2011

Energy Audit of Water and Wastewater Utilities in 6 towns of Moldova

Final Report

ORHEI

Tehno Consulting & Design

December 2011

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ABBREVIATIONS

Selected Definitions:	**Abbreviation / Synonym Definition**
A.S.L.	Above Sea Level
BPS	Booster Pumping Station
WB	World Bank
IDA	International Development Association
Client	Water Supply and Sanitation Projects Implementation Unit
Auditor/Consultant	Tehno Consulting & Design
EE	Energy Efficiency
ECM	Energy Conservation Measures
EEP	Energy Efficiency Program
EMP	Energy Management Program
PS	Pumping Station
SPS	Sewage Pumping Station
MSPS	Main Sewerage Pumping Station
NWSSP	National Water Supply and Sanitation Project
RWTP	Raw Water Treatment Plant
WWTP	Waste Water Treatment Plant
O&M	Operation and Maintenance
BoQ	Bill of Quantities
VSD	Variable Speed Drive
HVAC	Heating, Ventilation, and Air Conditioning
WSS	Water Supply and Sanitation

EXECUTIVE SUMMARY

Present Energy Audit report summarizes Apa-Canal Orhei facilities description, historical data, Auditors findings, site measurements data, analyses and ECM proposals.

Our energy audit team visited Orhei and collected historical water and energy usage data, as well as the existing equipment operating data. As a result of the site measurements we identified several ECM, which in our opinion will provide feasible opportunities for significant energy savings.

The feasibility of each proposed ECM was estimated through a payback analysis. The simple payback period was determined after establishing Engineer's estimation of capital investments, O&M equipment costs, projected annual energy savings estimates, and the potential value of energy tariff.

Recommended ECMs

The following table presents the ranking of recommended ECMs identified for Apa-Canal Orhei. The ECMs are ranked on a simple payback period basis.

ECM description	Annual energy savings, kWh	Annual energy savings, MDL	Capital investment cost, MDL	Simple payback period, years	Ranking
Replacement of pumping stations external lighting lamps	18,923	34,062	122,000	3.6	2
Implementation of SCADA system	80,173	661,188	1,881,600	2.9	1
Modifications of Jeloboc Water Main and PS6	182,795	329,031	2,234,720	6.8	3

Recommended ECMs to be included in the EMP

In order to prioritize investments from different Project towns, the indicator for relative energy saving as % of total energy consumption of each separate water utility was used as the most fair and important indicator. Thereby, the investments bringing the highest relative reduction in energy consumption in the respective towns were prioritized. This selection criterion was applied as primary one, while the secondary criterion of simple payback period was applied after preliminary sorting.

Two ECMs have been shortlisted for EMP investment package:

ECM description	Annual energy savings, kWh	Annual energy savings, MDL	Savings in % compared to total power consumption	Capital investment cost, MDL	Ranking
Modifications of Jeloboc Water Main and PS6	182,795	329,031	9.6%	2,234,720	**1**
Implementation of SCADA system	80,173	661,188*	4.2%	1,881,600	**2**

*Estimated 5% energy reduction and 5% leakages reduction

Total investment amount for selected Orhei ECMs is **345,619 USD.**

1. INTRODUCTION

The IDA provided financing in the amount of 0.9 mln USD which will be used for investments to raise energy efficiency in 6 (six) water and wastewater utilities of Moldova. The EEP is expected to demonstrate and disseminate through energy audits and following investments the potential for increasing energy efficiency in municipal water and wastewater operations.

The program finances energy audits, hydraulic regime optimizations, and the selective rehabilitation of electromechanical equipment (equipment replacement) which are expected to increase energy efficiency in municipal water and wastewater operations in the cities Balti, Cahul, Orhei, Ungheni, Causeni and Floresti.

This Final Audit Report summarizes findings, proposals, planned activities, schedule for completion of audit components, staffing and submission deadlines of audit reports and other deliverables for Energy Audit of Water and Wastewater Utilities in 6 towns of Moldova.

The contract has been let for open international tendering for consultancy services. The contract was awarded to Tehno Consulting & Design and became effective on 20th June 2011. The duration of the services is expected to be 6 months.

1.1 Draft Audit Report

In previous Draft Audit Report the Consultant has introduced his assessment of energy conservation measures and investment needs in the city of Orhei. The Report includes conditional and operational analysis of existing water and wastewater facilities and energy conservation measures, as well as a financial assessment of the proposed investments.

The report also includes the Consultants proposal of ECM measures for the future EMP investments.

Furthermore, this Report includes the output from the Baseline Studies as presented in the Consultants Inception Report.

There is one separate report for each of the six cities covered by the project.

1.2 Final Audit Report

Present Final Audit Report includes comments and suggestions to the Draft Report from the World Bank experts, WSSPIU and Apa-Canal Orhei.

The meeting with stakeholders was held on December 07, 2011. The agreed shortlist of EMP investments for Orhei contains the following:

Table 1-1 *Agreed EMP Investments for Orhei*

Ranking	The proposed ECM description	Annual energy savings, kWh	Annual energy Consumption of Water Utility, kWh	Savings in %, as compared to total consumption	Capital investment cost, MDL	Simple payback period, years
1	**Modifications of Jeloboc Water Main and PS6**	182 795	1 900 344	***9.6%***	2 234 720	6.8
2	**Implementation of SCADA system**	80 173	1 900 344	***4.2%***	1 881 600	2.9

The overall amount of proposed EMP investments for Orhei is 4,116,320 MDL or **345,619 USD** (USD exchange rate 11.91).

Consultant will prepare the following submittals for the selected ECMs:

- BoQ and Cost estimate for Goods, Works and associated services;
- Technical Specifications for Goods and Works within proposed EMP;
- EMP schedule of implementation.

2. WATER SERVICES IN THE TOWN OF ORHEI

2.1 General

The Town of Orhei is located in the Central part of Moldova, some 50 km from Chisinau. The Town of Orhei is the administrative and commercial center of Orhei rayon (district) with about 125,900 inhabitants.

Figure 2-1 *Location of Orhei*

Central part of Orhei is located along the Raut River at the altitudes of 33-135 m above sea level, highest regions being situated in the North-Western part of Orhei. A separate satellite district located south of the town reaches some 200 m a.s.l.

The Raut River, a tributary to the Nistru River, crosses (NW-SE) the City. The railroad runs through the Southern part of the City.

2.2 Service Area Definition

The Town of Orhei is provided with water services by a municipal company (Regia Apa-Canal Orhei) covering main part of the Town.

The estimated extent of water services provided by Apa-Canal Orhei is presented in the following figure:

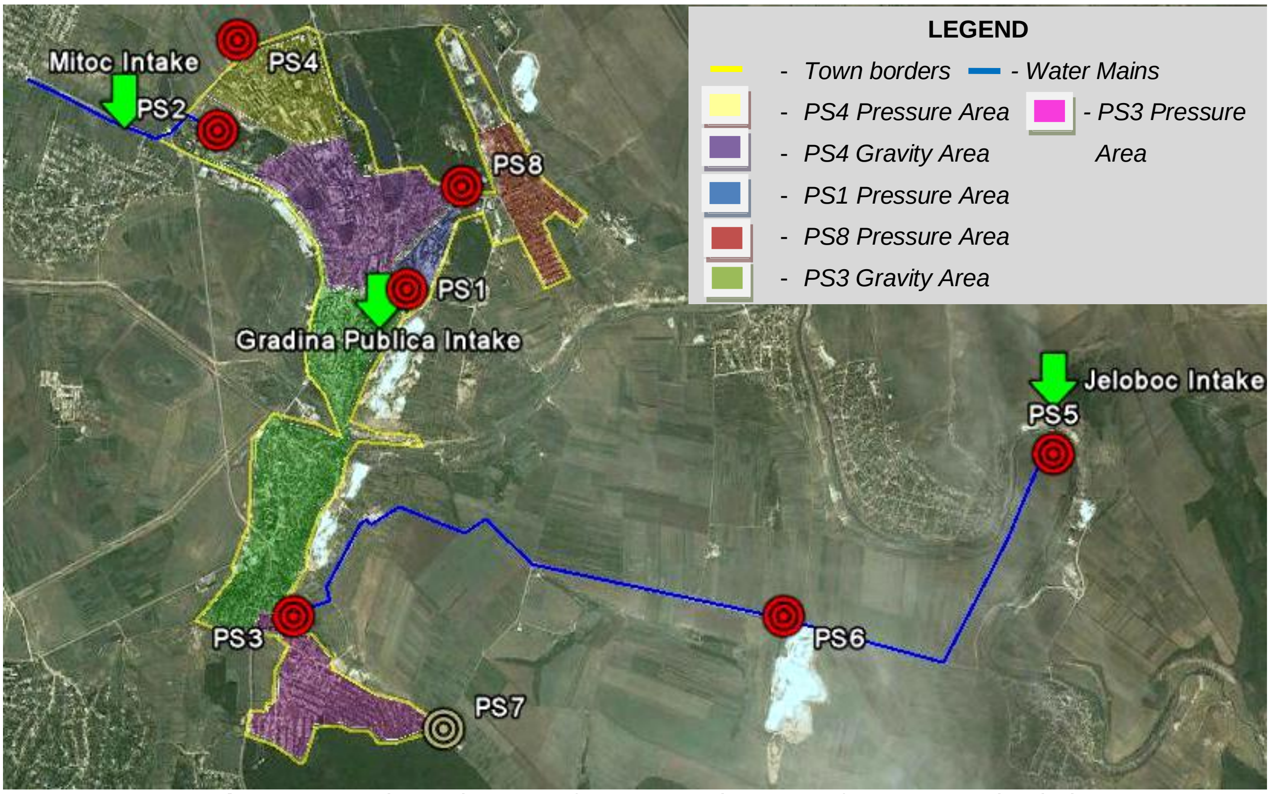

Figure 2-2 *Estimated Extent of Water Service Areas for Apa-Canal Orhei*

This study covers Apa-Canal Orhei (Water Utility) operations only. The possibilities of future water supply of uncovered areas by Water Utility shall be studied separately.

2.3 Population

The official population records for the Towns of Orhei are summarized in the table below:

Table 2-1 *Official resident population of Orhei, as of January1 by Years*[1]**,** *thou. people*

Town/Year	2005	2006	2007	2008	2009	2010	2011
Orhei Rayon	129.9	129.5	126.6	125.9	125.9	125.9	125.9
Orhei Town	36.7	36.6	33.7	33.1	33.2	33.3	33.5

As shown in the table, the official population number of the Town has been being rather stable over the last 5 years. Significant changes (especially growth) in population are not expected in the next years, as the average population growth rate for Moldova is estimated at -0.072% for 2011[2].

Notwithstanding the official statistical data, and taking into account high level of immigration, the real number of population (and consequently consumers) living in Ungheni is expected to be considerably lower. According to the City Hall data, some 33,140 people currently live in Orhei.

[1] National Bureau of Statistics of the Republic of Moldova
[2] Central Intelligence Agency, the World Factbook

2.4 Customers

The number of contracts (connections) by supply areas operated by the Apa-Canal is summarized in the following table.

Table 2-2 *Water Supply Customers – Apa-Canal Orhei*

Supply Area	No of Water Customers (Contracts)	Estimated No. of population connected to water services (people)	No of Sewerage Customers (Contracts)	Estimated No. of population connected to sewerage (people)
Orhei Town				
Households	10,859	**25,000**	6,299	**14,500**
Economic Agents	317		283	
Budgetary Institutions	19		19	

As can be seen from the Table, the major number of consumers are private households. In total, some 75% of the official area population is provided with water by Apa-Canal Orhei.

This Audit Report covers ECMs for current consumption conditions only and does not envisage any considerable future extensions in terms of consumers.

Currently, only some 44% of total population and only some 58% of total water consumers are provided with sewerage services.

2.5 Preliminary Water Balance

The following table derives from information provided by the Apa-Canal.

Table 2-3 *Reported Water Balance for Orhei Apa-Canal*

	Water Produced, thou m^3					
	Gradina Publica Intake	Mitoc Intake	Jeloboc Intake	Total Produced	Total Billed	Non-Revenue Water, %
2008	215.8	386.2	661.2	**1,263.2**	627	**50%**
2009	226.0	379.5	675.0	**1,280.5**	651.7	**49%**
2010	190.9	360.4	731.2	**1,282.5**	654.8	**49%**
2011(Jan-Jun)	80.6	155.6	365.9	**602.1**		

In respect of the water supply system, it is of note that the non-revenue water rate as estimated on the basis of the reported values over 3 years has relatively high values of some 50% of produced water. High NRW rates are subject to this Energy Audit and a general NRW analysis is presented in the following Sections.

The reported volumes of the collected wastewater are presented in the Table below.

Table 2-4 *Collected wastewater for 2008-2010*

	2008	2009	2010
Received Wastewater, thou m^3	765.4	622.7	719.1
Including from households	280.5	301.2	307.6
Water supplied/billed to households, m^3	486	524.7	525.8
Household sewerage return rate, %	**58%**	**57%**	**59%**

Overall the wastewater return rate remains low reflecting the much lower level of development of wastewater services.

3. WATER SUPPLY SYSTEM

3.1 General

The town of Orhei is provided with water from three groundwater intakes through eight (8) pumping stations PS feeding the service area.

The biggest part of the town is supplied from a natural spring intake Jeloboc, while the other two (2) wellfields are used to cover mainly northern and central part of the Town.

Most of town networks and pressure mains are in poor condition due to its age and heavy use, generating high amounts of leakages.

3.2 Water Production

Currently, three (3) underground water sources are used to supply the Town, as follows:

- Jeloboc Natural Spring, located some 9 km east of the town;
- Gradina Publica Wellfield, located in the Town Center;
- Mitoc Wellfield, located some 1 km north-west of Orhei.

It is of note that Orhei Apa-Canal is gradually switching the whole town supply to Jeloboc water source. The volume increase of water produced from the Jeloboc Intake over last years is shown in the next Figure.

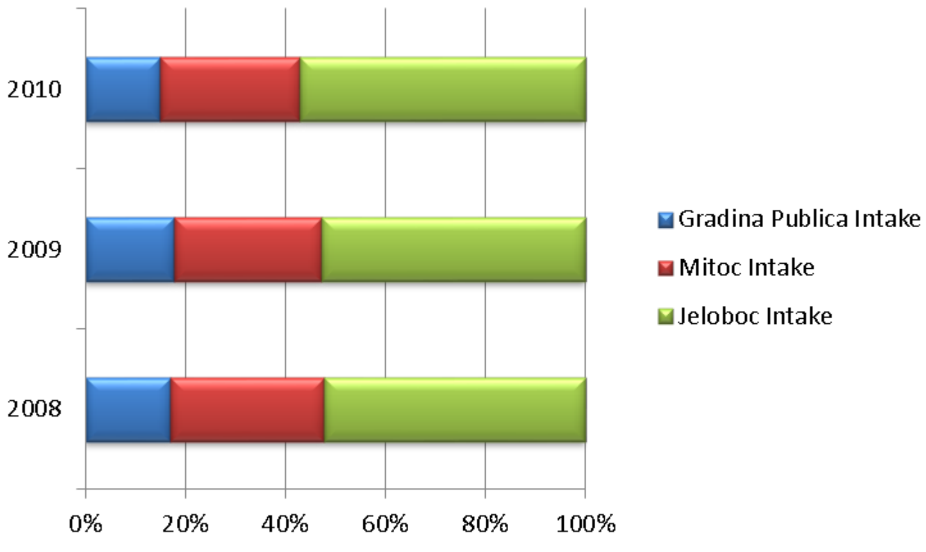

Figure 3-1 *Water produced from different sources in Orhei, 2008-2010*

Jeloboc Water intake is built over a natural spring and is located on the left bank of the Raut River. The intake area is located at ground elevation of some 40 m a.s.l. The spring water is led to the PS5 inlet reservoirs, located at the intake area across the River. The total capacity of the reservoirs is 2 x 125 m^3. From reservoirs, the water is pumped by PS5 and PS6 into the PS3 town reservoirs.

The length of pressure main from the PS5 to PS3 is some 12 km. Taking into consideration that the water main is built of 2 parallel pipelines, the total length of existing pipelines is 24 km. In 2006, the main pipelines were replaced with new HDPE DN200 pipes under the Pilot WSSP, financed by the World Bank.

Gradina Publica wellfield includes three (3) deep wells, out of which only two wells are in regular use and the third well is used as reserve. All submersible pumps in use lift water at a constant pressure head directly into two (2) existing water tanks from the PS1, having the total capacity of 2x125 m^3.

Mitoc wellfield includes fourteen (14) deep wells, out of which only three are in regular use and two (2) wells are used as reserve. The wellfield is located along the road Orhei – Balti. All submersible pumps in use lift water at a constant pressure head directly into three (3) existing water tanks from the PS2, having the total capacity of 1300 m^3 (2x500m^3, 1x300m^3).

General data on installed pumping equipment are presented in the following Table.

Table 3-1 *Design parameters of the existing pumping equipment at the water intakes in Orhei*

#	Well No	Model	Design Flow rate	Design Head	Design Motor Data					Opera-ting	Depth of instal-lation	Year of instal-lation
					P	Volt age	Speed	cosφ	In			
			m^3/h	m	kW	V	rpm		A	hrs /day	m	
					Gradina Publica Wellfield							
1	1	ЭЦВ -8/25/100	25	100	11	380	3000	0,83	24,2			2005
2	2	ЭЦВ -8/25/100	25	100	11	380	3000	0,83	24,2			2007
3	3	MK 615 -8N460	60	60	15.5							2006
					Mitoc Wellfield							
4	10	ЭЦВ 8/25/100	25	100	11	380	3000	0,83	24,2			2002
5	11	ЭЦВ 8/25/100	25	100	11	380	3000	0,83	24,2			2003
6	12	TWI 06.30-11-NB	25	106	12,5	380	2900		27,5			2002
7	13	NR615-8 NU60	25	70	9.5	380			19,8			2007
8	14	WILO TWU-6R 31-8-11	25	80	9.5	380						2002

All existing deep wells in use are subject to further measurements and efficiency analysis under this Energy Audit Study.

Existing pressure mains within wellfield areas are considered to be in an acceptable working condition. However, being at the end of life cycle, pressure pipelines can generate considerable amounts of leakages in future and need to be monitored.

Historical Energy Consumption

The present section represents historical energy usage and associated Apa-Canal costs. It is important to establish at least 3 years patterns of mainly electric, as well as gas usage, if relevant, in order to be able to identify areas in which energy consumption can be reduced.

The following summary of historical energy consumption registered by Water Utility is provided in the Table below.

Table 3-2 *Historical Energy Consumption Reported by Orhei Water Utility, kWh*

	2008	2009	2010
	WATER		
Mitoc Intake	164,760	157,560	148,920
PS1/Gradina Publica Intake	176,340	167,520	149,580
PS2	210,720	219,240	227,880
PS3	32,803	33,683	40,066
PS4	42,146	45,860	47,160
PS5	254,256	248,480	270,700
PS6	272,160	288,660	313,200
PS7	1,567	1,535	1,474
PS8	32,055	31,351	32,065
	SEWERAGE		
Main SPS	216,000	212,100	248,100
Local SPS1	8,600	10,240	11,720
Local SPS2	98,560	98,400	112,600
WWTP	52,200	183,720	262,440
	AUXILIARY		
Networks	3,452	3,815	4,678
Garage	5,782	7,169	6,791
Administrative building	24,302	22,863	22,970
TOTAL	**1,595,703**	**1,732,196**	**1,900,344**

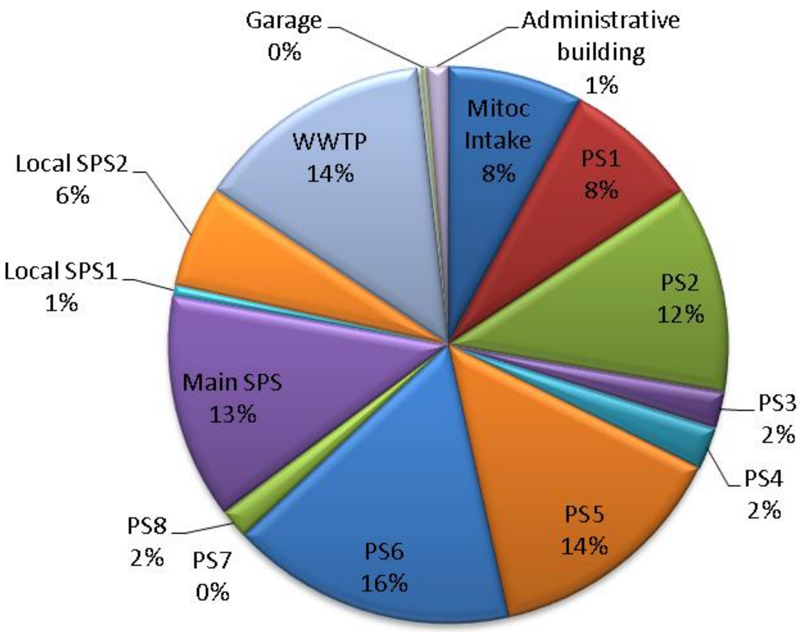

Figure 3-2 *Shares of energy consumption reported by Orhei Water Utility, 2010*

As can be seen from the Table above, the main energy consuming facilities are PS6 (16%), PS5 (14%) and Orhei WWTP (14%). Both PS5 and PS6 are part of supply chain from Jeloboc spring intake. The main focus of this Energy Audit will be aimed at the major energy consumers. However, it is of note that Orhei Water Utility has recently started construction of a new WWTP in a different location, which implies significant changes in whole sewerage network, including the Main SPS. Therefore, these sewerage facilities are not subject to this Energy Audit. For details please refer to the next Chapters.

Energy consumption breakdown for different types of services for 2010 is shown in the Figure below.

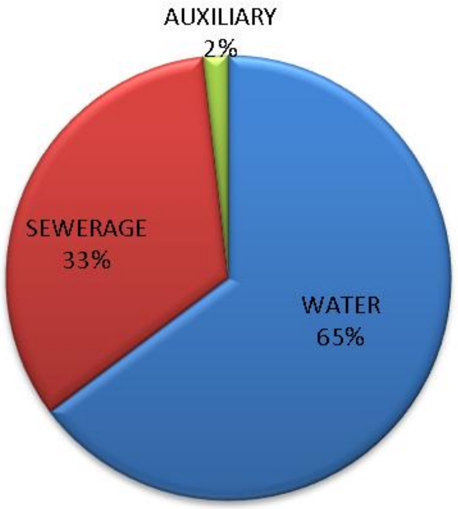

Figure 3-3 *Distribution of energy consumption reported by Apa-Canal, 2010*

3.3 Water Treatment

Acording to the water quality test results provided by Orhei Water Utility, the bacteriological parameters of the abstracted ground water from all water intakes in use are in accordance with the National Standard Requirements, thus the only treatment provided is chlorination with gas chlorine at the PS2. Chlorination at other existing PSs is not done.

3.4 Water Pumping

3.4.1 Gradina Publica Intake - PS1 and PS8

PS1 is used to provide water to the central service area from Gradina Publica wellfield. Water is stored into two reservoirs, having total capacity of 2x125 m^3. Pumping equipment includes one main pump group built of 2 parallel pumps of type CO-2 MVI 3207. A number of old stand-by pumps are used as reserve. The pumps intake water from the water tanks located at the PS1 territory and pump water to the service area. Also, PS8 tanks are supplied from the PS1.

PS8 is used to provide water to the western supply area from Gradina Publica wellfield. Water is stored into two reservoirs, having total capacity of 2x150 m^3. Pumping equipment includes two main pump groups - first built of 2 parallel pumps of type CO-2 MVI- 3204, and second is formed of 2 pumps of type K20/30 and K50/50. The second group is used as reserve. First group of pumps intake water from the tanks located at the PS8 territory and pump water to the service area.

General data on installed pumping equipment are presented in the following Table.

Table 3-3 *Design parameters of the existing pumping equipment at the PS1 and PS8 in Orhei*

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating	Year of instal-lation
					P	Voltage	Speed	cosφ	In			
			m^3/h	m	kW	V	rpm		A		hrs /day	
						PS1						
1	CO -2 MVI 3207	2	30	95	15	380	2950	0.93	26.5	Y	12	2006
2	ЦНСГ - 38/176	1	38	176	30	380					as reserve	2000
3	К20/30	1	20	30	4	380	1410	0.84	8.7		as reserve	2002
4	К 45/30	1	40	30	7.5	380	2900		15		4	2001
						SP8						
1	К 20/30	1	20	30	4	380	1410	0.84	8.7		as reserve	2002
2	К 50/50	1	50	50	15	380					as reserve	2003
3	CO -2 MVI-3204	2	24	60	7.5	380	2950	0.91	15.9	Y		2007

It is of note that in 2006 both PS1 and PS8 were renovated under the Pilot Water Supply and Sanitation Project, financed by the World Bank. Further Audit measurements are required in order to identify whether existing pumps operate in their best efficiency ranges. The detailed analysis is provided in the next Chapters.

Energy Consumption Pattern

The following summary of historical energy consumption for 2010 registered by Water Utility is provided in the Figure below.

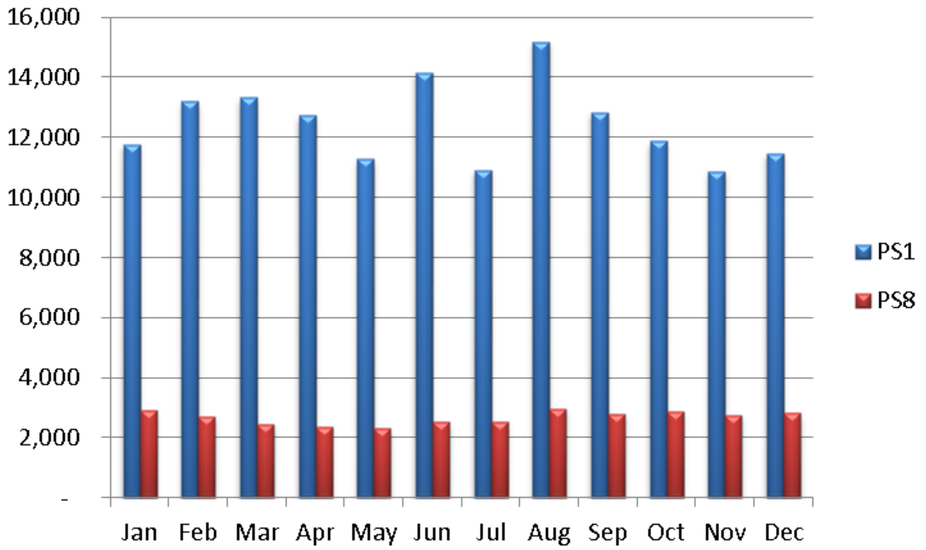

Figure 3-4 *Reported Energy Consumption of PS1 and PS8 for 2010, kWh*

This Figure shows that the highest energy consumption is registered during summer-autumn period. The Consultant has carried out its assignment, including site measurements, during the most energy consuming period of operation.

3.4.2 Jeloboc Water Intake – PS5, PS6 and PS3

Water from Jeloboc Intake is delivered to the town reservoirs through two pumping stations, PS5 and PS6, and is distributed using PS3 and partially PS2 and PS4. PS7 was used for intermediary pumping from PS6 to PS3. However, in 2006 Orhei water utility optimized the hydraulic system through construction of a new by-passing water main and consequently PS7 was taken out of operation.

PS5 is used to pump water to PS6 from Jeloboc Intake. Water is stored into two reservoirs, having total capacity of 2x125 m^3. Pumping equipment includes one main pump group built of 2 parallel pumps of type NR 80/250-75-75/2a. Two stand-by pumps are used as reserve. The pumps intake water from the water tanks located at the PS5 territory and pump water to the PS6 tanks. Also, a separate group of pumps at PS5 is used to provide water to a neighboring village of Piatra.

PS6 is used to pump water to PS3. Water is stored into two reservoirs, having total capacity of 2x250 m^3. Pumping equipment includes one main pump group built of 2 parallel pumps of type NRG 100/315A-90/2. A separate stand-by pump is used as reserve. The pumps intake water from the water tanks located at the PS6 territory and pump water to the PS6 tanks.

PS3 is used to provide water to the southern supply area and partially to the northern area (through PS2 and PS4). Water is stored into one reservoir with total capacity of 2,000 m^3. It shall be mentioned that most of stored water is supplied to the southern part of the city by gravity directly from the reservoir. Also, a part of this gravity water is led to the PS2 located in the northern part of the town. Pumping equipment includes several pump groups - first built of 2 parallel pumps of type CO -2 MVI-808, and second is formed of 2 pumps of type CO-2 MVI-1608. Two stand-by pumps are used as reserve.

General data on installed pumping equipment are presented in the following Table.

Table 3-4 *Design parameters of the existing pumping equipment at the PS5, PS6 and PS3 in Orhei*

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating	Year of instal-lation
					P	Voltage	Speed	cosφ	In			
			m^3/h	m	kW	V	rpm		A		hrs /day	
					PS3							
1	K20/30	1	20	30	4	380	1410	0.84	8.7		as reserve	1988
2	ЦНСГ - 38/176	1	38	176	30	380					as reserve	2004
3	CO -2 MVI- 808	2	10.8	60	3	380	2910	0.84	6.4	Y		2006
4	CO -2 MVI- 1608	2	15	120	7.5	380	2920	0.9	14.6	Y		2006
					PS5							
5	MVI 810 - Piatra	1	4	160	3	380	2840	0.84	7.8	Y		2006
6	ЦНС - 180/212	1	180	212	160	380					as reserve	1994

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating	Year of instal-lation
					P	Voltage	Speed	cosϕ	In			
			m³/h	m	kW	V	rpm		A		hrs /day	
7	D 200/95	1	200	95	90	380					as reserve	2003
8	NP 80/250V-75/2a	1	200	90	75	380	2970	0.9	134	Y		2006
9	NP 80/250V-75/2a	1	200	90	75	380	2970	0.9	134	Y		2006
					PS6							
10	ЦНС - 180/212	1	180	212	160	380					as reserve	1994
11	NPG 100/315A-90	1	200	100	90	380	2960	0.9	161	Y		2007
12	NPG 100/315A-90	1	200	100	90	380	2960	0.9	161	Y		2007

It is of note that in 2006 all three PSs were renovated under the Pilot Water Supply and Sanitation Project, financed by the World Bank. Further Audit measurements are required in order to identify whether existing pumps operate in their best efficiency ranges. The detailed analysis is provided in the next Chapters.

Energy Consumption Pattern

The following summary of historical energy consumption registered by Water Utility is provided in the Figure below.

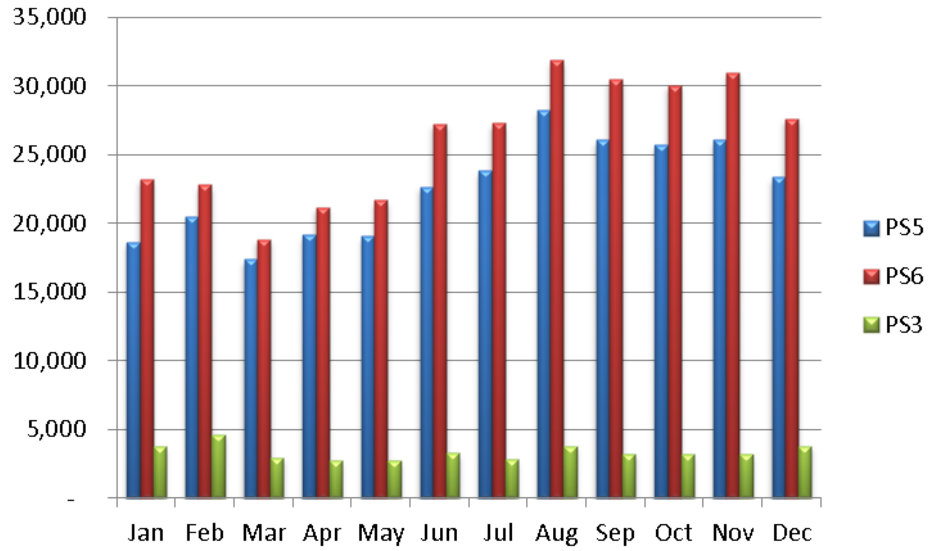

Figure 3-5 *Reported Historical Energy Consumption of the PS3, PS5 and PS6 for 2010, kWh*

This Figure shows that the highest energy consumption is registered during summer-autumn period. The Consultant has carried out its assignment, including site measurements, during the most energy consuming period of operation.

Since the PS5 and PS6 are major energy consuming facilities in Orhei, they are subject to further Energy Audit analysis.

3.4.3 Mitoc Intake – PS2 and PS4

PS2 is used to pump water to PS4 from Mitoc and Jeloboc Intakes. Water from both intakes is received and stored into three reservoirs, having total capacity of 2x500 and 1x300 m^3. Pumping equipment includes one main pump group built of 2 parallel pumps of type CO-2 MVI 7006. Several stand-by pumps are used as reserve. The pumps intake water from the water tanks located at the PS2 territory and pump water to the PS4 tanks.

PS4 is used to provide water to the northern and central supply areas of Orhei. Water is stored into three reservoirs, having total capacity of 2x2,000 and 1x300 m^3. Pumping equipment includes one main pump group built of 3 parallel pumps of type CO -2 MVI- 3204 PN 10 KFL. Two separate pumps are used as reserve. The pumps intake water from the tanks located at the PS4 territory and pump water to the service area. Also, a part of central area is supplied by gravity directly from the PS4 tanks.

General data on installed pumping equipment are presented in the following Table.

Table 3-5 *Design parameters of the existing pumping equipment at the PS2 and PS4 in Orhei*

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating	Year of instal-lation
					P	Voltage	Speed	cosϕ	In			
			m^3/h	m	kW	V	rpm		A		hrs /day	
					PS2							
1	ЦН-400/105	1	400	105	160	380					as reserve	1996
2	К 50/50	1	50	50	15	380						1996
3	MVI 7006	1	90	100	37	380	2950	0.9	64.5	Y		2007
4	MVI 7006	1	90	100	37	380	2950	0.9	64.5	Y		2007
					SP4							
5	К 50/50	1	50	50	11	380					as reserve	1996
6	К 45/30	1	40	30	7.5	380	2900		15			2002
7	CO -3 MVI-3204	3	42	30	7.5	380	2950	0.91	15.9	Y		2007

It is of note that in 2006-2007 both PSs were renovated under the Pilot Water Supply and Sanitation Project, financed by the World Bank. Further Audit measurements are required in order to identify whether existing pumps operate in their best efficiency ranges. The detailed analysis is provided in the next Chapters.

Energy Consumption Pattern

The following summary of historical energy consumption registered by Water Utility is provided in the Figure below.

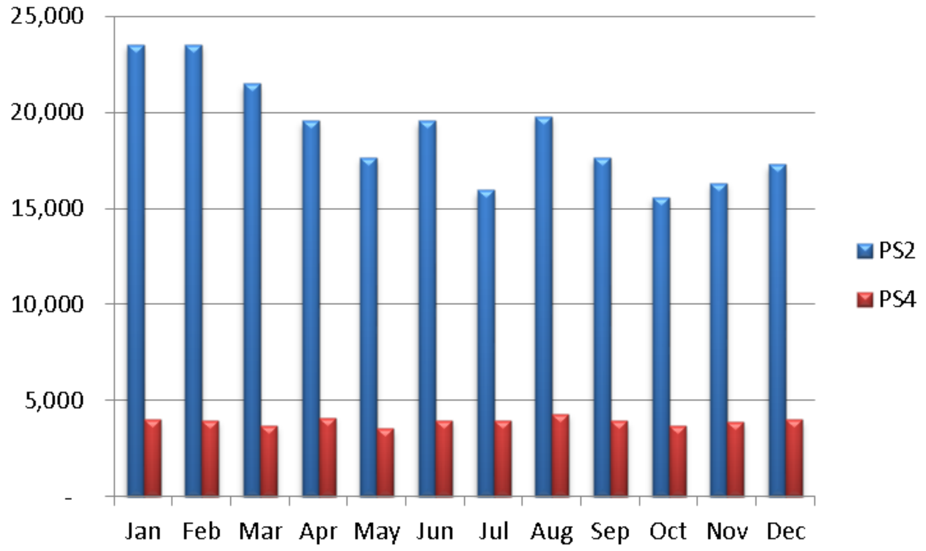

Figure 3-6 *Reported Historical Energy Consumption of the PS2 and PS4 for 2010, kWh*

Since the PS5 and PS6 are major energy consuming facilities in Orhei, they are subject to further Energy Audit analysis.

3.5 Water Pumping – Booster PS

There are no booster pumping stations operated by Orhei Water Utility. All water is supplied to the consumers by the pumping stations described above.

3.6 Water Distribution Network

Town water distribution network in Orhei is divided into nine (9) separate service areas by intakes, as follows:

PS	Network type	Supply Area
	Gradina Publica	
PS1	Pressure Network	City center
PS8	Pressure Network	Western part - Lupoaica District
	Pressure Network	Western part - Lupoaica District
	Jeloboc Intake	
PS3	Gravity Network	Southern part – Slobozia Doamnei District
	Gravity Network	Southern part – Nistreana District
	Pressure Network	Southern part – Nistreana District
	Mitoc/Jeloboc Intakes	
PS4	Gravity Network	Central part of Orhei
	Pressure Network	Northern part of Orhei

As can be seen from the Table above, the town networks are considerably fragmented in Orhei. This could be explained by presence of three different water sources used for water supply. Initially the town was designed to be provided with water from Mitoc and Gradina Publica Intakes. However, due to appeared problems with water quality from Mitoc Intake, a need for development of a new water source emerged. Jeloboc Natural Spring was initially used for farming purposes. However, over last years Orhei Water Utility is gradually switching to this water intake as the main water source for the town. The possibilities for hydraulic network optimization are studied in the next Chapters.

Main data about existing water pipelines are shown in the following Table.

Table 3-6 *Water Supply Networks operated by Apa-Canal Orhei*

Material	Range of Diameters, mm	Operation Period, years	Length, km
Distribution Network			
Steel	20-300	10-50	60.4
Cast Iron	100-300	10-60	31.2
HDPE	20-315	10-20	74.8
Total			**166.4**
Water Mains (from water intakes)			
Jeloboc			24.3
Mitoc			8.7
SP2-SP4			2.1
Total			**35.1**

In 2006, the Pilot WSSP financed by the World Bank rehabilitated parts of existing water networks and mains in Orhei Town. Some 12 km (out of 202 km) of network mains were replaced with new HDPE pipes. Still, only some 6% of networks were renovated and a good energy saving potential is seen in further renovation of the central and southern parts of the network. Apa-Canal is continuing rehabilitation works with their own sources.

Due to complicated geographic situation, pressure in water networks from some gravity supplied areas exceeds 6 bar, causing remarkable network leakages. Possibilities to reduce these water losses are subject to this Energy Audit.

Beginning of year 2011 there were some 12,191 household individual meters installed in all service areas covered by Orhei Water Utility. Also, 430 water meters are installed for economic agents, 58 pcs – for community buildings. There are 234 bulk meters in use.

4. SEWERAGE SYSTEM

4.1 General

Currently, Orhei Town sewerage collection system consists of four (4) drain areas and four (4) SPSs, pumping collected wastewater to the existing WWTP, located in the western part of the town at an inlet elevation of 121 m a.s.l.

Given to the Orhei Town geographic situation, all town wastewater is collected by gravity at the lowest points in the eastern part of the Town, and thereafter pumped to the Main SPS and WWTP.

The estimated extent of sewerage drain areas in Orhei Town is presented in the following figure:

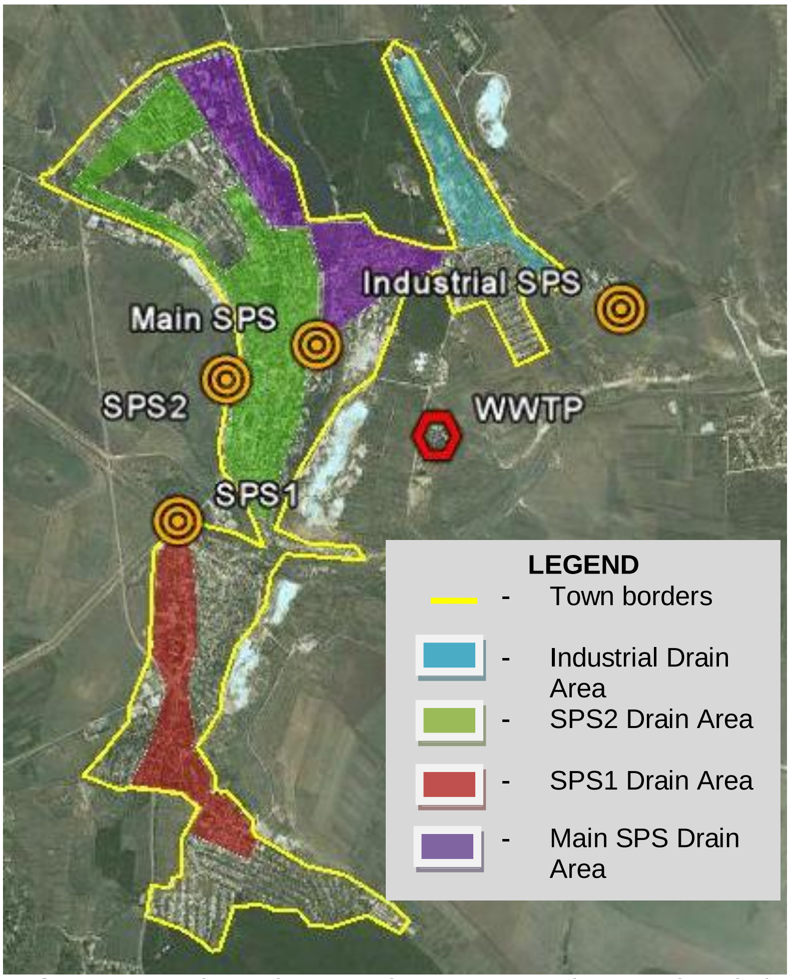

Figure 4-1 *Estimated Extent of Sewerage Drain Areas in Orhei*

Currently, only some 58% of the Town water consumers are covered by the sewerage services. The wastewater is collected from most of industrial entities, schools, kindergartens and other organizations and multistorred houses, while most of private houses are not covered by sewerage networks at all.

Detailed information on consumers is provided in the previous Chapters.

4.2 Wastewater Collection

Orhei Town wastewater collection is separated in four (4) main drain areas, thereof collected wastewater is led to the WWTP through four (4) sewerage pumping stations.

The areas are, as follows:

- Southern part (Slobozia Doamnei and Nistreana Districts) – area of private houses. Collected wastewater is drained and led by gravity to the District SPS1, which delivers wastewater to the District SPS2;
- Central/Northern part – area of mixed private houses, multi-storey buildings and industry. All wastewater is collected at the District SPS2;
- Eastern/Central part – area of mixed private houses, multi-storey buildings and industry. All wastewater is collected by gravity at the Main SPS and therefrom is pumped directly to the Main SPS. Also, the wastewater from the District SPS2 is delivered to the Main SPS;
- Industrial Area – collects wastewater from the eastern industrial area to the Industrial SPS, which pumps wastewater directly to the WWTP

The main sewerage network originates from the 1970-80's and only small segments have been renovated since.

4.3 Wastewater Pumping

In total, there are four (4) wastewater PSs in use in Orhei Town. General data on installed wastewater pumps in use are presented in the following Table.

Table 4-1 Design parameters of the existing pumping equipment

PS	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Operating	Instal-lation
					P	Voltage	Speed	cosφ	In		
			m^3/h	m	kW	V	rpm		A	hrs /day	
District SPS1	CD -250/22,5b	1	250	16	22	380					1988
	FA10.78Z-FK202-6/17	1	80	15	6.5	380	950	0.78	15.3		2007
	FA10.78Z-FK202-6/17	1	80	15	6.5	380	950	0.78	15.3		2007
District SPS2	CD -145/46	1	145	46	37	380					1988
	FA15.77Z-FK 34,1-4/42	1	303,8	51	80	380	1450		155		2007
	FA15.77D-FK 34,1-4/42		303,8	51	80	380	1450		155		2007
Main SPS	CD 450/95-2b		450	95	250	380					1995
	FA 15.99D-FKT49-4/42		434	91,8	165	380			315		2006
	FA 15.99D-FKT49-4/42		430	90	165	380			315		2007

It is of note that in 2006 the existing PSs were renovated under the Pilot Water Supply and Sanitation Project, financed by the World Bank. Further Audit measurements are required in order to identify whether existing pumps operate in their best efficiency ranges. The detailed analysis is provided in the next Chapters.

4.4 Wastewater Treatment

In 2008 the EC Moldova Regional Development and Social Protection Project was launched in Orhei. The Project includes construction of a new WWTP based on constructed wetlands technology. The new WWTP is designed to be located at a new more energy efficient location in the western part of the town.

This will allow avoiding pumping of collected wastewater to the existing elevated WWTP area and will considerably reduce the pumping costs. However, this will require network modifications within the town, including building of a new Main SPS.

Therefore, these facilities are not subject to this Energy Audit. However, in his Study the Consultant will cover District SPS1 and SPS2 which remain unchanged under the EC RDSP Project.

5. OTHER FACILITIES

The following transformer stations owned by Apa-Canal are reported to be used for power supply of the WSS facilities.

Table 5-1 *Transformers used for WSS in Orhei*

Facility	Qty	Transformer
Mitoc wellfield	2	100 KVA

The existing transformers are in adequate operation condition. However, the power cables are worn out and Apa-Canal bears considerable costs to cover the losses in the cables. This is considered to be subject to this Energy Audit.

6. SITE MEASUREMENTS

6.1 Methodology

In order to assess the operating efficiency of the existing water and waste water systems and their elements and to identify energy saving potential, a selective site measurement campaign was organized by the Consultant. The measurement campaign was carried out in October 2011.

The Consultant has performed flow measurements at all water/sewage supply pumping stations and wellfield.

We have also carried out flow measurements of individual pumps to register actual pump flow rate to evaluate actual performance of pumping equipment.

Energy consumption of individual pumps was measured in details by a power analyzer. Actual power, as well as reactive, apparent, power factor, voltages and current on each phase have been measured and registered.

The Consultant’s team used pressure measurements equipment at individual pumps suction and pressure sides in order to evaluate actual performance of pumps and pressure piping.

Flow Measurement Sites

Flow measuring equipment was installed at the following sites:

- Mitoc wellfield 3 operating wells;
- Gradina Publica wellfield 2 operating wells;
- PS 1;
- PS 2;
- PS 3;
- PS 4;
- PS 5 Jeloboc;
- PS 6;
- PS 8;
- SPS 1;
- SPS 2

Flow measurements protocols are presented in the electronic external Appendix to this Report.

Pressure measurements sites

Electronic pressure transducers were installed at the following sites:

- Mitoc wellfield 3 operating wells;
- Gradina Publica wellfield 2 operating wells;
- PS 1;
- PS 2;
- PS 3;
- PS 4;
- PS 5 Jeloboc;
- PS 6;
- PS 8;

Pressure measurements protocol can be found in the electronic external Appendix to this Report.

Pressure manometers were installed at:

- SPS 1;
- SPS 2

Electrical power measurements sites

The power measurements were performed at the following sites:

- Mitoc wellfield 3 operating wells;
- Gradina publica wellfield 2 operating wells;
- PS 1;
- PS 2;
- PS 3;
- PS 4;
- PS 5 Jeloboc;
- PS 6;
- PS 8;
- SPS 1;
- SPS 2

Detailed power characteristic of each measurement point contains:

- frequency,
- phase voltage on each phase,
- linear voltage on each phase,
- current of each phase,
- active power consumption for each phase and all phases,
- reactive power consumption for each phase and all phases
- apparent power consumption for each phase and all phases
- power factor of each phase and all phases
- displacement factor or cos φ of each phase and all phases.

Power measurements protocols can be found in the electronic external Appendix to this Report.

Equipment used for site measurements

Power analyzer	**Qualistar CA 8334 (Chauvin-Arnoux)**
Portable flow meter	**Prosonic Flow 93T (Endress + Hausser)**
Fixed-installation flow meter big size	**DigitalFlow DF868 (GE Measurement&Control Solutions)**
Pressure transducer	**Cerabar T PMP 131 (Endress + Hausser)**
Data storage	**Memorgaph M RSG40 (Endress + Hausser)**
Non-contact infrared thermometer	**OS562 (Omega Engineering)**

All equipment used complies with the accuracy requirements and international technical standards.

6.2 Site measurement and analyses

Flow and pressure measurements at PS 3 (Pressure supply zone Nistreana 1)

Flow measurements started on October 05, 2011 at 18:46 and finished on October 06 at 19:26. The time interval between instant flow measurements was set to 1 minute.

Below graph illustrates the flow pattern from PS 3 to Nistreana 1 direction:

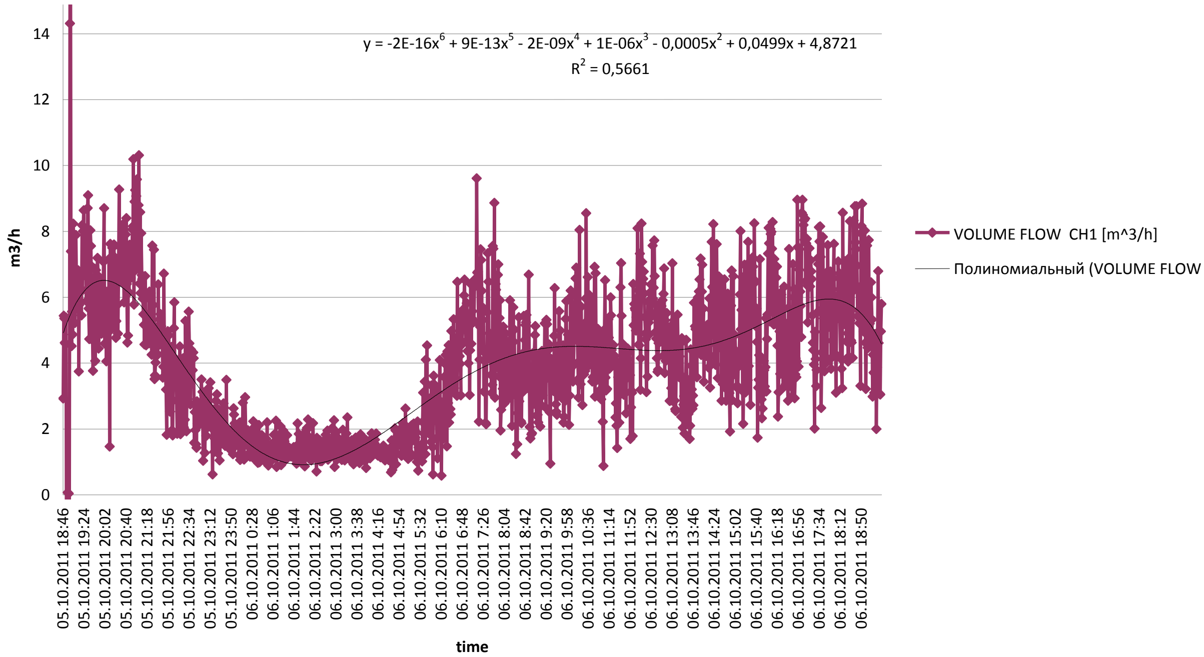

Figure 6-1 *Flow Measurements at PS3 to Nistreana 1*

The maximum registered morning/evening peaks are around 8 m^3/h, and minimum night flow is around 1.5 m^3/h.

Pressure measurements started on October 05, 2011 at 19:01 and finished on October 06 at 19:29. The time interval between instant pressure measurements was set to 1 minute.

Below graph illustrates daily pressure pattern:

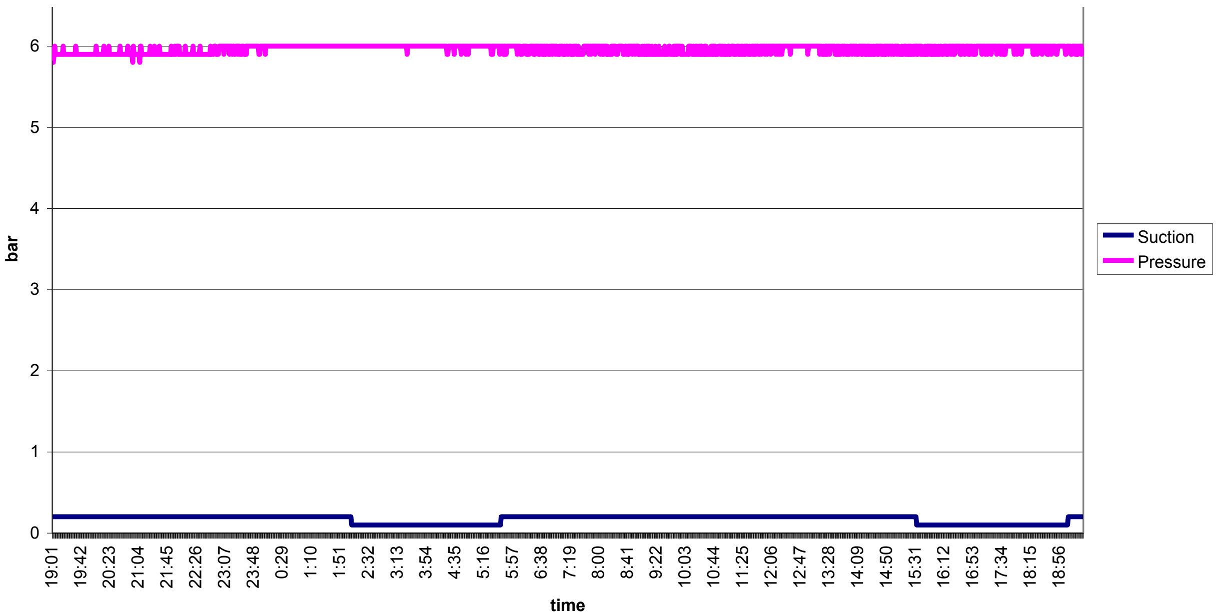

Figure 6-2 *Preassure Measurements from SP3 to Nistreana*

In working regime discharge pressure was constant and kept at 5.9 – 6 bar.

Suction pressure slightly varied depending on water level in PS 3 reservoir.

Flow and pressure measurements at PS 4

Flow measurements started on October 03, 2011 at 14:26 and finished on October 04 at 09:15. The time interval between instant flow measurements was set to 1 minute.

Below graph illustrates flow pattern from PS 4:

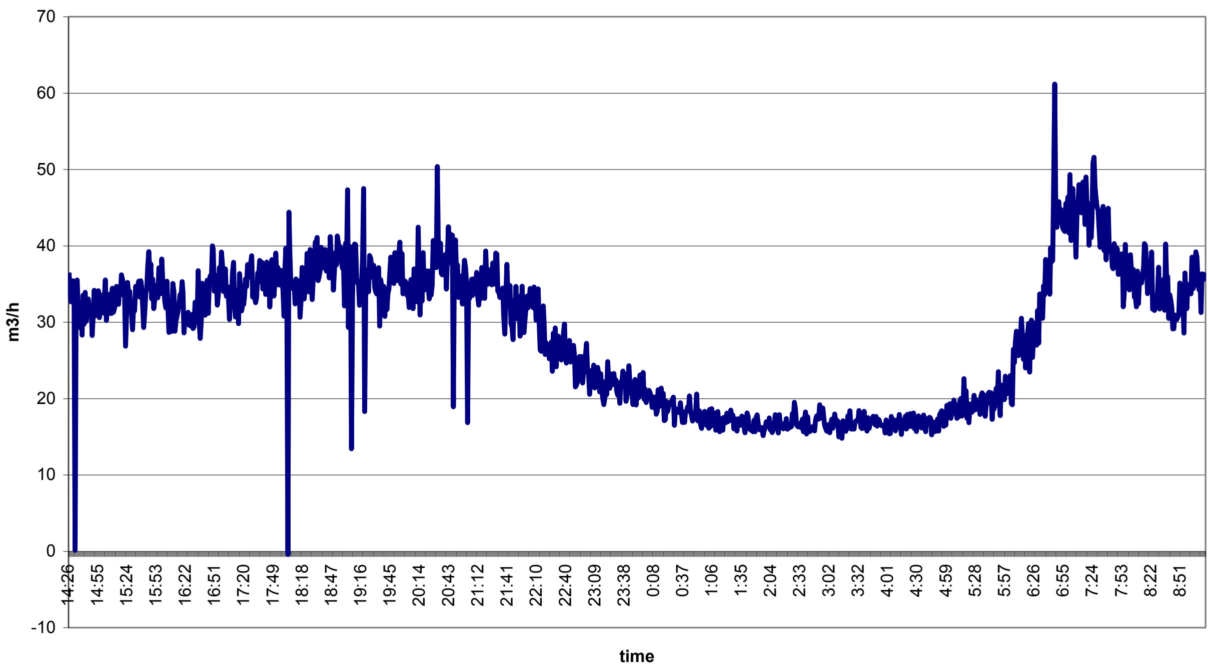

Figure 6-3 *Flow Measurements at PS4*

The maximum registered morning/evening peaks are around 50 m3/h, and minimum night flow is around 15 m3/h.

Pressure measurements started on October 03, 2011 at 14:35 and finished on October 04 at 09:19. The time interval between instant pressure measurements was set to 1 minute.

Below graph illustrates daily pressure pattern:

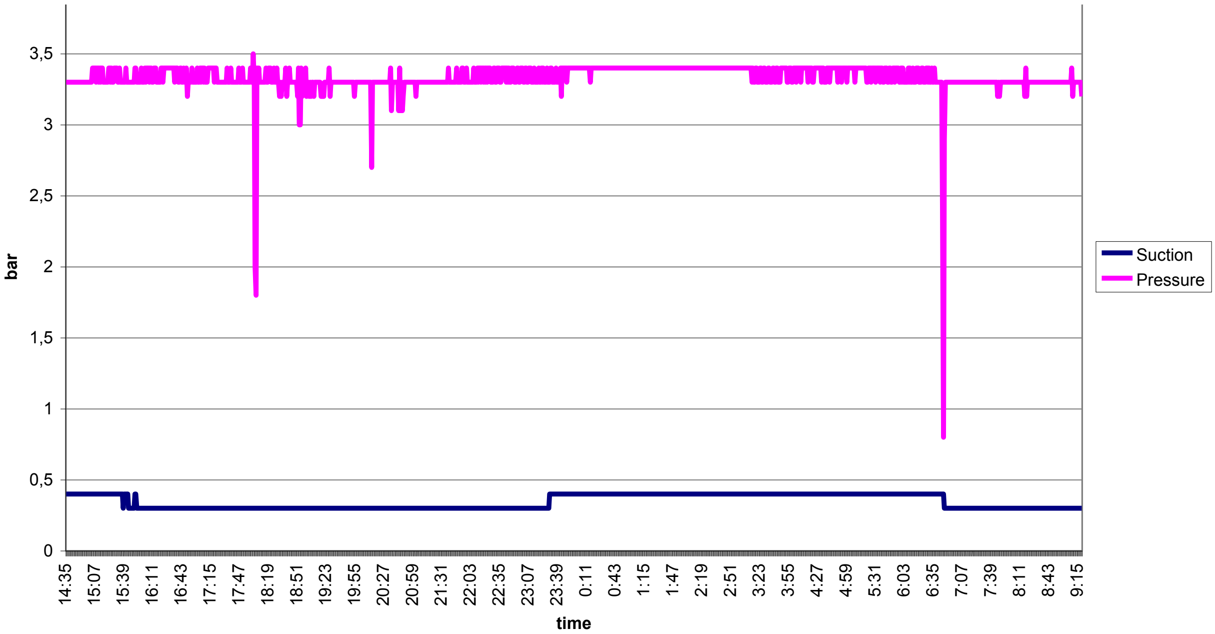

Figure 6-4 *Pressure Measurements from PS4*

In working regime discharge pressure was constant and kept at 3.3 bar.

Suction pressure slightly varied depending on water level in PS 4 reservoir.

Measurements of operating parameters of pumping equipment

The summary table of design and actual operating parameters of existing pumping equipment:

Table 6-1 *Data on Existing Pumping Equipment in Use in Orhei*

Orhei		PS 1			PS2	
Design parameters	**Units**	**Pump 1**	**Pump 2**	**Pump 3**	**Pump 1 (No. 2)**	**Pump 2 (No. 3)**
Pump type		MVI 3207	MVI 3207	K 45/30	MVI 7006-/25/E/3-400	MVI 7006-/25/E/3-400
Flow	m3/h	30	30	45	90	90
Head	m	95	95	30	100	100
Impeller diameter	mm	-	-	-		
Number of impellers		7	7	1	6	6
Shaft power	kW					
Pump Efficiency %	%					
Motor type						
Rated power	kW	15	15	7,5	37	37
Nominal voltage	V	380	380	380	380	380
Nominal current	A	26.5	26.5	15	64.5	64.5
Rotation Speed	rpm	2950	2950	2900	2950	2950
Cos φ		0.93	0.93		0.9	0.9
Motor Efficiency %	%					
Measured parameters pump						
Actual flow	m3/h	23.35	22.06	28.56	95.02	94.15
Suction pressure/dynamic level	m	1	1	1	2	2
Discharge pressure	m	99.27	97.45	28	87	87
Actual pump head	m	98.27	96.45	27	85	85
Active power consumption	kW	11.91	11.75	6.36	34.5	34.75
Reactive power consumption	kVAr	5.7	5.4	4.22	16.91	16.9
Apparent power	VA	13.2	12.93	7.62	38.41	38.61
Power factor		0.9	0.91	0.83	0.9	0.9
Calculated pumping efficiency						
Hydraulic power	kW	6.25	5.79	2.10	22.00	21.79
Overall pumping efficiency	%	**0.52**	**0.49**	**0.33**	**0.64**	**0.63**
Pump Efficiency	%					
Specific power consumption	kW/m3	0.51	0.53	0.22	0.36	0.37

Table 6-2 *Data on Existing Pumping Equipment in Use in Orhei*

Orhei		PS3				PS4		
Design parameters	**Units**	**Pump 1**	**Pump 2**	**Pump 1**	**Pump 2**	**Pump 1**	**Pump 2**	**Pump 3**
Pump type		MVI-808	MVI-808	MVI-1608	MVI-1608	MVI- 3204	MVI- 3204	MVI- 3204
Flow	m3/h	10.8	10.8	15	15	42	42	42
Head	m	60	60	120	120	30	30	30
Impeller diameter	mm							
Number of impellers		8	8	8	8	4	4	4
Shaft power	kW							
Pump Efficiency %	%							
Motor type								
Rated power	kW	3	3	7.5	7.5	7.5	7.5	7.5
Nominal voltage	V	400	400	380	380	380	380	380
Nominal current	A	6.4	6.4	14.6	14.6	15.9	15.9	15.9
Rotation Speed	rpm	2910	2910	2920	2920	2950	2950	2950
Cos φ		0.84	0.84	0.9	0.9	0.91	0.91	0.91
Motor Efficiency %	%							
Measured parameters pump								
Actual flow	m3/h	6.53	7.14	13.31	13.09	34.83	36.02	34.93
Suction pressure/dynamic level	m	2	2	2	2	4	4	4
Discharge pressure	m	66.54	73.09	114.81	114.18	44.18	42.45	40
Actual pump head	m	64.54	71.09	112.81	112.18	40.18	38.45	36
Active power consumption	kW	2.46	3.45	8.5	8.36	8.9	8.59	8.58
Reactive power consumption	kVAr	1.53	2.07	4.47	4.4	9.07	3.9	3.8
Apparent power	VA	4.52	4.02	9.6	9.46	12.71	9.46	9.4
Power factor		0.88	0.86	0.88	0.88	0.7	0.91	0.91
Calculated pumping efficiency								
Hydraulic power	kW	1.15	1.38	4.09	4.00	3.81	3.77	3.42
Overall pumping efficiency	%	**0.47**	**0.40**	**0.48**	**0.48**	**0.43**	**0.44**	**0.40**
Pump Efficiency	%							
Specific power consumption	kW/m3	0.38	0.48	0.64	0.64	0.26	0.24	0.25

Table 6-3 *Data on Existing Pumping Equipment in Use in Orhei*

Orhei		PS5 Jeloboc		PS6		PS8	
Design parameters	**Units**	**Pump 1**	**Pump 2**	**Pump 1**	**Pump 2**	**Pump 1**	**Pump 2**
Pump type		NR 80/250-75/2a	NR 80/250-75/2a	NPG 100/315-A90	NPG 100/315-A90	MVI- 3204	MVI- 3204
Flow	m3/h	200	200	200	200	24	24
Head	m	90	90	100	100	60	60
Impeller diameter	mm						
Number of impellers		1	1	1	1	4	4
Shaft power	kW						
Pump Efficiency %	%						
Motor type							
Rated power	kW	75	75	90	90	7.5	7.5
Nominal voltage	V	380	380	380	380	380	380
Nominal current	A	134	134	161	161	15.9	15.9
Rotation Speed	rpm	2970	2970	2970	2970	2950	2950
Cos φ		0.9	0.9	0.9	0.9	0.91	0.91
Motor Efficiency %	%						
Measured parameters pump						with VSD	without VSD
Actual flow	m3/h	167.05	151.59	148.26	145.51	9.6	25
Suction pressure/dynamic level	m	1	1	2	2	5	5
Discharge pressure	m	84.45	84.91	98.9	98.72	84.45	85
Actual pump head	m	83.45	83.91	96.9	96.72	79.45	80
Active power consumption	kW	65.21	62.84	81.89	79.21		
Reactive power consumption	kVAr	36.16	35.68	49.28	48.89		
Apparent power	VA	74.55	72.49	95.58	93.09		
Power factor		0.87	0.88	0.86	0.85		
Calculated pumping efficiency							
Hydraulic power	kW	37.96	34.64	39.12	38.33		
Overall pumping efficiency	%	**0.58**	**0.55**	**0.48**	**0.48**		
Pump Efficiency	%						
Specific power consumption	kW/m3	0.39	0.41	0.55	0.54		

Table 6-4 *Data on Existing Pumping Equipment in Use in Orhei*

Orhei		clogged pump		after cleaning		
			SPS R1		SPS R2	
Design parameters	**Units**	**Pump 1 (No. 2)**	**Pump 2 (No. 3)**	**Pump 2 (No. 3)**	**Pump 1**	**Pump 2**
Pump type		FA 10.78Z	FA 10.78Z	FA 10.78Z	FA 15.77Z	FA 15.77Z
Flow	m3/h	80	80	80	303.8	303.8
Head	m	15	15	15	51	51
Impeller diameter	mm				410	410
Number of impellers		1	1	1	1	1
Shaft power	kW					
Pump Efficiency %	%					
Motor type		FK 202-6/17	FK 202-6/17	FK 202-6/17	FK 34.1-4/42	FK 34.1-4/42
Rated power	kW	6.5	6.5	6.5	80	80
Nominal voltage	V	380	380	380	380	380
Nominal current	A	15.3	15.3	15.3	155	155
Rotation Speed	rpm	950	950	950	1450	1450
Cos φ		0.78	0.78	0.78	0.83	0.83
Motor Efficiency %	%					
Measured parameters pump						
Actual flow	m3/h	99.27	71.52	83.21	327.28	293.97
Suction pressure/dynamic level	m	1.5	1	1	1	1
Discharge pressure	m	13	14	14	42	44
Actual pump head	m	11.5	13	13	41	43
Active power consumption	kW	7.55	9.55	6.64	72.45	74.58
Reactive power consumption	kVAr	5.04	6.15	4.68	57.11	57.5
Apparent power	VA	9.1	11.35	8.12	92.25	94.18
Power factor		0.83	0.84	0.82	0.79	0.79
Calculated pumping efficiency						
Hydraulic power	kW	3.11	2.53	2.95	36.54	34.42
Overall pumping efficiency	%	**0.41**	**0.27**	**0.44**	**0.50**	**0.46**
Pump Efficiency	%					
Specific power consumption	kW/m3	0.08	0.13	0.08	0.22	0.25

Table 6-5 *Data on Existing Pumping Equipment in Use in Orhei*

Orhei		**Gradina publica**		**Mitoc Wellfield**		
Design parameters	**Units**	**Well no. 8**	**Well no. 10**	**Well no. 12**	**Well no. 13**	**Well no. 14**
Pump type			ЭЦВ 8/25/100	TWI 06.30-11-NB	NR 615-8 NU60-2/24	TVU-6R-31-8-11
Flow	m3/h		25	25	25	25
Head	m		100	106	70	77
Impeller diameter	mm		-			
Number of impellers			7	11		
Shaft power	kW			10		
Pump Efficiency %	%		0.6			
Motor type			ПЭДВ 11-180	NU60-2/32	NU60-2/24	
Rated power	kW		11	12.5	9.5	9.5
Nominal voltage	V		380	380	380	380
Nominal current	A		24.2	27.5	19.8	
Rotation Speed	rpm		3000	2900		
Cos φ			0.83			
Motor Efficiency %	%		0.81			
Measured parameters pump						
Actual flow	m3/h	30	57.1	30.5	30.5	22.5
Suction pressure/dynamic level	m	19.9	20	20	20	20
Discharge pressure	m	64.7	24	62	34	32
Actual pump head	m	88.6	48	86	58	56
Active power consumption	kW	12.7	16.07	13.3	8.7	10.84
Reactive power consumption	kVAr	7.7	11	10.32	7.04	9.96
Apparent power	VA	14.8	19.48	16.86	11.18	14.75
Power factor		0.85	0.83	0.79	0.78	0.74
Calculated pumping efficiency						
Hydraulic power	kW	7.24	7.46	7.14	4.82	3.43
Overall pumping efficiency	%	**0.57**	**0.46**	**0.54**	**0.55**	**0.32**
Pump Efficiency	%					
Specific power consumption	kW/m3	0.42	0.28	0.44	0.29	0.48

We found that most of pumping equipment operates within good or acceptable efficiency ranges. Therefore no ECM proposed for replacement of existing pumps.

7. FINAL ECM PROPOSALS

7.1 Proposed ECM1 - Replacement of pumping stations external lighting lamps

Present situation

Presently mercury-vapor bulbs are used for external lighting of pumping stations of Orhei. Table of lamps and yearly power consumption:

Table 7-1 *Used Lamps in Orhei*

No.	Site	Existing external lighting				
		Lantern type	Lamp power, W	Qty, pcs.	Working hours per year	Annual power consumptions, kW
1	PS 1	РКУ	160	3	3,360	1,612.8
2	PS 2	РКУ	160	5	3,360	2,688
3	PS 3	РКУ	160	4	3,360	2,150.4
4	PS 4	РКУ	160	6	3,360	3,225.6
5	PS 5	РКУ	160	2	3,360	1,075.2
6	PS 6	РКУ	160	5	3,360	2,688
7	PS 7	РКУ	160	2	3,360	1,075.2
8	PS 8	РКУ	160	2	3,360	1,075.2
9	SPP canal	РКУ	160	2	3,360	1,075.2
10	SPS 1	РКУ	160	2	3,360	1,075.2
11	SPS 2	РКУ	160	3	3,360	1,612.8
12	SEM	РКУ	160	2	3,360	1,075.2
13	WWTP	РКУ	160	6	3,360	3,225.6
	Total			**44**		**23,654.4**

Proposed Improvement

It is proposed to substitute existing inefficient bulbs with LED lumps of following parameters:

Lamp base	E40
Rated power	32 W
Led number	144 pcs.
LED type	LUMENMAX SMD5630
Input voltage	85 – 265 V
Frequency	47 – 63 Hz
luminous flux	2100 — 2300 Lm (15-16 Lm per LED)
Color	White 5,300-5,700 K
Lifecycle	> 50 000 hours
Working temperature	-30° + 40°C
Lamp efficiency	90%

Protection IP33

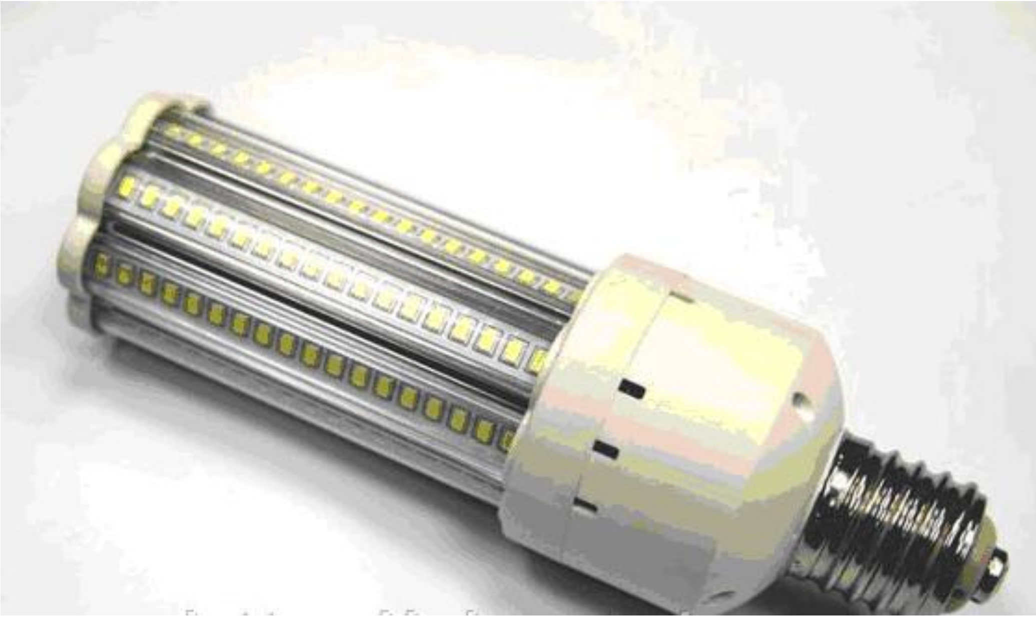

Figure 7-1 *Proposed LED bulb*

Estimation of Savings

Table of new lamps and their yearly power consumption:

Table 7-2 *Estimated Energy Savings*

No.	Site	New external lighting				
		Lantern type	Lamp power, W	Qty, pcs.	Working hours per year	Annual power consumptions, kW
1	PS 1	ЖКУ	32	3	3,360	322.56
2	PS 2	ЖКУ	32	5	3,360	537.6
3	PS 3	ЖКУ	32	4	3,360	430.08
4	PS 4	ЖКУ	32	6	3,360	645.12
5	PS 5	ЖКУ	32	2	3,360	215.04
6	PS 6	ЖКУ	32	5	3,360	537.6
7	PS 7	ЖКУ	32	2	3,360	215.04
8	PS 8	ЖКУ	32	2	3,360	215.04
9	SPP canal	ЖКУ	32	2	3,360	215.04
10	SPS 1	ЖКУ	32	2	3,360	215.04
11	SPS 2	ЖКУ	32	3	3,360	322.56
12	SEM	ЖКУ	32	2	3,360	215.04
13	WWTP	ЖКУ	32	6	3,360	645.12
	Total			**44**		**4,730.88**

Existing lamps power consumption = 23 654.4 kWh/year

New lamps power consumption = 4 730.88 kWh/year

Power saving	= 18 923.52 kWh/year
Assuming 1.8 MDL per 1 kWh	= **34 062 MDL/year**

Estimation of investment cost

Cost of LED lamps	2 500 MDL x 44 lamps = 110 000 MDL
Installation	12 000 MDL
Total investment costs	**122 000 MDL**

Payback period	**= 3.6 years**

7.2 Proposed ECM2 – Implementation of SCADA for the Main WSS Facilities

Current Situation

Currently, Orhei Apa-Canal doesn't have a comprehensive monitoring system for energy consumption and water and wastewater flows at every system facility (e.g. deep wells, PSs etc.). All data are collected and introduced in accounting system manually without any automation, having high risk of introduction of incorrect data.

No real-time energy monitoring system is in place, resulting in low efficiency of system operation.

Also, taking into consideration considerably high distances to Jeloboc water Intake and a number of pumping stations, Orhei Apa-Canal cannot operate these facilities in an efficient way without a permanent remote monitoring system. Considerable amounts of water losses result from a late detection of network leakages. The intervention of the operator could be faster and more efficient in case of SCADA (Supervisory Control and Data Acquisition) monitoring of water flows. There is a need for improving the speed and effectiveness of in-the-field repairs to the system, increasing the speed of discovering and responding to system failures, and integrating the data collection and monitoring into a single system-wide control center.

The registered energy consumption for the main WSS facilities, as well as water flow/balance monitored are shown in the previous chapters.

Proposed changes

In order to implement at a system scale the energy efficiency policy, permanent monitoring system for different periods of time (hour, day, month, year) shall be introduced.

The Consultant proposes implementation of SCADA for on-line monitoring of the WSS technological processes, system data collection e.g. energy and natural gas consumption, pumping pressures, pump flows etc.

The following SCADA elements are proposed to be implemented at WSS facilities.

Table 7-3 *Measurements Proposed for the SCADA System*

No	Facility	Range of values	Remote outputs	Note
1.	**MITOC**			
	WELL12			
	Active Electricity Power, Reactive Electricity Power			
	WELL12 power input (inclusive Well13 and Well14)	380V; 50Hz; 5A	2 Pulse outputs (or RS485/232)	
	Water flow			
	WELL12 output left	0…30 m^3/h	Pulse output	

No	Facility	Range of values	Remote outputs	Note
			(or RS485/232)	
	Pressure			
	WELL12 output	0…10bar	0(4)…20mA	
	WELL13			
	Water flow			
	WELL13 output	0…30 m^3/h	Pulse output (or RS485/232)	
	Pressure			
	WELL13 output	0…6bar	0(4)…20mA	
	WELL14			
	Water flow			
	WELL14 output	0…30 m^3/h	Pulse output (or RS485/232)	
	Pressure			
	WELL14 output	0…6bar	0(4)…20mA	
2.	**PS1**			
	Active Electricity Power, Reactive Electricity Power			
	SP1 power input (inclusive Well8 and Well10)	380V; 50Hz; 5A	2 Pulse outputs (or RS485/232)	
	Water flow			
	SP1 output left	0…30 m^3/h	Pulse output (or RS485/232)	
	SP1 output right	0…30 m^3/h	Pulse output (or RS485/232)	
	K45/30 output	0…45 m^3/h	Pulse output (or RS485/232)	
	Self needs	0…3 m^3/h	Pulse output	existent
	Well8 output	0…35 m^3/h	Pulse output (or RS485/232)	
	Well10 output	0…60 m^3/h	Pulse output (or RS485/232)	
	Pressure			
	SP1 input (level in reservoir)	-1…1.5bar	0(4)…20mA	
	SP1 output left	0…16bar	0(4)…20mA	
	SP1 output right	0…16bar	0(4)…20mA	
	K45/30 output	0…16bar	0(4)…20mA	
	Well8 output	0…10bar	0(4)…20mA	
	Well10 output	0…10bar	0(4)…20mA	
	Natural Gas			
	SP1 natural gas supply	0…6m^3/h	Pulse output	
3.	**PS2**			
	Active Electricity Power, Reactive Electricity Power			
	SP2 power input	380V; 50Hz; 5A	2 Pulse outputs (or RS485/232)	
	Water flow			
	SP2 output left	0…100 m^3/h	Pulse output (or RS485/232)	

No	Facility	Range of values	Remote outputs	Note
	SP2 output right	0…100 m^3/h	Pulse output (or RS485/232)	
	Self needs	0…3 m^3/h	Pulse output	existent
	Pressure			
	SP2 input (level in reservoir)	-1…1.5bar	0(4)…20mA	
	SP2 output left	0…16bar	0(4)…20mA	
	SP2 output right	0…16bar	0(4)…20mA	
	Natural Gas			
	SP2 natural gas supply	0…6m^3/h	Pulse output	
4.	**PS3**			
	Active Electricity Power, Reactive Electricity Power			
	SP3 power input	380V; 50Hz; 5A	2 Pulse outputs (or RS485/232)	
	Water flow			
	SP3 output left	0…15 m3/h	Pulse output (or RS485/232)	
	SP3 output right	0…15 m3/h	Pulse output (or RS485/232)	
	Self needs	0…3 m3/h	Pulse output	existent
	Pressure			
	SP3 input (level in reservoir)	-1…1,5bar	0(4)…20mA	
	SP3 output left	0…16bar	0(4)…20mA	
	SP3 output right	0…16bar	0(4)…20mA	
5.	**PS4**			
	Active Electricity Power, Reactive Electricity Power			
	SP4 power input	380V; 50Hz; 5A	2 Pulse outputs (or RS485/232)	
	Water flow			
	SP4 output left	0…30 m3/h	Pulse output (or RS485/232)	
	SP4 output right	0…30 m3/h	Pulse output (or RS485/232)	
	Self needs	0…3 m3/h	Pulse output	existent
	Pressure			
	SP4 input (level in reservoir)	-1…1,5bar	0(4)…20mA	
	SP4 output left	0…6bar	0(4)…20mA	
	SP4 output right	0…6bar	0(4)…20mA	
6.	**PS5**			
	Active Electricity Power, Reactive Electricity Power			
	SP5 power input	380V; 50Hz; 5A	2 Pulse outputs (or RS485/232)	
	Water flow			
	SP5 output left	0…150 m3/h	Pulse output (or RS485/232)	
	SP5 output right	0…150 m3/h	Pulse output (or RS485/232)	
	Self needs	0…3 m3/h	Pulse output	existent
	Pressure			

No	Facility	Range of values	Remote outputs	Note
	SP5 input (level in reservoir)	-1…1,5bar	0(4)…20mA	
	SP5 output left	0…16bar	0(4)…20mA	
	SP5 output right	0…16bar	0(4)…20mA	
7.		**PS6**		
	Active Electricity Power, Reactive Electricity Power			
	SP6 power input	380V; 50Hz; 5A	2 Pulse outputs (or RS485/232)	
	Water flow			
	SP6 output left	0…150 m3/h	Pulse output (or RS485/232)	
	SP6 output right	0…150 m3/h	Pulse output (or RS485/232)	
	Self needs	0…3 m3/h	Pulse output	existent
	Pressure			
	SP6 input (level in reservoir)	-1…1.5bar	0(4)…20mA	
	SP6 output left	0…16bar	0(4)…20mA	
	SP6 output right	0…16bar	0(4)…20mA	
8.		**PS8**		
	Active Electricity Power, Reactive Electricity Power			
	SP8 power input	380V; 50Hz; 5A	2 Pulse outputs (or RS485/232)	
	Water flow			
	SP8 output left	0…30 m3/h	Pulse output (or RS485/232)	
	SP8 output right	0…30 m3/h	Pulse output (or RS485/232)	
	Self needs	0…3 m3/h	Pulse output	existent
	Pressure			
	SP8 input (level in reservoir)	-1…1,5bar	0(4)…20mA	
	SP8 output left	0…16bar	0(4)…20mA	
	SP8 output right	0…16bar	0(4)…20mA	
9.		**Main SPS**		
	Active Electricity Power, Reactive Electricity Power			
	SPCP power input	380V; 50Hz; 5A	2 Pulse outputs (or RS485/232)	
	Water flow			
	Main SPS output left	0…450 m3/h	Pulse output (or RS485/232)	
	Main SPS output right	0…450 m3/h	Pulse output (or RS485/232)	
	Self needs	0…3 m3/h	Pulse output	existent
	Pressure			
	SPCP input (level in reservoir)	-1…1.5bar	0(4)…20mA	
	SPCP output left	0…16bar	0(4)…20mA	
	SPCP output right	0…16bar	0(4)…20mA	
	Natural Gas			
	SPCP natural gas supply	0…6m3/h	Pulse output	

No	Facility	Range of values	Remote outputs	Note
10.		**District SPS1**		
	Active Electricity Power, Reactive Electricity Power			
	SPCR1 power input	380V; 50Hz; 5A	2 Pulse outputs (or RS485/232)	
	Water flow			
	SPCR1 output left	0…100 m3/h	Pulse output (or RS485/232)	
	SPCR1 output right	0…100 m3/h	Pulse output (or RS485/232)	
	Self needs	0…3 m3/h	Pulse output	existent
	Pressure			
	SPCR1 input (level in reservoir)	-1…1.5bar	0(4)…20mA	
	SPCR1 output left	0…16bar	0(4)…20mA	
	SPCR1 output right	0…16bar	0(4)…20mA	
11.		**District SPS2**		
	Active Electricity Power, Reactive Electricity Power			
	SPCR2 power input	380V; 50Hz; 5A	2 Pulse outputs (or RS485/232)	
	Water flow			
	SPCR2 output left	0…300 m3/h	Pulse output (or RS485/232)	
	SPCR2 output right	0…300 m3/h	Pulse output (or RS485/232)	
	Self needs	0…3 m3/h	Pulse output	existent
	Pressure			
	SPCR2 input (level in reservoir)	-1…1.5bar	0(4)…20mA	
	SPCR2 output left	0…16bar	0(4)…20mA	
	SPCR2 output right	0…16bar	0(4)…20mA	
	Natural Gas			
	SPCR2 natural gas supply	0…6m3/h	Pulse output	

Estimation of Savings

This ECM measure will not bring direct energy savings to the existing equipment and machineries, but is expected to be the basis for a sustainable energy efficient WSS systems.

As a result of SCADA system, Orhei Apa-Canal will be able to identify the inefficient links in the existing WSS systems in a shorter period of time and will introduce all necessary measures to improve the problematic situation

According to the world experience and best practices, implementation of SCADA system results in reductions of energy consumption and water losses in the range of 5…40%. In its calculations, the Consultant used the lowest percentage.

Current Energy consumption (for WSS installations covered by SCADA)=1,603,465 kWh/year

Assuming energy tariff of 1.78 MDL/kWh,
estimated energy saving = 1,603,465 kWh/year * 5% * 1.78MDL = 142,708 MDL/year

Assuming water tariff of 16.52 MDL/m^3,
estimated reduction in water leakages = 627,700 m^3/year * 5% * 16.52MDL = 518,480 MDL/year

Total saving, in MDL: **= 661,188 MDL/year**

Total saving, in EUR: **= 41,320 Euro/year**

Additionally, this investment is expected to result in the following:

- Faster speed of detection of system malfunction and interventions;
- Reduction of operating time of inefficient pumping equipment;
- Institutional improvement (staff optimization).

Estimation of investment cost

Table 7-4 *Estimation of the Investment Costs for Meters*

No	Type of Meter	Quantity	Price per unit, EURO	Total Cost, EURO	Note
1.	Electricity Power Meters				
	Landys+Gyr ZMG310 (410)	12	500	5,500	All
2.	Electromagnetic flow Meters				
	Promag 10W DN250 Qn=250m3/h	4	4,500	18,000	Main SPS, District SPS2
	Promag 10W DN150 Qn=150m3/h	4	2,700	10,800	PS5, PS6
	Promag 10W DN100 Qn=100m3/h	4	2,300	9,200	PS2, District SPS1
3.	Ultrasonic flow Meters				
	Multical61 DN80 Qn=40m3/h	2	1,800	3,600	PS1, well10
	Multical61 DN65 Qn=25m3/h	8	1,500	20,000	PS1, PS4, well8, well12, well13, well14
	Multical61 DN50 Qn=15m3/h	2	1,200	2,400	PS3, PS7
4.	Pressure gauge				
	PMP131	38	250	9 500	all
5.	Gas Meters				
		4	100	400	all
			TOTAL:	**79,400**	

All installation works for the proposed meters are assumed to be done by the beneficiary and all associated installation costs are not included in the assessment.

Table 7-5 *Control and data acquisition equipment*

No	Control and data acquisition equipment	Price per unit, Euro	Qty	Total Cost, Euro
1.	Controller (with GPRS)	250	13	3,250
2.	Module discrete Input (8DI)	150	13	1,950
3.	Module discrete Output (8DO)	150	13	1,950
4.	Module analog input (8AI)	200	13	2,600
5.	Accessories	150	13	1,950
6.	Control equipment configuration Software	500	13	6,500
		TOTAL:		**18,200**

Table 7-6 *Dispatcher equipment*

No	Dispatcher equipment	Type of equipment	Qty, units	Price per unit, Euro	Total cost, Euro
	Server	PC compatible	1	2,000	2,000
	Software	SCADA	1	12,000	12,000
				TOTAL:	**14,000**

Installation and start-up = 6,000 Euro

Total Investment Cost **=6,000+14,000+18,200+79,400 =117,600 Euro**

=1,881,600 MDL

Payback Period **= 2.85 years**

7.3 Proposed ECM3 - Hydraulic Optimization of the Water Mains

Present situation

From Jeloboc Intake at 37 m a.s.l., the abstracted water is pumped by two pumping stations (PS5 and PS6) into a 2,000 m^3 reservoir from PS3, at an elevation of 118 m a.s.l. However, the PS6 pressure main's highest point reaches 155 m a.s.l. and thereafter water is led to a considerably lower point at the PS3, thereby PS6 (located at 76 m a.s.l.) generates high energy costs for pumping.

Proposed Improvement

The Consultant has studied the topographic maps of the region and found that a hill between PS6 and PS3 can be by-passed, thereby reducing the highest network point from 155 m to 134 m a.s.l. The proposed segment to be changed is shown in the Figure below.

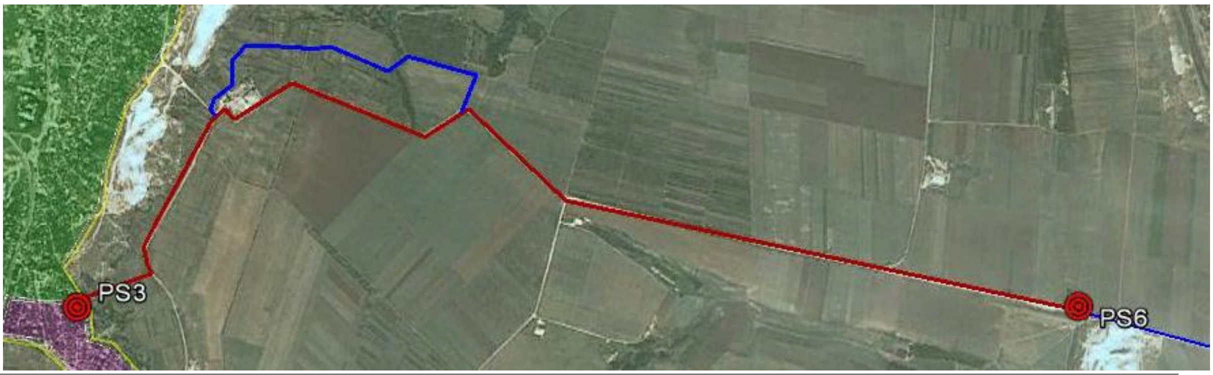

Figure 7-2 *Proposed Water Main Replacement*

The entire pressure main from PS6 to PS3 consists of the following pipes:

- HDPE 100 DN355 L=1,815m
- HDPE 100 DN225 L=1,555 m
- HDPE 100 DN180 L=764 m

The total length of the proposed new water main is longer than the existing one (Lproposed=1.96 km as compared to the existing Lexist=1.48km). The new segment is proposed to be built of the following pipes:

- HDPE 100 DN355 L=1,620m
- HDPE 100 DN225 L=340 m

The existing pumps at PS6 operate at considerably high efficiency of 0.48 (both pumps – please see the Measurements results Tab.s).

The measured actual pumping flow of the pump 1 is Q = **148.2 m^3/h**. The pressure in the suction pipe **2 m.** The pressure in the discharge pipe **99 m**. Therefore the overall pumping head is H = **97 m.**

Almost identical parameters for pump 2 result in Q = **145.5 m^3/h**, h=**2 m**, **H=97 m.**.

The town's highest water demand was registered in July 2010, when the water production from Jeloboc reached 78,000 m^3/month (3,250 m^3/day in average). However, this is the daily pumping capacity of a single pump at the PS6. Most of the year only 1 pump operates some 10 hours per day. The average daily demand from Jeloboc is some 2,000 m^3/day (avg. 83 m^3/h). Taking into consideration that the pump head will be reduced considerably, and though the pumps operate at a good efficiency rate, the Consultant proposes installation of smaller capacity pumps, meeting current conditions of flow/head and existing pipe system. This will result in considerable savings in specific energy consumption.

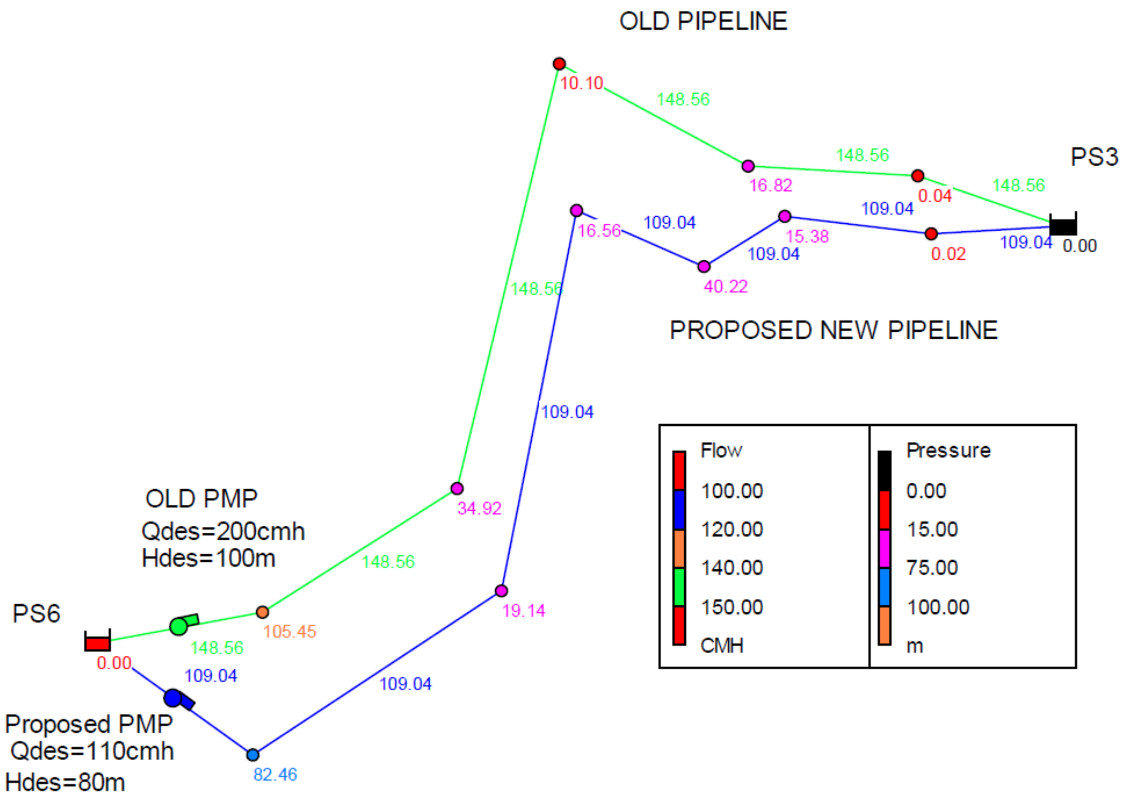

Fig. 7-3 *Hydraulic Modeling Results*

Estimation of Savings

Rated flow = 110 m^3/h
Rated head = 80 m
Motor rated power =37 kW
Actual power at duty point =32 kW

Estimation of Savings

Estimated power consumption of existing pumping regime = 402,148 kWh/year

Estimated power consumption of new pumping regime = 219,354 kWh/year

Power saving = 182,795 kWh/year

Assuming 1.8 MDL per 1 kWh =**329,031 MDL/year**

Estimation of investment cost

Tab. 7-7 *Estimation of Investment Costs*

No.	Description	Unit	Qty	Unit price, EUR	Total price, EUR
	Mechanical				
1	Pump/motor set Q=110 m3/h H=80 m (analogue SHF 65-250/370)	psc	2	12,000	24,000
2	Expansion joints DN125	psc	2	200	400
3	Expansion joints DN100	psc	2	160	320

No.	Description	Unit	Qty	Unit price, EUR	Total price, EUR
4	Gate valve DN200	psc	2	200	400
5	Gate valve DN250	psc	2	400	800
6	Check valve DN200	psc	1	200	200
7	Pipework and fittings	set	2	1,700	3,400
8	Pressure transducer	psc	1	1,500	1,500
9	Pressure gauge mechanical	psc	2	100	200
	Electrical				
10	Pump control unit with softstarter	psc	1	12,000	12,000
11	Power and signal cables	set	1	2,000	2,000
12	Earthing	set	1	500	500
	Auxillary				
13	Installation	Lump sum			2,300
14	Tools	set	1	200	450
15	Consumables	set	1	140	220
16	Mandatory spare parts	set	1	500	700
17	O&M manuals	set	1	100	100
	Pipeline				
13	Construction of 1,620 m HDPE 355 mm pipeline	Lump sum			81,000
14	Construction of 340 m HDPE 225 mm pipeline	Lump sum			9,180
	Grand total EUR				**139,670**
	Grand total MDL				**2,234,720**

Payback period	**= 6.8 years**

Please note, although the new pipeline was proposed to be laid along the public roads, the Consultant was informed that some land plots could be subject to acquisition. This may imply considerable investment costs, jeopardizing the feasibility of the proposed investment. Therefore, additional clarifications are needed before the investment is agreed.

It shall be noted that this Study does not cover any network/supply extension and all calculations are made to reduce current energy costs.

7.4 Other Recommendations - Hydraulic Optimization of the Water Distribution Networks

During its Assignment, the Consultant noticed that lower parts of the gravity supplied areas are exposed to high network pressures, exceeding the recommended 6 bar. The Consultant was informed that Apa-Canal Orhei had introduced a number of pressure reducer valves in different parts of the networks. However, the measures done are not enough to reduce the network pressure and consequently the amounts of water leakages.

The Consultant has analyzed the existing network and concluded that no systematic approach was used to install the reducers. Furthermore, the existing network does not allow to Consultant to propose any reliable and sustainable solution for pressure reduction.

In order to solve this problem, network zoning shall be implemented, which implies restructuring of a number of network segments and requires considerable amounts of investments. Also, older parts of networks need to be renovated before zoning is implemented. Some of the town districts are supplied from different pressure zones and a careful inventory and analysis of supply possibilities shall be done in future.

Therefore, the Consultant suggests to Apa-Canal to conduct inventory of existing networks/connections, introduce a pressure monitoring system and develop an action plan for restructuring of networks and reduction of leakages.

7.5 Economic Assessment of the Proposed ECMs.

The calculated payback period for the proposed ECMs is presented in the following Tab..

Tab. 7-8 *Calculated Payback for the Proposed ECM*

ECM description	Annual energy savings, kWh	Annual energy savings, MDL	Capital investment cost, MDL	Simple payback period, years	Ranking
Replacement of pumping stations external lighting lamps	18,923	34,062	122,000	3.6	2
Implementation of SCADA system	80,173	661,188	1,881,600	2.9	1
Modifications of Jeloboc Water Main and PS6	182,795	329,031	2,234,720	6.8	3

7.6 Analysis of the Energy Saving Measures proposed by Apa-Canal and Recommendations

In the inception phase Apa Canal Orhei submitted to the Consultant a list of ECM proposed to be implemented within EMP:

Description	Estimated capital costs, EUR	Yearly energy consumption, kW	Expected yearly energy saving, kW
Installation of reactive power compensators	30,000	1,714,500	51,435
Replacement of cable at PS 8 on Eliberarii str.	5,000	28,005	13,416
Optimization of hydraulic conditions of water distribution network, reduction of pressure by 1 bar. Expected losses reduction 11,5%	50,000	65,922	65,922
Replacement of power cables at wellfield Mitoc-1	50,000	157,560	57,288
Installation of low energy consuming lamps in the office and pumping stations	20,000	81,715.2	20,429

It was found that most of proposed ECMs are focused on Apa Canal Orhei operation reliability/sustainability strengthening, such as cables and reactive power compensators replacement. These measures will not bring to any sensible savings of energy.

One initially proposed ECM of low energy consuming lamps is included in our report.

We do not propose any ECM for replacement of pumping equipment, since all Orhei water/sewage pumping stations have been reequipped with new and considerably efficient pumps. Our measurements showed that existing pumps operate within good or accepTab. efficiency ranges.

Optimization of hydraulic conditions of water anticipates installation of pressure reducing valves (PRV) on Orhei water supply distribution network in order to reduce pressure in low located areas. We believe that this measure will bring to reduction of leaks. Detailed analysis of installation places, PRV sizes and savings has not been performed in this study.

However, the Consultant expects that the proposed SCADA system will allow a better analysis of hydraulic network and will help in network optimization, including installation of PRVs.