.Viteazul pînă la str. Petru Rares	500	948	Oţel + Fonta	ND 400 CAST IRON	5 634 503	11%	**4.0**
14	32	municipiul Chişinău	str.Albișoara, 84/4-6 - 80/5-80/4	300	476	Oţel + Fonta	ND 200 HDPE	691 767	206%	**9.1**
15	34	municipiul Chişinău	str.Izmail,102/3 pînă la str.Albișoara, 16/2	200	123	Oţel + Fonta	ND 200 HDPE	178 755	244%	**8.8**
16	35	municipiul Chişinău	str.Doga, de la str.Aerodromului pînă la str.Circului	500	860	Oţel	ND 315 HDPE	2 260 101	17%	**3.0**
17	36	municipiul Chişinău	str.Russo de la str.Dimo pînă la str.Kiev 4	400	425	Oţel + Fonta	ND 315 HDPE	1 116 911	26%	**3.1**
18	37	municipiul Chişinău	str.Russo pînă la str.Dimo,24	200	115	Oţel	ND 180 HDPE	150 839	124%	**6.5**
19	38	municipiul Chişinău	str.Vladimirescu, 5-7	300	200	Oţel + Fonta	ND 250 HDPE	379 470	65%	**3.7**
20	39	municipiul Chişinău	str.M.Basarab, 7/3-9/1-2	200	230	Oţel + Fonta	ND 200 HDPE	334 257	79%	**3.4**
21	40	municipiul Chişinău	str.M.Basarab, 7/1-9/1-2 (branșamente la blocuri)	100	100	Oţel	ND 110 HDPE	64 246	266%	**7.1**
22	41	municipiul Chişinău	str.Studenților, 10/3 ; 14	200	240	Oţel + Fonta	ND 200 HDPE	348 790	48%	**2.8**
23	42	municipiul Chişinău	str.Feredelului VPI	500	165	Oţel	ND 400 CAST IRON	980 689	19%	**4.0**
24	43	municipiul Chişinău	Bd Cantemir de la Albisoara pina la str. Izmail	300	185	Oţel	ND 200 HDPE	268 859	10%	**2.3**
25	44	municipiul Chişinău	str.Al.cel Bun de la șos.V.Alexandri pînă la str.Izmail	600	880	Oţel	ND 400 HDPE	3 995 766	11%	**2.6**
26	46	municipiul Chişinău	str.Podgorenilor de la str.Poștei pînă la str.Petricani	300	460	Oţel + Fonta	ND 200 HDPE	668 515	44%	**3.0**
27	47	municipiul Chişinău	str.Kiev de la nr.4 pînă la str.Kiev, 6/3	200	480	Oţel + Fonta	ND 200 HDPE	697 581	34%	**3.2**

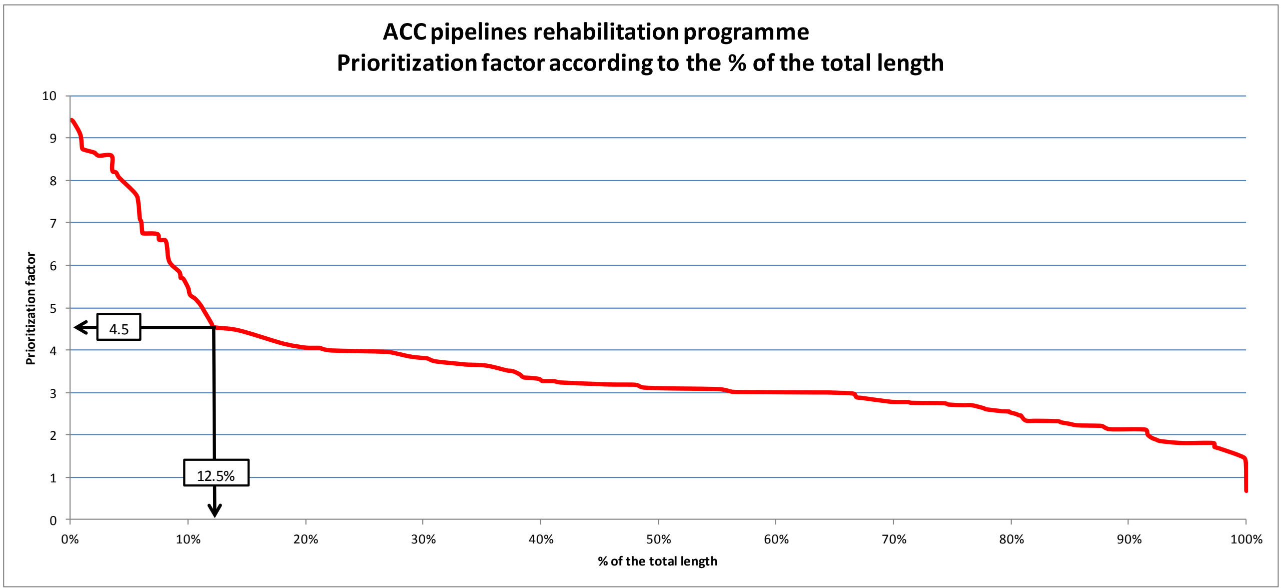
Nr d/o		Denumirea unităţii administrativ-teritoriale	Location	Existing diameter (mm)	Length (m)	Existing material	ND and material of the projected pipe	Cost of the new pipe (CAPEX in MDL)	Economical interest factor	Prioritization factor
29	99	municipiul Chişinău	stramutarea apeductului tranzit din str. Russo 3/1, 5/1, 7/1, 9/1, 11/2, 13/2, 13/3	100	450	Oţel	ND 110 HDPE	289 107	99%	**3.3**
30	100	municipiul Chişinău	str. Miron Costin de la nr. 17/3 de la Bul. Moscova pina la PTC (punct termic)	200	300	Oţel + Fonta	ND 200 HDPE	435 988	33%	**1.9**
31	101	municipiul Chişinău	str.Podgorenilor de la str.Poştei pînă la str.Socoleni si pe str. Socoleni pina la str. Doina	300	2500	Oţel + Fonta	ND 315 HDPE	6 570 062	16%	**2.1**
32	103	municipiul Chişinău	str.Petricani de la SP pînă la str.Balcani, str.Ghidighici și pînă la SP Petricani	300	1530	Oţel + Fonta	ND 300 CAST IRON	5 816 496	6%	**1.8**
33	102	municipiul Chişinău	str. A. Iancu de la str. Sf. Gheorghe pina la str. Izmail	100	380	Fonte roumain e	ND 110 HDPE	244 134	41%	**1.4**
				63	55	PE Ascim	ND 63 HDPE	23 085	69%	**0.7**
34	109	municipiul Chişinău	str.Doina de la IC-818 pînă la str.Doina, 148/2,3	150	60	Oţel + Fonta	ND 125 HDPE	59 813	67%	**1.7**
				100	510	Oţel	ND 110 HDPE	327 654	99%	**3.2**
SERA-2 Centru										
35	5	municipiul Chişinău	str.Lomonosov de la nr.47 pînă la nr.49/2	600	530	Oţel	ND 500 CAST IRON	4 212 960	6%	**3.7**
36	19	municipiul Chişinău	str.Grenoble de la str.Testemețeanu pînă la str.Grenoble, 130	500	1420	Oţel	ND 315 HDPE	3 731 795	35%	**3.5**
37	25	municipiul Chişinău	Str.31 August de la str.Tighina pînă la str.Puşkin	300	1000	Oţel + Fonta	ND 200 HDPE	1 453 293	29%	**3.0**
38	33	municipiul Chişinău	str. Ialoveni	200	250	Oţel	ND 200 HDPE	363 323	94%	**4.9**
				100	40	Oţel	ND 110 HDPE	25 698	1368%	**8.6**
38	45	municipiul Chişinău	str.Grenoble, 161 pînă la str.T.Strişca	300	510	Oţel	ND 250 HDPE	967 648	20%	**2.6**
				150	100	Oţel	ND 125 HDPE	99 688	185%	**7.0**
39	48	municipiul Chişinău	str.Tolstoi de la str.Anestiade pînă la bd. Şt. cel Mare	300	140	Oţel	ND 200 HDPE	203 461	134%	**6.6**
40	49	municipiul Chişinău	str.Grenoble la şcoală nr.38	300	700	Oţel	ND 250 HDPE	1 328 145	42%	**2.8**
41	50	municipiul Chişinău	str.Hînceşti de la str.Porumbiței pînă la str.Spicului	200	800	Beton armat	ND 125 HDPE	797 505	51%	**2.3**
42	51	municipiul Chişinău	str.Soarelui-str.Grenoble in or. Codru	200	2300	Oţel	ND 225 HDPE	3 834 724	22%	**2.7**
43	52	municipiul Chişinău	str. Lermontov	100	185	Oţel	ND 110 HDPE	118 855	144%	**5.7**

Nr d/o		Denumirea unităţii administrativ-teritoriale	Location	Existing diameter (mm)	Length (m)	Existing material	ND and material of the projected pipe	Cost of the new pipe (CAPEX in MDL)	Economical interest factor	Prioritization factor
44	53	municipiul Chişinău	str. St. cel Mare 3, de la str. Izmail	300	300	Oţel	ND 315 HDPE	788 407	20%	**2.7**
45	54	municipiul Chişinău	str. Gagarin, de la Tiraspol pina la str. Muncesti	300	620	Oţel	ND 200 HDPE	901 042	52%	**2.7**
46	55	municipiul Chişinău	str. Casu 20/1-/2-/3	150	35	Oţel	ND 125 HDPE	34 891	318%	**8.3**
				100	360	Oţel	ND 110 HDPE	231 285	102%	**5.1**
47	61	municipiul Chişinău	str. Lapusnei 20	150	45	Oţel	ND 125 HDPE	44 860	446%	**8.2**
				100	70	Oţel	ND 110 HDPE	44 972	224%	**6.8**
48	64	municipiul Chişinău	str.T.Strişca pînă la str.Testemiţeanu, 29/2	200	600	Oţel	ND 200 HDPE	871 976	8%	**2.3**
49	66	municipiul Chişinău	str. Negruzzi 1-5	100	340	Oţel	ND 110 HDPE	218 436	138%	**5.5**
50	67	municipiul Chişinău	str. Gagarin 7 a,b,v,g,d	100,76,6 3,32	1500	Oţel	ND 110 HDPE	963 688	76%	**2.2**
51	69	municipiul Chişinău	Pe str. V. Alecsandri de la str. Columna pina la str. V. Micle	400	500	Oţel	ND 250 HDPE	948 675	49%	**3.3**
52	72	municipiul Chişinău	Pe str. M. Eminescu, de la str. Matievici pina la 31 August	100	800	Fonta	ND 110 HDPE	513 967	87%	**3.2**
53	89	municipiul Chişinău	str.Negruzzi, 2/2	300	150	Oţel	ND 200 HDPE	217 994	168%	**8.1**
SERA-3 Buicani										
54	14	municipiul Chişinău	str.Alba Iulie, 202/4 BTP-40	300	190	Oţel	ND 250 HDPE	360 496	31%	**3.3**
55	15	municipiul Chişinău	str.Bucureşti de la str.M.Cibotaru pînă la str.Sciusev	300	700	Fonta	ND 200 HDPE	1 017 305	15%	**3.0**
56	16	municipiul Chişinău	str.I.Creangă,43 strămutarea branş. Din subsol	100	200	Oţel + PE	ND 110 HDPE	128 492	280%	**7.5**
57	17	municipiul Chişinău	str.O.Ghibu de la str.N.Costin pînă la Alfa-Service str.Alba Iulie	500	570	Oţel	ND 400 CAST IRON	3 387 834	13%	**3.8**
58	21	municipiul Chişinău	str.31 August1989 de la str.Puşkin pînă la str.T.Ciorba	300	1450	Fonta then Oţel	ND 250 HDPE	2 751 157	45%	**3.6**
59	24	municipiul Chişinău	str.B.Bodoni de la bd.Şt. Cel Mare pînă la str.Columna	300	360	Fonta	ND 200 HDPE	523 185	30%	**2.9**
60	25	municipiul Chişinău	str.Neaga de la str.I.creangă pînă la str.Livescu	200	315	Oţel	ND 200 HDPE	457 787	47%	**2.9**
61	56	municipiul Chişinău	str.Calea Ieşilor, 41-47/2 pînă la str.Ghidighici	200	735	Oţel	ND 200 HDPE	1 068 170	50%	**3.8**
62	59	municipiul Chişinău	str.I.Pelivan, 30 pînă la str.Marinescu, 11	200	350	Oţel	ND 200 HDPE	508 653	50%	**2.3**

Nr d/o		Denumirea unităţii administrativ-teritoriale	Location	Existing diameter (mm)	Length (m)	Existing material	ND and material of the projected pipe	Cost of the new pipe (CAPEX in MDL)	Economical interest factor	Prioritization factor
63	60	municipiul Chişinău	str.Coca-str.I.Creangă-str.I.Pelivan-str. Belinschi	300	1460	Oţel 80% Fonta 20%	ND 400 HDPE	6 629 340	12%	**2.3**
64	62	municipiul Chişinău	str.Bucureşti de la str.B.bodoni pînă la Iorga	300	160	Fonta	ND 200 HDPE	232 527	11%	**2.0**
65	83	municipiul Chişinău	str.Coca de la str.I.Creangă pînă la str.Neculce	150	300	Oţel	ND 125 HDPE	299 064	66%	**1.7**
66	84	municipiul Chişinău	str.Kogalniceanu de la str.Puşkin pînă la str.Bucureşti	600	1500	Oţel	ND 400 HDPE	6 810 965	13%	**3.1**
67	85	municipiul Chişinău	str.Mateevici de la str.Iorga pînă la str.Puşkin (speţ vodovod)- str. Bernardatii	300	570	Oţel	ND 250 HDPE	1 081 489	9%	**2.2**
68	88	municipiul Chişinău	str.Ghibu, 2 canal de vizitare	200	800	Oţel	ND 200 HDPE	1 162 634	292%	**8.7**
				150	90	Oţel	ND 125 HDPE	89 719	101%	**5.7**
				100	190	Oţel	ND 110 HDPE	122 067	78%	**2.5**
69	104	municipiul Chişinău	Str.V.Lupu de la str.Belinski pînă la str.I.Creangă – str.T.Vladimirescu	300	1500	Oţel + Fonta	ND 250 HDPE	2 846 025	28%	**1.5**
SERA Botanica										
70	8	municipiul Chişinău	bd.Troian, 23/2 SP	500	70	Oţel	ND 315 HDPE	183 962	52%	**4.5**
71	10	municipiul Chişinău	str.C.Moşilor de la trecerea str.Varniţa pînă la podul calea ferată	300	1250	Oţel	ND 315 HDPE	3 285 031	4%	**2.8**
72	63	municipiul Chişinău	str.Hanul Morii de la str.Busuioceşti pînă la str.Reni	400	650	Oţel	ND 315 HDPE	1 708 216	75%	**4.0**
73	65	municipiul Chişinău	str.Grenoble-str.Troian trecerea drumului str.Grenoble	400	50	Oţel	ND 400 HDPE	227 032	20%	**2.5**
74	68	municipiul Chişinău	str.Burebista-str.Munceşti-str.Pădurilor	300	800	Oţel	ND 200 HDPE	1 162 634	60%	**3.9**
75	70	municipiul Chişinău	str.Grenoble- Staţia de pompare Botanica în cartier	300	90	Oţel	ND 200 HDPE	130 796	57%	**2.5**
76	71	municipiul Chişinău	str.Munceşti de la nr.13 pînă la nr.73	100	1000		ND 110 HDPE	642 459	99%	**2.8**
77	73	municipiul Chişinău	str.Pădurii, 18-38	500	800	Fonta	ND 315 HDPE	2 102 420	52%	**3.3**
78	77	municipiul Chişinău	str.Decebal, 19-str.Plaiului, 57	500	810	Oţel	ND 315 HDPE	2 128 700	39%	**2.6**
79	105	municipiul Chişinău	str.Valea Crucii,22	200	250	Oţel	ND 160 HDPE	296 093	32%	**2.2**

Nr d/o		Denumirea unităţii administrativ-teritoriale	Location	Existing diameter (mm)	Length (m)	Existing material	ND and material of the projected pipe	Cost of the new pipe (CAPEX in MDL)	Economical interest factor	Prioritization factor
80	106	municipiul Chişinău	str.Cuza Vodă, 36	150	220	Oţel	ND 125 HDPE	219 314	93%	**4.1**
81	107	municipiul Chişinău	str.Zelinski, 38-40	150	300	Oţel	ND 125 HDPE	299 064	66%	**1.9**
82	108	municipiul Chişinău	str.C.Chilia-str.Titulescu	300	370	Oţel	ND 315 HDPE	972 369	82%	**5.2**
SERA Ciocana										
83	3	municipiul Chişinău	str. P. Zadnipru, 8 bd. M. cel Bătrîn, 5/3	300	530	Oţel	ND 200 HDPE	770 245	79%	**4.6**
84	4	municipiul Chişinău	str. Studentilor de la STA pina la str. A. Russo	1200	2800	Beton armat	ND 800 CAST IRON	37 496 492	9%	**4.2**
85	6	municipiul Chişinău	str.Maiacovskii de la nr.40-56	200	210	Oţel	ND 125 HDPE	209 345	191%	**8.2**
86	9	municipiul Chişinău	str.Industrială **(apă technică)**	800	3800	Oţel	ND 500 CAST IRON	30 206 131	6%	**4.0**
87	19	municipiul Chişinău	str.Milescu Spătaru, 23-25/2	200	100	Oţel	ND 200 HDPE	145 329	441%	**9.4**
88	22	municipiul Chişinău	bd.M.cel Bătrîn, 26/3	200	130	Oţel	ND 200 HDPE	188 928	369%	**9.4**
89	58	municipiul Chişinău	str.Transnistria pînă la str.Industrială RESAN **(apă tehnică)**	400	420		ND 400 HDPE	1 907 070	11%	**2.5**
90	74	municipiul Chişinău	str. A. Russo 59-63	300	250	Oţel	ND 200 HDPE	363 323	195%	**8.6**
				200	890	Oţel	ND 180 HDPE	1 167 362	194%	**8.6**
91	75	municipiul Chişinău	str.Movileni-str.Paraschiva-str.Călătorilor	100	2200	Fonta	ND 110 HDPE	1 413 410	40%	**1.8**
92	76	municipiul Chişinău	str. M. cel Batrin de la STA pina la str. M. Sadoveanu	1200	3810	Beton armat	ND 1000 CAST IRON	62 918 125	11%	**3.1**
93	78	municipiul Chişinău	str.Alcedar-str.V.Vodă-str.Coloniţa-str. Tirgoviste	100	1952	Oţel	ND 110 HDPE	1 254 080	99%	**3.7**
94	79	municipiul Chişinău	str.Uzinelor-str.Industriala **(apă tehnică)** MACON	300	142	Oţel	ND 315 HDPE	373 180	29%	**2.9**
95	80	municipiul Chişinău	str.V.Vodă de la str. M. Manole pina la str. Transnistria	1200	920	Beton armat	ND 400 CAST IRON	5 468 083	8%	**3.0**
96	81	municipiul Chişinău	str.Sadoveanu STA pînă la str.Transnistria CET-2	1200	5030	Beton armat	ND 1000 CAST IRON	83 065 136	1%	**3.0**
97	82	municipiul Chişinău	str.Voluntarilor pînă la str.Industrială	300	980	Oţel + Fonta	ND 200 HDPE	1 424 227	36%	**2.7**

Nr d/o		Denumirea unităţii administrativ-teritoriale	Location	Existing diameter (mm)	Length (m)	Existing material	ND and material of the projected pipe	Cost of the new pipe (CAPEX in MDL)	Economical interest factor	Prioritization factor
98	90	municipiul Chişinău	str.Rebreanu, 39	100	280	Oţel	ND 110 HDPE	179 889	99%	**3.5**
99	91	municipiul Chişinău	str.P.Zadnipru, 5/1-5/3-7/2	300	500	Oţel	ND 225 HDPE	833 636	14%	**2.1**
100	92	municipiul Chişinău	str.P.Zadnipru, 2/2-2/1 (2d)	150	1000	Oţel + Fonta	ND 125 HDPE	996 881	198%	**6.7**
101	95	municipiul Chişinău	str.Transnistria (combinatul de carton) pînă lastr.Industrială	300	290	Oţel + Fonta	ND 200 HDPE	421 455	36%	**1.9**
102	96	municipiul Chişinău	str.Uzinelor, 27 pina la str. Lunca Bicului	300	2500	Oţel	ND 315 HDPE	6 570 062	42%	**3.2**
103	97	municipiul Chişinău	str.Transnistria de la str.V.Vodă pînă la CET-2	500	1225	Oţel	ND 500 CAST IRON	9 737 503	25%	**3.2**
104	102	municipiul Chişinău	bd.M. Cel Bătrîn, 38/1 pînă la str. M. Spătaru, 25/3	200	90	Oţel	ND 200 HDPE	130 796	360%	**8.2**
105	54	Tohatin	Sectiunii de apeduct de la SP Tohatin spre Maximovca in zona vilelor "Izvorul Vesel"	300	200	Oţel	ND 250 HDPE	379 470	31%	**3.3**
106	54	Tohatin	Sectiunii de apeduct de la SP Tohatin spre RAP Colonita	250	200		ND 225 HDPE	333 454	29%	**2.6**
107	54	Colonita	Budesti Cimp	300	1500		ND 250 HDPE	2 846 025	86%	**4.5**
108	54		Transfer pipeline upstream Codru PS	500/400	700	Fonta	ND 400 CAST IRON	4 160 498	8%	**5.8**
TOTAL					**82 387**			**368 917 978**		

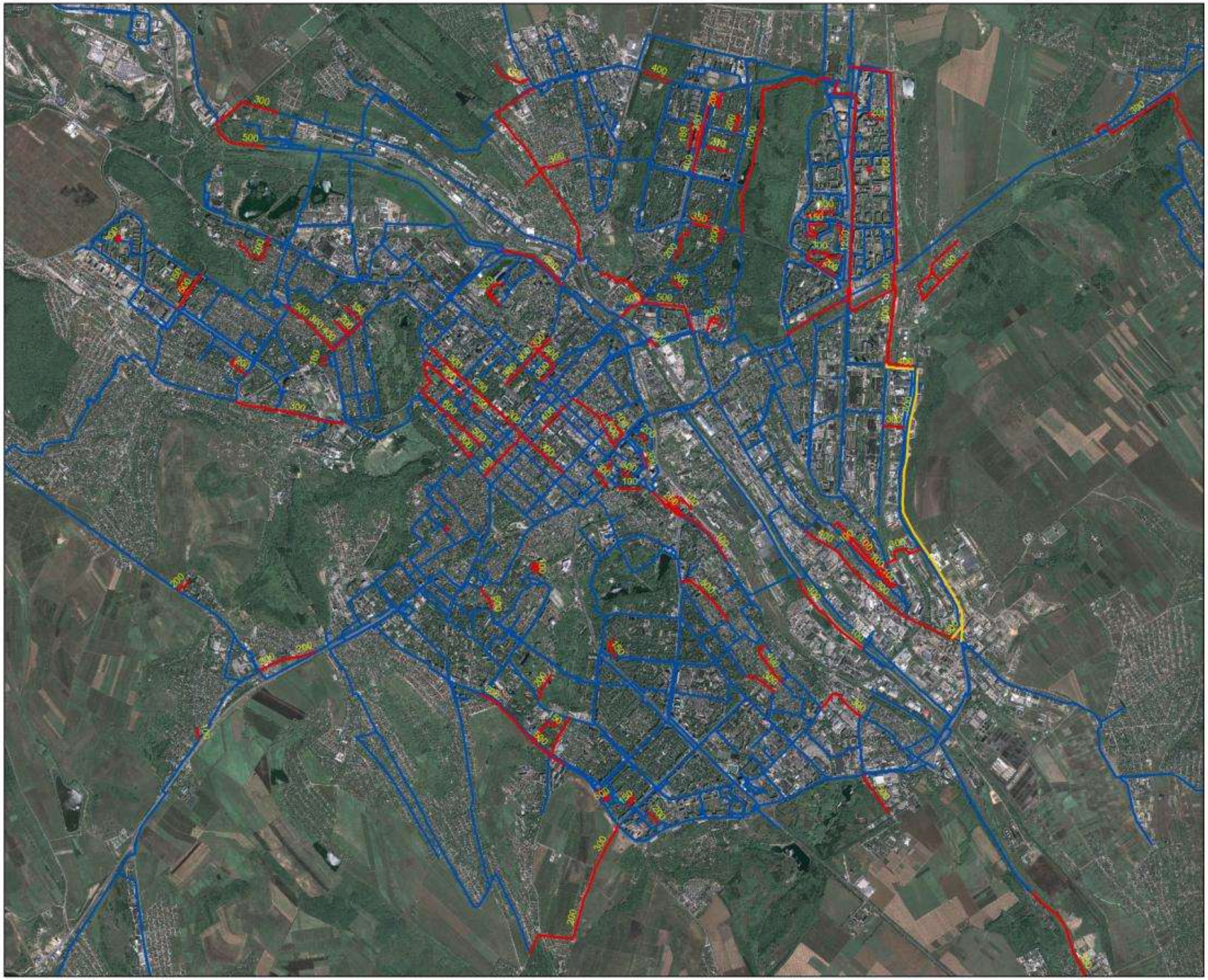


12.5% of the ACC pipelines rehabilitation programme have a prioritization factor higher than 4.5.

Program Water Pipes Rehabilitation

Legend

- Main Pipes
- Water Pipes to be rehabilitated
- Technical Pipes to be rehabilitated



The diameters indicated in the map are the old diameters of the pipe to be rehabilitated

N W E S

0 0.5 1 2 3 4 Kilometers

Program water pipes rehabilitation

Legend

Water Pipes to be rehabilitated

- main pipes
- group 1, 2
- group 3
- group 4
- group 5

1, 2 - ND 100 - 200 steel pipes
3 - ND 250 - 400 steel pipes
4 - ND 100 - 200 iron pipes
5 - ND 500 - 1200 steel pipes
ND 250 - 1200 iron pipes

The numbers in the map are the numbers of the first column in the table above

Program Water Pipes Rehabilitation