Infrastructure Projects Facility in the Western Balkans

TA-MON-05/07
Podgorica Water and Wastewater Development Project

Project Preparation Study

Final Report
April 2011

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1 Introduction

1.1 Study Background

This feasibility study has been undertaken under the auspices of the European Union funded Infrastructure Projects Facility in the Western Balkans for which WYG International is the appointed consultant. The study commenced on 27th July 2009.

The Municipality of Podgorica has the largest population and the second largest territory in Montenegro. The City of Podgorica is the administrative centre of the Municipality and capital of Montenegro. The City has a population of approximately 185,000 based on official data, although the actual population may exceed 200,000.

The project concerns rehabilitation and expansion of water and wastewater infrastructure in the City of Podgorica. The water supply and waste water services suffer from long term lack of investment. Facilities are therefore inadequate for a modern growing city. A programme of investments totalling about €93m has been proposed by the ViK, to be funded from various sources including the beneficiary, the City of Podgorica, and IFIs. The Project identified under this Study is expected to utilise financing provided by the EIB under a loan agreement to be negotiated. It is expected that the Project may also receive financing from other sources including both loans and grants.

The water supply suffers from low-pressure in certain area and there is a shortage of service reservoirs within the City. ViK has proposed a priority project to provide for a new 20,000 m3 reservoir sited at the top of Ljubovic hill within the City of Podgorica.

A number of studies and projects are currently under progress to improve operating conditions for the ViK. These include leakage studies, installation of meters, billing and collection improvements, replacement of distribution mains plus Mareza and other source developments.

The existing wastewater treatment plant (WWTP) has a capacity of 60,000 population equivalent (pe), while there are approximately 180,000 people living or working in Podgorica plus industries and institutions. Only around 55% of the urban population is connected to a sewerage network. The plant provides primary treatment and biological BOD removal to about 65% of the received flow, and mechanical treatment to the remaining 35% before effluent is discharged to the Moraća river. At times of high

wastewater flows some flow bypasses the treatment plant and is discharged to the Moraća river without any treatment. There are substantial negative environmental impacts downstream affecting Skadar Lake, water supply resources, and the coastal tourist industry.

The existing plant is on the right bank of the Moraća river adjacent to an area of ongoing urban development on potentially high value real estate. The commercial value of the current site which belongs to the City of Podgorica, if decommissioned and decontaminated, may be substantial. The expansion of the existing plant was rejected on the grounds that it will be soon be surrounded by the residential developments of the City. The Feasibility Study completed in 2004 recommended construction of a new wastewater treatment plant on the left bank of the river about 1.3km downstream from the current site. The site is owned by the Municipality and is reserved for the new WWTP. The site is undeveloped, and is located adjacent to an aluminium factory in the proposed industrial park.

1.2 Objectives of the Project

The objectives are to provide a significant positive public health impact through improved quantity and reliability of water supply and collection and treatment of wastewater in the City of Podgorica, to contribute to meeting Montenegro's future needs for compliance with EU and national environmental legislation, and to safeguard potable water resources and environmental quality for areas downstream under the influence of the Moraća river.

These objectives are intended to benefit the city of Podgorica and enable the economic development of regions downstream based upon a growing tourist industry with improved water resources. They will substantially reverse water quality deterioration and environmental degradation of economically and ecologically valuable tourist areas along the downstream reaches of the Moraća river, Lake Skarda National Park (Ramsar listed), and the coastline adjoining the lake outlet, with attendant cross border issues affecting neighbouring Albania.

1.3 Study Approach

The Terms of Reference for this Feasibility Study can be summarised as follows:

- Assess the existing infrastructure conditions,
- Assess the operational and financial performance of the ViK,
- Make realistic projections of demand, future requirements, and their costs
- Undertake the environmental review of present situation and highlight the threats posed to the environmental resources and assess the environmental benefits of the proposed investments
- Prioritise investments, and phase as necessary to ensure affordability of services
- Propose a prioritised investment project that is within the financial capacity of the Vodavod and Municipality to service.
- Recommend a cost recovery strategy to ensure long term sustainability of operations of ViK.

1.4 Structure of Report

The structure of the report follows closely the Terms of Reference, and includes the following Sections:

1. Introduction describing the background to the overall project and to the preparation of this report
2. Geographical, Socio economic and administrative background
3. Assessment of the water supply and wastewater infrastructure, service levels and operational and financial performance.
4. Environmental review of existing situation
5. Financial status of ViK
6. Long-term development needs.
7. Prioritisation and development options
8. Financial appraisal
9. Economic analysis
10. Environmental review of proposed project
11. Description of the recommended project
12. Implementation arrangements

1.5 Acknowledgements

The consultant's team would like to acknowledge the considerable assistance, advice and guidance provided by the ViK, the Municipality and various government agencies during the preparation of this Study.

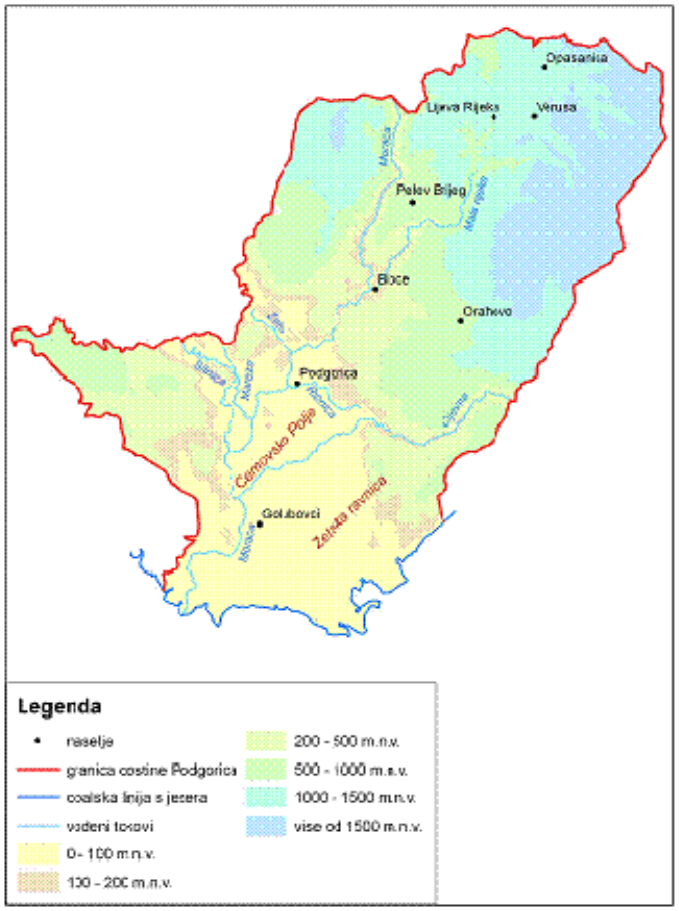
2 Background

2.1 Location, physical and climatic background

2.1.1 General

The Municipality of Podgorica has the largest population and the second largest territory (after Niksic). It covers an area of 1.441km2, i.e. 10.7 % of Montenegro territory, and based on the 2003 census, had a population of 168.812 residents, living in 50.912 households.

The town of Podgorica is the administrative centre of the Municipality and capital of Montenegro. It is an administrative, trade, educational, cultural, health and social centre of the state. It is situated 44.5m a.s.l. in the north of the Zeta plain, in near vicinity with hills and mountains. The geographical coordinates are 42° 26' of north latitude and 19° 16' of east longitude.



For the most part, Podgorica lies on the fluvioglacial terraces of Moraca river and its left affluent Ribnica, between Malo hill (205m a.s.l.) and Gorica hill (131m a.s.l.). Besides these, limestone elevations emerge from the Moraca river terraces: Krusevac in the east and Ljubovic in the west.

Podgorica has a favourable geographic position. It is positioned in a valley with five rivers – Moraca, Zeta, Cijevna, Sitnica and Ribnica and is an important and central crossroad in rail, airport and road transport. It is situated in the middle of Montenegro, between coastal and mountain areas, in the corridor of most important touristic routes. Podgorica is connected with the coast by the main road only 54 km long, and the nearest ski centre is in Kolasin, only 70 km away. The north and south of Montenegro are also connected with the Belgrade-Bar railway that passes through Podgorica. Podgorica airport is 12 km away from the city and is connected to airports abroad. Traffic from this airport and Tivat airport, which is 75 km away from Podgorica, is the main method of tourist travel.

Podgorica is an industrial centre that many companies operate from: Aluminium plant, tobacco industry “Duvanski kombinat”, chemical industry “19 Decembar”, “Elastik”, textile industry “Titeks“, pharmaceutical industry “Hemomont” and “Galenika”, food industries “Inpek”, “Mljekara”, “Agrokombinat”,and “Plantaže”.

The land is very fertile and around 70.000 ha of the land are used for farming purposes, offering good potential for food production.

2.1.2 Climate

The climate of Podgorica is influenced by the Adriatic Sea. This influence comes through the valley of Bojana River and Skadar Lake. Influenced by the surrounding mountains, the Mediterranean climate changes to altered-Mediterranean climate, characterised by dry and hot summers and mild rainy winters. Due to the thermal influences of the Adriatic Sea, Podgorica has high winter air temperatures. Winters are mild with few frosts, while summers are hot and dry.

The average annual temperature in Podgorica is 16.4ºC, and the maximum and minimum temperatures are 40.7ºC and –4.6ºC respectively. Monthly maximum and minimum temperatures as well as the variation range are shown in the Figure below.

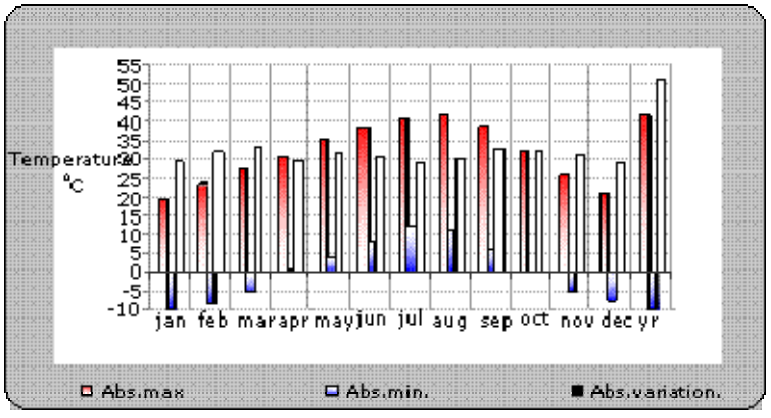


Figure 2.1: Monthly air temperatures in Podgorica (1961 2000)

The maritime influence of the sea results in autumn being 2.1°C warmer than the spring. The transition from winter to summer is milder than the transition from summer to winter.

The average relative air humidity is 63.6%, with a maximum of 77.2% in November and a minimum of 49.4% in July. The average annual amount of sunlight exposure is 2,456 hours, i.e. 56.1% of potential sunlight exposure. July is the month with most sunlight of 344.1 hour (74.0% of potential), while December is the month with least sunlight of 93 hours (34.9°% of potential).

The average annual precipitation is 1,692mm, with the maximum of 248.4 mm in November and the minimum of 42.0 mm in July. The variation of precipitation through the year is shown in Figure 2.2.

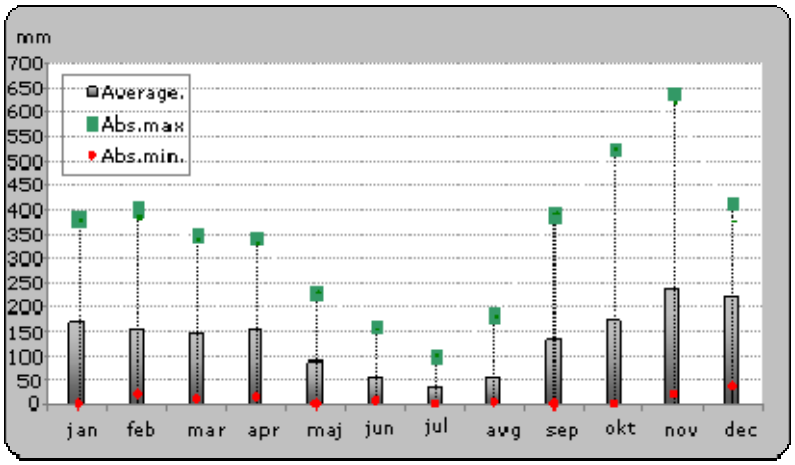
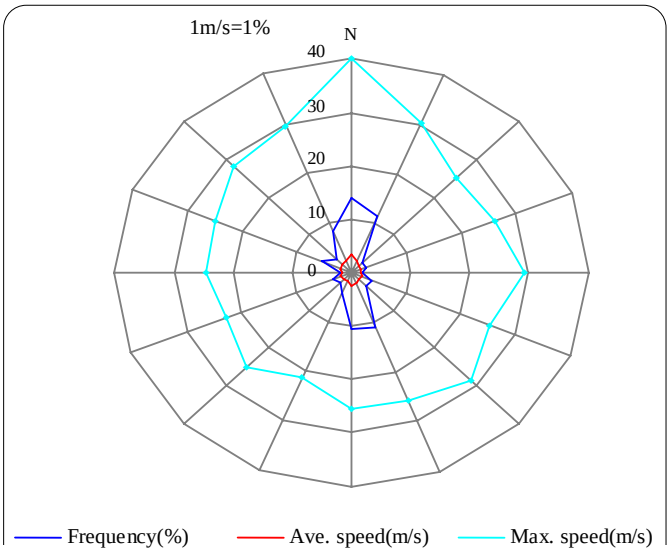


Figure 2.2 Monthly precipitation distribution (1961 – 2000)

It can snow between November and March but the snow rarely lasts more than one day.



The annual wind frequency (%), average and maximum wind speed for Podgorica (1985-1999) is shown on the Figure opposite. The most frequent wind blows from the north and the least frequent is an easterly wind. Northerly winds are most frequent in the summer and least frequent in the spring. The maximum wind speed of 34.8m/sec is recorded for a northerly wind. Strong winds are most frequent in winter with an average of 20.8 days, and least frequent in summer with an average of 10.8 days.

Figure 2.3: Wind rose for Podgorica

2.1.3 Hydrography and Hydrology

The Moraca and Ribnica rivers, which represent the most significant water flows for the city, are characterised by deep river beds of the canyon type and banks from 15m (Ribnica) to 18 m (Moraca) high. They are characterised by significant erosion activity manifested by a series of caverns of various sizes made by the rivers.

The Moraca is the principal river and receives flow from its tributaries Ribnica, Cijevna, Matica, Zeta and Sitnica. The Municipal territory also includes the upstream parts of Tara River.

In the summer the water throughput of all rivers drops drastically, and in extremely dry years most of water flows, even for the Moraca, dry out in the downstream parts.

Terrains with the following hydro-geological characteristics can be distinguished in the area of the Podgorica Municipality:

- Low water bearing terrains (hydro-geological insulators)
- Medium and interchangeable water bearing terrains
- Water bearing terrains

The lower areas of the Gorica hill belongs to water bearing terrains with limestone surfaces that represent crevices and cavernous porosity. Precipitation sinks quickly through crevices leaving the surface safe from flooding.

2.2 Economic development

2.2.1 GDP and consumer prices

Following the economic downturn of the 1990's, Montenegrin GDP nearly tripled in the period 2000 – 2008. High GDP growth rates of 8.6 and 10.7% in 2006 and 2007 (see Table 2.1) placed the Montenegrin economy among the fastest growing economies in the world. With the escalation of the global economic crisis and due to a number of internal imbalances, the growth slowed down in the second half of 2008 and the economy went into recession in 2009. According to Ministry of Finance estimates, GDP fell by 3.5% in the first half of 2009.

Table 2.1: Montenegrin GDP 2000 – 2008

	2000	2001	2002	2003	2004	2005	2006	2007	2008*
GDP (current prices, mill EUR)	1065.7	1295.1	1360.1	1510.1	1669.8	1815	2148.9	2807.9	3085.6
Per capita GDP (EUR)	1786	2113	2208	2435	2684	2912	3443	4484	4908
GDP growth rate, constant prices (%)	-	1.1	1.9	2.5	4.4	4.2	8.6	10.7	6.9

* Monstat's preliminary data

Services (including tourism) are dominant economic sector, whereas industry and manufacturing sectors focus on a small number of products, most notably aluminium and electricity.

GDP structure in the last few years shows an increased contribution of services (from around 72% of GDP in 2005 to 77% in 2008) at the expanse of agriculture and industry. In 2008, services accounted for 77.2% of GDP, while agriculture and industry contributed with 9.3 and 13.5% respectively.

Table 2.2: GDP structure in 2008

Sector	Amount (in '000 EUR)	Share (%)
Agriculture, forestry, fisheries	230,499	9.31
Mining and quarrying	37,438	1.51
Manufacturing	166,471	6.72
Electricity, gas, water	129,104	5.21
Construction	190,750	7.70
Trade	382,416	15.44
Hotels and restaurants	132,751	5.36
Transport, storage and communications	288,887	11.66
Financial services	119,590	4.83
Real estate	251,445	10.15
Public administration, defense	269,118	10.87
Education	116,357	4.70
Health and social work	109,671	4.43
Other communal, social etc. services	52,095	2.10
Total	*2,476,592*	*100.00*
Taxes on products less subsidies	609,029	
GDP (market prices)	**3,085,621**	

Source: Monstat

Tourism was one of the main driving forces behind recent economic growth, with the number of foreign tourists growing by more than 45% in 2005 and 2006, and by almost 55% in 2007. In 2008, close to 1.2 million tourists visited Montenegro and around 7.8 million of overnight stays were recorded. A high growth rate between 2007 and 2008 was also recorded for construction, where the total value of performed works increased by more than 45% (from app. 198 million euros in 2007 to 288 million in 2008). Total industrial production fell by 2%, mainly due to shrinking of the manufacturing sector (a decrease of 11% in 2008 compared to 2007).

In the period prior to 2008, changes in consumer prices were measured through retail prices and living costs indices. In 2008, Monstat introduced Consumer Price Index (CPI) as a sole measure of inflation.

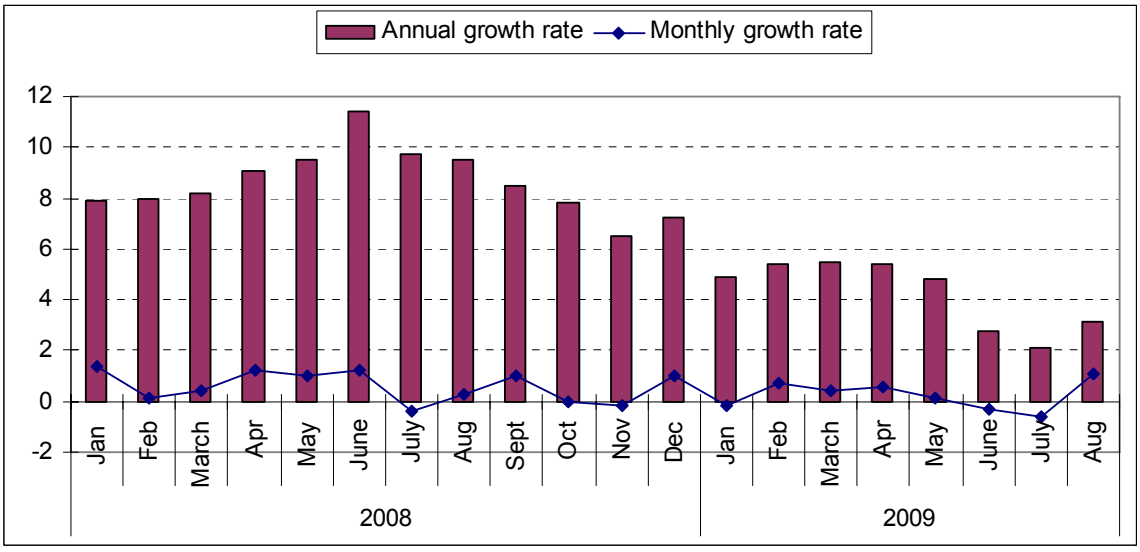
Indices presented in the Table 2.3 show that the most substantial increases in retail prices and living costs in the period 2003 – 2007 were linked to services i.e. to energy and housing (including rents and communal expanses) costs.

Table 2.3: Retail prices and costs of living indices 2003 – 2007 (2006=100)

	2003	2004	2005	2006	2007
Retail prices					
Total	*91.6*	*94.7*	*97.9*	*100.0*	*104.2*
Goods	94.2	96.5	97.8	100.0	104.2
Services	80.9	87.5	98.5	100.0	104.3
Living costs					
Total	*92.6*	*95.0*	*97.1*	*100.0*	*104.2*
Food	95.0	96.0	95.7	100.0	104.4
Tobacco and beverages	93.8	94.3	98.8	100.0	100.6
Clothing and footwear	91.5	96.8	99.0	100.0	101.9
Housing	89.9	96.3	98.5	100.0	104.0
Electricity and fuel	94.9	99.2	99.3	100.0	114.4
Household furnishings	97.8	99.1	99.4	100.0	101.3
Hygiene and health care	96.6	98.8	99.6	100.0	101.1
Culture and entertainment	93.1	98.2	98.8	100.0	102.5
Transport and communication	88.2	73.1	96.2	100.0	103.8

Source: Monstat

The 2008 annual inflation rate (measured by CPI) was 6.9%. The average annual rate of consumer prices recorded a growth of 7.4% in the same year. In the first eight months of 2009, inflation rate measured by CPI was 1.7%. Annual inflation amounted to 3.1%, whereas average inflation rate for the eight months (period to period) was 4.2%. Consumer prices growth in 2008 and for the first eight months of 2009 is depicted in the Figure 2.4 below.



Source: Central Bank of Montenegro

Figure 2.4: Consumer prices: annual and monthly growth rates January 2008 through August 2009

2.2.2 Employment and unemployment

The number of employed persons has been steadily increasing over the last five years, halving the number of unemployed - from around 65,000 in 2004 to below 30,000 in 2008. The trend continued in 2009, despite the economic crisis, with 26,844 recorded unemployed persons in August 2009.

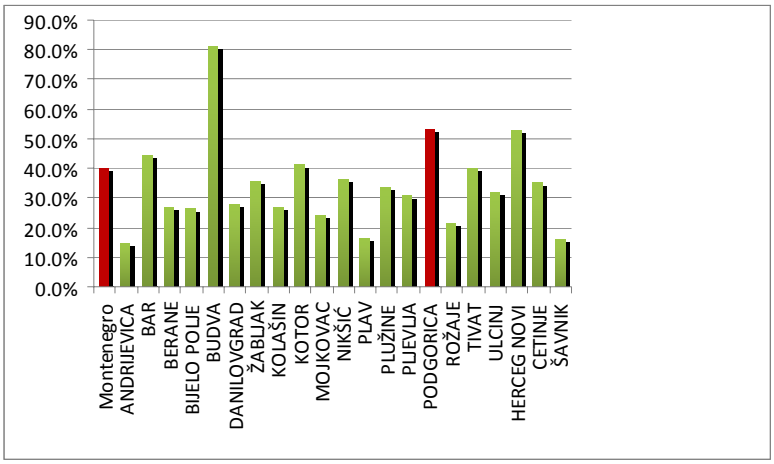
Table 2.4: Key employment figures 2004 – 2008

Year	No of people, national level		Podgorica		Wages, national level	
	Employed	Unemployed	No of employed	Share in nat. empl.	Gross wage (EUR)	Net wage (EUR)
2004	143,479	65,064	52,244	36%	303	195
2005	144,358	54,457	-	-	327	213
2006	150,800	43,190	53,103	35%	433	282
2007	156,408	34,396	56,118	36%	497	338
2008	166,221	29,535	61,032	37%	609	416

Source: Monstat

Between 35 and 37% of all the national level employment is recorded in Podgorica municipality, where a similar trend of increase in the total number of employed persons has been exhibited during the last years (see Table 2.4 above)

The figure illustrates the relative importance of Podgorica in terms of employment generation for the economically active population (15-64 years)



The key employment sectors for Podgorica (much like for Montenegro as a whole) include public administration, trade and manufacturing industries.

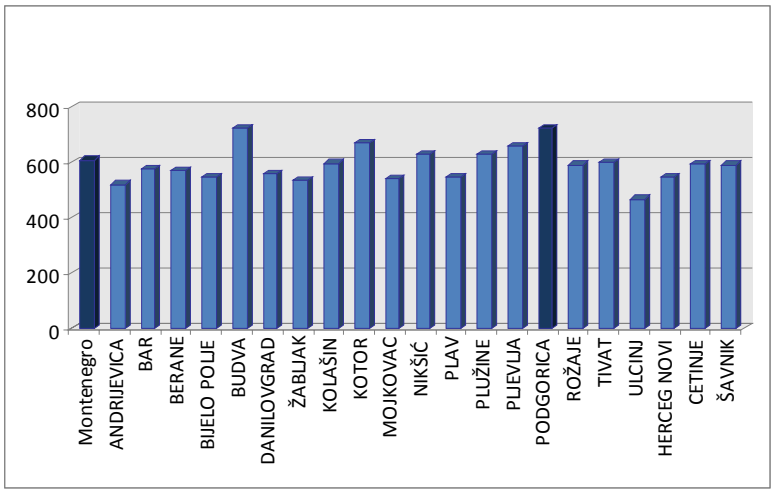
Other significant sectors are transport, storage and communications, communal and other services, as well as public sector services such as education, health and social security.

2.2.3 Income levels

In the period 2004 – 2008, average salary in Montenegro doubled, reaching EUR 600 per month in 2008.

The highest average salaries at the end of 2008 were recorded for the Municipality of Podgorica followed closely by the Municipality of Budva, host to one of most sought after international tourist destinations in the world. Nevertheless, the distribution of wage levels in the country does not show a greatly disparity. The variations are within the accepted norms which demonstrates relatively evenly balanced economic opportunities within the country

Figure 2.5: Average Wages by Municipalities - 2008



Source: Monstat Monthly Statistical Review

According to the Monstat household consumption survey, the average monthly disposable income per household for Podgorica (based on a sample of 434 households), was EUR 652 in 2008. The key sources of household income were wages/ other personal earnings (around 62% of the total) and pensions (24%). Social security benefits added slightly more than 1%, while income from agricultural activities, small businesses and property totalled around 2%. Another 2% in household income structure came from gifts and gains, while the remaining share of total disposable income was attributed to other sources.

Table 2.6: Structure of household income in Podgorica in 2008

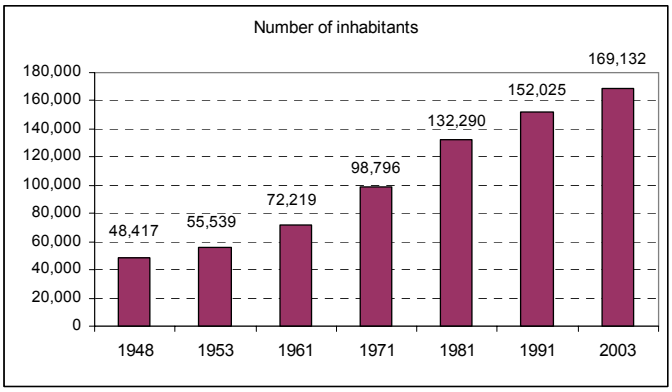
Income/ consumption categories	EUR
Wages and other earnings	402
Pensions	155
Social security benefits	7
Income from agriculture	8
Income from small businesses	1
In-kind income	0
Income from property	6
Gifts and gains	12
Other available resources	61
Total disposable income	**652**

Source :Monstat Household Consumption Survey

2.3 Socio economic characteristics of Podgorica

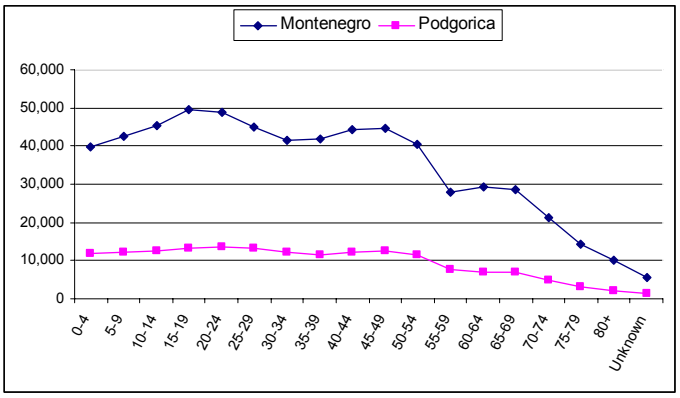
An increase of 3.5 times in the number of inhabitants of Montenegrin capital was recorded over the second half the XX century (as illustrated in the Figure 2.6). The share in total Montenegrin population thus increased from 12.8% in 1948 to 27.3% in 2003. According to Monstat mid-year population estimates, Podgorica's population stood at 176,569 in 2007. Average annual population growth rate for the period 1948 – 2003 was 2.26%. Population growth slowed down during the 1990s and 2000s. During the last five years, there were between 14 – 16 live births per 1,000 inhabitants. At the same time, natural increase rates varied around 6 – 8 per 1,000 inhabitants.

Figure 2.6: Podgorica's population, censuses 1948 - 2003



Podgorica population is evenly distributed by five-year age groups, whereas numbers of persons vary between 11,500 and 13,700 for all the brackets up to the age of 54 (peak number is for the category 20 – 24 years). Numbers fall significantly after the age of 55 and are maintained at the level of around 7,000 per age group until 69 years, where there is a further sharp decline. Life expectancy at the national level is 72 years.

Figure 2.7: Distribution of population by age groups



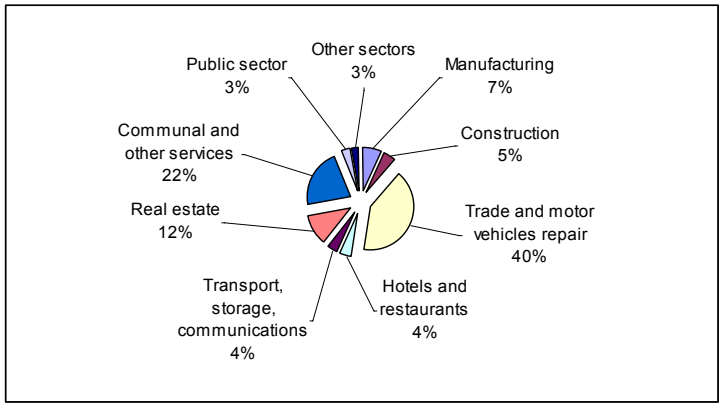
The population density in 2003 was 117 per km^2. The number of households grew faster than the total population in Podgorica (an increase of 4.4 times) between 1948 and 2003, and average number of persons per household decreased from 4.4 in 1948 to 3.5 in 2003. Another demographic indicator that changed significantly during the last couple of decades was urban - rural population ratio. For example, urban population in Podgorica municipality increased from 79.4% in 1991 to 82.9% in 2003.

A total number of 53,665 housing units was recorded in Podgorica at 2003 census with the total surface of 3,749,838 m2 of space (average surface of 70 m2 per housing unit), against 48,416 households. Average surface of the dwelling per household member was 20m^2. Out of the total number of units at 2003 census, 99.7% had electrical installations, 92.7% had plumbing (water supply) while 89% had bathrooms (11% were fitted with other types of sanitary facilities). Close to 98% of all the housing units were privately owned. During the last five years (2004 – 2008), an additional stock of 4,589 units was built with the total surface of 318,440 m^2. The total recorded housing stock in Podgorica municipality in 2008 is thus 58,254, which surpasses the estimated number of 52,245 households .

According to available data (2003 census), the largest employer in Podgorica was public administration with more than 17% of all employment, followed by trade (16%) and manufacturing (15%). Transport, storage and communications employed around 9%, while between 6 and 8% of employed persons were working in health and social security, education and communal/ other services sectors. Real estate, hotels and catering, construction and agriculture accounted for less than 5% of total employment each. Public sector (administration, health, education and social security) thus accounts for close to 1/3 of all employment in the municipality (29% according to 2003 census data). Comparison with more recent data for the national level indicates that there were no major changes in the structure of employment over the course of the last five years, so the above figures may be taken as representative of the current state of the affairs.

When economic activity is analysed by the number of registered economic units (enterprises, institutions, etc.), the largest sectors are trade (40% of the total of 11,781 registered units), communal and other services (22%) and real estate (12%). These three sectors make up nearly ¾ (around 8,700 of economic units) of all the registered enterprises, while the combined share of employment in these sectors is slightly over ¼ (26.5%).

Figure 2.8: Registered economic activity by sector in 2007



Source: Monstat

This means that the majority of economic units in these sectors refer to small and medium sized enterprises (SMEs) with low number of employees. Except for the Aluminium Plant, the largest single employer in Podgorica, SMEs are also dominating in the manufacturing sector that accounts for 7% of all the registered units. Almost 1/3 of employment in the public sector is however matched by a low number of organisational units – different institutions in public administration, health and social security, and education account just for 3% of the total number of registered economic units in Podgorica.

At the end of the 2007/ 2008 school year, there were 53 regular primary schools and 11 secondary schools in Podgorica municipality. Furthermore, Podgorica is a university centre with a large number of faculties of the state University and two private Universities. Public health institutions include Clinical Centre of Montenegro, Health Centre Podgorica (with several branches throughout the municipality) and the Public Health Institute.

2.4 Administration and institutional arrangements

2.4.1 National Framework

The main competence of water management is with the Ministry of Agriculture, Forestry and Water Management; executive water management tasks are assigned to Water Administration.

The Water Law (Official Gazette of the RM No 27/07) regulates status and the ways for managing all types of water, water resources and objects, as well as other matters of

relevance for water resources management. The Law prescribes integrated river basin management, establishment of water information system, sustainable development, long-term protection of water quality, economic water pricing in line with the 'user/ polluter pays' principle etc. The Law is partly harmonised with the Water Framework Directive 2000/60/EC (WFD). Further transposition of the EU water legislation is addressed/ planned through adoption of bylaws (around 20 envisaged under the Water Law, some of which have already been adopted).

In Montenegro, water and wastewater services are decentralized to the municipal level, but utilities and their services are regulated by a number of laws. Water and sewage utilities in Montenegro are public utilities founded by their respective municipalities to provide water supply and wastewater services to the population in the service area. They are called "ViK i Kanalizacija" (VIK). The current legislation specifies that the local self-government unit decides on general terms for the use, preservation and maintenance of the utility assets, determines the manner and conditions for the organization of the activities, and supervises and controls the utility. All water and sewage utilities have a board, comprising three representatives from the municipality and two from the utility. The Management Board appoints the management with the approval of the municipal assembly, takes decisions on the business development of the utility and on new tariffs.

Utilities are responsible for the management, operation and maintenance of water supply and sewage infrastructure. Ownership of the assets remains with the municipality. The enterprise is financially and legally independent; however, it has to operate on a cost-covering basis. The municipality, though the owner of the enterprise, has no obligations to cover any losses through municipal operating subsidies. However, municipalities have the obligation to finance capital investments for new facilities and system expansion.

The water sector faces enormous investment needs due to large cost of developing drinking water and wastewater infrastructure, including water treatment, distribution, transmission, and storage systems as well as sewer collection networks and treatment facilities. At the same time, asset decrease strongly relates to weakening economic and financial performance.

As a result of high regulation and dominantly public ownership, water and sewage companies often rely on mature and often traditional designs that are operationally risk free and approved by regulatory bodies. They are typically slow to innovate and continuously seeking for affordable sources of investment finance. Private sector participation and commercial financing can bring new managerial know-how, tap new sources of investment funding, help to trigger innovation and increase efficiency.

Water and Sewage companies operate in a very specific environment. Regulation is a defining element of water supply and wastewater systems and the capital requirements for regulatory compliance have been substantial. The high degree of regulation stems from the essential importance of drinking water and wastewater systems: they protect the public from waterborne diseases, help to preserve water quality and support economic growth.

2.4.2 Legislative and Regulatory Framework

Regulatory framework pertinent to the development and operation of water supply and wastewater disposal systems in Montenegro is a complex one, and is being increasingly aligned with relevant EU legislation as the country progresses with its accession agenda.

Local level/ municipal administrations i.e. public utility companies that are established and owned by municipalities are responsible for provision of drinking water and collection/ disposal of wastewater. The key piece of legislation that regulates operation

of public utilities is the 1995 Law on Communal Services (Official Gazette of the Republic of Montenegro 12/95). Legal basis for participation of private sector in public utilities is the Law on Private Sector Participation in Delivery of Public Services (Official Gazette of Montenegro 31/02).

2.4.3 Water and Wastewater Company in Podgorica

The Podgorica Water and Sewer Company is a public enterprise owned by the Capital City of Podgorica. It serves approximately 140,000 customers in Podgorica and the districts of Zeta and Tuzi, and has plans to connect an additional 20,000 clients in the next five years.

PE ViK Podgorica was assigned to perform the following communal activities of public interest:

- Supplying Podgorica, town of Tuzi and upper Zeta settlements with potable water,
- Maintaining water supply system in the rural areas of the capital city of Podgorica,
- Collecting and treating wastewaters from the sewage system of the Podgorica GUP area,
- Maintaining the system for collection and evacuation of storm waters.

Besides these, ViK also performs additional activities in order to increase effectiveness of capacity utilisation:

- Construction of hydro-technical facilities for primary and secondary water supply and sewage networks,
- Preparing of technical documentation in the field of hydrotechnics,
- Construction of water supply and sewage connections,
- Repair and calibration of water meters

Below the Director, the staff are divided into four units:

- Technical Department
- Department for Maintenance and Construction
- Department for Economical and Financial Affairs
- Department for Legal and General Affairs

The Management Board appoints the management with the approval of the municipal assembly, takes decisions on the business development of the utility and on new tariffs.

The Regulation on staff structure defines 157 work positions and determines the theoretical necessary number of employees in the Company as 377.

The total current staff complement of 371 is organised as indicated below. Despite the planned expansion of the systems there are plans to reduce the number of staff by 20 to 30 in the next few years

Staff organisation chart

Total planned complement	377
Total filled positions	371

DIRECTOR OF THE COMPANY

TECHNICAL SECTOR	No of emp.
TOTAL	**148**
Watersupply Service	**41**
Department for network maintenance	31
Laboratory for drinking water	9
Service for Wastewater Network	**24**
Department for waste water network	13
Department for stormwater network	10
Wastewater Treatment Service	**21**
Technical Service	**26**
Department for technical preparation	9
Design department	6
Department for installations cadastre	10
Department for Control and Measurement	**35**
Department for water meters calibration	8
Department for replacement and disconnection of water meters	11
Department for measurement	15

MAINTENANCE & CONSTRUCTION SECTOR	No of emp.
TOTAL	**82**
Service for Investment, Planning and Development	**10**
Department for investment and development	5
Planning department	4
Maintenance Service	**71**
Pumping stations department	25
Department for maintenance of electro-mechanical equipment	13
Department for maintenance of motor vehicles	32

SECTOR FOR ECONOMICAL & FINANCIAL AFFAIRS	No of emp.
TOTAL	**67**
Financial Service	**8**
Accounting Service	**7**
Commercial Service	**16**
IT Service	**15**
Department for maintenance & development of IT system	3
Data processing department	11
Payment Department	**20**
Commercial department	5
Households department	14

SECTOR FOR LEGAL & GENERAL AFFAIRS	No of emp.
TOTAL	**73**
Service for Legal and General Affairs	**27**
Department for legal effairs	4
Department for general affairs	22
Protection Service	**45**
Department for protection of facilities	42
Department for occupational safety	2

3 Assessment of existing infrastructure

3.1 Review of water supply infrastructure and service levels

3.1.1 General

The Public Company ViK i Kanalizacija (ViK) Podgorica is responsible for supplying water to the inhabitants of Podgorica and surrounding areas. The water supply network under ViK's control essentially comprises two systems, one covering the main area of the city and a second covering Tuzi area to the south of the city. Extensions to the southern system has been constructed in the last few years and some are not yet fully commissioned - the system receives some 6 - 7,000 m^3/day from the Podgorica network. Ultimately Tuzi will be fully integrated with the main Podgorica system. Bulk water supplies feed Danilovgrad and Zeta areas.

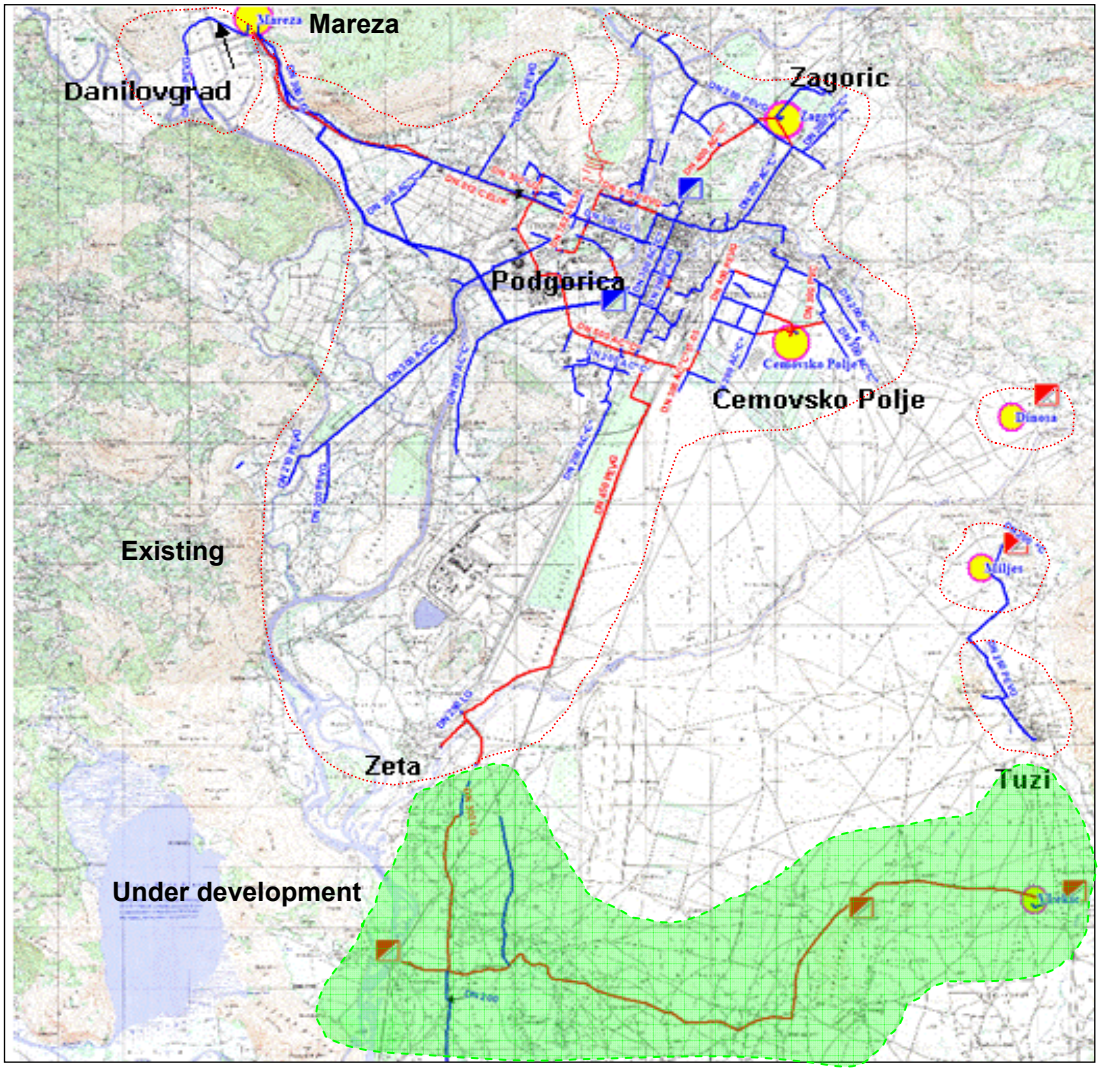


Figure 3.1: Coverage of Existing Water Supply System

Both systems rely on groundwater, either boreholes or natural springs; flow from the springs at Mareza is the principal source and provides approximately 60% of the supply, which is currently 108,000m^3/d. There is minimal reservoir storage within the systems with only one 3,000 m^3 service reservoir.

The reliability of supply is good reflecting the reliability of the power supply. The absence of service reservoirs mean that the effects of a power outage at one or all of the sources will immediately impact the water service particularly on high ground. Data for 2008 shows that power failures average around 7 hours per month and did not affect all the main sources simultaneously.

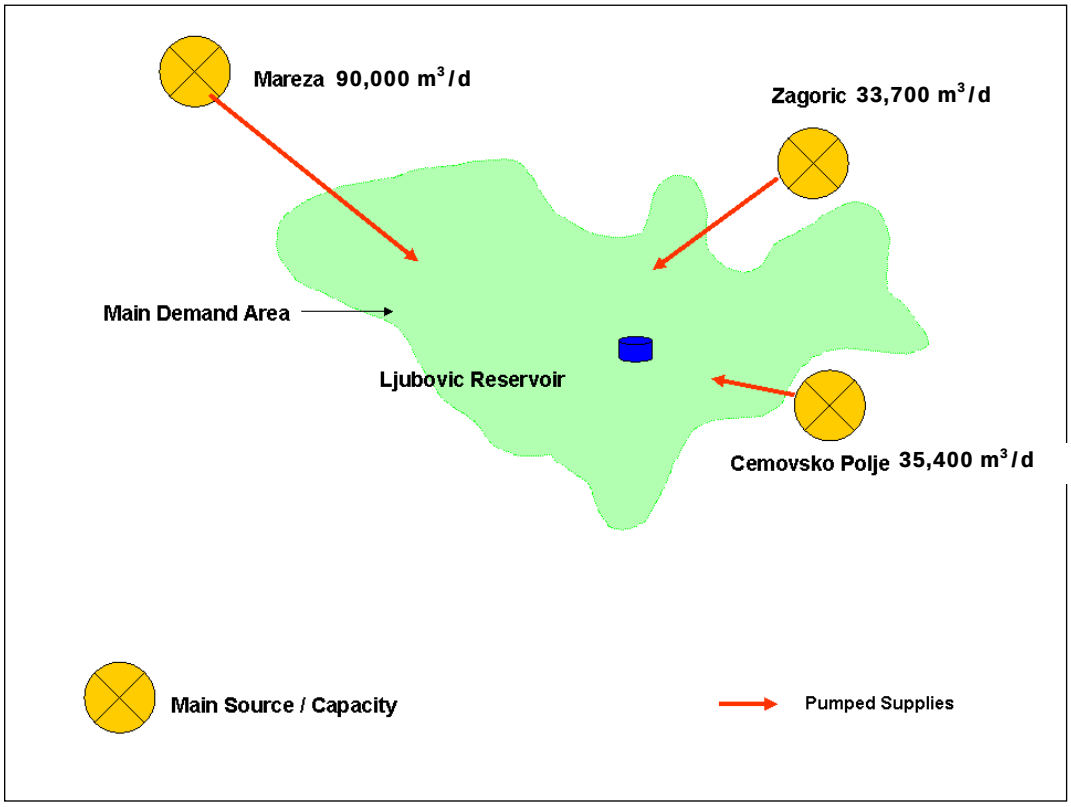


Figure 3.2: Schematic of Main Supply System

3.1.2 Water Resources

Geology plays a major role in the provision of water for Podgorica, with all water obtained from the aquifers beneath the city or natural springs.

The elevated terrain of Podgorica and its surroundings consist of Upper Jurassic carbonate rocks, while the low parts are Quaternary sediments (conglomerates and gravels), 20 to 40 m in thickness. These gravels form the aquifers for the wellfields that provide 40% of ViK's source capacity. Topsoil is generally of sandy clay type, up to 2 m thick.

Numerous cracks and caverns are present in the Upper Jurassic limestone and dolomites, giving rise to a succession of karstic springs which have been captured in the north east of the city to provide the main source of water for Podgorica at Mareza.

The water supply system to Podgorica comprises 3 principal sources and 4 lesser sources:

Table 3.1: Water Sources – Theoretical capacity

Source	Type	Capacity Mm^3/yr (m^3/d)
Mareza (I & II)	Karstic Springs	36.3 (99360)
Zagoric	Boreholes	12.6 (34560)
Cemovsko Polje	Boreholes	12.9 (35420)
Tuzi 3	Boreholes	0.4 (1040)
Miljes	Boreholes	2.5 (6740)
Dinosa	Borehole	0.8 (2250)
Vuksan Lekici	Borehole	0.5 (1300)
Total		66.0 (180670)

The average daily volumes pumped from each of the pump stations for the last 3 years are shown in Table 3.2 together with total average pumped each year.

Table 3.2: Average daily volume pumped 2007 - 2009

Pumping Station	Average pumped, m^3/d		
	2007	2008	2009
Mareza 1	25,065	22,704	15,419
Mareza 2	41,762	42,630	47,237
Zagoric	23,028	22,061	20,354
Cemovsko Polje	17,936	17,912	21,343
Tuzi 3	891	1,123	1,033
Miljes	4,420	3,623	2,490
Dinosa	0	2	83
Vuksan Lekici	0	0	0
Total	**113,102**	**110,055**	**107,959**

The recorded maximum amount pumped is 144,451 m^3/d.

Records show that generally there is more than adequate water available at each source for the production facilities constructed. The reliable yield of the Mareza source is believed to be in excess of 50 Mm^3/yr. However, the Cemovsko Polje wells suffer from low water table levels during some dry seasons. Plans exist to investigate the possibility of expanding the source at Dinosa, with a view to releasing a further 6.3 Mm^3/yr (17,280 m^3/d).

Abstraction rights are granted by the Ministry of Agriculture, Forestry and Water Management (the body in charge for this is Water Management). ViK Podgorica has annual rights and every year these rights are extended.

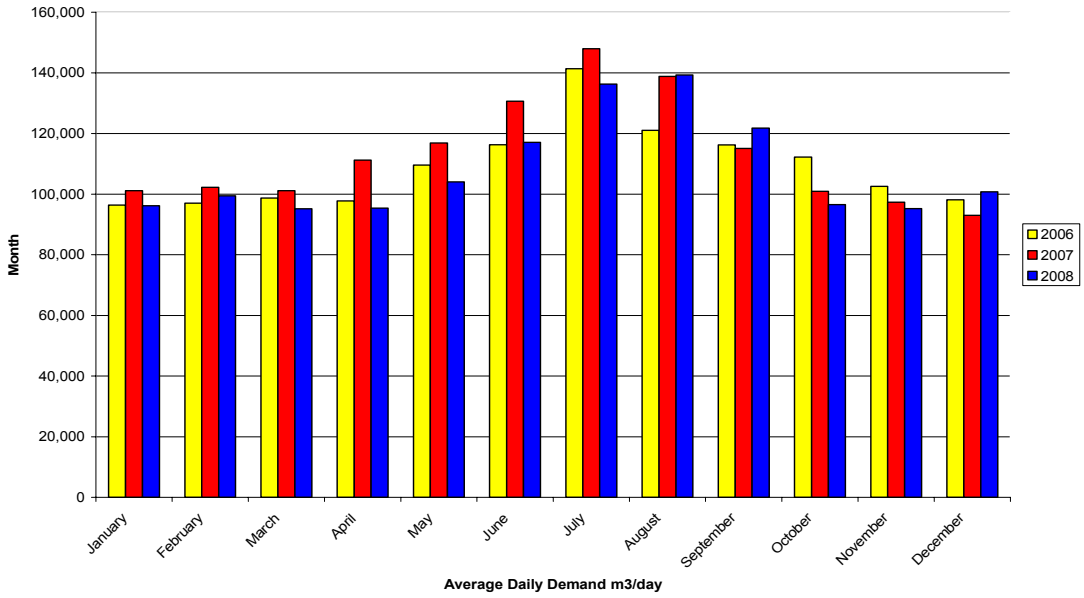


Figure 3.3: Monthly Production – Daily Averages 2006 - 2008

Data for the years 2006 – 2008 shows a fairly repeated pattern with a very distinct increase during the summer months, due to the increased use of water for horticultural (and probably agricultural) use.

(a) Mareza

The water source at Mareza comprises natural springs delivering water to Podgorica and Danilovgrad since 1950. The yield of the source is unknown, but is believed to be around 147,000 m^3/d; this based upon anecdotal evidence, as there are no reports confirming this. The installed plant capacity for Podgorica can be fully used at times during the summer period, while for Danilovgrad only 4,300 m^3/d or so are used out of the installed capacity of 8640 m^3/d. Remodelling of both Old and New pumping stations is in hand to bring the installed pump capacity to 129,600 m^3/d, and to capture a fourth spring.

Mareza source is the largest captured karst vauclusian springs in Montenegro. The source manifests itself through multiple springs, starting with Ljeskovac at the northern end of the spring line. Deep karst accumulations of underground water are drained through the sequence of siphonic and overflow springs. The springs are situated close to Podgorica, but the land mainly belongs to the municipality of Danilovgrad.

Regular testing of the springs confirms their high water quality. The results of a water analysis in December 2010 from Mareza PS are given in Appendix E Some biological analyses have occasionally raised concerns about the protection of the source showing evidence of faecal contamination. Development within the water source protection zone is the likely source of the pollution.

A new Regulation on 'Determination and maintenance of zones and belts of sanitary protection of water sources and limitations in these areas' was adopted in October 2009. The text of this Regulation is included in Appendix B.

Based on regulations, available data on water source regime, performed geological and hydro-geological surveys and observations on terrain and topographic characteristics, three sanitary technical protection zones for Mareza have been defined:

1. **Immediate protection zone (zone 1)** - includes area directly around the source including the ViK facilities, including approach roads and the immediate vicinity of the source. The immediate protection zone is partially fenced in order to control movements, and efforts are being made to maintain the sanitary regime.
2. **Inner protection zone (zone 2)** - includes area within the general vicinity of the source from which surface waters will drain readily to the water source. This area should be marked and under constant supervision. There is some development within the inner protection zone. There is a danger of faecal waters from this settlement reaching the water source through underground channels. To combat this problem it is necessary to ensure that any faecally contaminated waters from the settlement are prevented from reaching the source through protection measures to ensure adequately sanitary conditions are maintained.
3. **Outer protection zone (zone 3)** - has not yet been defined due to the unknown position and area of the source catchment. A recent study recommended that a detailed study of the sanitary-technical protection zones should be prepared, based on suggested surveys and terrain reorganisation, with the application of surveillance and regime as prescribed by the law.

The layout of the main features at Mareza and the location of protection zones 1 and 2 are shown on Figure 3.4 overleaf. The location of settlement areas within protection zone 2 are shown on Figure 3.5.

The Mareza spring is the only for ViK that is located partly outside the territory of the Municipality of Podgorica.

The immediate protection zone 1 includes the territory of both Danilovgrad Municipality and the Municipality of Podgorica. Within the Municipality of Danilovgrad there is 18.6574 ha that belongs to ViK Podgorica and 10.3570 ha that belongs to the Municipality of Danilovgrad. 30.3185 ha of zone 1 is in the Municipality of Podgorica and this land belongs to the Municipality. Pumping stations Mareza I and Mareza II, catchment facilities 'Pod Vrbom' and Velje Oko' are located within the Municipality of Danilovgrad on the land owned by ViK Podgorica. The downstream flow and water source Ljeskovac are in the area belonging to Danilovograd Municipality.

The inner protection zone of the Mareza water source includes an area of 103.80 ha. Land located in the territory of Municipality of Podgorica (see Figure 3.4) is part of the cadastral parcel KO Tolosi 4311 and is owned by ViK Podgorica. The inner protection zone land in Danilovgrad Municipality is partially adopted in other municipalities while its part of the 33.2875 ha is in private ownership.

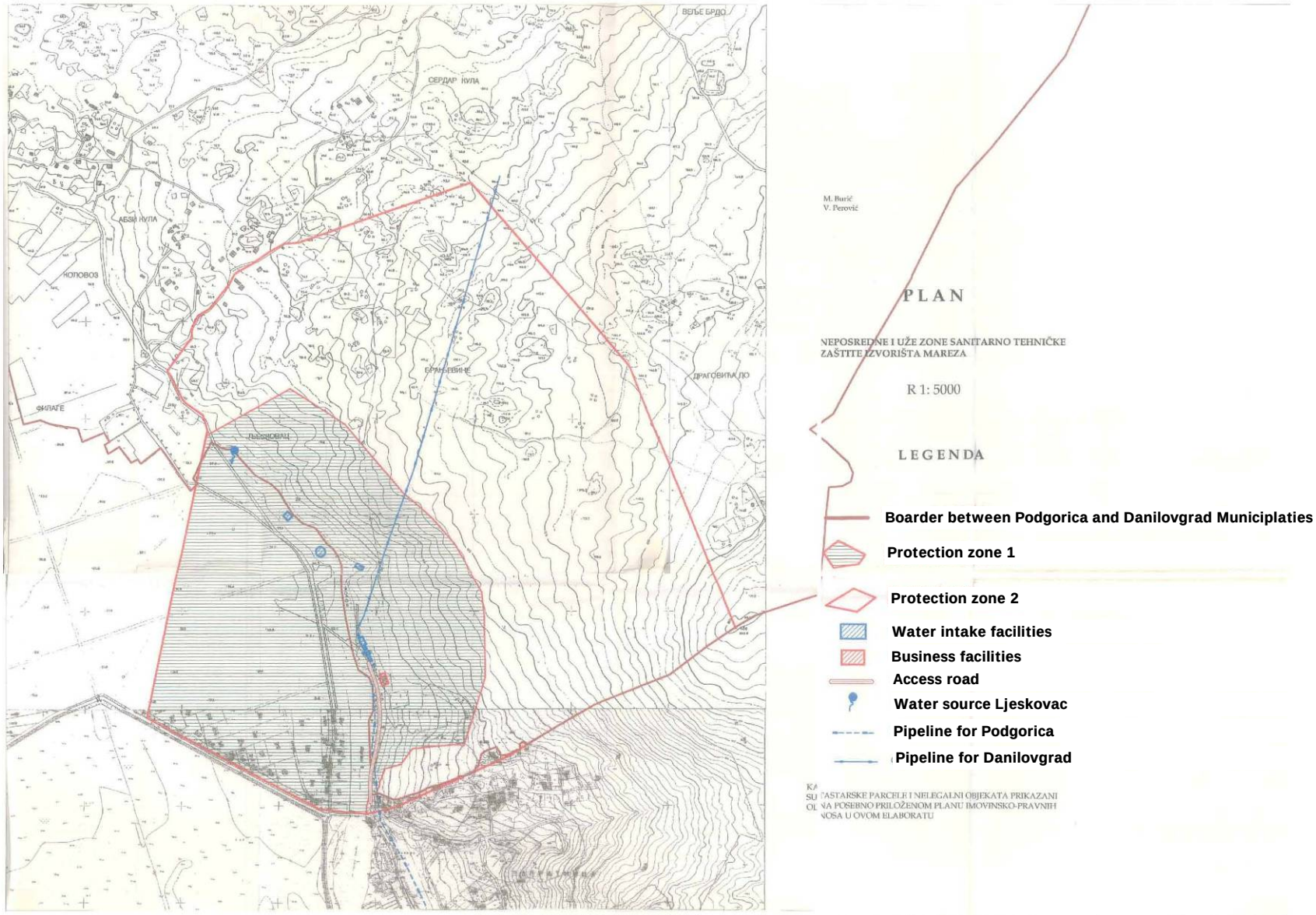


Figure3.4: Mareza protection zones 1 and 2 and general features

Figure 3.5: Areas with development within Mareza protection zone 2

Water levels in the boreholes and monitoring piezometers at Mareza are very stable and, as can be seen in Table 3.3, the maximum variation in level throughout 2009 was 0.90m.

Table 3.3: Absolute groundwater levels at Mareza in 2009, m

Date	Kod Fontane	Stara C.S.	Nova C.S1	Nova C.S2	Izvor "Pod Vrbom"	Izvor "Velje Oko"	Izvor "Oko"
23.02.2009.	32.82	32.82	32.84	32.84	33.14	32.87	32.86
03. 03.2009	33.10	33.11	33.11	33.12	33.14	33.02	33.00
16.03.2009	33.18	33.18	33.18	33.18	33.38	33.22	33.20
23.03.2009	32.80	32.80	32.81	32.81	33.08	32.96	32.96
06.04.2009	33.15	33.15	33.15	33.16	33.32	33.18	33.22
14.04.2009	32.98	32.98	33.00	33.00	33.14	33.02	33.03
27.04.2009	32.81	32.81	32.82	32.82	33.08	33.00	32.99
04.05.2009	32.79	32.78	32.80	32.79	32.96	33.05	32.94
19.05.2009	32.72	32.73	32.73	32.74	32.93	33.03	32.92
04.06.2009	32.42	32.42	32.43	32.43	32.84	32.73	32.73
12.06.2009	32.78	32.78	32.78	32.78	33.00	32.86	32.86
24.06.2009	32.96	32.97	32.96	32.96	33.16	33.02	33.00
10.07.2009.	32.75	32.75	32.76	32.78	33.02	32.89	33.01
22.07.2009.	32.60	32.60	32.61	32.60	33.00	32.86	32.86
05.08.2009.	32.82	32.82	32.83	32.83	33.08	32.98	32.99
17.08.2009	32,54,	32.54	32.56	32.56	33.00	32.91	32.91
24.08.2009.	32.42	32.42	32.42	32.46	32.90	32.70	32.70
01.09.2009	32.51	32.51	32.48	32.50	33.02	32.76	32.90
03.09.2009	32.52	32.52	32.48	32.48	33.02	32.76	32.91
08.09.2009	32.46	32.47	32.46	32.46	32.98	32.73	32.86
15.09.2009	32.71	32.72	32.72	32.72	32.99	32.90	32.99
22.09.2009	32.68	32.68	32.68	32.68	32.98	32.85	32.96
24.09.2009.	32.67	32.67	32.68	32.68	32.98	32.85	32.96
28.09.2009	32.53	32.53	32.53	32.53	32.98	32.86	32.95
30.09.2009	32.58	32.58	32.60	32.60	32.98	32.82	32.94
06.10.2009.	32.70	32.70	32.72	32.72	33.00	32.90	32.92
12.10.2009	32.75	32.75	32.76	32.76	32.94	32.94	32.93
21.10.2009	32.94	32.94	32.94	32.92	33.04	33.04	32.93
28,10,2009	32.99	32.99	32.99	32.99	33.30	33.03	33.03
02.11.2009.	32.83	32.83	32.83	32.83	33.00	33.10	33.08
09.11.2009.	33.28	33.28	33.28	33.28	33.58	33.48	33.60
26,11,2009	32.84	32.84	32.84	32.84	33.10	33.00	33.05
26,11,2009	32.98	32.98	32.98	32.98	33.30	33.18	33.16
08,12,2009	32.94	32.94	32.94	32.96	33.24	33.11	33.12
17,12,2009	33.05	33.05	33.06	33.06	33.41	33.20	33.22
Max	**33.28**	**33.28**	**33.28**	**33.28**	**33.58**	**33.48**	**33.60**
Min	**32.42**	**32.42**	**32.42**	**32.43**	**32.84**	**32.70**	**32.70**
Variation	**0.86**	**0.86**	**0.86**	**0.85**	**0.74**	**0.78**	**0.90**

(b) Ćemovsko Polje

The Cemovsko field is situated within GUP Podgorica and slopes gently from east to west. Cemovsko field forms part of the Zeta Plain that is a collection area for surface and underground waters from the vast watershed of Skadar Lake.

The field, on the north part of the Zeta plain, merges with the Dinosa field in the north east; the Zagoric and Doljane fields in the north; and the Tolosi and Ljeskopolje fields in the northwest and west. Northeast, north and northwest from these peripheral fields the terrain rises rapidly to form hills and ultimately the mountains of southeast Dinarides (Dinaric Alps).

These hills and mountain terrains north, east and west of Podgorica are bounded by deep canyons of the Cijevna, Morača and Zeta rivers and their tributaries. These rivers form the Moraca river catchment that contributes the largest quantities of water to Skadar Lake.

The hydrology of the Cijevna river, which is the most downstream tributary of the Moraca river on its left side, is of importance for the Cemovsko field aquifer. Within its canyon the Cijevna River flows during the entire year, but during the dry period river bed of Cijevna in the Zeta Plain can dry up. Waters from the river percolate immediately after leaving the canyon and feed the aquifer that is the source of the water for the wellfields.

The areas to the west, north and north east of the wellfield are fairly densely populated parts of the city of Podgorica. Less developed are the area south from Ribnica River and east from Moraca river. Population has increased greatly in the last decade. The tendency to expand is stronger in settlements like Stari Aerodrom, Konik, Ribnicka Vrela and further towards Dinosa field. The existing population represents a risk to the aquifer and further population increases with heighten that risk. The results of water analysis from Cemovsko Polje wells 1, 2 and 3 in December 2010 are included in Appendix E.


Cemovsko Polje Control House

The protection zones for Cemovsko Polje are shown on Figure 3.6. The immediate protection zone (zone 1) is owned by ViK Podgorica. The inner and outer protection zones (Zones 2 and 3) are partly owned by Podgorica Municipality and partly in private ownership.

North parts of the Zeta plain, including the Cemovsko field with surrounding terrain are made up of sedimentary rocks, either upper cretaceous or quarternary sediments. Farther bounds of the Cemovsko field are constituted of older Mesozoic rock i.e. Triassic, Jurassic and lower cretaceous sedimentary rocks as well as paleogene flysch sediments.

The field comprises 5 wells, four of which tend to operate more or less continuously with the fifth for peak demands, although during dry periods more than one well may have to be stopped. The variation in water levels in the Cemovsko Polje boreholes and monitoring wells is quite large as can be seen in Table 3.4, where the maximum variation recorded in 2009 was in excess of 16m.

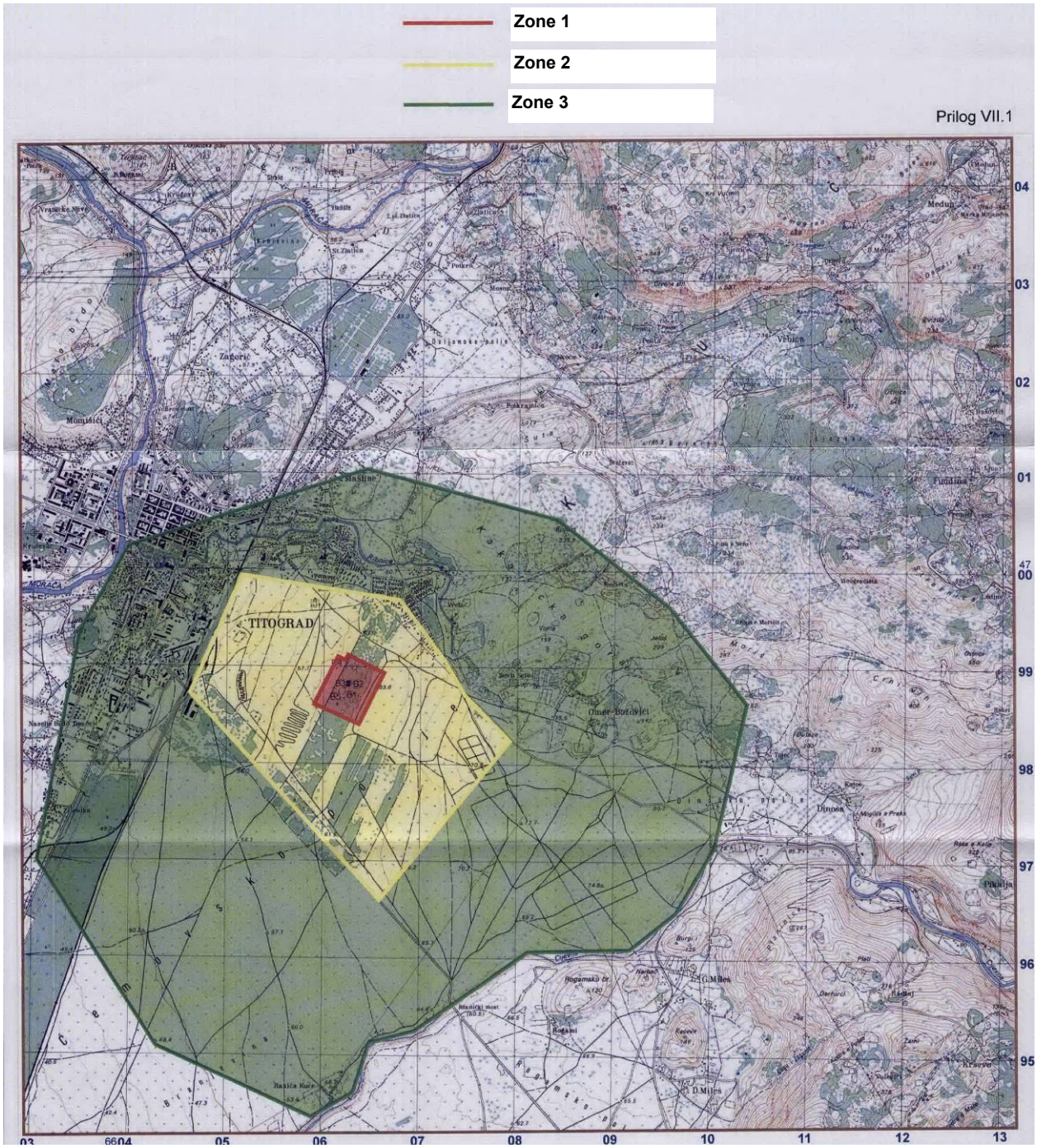


Figure 3.6: Cemovsko Polje protection zones

Table 3.4: Absolute groundwater levels at Cemovsko Polje in 2009, m

Date	Č7 62.62	Č10 63.35	Č12/B3 61.32	Č13 64.47	Č16 61.64	Č18 63.67	B1 59.93	B2 59.14	B4 59.97	B5 59.47
12.01.2009.g			33.64		32.39	34.47	32.89	32.12	31.66	33.49
27.01.2009.g.	37.52	35.92	34.79	37.92	33.38	35.45	33.79	33.09	32.75	34.56
03.02.2009.	38.30	36.64	35.30	39.06	34.36	36.36	34.77	33.76	33.78	35.66
10.02.2009.g.	37.97	36.23	34.81	38.49	33.90	35.85	34.25	33.26	33.03	35.15
20.02.2009.g.	37.70	35.94	34.49	38.35	33.71	35.65	34.02	33.12	33.04	34.62
02.03.2009.g.	37.26	35.62	34.16	38.02	33.23	35.24	33.56	32.76	32.65	34.56
10.03.2009.g.			33.49		32.36	34.73	31.86	32.27	32.06	31.97
23.03.2009.g.	37.21	35.39	33.21	37.72	32.12	34.48	31.57	32.09	31.77	31.66
07.04.2009.g.	36.30	33.11	32.41	36.89	31.15	33.71	30.53	31.05	30.79	30.48
27.04.2009.g.	35.90	29.84	32.22	36.82	31.02	33.58	30.28	30.92	30.62	30.29
04.05.2009.g.	35.71	30.63	33.00	37.66	31.72	34.35	31.13	31.63	31.96	29.55
15.05.2009.g.	38.47	32.33	34.24	38.91	33.44	29.65	32.82	32.53	32.10	31.46
26.05.2009.g.		31.35	33.10	35.02	29.66	31.36	29.48	31.71	30.11	31.04

03.06.2009.g.		30.37	30.57	32.60	27.08	29.76	28.33	30.09	28.96	28.91
10.06.2009.g.		28.57	28.91	29.90	25.54	28.67	26.91	29.13	27.63	27.53
29.06.2009.	37.14	28.66	28.93	32.64	27.00	29.87	28.45	30.13	31.13	29.15
01. 07. 2009.	35.70	33.54	30.57	31.49	35.05	32.25	30.66	29.13	28.07	29.87
08. 07.2009.	33.97	31.90	29.76	31.06	29.75	31.09	29.48	29.69	27.86	28.91
16. 07. 2009.	32.22	30.66	28.93	30.64	27.00	29.87	28.45	29.34	26.79	27.65
23. 07. 2009.	31.66	33.05	29.24	32.96	27.44	30.08	28.71	29.48	26.35	26.61
24. 07. 2009.			28.41				27.88	27.66	25.26	26.06
07. 08. 2009.	30.83	29.24	28.51	32.51	26.39	29.29	27.62	26.20	24.49	25.84
18. 08. 2009.	29.98	28.42	26.72	31.05	25.60	27.74	25.02	24.52	22.55	24.91
25. 08. 2009.			25.39				24.08	22.32	21.10	24.27
28.08. 2009.			25.14				23.68	21.89	20.45	23.84
31. 08. 2009.	28.64	27.71	24.72	28.76	22.68	26.17	23.43	21.81	20.45	23.52
02. 09. 2009.			24.41				23.22	21.72	20.13	23.19
04. 09. 2009.			24.24				23.10	21.45	19.99	22.84
07. 09. 2009.			24.41				23.18	21.86	20.01	22.46
09. 09. 2009.			24.09				22.99	22.32	20.26	25.84
11. 09. 2009.			24.47				23.15	22.38	20.35	22.93
14.09. 2009.			24.34				22.03	22.47	19.97	22.52
16.09.2009.			24.37				21.99	21.24	20.01	22.66
18.09.2009.			24.16				22.00	20.42	19.97	22.57
21.09.2009.			23.54				21.46	19.19	23.21	22.02
23.09.2009.			24.00				21.42	18.68	23.17	22.22
25.09.2009.			23.97				21.33	18.58	23.05	22.13
28.09.2009.			23.80				21.15	17.82	23.07	21.98
29.09.2009.			23.88				21.17	17.75	22.87	22.02
30.09.2009.			23.82				21.16	17.77	22.87	22.01
01.10.2009.			23.85				21.15	17.78	22.78	21.90
02.10.2009.			23.90				21.15	17.74	22.85	21.96
05.10.2009.			23.72				20.85	17.54	22.67	21.80
06.10.2009.			23.69				20.79	19.10	22.70	21.80
07.10.2009.			23.62				20.90	19.10	22.68	21.75
08.10.2009.			23.61				20.89	18.86	22.67	27.72
09.10.2009.			23.69				20.81	18.96	22.60	21.71
12.10.2009.			23.58				20.79	18.94	22.61	21.72
13.10.2009.			23.58				20.80	18.83	22.57	21.68
14.10.2009.			23.65				20.87	20.12	22.65	21.72
14.10.2009.			23.16					17.64		
14.10.2009.			23.75					17.54		
14.10.2009.								18.62		
15.10.2009.			23.72				20.87	19.76	22.63	21.72
16.10.2009.			23.62				20.88	19.87	22.58	21.67
19.10.2009.			23.92				21.10	20.12	22.91	21.99
19.10.2009.			23.92					17.84		
19.10.2009.			23.50					17.78		
20.10.2009.			23.74				21.39	17.96	23.01	22.16
21.10.2009.			23.82				21.35	18.18	23.10	22.24
26.10.2009.			24.19				22.55	19.96	24.07	22.99
28.10.2009.			23.97				23.69	20.94	24.77	23.77
29.10.2009.			25.12				23.53	21.36	24.97	24.07
30.10.2009.			25.88				24.21	22.31	25.56	24.65
30.10.2009.									22.43	
30.10.2009.									22.55	
30.10.2009.									21.97	
30.10.2009.									21.85	
02.11.2009.			27.02				25.14	25.82	22.85	25.34
04.11.2009.			27.45				25.71	26.53	23.54	25.89
09.11.2009.			28.32				26.50	27.14	24.67	26.92
23.11.2009.			33.68				31.14	31.59	29.97	31.25
30.11.2009.			32.72				31.04	31.71	29.97	31.47
07.12.2009.			32.75				31.34	31.71	30.07	31.33
14.12. 2009.			32.67				32.90	31.52	30.01	31.16
Max	**38.47**	**36.64**	**35.30**	**39.06**	**35.05**	**36.36**	**34.77**	**33.76**	**33.78**	**35.66**
Min	**28.64**	**27.71**	**23.16**	**28.76**	**22.68**	**26.17**	**20.79**	**17.54**	**19.97**	**21.67**
Variation	**9.83**	**8.93**	**12.14**	**10.30**	**12.37**	**10.19**	**13.98**	**16.22**	**13.81**	**13.99**

(c) Zağoric

The Zagoric wellfield is within the municipality of Podgorica, north east from the Gorica Hill, between the Podgorica to Zlatica road in the north and railroad Beograd to Podgorica in the northwest. The catchment area is much larger, belonging to the Moraca river catchment, upstream from the junction with Ribnica river. This catchment is some 3000 km2.

Morphological and hydrological characteristics of the Zagoric wellfield are simple flat terrains sloping down from the northeast towards the Moraca river bed. The morphological and hydrological characteristics of the catchment area of the Zagoric wellfield are complex. They slope upwards from the field towards the northwest, north and northeast to the hills and mountains. The terrain is characterised with prominent and pronounced processes and karstic, river and glacier erosion.

Recent Zagoric Installation

Zagoric wellfield is covered with park vegetation, and surrounded by an immediate protection zone of around 3.4 ha. The three protection zones; Immediate (zone 1), Inner (zone 2) and Outer (zone 3) are shown on Figure 3.7. The immediate protection zone (zone 1) is owned by ViK Podgorica. The inner and outer protection zones (Zones 2 and 3) are partly owned by Podgorica Municipality and partly in private ownership.

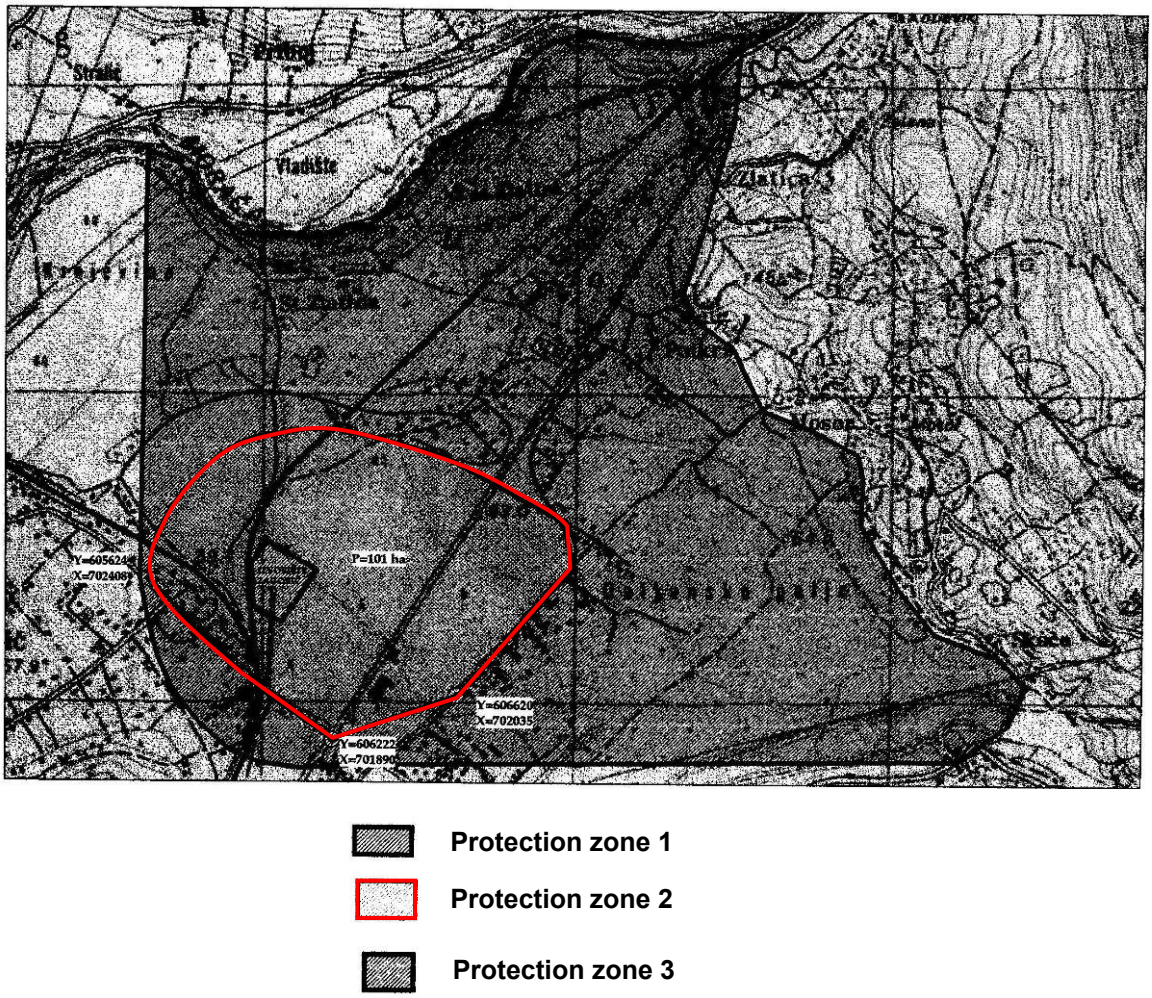


Figure 3.7: Zagoric protection zones

The wellfield comprises 4 pumps with a total capacity of around 33,700 m^3/d. Three wells tend to operate continuous with a fourth switching on and off depending upon demand. The variation in water levels in the Zagoric boreholes and monitoring wells is quite large as can be seen in Table 3.5, where the maximum variation recorded in 2009 was in excess of 13 m.

The results of a water analysis in December 2010 from Zagoric well 2 are given in Appendix E.

Table 3.5: Absolute groundwater levels at Zagoric in 2009, m

Elevation	58.54 m	59.22 m	60.1 m	59.53 m
No of well / Date	B2	B3	P1	B4
04.05.2009.	32.89	33.32	32.29	32.53
22.05.2009.	32.98	33.39	32.65	32.70
05.06.2009.	33.05	33.47	32.79	32.82
24.06.2009.	33.13	33.47	32.98	33.05
10.07.2009.	32.09	31.90	30.65	31.08
23.07.2009.	30.91	32.11	29.98	29.92
10.08.2009.	30.35	30.57	30.43	31.30
19.08.2009.	28.38	28.81	28.85	28.63
26.08.2009.	27.56	28.14	28.01	27.65
01.09.2009.	26.79	27.44	27.15	27.38
03.09.2009.	31.93	32.51	> 35.0	32.23
08.09.2009.	26.65	26.74	25.14	27.35
15.09.2009.	27.14	26.78	> 35.0	26.90
18.09.2009.	27.13	26.76	> 35.0	26.88
21.09.2009.	26.98	26.72	> 35.0	27.10
23.09.2009.	26.26	26.74	> 35.0	26.94
25.09.2009.	26.48	26.63	> 35.0	26.85
29.09.2009.	25.59	26.37	> 35.0	26.49
01.10.2009.	25.56	26.32	> 35.0	26.47
07.10.2009.	25.49	26.24	> 35.0	26.42
15.10.2009.	25.91	26.55	> 35.0	25.84
20.10.2009.	29.16	29.10	29.76	27.92
29.10.2009.	31.20	30.41	30.77	28.81
04.11.2009.	31.82	30.87	31.87	29.37
11.11.2009.	37.19	36.74	36.62	35.00
26.11.2009.	37.76	37.27	37.18	35.55
07.12.2009	39.12	38.83	37.54	37.21
Max	**39.12**	**38.83**	**37.54**	**37.21**
Min	**25.49**	**26.24**	**25.14**	**25.84**
Range	**13.63**	**12.59**	**12.40**	**11.37**

(d) Other Sources

These sources are basically for the supply to the Tuzi area. Water is supplied from a number of wells located in the general area of the town. On all water source sites water is extracted from wells: The source are Dečići, Miljes, Dinosa, and a new source Vuksan Lekici.

Tuzi 3

The source is situated near to Tuzi on the south-eastern fringe of the Zeta plain. This source is used partly for supplying the town of Tuzi and partly for supplying Zeta. This is a temporary source that will be taken out of service in two years. There is no danger of pollution at the source but, being temporary, it does not have a formal protection zone.

The results of a water analysis in December 2010 from Tuzi PS are given in Appendix E.

Miljes

Situated to the north of Tuzi, wells here supplement supplies to the town and surrounding areas. The protection zones for this are shown on Figure 3.8. The immediate protection zone (zone 1) is owned by ViK Podgorica. The inner and outer

protection zones (Zones 2 and 3) are partly owned by Podgorica Municipality and partly in private ownership.

The results of a water analysis in November 2010 from Miljes well 1 are given in Appendix E.

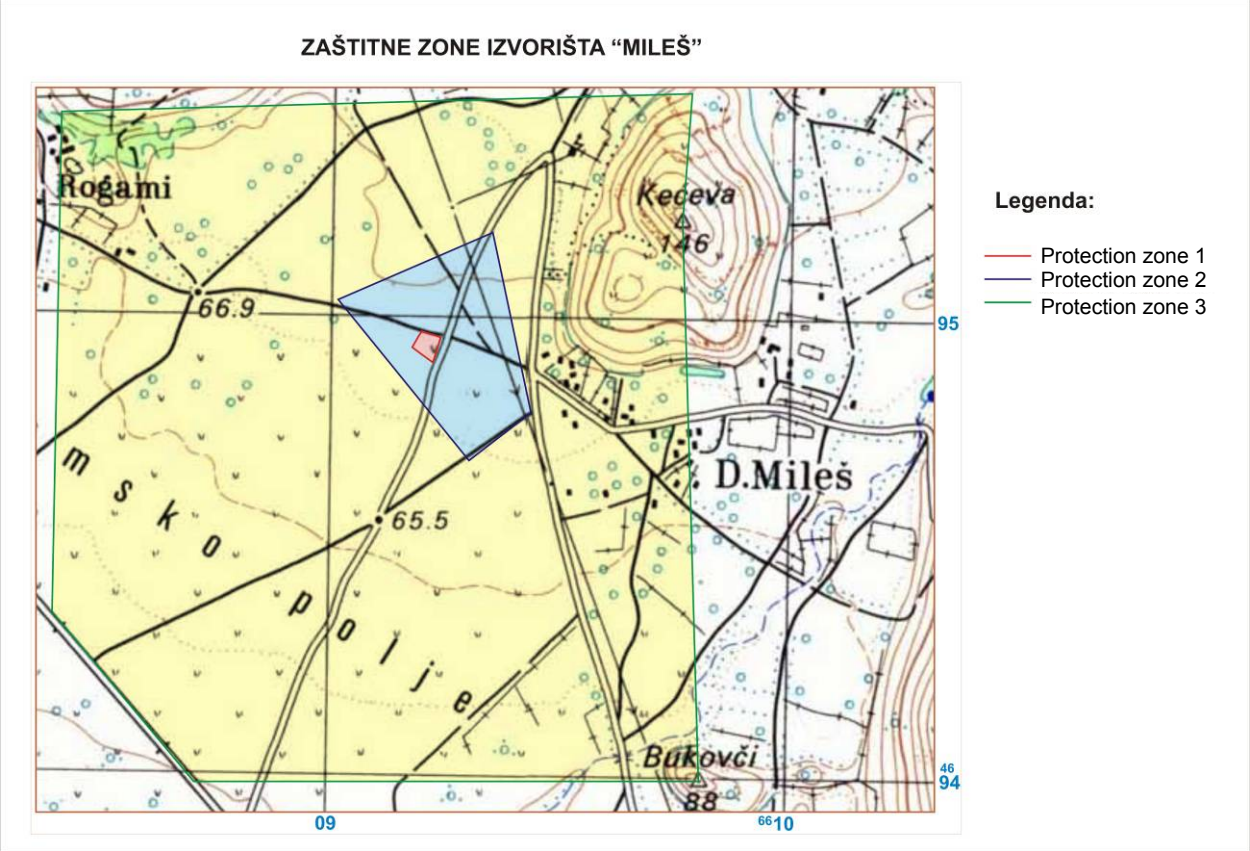


Figure 3.8: Miljes protection zones

Dinosa

The purpose for developing this water source is to provide the necessary quantities of water for Dinosa village as well as additional quantities for Podgorica. The inner protection zone (zone 2 for Dinosa is shown on Figure 3.9. The immediate protection zone (zone 1) is owned by ViK Podgorica. The inner and outer protection zones (Zones 2 and 3) are partly owned by Podgorica Municipality and partly in private ownership.

The results of a water analysis in November 2010 from Dinosa PS are given in Appendix E.

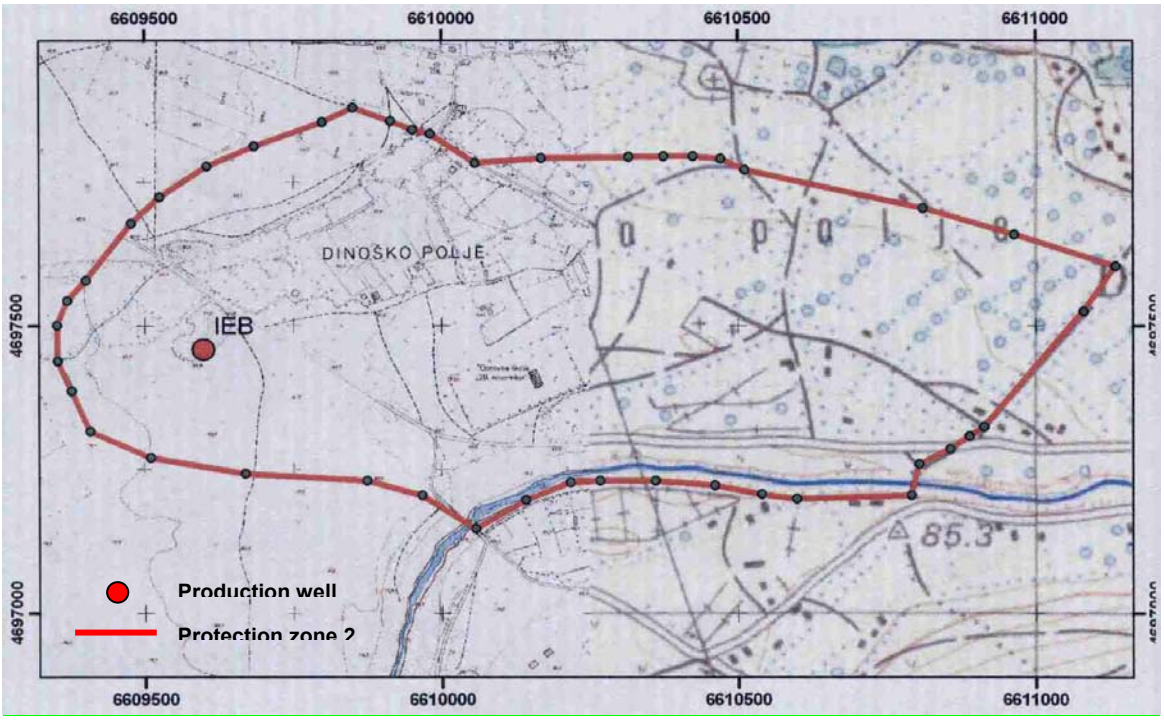


Figure 3.9: Dinosa protection zone

Vuksan Lekici

This is a new wellfield at the southeast end of the southern supply zone which was brought into production during 2010. The inner protection zone (zone 2) for Vuksan Lekici are shown on Figure 3.10. The immediate protection zone (zone 1) is owned by ViK Podgorica. The inner and outer protection zones (Zones 2 and 3) are partly owned by Podgorica Municipality and partly in private ownership.

The results of a water analysis in July 2005 and April 2009 from Vuksan Lekici are given in Appendix E.

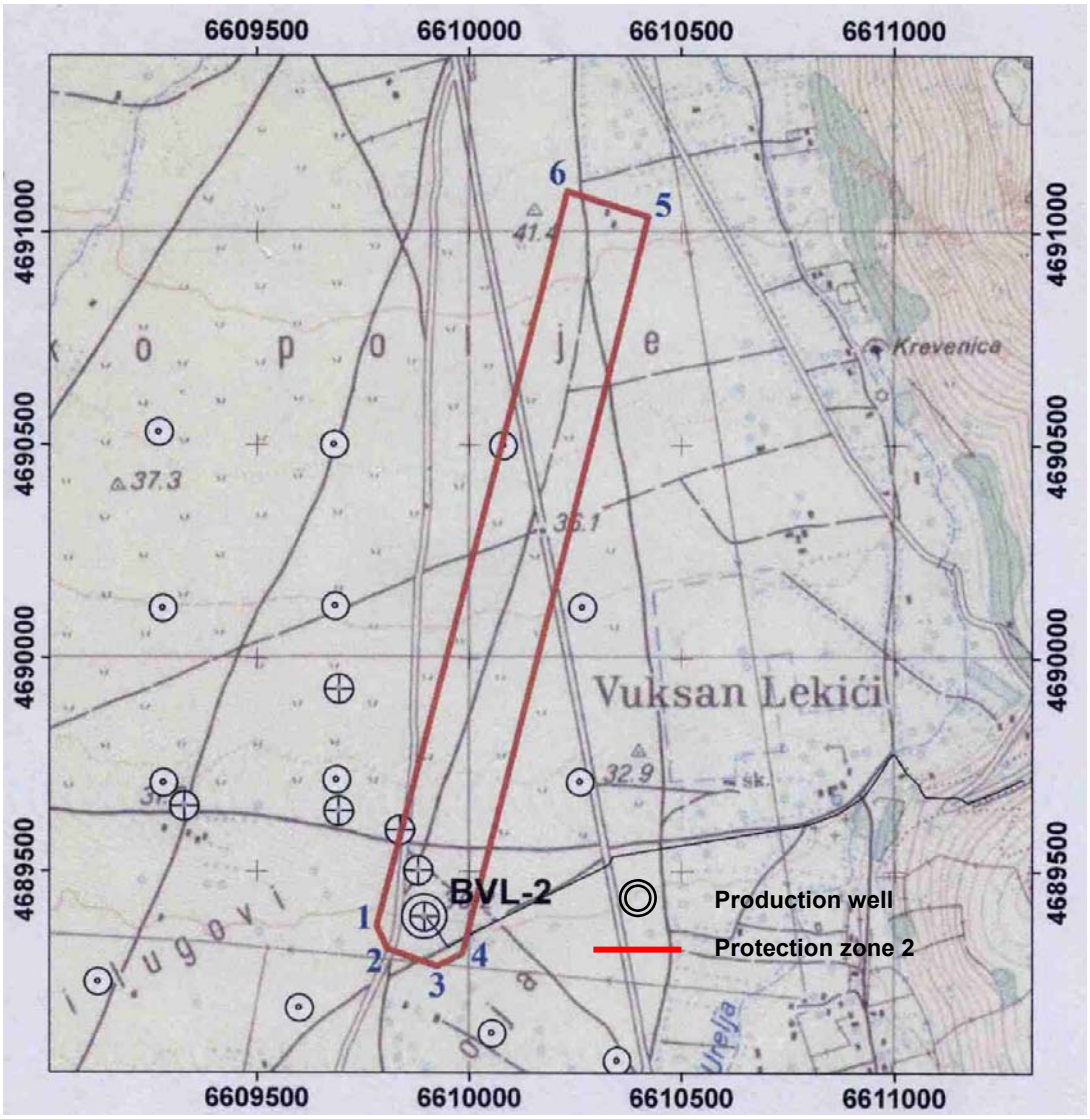


Figure 3.10: Vuksan lekici protection zone

3.1.3 Water Source Pumping Plant

Water from all sources is pumped directly into supply; from Mareza using a number of pump units housed in two separate pumping stations on the same site, and from the wellfields using the individual borehole pumps. There is no provision for storage at any of the sources. Treatment comprises disinfection by chlorine gas with an initial dose designed to give a residual of 0.4 mg/l.

Details of the pumping plant associated with each source are presented in the following table.

Table 3.6: Water Sources – Pumping Capacity

Source	Pump	Type	Duty			Remarks
			Flow l/s	Head m	Power KW	
Mareza	Old P3	HS	100	110	182	
	Old P4	HS	75	100	132	
	Old P5	HS	75	100	132	Danilovgrad
	Old P6	VS	200	110	370	
	New P1	VS	320	90	400	
	New P2	VS	320	90	400	
	New P3	VS	320	90	400	
	New P4	VS	320	90	400	
Zagoric	P1	S	120	100	132	
	P2	S	120	100	132	
	P3	S	55	50	55	
	P4	S	90	90	110	
Cemovsko Poije	P1	S	60	80	59	
	P2	S	45	80	51	
	P3	S	60	80	75	
	P4	S	105	80	110	
	P5	S	105	80	110	
Tuzi 3	P1	S	12	80	18	
Miljes	P1	S	40	100	51	
Miljes	P2	S	20	100	30	
Miljes	P3	S	10	100	22	
Dinosa	P1	S	25	110	53	

Key: HS horizontal shaft; VS vertical shaft; S submersible
Note: Some of the pumps at Old Mareza are scheduled for replacement later this year, whilst the pumps at New Mareza will be replaced under a JICA funded project

The following Figures record the operation of the various source pumps on 29th July 2009. It demonstrates the contributions from each source and shows the switching of pumps that occurred throughout the day.

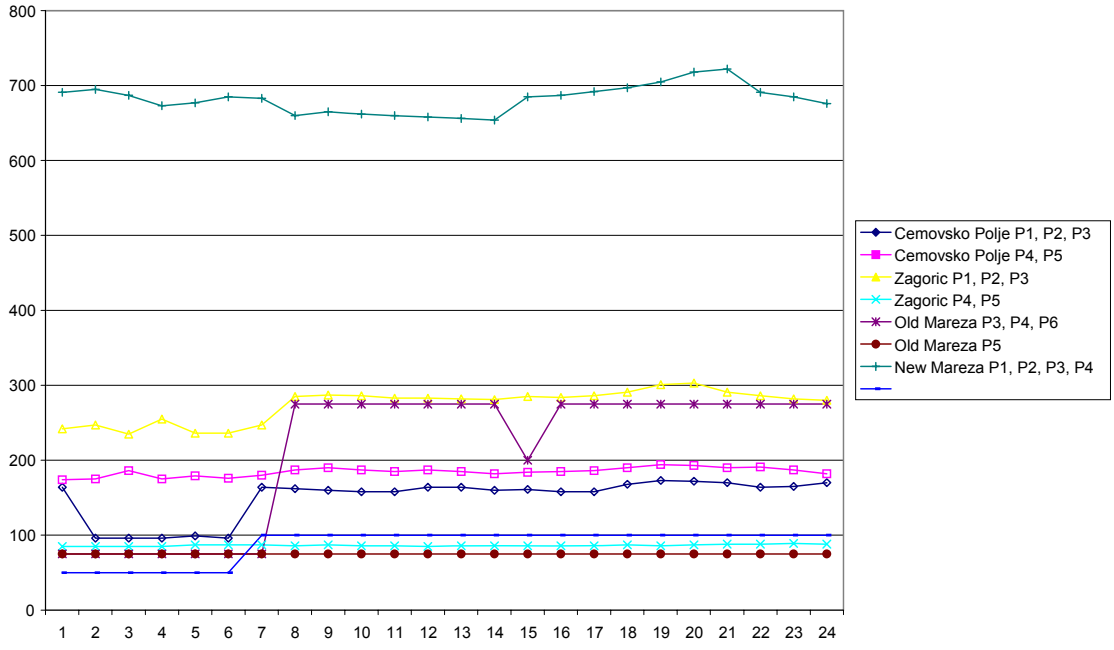


Figure 3.11: Contribution from Sources

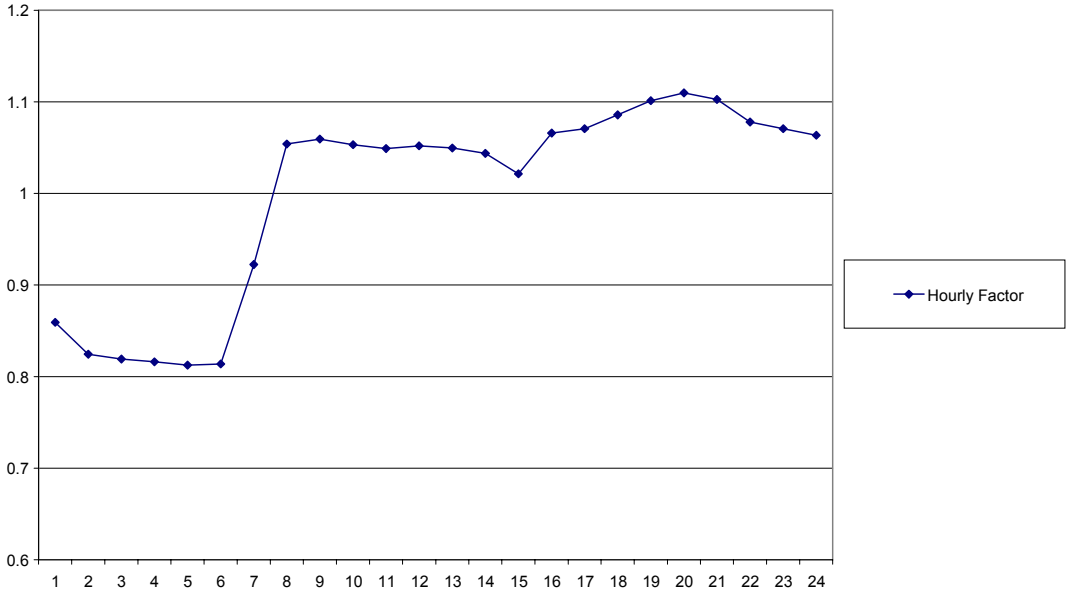


Figure 3.12: Hourly Fluctuation in Supply - All Sources (29/07/09)

Note: The full effect of supply fluctuations is masked by the fact that sources pump directly into the network so some demand variations will be absorbed by pressure changes.

The water distribution operates as a single pressure zone with all sources pumping directly into the network at various locations. System pressures fluctuate depending upon consumer demand and the number of source pumps operating.

Old Mareza Pumps

New Mareza Pump Motors

Each source is controlled locally with pump operation initiated by delivery pressures measured at the site. Experience has told the operators the maximum and minimum delivery pressures at which supply problems are avoided. If pressure falls below the minimum additional pumps are initiated, if they rise above the maximum then pumps are

shut off sequentially. Control is manual although ViK has plans to install a SCADA system, and to create a system control room at ViK's HQ building.

3.1.4 Distribution Network

The water supply system of Podgorica has a single pressure zone although some properties are being constructed above the hydraulic level of the distribution network and these require small (5 – 7 l/s) local booster pumping stations to supply a proportionally very small population.

Generally, system pressures are good although the city centre sometimes experiences low pressures. Also in areas around the fringe of the city, low pressures can be experienced on the higher ground.

The topography of the city is less than ideal for a water supply network causing system pressures, in some areas, to be higher than necessary. The topography requires high supply pressures in order to reach the higher ground in the north and east of the city, which increases losses throughout the system.

Cemovsko Polje and Zagoric produce water at a head of around 100 mamsl and much of the city centre is lower lying with ground levels around 40 mamsl. Heads from Mareza are 10 – 20m higher. ViK's design criteria are for a minimum nodal pressure of 25m and a maximum of 60m. Areas close to Mareza can exceed this value due to their proximity to the source.

The results modelling of the existing network are given in Appendix A and pressure contours for 2009, average demand, and 2009 maximum demand are included.

ViK report the following problem areas caused by system pressures.

Table 3.7: Reported Network Problem Areas

Area	Problem	Comment
City Centre	Intermittent Low Pressure	Strategic important area
Gorica	Inadequate pressure	Properties built on higher ground around hill
Murtovina – Zlatica	Inadequate pressure	Properties on built higher ground in the North East of the city
Gornja – Donja Gorica	High Pressure	Old pipes in rural areas
Dajbabe	Low Pressure	Inadequate network capacity in the south

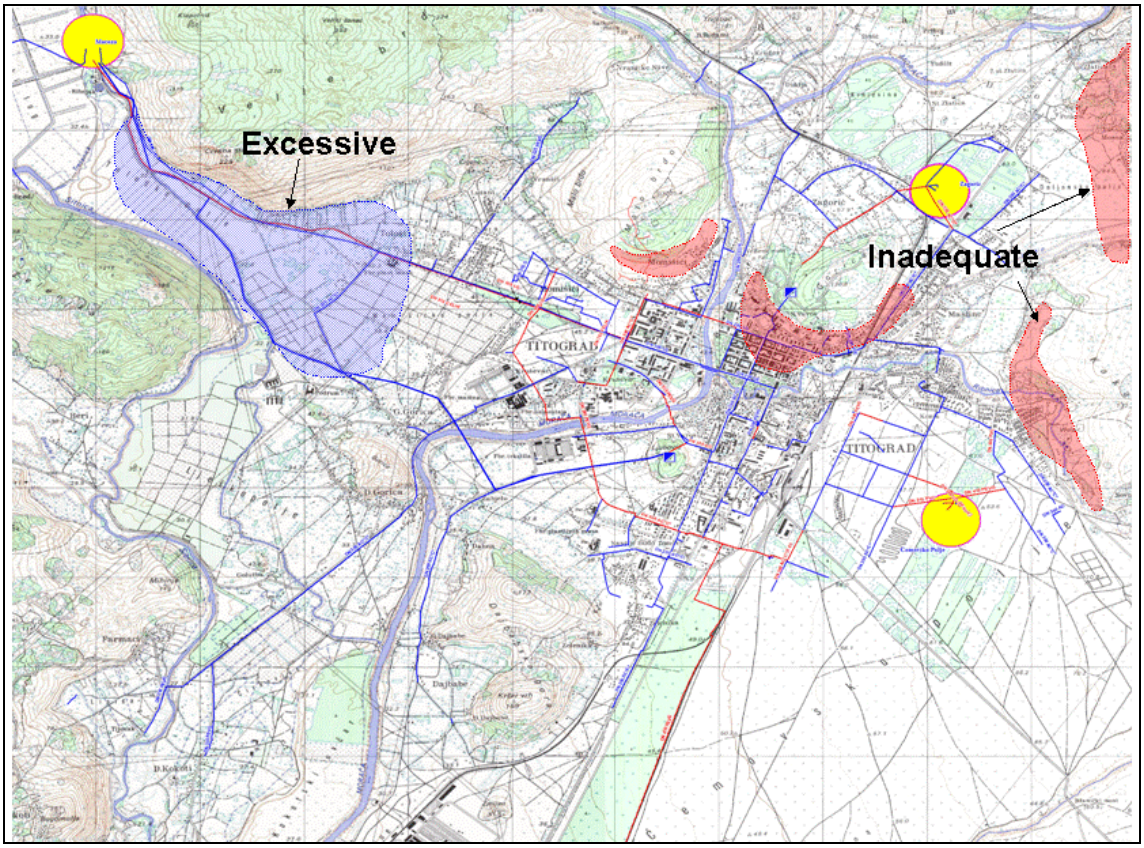


Figure 3.13: Main network – Reported Pressure Problems

As development of the city continues to rise onto the hills at the fringe of the city, low pressure problems will increase as will the need for small localised booster pumps to supply those above the hydraulic level of the main network.

Supply pressure problems are aggravated by the lack of service reservoir capacity within the system. Reservoirs would help stabilise the network, limit supply pressure fluctuations and provide reserves against failures. There are only two existing service reservoirs, one of which is dedicated to fire reserve for Gorica Hill. Both reservoirs are too small to be of significant value, totalling less than 1 hour's storage at average day demands, and Ljubovic particularly would benefit from refurbishment. At the present time the access road has been reconstructed, new fencing erected and the necessary valves and fittings for the refurbishment of the valve house have been acquired. During the next year the implementation of the refurbishment of the interior of the valve house will be carried through the donation of the Japanese Government. The Ljubovic reservoir 'floats' on the system and at times there is insufficient pressure for the reservoir to fill.

Table 3.8: Existing Service Reservoirs - Podgorica

Reservoir	Capacity m^3	WL mamsl	Hours Supply hrs	Type	Location
Ljubovic	3000	99 - 94	0.67	Buried Reinforced concrete	Ljubovic Hill south of the city centre - operating
Gorica	1200	97 - 93	0.11	Buried Reinforced concrete – 1948	Gorica north of the National Stadium – fire fighting reserve
Total	4200		0.78		

The network comprises numerous pipe diameters, types and ages, the details contained in ViK database are summarised in the following table. ViK believe that the total length of their pipework is around 750km with 500km of primary and 250km of secondary mains. Unfortunately the ViK mains database is not complete indicating only some 300km of mains. Main pipe are either Asbestos Cement, cast iron, UPVC, steel, ductile iron or HDPE, available details are given below.

Table 3.9: Pipe Data in ViK Database (incomplete)

Material	Lengths of Pipes with Diameters ≥100mm (m)	Lengths of Pipes with Diameters <100mm (m)	Year of Construction
Cast Iron	8,980	1,073	1960
Steel	6,719	0	1990
Galvanised	0	40,269	1960-90
Ductile	3,596	0	2007
PVC	1,897	806	1990
HDPE	69,388	24,885	1995-2009
Asbestos Cement	105,736	26,700	1970 – 1990
Total Lengths (m)	196,316	93,733	
Total Length Of The Surveyed Water Supply		290,049	

Service pipes are generally Galvanised Mild Steel (GMS) or HDPE.

Flowmeters are installed at the sources and at the majority of consumer points. Source meters are electro-magnetic. Currently a JICA funded project is making proposals for District Metering to provide base data for a centralised system of operation and control. ViK have a policy of universal metering of all consumers.

The majority of consumer water meters in the water supply system are ½" and ¾". Until now the company has been unable to perform regular calibration of water meters as required by the law (i.e. replacement and calibration of meters should be carried out every five years). We estimate that the average age of the meters on the network ranges from 10 - 12 years. Additional efforts have been made and during 2011 a new calibration station with a capacity of about 10,000 water meters per year will be put into operation. The following table presents an overview of water meters in diameter.

Table 3.10: Numbers and diameters of consumer water meters

Water meter diameter	Number
½"	5000
¾"	28037
1"	537
5/4"	347
6/4"	991
2"	149
> 2" (DN 80 – DN 100 mm)	62
TOTAL:	**35123**

3.1.5 Supply to Zeta and Tuzi

Both Zeta and Tuzi water supply systems are operated by ViK.

The area of Zeta was originally supplied with water from the wells in KAP, but after recorded pollution of groundwater aquifers, and growing water demand of Zeta area, it was decided to connect Zeta to the water supply system of Podgorica.

Water supply for the town of Tuzi is from the wells in Tuzi, Miljes and Dinosa (a new source at Vuksan Lekici is also being developed). Total installed capacity of the wells is 11,600 m^3/d, and individual capacities are:

- PS Tuzi 2,600 m^3/d
- PS Miljes 6,740 m^3/d
- PS Dinosa 2,250 m^3/d

PS Tuzi and PS Miljes form a part of the water supply system of Tuzi, while the PS Dinosa forms a part of the smaller separate system.

The water supply system of Tuzi includes two reservoirs, Kecevo 200m^3 (not in use) and Sipcanik 200m^3.

For the purposes of extension of water supply of Zeta and Malesija areas, a design, prepared by ViK, for supplying Zeta and Malesija with water was prepared in 2006, and includes:

- Construction of mains and distribution network in both areas (significant part of the mains has already been constructed or reconstructed in accordance with the design);
- Construction of two wells in Vuksanlekici (both boreholes are carried out and pumps have recently been installed);
- Construction of three reservoirs: Vuksanlekici - 800m^3 (already constructed), Vranjska gora – 800m^3 and Orlovina – 2000m^3;
- Connection the area of Malesija to the Tuzi water supply system (already finished).

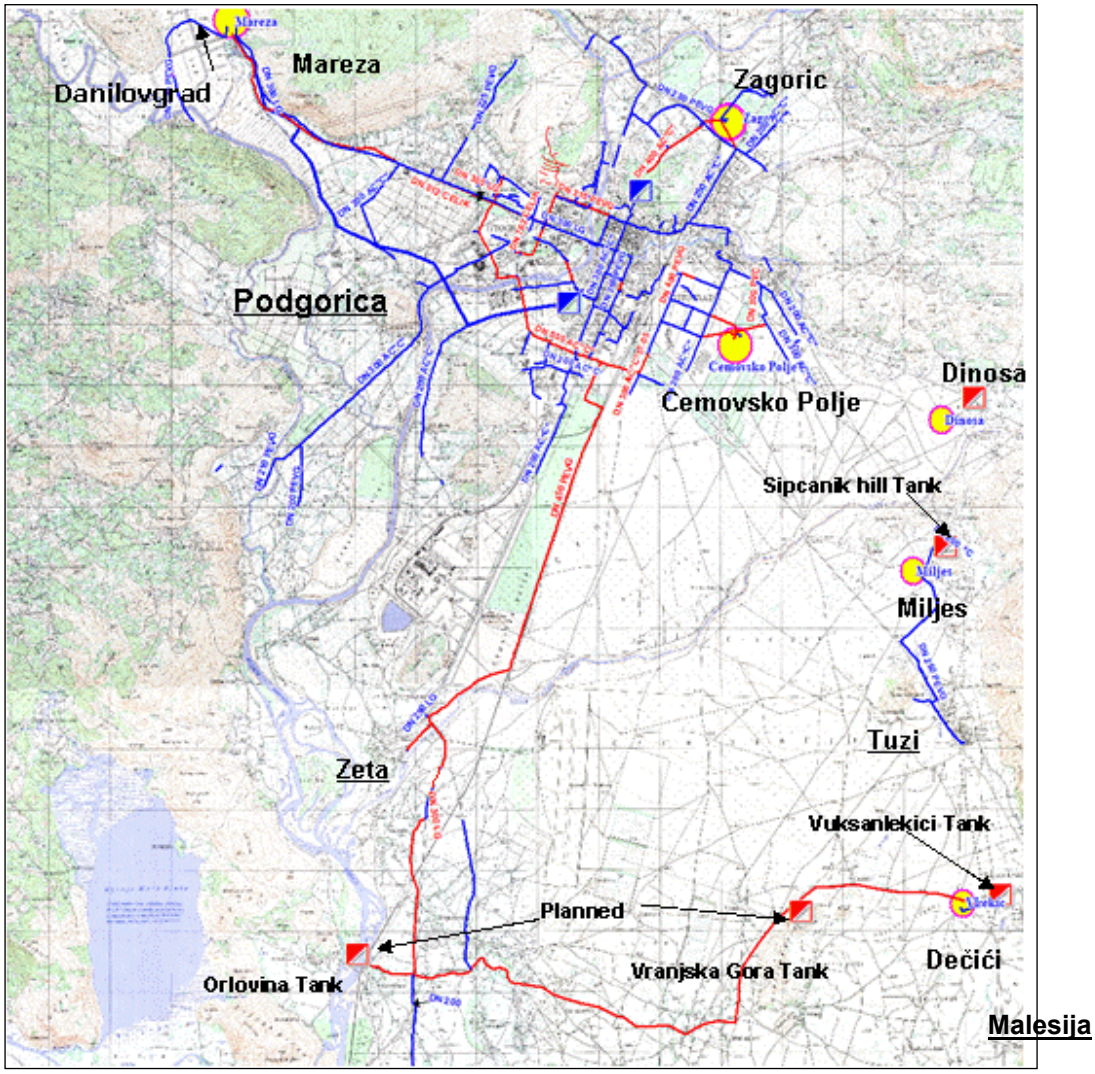


Figure 3.14: Supply to Zeta and Tuzi

3.1.6 Water Treatment

The ViK water sources all produce water of generally high quality. Water treatment is therefore confined to chlorination and ViK dose using chlorine gas at all sites. All the equipment for chlorination has recently been renewed and is fully automated and regularly maintained. The capacity of the equipment is more than sufficient for the existing amount of pumped water. ViK target a dose to give a chlorine residual of 0.4 mg/l at the point of dosing in accordance with local IPH guidelines.

Some water quality tests taken at points of discharge within the distribution system show little or no residual, leaving the system vulnerable to contamination of the network. Ideally chlorine dosing should be increased but the absence of service reservoirs giving adequate contact time limits the possible dosage because consumers are connected near to the sources. Following the construction of the proposed new service reservoir(s) it is recommended that chlorine re-dosing should occur at the tank inlet to maintain the required residual throughout the network.

3.1.7 Water Balance

A water balance based on average day figures for 2008 and 2009 is reproduced below.

Table 3.11: ViK Water Balance – 2008 and 2009
(Average flows m^3/d)

Category	2008			2009		
	Element	Sub-total	Total	Element	Sub-total	Total
Production			108,157			107,959
Mareza	*62,701*			*62,656*		
Zagoric	*22,291*			*20,354*		
Cemovsko Polje	*17,905*			*21,343*		
Tuzi, Miljes and Dinosar	*5,250*			*3,606*		
Authorised Consumption			57,147			57,007
Billed Authorised Consumption		44,561			43,163	
Danilovgrad	*5,115*			*5,902*		
Zeta	*6,781*			*6,263*		
Cancelled	*690*			*1,679*		
Unbilled Authorised Consumption		12,586			13,844	
Water Losses			51,010			50,952
Real Losses		27,092			26,990	
Apparent Losses		23,920			23,962	

The assessment of consumption is based on ViK's meter and production records. As detailed in Section 5.7.3, all water meters are the property of ViK Podgorica and the company is in charge of their maintenance.

The assessment of Real Losses is based upon an assessment of Night Flows during March 2008, the month of minimum demand, when unauthorised use for irrigation etc can be assumed to be negligible. Thus the system demand occurring during the night (minimum flow occurred at 05.00) can be assumed to be losses after an allowance for authorised consumption is deducted.

To make sense of the data it was necessary to include a relatively high level of night-time 'billed' consumption, indicating a high level of on-property wastage/leakage. This is consistent with a relatively low domestic tariff which may not provide sufficient incentive to consumers to repair leaks within their properties. This is also consistent with the current high per capita consumptions apparent.

The analysis concludes that 'real' losses due to system leakage are around 25% of supply, other losses are given below:

Table 3.12: Percentage Losses 2008 and 2009

	2008		2009	
Category	Average Flow m^3 /day	Percentage of Supply	Average Flow m^3 /day	Percentage of Supply
Real (Physical) Losses	27,092	25.0%	26,990	25.0%
Total Losses	50,010	47.2%	50,952	47.2%
Non Revenue Water	63,589	58.8%	64,796	60.0%

Visual evidence does not tend to support high system losses but this may be due to the presence of shallow gravel strata underlying the city which could discourage leaks from showing on the surface.

ViK believe there to be around 3,000 unregistered connections, which although significant will not make much impact upon leakage estimates based on Night Flow Measurements representing around 6% of all connections.

It should be noted that there is a large variance between maximum and minimum monthly flows and this will be very significant when designing the water system components. Maximum day demands are also significantly higher than maximum month figures, being some 1.5 times the annual daily average.

Table 3.13: Monthly Flow Variations – 2008

	Average Daily Production m^3/day	Normalised
January	96,131	0.89
February	99,415	0.92
March	95,174	0.88
April	95,393	0.88
May	104,002	0.96
June	117,040	1.08
July	136,239	1.26
August	139,299	1.29
September	121,795	1.13
October	96,516	0.89
November	95,189	0.88
December	100,743	0.93

ViK have confirmed that there are doubts over the accuracy of many consumer meters. Many of the meters are old and their performance is unreliable. Replacement of these meters is a priority with ViK.

3.1.8 Leakage Index

Calculating the internationally recognised IWA Infrastructure Leakage Index for Podgorica gives a value of 8.8 for 2008. The Index is the ratio of the assessed level of Real Losses (leakage) with a theoretical value for unavoidable losses – background leakage that is almost undetectable. A 'perfect' system would have an index of 1.0, poor performing systems indices above 5.

Table 3.14: Water Supply Performance Indicators

Annual Input Volume to Water Balance				39,477,353	m^3/year
Billed Authorised Consumption		Unbilled Authorised Consumption	Water Losses Volume m^3/year		
			Apparent	Real	
16,264,247		4,593,710	8,730,816	9,888,580	
Simple Financial Performance Indicators					
Currency	Euro	Annual Cost of Running System		5,909,000	per year
Unbilled volumes m^3 / year			**Unit Value**	**Valuation of Annual Losses**	**% of Annual Running Cost**
			€/m^3	**€**	
UAC		4,593,710	0.46	2,113,107	35.76%
Apparent Losses		8,730,816	0.46	4,016,175	67.97%
Real Losses		9,888,580	0.15	1,480,130	25.05%
Total Unbilled		23,213,106		7,609,412	128.78%
Average Daily Real Losses and Technical Indicator for Real Losses					
Annual Volume of Real Losses			9,888,580	m^3/year	
% of time system is pressurised			100	% of time per year	
Average Daily Real Losses when system is pressurised			27,092	m^3/day when system is pressurised	
No. of Service Connections			49,005		
Technical Indicator Real Losses (TIRL)			**553**	**l/conn/day w.s.p.**	
Unavoidable Average Real Losses and Infrastructure Leakage Index (ILI)					
Average Pressure w.s.p.			45	metres	
Density of connections			65	per km of main	
Underground house connections			637	Km at 13	m per con
Components of Unavoidable Average Real Losses					
750	Km mains @	18	13,500	l/day/m pressure w.s.p.	
49,005	Connections @	0.8	39,204	l/day/m pressure w.s.p.	
637	Km underground Pipes @	25	15,927	l/day/m pressure w.s.p.	
Unavoidable Average Real Losses (UARL)			**68,631**	**l/day/m pressure w.s.p.**	
UARL at average pressure of		45	3,088,378	l/day w.s.p.	
UARL in same units as TIRL			63.0	l/conn/day w.s.p.	
Technical Indicator Real Losses			553	l/conn/day w.s.p.	
INFRASTRUCTURE LEAKAGE INDEX			**8.8**	**= TIRL/UARL**	

This ILI index for Podgorica is high reflecting the high levels of losses and unauthorised consumption evident. ViK are already taking steps to increase their efforts on leak detection by implementing a District Metering project with assistance from JICA. This is the logical first step in the required intensive programme of active leakage detection that will be necessary. The illegal use of water and household losses must also be tackled as a priority.

3.1.9 Operations and Maintenance

(a) Leak Repairs

ViK records indicate that they performed 978 leak repairs (interventions) during 2008, this is an increase on 2007 (864) and 2006 (638). ViK adopt a 'passive' approach to leakage control repairing visual and reported leaks.

Table 3.15: Leak Repair Records, 2008 & 2009

Material	2008		2009	
	Diameters (mm)	Number of Repairs	Diameters (mm)	Number of Repairs
Asbestos Cement	60 – 500	251	60 - 500	66
Steel	100 – 300	5	100 - 300	1
HDPE connections	20 – 40	118	20 - 40	106
HDPE pipes	50 – 250	92	50 - 250	103
Galvanised connections	12 – 40	406	12 - 40	117
Galvanised pipes	50 – 90	106	50 - 90	56
	Total	978	Total	449

The asbestos cement and galvanised pipes tend to be particularly problematical due to their age and condition and require systematic replacement.

(b) Network Maintenance

Vik's network maintenance records indicate the following interventions.

Table 3.16: Network Maintenance Records

Intervention	Unit	2007	2008	2009
Interventions performed on pipeline	Nr	864	590	627
Maintenance of manholes/chambers	Nr	341	231	79
Located malfunctions (physical and legal entities)	Nr	82	144	
Maintenance and calibration of water meters	Nr	1,536	1,383	1,329
Replacement of water meters	Nr	1,601	1,389	1,293
Replacement of water installations – valves	Nr	1,630	1,733	3,143
Replacement of water installations – minor parts	Nr	779	777	

The data also reflects ViK policy of passive management of the network.

(c) Pumping Efficiencies

Two problems are apparent when reviewing the operations of the various pumpsets, both reduce the efficiencies of the pumpsets:

- There are fluctuations in delivery head amounting to around 2 bars as a result of system demand variations and pumping directly into supply.
- Pump Duties (optimum efficiency points) seem to be generally higher than the current operating ranges again sometimes by a significant margin.

An analysis of pump heads indicates that most of the pumpsets are operating well outside (below) their efficient operating ranges. In some cases pumps are known to be

throttled at delivery to promote more efficient running i.e. pumps at Mareza. The absence of appreciable service reservoir storage within the distribution network exacerbates the pressure fluctuation as there are no fixed head reference points.

Table 3.17: Source Delivery Heads[1]

Source	Delivery Head Variation m ad	Pump Delivery Pressure Variation m	Efficient Operating Pressure Range[2] M
Mareza New	109 – 120	70 - 88	80 – 110
Mareza Old	100 – 115	62 - 82	88 – 115
Zagoric	88 – 100	50 - 70	80 – 100
Cemovsko Polje	81 – 94	42 - 72	53 – 125

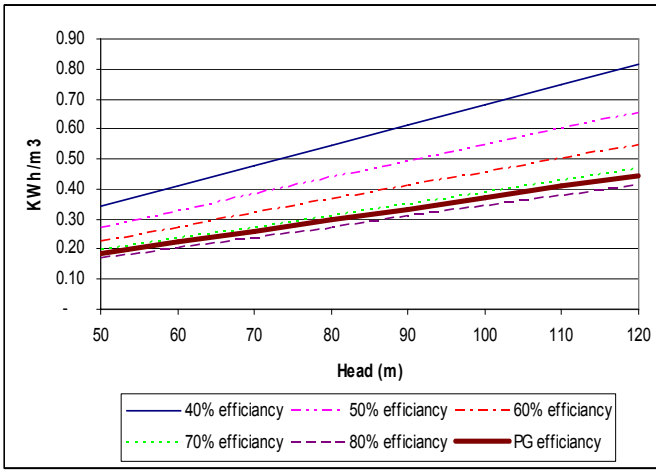
The inclusion of service reservoirs within the network can stabilise delivery heads and make pump operation more efficient by limiting the operating range and allowing better pump selection.

3.1.10 Operating efficiencies

There are a number of indicators to judge operating efficiencies, some of which are discussed below:

- Staffing ratio: A staffing ratio for water and wastewater of almost 10.0 staff per connection for a system such as Podgorica's suggests a relatively inefficient operation with respect to staffing numbers. However, the ViK Podgorica operates a rainwater drainage system and a wastewater treatment plant – the only operational treatment plant in the studied towns of Montenegro.
- Losses: The total unaccounted water appears to be unacceptably high. Unmeasured consumption constitutes a significant proportion of the losses in Podgorica.
- Energy: Figure 3.15, indicates the variation of unit electricity consumption expected for groundwater supply systems with different pumping characteristics.

Figure 3.15: Unit power consumption



Pumping heads at Podgorica range from 110 m at Milješ to 65 m at Zagorič. Unit power consumption for reasonably efficient pumps ($\eta = 74\%$) should therefore be in the range of 0.4 to 0.25 kWh/m3 respectively.

ViK's estimate for energy consumption for 2008 is 14,341,000 kWh, which is

[1] Records from 29th July 2009
[2] Indicative data as not all pumps at individual sources are identical – taken from manufacturer's pump curves

equivalent to 0.7 kWh/m3 of water billed. This is very high, and can be partly explained by the impact of the high level of losses. The reduction of losses would thus seem to be an attractive financial investment.

3.1.11 ViK Development Plans

ViK have developed and published their investment plans for water supply for the period 2007–17. The plans focus upon mains replacement and expansion of the current network, the provision of service reservoir storage within the network and the development of the groundwater source and protection zone at Dinosa to the west of the city.

ViK are developing plans for the remodelling of Mareza pumping station together with improved remote control of the water supply system from a new control room in the ViK Headquarters (this is being implemented with assistance from JICA).

Table 3.18: ViK Proposed development and upgrade of the water supply system investments

Expenditure Item	Cost € million
Construction of new pipelines along new and reconstructed roads	17.50
Replacement of old pipelines	14.00
New supply pipeline from Mareza	3.00
Construction of new 20 Ml service reservoir at Ljubovic with inlet and outlet pipelines	12.80
Construction of new 10 Ml service reservoir at Vrsak with inlet and outlet pipelines	4.10
Carrying out additional investigation works at the water source Dinosa to extract 200 l/s including establishing a source protection zone	2.00
Equipping the control system for remote controlling of the water supply system	2.10
Replacement of the old water supply network for Gornja Zeta	0.70
Construction of the water supply network for the settlements Donja Zeta	3.50
Reconstruction of the service reservoir on the Hill Gorica and construction of the hydrant network	0.40
TOTAL	60.10

No details of the proposed new and replacement mains were available in terms of lengths and diameters as these figures appear to be derived from historical expenditure levels rather than engineering estimates of the works required, some of which cannot be identified at this time anyway.

Items such as meter replacement are not included here but are normally funded from ViK revenues.

The development of the spatial plan of the Municipality of Podgorica is in preparation and, as ViK has all the basic documents, including this project, they are obliged to provide the drafter of the Spatial plan with all available documentation., Thereby the Spatial Plan document takes into account the existing and future facilities (water

sources, reservoirs, main pipelines, etc.) in accordance with the future development of the city.

3.1.12 Network Model

The construction of a fully calibrated operational model of the supply system was beyond the scope of the ToR for this project. However to analyse ViK proposals for the introduction of storage reservoirs into the system a hydraulic model of some kind was necessary. Fortunately, ViK had an existing model of the network prepared during the 1998 project assessing the supply system. A new model was therefore constructed using the old ViK model as a starting point. The model was successfully converted from the original WESNET software to EPANET. With this model development options could be evaluated in detail.

The physical data in model was updated to reflect the actual network in a joint the exercise with ViK's technical staff. Nodal demands were recalculated based upon the most recent census (2003), data modified to reflect changes in the intervening time. Demand patterns were taken from the original model and revised as appropriate based upon available flow data.

To test the model the operating regime for the 29th July 2009 (peak flow) and 14th March 2009 (average flow) were modelled by setting the pumps to mimic actual operating regime on that day, the resulting predicted pressure were found to give a fair representation of the records from that day.

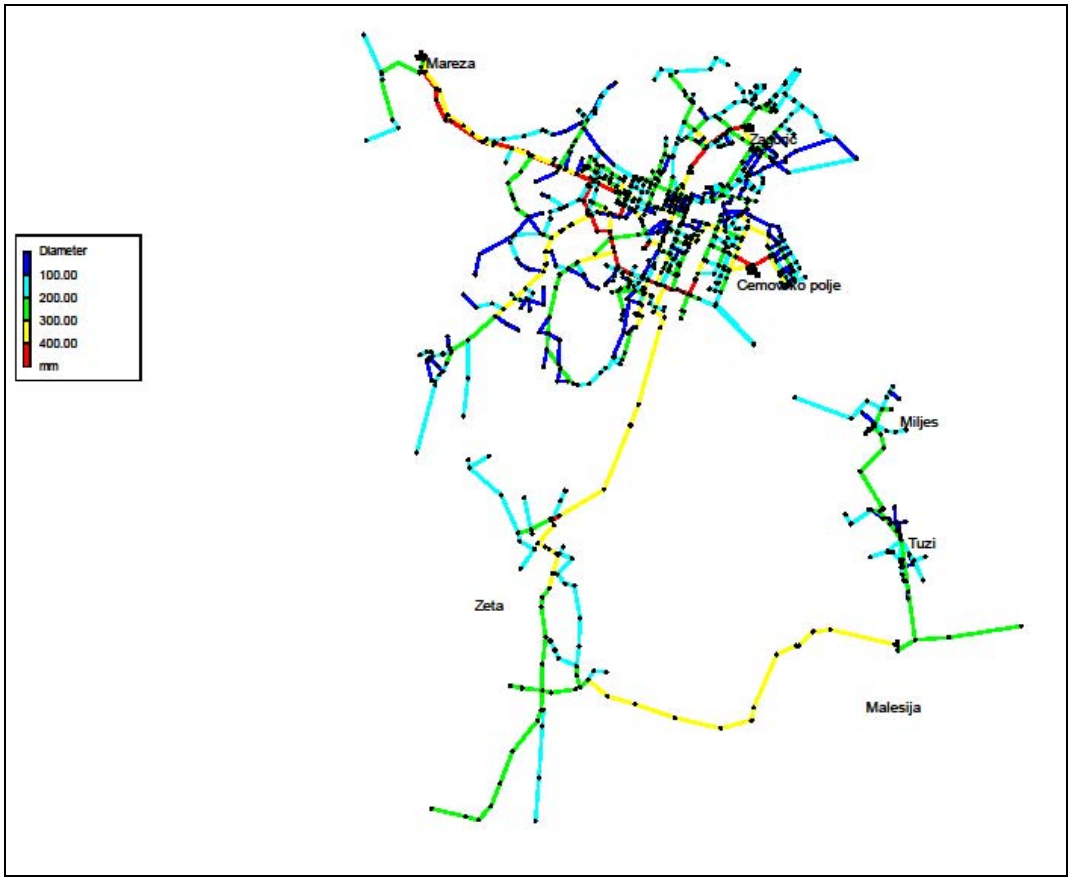


Figure 3.16: Existing Network from Computer Model

Figure 3.17 demonstrates the pressure map generated for the Peak Day during 2009 and it shows large areas at pressures less than 25m. The problem areas highlighted by ViK (section 3.1.4) are not highlighted specifically, because the ground levels used in the model are the level at the pipe node rather than level of the highest property served within the area served by that node.

The principal features of the basic model are:

Number of Junctions	942
Number of Reservoirs	16
Number of Tanks	5
Number of Pipes	1143
Number of Pumps	23
Number of Valves	3

Within EPANET software, a well is treated as a reservoir, so in the Podgorica model there are 16 wells and 5 tanks. System losses are treated as a separate consumption category within the model and the chart of hourly fluctuations for losses corresponds to fluctuations in water production.

A number of models were prepared representing different development options and different demand scenarios and the results of the modelling are present in Section 6.

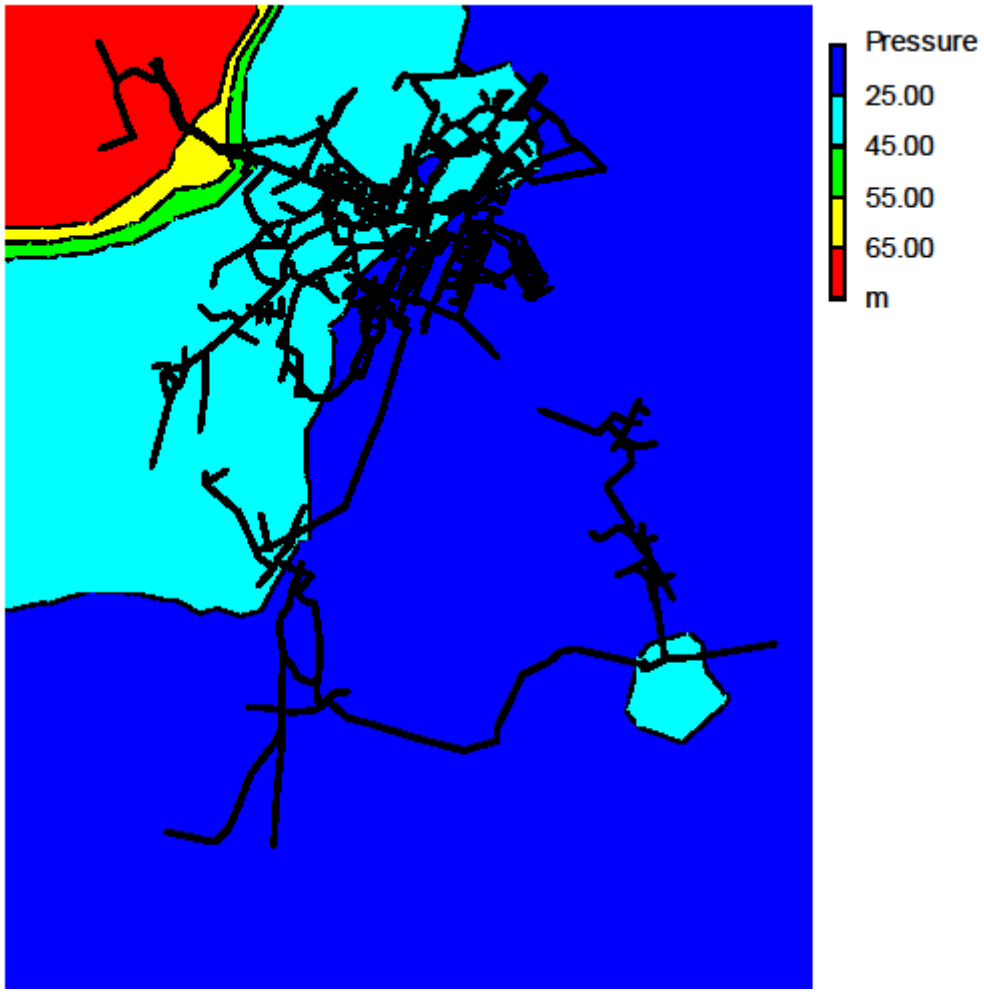


Figure 3.17: Model Output – Pressure Contours – 2009 Peak Demand – 19.00

Full details of the model are presented in Appendix B.

3.2 Review of wastewater infrastructure and service levels

3.2.1 Coverage

The area of the General Urban Plan is 8446 ha, which is 5.6% of territory of Municipality of Podgorica (1500km^2). The existing wastewater system of Podgorica city covers approximately 2626 ha (32 % of area covered by the General Urban Plan). The area of the City presently served for wastewater is shown on Figure 3.18.

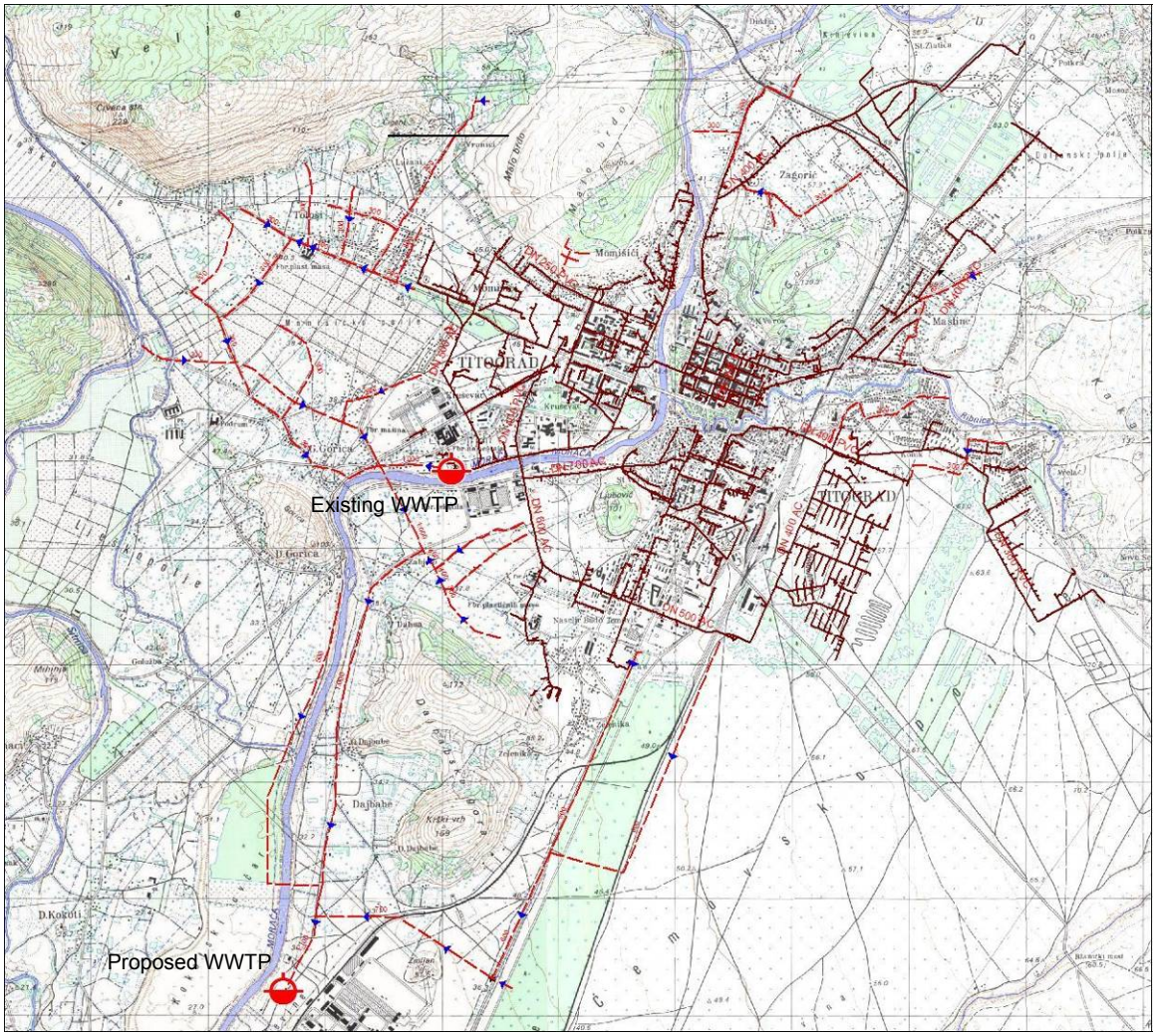


Figure 3.18: Layout of Existing Wastewater Network and Service Area

The vast majority of apartment buildings in the city are connected to the wastewater system but, as shown in Table 3.19, few of the individual houses are connected. At present nearly 60,000 private house residents are without sewerage service whereas the number for apartment residents is 6,000. It is noticeable that the numbers without sewerage service are increasing for both categories as more development of private houses and apartments takes place in areas not covered by the sewerage system.

Table 3.19: Domestic Water and Wastewater Connections

	2007	2008	2009
Water Supply			
Nr private house connections	18,761	18,998	20,081
Approximate number of consumers	60,000	60,800	64,300
Nr apartment connections	24,171	25,207	26,315
Approximate number of consumers	77,300	80,700	84,200
Wastewater			
Nr private house connections	1,300	1,307	1,404
Approximate number of consumers	4,200	4,200	4,500
Nr apartment connections	23,000	23,917	24,423
Approximate number of consumers	73.600	76,500	78,200
% wastewater: water private house connections	6.9%	6.9%	7.0%
% wastewater: water apartment connections	95.2%	94.9%	92.8%
Approx. nr private residents without sewer connection	55,800	56,600	59,800
Approx. nr apartment residents without sewer connection	3,700	4,200	6,000

Most of the private houses that are not connected to the wastewater network have septic tanks. These tanks generally allow the liquid faction of the sewage to soak into the permeable ground. Septic tanks are emptied when necessary by private contractors who dispose of the septage to the wastewater treatment plant or to particular manholes in the wastewater network.

Where houses are close to rivers are streams it is not unusual for septic tank effluent to be discharged directly to the water course. In a few cases untreated wastewater is discharged directly to water courses

3.2.2 Characteristics of the existing wastewater system

The sewerage system in Podgorica is a separate system, i.e. rainwater and wastewater are collected and discharged separately. Practically all wastewaters that are discharged through the public sewerage system are drained by gravity to the existing wastewater treatment plant. An exception to this is the area of the military facility Masline, where wastewater is pumped through the pressure pipeline, 150mm in diameter, in Goce Delceva Street, to a point where gravity discharge is continued. The total length of the wastewater network system is approximately 180 km.

The primary network with a length of 47 km was, for the most part, constructed in 1980, 1987, 1990 and 1995. Most of the pipes are Asbestos Cement (approximately 31 km of primary network). Another material widely used is PVC (approximately 12 km of primary network). The least used materials for primary network construction are ceramics (approximately 3 km of primary network) and concrete (approximately 750 m of primary network).

The majority of the primary pipes were built in 1980 (approximately 34.5 km). Subsequently approximately 1.7 km of primary network was built in 1987, approximately 2.8 km in 1990, and approximately 1.2 km in 1995. Considering the years of construction of the primary network, it may be expected that the network is average to good condition.

Pipes in the primary network were mostly constructed with the minimum permissible gradients for selected type of material the pipe (for example PVC – 0.0038 for pipes with 250 mm diameter, 0.002 for 400mm diameter pipe, 0.0015 for 500mm diameter pipe, 0.0012 for 600mm diameter pipe, 0.0010 for 700mm diameter pipe, 0.0008 for 800mm diameter pipe, 0.0007 for 900mm diameter pipe, and 0.0006 for 1000mm diameter pipe).

Pipe diameters in the primary network are 200 mm, 250 mm, 300 mm, 315 mm, 350 mm, 400 mm, 500 mm, 600 mm, 700 mm, 800 mm, 900 mm and 1000 mm. The average length of pipeline without a change its basic properties (diameter, material, descent) is 165m and the average distance between inspection chambers is around 60m. The maximum distance between inspection chambers is 290m, on the 800 mm diameter collector made of asbestos-cement near the Clinical centre, i.e. in the extension of the Ljubljanska street.

To date, ViK have entered details of 122707m of wastewater sewer in their GIS data base (see Table 3.20).

Table 3.20: Details of Wastewater Network from Data Base

Diameter (mm)	Length (m)
50	23.65
60	11.31
70	10.98
100	1032.14
110	612.7
120	8.9
125	635.39
150	8384.84
160	4595.25
200	33125.27
250	18329.48
300	14336.41
315	6442.24
350	4413.66
400	16921.39
500	3785.49
600	2150.9
615	106.71
630	416.39
700	1307.68
800	1817.98
900	193.18
1000	128.97
1600	458.92
Unknown	3457.25
Total	**122707.08**

There remain some 50 to 60km of network which are not in the data base and for which ViK do not have detailed information.

3.2.3 Pumping stations

There are two pumping stations in the system: one in Mojkovacka Street and the second in the area of the Masline military facility. The pumping station in Mojkovacka Street has two pumps with a capacity of 45 l/s, lifting height 15.5 m and power 5.5 kW.

ViK do not have any information about pump station in the Masline military area.

3.2.4 Storm water drainage

ViK maintains the street network and the system of storm water collectors in the area of the city of Podgorica. It has therefore started recording details of the system in their GIS data base and determining existing network condition, although the Municipality is responsible for investment in the storm water system. To date, 57.250m of storm water drains, 2.913 gutters and 279 manholes in the storm water system have been recorded in the data base. The layout of the storm water system is shown in Figure 3.19.

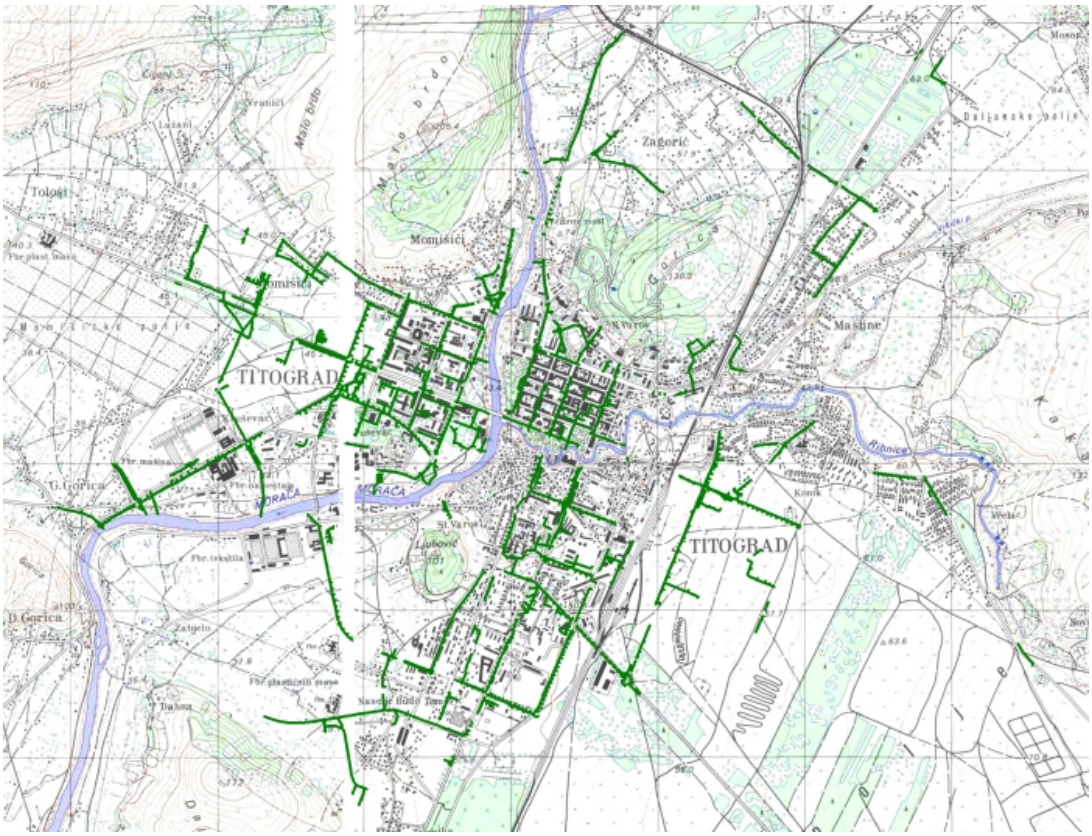


Figure 3.19: Layout of Existing Rainwater Network

3.2.5 Industrial Wastewater

The water consumption of the largest industrial and institutional consumers for the period beginning 2007 to end July 2009 is shown in Table 3.21 together with the monthly average, minimum and maximum quantities.

Discharge permits are issued by the Ministry for Spatial Planning and Environment and ViK Podgorica have to provide their approval. The wastewater statutory procedures have been clearly defined and the Polluter is required in accordance with the Regulation on wastewater discharge to the sewer system to comply with the given parameter of quality of discharged water. This means that it may be necessary that prior to discharge to municipal sewage system pre-treatment is carried out. Jurisdiction for the implementation of this decision is the Agency for Environmental Protection, as a state agency.

Table 3.21: Water consumption of largest industries and institutions

No	Industry/institution	Total m^3, period 2007 to July 2009	Monthly Water Consumption (m^3)		
			Min	Max	Average
1	Military barrack "Masline"	701275	0	37017	22622
2	Clinical centre –new hospital	630438	9968	43250	20337
3	Clinical centre –old hospital	160692	0	10133	5184
4	Hotel "Crna Gora"	134106	2351	5393	4326
5	Technical University "Veljko Vlahovic"	128591	1889	6086	4148
6	AD "Plantaze" wine cellar	114888	1127	7719	3706
7	AD "Plantaze"	112009	1139	7037	3613
8	DKP Cigarette Factory	108450	0	7015	3498
9	Students' dormitory -Restaurant	104944	93	5740	3385
10	Hemomont DOO	89114	1403	4121	2875
11	Medical institute	83242	1638	4087	2685
12	Pupils and students' dormitory	64323	0	4412	2075
13	Students' dormitory-Bloc 2	59727	0	2879	1927
14	Medical institute	58180	905	3039	1877
15	Airport of Montenegro	45439	0	3701	1466
16	Ministry of Internal Affairs	40558	451	3020	1308

It can be seen the majority of these consumers will produce wastewater of domestic nature. Questionnaires regarding wastewater quantity and characteristics were issued to industries by ViK in 2008. No detailed answers were received and ViK have advised us that the industries cannot be forced to reveal this data at present.

The only discharge having a significant on the operation of the existing treatment is AD "Plantaze" which, as discussed below, discharges wastewater with a high biological load at certain times of the year. Plantaze did cooperate with the study in providing information (see Section 4) and also cooperate with ViK. They have recently started paying penalties to ViK for the damage caused to the treatment plant.

Approximately 53% of the water supplied to industries is discharged to the wastewater network, the remainder normally being discharged to septic tanks. Over 86% of the water supplied to institutions is discharged to the wastewater network.

It should be noted that the largest industry in Podgorica (the aluminium plant, KAP) has its own water supply and does not discharge wastewater to the municipal sewerage system.

3.2.6 Problems in the existing wastewater network

Data provided by ViK indicates that there are a significant number of locations in the sewage network where repair interventions are quite frequent (often for the same problems).

Sections of the sewage network with most recorded interventions include:

- Proleterska – Vrela Ribnicka, 300 mm diameter, PVC, construction year 1987.
- Aerodromska – Stari Aerodrom, 300 mm diameter, AC, construction year 1995.
- Cvijetna – Stari Aerodrom, 300 mm diameter, AC, construction year 1995.
- Zmaj Jovina – Stari Aerodrom, 300 mm diameter, AC, construction year 1995.
- Žikice Jovanovica Španca – Vrela Ribnicka, 350 mm diameter, PVC, construction year 1987.

- II Sandžacke brigade – Vrela Ribnicka, 350 mm diameter, PVC, construction year 1987.
- Hercegovacka – Nova Varoš, 200 and 250 mm diameter, AC, construction year 1980.
- Karadjordjeva – Nova Varoš, 350 mm diameter, AC, construction year 1980.
- Vuka Karadžica – Nova Varoš, 350 mm diameter, AC, construction year 1980.
- Mitra Bakica – Drac, 200 mm diameter, AC, construction year 1980.
- Jerevanska – Zabjelo, nepozanto
- Svetozara Markovica – preko Morace, 200, 250 and 300 mm diameter, AC, construction year 1980.
- Vasa Raickovica – preko Morace, 200 and 250 mm diameter, AC and C (ceramics), construction year 1980.
- Džordža Vašingtona – Kruševac, 350 mm diameter, AC, construction year 1980.
- Trg Nikole Kovacevica – Blok V, nepoznato
- Serdara Jola Piletica – Momišici, 300 mm diameter, AC, construction year 1980.
- Dalmatinska – Blok V, 200 and 250 mm diameter, PVC, construction year 1980.
- Bulevar Svetog Petra Cetinjskog – preko Morace, 300 mm diameter, AC, construction year 1980.

As it can be seen from the list, almost all pipes in the relevant sections are old (the year of construction is mainly 1980). This may well explain the interventions on the AC pipes. Ceramic pipes have significantly longer service life than AC pipes, but as with AC pipes, ceramic pipes are also very brittle. These pipes can crack because of ground subsidence, due to the various construction works carried out in their vicinity. It can be noticed that the pipes that are repaired have small diameters, i.e. they are secondary network pipes. A certain amount of damage to these pipes is a result of unskilled (illegal) installation of household connections. In addition, a certain number of pipes, mostly ceramic ones, have been exposed to pressurised flow during the maximum flow periods and they sustained damage that tends to appear more and more frequently.

Table 3.22: Number of interventions in the sewage and storm water network for the period 2006-2009

Interventions		2006	2007	2008	2009
Sewage network					
Sewage network unclogging	In the sewage network and connections when reported	734	1223	1446	869
	Reconstruction and repair of malfunctions in the network and network structures(inspection chambers, pipes)		55	9	1
Unclogging connections to sewage	Invoiced to third parties		215	368	96
	Invoiced to the institutions of the city (Public Housing Agency, Secretariat for Utilities and Housing Services)		347	540	204
Pumping septic tanks	WU Sewage				41
	Individuals				16
	Legal entities				30
Current maintenance	Manual gutter covers digging out in the primary and secondary sewage	57	49	48	102
Storm water network					
Current maintenance	Repairs in the existing storm water network at locations where pipes have broken (earthworks, concrete and installation works)	55	5	10	3
	Manual cleaning of the gutter manholes and transport of materials to the dump	190	173	569	620
	Cleaning and pumping accumulated storm waters from roads and streets using faecal tank truck	174	91	70	51

3.2.7 Wastewater treatment plant

All wastewaters collected through the city sewerage system are drained to the waste water treatment plant in the settlement of "Krusevac" in the vicinity of the Krivi Bridge. The existing site is situated within the urban development area of the city. Commercial and residential developments in the surrounding areas are encroaching on the site and the land is planned to be used for housing in future. Existing housing areas are very close to the site and complaints are received about odour and other nuisance problems.

The plant was constructed based on the design made by the company “Hidroinzinering” from Ljubljana in 1978. Construction was envisaged in three stages, with total treatment capacity of 165.000 p.e. (population equivalent). Only the first stage of the wastewater treatment plant, with a capacity of 200l/s, was constructed, with a design biological load of 55.000 p.e. Mechanical and biological activated sludge treatment is used in the WWTP.

The current wastewater treatment plant of Podgorica was in operation from 1978 without any major refurbishing works being carried out until 2006. The rehabilitation of the existing plant which was completed in 2007, allows the sound operation of the plant until the start of operation of a new treatment plant.

The WWTP was designed with a capacity of 55,000 p.e. but the current load greatly exceeds this. In 2008 the average load received at the plant was approximately 112,500 p.e. Of this load 75,000 p.e. received biological treatment and 37,500 p.e. (i.e. one third of the flow to the treatment plant) received primary treatment only. In addition, a load of

an average of 16,600 p.e. bypassed the treatment plant and was discharged directly to the Muraca River without treatment.

The capacity of the WWTP is also limited by the inlet screw pumps which have maximum flow capacity of 360l/s (180 l/s capacity each). The capacity of the biological treatment stream is not much more than 200l/s and flows from the inlet pumping station in excess of this are discharged into the river via a by pass after receiving primary treatment. According to data provided by ViK the maximum recorded incoming wastewater flow to the WWTP site was about 1200 l/s in 2008. The excess quantity of wastewater that cannot be pumped to the WWTP is overflowed before the plant into the river without any treatment.

The monthly wastewater flows to the treatment plant for the last 4 years are shown in Figure 3.20. Flow measurement on the by-pass (no treatment) was only installed during 2008 and a lot of the apparent reduction of wastewater flows to the treatment plant in 2009 is related to more accurate flow measurement rather than any real reduction in flows.

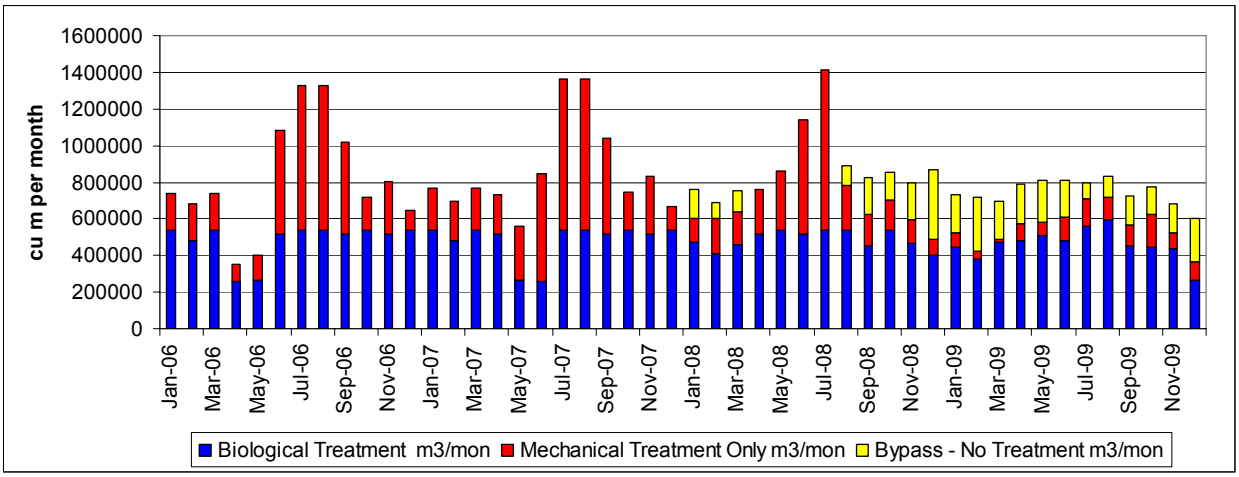


Figure 3.20: Wastewater flows received at Podgorica WWTP

The characteristics of the raw sewage, primary treated effluent and biologically treated effluent in terms of BOD_5 concentration are presented in Figure 3.21 for a period of 18 months.

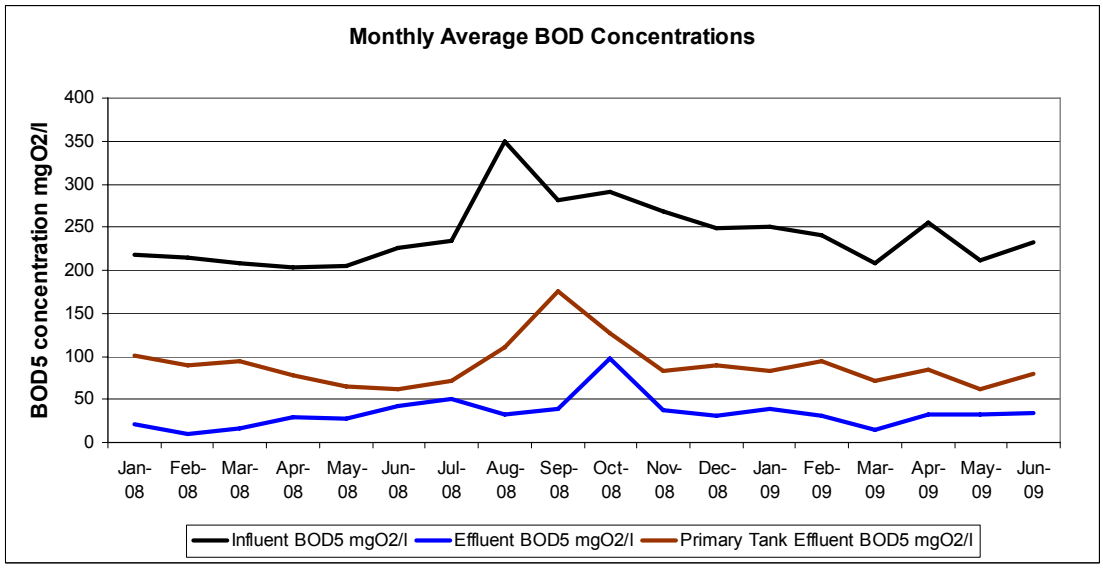


Figure 3.21: BOD_5 concentration of raw sewage and effluents

Considering the overloading of the treatment plant the effluent quality is generally quite good with the biologically treated effluent having an average BOD5 concentration of 36 mg/l in 2008. However, it can be seen that concentrations increase in the autumn and this is believed to be due largely to the wine producer AD "Plantaze" which discharges process wastewater with a high biological load to the city sewerage system at this time. Regulations require pre-treatment of industrial wastewater prior to discharge to the sewerage system but it is apparent from the analyses of raw sewage that this is not done effectively.

(a) Description of treatment units

The wastewater is brought to the treatment plant site by a DN 1000 collector. The raw water pump chamber is the first facility in the plant. After passing through the pump chamber, wastewater passes through two automatic coarse screens and enters the screw pumps chamber.

Three screw pumps (one standby pump), two of 180 l/s capacity and one of 370 l/s, are installed. The screw pumps raise the level of the raw wastewater and direct it to the fine (7 mm) screens. Two parallel automatic screens have been provided together with a screenings dewatering system.

Inlet screens and screw pump

Primary tank

Aeration tank

Sand, grease and floating debris are removed in two aerated channels. The grit and grease separator consists of two parallel 140 m^3 volume tanks. Sand settles to the bottom by gravitation while floating debris (grease) collects on surface of the tanks, the sedimentation and floatation processes being improving by aeration. There are two blowers: one duty plus one standby. The aeration is carried out by coarse bubble air diffusers at the bottom. The sand deposited in the two channels is removed by two grit pumps and transported to a silo mounted on the bridge-scraper. Segregated grease is removed from channel surface by a skimmer also mounted on the bridge.

There are storage and dosing facilities for ferric chloride to be added to the incoming wastewater to improve settlement in the primary sedimentation tank. The chemical dosing and storage facilities consist of: storage tanks; dosing pumps; filters; membrane pulsation dampers; static mixing; dilution units; service water units; pipes, valves and accessories; back pressure valves.

The process of primary settlement is carried out in one rectangular sedimentation tank of 1000m^3 volume. The bridge-scraper gathers the sludge from the tank floor as well as floating debris from the tank surface. The sludge travels toward the sludge chamber, from which it is overflowed into a sludge sump and then transferred to the raw sludge storage tank by means of submersible pump. Floating debris is collected into a channel and flushed with water into the storage sludge tank.

Secondary wastewater treatment by the activated sludge process is carried out in two 900m^3 volume aeration tanks. The dimensions of the aeration tanks are: 18 metres by 14 metres, with a depth of 3.9 metres. The aeration is carried out by a diffused air system. The aeration system consists of centrifugal air blowers, pipes and diffusers. The

sludge from the secondary clarifiers is recirculated by pumps into both activated sludge reactors.

The secondary clarification process is carried out in two rectangular secondary clarification tanks, 1000 m^3 volume each. The sludge is scraped from the chamber's floor by a system of chain scrapers. In normal flow conditions (approximately 200l/s), a return activated sludge rate of 100% is achieved using submersible pumps delivering to the aeration tanks.


Secondary tank


Sludge centrifuge


Dewatered sludge

All sludge from the primary sedimentation tank and all excess sludge from the secondary clarifier is directed to the sludge treatment facilities. All supernatant liquors and permeate from the sludge thickeners, filters or the decanter are returned to the inlet for treatment. The first facility of the sludge treatment line is a storage tank (formerly a sludge digestion tank) of 1800 m^3 volume. There is then a gravity sludge thickener, polyelectrolyte dosing, and sludge de-dewatering in a centrifuge. There is a lime storage and dosing facility designed to work in tandem with the sludge dewatering equipment. The dewatered sludge from the centrifuge can be automatically conveyed to the lime treatment facility. At present the dewatered sludge is stored on the site.

All control functions are monitored by a SCADA system which enables the operator to control all functions. The SCADA system also monitors and displays the status of all process information, raises alarms for all abnormal conditions and provides reporting and historical data storage. There are three flow measurement locations in the treatment plant: after grit removal, at the plant outlet and at the by-pass.

3.3 Comparative performance with other water companies

Operating performance of water and wastewater utilities can be assessed by comparing them with other similar utilities to gain an understanding of their comparative performance. The following section therefore compares operating performance indicators with a number of other towns in Montenegro. Since the most of these towns in Montenegro are relatively small, with varying sizes of service areas and rural populations, they are not directly comparable to Podgorica. The operating indicators for the Serbian cities of Subotica and Niš are also provided so that a comparison can be made with relatively similar utilities in the region, reflecting the impact of economies of scale.

(a) System Characteristics and Staffing

Staffing requirements for the operation of water utilities depend on a number of factors including:

- Type of water source
- Gravity or pumped supply
- Level of treatment

- Pipe density of system
- Number of connections
- Wastewater treatment

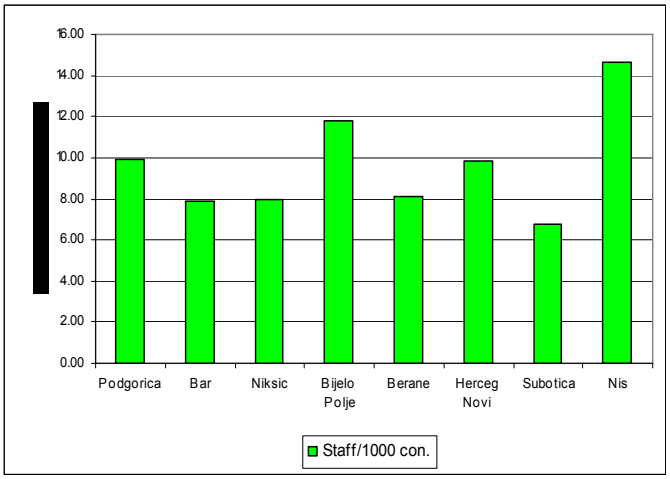
Table 3.23: Basic System Characteristics

	Podgorica	Bar	Niksic	Bijelo Polje	Berane	Herceg Novi	Subotica	Nis
Source	Spring & Boreholes	Spring & Boreholes	Spring	Spring	Spring	Lake Bileća	Boreholes	Spring
Pump/gravity	Pump	P & G	Pump	Gravity	P & G	Gravity	Pump	P & G
Treatment	Cl_2 only	Cl_2 only	Cl_2 only	Cl_2 only	Cl_2 only	Full	Full	Cl_2 only
WWTP	Yes	None	None	None	None	None	Yes	None
Pipe length/ connection (m)	15	24	23	22	21	27	14	17
Connections	37,300	18,749	19,500	6,950	7,620	14,719	34,757	49,868
Staffing/ 1,000 connections	9.9	7.9	8.0	11.8	8.1	9.9	6.8	14.7

All systems report nearly full metering and require staff for maintenance and repair, meter reading, billing and accounting. Additional staffing will be required for systems with pumping stations and treatment works. Systems with long gravity supply mains or extensive rural distribution systems, will also require higher levels of staffing compared to more dense systems.

The most common indicator for measuring staffing efficiency is the number of staff per 1,000 connections, which are shown in Figure 3.22 for each town studied under this programme. Bijelo Polje and Berane, are fairly small simple systems and require a minimum of staff but suffer from the fact that they are small and require the same minimum complement of staff that could operate and maintain a much larger system.

Figure 3.22 Staffing Efficiencies



The staffing level in Podgorica of nearly 10.0 appears relatively high given the size of the city. However, in addition to the water and wastewater systems the ViK Podgorica operates a rainwater drainage system and a wastewater treatment plant – the only operational treatment plant in the studied towns of Montenegro. The Podgorica water company recognises this, and is planning to introduce a programme to reduce staff, which would bring the staffing level down to a more reasonable ratio. Staff ratios should not, however, viewed in isolation

In global terms all the above staffing ratios are high, and this is a direct factor leading to high operating costs. However, these figures are not particularly high for the region. Although there are some areas where efficiencies can be gained, it will prove difficult for the individual towns to reduce these numbers significantly, particularly in the light of developing new infrastructure, which would need additional staff.

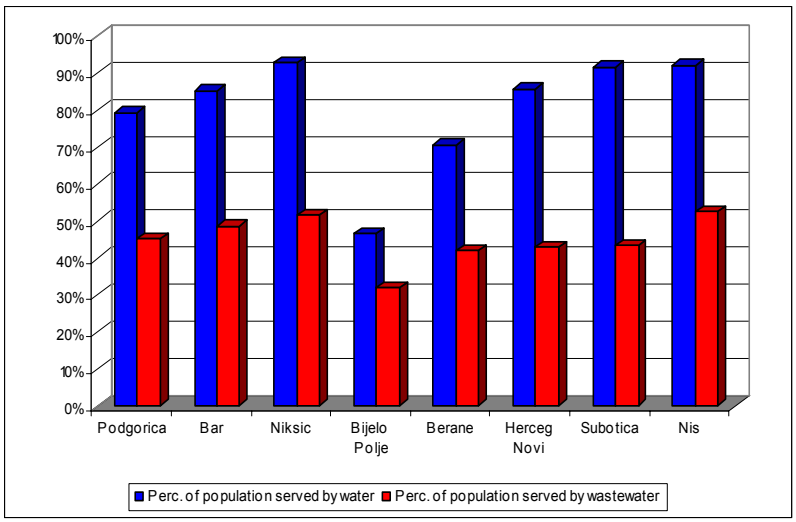
(b) Service levels

The water supply systems for the various towns all supply almost 100% of the urban population, but varying levels of the rural population.

Only Podgorica and Subotica have an operating wastewater treatment plant, but all have some wastewater collection.

A comparison of the level of the services provided to the respective municipal population (including both urban and rural) is shown in Figure 3.23.

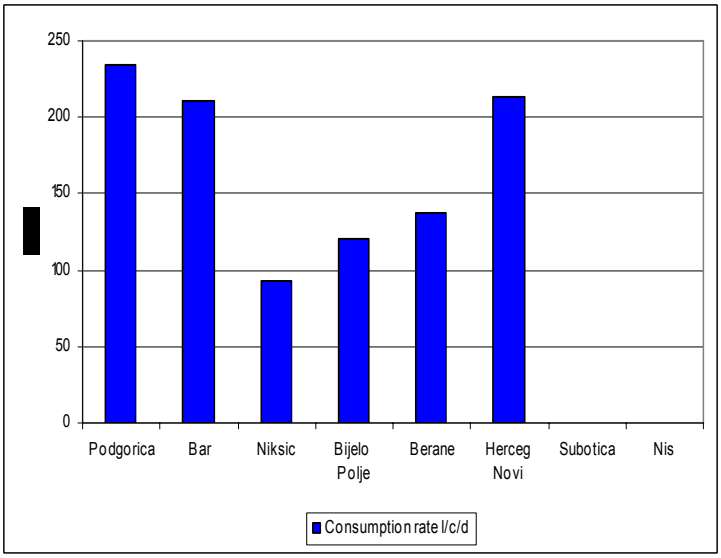
Figure 3.23: Percent of Municipal Population with Water and Wastewater Services



The per capita demand for each of the presented towns, as shown in Figure 3.24, varies from 90 litres per capita per day (l/c/d) to almost 240 l/c/d in Podgorica, averaging at around 170 l/c/d.

The high demands in Podgorica can be explained by a number of factors such as city status and higher development level, the warm climate and the low domestic water tariff. It is noticeable that consumption in the coastal areas of Montenegro is also high.

Figure 3.24: Per capita consumption(l/c/d)



For comparison, the average per capita consumption for 10 large regional water companies in the UK is 145 l/c/d for un-metered connections and 135 lcd for metered connections[3].

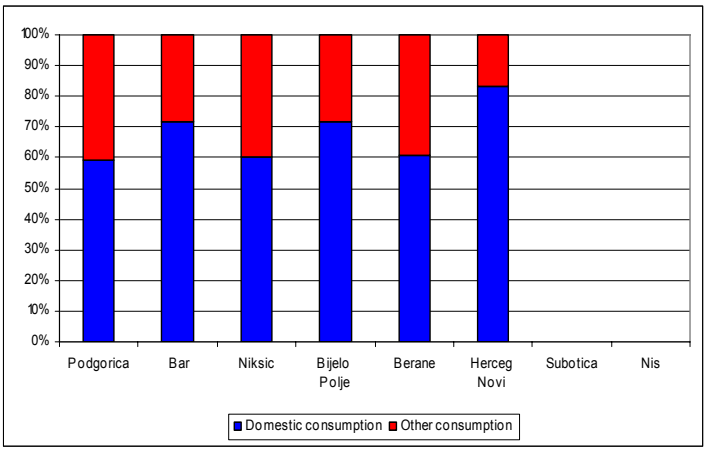
[3] Offwat 2000

(c) Structure of consumption

Domestic consumption forms the main component of demand in all towns, averaging at around 70% of all consumption. Industrial consumption of water in the region has decreased significantly over the last twenty years due to economic adjustments and transition since independence. As a result, the combined commercial and institutional demand now only represents on average around 30% of the total demand.

Note: Consumption ratio for Herceg Novi is questionable.

Figure 3.25: Structure of Consumption



(d) Unaccounted for water

A major indicator of operating efficiency is the level of unaccounted for water, or losses, which can be caused by a number of factors including:

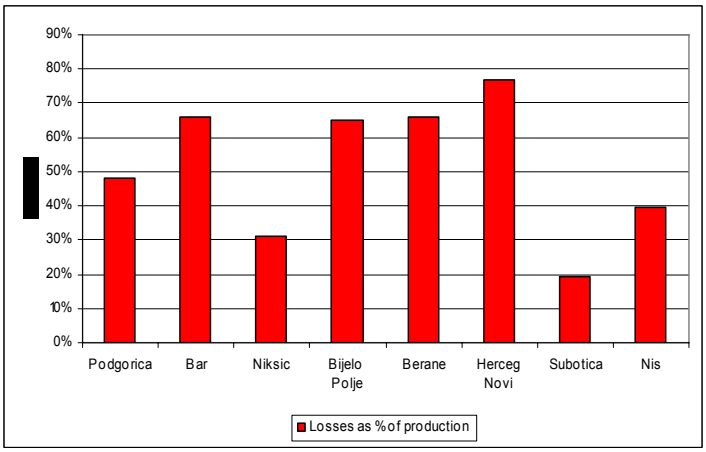
- Water losses through leakages and pipe bursts (physical losses)
- Faulty flow meters
- Under measurement by flow meters
- Un-metered connections
- Illegal connections

Well run systems in Western Europe are managed using the economic level of losses (the point at which the incremental cost of reducing the losses exceeds the incremental benefits). This level differs for different systems but is generally below 20%. The average level of unaccounted for water for 20 water companies in the UK is 16%, with a minimum of 9% (smaller utilities) and maximum of 26% (Thames Water)[4]. However, there is increasing pressure on these water companies to reduce losses even below the "economic" level for a number of reasons, including rising energy costs, concerns over conservation of increasingly scarce resources, accountability and pollution.

[4] BTNET Database (2003 figures)

Losses, as they increase over 30% have an increasing impact on the cost of running the network in terms of energy charges, over investment in infrastructure, and effort in repairs and maintenance. Losses over 50% represent systems that are highly inefficient and, unless these are due to exceptionally high levels of non physical losses, mean that they are also vulnerable to pollution. It can be seen from Figure 3.26 that Podgorica is near to this level although this is partly due to high non physical losses.

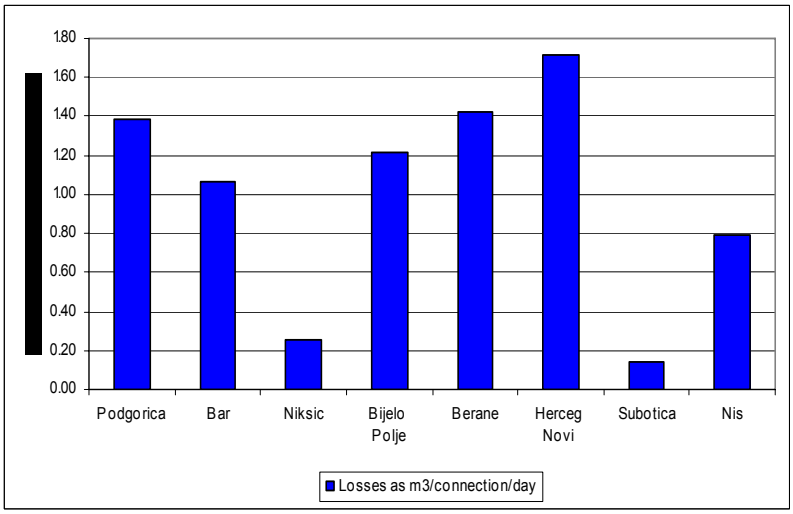
Figure 3.26: Losses as % of Production



Note: Losses for Bar include overflow and data for Herceg Novi is questionable.

Another widely used performance indicator for losses is the volume of unaccounted water per connection per day, and respective values are shown in Figure 3.27 If these values are compared with the UK average of 0.15 m^3/ connection/ day, it demonstrates that while Nikšić, and Subotica perform reasonably well, the losses in the other towns, particularly Podgorica and Berane (data for Herceg Novi is questionable), are well above acceptable levels.

Figure 3.27: Losses as m3/connection/day



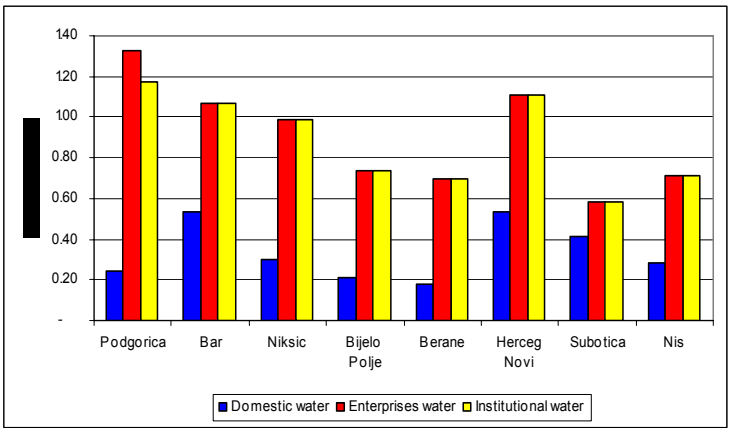
The nature of the unaccounted water can be deduced from the characteristics of the losses: Losses from leakage should remain roughly constant, whereas unmeasured consumption will reflect similar daily and annual characteristics as measured consumption.

It appears that unmeasured consumption constitutes a significant proportion of the losses in Podgorica, and an active policy towards reduction of such losses is warranted.

(e) Tariff Levels

Water tariffs for the individual towns are given in Figure 3.28, which shows that the commercial tariffs are generally twice as high as the domestic tariffs and very much higher than that in the case of Podgorica. Consideration needs to be given to whether these high non-domestic tariffs are acting as a constraint on demand and hence revenues, and also impacting economic development of the areas.

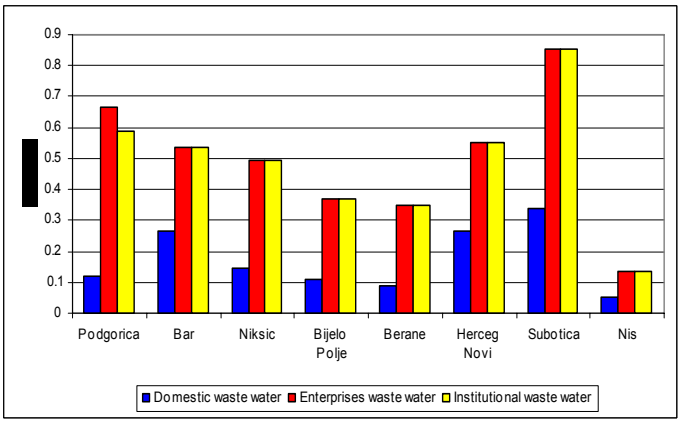
Figure 3.28: Water Tariffs (EUR/m^3)



It is of interest to note that Podgorica has very low domestic tariffs, despite the fact that in a capital city the income levels will be significantly higher. This results in a high level of consumer affordability, which contributes to the high per capita consumption level. It is suggested that consideration be given to increasing future domestic tariffs at a higher rate than non-domestic tariffs.

The wastewater tariffs shown in Figure 3.29 for the smaller towns tend to reflect the low levels of wastewater services provided and these will need to be increased to recover increased operating costs when the new infrastructure is commissioned. The highest tariff levels for Subotica can be explained with the fact that Subotica has an operational WWTP. On the other side, the domestic wastewater tariff for Podgorica is low considering that it is also the system with an operational WWTP. However, the relatively high non domestic tariffs are again evident.

Figure 3.29: Wastewater Tariffs (EUR/m^3)

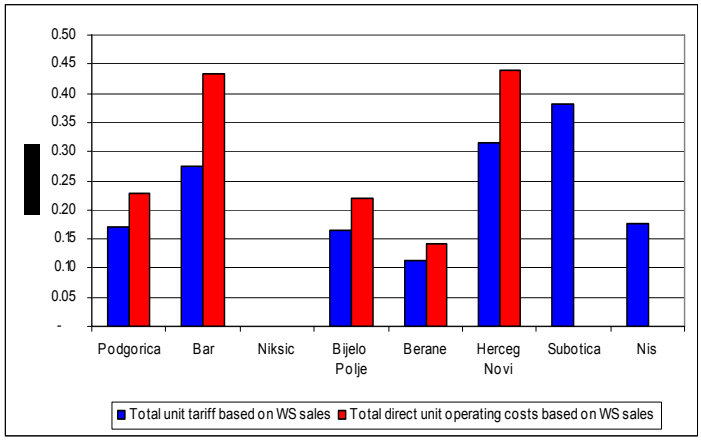


(f) Comparison of Average Unit Operating Costs and Average Tariffs

To provide an indication of the overall performance of the water and wastewater utilities, the combined direct unit operating costs for water and wastewater is shown in Figure 3.30. It can be seen that these vary from around 0.15 (Berane) to almost 0.45 EUR/m3 (Bar and Herceg Novi).

These costs can be compared to the combined average tariff for water and wastewater, calculated from the total billed revenue for water and wastewater divided by the total production for water.

Figure 3.30: Unit Operating Costs and Average tariff



It can be seen from Figure 3.30 that with the revenue for water and wastewater, presented towns do not even recover their direct operating costs in 2008. However, the data for Podgorica does reflect the influence of the new tariffs introduced from November 2008. Results for the first 9 months of 2009 indicate that ViK Podgorica has made a significant operating profit during this period. It should be noted that the above direct operating costs do not include depreciation, which if included would further reduce the financial performance of the utilities.

(g) Conclusions:

- It is clear that water and wastewater tariffs in the region are set to recover no more that the direct operating costs (although the situation in Podgorica has changed in 2009)
- It appears that maintenance and re-investment in old infrastructure have been neglected due to budget constraints,
- Apart from the recent tariff increases in Podgorica, little attempt has yet been made to set the tariffs at full cost recovery levels to generate surplus to finance capital investments in urgently needed water and wastewater infrastructure

4 Environmental review of existing situation

4.1 Regulatory Framework

4.1.1 Environmental Impact Assessment Procedures in Montenegro

Economic activities that could have a significant impact on the environment or are connected with the use of natural resources are permitted only after conducting an EIA.

The Law on Environmental Impact Assessment (EIA) (Official Gazette of the RM No 80/05) is in force since January 2008 and it prescribes procedures for carrying out an EIA for projects that may have significant impact on the environment, contents of the EIA study, participation of interested organizations and of the public, procedures for evaluating EIA studies and issuing approvals, notification of other states on projects with potential transboundary impacts, and other relevant issues.

The EIA procedure in Montenegro includes screening, scoping and review of EIA Report. These stages can be broken down into a number of steps, as indicated in a Table 4.1.

Table 4.1: EIA procedure – description of the steps required under Montenegrin legislation[5]

Action	Description
Request for determining the need for EIA (screening)	The EIA Law 80/05 refers to two groups of projects regarding the need for impact assessment; the Decree on projects subject to EIA (Official Gazette of Montenegro No 20/07) provides specific lists for each of the two groups: - projects for which EIA is mandatory (List I of the Decree); and - projects where an EIA procedure may be required (List II). For the List II projects, project proponent is obliged to submit to competent authority request for determining the need for EIA with the following supporting documentation (Article 10 of the EIA Law): 1. description of the location; 2. description of the project; 3. description of possible significant impacts on the environment; 4. completed questionnaire on environmental impacts of the project. The content of necessary documentation is detailed in the Rulebook on content of documentation to be submitted together with request for determination of the need for EIA (Official Gazette of Montenegro No 14/07). Competent authorities for EIA procedures are national level administration (Environmental Protection Agency) for projects where other state administration bodies act as consenting and permitting authorities and local (municipal) level administrations for projects where consenting and permitting procedures are handled by local governments.
Deciding on the need for EIA	Competent authority evaluates completeness of documentation submitted with the request and may require additional/ amended documentation from project proponent. Once the request is evaluated to be complete, competent authority will, within 7 days, inform interested bodies, organisations and public about the request. The

[5] In addition to the steps described in this box, relevant legislation prescribes procedures for notifying other countries in cases of possible transboundary impacts and ways in which the public is informed on different stages of the EIA process.

Action	Description
	information will in particular contain name/ title of the project proponent, title of the project, place and time when project documentation will be made available for review, and how/ to whom can interested parties submit their opinion on the request. The deadline for submitting opinions on the request is 10 days from the day of publishing the information. Competent authority decides on the need for EIA within 10 days following the expiration of the period for submission of interested parties' opinions and is obliged to consider these opinions in the decision making process.
Request for determining the scope and content of the EIA study	For the List I projects and List II projects where competent authority decided the EIA was necessary, project proponent may submit a request for determining the scope and content of the study (Article 15 of the Law). This request has to be accompanied with the following documentation (detailed in the Rulebook on content of documentation to be submitted together with request for determining the EIA scope and contents of the EIA study, Official Gazette of Montenegro No 14/07): 1. general information; 2. description of the location; 3. description of the project; 4. description of considered alternatives; 5. description of different segments of the environment; 6. description of possible significant environmental impacts; 7. description of measures planned to prevent, mitigate or eliminate significant negative environmental impacts; 8. summary of information listed above; 9. information on possible difficulties encountered by project proponent in collecting information and documentation; 10. completed questionnaire for determining scope and content of the study.
Deciding on the EIA scope and content of the study	Competent authority forwards the request and accompanying documentation to the EIA Commission within 5 days from the receipt of complete request. The Commission considers request and within 15 days issues a report with proposed scope and content of the EIA. Competent authority forwards this proposal to the project proponent and within 7 days informs interested bodies, organisations and public; interested parties have 15 days to submit their opinions. • Following the expiry of consultation period, competent authority has 20 days to decide on the scope and content for the given EIA process. Final decision on scope and content is sent to the project proponent and public is informed.
Request for issuance of consent (approval of EIA study)	Project proponent submits to competent authority request for approval of EIA study (Article 17 of the Law). If competent authority has previously issued a decision on the scope and content, the request for final ruling on the EIA has to be submitted within one year from the date of issuance of scope and content decision. The request is submitted together with the EIA study. The Study is constituent part of the documentation necessary for procurement of permits, approvals and consents for carrying out projects and eventually for procurement of operational permits. The EIA study contains all the information stipulated in the points 1 to 9 under the Step 3 above, environmental monitoring programme, and information on organisations and/ or persons that prepared the study and environmental monitoring programme. Detailed contents of the Study are prescribed under the Rulebook on contents of the EIA study (Official Gazette of Montenegro No 14/07). EIA studies may only be prepared by authorised entities/ persons that have adequate qualifications and expertise.
Public discussion	Within 10 days from the receipt of the request for EIA consent, competent authority informs interested bodies, organisations and public on the ways and timing/ deadlines for public disclosure of the EIA study, submission of objections and opinions, as well as on the time and place for holding the public discussion (the discussion may be at earliest organised after 20 days from publishing the

Action	Description
	information). Public discussion is organised and conducted by the competent authority.
Evaluation of the Study by the EIA Commission	An ad hoc EIA Commission is appointed by the competent authority (based on Article 21 of the Law) to advise on the scope and content of the EIA study (as discussed under Step 4) and to evaluate the EIA study. Members of the Commission are staff of the competent authority and other experts; size, composition and the way in which the Commission works are determined through a decision on its appointment. Those who have participated in preparation of the EIA study may not be appointed as Commission members for the given EIA process. Within 7 days from completion of the public discussion, competent authority forwards to the Commission the EIA study together with an overview of objections and opinions submitted in the course of public disclosure and public discussion. The Commission reviews the study and may require project proponent to submit additional information or to change/ amend the study. It is obliged to send a report on the study and proposal of the final decisions to the competent authority within 30 days from the receipt of the documentation (the deadline does not include periods left to project proponent to provide additional information, if such a request is made). Project proponent bears full costs of the EIA procedure.
Deciding on the request for EIA consent	Based on the report and proposal of the EIA Commission, competent authority brings final decision on the project proponent's request by either consenting to the project (approving the EIA study) or refusing the request. The decision has to be brought within 10 days from the receipt of the Commission's report and proposal, and is forwarded to the project proponent. Competent authority is obliged to inform interested bodies, organisations and public of the decision within 10 days from its issuance and to make the following documents available to interested parties: 1. content of the decision and conditions if they are set; 2. reasons underpinning the decision including the reasons for accepting or refusing submitted objections, proposals and opinions of interested parties; 3. as needed, description of the most important measures project proponent is obliged to implement in order to prevent, eliminate, mitigate or restore consequences of detrimental impacts. Consent to an EIA study becomes invalid if project proponent fails to procure permits or consents to carry out the project within two years from the issuance of the consent. Project proponent id obliged to implement all the measures envisaged in the study to which the consent is issued.

4.1.2 National legislation

Regulatory framework pertinent to the development and operation of water supply and wastewater disposal systems in Montenegro is a complex one, and is being increasingly aligned with relevant EU legislation as the country progresses with its accession agenda.

Local level/ municipal administrations i.e. public utility companies that are established and owned by municipalities are responsible for provision of drinking water and collection/ disposal of wastewater. The key piece of legislation that regulates operation of public utilities is the 1995 Law on Communal Services (Official Gazette of the Republic of Montenegro 12/95). Legal basis for participation of private sector in public utilities is the Law on Private Sector Participation in Delivery of Public Services (Official Gazette of Montenegro 31/02).

The Law on Communal Services defines what communal services are (e.g. provision of water, waste and wastewater collection, treatment and disposal, maintenance of public and parking areas, etc.), and determines main principles, general conditions

and manners of operation of public utilities. Responsibility for development of communal services is with local governments, who are also supervising public utilities providing them.

Environmental management (horizontal and sectoral), spatial planning and construction, as well as legislation on protection of cultural heritage makes an important segment of the regulatory framework for development and operation of water supply and wastewater disposal systems. An overview of the main pieces (primary legislation – laws) of environmental, planning and cultural monuments legislation is presented in the Table 4.2 below, while brief description of the laws (and related bylaws) that are most relevant for the Project is presented in the next sections.

Table 4.2: The key environmental, spatial planning and cultural heritage legislation

Environmental (horizontal and pollution prevention) legislation	Waste
Law on Environment Law on Environmental Impact Assessment Law on Strategic Environmental Assessment Law on Integrated Pollution Prevention and Control	Law on Public Sanitation, Collection and Use of Waste Law on Waste Management
Water	Planning and construction legislation
Water Law Law on Water Management Financing	Law on Spatial Planning and Construction
Nature	Cultural heritage
Law on Nature Protection Law on National Parks	Law on Protection of Cultural Monuments

(a) Environmental management

The key competencies for general environmental policy, environmental legislation and enforcement are vested with the Ministry of Spatial Planning and Environment (previously Ministry of Tourism and Environment) and the Environmental Protection Agency (EPA).

The Law on Environment (Official Gazette of Montenegro No. 48/2008) introduces integrated approach to environmental management and defines objectives and principles for environmental protection. Under this Law, Environmental Protection Agency (EPA) was established. Instruments for environmental protection specified under the Law and include, inter alia, environmental assessments, technical standards, integrated pollution prevention and control, prevention and control of accidents involving dangerous substances, Eco-Management and Audit Scheme, etc.

The Law defines scope and content of the monitoring programme and introduces obligation of self-monitoring for polluters. Setting up of an environmental information system, its contents, reporting obligations, public access to environmental information and justice are also regulated under the 2008 framework legislation. Other issues regulated under the Environment Law include liability for environmental damage, eco-labels, financing, and national plans and strategies required under certain multilateral environmental agreements.

The Law on Environmental Impact Assessment (EIA) (Official Gazette of the RM No 80/05) is in force since January 2008 and it prescribes procedures for carrying out an EIA for projects that may have significant impact on the environment, contents of the EIA study, participation of interested organizations and of the public, procedures for evaluating EIA studies and issuing approvals, notification of other states on projects

with potential transboundary impacts, and other relevant issues. Several bylaws have been passed in 2007 to enable implementation of the Law, including:

- Decree on projects subject to EIA (Official Gazette of Montenegro No 20/07) ;
- Rulebook on content of documentation to be submitted together with request for determination on the need for EIA (Official Gazette of Montenegro No 14/07);
- Rulebook on content of documentation to be submitted together with request for determining the EIA scope and contents of the EIA study (Official Gazette of Montenegro No 14/07);
- Rulebook on content, form and a way of keeping the public record on actions and decisions on EIA (Official Gazette of Montenegro No 14/07); and
- Rulebook on contents of the EIA study (Official Gazette of Montenegro No 14/07).

The EIA law and related secondary legislation are harmonized with the EU Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment, as amended by 97/11/EEC and 2003/35/EC.

Even though they are not directly relevant for the Project, a brief description of the laws on strategic environmental assessment and integrated pollution prevention and control is provided below, as they represent cornerstone legislation for overall environmental management in Montenegro.

The Law on Strategic Environmental Assessment (SEA) (Official Gazette of the RM No 80/05) came into effect in 2008, prescribing full procedure – from screening to approval stage – for assessment of impacts of certain plans and programmes on the environment through integration of principles of environmental protection into procedures for preparation, adoption and implementation of plans and programmes that have significant impact on the environment. The Law is aligned with the EU Directive 2001/42/EC.

According to the Article 5 of the Law, an SEA is mandatory for all the plans and programs for inter alia agriculture, forestry, water management, waste management, spatial plans etc., when they are laying down framework for future development of projects that are subject to EIA, as well as for plans and programs that considering the area within which they are carried out could affect protected areas, natural habitats and wild flora and fauna.

Another important piece of environmental legislation that came into force in 2008 is the Law on Integrated Prevention and Pollution Control (IPPC) (Official Gazette of the RM No 80/05 and 54/09). The IPPC Law regulates environmental pollution prevention and control through integrated permits for installations and activities that may have a negative impact on human health, the environment or material resources. It lays down measures designed to prevent or to reduce emissions to air, water and soil, including measures concerning waste, efficient energy consumption, reduction of noise and vibrations, use of raw materials, prevention of accidents, and risk assessment. The integrated permitting system is based on the concept of best available technique (BAT).

Several bylaws were passed under the IPPC Law including: the Decree on types of activities and installations subject to integrated permits (Official Gazette of Montenegro No 7/08) ; the Decree on criteria for determining best available techniques, for application of quality standards and for determining limit emission values in the integrated permit (Official Gazette of Montenegro No 7/08); and the Decree on content of the program of measures for adjusting the existing activities or

installations to prescribed conditions (Official Gazette of Montenegro No 7/08). Existing installations are required to comply with the IPPC requirements by 2015.

(b) Water management

The main competence is with the Ministry of Agriculture, Forestry and Water Management; executive water management tasks are assigned to Water Administration. There are ongoing discussions on shifting competencies for water quality management to environmental administration.

The Water Law (Official Gazette of the RM No 27/07) regulates status and the ways for managing all types of water, water resources and objects, as well as other matters of relevance for water resources management. The Law prescribes integrated river basin management, establishment of water information system, sustainable development, long-term protection of water quality, economic water pricing in line with the 'user/ polluter pays' principle etc. The Law is partly harmonised with the Water Framework Directive 2000/60/EC (WFD). Further transposition of the EU water legislation is addressed/ planned through adoption of bylaws (around 20 envisaged under the Water Law, some of which have already been adopted).

The Decree on categorisation of surface and groundwater (Official Gazette of Montenegro 2/07) prescribes standards which have to be met for different categories of water bodies depending on intended water uses. The Decree refers to three principal water uses, namely for the use of water for drinking and food processing, fishing and shells production, and bathing.

Water classes are prescribed for each water use, and limit values for relevant parameters (indicators of quality) are set. Waters that can be used for drinking and in food processing industries can be assigned to one of the four classes: 1) class A – water suitable for drinking in its natural form (with possible disinfection); 2) class A1 – water that can be used for drinking after simple physical treatment and disinfection; 3) class A2 – water that can be used for drinking only after appropriate treatment (coagulation, filtration and disinfection); and 4) class A3 – water that can only be used for drinking after an intensive physical, chemical and biological treatment with extended disinfection and chlorination, i.e. coagulation, flocculation, decantation, filtration, active coal absorption and ozone/ chlorine disinfection.

Limit values for a selected number of a total of parameters pertinent to different water classes is provided in the Table 4.3 below.

Table4.3: Limit values for some of the key parameters defining water quality classes A – A3

	Parameters	Units	A	A1	A2	A3
1	pH		6.80-8.30	6.80-8.50	6.50-8.50	5.50-9.00
2	Colour (after simple filtration)	mg/l Pt scale	5	5	10	20
3	Turbidity	NTU	1	5	5	10
4	Total suspended matter	mg/l	0	<10	20	50
5	Temperature	˚C	8-12	9-12	30	30
6	Conductivity	µs/cm at 20˚C	300	400	600	1000
7	Nitrates	mg/l	10	20	25	50
8	Nitrites	mg/l	< DL*	0.003	0.005	0.02
9	Cadmium	mg/l	0.000	0.001	0.005	0.005
10	Lead	mg/l	0.001	0.010	0.05	0.05
11	Selenium	mg/l	0.001	0.001	0.010	0.010
12	Mercury	mg/l	< DL*	< DL*	0.0005	0.001
13	Cyanides	mg/l	< DL*	0.001	0.005	0.005
14	Sulphates	mg/l	20	20	50	200
15	Chlorides	mg/l	10	20	40	200
16	Total mineral oils	mg/l	< DL*	0.01	0.05	0.5
17	PAHs	mg/l	< DL*	0.0002	0.0002	0.001
18	Total pesticides	mg/l	< DL*	< DL*	0.001	0.0025
19	COD	mg/l O_2	1	2	4	8
20	Oxidisability	mg $KMnO_4$/l	5	5	8	8
21	BOD5	mg/l O_2	2	3	4	7
22	Total organic carbon	mg/l	1	1	2	2,5
23	Total coliform bacteria 37˚C	/1ml	10	10	500	5000
24	Faecal coliform bacteria	/100ml	10	20	2000	20000

* DL – detection limit

Regarding fish and shell production, waters are, based on limit values for 10 parameters, classified into three categories: 1) class S – waters that can be used for salmonid fish farms; 2) class Š – waters suitable for shells; and 3) class C – waters suitable for cyprinid fish farms.

Bathing waters are assigned to one of the two possible classes: K1 – excellent, and K2 – satisfactory bathing water. Limit values for sea bathing waters for intestinal enterococci for class K2 is 200 / 100 ml, and for Escherichia coli 500/ 100 ml.

The Decree also prescribes sampling and reference water testing methods for classification. Finally, all water bodies are categorised as on of three possible categories based on assigned classes:

- Category I – freshwater classes A1, S and K1, as well as marine waters class Š
- Category II – classes A2, C and K2
- Category III – class A3 (and other waters falling outside prescribed classes).

Moraca river upstream from Podgorica is Category I watercourse, and downstream from Podgrica Category II.

Rulebook on conditions for discharging wastewater into recipients and sewage systems (Official Gazette of Montenegro 45/08) prescribes standards that need to be achieved when discharging all types of wastewater (urban, industrial, cooling, atmospheric etc.). Maximum allowed concentrations (MACs) in the effluent are set for a large number of parameters (50 for discharges into public sewage systems i.e. 53 for discharges into recipient waters; full overview of discharge standards is provided in Appendix B) including pH, temperature/ temperature change, suspended matter, BOD5, COD, heavy metals, phosphorus, nitrogen, phenols, fluorides, mineral oils, PAHs, pesticides, detergents etc. Standards for discharges into recipient waters are differentiated depending on whether recipient waters are classified as category I (stricter effluent standards) or categories II and III.

EU Directive 91/271/EEC on Urban Wastewater Treatment (UWT) prescribes a time-bound schedule by which Member States have to provide for (secondary) treatment of urban wastewater depending on the size of respective agglomerations. It introduces a distinction between recipient waters and prescribes more stringent standards for effluent discharges into sensitive areas (subject to eutrophication). Standards are either expressed as concentrations of the key pollutants that have to be achieved through treatment or as minimum percentage reduction in pollution loads of the influent. Pre-treatment for industrial waste water entering collecting systems and urban waste water treatment plants is mandatory. The Directive also prescribes reference methods for monitoring the effluent quality and minimum annual number of samples depending on the size of WWTP.

Table 4.4 Comparison of the EU and Montenegrin requirements for wastewater treatment/ discharges into natural recipients (overview for the key pollutants)

Parameters	**EU requirements**		**Montenegrin requirements**	
	Concentrations	Minimum % of reduction	Maximum allowed concentrations	
	All receiving waters		I category waters	II and III category waters
BOD_5	25 mg/l O_2	70 - 90 40 under Article 4 (2)	25 mg/l O_2	40 mg/l O_2
COD	125 mg/l O_2	75	90 mg/l O_2	125 mg/l O_2
Tot suspended solids	35 mg/l * 35 under Article 4 (2) (more than 10,000 p.e.) 60 under Article 4 (2) (2,000-10,000 p.e.)	90 * 90 under Article 4 (2) (more than 10,000 p.e.) 70 under Article 4 (2) (2,000-10,000 p.e.)	30 mg/l	60 mg/l
	Sensitive areas			
Total phosphorus	2 mg/l (10,000 - 100,000 p.e.) 1 mg/l (more than 100,000 p.e.)	80	1 mg/l	2 mg/l
Total nitrogen	15 mg/l (10,000 – 100,000 p.e.) 10 mg/l (more than 100,000 p.e.)	70 – 80	10 mg/l	15 mg/l

In comparison with the EU, Montenegrin legislation (Water Law and Rulebook) does not include standards expressed as percentage reduction of pollution load, does not differentiate between effluent standards depending on the size of WWTP, nor does it make distinction between sensitive and other waters (but refers to national categorisation of waters). Finally, Montenegrin legislation does not include a time bound plan for provision of urban wastewater treatment and refers to all wastewaters. Sampling frequency is determined based on the point of discharge and dissolving coefficient, i.e. based on the total quantity of wastewater.

The Rulebook on Hygienic Appropriateness of Drinking Water (Official Journal of FRY, 42/98 and 44/99) prescribes drinking water quality standards by setting maximum allowed concentrations (MACs) for a large number of parameters. In particular, the Rulebook defines:

- micro-biological properties that have to be attained for drinking water (List I of the Rulebook);
- MACs for chemical substances (inorganic, organic and pesticides - Lists IIIa, IIIb, and IIIc);
- MACs for remainder of coagulation and flocculation agents (List IV);
- MACs for remainder of disinfection agents (List V); and
- required physical, chemical and physical-chemical properties (List VI).

The Rulebook also prescribes standards for bottled water. Furthermore, the Rulebook defines several types of analyses (monitoring) that need to be conducted to determine whether drinking water is hygienically appropriate. These include basic, periodic, analyses of new water supply sources and special analyses based on hygienic and epidemiological indications. Frequency and number of parameters that are tested depend on the type of analysis. For example, basic monitoring of micro-biological properties is done for the following micro-organisms: coliform bacteria of faecal origin; total coliform bacteria; streptococci of faecal origin; proteus spp.; sulphites-reducing clostridium; Pseudomonas aeruginosa; and total number of aerobic mesophylic bacteria. In additions to these, periodic analyses need to cover presence of enteroviruses in drinking water (when source of extraction is surface water) and intestinal protozoa (when there are hygienic and epidemiological indications for such analyses).

Regular analyses of drinking water i.e. basic and periodic analyses refer to, respectively, 17 and 21 physical-chemical parameters including temperature, colour, odour, turbidity, pH, ammonia, residual disinfection agents, chlorides, nitrates, nitrites, fluorides, phenols, detergents, iron, manganese, etc. Water is tested for presence of a set of chemical substances (inorganic, organic and pesticides - stipulated in Lists III a, b and c of the Regulation) only for new water sources or at least once in three years.

Number of samples is determined based on the number of population equivalents (PE) supplied through the network (whereas one PE is defined as daily consumption of 150 l). For a system with a capacity of more than 400,000 PE, it is mandatory to test 360 samples of raw water annually, including 348 basic and 12 periodic analyses. Raw water samples need to be taken from all the water supply sources (if they are directly linked to a supply network) or from the main collector/ raw water reservoir in case water supply sources feed into a joint system prior to distribution. Furthermore, sampling has to cover drinking water reservoirs and water supply network. Number of points on the network from which samples are taken is determined based on the capacity: for a system supplying 400,000 – 600,000 PE, samples need to be taken from 15 points (plus one additional point per each additional 200,000 PE).

The Drinking Water Directive (DWD) 98/83/EC regulates the quality of water intended for human consumption. Its objective is to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean.

To make sure drinking water everywhere in the EU is indeed healthy, clean and tasty, the Drinking Water Directive sets standards for the most common substances (so-called parameters) that can be found in drinking water. According to DWD, a total of 48 microbiological, chemical and indicator parameters – set out in Annex I – have to be monitored and tested regularly. The Directive requires that drinking water is free from any micro-organisms and parasites and from any substances which, in numbers or concentrations, constitute a potential danger to human health, such as Escherichia coli and Enterococci listed in Annex I, Part A, and that it meets minimum requirements for chemical parameters set in Annex I, Part B, such as benzene, benzo(a)pyrene, heavy metals, cyanide, 1,2-dichloroethane, epichlorohydrin, fluoride, nitrate, nitrite, pesticides, PAHs, etc. As for indicator parameters (Annex 1, Part C), DWD inter alia prescribes standards for aluminium, ammonium, chloride, Clostridium perfringens (including spores), colour, conductivity, iron, manganese, odour, sulphate, taste, coliform bacteria, total organic carbon, and turbidity.

For a selected number of parameters, a comparison between requirements set under EU and Montenegrin legislation is provided in the Table 4.5 below

Table 4.5: Comparison between EU and Montenegrin drinking water standards for selected parameters

Parameter	EU	Montenegro		MN standard is
	µg/l	mg/l		
Acrylamide	0.1	0.00025		Weaker
Aluminium	200	0.2		Same
Arsenic	10	0.01		Same
Benzene	1	0.001		Same
Benzo(a)pyrene	0.01	0.00001		Same
Cadmium	5	0.003		Stricter
Chromium	50	0.05		Same
Copper	2 mg/l	2		Same
Cyanide	50	0.05		Same
1,2-dichloroethane	3	0.003		Same
Epichlorohydrin	0.1	0.0004		Weaker
Fluoride	1.5 mg/l	1.2		Stricter
Lead	10	0.01		Same
Mercury	1	0.001		Same
Nickel	20	0.02		Same
Nitrate	50 mg/l	50		Same
Nitrite	0.50 mg/l	0.03		Stricter
Pesticides - Total	0.5	0.5 µg/l		Same
PAHs	0.1	0.0002		Weaker
Selenium	10	0.01		Same
Tetrachloroethene and Trichloroethene	10	0.04	Tetrachloroethene	Weaker
		0.07	Trichloroethene	Weaker
Trichalomethanes - Total	100	0.1		Same
Ammonium	0.5 mg/l	0.1		Stricter
Chloride	250 mg/l	200		Stricter
Clostridium perfringens	0/ 100 ml	0/ 100 ml		Same
Iron	200	0.3		Weaker

Manganese	50	0.05	Same
pH	6.5 - 9.5	6.8 - 8.5	Similar
Coliform bacteria	0/ 100 ml	0/ 100 ml	Same
Turbidity	Acceptable	1 NTU	non-comp

As for the monitoring, the Drinking Water Directive distinguishes between check monitoring (regular monitoring done for a limited number of parameters) and audit monitoring, which is done for all the parameters prescribed by the Directive. Frequency of testing is determined based on the quantity of water pumped by the given supply system. For example, if the daily volume of distributed water exceeds 100,000 m^3, annual number of samples for check monitoring is 4 plus 3 for each additional 1,000 m^3/d, while as the number of audit monitoring samples per year is 10 + 1 for each additional 25,000 m^3/d.

Drinking water standards for specific parameters applied in Montenegro are in some cases stricter (lower concentrations are permitted) than those in the EU, however there are several parameters where Montenegrin legislation allows concentrations higher than those prescribed under the DWD. This means that national legislation is not harmonised with the EU Directive, which sets minimum requirements (meaning that national legislators may opt for more but not less stringent standards).

The EU monitoring system is focused on the 'point of compliance' – parametric values are to be complied with at the point where water intended for human consumption is made available to the appropriate user, whereas Montenegrin system is designed in a way that pays equal if not greater attention to raw (extracted) water compared to water supplied to consumers. As for the frequency of testing, much larger number of analyses is required under Montenegrin legislation. The EU requirements are on the other hand more rigorous in respect to number of parameters that have to be tested: audit monitoring (covering all the DWD parameters) is done regularly, while is in Montenegro the full set of parameters is checked only for new water sources or once in three years. The Law on Water Management Financing (Official Gazette of Montenegro 65/ 08) determines water management financing sources, prescribes manners of calculating and paying water use and water protection charges, and regulates other matters of significance for the use of the funds raised from water charges. Water protection charge is paid for direct or indirect pollution of recipient waters proportional to the pollution potential of the effluent/ polluting activity.

(c) Waste management

Waste management is one of the competencies of the Ministry of Spatial Planning and Environment and related environmental institutions (such as EPA). As mentioned earlier, communal waste collection, removal and disposal is a competence of local level administrations and related public utility companies.

The Waste Management Law (Official Gazette of the RM, No. 80/05) regulates types and classification of wastes; planning of waste management; conditions for waste collection, transport, treatment, storage and disposal; rights, duties and responsibilities of legal and physical persons involved in waste management; and conditions and procedures for waste management permits. It also defines principles for managing specific waste streams, sets basic provisions for waste incineration, etc.

The Law transposes a significant share of provisions of Waste Framework Directive 2006/12/EC and Hazardous Waste Directive (Directive 91/689/EEC, as amended by Directive 94/31/EC). Its adoption also marked a significant progress in transposition of the Landfill Directive 99/31/EC, as amended by Regulation (EC) 1882/2003.

Transposition of the rest of the complex EU waste legislation, however, remains on rather low level.

The Law was planned to come into force in November 2008, but due to a delay in fulfilling conditions for its implementation, the coming into force for a number of provisions was postponed for 1 January 2010 . Until the Law comes into effect fully, provisions of the old Law on Public Sanitation, Collection and Use of Waste (Official Gazette of the Republic of Montenegro 20/81, 27/94) also apply. In addition, the Decree on sanitary and technical conditions for waste disposal (Official Gazette of the Republic of Montenegro 20/83) regulates operation of waste disposal sites.

Transposition of the Sewage Sludge Directive 86/278/EEC, as amended by the Directive 91/692/EC and Regulation (EC) 807/2003 is underway, as the Government drafted relevant bylaw that is now pending adoption. The EU Directive seeks to encourage the use of sewage sludge in agriculture and to regulate its use in such a way as to prevent harmful effects on soil, vegetation, animals and man. To this end, it prohibits the use of untreated sludge on agricultural land unless it is injected or incorporated into the soil. The Directive also requires that sludge should be used in such a way that account is taken of the nutrient requirements of plants and that the quality of the soil and of the surface and groundwater is not impaired. The Directive specifies rules for the sampling and analysis of sludges and soils. It sets out requirements for the keeping of detailed records of the quantities of sludge produced, the quantities used in agriculture, the composition and properties of the sludge, the type of treatment and the sites where the sludge is used.

Available reports on transposition of the EU acquis on waste point out that the existing definitions of sewage sludge in the Waste Management Law are not fully consistent with the Directive 86/278/EEC. Until the adoption of secondary legislation on the use of sewage sludge and further transposition of the Landfill Directive, disposal of sludge generated through the operation of WWTPs remains unregulated.

The forthcoming bylaw is expected to prescribe limit values for disposal of sewage sludge on agricultural land, as well as ways for setting up a system of sludge disposal control and control of untreated sludge introduced into soil. Sewage sludge generators will be obliged to provide information on the quality of sludge to the users (in line with Article 52 of the Waste Management Law, which needs further harmonisation with the Directive 86/278/EEC).

(d) Nature protection

Ministry of Spatial Planning and Environment and related environmental institutions such as EPA, Nature Protection Institute and Protected Area (PA) managers are responsible for nature/ biodiversity protection. Local level administrations also have a role through their competencies for establishment and management of certain categories of PAs.

The new Law on Nature Protection was adopted in August 2008 (Official Gazette of Montenegro No. 51/08) aiming to transpose into the national legislation Habitats (92/43/EEC) and Birds (79/409/EEC) Directives, and Regulation (EC) 338/97 on the protection of species of wild fauna and flora by regulating trade. The rationale for the adoption of the Law was to improve some of the outdated solutions from the old law, introduce an EU compliant categorization of protected areas, prescribe procedures for designation of protected areas and set a legal basis for establishment of Natura 2000 network. Provisions on public participation, landscape and soil protection (the latter only from nature conservation perspective) are also included in the Law.

The Law provides for integration of nature protection requirements into planning, land and natural resources use, and regulate procedures for issuance of consents for works and activities that may affect nature and protected areas, as well as mitigation

and/ or compensatory measures for damages that might be inflicted to natural assets through such works and activities. The Law further prescribes requirements for protection of habitats, ecosystems (forest, wetland and water ecosystems, marine ecosystems, agro-ecosystems) genetic diversity, landscape protection, and for protection of speleological objects.

Protected natural assets are defined under the Law as sites with pronounced biological, geological, ecosystem or landscape diversity, and they encompass protected areas (localities), protected plant, animal and fungi species, and protected geological and speleological objects. Six categories of protected areas are envisaged under the Law and these are: 1) Strict and special nature reserves; 2) National parks; 3) Regional parks and nature parks; 4) Natural monuments; 5) Protected habitats; and 6) Landscapes with outstanding features.

In addition to protected sites, the Law prescribes protection regimes that apply to certain species (strictly protected ones and species of significance for Montenegro), and geological and palaeontological objects. Species protection is regulated in detail under the Decision on Placing under Protection Rare, Declining, Endemic and Endangered Plant and Animal Species (Official Gazette of the RM, No. 76/06) and Decision on the Control List for Import, Export and Transit of Goods (Official Gazette of the RM, No. 19/06). The Decision 76/06 refers to/ protects 417 plant and 423 animal species.

Preparation of secondary regulations is ongoing/ planned, in order to complete legal framework for nature protection and harmonise it fully with the EU acquis in this area (including e.g. rulebook on habitat types, endangered and rare habitats, Red Book of species, etc.).

National parks are managed based on the new Law on National Parks (Official Gazette of Montenegro No 56/09); previously, the 1991 national parks legislation applied. The Law defines borders, protection measures, permitted use of natural resources in the parks, and how the national parks are managed. Five national parks designated and managed under provisions of this Law are: Biogradska gora, Durmitor, Skadar Lake, Lovcen, and Prokletije National Parks. National parks are managed by Public Enterprise National Parks (PENP) of Montenegro.

(e) Protection of cultural heritage

The Law on the Protection of Cultural Monuments (Official Gazette of the Republic of Montenegro 47/91, 27/94) prescribes what constitutes a cultural monument (what categories exist and how are they defined), the procedures on how cultural monuments are proclaimed, registered and managed, what protection measures are applied, etc. Designated responsible institution is Republican Institute for Protection of Monuments (under the administrative supervision of the Ministry of Culture, Sports and Media). The new Law on Cultural Assets is under preparation.

Articles 58 - 60 of the Law on Protection of Cultural Monuments prescribe how/ under which conditions works on cultural monuments can be performed ('works' meaning any action that can cause changes on a monument). Articles 69 – 70 of the Law regulate procedures in case of ‘chance finds’: when objects with potential archaeological significance are found during construction works, the investor is obliged in to notify the Republican Institute, which visits the site, makes a report and orders a survey to determine whether the site (lower layers) contains other potential findings. The costs are borne by the investor.

4.1.3 Compliance issues

Existing wastewater system in the city of Podgorice does not currently meet national or international standards for wastewater discharge quality.

Wastewater discharges will not currently be meeting national or international standards and will be contributing to the pollution load entering the Moraca river which flows into ... protected Skadar lake which is of international importance.

Improvements to the water supply system are identified in this feasibility study as desirable and necessary in order to achieve stable, undisturbed provision of water to the inhabitants of Podgorice municipality.

Traditionally, compliance with environmental legislation has not been on satisfactory level in Montenegro. Despite the growing efforts to improve the situation – including awareness raising and creation of incentives for voluntary compliance as well as strengthening of enforcement capacities, there are still widespread examples of non-compliance. Since recently, the situation is made more complex by adoption of new regulations (as a part of harmonisation with the EU environmental acquis) the implementation of which has, for various reasons, proved to be difficult. Some examples of non-compliance that are directly relevant to the Project include failures, on part of many generators of wastewater, to monitor quantity and quality of wastewater and report on it, as well as to provide for pre-treatment of certain industrial wastewaters prior to discharge into sewage network.

Enforcement of environmental and other legislation relies on different inspectorates, the key ones of significance for the Project being environmental, water, and spatial planning/ construction inspectorates. Environmental monitoring and permitting systems are also important tools for ensuring compliance with legal requirements.

Environmental monitoring programme in Montenegro is designed by competent authority (now EPA, previously environment ministry) and it covers various environmental media and themes, including air, soil, ionising radiation, noise, biodiversity (since 2001) and seawater (since 2008). Water monitoring (freshwater, groundwater) is not a competence of environmental but of water management administration , and as such it has been a subject to changing approaches during the past years. There is no specific programme for waste. However, some waste monitoring activities are taking place through efforts of the national statistical office to gather data on collected municipal waste. In addition to the national monitoring programmes, local self-governments can, through their own decisions, prescribe specific monitoring programmes.

National monitoring programmes are executed by different institutes under specific service contracts. Recent practices show that monitoring programmes for air, noise, ionising radiation and soil contamination are executed by Centre for Eco-toxicological Research, while Nature Protection Institute carries out biodiversity monitoring. Marine Biology Institute is involved in recently established programme for seawater quality monitoring. Monitoring of water quality is conducted by Hydro-meteorological Institute as a part of their regular activities (i.e. not as contracted service).

Based on the results of monitoring programmes, Environmental Protection Agency prepares annual reports on the state of the environment (previously, this was a task of environment ministry).

Obligation of self-monitoring for polluters is rarely if at all applied, and consequently there are no cadastres of polluters for different environmental media.

Monitoring of drinking water quality is under overall competence of the Ministry of Health, and is executed by Public Health Institute under service contracts with various water supply companies.

As for the environmental permitting, a number of permits and consents has to be procured from competent authority (now EPA) for activities impacting on the environment. These include permits for hazardous waste transport and export, import and export of sources of ionising radiation and ozone-depleting substances, permits for trade with CITES species, and decisions and consents in the EIA and SEA procedures. Once the 2005 Waste Management Law comes into effect, EPA will be in charge of issuing waste permits and consents for waste management plans, in line with provisions of this Law. EPA will be also in charge for issuing integrated environmental permits for facilities subject to the Law on Integrated Pollution Prevention and Control.

Environmental inspectorate is since 2009 located within the Environmental Protection Agency; previously, it used to be part of the supervision/ enforcement capacity of environment ministry. It is a growing sector of the EPA, meant to carry out all the inspection tasks related to enforcement of a complex body of environmental legislation. Environmental inspectorate performs regular (planned) and random/ irregular inspections and has a mandate to issue recommendations and fines, as well as to raise court charges in cases of misdemeanours and criminal offences.

In 2009 (period March – September), Inspectorate has issued around 340 decisions (containing either specification of measures that need to be implemented to comply with regulations or fines for non-compliance) and has raised 25 misdemeanour and 3 criminal charges procedures. In addition, 20 notifications were sent to other inspectors (when observed irregularities fell outside the scope of work of environmental inspectors).

Water inspectorate operates under the Ministry of Agriculture, Forestry and Water Management. Its specific competencies include:

- Supervision of works that may lead to quantitative or qualitative changes in water regime;
- Enforcement of water management consents and permits;
- Controlling compliance with various documents related to water management;
- Controlling water regime and quality in all surface and ground water bodies;
- Supervision over operation, appropriateness and efficiency of wastewater treatment plants, etc.

Under the Law on Spatial Development and Construction of Facilities (Official Gazette of Montenegro No. 51/08), enforcement of spatial planning and construction legislation is competence of three inspectorates: urban development, protection of space, and construction inspectorates. They are organised both on national and local level, and their mandates are shared depending on who the permitting authority is for the area/ structure in question. The key competencies include:

- Controlling spatial plans development processes and ensuring compliance of construction permits with relevant spatial plans (urban development inspectorate);
- Controlling whether facilities under construction have valid construction permits (protection of space inspectorate); and
- Enforcement of construction regulations (construction inspectorate).

4.1.4 Planning and permitting procedures

Planning and permitting procedures for construction of objects are regulated under the Law on Spatial Development and Construction of Facilities (Official Gazette of

Montenegro No. 51/08). The Law prescribes a spatial planning system that relies on preparation of different planning documents on national and local levels. Spatial plans are developed in a hierarchical manner – from the national spatial plan down to Detailed Urban Plans (DUP) and studies of location.

Based on DUPs and/or studies of locations, urban and technical conditions for all developments are issued and they include, inter alia, geodetic and cadastre baselines, purpose of planned developments, category, type and technological units of planned facilities, maximum allowed capacities of the development, situation plan with borders of urban plot and relations to neighbouring plots, meteorological data (wind directions, rainfall etc), environmental protection requirements and conditions, conditions for connection to infrastructure (roads, power, water, sewage), etc. Procurement of urban and technical conditions is the first step in permitting procedure for the construction of objects and it represents a baseline for the development of project documentation (project designs). Urban and technical conditions are issued either by national or local authorities, depending on who has responsibility for adoption of plans that serve as a basis for the given development.

Construction permit is issued by competent authorities – national or local, depending on the type of plan that regulates development in question and type of object . Competent authorities issue this permit based on approved (by authorized reviewers) preliminary or main design of the project, which has to be developed in conformity with previously provided urban and technical conditions, and the proof of ownership over the construction land/ proof of rights to construct.

Operational permits are issued once the construction of objects is completed and objects are ready to be used. In case when constructed objects entail equipment and installations used in technological processes, a trial period is mandatory prior to issuance of operational permit. Competences for the issuance of these permits are shared between national and local level in the same manner as for construction permit.

Other aspects of operation of different facilities (such as for example environmental management, waste management, water use etc.) are regulated under a set of consents and permits, as determined through various sectoral legislation. These permits and consents are procured at different stages of project development.

Environmental consent is a ruling of the competent authority (EPA or local level environmental administration) with which Environmental Impact Assessment study is approved and a project given a green light to proceed. EIA is undertaken at the early stages of project development prior to issuance of construction permit. SEA are carried out in the process of developing certain spatial plans, and decisions on approving final SEA reports are issued by competent authorities (EPA or local level bodies) in such cases.

Procedures for issuance of water use conditions, water consents and water permits are regulated under the Water Law 27/07 (Articles 114 – 124).

Starting point in the procedure for obtaining water permits is procurement of water use conditions. Investors are obliged to obtain water use conditions for, inter alia, public water supply systems and water bottling facilities, facilities for treatment of water intended for human consumption, discharging of wastewater into surface waters or public sewage system, systems for evacuation of storm water from settlements, public sewage systems, storing of materials with pollution potential at water bodies banks, septic tanks, and other systems for collection, treatment, removal and discharge of wastewater.

Water consent is an integral part of documentation that has to be submitted for procurement of construction permit, and it establishes whether relevant project documentation was developed in line with issued water use conditions.

Water permit is procured prior to operation of facilities, establishing/ confirming they have been constructed in line with water consent. Water permits determine the ways (quantities, conditions etc.) in which water may be used or wastewater discharged, manners in which materials with water pollution potential may be stored, and conditions under which other activities affecting water regime in general may be carried out.

The Waste Management Law (Official Gazette of the RM, No. 80/05) envisages procurement of a set of waste permits and consents for different entities depending on their role in waste generation/ management cycle. Waste generators (depending on quantities and types of wastes) will be required to develop waste management plans, which will have to be approved (consented to) by competent authorities. Furthermore, permits for collection and transport, and permits for treatment and disposal of waste will need to be procured for entities involved in these activities.

Waste management plans will be mandatory (Article 22 of the Law) for all waste generators producing more than 200 kg of hazardous or more than 40 t of non-hazardous waste annually. Local governments may impose stricter thresholds and demand waste management plans be drawn by generators producing more than 10 t of non-hazardous waste per year. According to the Article 52 of the Law, communal sewage sludge generators will have to keep records with data on quantities of generated and sludge delivered to different users, sludge composition and characteristics, characteristics of technology used for sludge treatment, evidence on sludge users etc. As discussed earlier, provisions of this Article are not fully harmonised with relevant EU legislation.

When certain works, activities and/ or projects affecting protected natural assets are conducted, an application has to be submitted (by investor) to competent administration body to evaluate their acceptability, unless the activities/ projects in question are among those requiring an EIA . In case of positive decision (ruling that given project is acceptable from nature protection perspective), competent authorities issue consent for works on protected natural assets, allowing the investor to proceed.

Integrated environmental permits will be issued for facilities falling under the provisions of the Law on Integrated Pollution Prevention and Control (for existing facilities by 2015, for the new ones as they are developed).

4.1.5 International obligations/ standards and national policy

As the process of EU accession is one of the country's top priorities, national policies and legislation are being increasingly aligned with the EU ones; the so far achievements are more considerable in the area of transposition than implementation. Relation between EU and national standards pertinent to the Project has been discussed in more detail in the general part of section 7.1.1 Regulatory Framework.

As for public participation and access to information, specific provisions are integrated in environmental (for example framework Law on Environment, EIA and SEA Laws) as well as in sectoral legislation (such as water management, spatial planning and construction legislation). International standards pertaining to public participation and access to information and justice in environmental matters have been also incorporated into the national legal system through recent (July 2009) confirmation of the Aarhus convention.

4.1.6 Signed conventions

Montenegro is a party to a large number of multilateral environmental agreements; an overview of various agreements with status of their ratification is provided in Appendix C.

According to Montenegrin Constitution, once ratified, international treaties have precedence over national legislation. In case of conflicting solutions between national laws and international treaties, the more stringent standards are applied.

4.2 Existing environmental conditions and issues

Baseline conditions have been determined from existing data, discussions with Municipal and Ministerial authorities, and from site reconnaissance undertaken specifically for the project, covering aspects of the biophysical, cultural and socio-demographic environment. The aim has been to determine existing conditions and to identify current pressures on the environment and any trends in these pressures, and their impact on environmental quality. The study area for this environmental assessment includes the following:

- Existing municipal water supply system
- New development sites – proposed sites for new water supply reservoirs
- Existing WWTP
- Proposed WTP site and their environs
- Main industrial discharge points and their environs

4.2.1 Climate

According to Koppen classification Podgorice climate is classified as c s a, Mediterranean climate with hot, dry summers and cold winters. Although the city is located some 50 km away from Mediterranean Adriatic Sea, the proximity of Dinaric Alps on the north alters its climate. The mean annual rainfall is 1.544 mm (60.8 in).

The temperature exceeds 25 °C on about 135 days each year and the median daily temperature is 16.4 °C. The number of rainy days is about 115, and those with the strong wind around 60. A periodic but strong northerly wind has an influence on climate in the winter, making sensible temperature a few degrees lower.

Podgorica is particularly known for its extremely hot summers: temperatures over 40 °C are common in July and August. The highest temperature recorded was 44.8 °C on 16 August 2007.

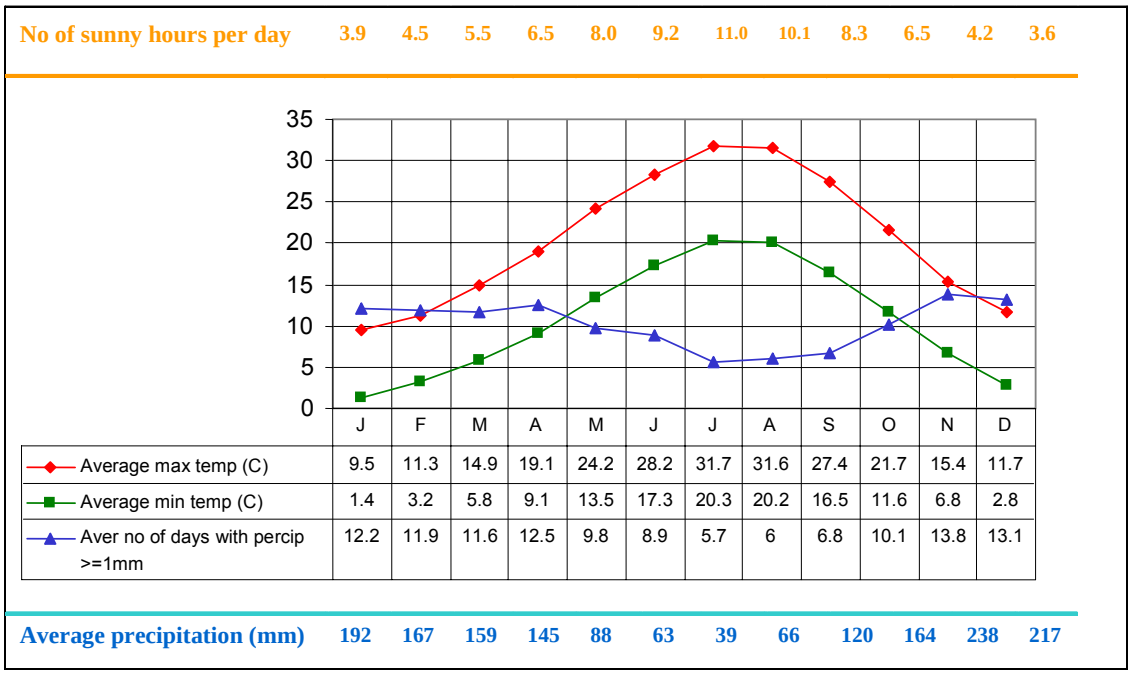


Figure 4.1 Climatic data, Podgorice

Snow is a rare occurrence in Podgorica, as it rarely snows more than a few days per year.

Average annual temperature for the period 1961 – 2000 is 16.4ºC, and the maximum and minimum temperatures are 40.7ºC and –4.6ºC respectively; average annual precipitation is 1,692mm. The driest period is June, July and August which receives less than 10% of the annual rainfall. The highest ever recorded temperature was 44.80C (measured in August 2007).

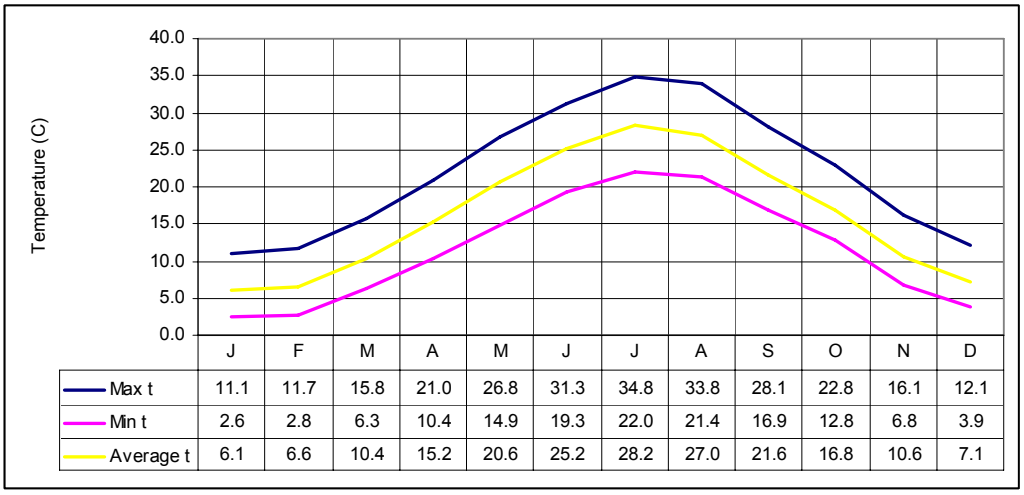
Average annual relative humidity of 64% is quite high. July and August had the lowest average monthly relative humidity, while maximum value of 86% is recorded for December.

Hydro meteorological Institute data (period 1995 – 2003) show that 40% of the time north - winds (N) prevail; 25-30% of time southern winds are dominant. The least frequent are eastern winds. Maximum wind speed of is recorded for northern wind - 34.8m/sec. Strong winds are most frequent in winter with average of 20.8 days, and least frequent in summer with average of 10.8 days.

On average around 2,478 hours of sunshine are recorded in Podgorica per year.

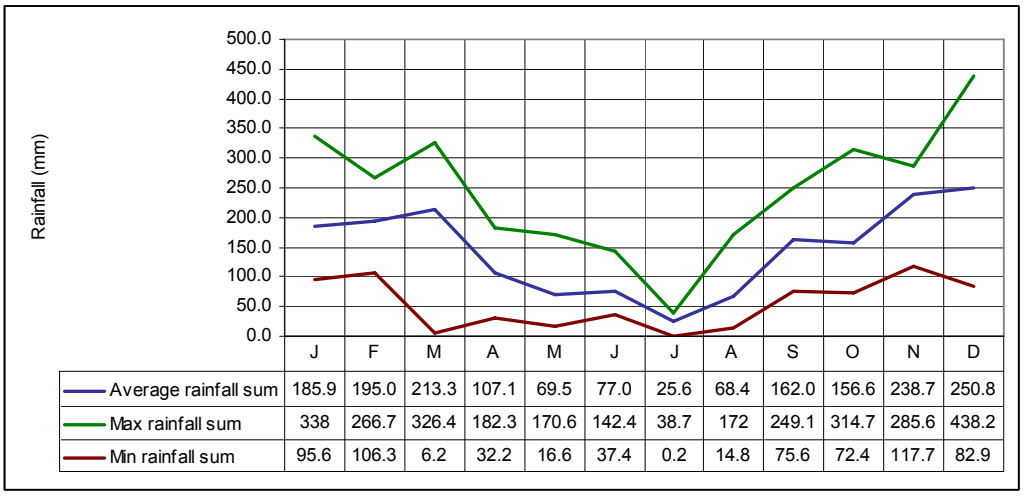
Figure 4.1 shows basic climate parameters and their variations throughout the year for the period 1961 – 1990. The coldest month is January, while the highest monthly temperatures in this period have been recorded for the month of July. Average precipitation during summer months ranged between 39 and 66 mm, and the highest rainfall of 238 mm was recorded for the month of November. The highest number of sunny hours per day ranged between 9.2 hours in June and 11 hours in July).

Even though the two sets of data shown in Figures 4.2 and 4.3 below refer to different lengths of time and are not readily comparable, an increase in maximum and minimum monthly temperatures for the period 2003 – 2008 is observed suggesting that this period was significantly warmer and dryer compared to average temperatures and precipitation for the second half of 20th century.



	J	F	M	A	M	J	J	A	S	O	N	D
Max t	11.1	11.7	15.8	21.0	26.8	31.3	34.8	33.8	28.1	22.8	16.1	12.1
Min t	2.6	2.8	6.3	10.4	14.9	19.3	22.0	21.4	16.9	12.8	6.8	3.9
Average t	6.1	6.6	10.4	15.2	20.6	25.2	28.2	27.0	21.6	16.8	10.6	7.1

Figure 4.2 Monthly temperatures and precipitation in Podgorica 2003 - 2008



	J	F	M	A	M	J	J	A	S	O	N	D
Average rainfall sum	185.9	195.0	213.3	107.1	69.5	77.0	25.6	68.4	162.0	156.6	238.7	250.8
Max rainfall sum	338	266.7	326.4	182.3	170.6	142.4	38.7	172	249.1	314.7	285.6	438.2
Min rainfall sum	95.6	106.3	6.2	32.2	16.6	37.4	0.2	14.8	75.6	72.4	117.7	82.9

Figure 4.3 Monthly temperatures and precipitation in Podgorica 2003 - 2008
Source: Hydro-meteorological Institute

The warmest month in the period 2003 – 2008 was July with maximum monthly temperature of 34.8ºC (average 28.2ºC), while the coldest month was January with minimum temperature of 2.6ºC (average 6.1ºC). For the same period, the heaviest rainfall was recorded in December and November with average rainfall between 239 and 251 mm. Maximum rainfall was observed in December and reached 438 mm. Minimum rainfall was as low as 6 mm in March and 0.2 mm in July.

4.2.2 Air

Air quality is monitored at four locations:Donja Gorica, Srpska, Konik and CETI building. Monitoring station in Srpska is located to the southeast from KAP Aluminium Plant and is affected by pollution from both industry and transport, whereas other stations are urban/ poly-urban locations with predominant impact of pollution from transport. Key pollutants that are subject to monitoring include SO_2, NOx, ground

level ozone, smoke and soot, total particulate matter, heavy metals and PAHs content in PM, fluorides and others[6].

Results of the monitoring programme show that transport and industry/ KAP are the main sources of air pollution in Podgorica. Dominant wind directions at the KAP site are northeast – southwest and north-south.

4.2.3 Geology

(a) General geological characteristics

As shown on the Figure 4.4, Litho-stratigraphic composition of the terrains in Podgorica and its surroundings comprises glacio-fluvial (glf) Quaternary sediments deposited over carbonate sediments of Cretaceous age (K 1 2, K 2 2).

Zeta plain and Cemovsko polje as its constituent par are made of glacio-fluvial sediments represented with inter-changing layers of conglomerates, boulders, gravel and sands, with some clay. Thickness of the sediments varies between 30 and 90 m. To the south of Podgorica, as Moraca river approaches Skadar Lake, glacio-fluvial sediments change into terraced and eventually into lake sediments.

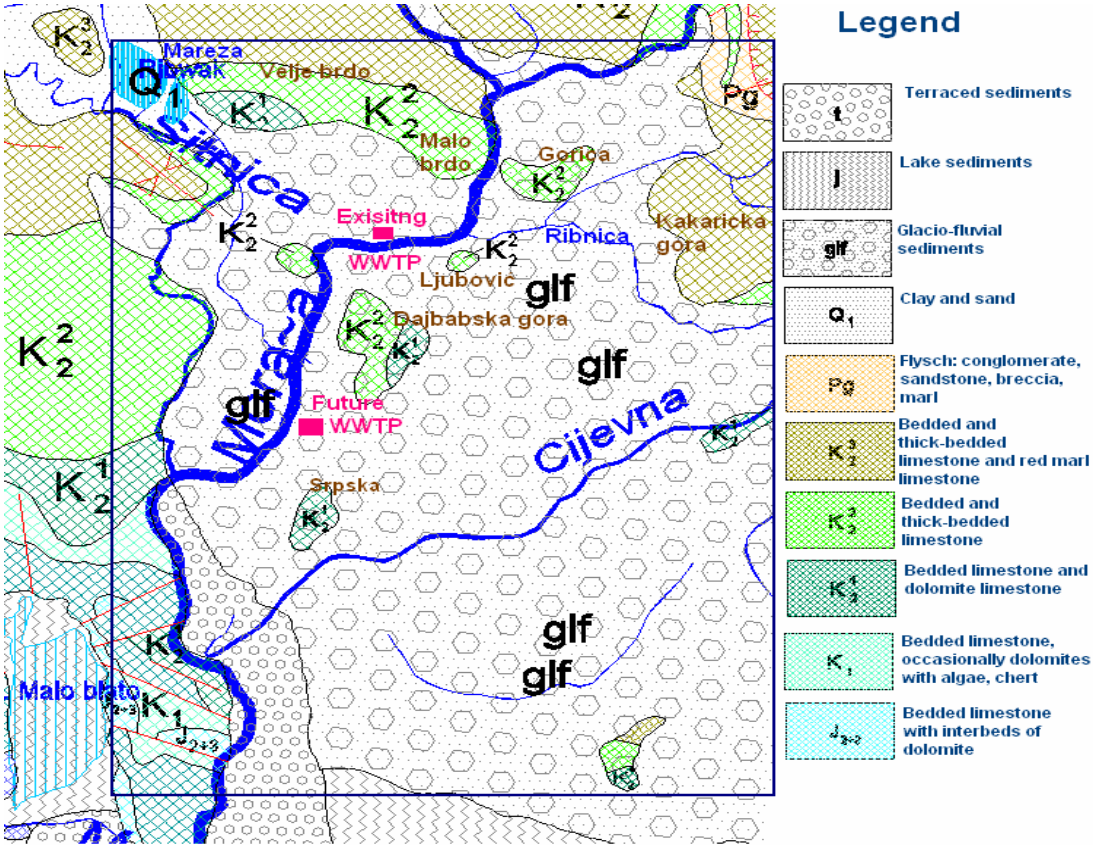


Figure 4.4: Excerpt from Geological Map of Montenegro 1 : 300 000
Source: Water Resources Management Basis of Montenegro

Quaternary deposits are overlain by thick-bedded and bedded dolomite, dolomite limestone and limestone. Limestone and/ or dolomite elevate to the surface in the areas of Podgorica hills (i.e. Gorica and Ljubović hills within city centre, Dajbabska gora and Srpska in the vicinity of the location for new WWTP).

[6] Some pollutants for which monitoring is required under the relevant EU legislation yet are not monitored in Montenegro are $PM_{2.5}$, CO and benzene. As for PAHs, measured values refer to total PAHs.

Paleogene flysch is represented with conglomerates, sandstone, breccia and marl on the territory of the rim of Zeta plain on the left bank of Moraca river and in the upper part of project area (depicted by the grey square on the Figure 4.4). Bedded and thick bedded limestone and red marl limestone comprise terrains in the hinterland of Ribnica river (Kakaricka gora).

Project area belongs to the High Karst zone i.e. to the anticline of the Old Montenegro (its axis plummeting towards southeast) which gradually converts into Zeta Valley syncline. Paleo-relief is incised with faults extending in different directions. Cretaceous limestone runs deeply under Quaternary sediments – up to more than 100m. Deep faults detected through geophysical research are generally extending in the northwest – southeast direction, which is also a predominant direction of seismic activities in this area.

(b) Hydrogeological conditions

Hydro-geological properties of the terrain are closely related to lithological composition. Due to their intergranular porosity, Quaternary glacio-fluvial deposits such as gravel and sands make highly water permeable terrains with filtration coefficients ranging between 1 x 100 cm/s to 1 x 10^{-3} cm/s. Depending on the quality of cementation of gravel and sand granules, conglomerates have poor permeability or are non-permeable. Accordingly, they may play a role of hydrological collectors or of hydrological isolators.

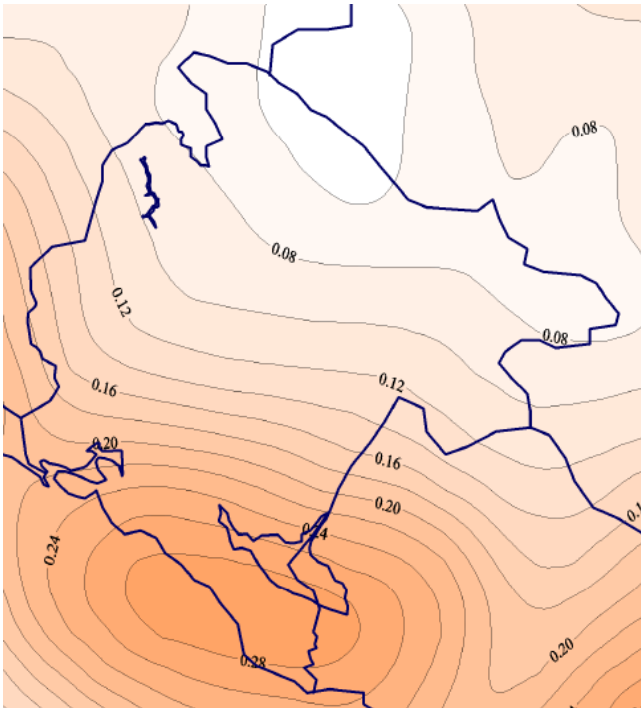
Cretaceous limestones in the project area are divided by inter-layer surfaces and numerous fractures (cracks, ruptures and faults) created through geotectonic activities. These rocks have been subject to karstification processes that contributed to expansion of discontinuities in their masses into caverns of varying dimensions and spatial positioning. Limestone rock masses are characterised by combined rupture cavernous porosity and are highly permeable..

Runoff permeates into the ground quickly and feeds dense aquifer located below Zeta plain which turns into fissured karst aquifer at lower horizons. Aquifers are recharged through infiltration of Morača and Cijevna river waters.

General direction of dense aquifer is to the southeast from Moraca watercourse.

In the area to the south from Dajbabska gora, in the vicinity of the proposed location for the new WWTP, groundwater level is around 20m and in the area of KAP Aluminium Plant it is around 15 m.

(c) Seismic characteristics



Southern part of Montenegro in which Podgorica is located is seismically active.

According to the Map of seismic micro-categorisation for urban area of Titograd, Podgorica, Golubovci and Tuzi settlements are located on terrains built from Quaternary sand and gravel sediments with or without clay, most frequently bound into conglomerates with layer thickness of more than 35 m, this area is defined as zone C1 with maximal earthquake intensity estimated at IX degrees of MCS scale (maximum magnitudes that can be expected for 100 year return period is 5.9 degrees Richter scale).

Figure 4.5: Map of seismic hazard for Montenegro (expected maximum horizontal ground acceleration in gravity parts) for a return-period of 100 years with a 70% possibility of not overcoming the events

Source: Spatial Plan of Montenegro

(d) Pedological characteristics

Predominant type of soil in Podgorica and its surroundings is eutheric brown soil. Below Cemovsko polje, spreading southwards from Cijevna river towards Skadar Lake, is an area where limestone dolomite dark soil is found. Terra rosa is surrounding Zeta Plain to the west, north and east, while at its lowest parts, moving in the direction of Skadar Lake, alluvial deluvial soils and eventually marshland and peat are found as shown on the right.
Podgorica territory is characterised by very weak erosion, except areas of Velje and Malo brdo where erosion processes are of medium intensity.

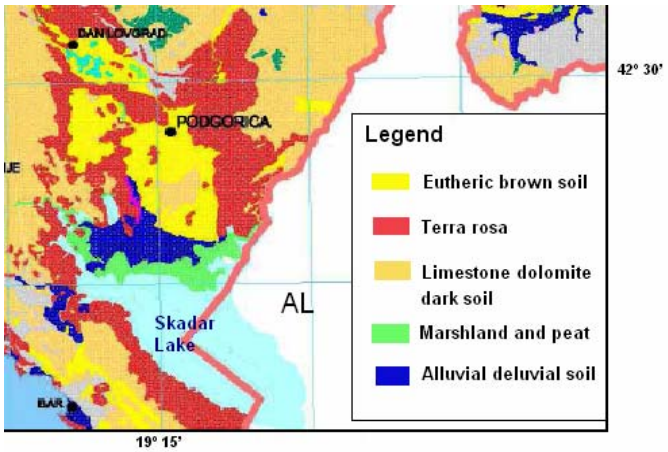


Figure 4.6: Excerpt from Pedologic Map Montenegro
Source: Spatial Plan of Montenegro

Systematic soil monitoring programme being implemented in Montenegro encompasses 15 settlements and around 80 sites exposed to most significant pollution sources. In 2008 in Podgorica the results of the analyses have shown:

- increased concentrations of Cadmium at the city waste disposal site and Zagoric sub-station;
- Increased concentrations of Lead were determined at several locations: at the city waste disposal site, Zagoric sub-station, Srpska village and the airport;
- High concentrations of Nickel were measured at all the locations;

- Fluorine concentrations were below permitted levels only at the city disposal site and Zagoric sub-station;
- Increased concentrations of Arsenic in Srpska village, airport and one location at Cemovsko polje;
- Increased concentrations of PAHs in Srpska and Donja Gorica settlements, as well as at one of the Airport locations. The worst situation is determined for Srpska where measured concentrations at on of the locations exceeded 3 mg/kg, which is five times the maximum allowed concentration.

Soil contamination in the vicinity of Aluminium plant KAP bordering with the proposed WWTP site is occasionally tested as a part of specific studies or monitoring campaigns. Soil samplings results for the future WWTP site are not available, however some measurements conducted in the course of preparation of study on KAP emissions "Zero State Study"[7] - are available for different types of land in the neighbouring villages of Botun and Srpska (sampling points were located close to red mud basins). Summary of findings from these analyses is presented in Table 4.6.

Table 4.6: Results from soil pollution testing for Botun and Srpska villages (October 2005)

			Srpska		Botun - Velji brijeg	
Pollutant	**MAC**	**Unit**	**cultivated**	**non-cultivated**	**cultivated**	**Non-cultivated**
Cadmium	2	Mg/kg	0.71	0.68	0.53	1.47
Lead	50	Mg/kg	38.97	35.62	34.19	71.22
Mercury	1.5	Mg/kg	3.28	2.31	5.28	7.1
Arsenic	20	Mg/kg	< 2	< 2	< 2	< 2
Chromium	50	Mg/kg	26.96	32.84	27.67	46.99
Nickel	50	Mg/kg	102.1	105.83	147.77	123.42
Fluorine	300	Mg/kg	50.09	41.6	23.47	48.75
Zinc	300	Mg/kg	290.75	260.04	215.7	279.65
Copper	100	Mg/kg	39.33	40.88	35.9	39.56
Cobalt	50	Mg/kg	11.96	12.97	14.1	15.25
PAHs	0.6	Mg/kg	1.49	2.21	4.98	21.72
PCBs	0.004	Mg/kg	< 0.003	< 0.003	< 0.003	< 0.003
Congeners	0.004	Mg/kg	< 0.002	< 0.002	< 0.002	< 0.002
Mineral oils	/	Mg/kg	4.69	3.56	1.32	3.56

Source: KAP 'Zero' State Study 2006

The results show that concentration of Mercury, Nickel and PAHs in cultivated land at both Botun (Velji brijeg) and Srpska villages (located to the southwest/ south from the red mud basins[8], were above maximum allowable concentrations. Concentrations of these pollutants exceeded MACs by a factor of 2 to 8. More recent measurements (from 2007)[9] on several locations in the villages neighbouring KAP confirmed increased excess concentrations of these pollutants. In addition, excess concentrations of fluorine and PCBs were also identified at several sampling points.

[7] The study was prepared by Centre for Eco-toxicological Research following the Plant's privatisation based on 2005 surveying of emissions and existing conditions at the KAP, and was published in 2006.
[8] Dominant wind directions at the KAP site are northeast – southwest and north – south.
[9] These measurements were commissioned by private owners of cultivated and non-cultivated land in the villages neighbouring the Plant for the purpose of court cased raised against KAP. Measurements were conducted by Centre for Eco-toxicological Research.

4.2.4 Biodiversity and Protected Areas

(a) National level

Montenegro has high ecosystems and species diversity. With species/area index of 0.837 it is one of the most floristically diverse areas of the Balkan Peninsula. Around 20% of the total flora refers to prevalent endemic and sub-endemic plants. A number of relict species and ecosystems of international importance are found in the country.

Existing network of nature protected areas (PAs) has a surface of 126,950 ha (9.2%) of the overall country's territory. Large share of the PAs network refers to the five National Parks – Durmitor, Skadar Lake, Biogradska gora, Lovcen and Prokletije, which together cover an area of 103,800 ha (7.5%) of the national territory. Remaining PAs (23,150 ha) fall into categories of Monuments of Nature, Areas of Outstanding Natural Beauty and Nature Reserves.

Plans for further designations consider substantial territory, and the 2008 Nature Protection Law has set a legal basis for establishment of Natura 2000 network. In the period 2005 – 2007, Emerald project was carried out aiming to determine what Areas of Special Conservation Interest at the European level (ASCIs) exist in Montenegro. The project is a step towards Natura 2000, since it identified plant and animal species pursuant to Resolutions 4 and 6 of the Bern Convention as well as pursuant to Annexes to the EU Birds and Habitats Directives, and created a database on 32 proposed Emerald sites (ASCIs). These sites encompass 162 animal species, 10 plant and moss species and 156 habitat types of international importance.

Biodiversity monitoring programme is carried out since 2002 on the national level, focusing on the species and habitats of international and national importance (there is a separate sub-programme for Skadar Lake). Findings of the monitoring programmes are published in annual State of the Environment Reports, which together with other available studies (draft National Biodiversity Strategy and Action Plan, 2008; USAID Report on Biodiversity, 2005) suggest that biodiversity is declining. The main pressures include logging, tourism and infrastructure development (especially at the coast and on river banks), pollution of watercourses, illegal fishing and hunting, overgrazing. The most threatened ecosystems are forests and freshwater bodies.

(b) Podgorica biodiversity

The key biodiversity features in Podgorica municipality are linked to Moraca river valley, Skadar Lake (National Park and Ramsar site) and both Cijevna river canyon and Ćemovsko polje (identified as Emerald sites).

Distribution of protected species in wider area of Podgorica city is shown on the map in Figure 4.7.

Moraca river valley is an important migratory corridor between the Skadar Lake area and Podgorica and is classified as a Sub-Mediterranean floristic region. Many of the plant species are of Mediterranean-Sub-Mediterranean character, but also numerous Central European and mountainous species of South Europe are present. A total of 30 fish species were found so far in Moraca River area, 8 of these being listed on the IUCN Red list. The most common species are Phoxinus phoxinus, Barbus rabeli and Telestes montenegrinus. Sections of the river north from Podgorica and in particular river canyon are, according to recent WWF study, home to 130 bird species. Amongst those, 24 species are listed in Annex I of the Birds Directive[10].

[10] Also, Morača bird species include 29 of 52 species which are criterion for declaring an Important Bird Area.

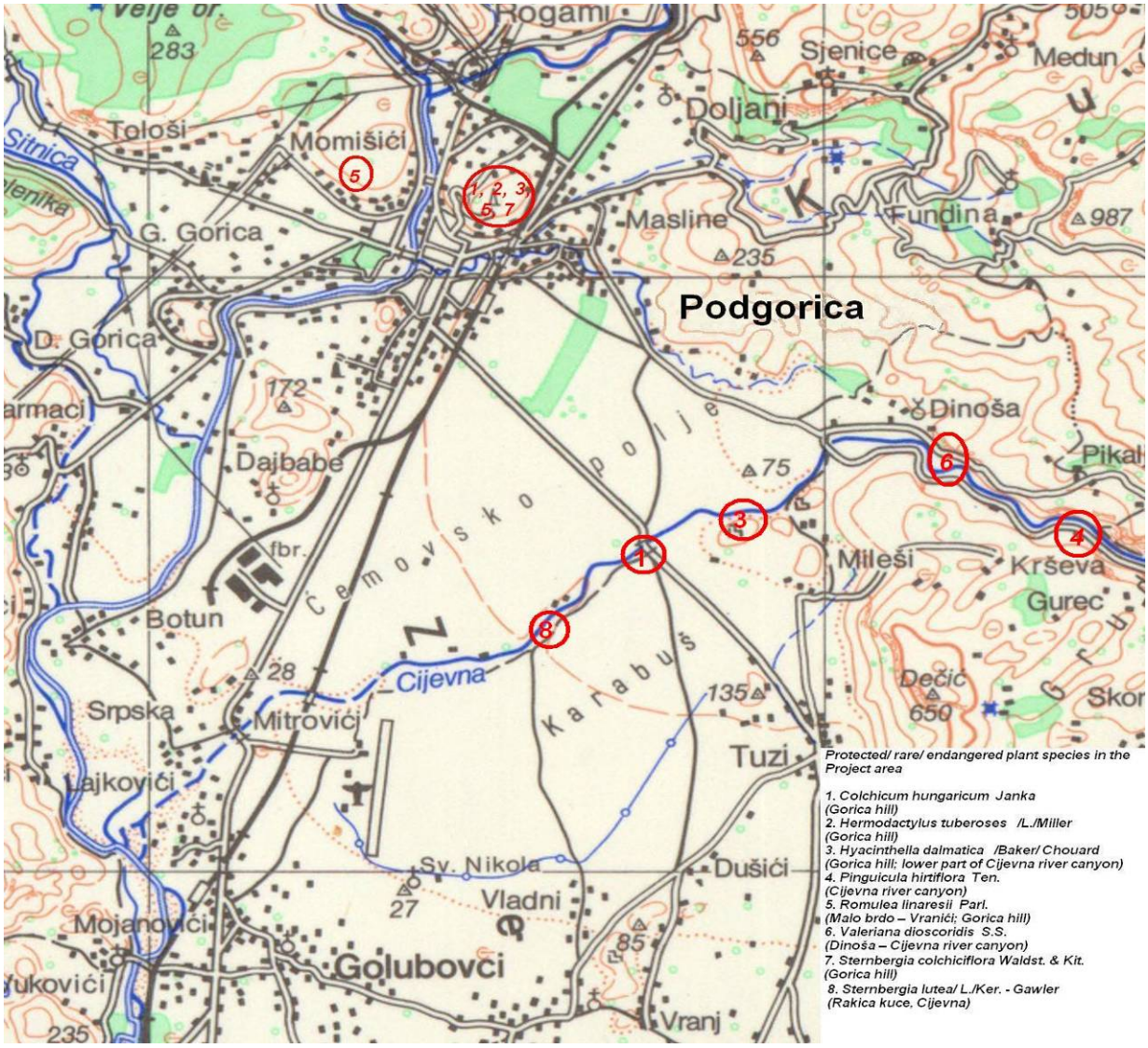


Figure 4.7: Protected/ rare/ endangered species in the project area

Skadar Lake and surrounding wetlands (formed due to high variations in water levels) make an extremely important biodiversity centre, especially significant for migratory birds. The whole area has been enlisted as Ramsar site (due to the richness and diversity of avifauna and recognized as an Important Bird Area – IBA. Numbers on bird species found in literature vary between 271 and 281, and belong to 18 taxonomic orders. More than 205 species are breeding in the Lake area.

About 64 genera with 310 species and taxa of phytoplankton can be found in the Skadar Lake. Aquatic macrophytes are represented with great diversity - 164 species belonging to 66 genera and 43 families. Willow forests (Salicetum albae) are the most abundant forests around the lake, mainly on the northern shore and in the flooded area. Oak and chestnut forests are also found – the former being significantly degraded with dwindling surfaces.

Invertebrates are not well researched – number of known species is around 257.

Skadar Lake is very rich in amphibians and reptiles, including endemic and endangered species such as Skadar green frog, Rana shqiperica. Fish fauna is highly diverse, varying from highland coldwater fish species to warm freshwater fish species as well as several marine species. The level of endemism is high - according

to recent WWF study 31 species are endemic with Adriatic – Ionian distribution and of these 8 species are endemic to Skadar Lake system.

Skadar Lake mammals (around 50 species are found so far) are poorly researched. There are only few species such as the otter (Lutra lutra) that are strongly linked to the water habitat, whereas most of the species are living in the hilly areas to the southwest of the lake. Bats are one of the mammal groups that is especially abundant around the lake.

Number of protected/ rare/ engendered species and locally protected areas (designated and planned) such as park forests and protective forests can be found within city boundaries (developed/urban part of Podgorice),[11]. These areas have been determined through appropriate municipal decisions and spatial plans, with the main purpose to protect water springs, protection from wind and erosion, industrial pollution and to serve as recreational areas for urban population.

Protective forests within Podgorica General Urban Plan area (8,446 ha) were planned to reach an area of around 1,000 ha in 2011 (located in Ćemovsko polje, Dajbabska gora, Velje brdo and Malo brdo, Mareza, Zagorič – Zlatica, Kakarička gora etc.) Park forests cover an area of 173 ha and include, among others, Gorica and Ljubović hills. Number of flora species at Gorica hill is 405. A recommendation for managing park forests is to preserve autochthonous species.

Plans for future establishment of nature PAs of national/ international significance refer to Cijevna river canyon and Cemovsko polje as Emerald sites likely to be included in future Natura 2000 network. Alluvial land at Cemovsko polje is an area where declining dry grassland ecosystems are found. Some of the species that qualify Cemovsko polje as an Emerald site are Lesser Grey Shrike (Lanius minor) and Levant sparrowhawk Accipiter brevipes (birds/ migratory birds), Hermann's tortoise (Testudo hermanni)(amphibians) as well as other significant/ endemic species such as Ramonda serbica, Hiacinthella dalmatica, and Romulea bulbocodium subsp. Graeca. Habitat types of interest for conservation (Resolution 4 of Bern Convention) that are found at Cemovsko polje include:

- Dense perennial grasslands and middle European steppes,
- Thermophilous and supra-Mediterranean oak woods, and
- Southern riparian galleries and thickets.

4.2.5 Cultural heritage

Within wider project area and Skadar Lake basin in particular, evidence of early man's existence dates back to Palaeolithic times. An excerpt from the map of prehistoric sites in Montenegro showing locations for Podgorica and surrounding areas is presented in Figure 4.8. Other archeological localities in the Lake's basin include Samobor (Illyrian-Hellenic period), Mataguži, Oblun and Gostilj (Hellenism), and Plavnica, Mijele and Livari (middle ages).

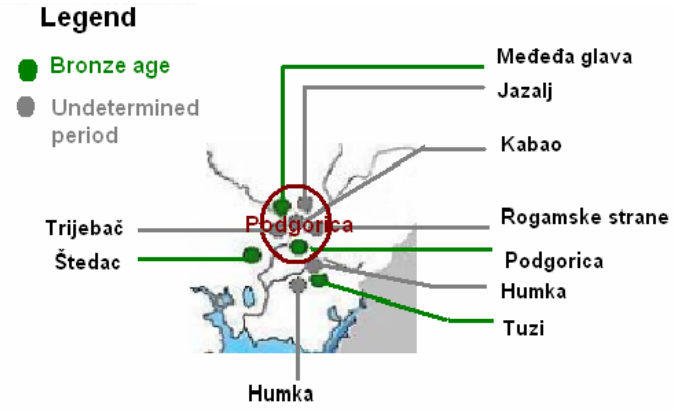


Figure 4.8: Prehistoric sites located in wider Podgorica area

Source: Draft SEA for Detailed Spatial Plan for Hydro

According to the current legislation, 357 archaeological, historical, artistic,

[11] There are no nationally nature protected areas in the city of Podgorica (in the sense of categories determined under Nature Protection Law.

ethnological and other types of monuments in the whole of the country are considered to be cultural heritage. Based on their significance, all monuments are classified into one of the three general categories. Category I (with 35 such monuments) refers to monuments of exceptional significance, including the ones registered as the World Cultural Heritage. Categories II and III include, respectively, monuments of major significance (135) and monuments of local significance (187).

Table 4.7: Overview of protected cultural monuments in Podgorica municipality by category and type

Municipality	Category			Type of monuments									Total
	I	II	III	Urban unit	Old town	Sacr mon	Prof mon	Fortif mon	Archeol mon	Ethnol mon	Tech mon	Memor mon	
Podgorica	2	6	32	-	-	19	4	6	6	2	2	1	40

Source: National Spatial Plan

Within the city of Podgorica (area covered by General Urban Plan) there are 26 monuments (out of the total number of 40 on municipal level) and none of the them are located in the project area. Those that are situated in the proximity of existing or planned water supply and wastewater facilities (and could be potentially affected by future interventions other than those proposed by the current project) include:

- Sacral monuments: St Djordje Church on Gorica hill (category II) and Dajbabe Monastery (category III); and
- Archeological sites: Kakarički town (category III).

4.2.6 Landscape

Podgorica is located in central Montenegro within large plain comprising two parts: elongated Bjelopavlicka plain with average altitude of 50 m asl, spreading along Zata river course and towards the town of Danilovgrad (direction W- NW) and Zeta plain expanding to the Southeast towards Skadar Lake (valleys of Moraca and Cijevna rivers). Altitudes of Zeta plain are below 80 m asl and declining towards Skadar Lake. The lowest parts of the Lake's basin are a crypto-depression.

Podgorica landscape is characterised by a number of hills within city centre (Gorica, Ljubovic, Malo brdo) and on its outskirts (amongst others Velje brdo, Kakaricka gora, Dajbabska gora). Altitudes of these hills are ranging from around 100 to above 250 metres.

The plain area to the north from the location of future WWTP towards Dajbabska gora is about 40m a s l, and to the south of Srpska hill the altitude is around 25m. KAP area is at around 30 m a s l. Important feature of project area landscape is Cemovsko polje - flat and steppe like area spreading east and south of the city with Cijevna river canyon, and higher mountains that rise from the rim of Zetsko-Bjelopavlicka plain in all directions.

4.2.7 Land use

Intended land uses, sitting and development of infrastructure and settlements are determined through spatial planning processes. Based on GUPs (General Urban Plans), detailed urban plans are prepared for particular sections of developed parts of the cities/ towns to regulate in detail land use and construction. New Spatial Development Plan hasn't been adopted yet and an old plan, dated 1986 is still in force.

Agricultural land in mid-1980s comprised 43% of municipal territory, forests accounted for 29% and non-productive areas for 28%. The last category included some 4,500 ha of settlements, around 20,000 ha of bare and non-productive areas and around 15,500 ha of water bodies (mainly Skadar Lake). Planned changes for 2011 were not significant and referred to just a few percent increase in agricultural land (at the expense of forested areas).

The main settlements in Podgorica municipality include Podgorica urban centre with its suburbs, Golubovci, and Tuzi settlements. Urban – rural percentage ratio according to 2003 census is respectively 81% to 19%). Urban areas covered by the three abovementioned settlements are around 2,170 ha (Corine Land Cover data shown on Figure 4.9), which is broadly in line with GUP figures for built areas. There are around 35 smaller settlements (villages) in the area surrounding Podgorica. The settlements closest to KAP and location of the future WWTP are Dajbabe and Zelenika (Podgorica suburban areas), Botun, Srpska, Mojanovici, Mahala and Ljakovici. During the past couple of decades and in particular during the last five years, a process of accelerated urbanisation and expansion of developed areas was recorded, including quite widespread construction without necessary permits. Precise data on impacts of these urbanisation processes on land use within GUP area is expected to be gathered through the forthcoming development of new Spatial Development Plan.

Within urban centre of Podgorica, there are two natural forested areas (Gorica and Ljubovic hills) and several smaller surfaces green urban areas, sports and leisure facilities such as Toloska forest and Krusevac).

Industrial and/ or commercial units (grey areas on the Figure 4.9 below) comprise an area of around 585 ha. Main infrastructure land take refers to road network, railroads

and Podgorica airport located in the vicinity of Golubovci settlement. Major waste disposal areas include locations within KAP and municipal (now regional) sanitary landfill at Livade.

There are no significant mineral resources excavation sites within project area except for sand and gravel that is exploited on a number of locations in Cijevna and Moraca river valleys.

Forested and shrub areas make an outer ring around Podgorica city and adjoining settlements to the west, north and east (Skadar Lake is located in the south). Shrubs are predominant type of vegetation and include various associations – ranging from natural grasslands to transitional woodland scrub – while high forests (darker green areas on the map) cover by far smaller surfaces.

Agriculture is predominant land use in the project area, with relatively small share of arable land and larger share of land used for mixed agricultural purposes, including areas with natural vegetation (according to Corine Land Cover classification, this comprises two categories: complex cultivation patterns and land principally occupied with agriculture but with significant natural vegetation areas. Significant shares of agricultural land are also under vineyards/ orchards (around 2,500 ha in the area shown on the Figure 4.9) and pastures located mainly in the area of Cemovsko polje.

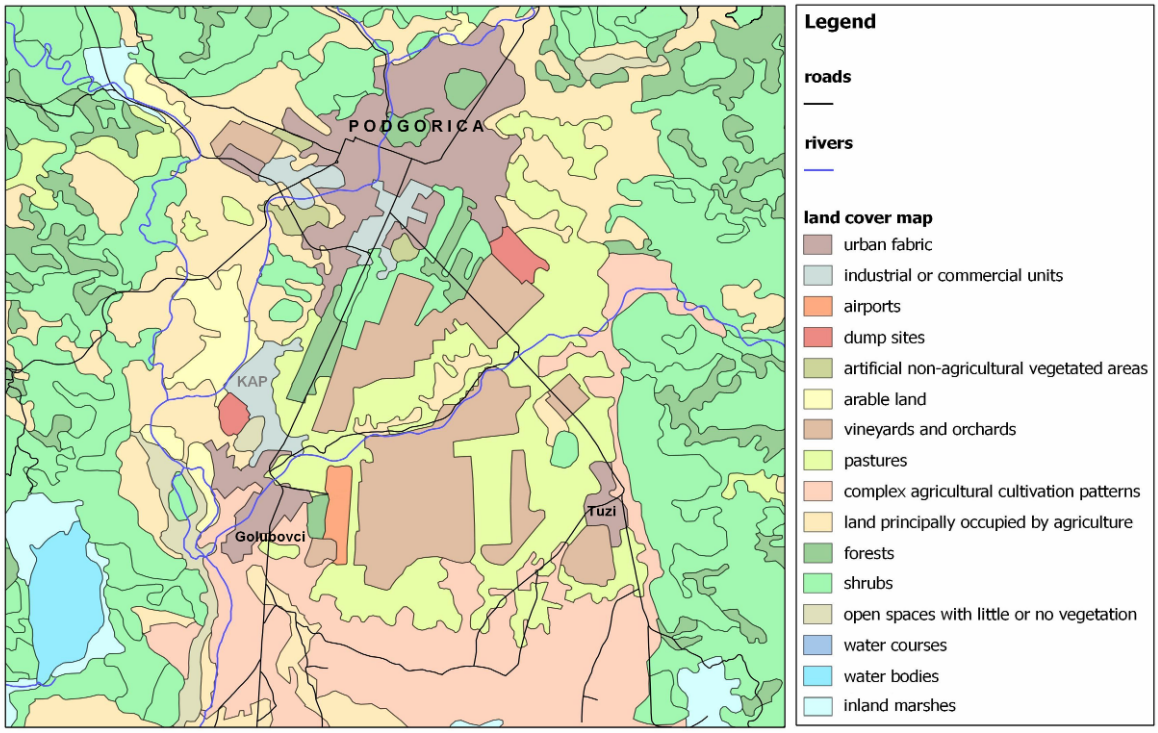
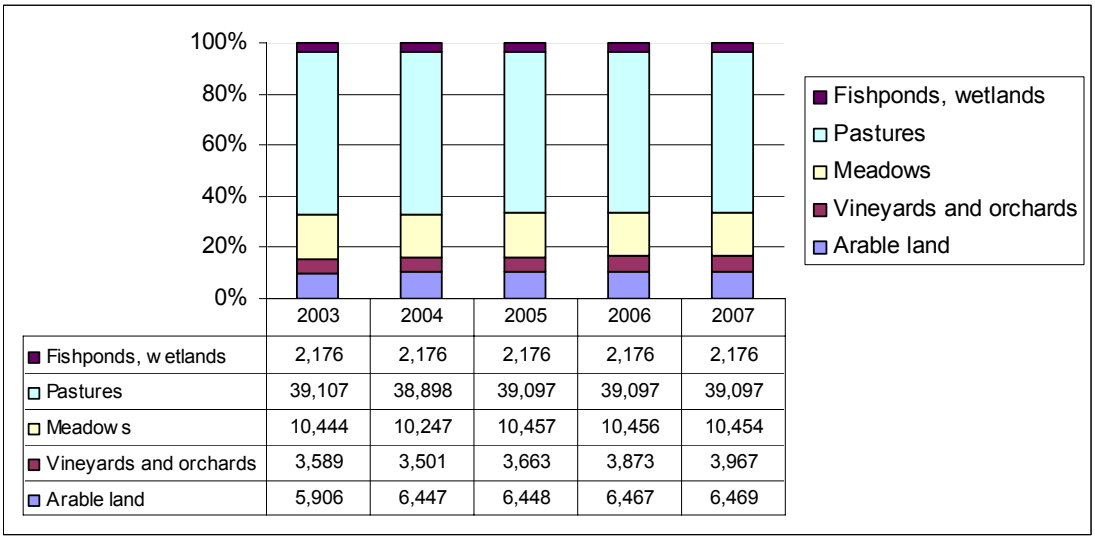


Figure 4.9 Land use in Podgorica and surrounding areas
Source: Corine Land Cover 2000 and UNDP

Around 8% of total agricultural land in Podgorica Municipality is located within GUP area. Structure of agricultural land for the entire municipality in the period 2003 – 2007 based on the data from Statistical Yearbook is shown below (Figure 4.10). Total surface of agricultural land in this period ranged between 61,000 and 62,000 ha. This data confirms that there were no major changes in agricultural land compared to the data from municipal Spatial Plan from 1986 (62,000 ha). Data on conversion of agricultural land that has taken place during the last two decades in the areas closer

to urban centres and those more attractive for construction (i.e. in the areas covered by GUP or DUP) are not available.



	2003	2004	2005	2006	2007
Fishponds, wetlands	2,176	2,176	2,176	2,176	2,176
Pastures	39,107	38,898	39,097	39,097	39,097
Meadows	10,444	10,247	10,457	10,456	10,454
Vineyards and orchards	3,589	3,501	3,663	3,873	3,967
Arable land	5,906	6,447	6,448	6,467	6,469

Figure 4.10 Agricultural land in Podgorica Municipality (by category, in ha and % of total)

Source: Statistical Yearbook 2008

In 2007, pastures and meadows accounted for 80% of total agricultural land in Podgorica municipality, arable land covered 10% and vineyards/ orchards 6%. Remaining 4% referred to fishponds and wetlands.

Out of approximately 6.5 thousand ha of arable land in the municipality, around 24% were not cultivated in 2007. Vegetables were produced at around 3 thousand ha, fodder at around 1.4 thousand ha, while small area were sown with cereals (around 400 ha) and industrial plants (100 ha).

The main agricultural areas with their predominant produce are represented in the table below

Agricultural areas	**Dominant crop**
Lijeva Rijeka, Piperi and Kuci	Fruits, potato, mushrooms
Ljesanska and Katunska nahija	Grape vine, peach, fig, pomegranate, apple
Ljeskopolje	Olericulture and green house production
Zeta	Pepper, tomato, melon, watermelon, cabbage
Malesija	Potato, pepper, cabbage, tomato, tobacco

There is no data on mineral fertilizers and pesticides use in wider project area. The most important permanent crop is vine. In 2007, there were 13.6 million of vine trees in Podgorica municipality, which represents an increase of 20% compared to 2003. The largest vine plantations in wider project area are found in Cemovsko polje (mainly owned by „Plantaze" wine production company).

Livestock and poultry are not significant agricultural activities. In 2007, numbers of cattle and pigs in Podgorica municipality were around 5,900 and 1,100 respectively. Sheep production was around 15,400 heads. Small scale poultry farms breed around 22,200 poultry for the same year.

Fish production is organised in one fishpond in the project area - Mareza ribnjak and commercial fishing is present at Skadar Lake.

The main operational industrial facility in Podgorica is KAP Aluminium Plant, which is the key polluter in the project area. KAP has its own water supply system and

discharges wastewater directly into Moraca river. Environmental implications from aluminium production are mainly related to the smelting, and electrolysis processes. The main risks include emissions of hydrofluorocarbons and perfluorocarbons (PFCs) and CO_2 to the atmosphere, and pollution of soil, surface waters and groundwater with fluorides, phenols, PAHs, and PCBs and heavy metals. KAP generates around 370,000 t of red mud tailings and around 8,000 t of other wastes including cathode and anode residues, sludge from primary and secondary production, PCBs from transformers annually. Large quantities of hazardous and non-hazardous waste have been accumulated on the KAP site during more than 30 years of Plant's operation; their handling and disposal is inadequate with an exception of management and disposal of PCBs during the recent years.

According to the Detailed Urban Plan for KAP industrial zone covering an area of 483.68 ha that was adopted in 2009, the new WWTP is to be situated next to KAP facilities, bordering its processing plants area, water supply wells area, wastewater channel and road connecting Dajbabe/ Zelenika and Botun settlements (see Figure 4.11).

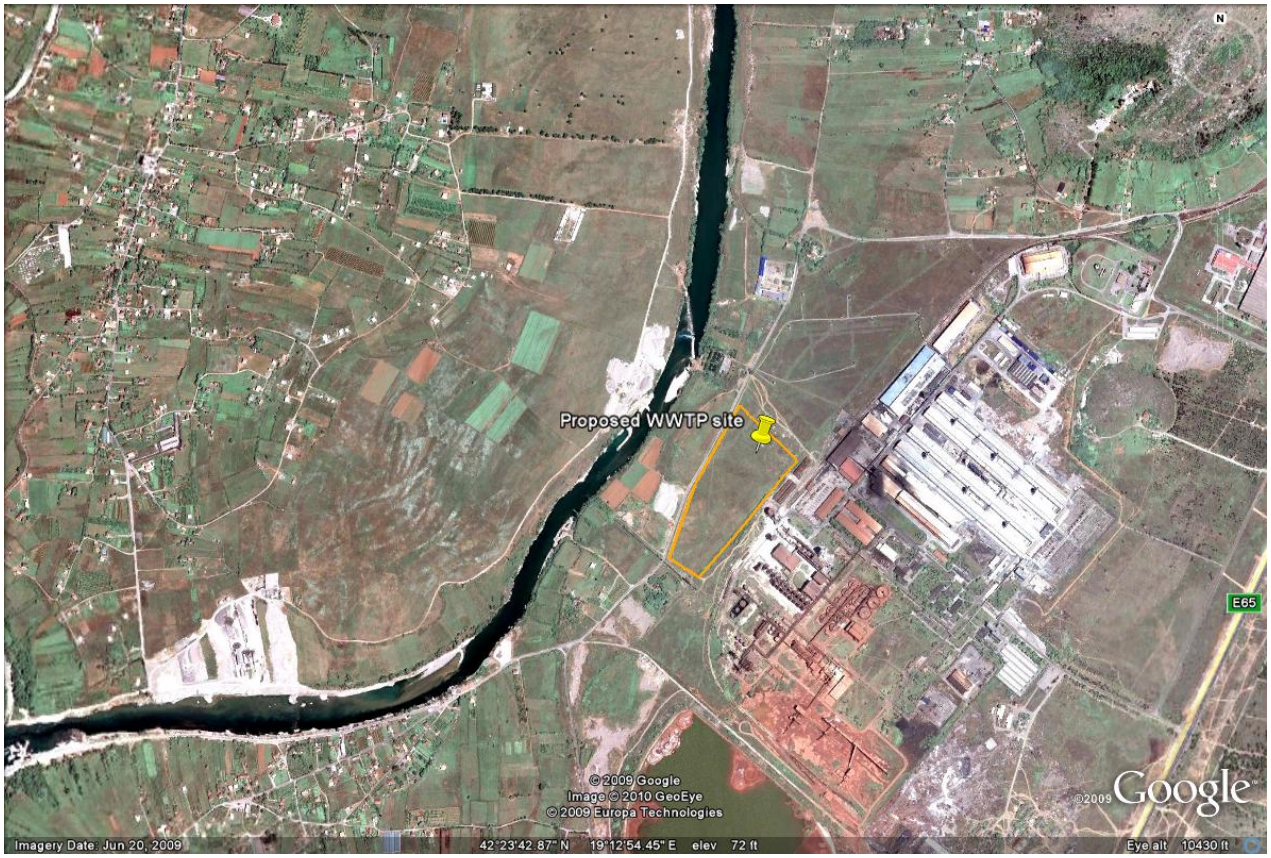


Figure 4.11 Future WWTP bordering with KAP Aluminium plant Facilities

Other large industries that used to operate in Podgorica, such as production of civil engineering machinery, production of furniture and wooden fittings, and textile industry scaled down during 1990's and eventually closed down. Sites where the former two industries were located have been turned into residential/ commercial area. Former textile industry facilities are situated on the bank of Moraca river opposite the existing WWTP in an area still designated as industrial zone, neighbouring currently operational pharmaceutical industry Hemomont.

Besides above-mentioned industries, there is a number of small and medium sized industrial enterprises operating in Podgorica area, mainly in food processing branch, as well as a number of service facilities such as petrol stations and car mechanics,

photo and cosmetics shops that generate specific types of wastewater/ waste which needs to be pre treated prior to discharge into municipal sewage system. This issue is discussed in Table 4.13 Industrial Effluents Volumes and Characteristics.

4.2.8 Water resources and quality

(a) Surface waters

Montenegro is drained into two catchments: Adriatic and Black Sea: Hydrological system of Podgorica area belongs to Adriatic catchment. The main surface water courses include Moraca river with its tributaries:

- Zeta (the key tributary, confluence point upstream from urban centre),
- Ribnica (confluence point in the city, upstream from the existing WWTP),
- Sitnica (confluence point downstream from urban centre and future WWTP),
- Cijevna (confluence point downstream from the city and future WWTP).

The system discharges into Skadar Lake (Skadarsko jezero) which is the largest lake in the Balkans; a large wetland is constituent part of the Lake's hydrological ecosystem. Network of rivers, hydrological and water (surface and groundwater) quality monitoring stations are depicted on a Figure 4.12 (approximate locations of the existing and new WWTP are also marked on the map).

Figure 4.12 Excerpt from Hydrological Map of Montenegro 1 : 300 000

Source: Water Resources Management Basis of Montenegro

Moraca main hydrological parameters:

- Q absolute minimum: 5.5 m^3/s
- Q average: 140 m3/s
- Q absolute maximum 900 m^3/s

Average annual flows of the two key tributaries – Zeta and Cijevna – are 73 and 25 m^3/s at Danilovgrad and Trgaj hydrological stations respectively, while Sitnica and Ribnica have much lower flows and regularly dry up during the summer.

The average annual flow of Moraca river at Podgorica hydrological station is about 140 m^3/ s, and the volume is around 4,415 mill m^3. Mean monthly flows for two hydrological stations – Zlatica and Podgorica are shown in the Figure 4.13. The highest monthly flows for Podgorica station are in April and December, while in July and August flows fall to lowest values of less than 30 m^3/ s.

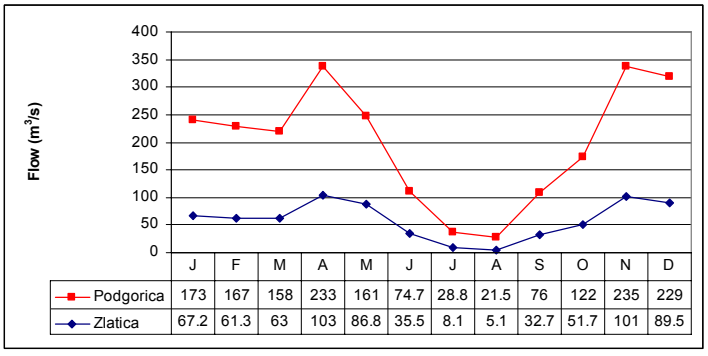


Figure 4.13 Moraca mean monthly flows at Zlatica and Podgorica stations 1983 – 2002 (m3/s)

Source: Hydro-meteorological Institute

A system of four large hydro-power plants is planned for Moraca river upstream from Podgorica, on river section starting with Zlatica site (outside of urban Podgorica area) and ending with Platije canyon.

Available simulations (draft SEA) of mean monthly flows indicate that if constructed, these plants would cause reduction in spring and autmn discharge peaks at Podgorica hydrological station, and an increase in water flows during summer months.

Skadar Lake catchment area covers approximately 5,500 km^2 (4,470 km^2 in Montenegro and 1,030 km^2 in Albania). Surface of the Lake varies varies between 354 km^2 in dry periods and 506 km^2 in wet periods, while as total water volume varies accordingly between 1.8 km^3 and 4.1 km^3. On Montenegrin side, Morača river system and smaller tributaries on north-east and south-west shores together with groundwater from Zeta plain aquifer and karstic springs represent the main contributors to the Lake's water balance. The outflow is Bojana river with an average flow of about 300 m^3/s. Skadar Lake is a natural freshwater lake, with zones of:

- open, not vegetated water,
- plant covered water (reed, lilies and other marsh plants),
- flooded fields, willow groves and floodplain oak woods.

Minimum and maximum mean monthly water levels at Plavnica (period 1948 – 2002) are 4.8 m (September) and 9 m (January/ December). Surface of the wetland area to a large extent depends on the season/ water level.

There are several monitoring stations on Moraca river including: Smokovac (downstream from Zlatica hydrological station, upstream from confluence with Zeta); at the city beach (Gradska plaza, downstream from confluence with Zeta, upstream from the existing WWTP); at the existing WWTP (Gradski kolektor); and in Grbavci and Vukovci settlements (downstream from both the existing and future WWTP). For the purpose of this report, results from two monitoring stations – at the existing WWTP and in Vukovci settlement are discussed in more detail.

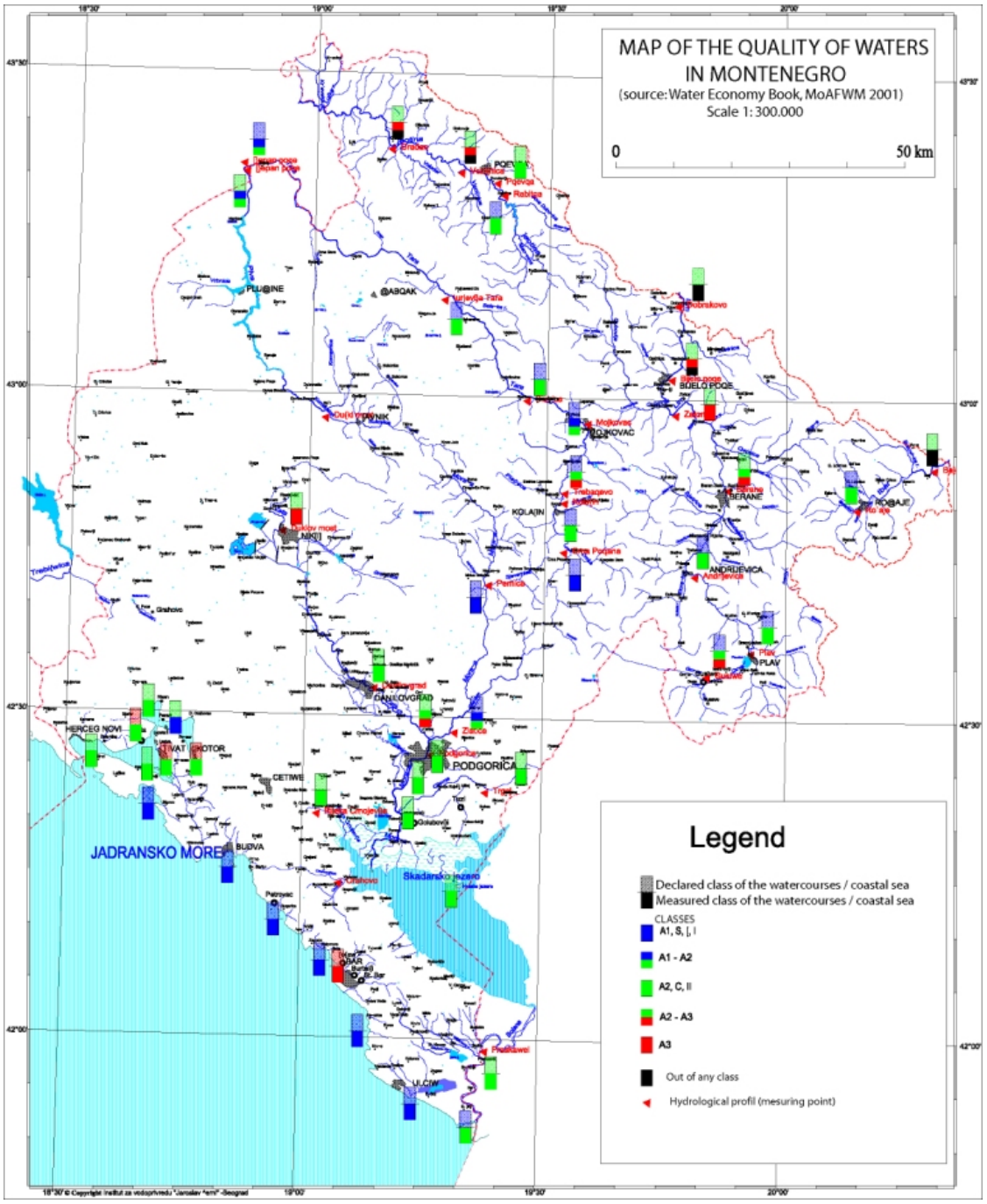


Figure 4.14 Hydro meteorological monitoring points, Montenegro

Monitoring of water quality is done through regular water sampling on a network of stations. Limit values for a large number of pollutants are prescribed for different water classes depending on their intended use (Decree on categorisation of surface and groundwater, Official Gazette of Montenegro 2/07), and assessments of water quality are made based on comparison between measured and prescribed concentrations of polluting substances for respective water categories. Table 4.8 shows categorisation of major water bodies in the area.

Table 4.8: Prescribed water classes/ categories for Moraca and Zeta rivers and Skadar Lake

River/ part of river or lake	Drinking (A1, A2, A3)	Fish farming (S, C)	Bathing (K1, K2)	Overall category
Moraca				
Upstream from Duklja (upstream from Podgorica urban centre)	A1	S	K1	I
From Duklja to the confluence with the Skadar Lake	A2	C	K2	II
Zeta				
Upstream from Brezovik	A1	S	K1	I
From Brezovik to the confluence with Morača	A2	C	K2	II
Skadar Lake	A2	C	K2	II

Moraca river water is of a good quality (within prescribed limits for category I waters) upstream from Zlatica hydrological station. The good water quality is well preserved upstream of Podgorica town. At Smokovac, water quality begins to degrade due to anthropogenic pressures along the river banks. As shown by results from the monitoring station at Gradska plaza (downstream confluence with Zeta river), water quality degrades further at this section of the river due to impacts of pollution carried by Zeta river.

Results of monitoring programme conducted in 2008 for Zeta river show that almost the entire river course has 'out of class[12]' concentrations of Phosphates and Nitrites as a result of discharges of untreated urban wastewaters and organic industrial wastewaters.

Downstream confluence with Moraca river, Ca/Mg ratio, COD, Ammonium, Phosphates were recorded above maximum allowed concentration prescribed by law.

The highest pollution of Moraca river is recorded at the monitoring station Gradski kolektor, below the existing WWTP. Increased amounts of organic matter entering the river from the WWTP create anaerobic conditions especially at the end of the summer period when flow in the river is low. In 2008, water was 'out of class' for Ammonium, Phosphates, Nitrites and faecal coliform bacteria on several occasions, while a number of other parameters exceeded allowed concentrations for class A2.

Average values for selected parameters for WWTP and (downstream) Vukovci monitoring stations in 2007 and 2008 are presented in Table 4.9 averages are derived from the data for sampling period June - October (4 to 5 measurements), when the flows of Moraca river are the lowest, ranging from 20 to around 120 m^3/ s at Podgorica station.

[12] When measured values exceed prescribed concentrations for all the classes i.e. are higher than allowed for class A3

Table 4.9: Selected water quality parameters at WWTP and Vukovici monitoring stations

Parameters	Units	Limit values A2 class	WWTP		Vukovci	
			2007	2008	2007	2008
pH		6.50 - 8.50	8.1	7.8	8.2	8.1
Total suspended matter	mg/l	20	38	6.75	0.3	0
Nitrates	mg/l	25	5.23	3.46	2	1.49
Nitrites	mg/l	0.005	0.026	0.04	0.01	0.015
Sulphates	mg/l	50	8.08	10.38	6.1	5.78
Chlorides	mg/l	40	7.25	8.36	6	9.5
Ammonium	mg/l	0.05	1.25	1.34	0.1	0.04
Phosphates	mg/l	0.05	0.74	0.79	0.2	0.11
COD	Mg/l O_2	4	2.4	2.3	1.8	1.9
BOD5	Mg/l O_2	4	7.1	6.25	2.5	1.9
Faecal coliform bacteria	/100ml	2,000	12,945	22,330	720	677

Source of data: Hydro-meteorological Institute

Comparison of the last five years (sampling period June to October) results from those two monitoring stations allows for a conclusion that there is a general water quality improvement in Moraca river downstream Podgorica. Figure 4.15 shows that in the period 2003 – 2008, particularly high BOD5 (exceeding occasionally 10 mg/ l) was recorded at WWTP in late summer/ early autumn and in the first half of 2007. These peaks in BOD_5 levels coincide with the lowest flows and substantial discharges of wastewaters with high organic pollution load from Plantaze Company, as well as with the period of WWTP reconstruction in the first half of 2007. BOD5 levels for the same period/ dates at Vukovci monitoring station were mainly below permitted level of 4 mg/ l. As for the COD, levels at Vukovci station were, with few exceptions, at or below WWTP level and mainly within prescribed standards for class A2.

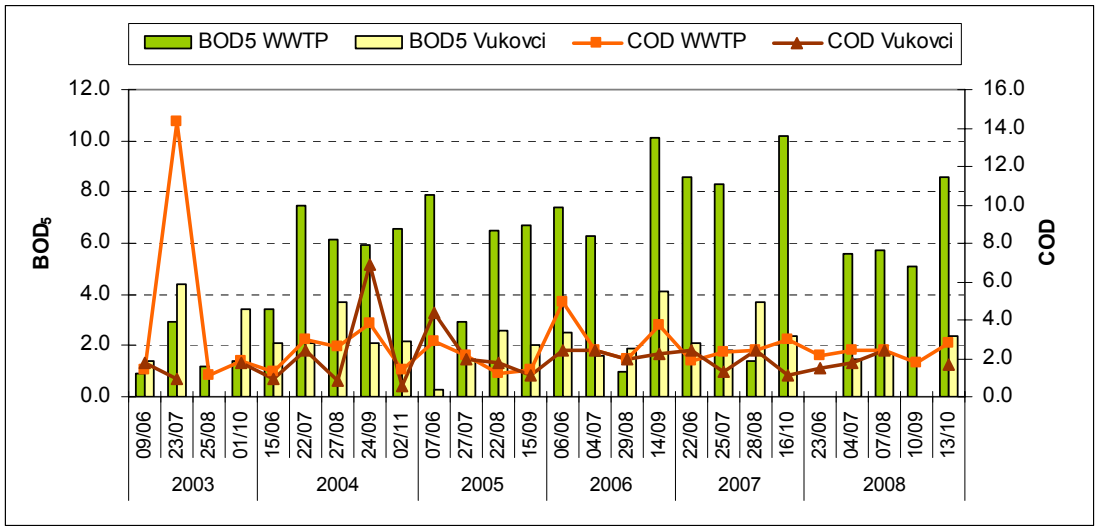


Figure 4.15 Key water quality parameters at WWTP and Vukovci monitoring stations 2003 – 2008 (low flow periods)

Source: Hydro-meteorological Institute

The key sources of pressures on Moraca river aquatic ecosystem and its water quality downstream Podgorica include large scale gravel extraction and, to a certain

extent, discharges of wastewater from the KAP Aluminium Plant. KAP channel for wastewater discharge receives all the collected rainwater from the entire installation, cooling waters from all the Plant's units, sewage and accidental releases from tanks for storing oil derivatives. Analyses conducted in the course of preparation of the "Zero State Study"[13] showed that water samples from the channel did not meet criteria for discharging into natural recipient due to increased concentrations of ammonia and PAHs. Furthermore, analyses of water samples from Moraca river upstream and downstream from the point of KAP channel discharging showed deterioration in water quality from A2 to A3 class for some parameters i.e. an increase (even though not significant) in pH value as well as increases in Nitrates, Aluminium and PAHs content. The overall conclusion of the Study was that under normal operating conditions and with adherence to relevant technological procedures, KAP wastewater was not significant contributor to pollution of the river and Skadar Lake. This does not apply to accidents of varying degrees that have been repeatedly evidenced in the past, the last one linked to discharge of substantial quantity of caustic soda into the KAP channel and further into Moraca river in September 2009. As of recently, wastewater from KAP channel is regularly monitored by the Centre for Eco-toxicological Research.

Results of the 2008 monitoring programme showed that Skadar Lake waters were mainly within prescribed quality classes for majority of parameters. The most significant deviations from prescribed concentrations ('out of class' values) were recorded for phosphates at several locations (Virpazar, Plavnica, Starcevo, Moracnik and Ckla), dissolved oxygen (at Virpazar) and nitrites (Vranjina, Virpazar)[14]. Regular monitoring programme is however not comprehensive and available data sets are often fragmented and inconsistent (for example, data on total phosphorus and total nitrogen are almost non-existent). It is therefore difficult to make complete conclusions on pollution trends for the Lake.

Results of the 2008 monitoring campaign conducted as a part of DRIMON project[15] (analysing key pollutants in relation to discharges from the Lake's tributaries) showed there is in general an increase in the concentration of suspended matter and phosphorus in periods with high flow, indicating erosion of agricultural soils rich in phosphorus. Nitrogen levels are in general high throughout the year, whereas faecal bacteria increase during the low flows in summer. The transport of nutrients and sediments through Moraca river and other tributaries is relatively high. It is estimated that about 60 – 70,000 tons of sediments and about 150 tons of phosphorus were transported into the Lake in 2008 (which was a year with standard hydrological conditions[16]). Eutrophication that could be expected with such values has been largely avoided so far due to short hydrological residence time of the Lake's waters.

Most basic parameters of the Lake's water quality have remained more or less the same since the 1980s, but there is a trend of increase in nitrates and dissolved oxygen, most likely as a result of upstream discharges of urban wastewater. The Lake is assessed to have mesotrophic properties, with potential of developing early eutrophic stages. Risks from eutrophication are more pronounced for stagnant corners of the Lake near the mouth of Moraca river and Zeta plain. Recent measurements of PCB and PAH concentrations show these pollutants are below the detection limit, which as an improvement compared to the first half of 1990s when their excess concentrations were recorded in Moraca due to improper operations at

[13] The study was prepared by Centre for Eco-toxicological Research following the Plant's privatisation based on 2005 surveying of emissions and existing conditions at the KAP, and was published in 2006.
[14] Vranjina and Virpazar are small settlements on the Lake's shores.
[15] www.drimon.no
[16] For example, water discharge at Podgorica station in 2008 was 144 m^3/s, whereas the average for the period 1983 - 2002 was 140 m^3/s.

KAP. Recent analyses also show an increase in concentrations of heavy metals, even though they remain within prescribed limits for category II waters. The concentrations are higher at the mouth of Moraca river, mainly due to industrial wastes originating from the KAP. The water refreshment rate is around 2 – 3 times per year, and it appears to be the main factor that contributes to maintenance of reasonably good water quality. However, quality of the Lake's sediments and dry soil in some locations is a concern.

Results from 2008 groundwater monitoring at eight locations in Zeta plain show significant pollution of groundwater in this area and worse quality than what is prescribed under relevant legislation. Some of the exceedances in individual locations are presented below:

Location of GW monitoring point	Exceeded parameter
Gostilj	Nitrites and Phosphates were 'out of class', nitrates were in class A3, and pH, conductivity, dissolved oxygen and detergents were in class A2.
Vranj	Dissolved oxygen, COD, nitrites and phosphates were 'out of class'; conductivity and nitrates contents were in line with requirements for class A3, and sulphates and detergents in class A2.
Drešaj	'out of class' for phosphates; ammonia and nitrates were in class A3, and conductivity, COD and nitrites were in A2 class
Mitrovići	Concentration of phosphates was also 'out of class' at; pH, ammonia, nitrates, nitrites and detergents measured at this location were in concentrations suitable for A3 class, while COD was in class A2.
Farmaci	groundwater was 'out of class' when it comes to phosphates contents, while ammonia and nitrites were in class A3; conductivity, dissolved oxygen, COD and detergents matched requirements for A2 class;
Golubovci	concentration of phosphates was 'out of class', concentration of ammonia was in class A3 and conductivity, nitrites, sulphates and detergents were at levels suitable for class A2
Grbavci	was of somewhat better quality compared to previously discussed locations: ammonia and phosphates were in class A3, while dissolved oxygen and COD were in class A2.
Vukovci	groundwater did not match prescribed levels for the following parameters: ammonia was in class A3, oxygen and phosphates in class A2.

(b) Groundwater resources

Glacio-fluvial deposits of Cemovsko polje and Zeta plain to the north of the Lake hold a major reservoir of groundwater. This dense aquifer has a water table surface of more than 200 km2 and is recharged through direct infiltration of precipitation, infiltration of river water (principally of Moraca and Cijevna rivers) and inflow from surrounding karst aquifers. Zeta plain aquifer, karst springs at the Plain's rim, surface watercourses and the Lake water are all hydraulically connected.

General direction of the groundwater movement is from north and northwest to south and south-east.

Groundwater upstream settlements are classified as A1 waters, while A2 class applies for groundwater located within and downstream inhabited areas.

Comprehensive groundwater quality monitoring programme is not in place in Montenegro. Groundwater quality is tested on a limited number of locations, including eight locations to the south from Podgorica (Framaci, Grbavci, Vukovci, Mitrovici, Golubovci, Gostilj, Vranj and Dresaj locations – see Figure 4.14).

Major sources of pollution that affect water quality in Podgorice (Moraca river, Skadar Lake, Zeta plain groundwater) include:

- Industrial and domestic wastewater from settlements in Zeta river catchment area, significantly polluting Moraca and having an impact on groundwater quality;
- Existing WWTP (due to limited capacity and lack of pre-treatment for some industries that discharge into public sewer, WWTP effluent is of inadequate quality);
- Industrial wastewater discharged directly into Moraca river (this primarily refers to KAP Aluminium Plant);
- Inadequate disposal of waste;
- Agricultural runoff.

4.2.9 Water management

(a) Podgorice Water supply

Detailed assessment of the water supply system is presented in Section 3.1 Review of Water Supply Infrastructure. Only a water quality analysis in presented below is presented below.

Podgorica ViK has provided results from its routine testing of water quality at its sources. The results of its less frequent comprehensive analyses are summarized in Table 4.10 and show that the quality of the water from each of its sources has good physical and chemical properties. There are no full water quality analyses with all EU parameters available for the existing sources. However, a comprehensive analysis has been carried out for the new Vuksan Lekici source and details of this analysis are included in Appendix E

The results of its less comprehensive daily sampling and analyses are too voluminous to enter from paper records so ViK has provided a summary of the results for the failed samples. Table 4.10 summarises these by location and parameter. These results show that there have been frequent cases of bacterial contamination at the principal sources and isolated instances of bacterial contamination in the distribution system. Figure 4.16 shows the occurrence of total coliforms and aerobic mezophylic bacteria at the principal source, Mareza. This shows that these incidents occur mainly in the summer.

Table 4.10– Recorded Water Quality Failures, 2006 – 2009

Abbrev Location	Coliform bacteria - faecal origin	Pseudomonas aeruginosa	Residual chlorine	Streptococci - faecal origin	Total coliform bacteria (MPN)	Total number of aerobic mesophylic bacteria in 1 ml	Turbidity	Grand Total
Sources								
Cemovsko	4			1	4	6		15
Mareza	66	15	2	15	101	105	8	312
Miljes	3	2		1	4	6		16
Tuzi	3		1		4	4		12
Zagoric		1		1		2	1	5
Other								
Big open market							1	1
Camaj Markao house, Vuksanlekici - tap							1	1
Camaj Marko house - tap			1					1
Coffee bar Atelje, St. Aerodrom - tap			1					1
Donja Gorica, University Donja Gorica			1					1
Elem. School Dajbabe - tap							1	1
Flat, 13 July Street, Podgorica - tap			1					1
Gojka Radonjica Street, public tap					1	1		2
Gornja Gorica						1	2	3
Gornja Gorica - tap			1		1	1		3
Milk factory - tap	1		1	1	1	1		5
Milk factory lab							1	1
Oktoih elementary school							1	1
Pizzeria Apolon Block V							1	1
Radoje Dakic							1	1
Radoje Dakic						1	1	2
Radoje Dakic - tap							1	1
Radoje Dakic labaratory			1					1
Radojica Perovic elementary school			2			1		3
S. Mugose street						1	1	2
Vranici house - yard							1	1
Zabjelo shop							1	1
Grand Total	77	18	12	19	116	130	23	395

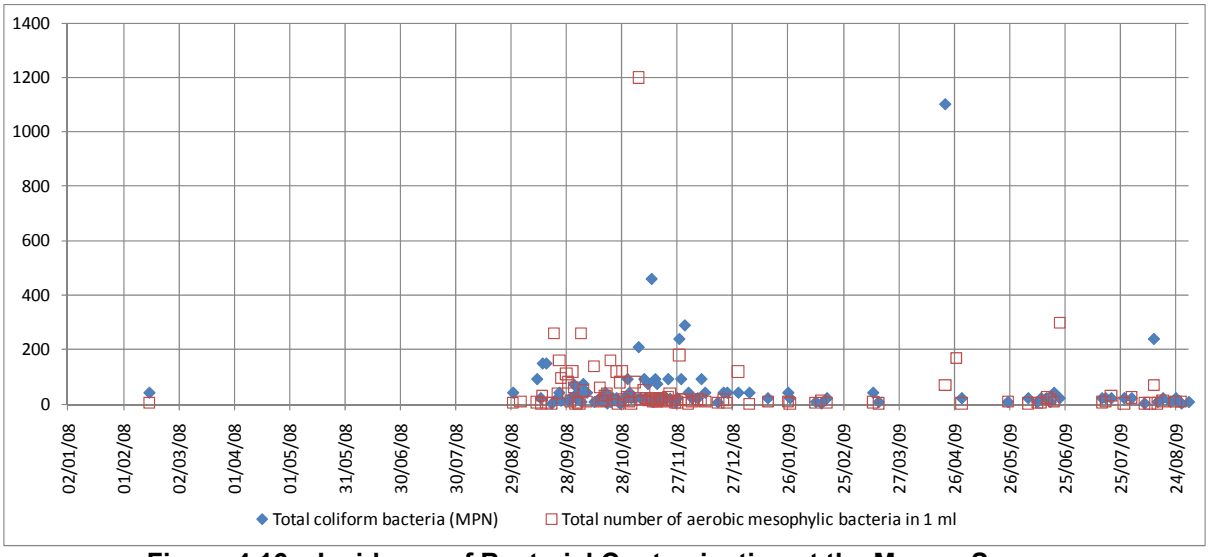


Figure 4.16 – Incidence of Bacterial Contamination at the Mareza Source

These results show that protection of the source aquifers must be improved as a matter of urgency. It is also vital that the chlorination system at each source be provided with dual cylinders, weigh scales and automatic switching between cylinders to ensure that there is no break in chlorine injection.

Table 4.11 – Summary of Water Quality Analyses by Water Source

Parameter	Units	MAC	Cemovsko				Mareza				Miljes				Tuzi				Zagoric			
			Min	Avg	Max	No.	Min	Avg	Max	No.	Min	Avg	Max	No.	Min	Avg	Max	No.	Min	Avg	Max	No.
Temperature	° C		13.0	15.1	22.0	7	11.0	12.2	13.0	5	15.0	15.0	15.0	1	11.0	13.0	15.0	2	11.5	13.6	15.3	6
Colour	° Co-Pt scale	5	5	5	5	7	5	5	5	5	5	5	5	1	5	5	5	2	5	5	5	6
Odour			-	-	-	7	-	-	-	5	-	-	-	1	-	-	-	2	-	-	-	6
Taste	-		-	-	-	7	-	-	-	5	-	-	-	1	-	-	-	2	-	-	-	6
Turbidity	NTU	1.0	0.2	0.4	0.8	7	0.2	0.3	0.5	5	0.8	0.8	0.8	1	0.2	0.4	0.6	2	0.2	0.3	0.6	6
pH			7.39	7.56	7.96	7	7.35	7.58	7.74	5	7.35	7.35	7.35	1	7.13	7.25	7.37	2	7.08	7.45	7.66	6
KMnO4 consumption	mg/l	8.00	0.32	1.72	2.50	7	2.24	3.31	4.80	5	1.92	1.92	1.92	1	1.60	1.76	1.92	2	1.24	1.96	2.88	6
Ammonia	mg/l	0.10	0.05	0.05	0.05	7	0.05	0.05	0.05	5	0.05	0.05	0.05	1	0.05	0.05	0.05	2	0.05	0.05	0.05	6
Residual chlorine	mg/l	0.50	0.10	0.20	0.30	5																
Chlorides	mg/l	200.0	3.2	5.6	8.0	7	4.5	6.6	8.8	5	8.8	8.8	8.8	1	2.0	5.5	9.0	2	4.5	6.3	10.0	6
Nitrites	mg/l	0.030	0.005	0.005	0.005	7	0.005	0.005	0.005	5	0.005	0.005	0.005	1	0.005	0.005	0.005	2	0.005	0.005	0.005	6
Nitrates	mg/l	50.00	0.50	6.64	16.50	7	0.50	1.00	1.50	5	7.00	7.00	7.00	1	1.00	8.25	15.50	2	0.50	9.67	15.00	6
Fluorides	mg/l	1.200	0.011	0.014	0.024	4	0.018	0.034	0.052	4	0.014	0.014	0.014	1	0.067	0.067	0.067	1	0.015	0.027	0.046	3
Remains from evaporation at 378.16 K	mg/l		165	189	222	7	165	182	205	5	190	190	190	1	183	196	208	2	195	219	261	6
Electrolytic conductivity at 293.16 K	µS/cm	1,000	300	332	371	7	251	296	316	5	346	346	346	1	310	345	379	2	310	378	435	6
Iron	mg/l	0.300	0.020	0.046	0.106	7	0.008	0.014	0.020	5	0.020	0.020	0.020	1	0.007	0.014	0.020	2	0.002	0.017	0.027	6
Manganese	mg/l	0.050	0.001	0.004	0.010	7	0.001	0.005	0.010	5	0.010	0.010	0.010	1	0.001	0.006	0.010	2	0.002	0.008	0.019	6
Detergents - anions	mg/l	0.10	0.05	0.05	0.05	7	0.05	0.05	0.05	5	0.05	0.05	0.05	1	0.05	0.05	0.05	2	0.05	0.05	0.05	6
Phenols	mg/l	0.0010	0.0005	0.0009	0.0010	7	0.0005	0.0008	0.0010	5	0.0005	0.0005	0.0005	1	0.0005	0.0005	0.0005	2	0.0005	0.0009	0.0010	6
Mineral oils	mg/l	0.010	0.001	0.001	0.001	5	0.001	0.001	0.001	3									0.001	0.001	0.001	4
% oxygen saturation 293.16 K	mg/l	50.0	6.8	91.3	132.7	7	64.9	95.5	132.8	5	77.9	77.9	77.9	1	73.1	96.3	119.42	2	62.1	91.4	116.51	6
Coliform bacteria - faecal origin	100	0	0	0	0	7	0	0	0	5	0	0	0	1	0	0	0	2	0	0	0	6
Total coliform bacteria (MPN)	100	-	-	-	-	7	-	2	7	5	-	-	-	1	-	47	93	2	-	1	4	6
Streptococci - faecal origin	100	-	-	-	-	7	-	-	-	5	-	-	-	1	-	-	-	2	-	-	-	6
Proteus spp.	100	-	-	-	-	7	-	-	-	5	-	-	-	1	-	-	-	2	-	-	-	6
Sulphites-reducing clostridium	100	-	-	-	-	7	-	-	-	5	-	-	-	1	-	-	-	2	-	-	-	6
Pseudomonas aeruginosa	100	-	-	-	-	7	-	-	-	5	-	-	-	1	-	-	-	2	-	-	-	6
Total number of aerobic mesophylic bacteria in 1 ml	1	-	-	-	-	7	1	5	20	5	-	-	-	1	-	3	6	2	-	7	30	6

4.2.10 Health

Bacteriological contamination of treated water can lead to public health problems if customers use the water for drinking and food preparation. The Institute of Public Health publishes annual statistics for Municipality on the numbers of reported cases of a range of infectious diseases. According to this data and to the director of Epidemiological department, there are no significant instances of diseases that may have been related to water contamination.

4.2.11 Wastewater management

The most serious environmental problem in municipality is related to the potential for surface and ground water contamination. Raw sewage and industrial wastes contaminate most surface water sources. Not all of the operating industries provide wastewater treatment, and un-treated effluent discharges straight to the Zeta and Moraca river.

55% of Podgorica municipality inhabitants are not connected to the sewage network.

In rural and less urbanized areas in the Podgorice municipality and in private residences within the city, majority of houses discharge wastewater into septic tanks which are generally expected to be badly constructed and leaking. In some cases sewage was found to be discharged directly into streams however no evidence of such was witnessed during the time of the study. The organic contamination from all the discharges is causing significant groundwater and surface water contamination.

35% of the flow from the existing WWTP is discharged to Moraca river after primary treatment only, and around 15% of the flow is discharged to the river without any treatment at all. The WWTP is located very closely to residential and retailing area, local inhabitants raise complaints regarding the odour nuisance, especially during the period September – October. This is associated with September – November wine production campaign in Plantaze, which regularly causes breakdowns of the work of the WWTP due to the very high organic loads discharged into the WWTP.

Table 4.12. Number of WWTP breakdowns related to Plantaze discharges during 2006 and 2008[17]

Date	Duration (minutes)	pH	COD (mg/l)	BOD5 (mg/l)	dry residue (mg/l)
4-Apr-06	60	6.56	1,840	1,700	324
2-Sep-06	90	5.04	3,160	2,305	566
16-Sep-06	300	6.25	1,328	690	216
26-Sep-06	260	6.10	880	840	455
2-Oct-06	330	5.01	2,000	1,950	768
9-Oct-06	210	6.32	2,448	1,600	300
12-Oct-06	90	6.60	1,840	1,500	480
13-Oct-06	240	6.42	1,240	1,181	296
5-Dec-06	105	6.27	1,960	1,800	341
10-Dec-06	120	6.61	1,200	840	242
21-Feb-08	240	-	816	-	-
27-Aug-08	30	7.00	880	818	367
29-Aug-08	300	4.58	1,520	1,195	512
1-Sep-08	240	6.88	548	390	208
3-Sep-08	300	6.10	1,160	692	303
7-Sep-08	390	5.48	2,548	2,080	990
17-Sep-08	240	6.73	1,797	1,250	214
23-Sep-08	240	5.96	2,144	2,000	397
29-Sep-08	660	6.53	8,650	6,640	308

Local industries discharge wastewater to the river Moraca and its tributaries. These include premises associated with wine production, power generation, aluminium production and smelting and on the lesser scale, production associated with food processing. Details regarding actual pollution loads from industrial waste water discharges are not available, and need to be assessed.

The largest polluters and water consumers in the municipality, in addition to municipal sewage and smaller communities are listed in Table 4.13. Table also gives an indication of potential pollution resulting from processes associated with operation of those industries.

Table 4.13 - Industrial Effluents Volumes and Characteristics

Pollution Source	Description of Liquid Waste	Volume and Characteristics	Suitability for WWTP
Plantaze	Vinasse (wastewater from cleaning operations during each production phase, sludge vinasse (semi semi-solid material that comes)from cleaning troughs, filters and pipes in wineries)	Organic contamination, High in tartaric acid which after electrodialysis can be used in food and pharmaceutical industry	Suitable after one of the pre treatment processes: anaerobic digestion, ozonation, thermophilic anaerobic digestion, aerobic biodegradation, sequencing batch reactor, electrodialysis, and wet oxidation

[17] 2007 was considered not representative due to the WWTP modernization works

DKP Tobacco Industry	Treatment plant effluent	Nicotine, flavoring chemicals containing glycogen and alcohol, absorbable organic halogens (AOX), and pesticides from tobacco leaves	Suitable after pre treatment
"KAP" Aluminum Plant	Mine and foundry of Fe, Ni	Fluorides, phenols, PAHs, and PCBs and heavy metals	Not suitable
"Hemomont" DOO (pharmaceutical)	Production and processing of paper	PCB's, Dioxins and Chlorine compounds to land; sulphates, chromium and aluminium, potentially selenium cinc	Not suitable
Municipal wastewater system	Liquid domestic waste	Domestic	Suitable after pre-treatment
Dairies	Cleaning waste	BOD_5 suspended solids, chemicals, disinfectants and animal waste	Suitable
Slaughterhouses	Technical water	Hazardous organic waste BOD_5, total suspended solids, pH and bacterial count	Suitable after pre-treatment
Petrol Stations	Cleaning waste, oil residues	BOD_5, suspended solids, heavy metals, volatile organic chemicals	Suitable after pre-treatment
Unofficial solid waste tips	Leachate	All variety , high BOD_5, COD, heavy metals, suspended solids	Not suitable
Agriculture	Fertilizers and pesticides	Hazardous organic waste, Nitrogen, Phosphorus, Pesticides	Suitable
Farming	Animal waste	Strong organic waste, Nitrogen, phosphorus, Synthetic hormones, Antibiotics, parasites, Spores of Cryptosporidum - a protozoan which is resistant to drinking water treatment processes, Spores of Giardia, Human pathogenic bacteria such as Brucella and Salmonella	Suitable

5 Financial status of ViK

5.1 Introduction

This section provides an analysis of the recent financial performance of the Water and wastewater company of Podgorica (ViK). It highlights the main issues affecting its existing operations and future financial sustainability. The section focuses on the following key aspects:

- Tariff policy, structure and tariff levels
- Operating revenue and costs
- Assets and liquidity
- Billing and collection
- Financial relationship with the Municipality

The section is supported by an Appendix that contains an Income Statement, Balance Sheet and Asset Statement for ViK's activities.

5.1.1 Overview of Financial Position

(a) Summary

The summary conclusions from the assessment are that:

- ViK tariffs have been sufficient to cover operating costs and depreciation since 2009 and allow for limited capital investment
- The Municipality regularly provides funds for investment
- The increase in tariffs from 1 Nov 08 is generating increased revenue for ViK which can be used to finance efficiency measures or new investment
- There is significant cross-subsidisation of customers by category and by service
- ViK would be in a much stronger financial position if it could reduce the amount of debtors and reduce the volume of unaccounted for water and take other action as set out in the next section
- There is scope for improved efficiency by reducing the significant costs of the production and distribution of water which is unaccounted for
- The accounting and information systems should be improved

The financing relationship with the Municipality means that the ViK accounts may not show the true level of public water and wastewater assets of the City.

(b) Areas for Immediate attention

- The billing system is not satisfactory. The procedures should be reviewed and changes made to ensure that the customer database is accurate, all customers are billed every month and accuracy of meters is checked regularly

- The collection performance, whilst improving, is not satisfactory The procedures should be reviewed and new tougher collection methods implemented to reduce level of debt. These may include charging interest on unpaid accounts, more disconnections and making special arrangements to recover debts from properties with multiple occupancy

- Improve accounting systems to provide effective costing of all different activities so that tariffs can be related to costs
- Rationalisation of the increasing amounts owed to and from the Municipality and Government
- Reliable calculation of deferred taxation
- Establishment of an audit board or employment of an internal auditor

(c) Areas for Future Action

Actions that ViK should take in the future include:

- Once the development of the network is completed, to introduce tariffs for the water (and wastewater if applicable) services to Zeta. If water sales were charged at the average tariff of June 2009, there would be increased annual income of around €1.15m
- Develop integrated computerised systems for both accounting and billing and collection and introduce a MIS (Management Information Systems). This should form part of Information Systems development for the whole company

(d) Tariff structure

Tariff issues that should be considered as part of its long-term water and wastewater investment and financing strategy are:

- The extent to which institutional, industrial and commercial customers can continue to heavily subsidise domestic customers
- The scope for the introduction of trade effluent charges so that dischargers pay for treatment according to the costs of treating their own discharge

(e) Significant Items in the Accounts

- 73% of ViK income is from the core services of water and wastewater. ViK should ensure that its tariffs should recover the costs for these services and income from other activities should not be relied upon as part of the permanent income base
- 20% of operating costs are write-off of as accounts receivable. This is not only a very high percentage but means that those who pay are subsidising those that do not
- There are lawsuits filed against ViK, the largest of which is €0.22m, for which no liability or provision was made in the accounts.
- The leases for cars should be treated as operational costs and not lease costs
- The level of inventory should be reviewed and reduced where possible without affecting operational integrity

It is appreciated that not all the actions recommended above could be addressed by ViK alone but need Municipal and Government support. However, the issues should be analysed and ViK should develop a plan for each action.

(f) January – December 2009

The average tariff increased by 46% from 1 November 2008. The income from water and wastewater services shows a 26% increase in 2009, tariffs having been increased

by 46% on average. Total sales for 2009 decreased marginally compared with 2008 but household sales have increased whilst other non-domestic sales (where the tariff increase was 81%) have decreased.

5.2 Tariff Setting and Subsidy Payments Policy

5.2.1 Tariff setting

Tariff setting for ViK is within the framework of the following regulations which cover water supply, wastewater and drainage services

5.2.2 National regulations

National regulations which relate to water supply are contained in Official Gazettes of Montenegro

1. Law on communal activities (Official Gazette of Montenegro, No 12/95)
2. Law on obligatory relations (Official Gazette of Montenegro, No 47/08)

5.2.3 Podgorica City Regulations

The following City regulations relate to water supply and are contained in Municipality Official Gazettes.

1. Decision on water supply of Municipality of Podgorica and Tuzi (Official Gazette of Montenegro, Municipal Regulations 22/2003 on meter reading and invoicing)
2. Decision on collection and disposal of storm waters from the area covering general physical plan (Official Gazette of Republic of Montenegro, Municipal Regulations No 22/2003)
3. Decision on drainage and treating sewage from the area covering general physical plan of Podgorica (Official Gazette of Republic of Montenegro, Municipal Regulations 22/2003)
4. Decision on organising of activities in the area of municipal activities (Official Gazette of Republic of Montenegro, Municipal Regulations 14/01)

5.2.4 ViK Regulations

1. Decision on adopting new prices of services related to delivery of water and wastewater services - August 2008
2. Decision on subsidising water and wastewater - August 2008

5.3 Approval of Tariffs

5.3.1 Procedure

Tariffs proposals are prepared by ViK in accordance with the methodology defined in the regulations and submitted to the Municipality, initially for scrutiny by the Secretariat for Municipal Services and Traffic prior to a decision being made by the Municipal Parliament, or the Mayor.

There is not a formal timetable for review of tariffs. Following the tariff approval effective from 1 April 2004, tariffs were not increased until 1 November 2008, the Municipality having indicated informally that increases were not appropriate. It is not known when the next review of tariffs would take place.

The approval in 2008 followed a calculation by ViK of the increases in usage and cost of fourteen items of expenditure since the last calculation in 2002. This calculation showed the need for an overall increase of 46%

5.3.2 Current Tariffs

The previous (from 1 April 2004) and current tariffs are shown below in Table 5.1.

Table 5.1: Current Tariff Levels

€ / m3 excl VAT	1 Apr 2004	31 Dec 2009	% increase
Water			
Household	0.210	0.240	14
Institutional	0.670	1.146	71
Other	0.736	1.330	81
Wastewater			
Household	0.105	0.120	14
Institutional	0.335	0.573	71
Other	0.368	0.665	81

The average tariff was increase by 46% but a different level of increase applied to each customer group. This decision was related to the perceived ability of the different groups to pay. The tariffs remained unchanged throughout 2009 after the increases on 1st Nov 2008

5.3.3 Trade Effluent Charges

There are no specific charges for industrial trade customers based on the strength and volume of their discharge but there is the legal right to levy a charge if the discharge is outside consent conditions. These charges, which are related to the average salary in the Republic, have not been levied during the last three years.

However, ViK has made a firm commitment to enforce the regulations, with the support of the Municipality and the Ministry of Environment, once it has fully functional wastewater treatment facilities. The success of this endeavour remains to be seen as it is common for large industrialist with political influence not to comply with environmental legislation

5.3.4 Subsidisation of Individual Household Customers

Certain classes of customer receive a 50% reduction on their water and wastewater tariff. 250 domestic customers received this reduction in 2008. The classes include:

- Customers with low incomes as defined in the regulations
- Customers receiving social benefits
- Disabled and blind customers
- Customers in apartment blocks and other buildings who do not receive 24 hour supply during the summer months.

5.4 Tariff Issues

5.4.1 Cost-Recovery Tariffs

The accepted best practice for charging for water and wastewater services is that best use of resources is achieved when charges reflect the cost of providing the services. The overall level of tariffs currently charged by ViK enables the company to recover its current operating costs plus depreciation and finance limited capital investment. The small profit in the accounts in 2008 was only achieved with a Municipality contribution.

5.4.2 Cross-subsidisation between Classes of Customer

Table 5.1 above shows that the extent of cross-subsidisation between classes of customers is significant and increased as a result of the latest tariff increases. It is understood that there are social reasons why ViK and the Municipality wish to assist the domestic customer but there may be other ways in which this can be achieved.

The cross-subsidisation is an important issue when considering the affordability of the proposed investments that may follow from this project. The Financial Appraisal section of this report examines the affordability of the current and future tariffs by calculating the amount of household income that is spent on water and wastewater services. If at this stage the cross-subsidy was removed, the required changes in tariff would be

- Household +60%
- Institutional -50%
- Other -55%

5.4.3 Cross-subsidy between Services

Table 5.1 shows that for all classes of customer, the wastewater tariff is 50% of the water tariff. The tariff approval procedure was based on the total costs of ViK and did not take into account the costs of the individual water and wastewater services, nor did it take account of the costs of construction services and other rechargeable work which accounts for 25% of the ViK's total income.

Based on a detailed analysis of the costs, the tariff changes required if the tariffs were to be based on costs would be:

- Water +11%
- Wastewater 0%

This assumes that recharges for all construction work and other services provided are based on full cost recovery. Costs are not directly allocated to all activities but based on a high level exercise, the profit and loss in 2008 was:

- Construction work +€ 60,000
- Other services - € 323,000

5.4.4 Supplies to Zeta and Danilovgrad

Approximately 4.4m m3 of water, or 12% of the water produced, is supplied to the Municipality of Zeta and Danilovgrad at no charge. The reasons for this are

- Zeta is supplied 2.5m m^3 of treated and distributed water. The water supplies in this area were unsatisfactory as a result of polluted sources. The Municipality decided to extend the city system to improve the supplies but so far ViK is not allowed to recover the costs from the consumers in the area. The costs are being recovered from the other billed customers who are subsidising customers in Zeta. There is no apparent reason why customers should not be billed and charges should be introduced when the work on the network is completed

- Danilovgrad ViK receives a bulk supply of 1.9m m^3 of treated water without charge. This was agreed to compensate Danilovgrad for the use of the land for the water treatment plant and for the use of raw water resources in the area. Danilovgrad ViK distributes the water in its area and bills customers. This was a commercial decision by the Municipality but as far as it is known this arrangement is unlikely to be changed in the foreseeable future.

The network in Zeta serves 5,000 to 6,000 people but the connections are not metered and in the past the water supplied to Zeta has not been billed by ViK. However, the 2011 programme for the Municipality of Podgorica and ViK includes prviding remotely read meters for all connections in Zeta

5.5 Operating Revenues and Costs

5.5.1 Revenue from Water, Wastewater and Other Services

Revenue from water and wastewater services for 2007 - 2007 is summarised blow in Table 5.2.

Table 5.2: Operating Revenues (€ 000)

	Water Income		
	2007	**2008**	**2009**
Water Sales	5,073	5,339	6,766
Wastewater Services	1,379	1,447	1,782
Sub-total	**6,452**	**6,786**	**8,548**
Other Services	2,245	2,478	1,136
Total	**8,697**	**9,264**	**9,684**
Increase %		**6.5%**	**4.5%**

The increase in the income from water sales in 2009, although the overall volume sold went down as shown in the next table, resulted from the increase in tariffs that took place from November1 2008. The effect of the tariff increase on revenues by consumer categories from 2008 to 2009 is shown in the table below in Table 5.3.

Table 5.3: Revenue in 2008 and 2009 by Consumer categories (€ 000)

	2008		2009	
	Water	**Wastewater**	**Water**	**Wastewater**
Household	2,440	526	2,772	584
Institutional	901	373	1,122	436
Other	1,998	548	2,872	762
Total	**5,339**	**1,447**	**6,766**	**1,782**

Change %			**+27%**	**+23%**

The billed income is shown to have increased significantly for each consumer category for both water and wastewater as a result of the tariff increases between 2008 and 2009

5.5.2 Volumes of Water and Wastewater Services

The volume of water and wastewater services for the last three years is shown in Table 5.4. The summary of trends is:

- Sales to industry and commerce have declined marginally in 2009
- Sales to households have increased
- Sales to institutions have reduced

It seems that while industrial and commercial consumers may able to "pass on" the relatively high costs of water and wastewater services to their customers in the future, this is not the case with the institutional consumers and consequently they have started managing their demands more efficiently, especially as VIK has been pursuing a more aggressive policy of cutting of supplies to non domestic consumers for non payments.

Table 5.4: Volume Water and Wastewater Services by Consumers (m3)

	2007		2008		2009	
	Water	**Waste-water**	**Water**	**Waste-water**	**Water**	**Waste-water**
Household	12,226	5,366	12,127	5,172	12,414	5,300
Institutional	1,576	1,499	1,277	1,370	1,049	1,031
Other	2,348	1,156	2,588	1,219	2,290	1,332
Total	**16,150**	**8,021**	**15,992**	**7,761**	**15,753**	**7,663**

5.5.3 Other Income

Table 5.5 below summarises the analyses of the other income for the period for which detailed data is available

Table 5.5 Summary of Other Incomes

	2006	2007	2008
Other Income			
Storm water collection		80,567	141,750
Construction works		721,182	457,104
Licences for new connections		489,808	535,806
New connections		100,948	155,673
Emptying septic tanks		89,164	37,644
Other		198,367	107,452
Contributions from Municipality			809,482
	1,004,000	**1,680,036**	**2,244,911**
Extraordinary income			
Income from previous years		232,786	232,234
Sales of assets		276,000	0
Other		56,627	0
	692,000	**565,413**	**232,234**

The contributions from the Municipality towards capital investments have been treated as revenue income.

5.5.4 Operating Costs

The total operating costs for ViK from 2007 to 2009 are summarised below in Table 5.6

Table 5.6 Summary of Operating Costs (€ 000)

		2007	2008	2009
Electricity costs		1,142	1,144	945
Material costs		538	519	360
Fuel		168	115	54
Personnel		1,541	1,827	2,100
Repair and maintenance		167	116	115
Other expenses		865	895	1,046
Depreciation		936	1,034	1,121
Total Operating Costs	**€ 000**	**5,357**	**5,650**	**5,740**
Annual Increase	**%**		**5.5%**	**1.6%**

The table shows that the operating costs have been rising only gradually over the last two years.

5.5.5 Accounting Department

The finance department has seven people on financial accounting, four on management accounting, eight on payments, and eight on payroll.

The Chart of Accounts is in accordance with International Accounting Standards but there is little use made of facilities to analyse the data. The accounts are only closed annually but financial reports are made quarterly to the Board.

Under the legislation, the accounts have to be closed by February 28 and are subject to external audit.

There is old accounting software in use which is not very satisfactory. There is little interface between the accounting systems most of which are kept manually.

5.6 Assets and Liabilities

5.6.1 Value of Fixed Assets

The value of fixed assets in the balance sheet at 31 December 2009 was €25.8m with average gross investment of €1.9m for each of the last three years. This investment has been financed mainly out of ViK revenues although there were contributions from the Municipality of €0.8m in 2008.There were also contributions in 2009 of €0.4 m

Approximately two-thirds of the historical costs of the assets have now been depreciated indicating that there is an aging asset base. This may be one indicator why there are significant losses of water in the aging network.

It is understood that investment in water and wastewater facilities has also been undertaken by the Municipality in its own right. The cost of these assets is not included in ViK accounts and it is not making any depreciation provision for replacement. The total value of these assets could not be established but in future it is advisable for all water and wastewater assets to be vested in ViK.

5.6.2 Financing Structure

The statutory capital in the balance sheet is €28.7m with accumulated profit of €0.5m, a small profit having been made in 2009

5.6.3 Long-term Liabilities

There were long-term liabilities of € 0.575m as at 31 December 2009

5.6.4 Current Assets

- The inventory was €0.483m which represents a continuation of a down ward trend in the levels.
- The trade and other accounts receivable were €4.8m equivalent to eight months income. This is a very high figure although €2.5m was owed by domestic customers.
- The total of accounts receivable increased from €4.5m to €4.8m by the end of 2009. The total owed by the 10 largest debtors combined was €1.1 m.

5.6.5 Current Liabilities at 31 December 2009

- Current liabilities were €1.036m of which €0.4m was owed to the Electricity Company and €0.3m to the Municipality
- The balance sheet shows short-term liabilities of €0.123m but this is actually in respect of a lease on vehicles and should be shown as long-term, the final payment was due in 2010

5.6.6 Liquidity Position

The current ratio of assets to liabilities is 5.5 but this ratio is misleading as it is unlikely that all the trade accounts receivable will be recovered, certainly not in the short to medium term. The collection performance is improving for domestic customers but the absolute total of debtors is still high.

There needs to be a discussion with the Municipality about the debtors and creditors outstanding with Government and Institutional customers as the reduction of these customer's budgets is putting pressure on ViK's cash flow.

5.7 Billing and Collection

5.7.1 Customers

The following tables analyse the customer base for the first six months of 2009 according to the number of bills sent out.

Table 5.7: Number of Bills Sent in first half of 2009

Customer group	Number of Monthly Bills Sent	Population Connected
Households		
Apartments	21,613	68,080
Private	14,825	48,698
Total	**36,438**	**116,778**
Institutional	317	
Industry	846	
Commercial	1,260	
Other	34	
Total	**38,895**	

Although all customers are due to be billed monthly, this does not always happen.

5.7.2 Customer Agreements

The relationship with customers is based on Municipal Regulations 22/2003. These cover registration of consumers and invoicing and collection. A consumer submits request for connection and after technical approval, receives working licence and a meter can be installed. After that there is no individual legal agreement or contract between ViK and the consumers.

5.7.3 Meter Reading and Billing

The meters are read monthly between 3rd and 25th of month. Readings are submitted to information service. Afterwards, information service prints bills and payment books. ViK has started trials with remote meter reading facilities.

All customers are supposed to receive monthly bills which are produced within one week of the completion of readings by the 25th. Household bills are printed and delivered by the postal service whist all other customer bills are printed in-house and distributed by bill collectors / meter readers

The data in the table above shows that bills are not sent out monthly to all domestic customers. In the first six months of the year, only 70% of domestic customers in houses and 78% in apartment blocks received a monthly bill. There were no satisfactory

explanations given although there was an assurance that over the course of a year, all customers were billed for all the water that had gone through their meter.

ViK is responsible for repair and/or replacement. If the meter is stopped, the municipal regulations allow ViK to base bills on the previous three months consumption or another agreed basis.

The water meters are owned by ViK and there is an obligation/policy to test the accuracy every 5 years. This would imply that out of 35,123 existing meters ViK should be testing about 7,000 meters each year but this does not appear to happen. The activity report for 2008 shows that the number of meters maintained and calibrated was:

- 1,536 in 2007
- 1383 in 2008

The number of meters replaced in these two years was:

- 1,601 in 2007
- 1,389 in 2008

The actual activity in these two years was only about 50% of what was planned. With unaccounted for water estimated to be 47%, more attention should be paid to this activity as it is a way to tackle the unaccounted for water and to increase the income base.

A related activity is to validate the accuracy of the customer database. Whilst meter readers are required to report any illegal connections and look for other evidence of malpractice, or malfunctioning equipment, ViK should initiate a separate exercise to validate its billing base against other records of housing and population.

It is known that there are properties without the correct documentation which are receiving water but cannot be billed.

5.7.4 Collection

Households can pay through post, bank, in the ViK office and three payment stations at different points in the city. The follow up procedure after non-payment is as follows

- Householders receive a written warning after six months and other customers after 30 days
- If payment is not made within 7 days, supplies can be disconnected. 108 properties were disconnected in 2008
- If neither of these is successful, court action can be taken. 920 customers were taken to court in 2008 and 733 have been taken to court in the first eight months of 2009

There is no default interest or penalty for non-payment but

- If a property is disconnected, a reconnection fee of €20 is payable by household customers and €30 by other customers
- If there is court action, the customer has to pay administrative costs.

The following table shows that the collection performance has been satisfactory over the last three years for institutional, industrial and commercial customers but not very satisfactory for domestic customers

Table 5.8: Cash Collection

Cash Collection %	2007	2008	2009
Household	67%	51%	74%
Institutional	92%	88%	118%
Other	122%	95%	100%
Total	**91%**	**75%**	**93%**

The Finance Director reported that that there had been a significant improvement in collection of household debt in 2009 and that the percentage collection had increased to 74%. ViK will need to take decisive action to increase this figure still further. It is suggested ViK should target at least 98% collection. This should be achieved before any tariff increases become necessary.

5.7.5 Debtors at 30 Jun 09

Table 5.9 below summarises the debts outstanding at 30 June 09 which have now risen to €6.6m, an increase of €2.0m since the start of the year.

Table 5.9: Debtors at 30 June 09

Customer Category	Debt at 30 Jun 09	Billed since 1 Jan 08	% Billed
Domestic	3,489,972	3,945,648	88%
Industrial	517,325	1,067,177	48%
Commercial	1,087,526	1,579,729	69%
Institutional	1,306,784	2,220,056	59%
Other	202,842	651,509	31%
Total	6,604,449	9,464,119	**70%**

Three main issues arise

- Debts from institutions and government totaled €1.3m by middle of 2009. This is a major problem caused by the economic recession resulting in cuts in institutional and government budgets and cannot be resolved by ViK itself.
- The need for more decisive action to reduce household debt which is possibly a case of “won’t pay” as opposed to “can’t pay”. One possibility is that there could be a well-publicised campaign to disconnect more domestic properties with individual connections which may encourage others to pay.
- There is a separate problem with properties in apartment blocks which can effectively not be disconnected if one or more of the customers is paying

5.7.6 Writing off of debts

In future, household debts can be written off after two years and other debts after three years. The debt written off in 2009 was €1.240 m which was equivalent to 14.5% of the total revenue income from water and wastewater services. The debt written off for households was 11.5% of the billed income for the year. The write-offs were partly offset by the recovery of €0.3m that had been written off in earlier years.

- Households 783,086

- Others 429,834
- Services 28,354

1,240,824

Over the last three years, ViK has collected the following amounts that have been previously written off in the accounts

- 560,160
- 232,785
- 232,219

1,025,165

Various reasons were given for non-collection in particular from apartment blocks where the supply cannot be cut off if some of the customers are paying. Court action is generally a very slow procedure and it is difficult for ViK to take every debtor through the legal process. In each of the last two years less than 1,000 have been taken to court.

It is acknowledged that the customers may be in a difficult financial situation and suffering hardship. However, the amount of the average household income that is spent on water and sewerage services was calculated to be less than 2% in 2007 when the calculations for the tariff increase submission were carried out. This percentage is considered to be well within the criteria for affordable limits used by the international financing institutions and the World Health Organisation.

The Municipality has the facility to give assistance of up to 50% of the water and wastewater bills to certain categories of citizen including those whose incomes are less than 35% of the average monthly salary. 250 people benefited from this in 2008

The average income in Podgorica is higher than the national average, yet the tariff appraisal in 2007 showed that Podgorica had the second lowest tariff of the twenty municipalities surveyed.

5.7.7 Staffing

There are two sections for billing and collection

- Billing section of 11 people responsible for issuing bills
- Collection section which is in two parts
  - Households - 14 staff
  - Other - 13 staff

These numbers relate purely to financial aspects of metering and do not include the section of 11 staff which removes and replace meters. The total number of meters is approximately 32,000. ViK is currently installing remote readers and it should ensure that proper monitoring arrangements are in place to review the effect of these readers on frequency and speed of billing and number of staff required to carry out the metering and billing function.

5.7.8 Billing and Collection System

There is no billing and collection software – only a data base created fifteen years ago. A new integrated information system with links between technical and financial sectors is needed for the process to become more efficient. There is no interface with the accounting system and there is management information available. The following reports are available

- Analysis of billing by customer category
- Stopped meter reports
- Consumption statistics by area of the city
- Detailed reports on major customers
- Daily information of payments due that day

ViK should review the whole of its billing and collection operation to seek efficiencies and improvement and in particular should review the IT system. More efficient meter reading through the use of remote readers will only yield minor benefits unless it is integrated into improvements elsewhere.

Billing and collection are two activities that are often out-sourced by water utilities but outsourcing an inefficient system often leads to a more expensive inefficient system. ViK should appraise outsourcing but should aim to improve its in-house operation first.

5.8 Financial Relationship with Municipality

5.8.1 Municipality Finance

ViK is a public enterprise 100% owned by the Municipality. This has the effect that every major financial decision by ViK has to be approved by the municipality.

Table 5.12 Summary of Municipal Income and Expenditure €

	Income and Expenditure Summary		
	2006	**2007**	**2008**
Income			
Taxation	17,186	21,941	26,441
Fees and charges	3,366	28,976	33,266
Non-taxation income	644	4,452	7,101
Sales of assets	13,054	20,382	6,156
Previous years	460	905	12,318
Grants and contributions	541	183	50
Loans	0	1,100	8,000
Total	**35,253**	**77,941**	**93.333**
Expenditure			
Revenue expenditure	10,087	14,534	16,635
Revenue grants	21,026	48,495	57,394
Capital grants	1,108	1,179	0
Other	2,127	1,412	1,122
Total	**34,348**	**65,623**	**75,151**
Balance	**905**	**12,318**	**18,182**

It is stated that there is no formal balance sheet for the Municipality and no legal requirement to provide one as the accounting is carried out on a Treasury basis. The only financial information made available was the Income and Expenditure statement summarised above.

5.8.2 Municipal Borrowing

The schedule of Municipal debt at 31 August 09 showed total debt outstanding including interest payments was €26.8m. The loans have all been taken out during the last five years with the largest being for €8m from Dexia Banka in 2008.

The debt servicing liabilities peak in 2010 when €3.4m will be needed. This equates to about 5% of the municipal budget for 2008. For the subsequent six years to 2016, the requirement is €2.0m equal to 2.7% of the budget.

The permissbale limit to the amount that the Municipality can borrow is based on the law that annual debt service including interest, capital repayments and fiancial fees should not exceed 10% of the previous year's budget. Any borrowing is subject to Government approval.

5.8.3 Municipal Approval of Tariffs

The Municipality approves the tariffs on the basis of submissions by ViK. These submissions are on the basis of costs increases since the last approval. It is understood that the approval is for the overall tariff increase and that the increases in individual tariffs are the responsibility of ViK.

5.8.4 Municipal Assistance to ViK

The Municipality has made contributions towards capital investment by ViK for each of the last three years with a contribution of €0.8m last year. In 2009 to date, there have been contributions of €0.4m. These contributions are included in ViK's income and expenditure statement.

The Municipality stated that water and wastewater were high priority and it would continue to make contributions to future investment.

5.8.5 Other Bodies

It is possible that external finance can be received either as loans or as grants from other bodies such as

- National government from which no contributions are currently received
- International financing institutions and other external donors
- Local commercial loans

6 Long term development needs

6.1 Development Needs and Policies

This Section projects the water and wastewater requirements to a planning horizon of 2035 and assesses the "long-term" infrastructure requirements to meet these needs. Prioritisation of these needs is considered in the following Sections to derive the most effective affordable 'Project'.

6.2 Demand projections

6.2.1 Population

The last census was taken in 2003 and the results of this census for Podgorica are shown below together with results of the previous census in 1991.

Area	1991 Census	2003 Census	Annual growth rate, %
Municipality of Podgorica	145,696	168,812	1.23%
City of Podgorica	116,013	136,351	1.35%
Rural areas of Municipality	29,683	32,461	0.75%

The urban population grew at a faster rate than the rural population between the two censuses and it is considered that this trend has continued since 2003.

The statistics office of Montenegro, MONSTAT, has provided the following estimated populations for Podgorica Municipality based on the 2003 census updated using net population growth and migration figures.

MONSTAT Population Estimates for the mid year

	2004	2005	2006	2007
Podgorica Municipality	170,879	172,626	174,401	176,569

These figures suggest that Podgorica Municipality grew at an average rate of 1.13% p.a. in recent years and it is considered that the rate in the urban area has been higher.

The following recent studies have included population projections for Podgorica:

- Prefeasibility Study for Pogorica Wastewater Treatment Project, Sogreah, February 2004.
- Preparation of a Sewerage and Wastewater Strategic Masterplan (Central and Northern Region) Montenegro, Safege in association with Tebodin & LDK, November 2004.
- Pre-feasibility Study and General Project for the Sewerage System for Waste Water from the City of Podgorica, IK Consulting Engineers, December 2008.

Details of the projections in these reports are shown below:

Projection from Sogreah Study (prepared before 2003 census results available)

Area	1991	2001	2011	2021	2031
City	120 762	147 500	163 000	180 000	215 000
Rural	31 263	26 000	28 000	30 200	32 500
Total population	152 025	173 500	191 000	210 200	247 500

Projection from Safege Study

	2003 Census	Growth rate, % p.a.	2009	2019	2029
Podgorica Municipality	168,812		182,780	208,873	238,991
City of Podgorica	139,998	1.50%	153,080	177,665	206,176
Rural Areas	28,824	0.50%	29,700	31,218	32,815

Projection from IK Consulting Engineers Study (for General Urban Plan area which is larger than the census urban area)

Area	2003	2010	2012	2015	2018	2021	2031
Podgorica GUP	146,742	162,210	167,635	176,114	180,912	185,841	203,261

The projection of IK Consulting Engineers for the Podgorica GUP area, which assumes a growth rate of 1.67% p.a. until 2015 and 0.9% p.a. after that, is somewhat lower than the other two projections. The publication 'Demographic trends in Montenegro from mid 20th century and projections to 2050' by MONSTAT suggests that the population of the Central Region (of which Podgorica is the largest component) will only increase by 8.2% between 2005 and 2025 (or 0.39% p.a. growth rate) and by 10.9% between 2005 and 2050 (or 0.23% p.a. growth rate). Therefore, for a growth rate as high as 1.67% p.a. to be sustained in the urban areas of Podgorica until 2015 there is an implied reduction in the population in the other areas of the Central Region.

It is considered that the growth rate of Podgorica Municipality will be approximately 1.3% until 2011 and that it will then gradually reduce to 0.9% by 2018. Beyond 2018 a growth rate of approximately 0.8% is expected. For the urban area of Podgorica a growth rate of 1.67% is expected until 2010, falling to 1.6% in 2013 and then gradually falling to 0.9% by 2021. These growth projections result in the population of the rural area of the Municipality remaining relatively stable with a slight reduction to approximately 30,000 by 2019 and then a gradual increase to 30,700 by 2031

Table 6.1 shows the population projections for the Municipality plus the urban and rural areas until 2035. Figure 6.1 shows graphically the recent population estimates together with the consultant's projections to the year 2035.

Table 6.1: Population projection data for Podgorica

Area	2007	2010	2015	2025	2035
Podgorica Municipality	176,569	183,550	195,300	213,214	230,670
Urban area	145,690	153,112	165,107	182,823	199,939
Rural area	30,879	30,438	30,193	30,392	30,731

Both ViK and the Municipality of Podgorica have concerns that the MONSTAT quoted population of 176,569 and the derived figure of 183,550 for 2010 are underestimates of the actual population resident in Podgorica. Estimates based on health cards suggested that the present (2010) population could be 200,000 or more. It is believed that the difference of some 15,000 to 20,000 could be due to non registration of residents and registration in other Municipalities. Despite these concerns, the demand projections have been based on the figures in Table 6.1 but it must be born in mind that flexibility may be needed regarding future phasing of work. In particular, the timing and size of the Phase 2 extension of the wastewater treatment plant should be kept under review.

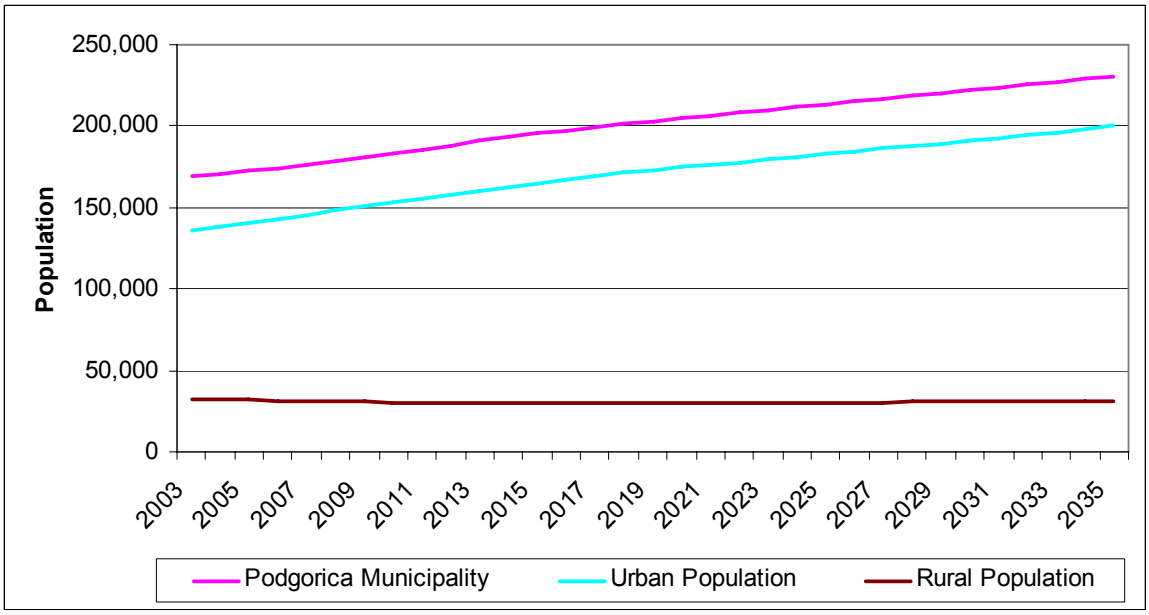


Figure 6.1: Population projection for Podgorica

6.2.2 Basis for Water Demand Projections

Future water demand has been extrapolated using the above population projections from an analysis of the existing billing and production figures for the years 2006 to 2009, which are summarized in Table 6.2 below:

Table 6.2: Billing and Production data (m^3 per annum)

Category	2006	2007	2008	2009
Production (m^3/yr)	39,803,605	41,282,389	39,477,353	34,351,992
Domestic billings (m^3/yr)	11,122,318	12,226,385	12,127,484	12413660
Industry billings (m^3/yr)	2,515,971	2,347,975	2,588,259	2275419
Institution billings (m^3/yr)	1,719,193	1,576,695	1,277,305	1065338
Total billings (m^3/yr)	15,366,889	16,270,798	16,135,726	15754417
Unbilled water consumption (m^3/yr)	6,684,160	5,511,175	4,593,710	13,844
Unaccounted water (m^3/yr)	17,752,556	19,500,416	18,747,917	18597575
UFW as % of production	44.6%	47.2%	47.5%	47.2%
Population served (estimated)	130,413	137,382	141,456	148,467
Per capita domestic consumption (lcd)	234	244	235	229

(a) Losses

As discussed in Section 3, overall losses are high at around 47% for the last two years although it is thought that a considerable proportion arises from unmeasured consumption rather than physical losses. Nevertheless the high level of unaccounted water will result in significant additional costs through excess energy and chemical consumption and the need to provide excess infrastructure. It is believed that the measures outlined in Section 3 should have an impact on reduction of losses, and ViK should set a long term target for reducing the unaccounted water to below 20%. Nevertheless, the proposed demand projections use a target of 30% unaccounted water by the year 2016 and 25% by 2035. These lower targets have been used for planning purposes to reduce the risk of adopting a too ambitious target and thereby under stating the demand requirements, which would result in a constrained supply situation.

(b) Per capita demand

The present per capita demand figure of 235 l has been calculated from the total domestic billings divided by the estimated population served. In global terms this figure

is high and examination of breakdown of consumption between private house and apartments reveals part the reason for this. Figure 6.2 shows the monthly variations in domestic consumption for the last three years.

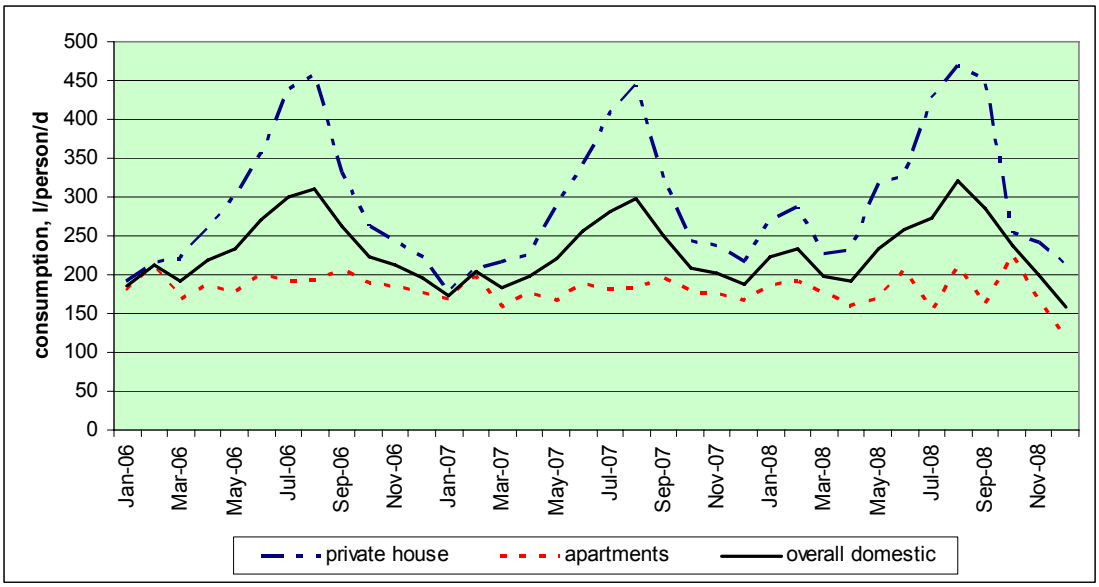


Figure 6.2: Monthly variation in domestic water consumption

It can be seen that, while consumption in apartments remains relatively stable at a little below 200 lcd, consumption in private houses varies from around 200 lcd in the winter to a peak of more than 450 lcd in the summer. The high consumption rates and extensive use of the public water supply for garden and yard watering can be related in large part to the low unit cost of water of 0.24 Euro/m^3. A tariff set to recover full costs, including wastewater costs will be considerably higher (commonly in the order of 2 Euro/m^3), and following the normal economic rule of price elasticity, will act as a deterrent to high consumption levels. This will be countered to some extent by an expected increase in income levels, The demand model uses a price elasticity coefficient of -0.35 and an income elasticity coefficient of 0.15 together with a preliminary assessment of annual tariff increases of 10% and annual income growth rates of 3% for the next 10 years. The overall per capita consumption is predicted to reduce towards a figure of 160 lcd by 2030, which is in line with consumption figures for middle income Mediterranean countries which have introduced cost recovery tariffs.

(c) Non domestic demand

The billing data indicates non-domestic (industry and institutions) demand at around 32% of domestic demand (21.3% for industry and 10.5% for institutions in 2008). The tariffs for industry and institutions are high relative to the domestic tariff and this is likely to limit future increases in consumptions by these categories as water saving measures are introduced. Following the increases of 81% and 71% in industry and institution tariffs respectively in November 2008 sales in 2009 indicate that is has happened to an extent with industry demand falling to 18.3% of domestic demand and institution demand to 8.6%. Nevertheless, a large new industrial area is planned in the south of the City and this will attract additional industries, although these will probably be mainly 'dry' rather than large water consuming industries. On balance it is considered that industrial consumption will recover marginally to 19% of domestic consumption by 2011 and then to 25% by 2035. Institutional consumption is expected to fall further to 8.3% of domestic consumption by 2011 and then increase slowly to 10% by 2035.

It should be noted that because the high tariffs industries and institutions account for 55% of billed revenue. The ViK should ensure that its pricing policies do not impact adversely on the revenue from these important customers.

(d) Unbilled consumption

The major items of unbilled consumption are water supplied to Danilovgrad and to Zeta. Zeta is now part of ViK supply system but the distribution system, which originally had independent source wells, had no metering. As meters are installed this will cease to be unbilled consumption and will become billed consumption. The demand projection assumes metering in Zeta will be completed by 2015. It has recently been learnt that ViK proposes a major metering programme in Zeta in 2011 so that the transfer from unbilled to billed consumption may be more rapid than assumed in the projection.

Danilovgrad is a separate Municipality which is supplied with water from the Mareza source, which is located within the Municipality of Danilovgrad. It is expected that this water will remain as unbilled consumption under the agreement with Danilovgrad Municipality.

(d) System extensions and connection rates

The percentage population served within the Municipality is already fairly high at 82%. However, it is that in the long term the water supply system plan will be extended to serve all the urban and rural population within the Municipality. The rate at which 100% connection is achieved will depend to a large extent on available finances. In the most favourable scenario it is assumed that 95% connection will be achieved by 2016 and 100% connection by 2035.

6.2.3 Water demand projections

Based on the criteria discussed above, the water demand projections for the municipality are estimated for the design horizon of 2035, and are summarised in Table 6.3 and Figure 6.3 below.

Table 6.3: Projected water demand (m^3/d)

Category	2009	2015	2025	2035
Domestic sales m^3/day	34,873	35,918	33,835	36,134
Industry sales m^3/day	6,455	7,184	7,613	9,034
Institution sales m^3/d	3,022	3,083	3,144	3,613
Total sales m^3/d	44,351	46,184	44,591	48,781
Unbilled water m^3/d	11,652	6,048	5,761	6,480
Total Billed + Unbilled m^3/d	56,002	52,233	50,353	55,261
Losses as % of requirements	47%	32%	28%	25%
Total unaccounted water m^3/d	49,662	25,067	19,226	18,420
Total requirements/production m^3/d	105,665	77,300	69,578	73,682

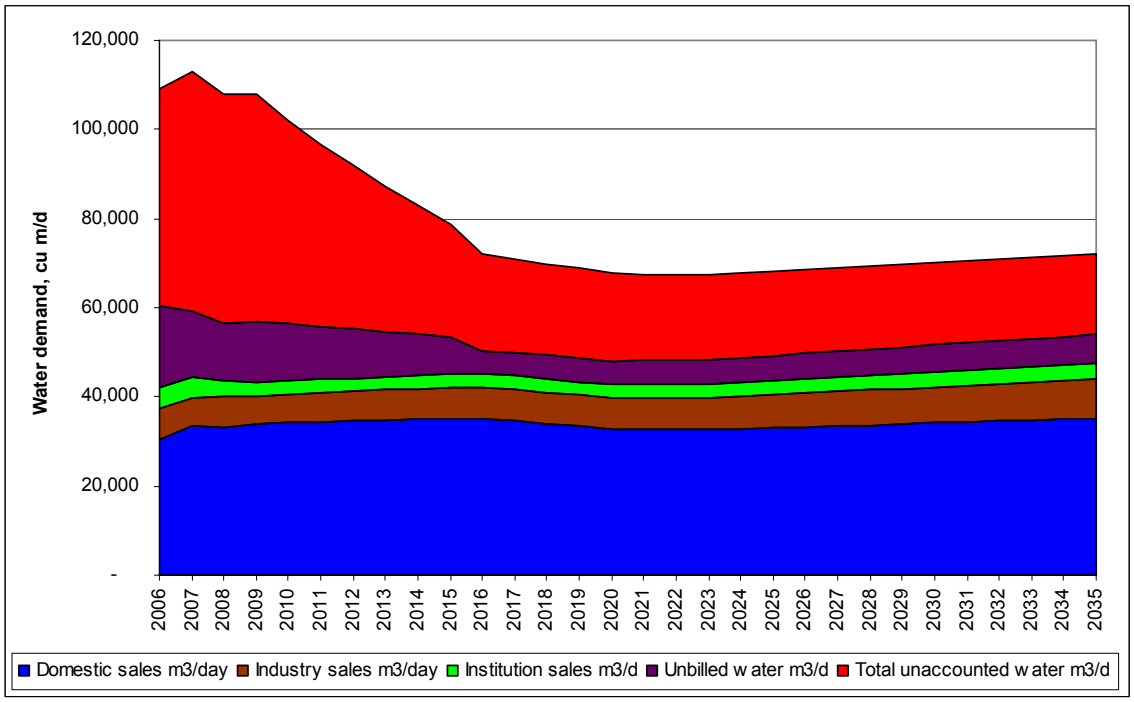


Figure 6.3: Average water demands

The most significant feature of these projections is the relatively constant level of sales volumes due to the combination of increasing population and coverage but decreasing per capita water consumption. The volume of unbilled water is assumed to reduce quite quickly as communities not presently billed by ViK are added to the metering and billing systems. A significant reduction in the level of unaccounted for water has been assumed in the period up to 2016 as leakage reduction measures (making use of the district metering to be installed under the current Japanese studies) are implemented. Beyond 2016 a lower rate of reduction in the level of unaccounted for water has been assumed for the reasons given in Section 4.2.2(a) above. Nevertheless, water production is expected to fall for the current level of approximately 105,000 m^3/d to a minimum of about 70,000 m^3/d and then increase gradually to approximately 74,000 m^3/d in 2035.

6.2.4 Wastewater flows

The present flows to the existing wastewater treatment plant are considered in Section 3.2.7. Wastewater flows vary seasonally in the same manner as water demand but are also influenced by rainwater and other infiltration. In 2008 the average volume of wastewater billed by ViK was 21,000 m^3/d whereas the average flow received at the treatment plant was approximately 29,000 m^3/d, suggesting a considerable amount (approximately 35%) of infiltration and/or unbilled wastewater discharges. Since sewers in Podgorica are generally above groundwater level it is considered that most this 'infiltration' results from rainwater and unbilled wastewater discharges. As the wastewater collection system is expanded and renewed it is expected that rate of infiltration will reduce to 25% by 2020 and then to 20% by 2035.

The rate at which new connections will then be made to the system will depend on the scale on the wastewater project adopted and the rate at which it is implemented. The chart below shows the expected situation if all the proposed wastewater network extensions are implemented at a relatively fast but realistic rate.

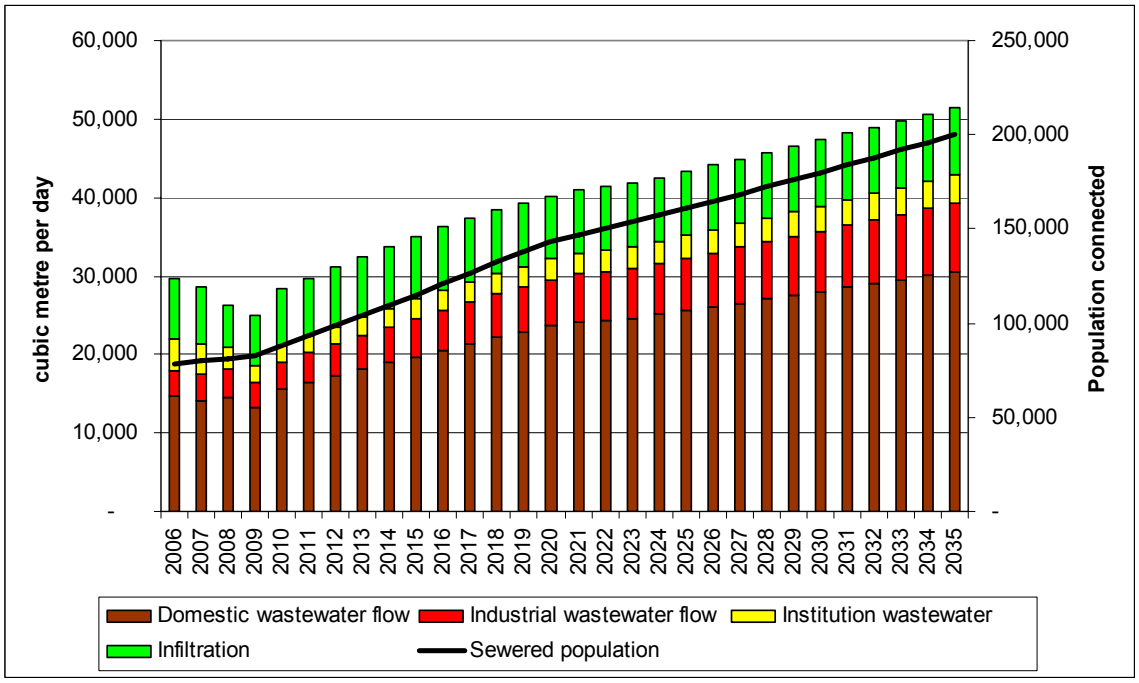


Figure 6.4: Projected wastewater flows and population connected

It is expected that this development scenario will result in the population served increasing from approximately 83,000 at present to 143,000 by 2020 and then increasing at a slower rate to 200,000 by 2035. The total volume of wastewater generated increases from approximately 29,000 m^3/d to nearly 55,000 m^3/d by 2035. The lower rate of increase in wastewater flows compared to population connected reflects the expected reduction in per capita consumption.

Should the rate of extension of the wastewater network be slower than assumed in the scenario above the number of people connected will be reduced. Differing options for phasing of network construction are considered in Chapter 7.

6.3 Long term investment requirements for water supply and distribution

6.3.1 General

This section outlines the proposed investment in water until 2035. It has taken as its starting point the distribution studies carried out in 1998 and ViK's own development plans for the period 2007 – 2017. It has three focus areas derived upon ViK's development plans to improve the function of the water supply service. This study generally supports the proposals of both plans. The envisaged improvements fall within three basic categories.

- Operational improvements to increase direct control over the operation of the networks, including loss control and some enhancement of water sources
- New reservoirs to maintain supply pressures in certain problematical areas of the city and to stabilise supply pressures within the (wholly pumped) network
- New pipelines; either to extend the network into areas of new development around the city or to replace old pipes in poor condition,

Because of the high level of losses within the system, it is recommended that a programme of active leakage control be initiated targeted at reducing the high levels of losses within the system. Preparatory work in this area has already commenced with the implementation of District Meter Areas under JICA funding.

The principal investment amongst ViK's proposals is for the construction of a major service reservoir to improve supplies within the city, a development that will have a positive impact on many aspects of the water network.

6.3.2 Reduction in Water Losses

The very high levels of water losses need to be addressed. The following actions are recommended.

(a) Water Losses

The current levels of losses are unacceptable representing a considerable waste of ViK's financial resources. The current best estimate of Real Losses (leakage) is 25% of supply or 553 litres/connection/per day. Apparent Losses (unauthorised usage) amounts to 22% of supply or 488 litres/connection/per day; making Total Losses of 1041 litres/connection/per day (47% of supply). ViK must therefore make strenuous efforts to reduce their losses overall.

(b) Meters and Accuracy

In network management the most valuable tool is data, particularly flow data. If there are insufficient meters or they are inaccurate then making informed decisions on network operations becomes more difficult. ViK are instigating District Meter Areas as part of overall leakage control strategy but consumer meters need to be functioning and accurate too. Consumer metering also needs improvement as coverage is far from universal at about 65% coverage.

(c) Illegal Connections

Upward of 1,000 illegal connections are believed to exist. Clearly this represents a considerable quantity of lost water and lost revenue. ViK need to identify the illegal connections and regularise the accounts

(d) Records of Repairs (and network verification)

ViK should use the opportunity of pipe repairs to:

- Record the exact location of the burst (using GPS or survey)
- Record the details of the pipe and cause of the defect

This information can then be fed back to the records department who can verify the mains details held in the GIS database and record the locations of all leaks – so that pipes with unacceptably high burst frequencies can be prioritised for repair.

(e) Flow Monitoring and Metering

The first step in tackling losses is to divide the network into smaller distinct districts (DMAs) that can be isolated from each other so that precise demand (inflows) to the DMA can be measured. All consumer data and customer meter readings can be prepared so that for each area a precise relationship between consumption and demand (and hence losses) can be calculated for each DMA. Such data helps identify those areas with the highest losses and will assist in prioritising leak detection and repair efforts.

ViK have already begun planning the division of the city into DMA with technical assistance from JICA. These plans may need to be modified slightly to take into account any zoning recommendations adopted as a result of this Study.

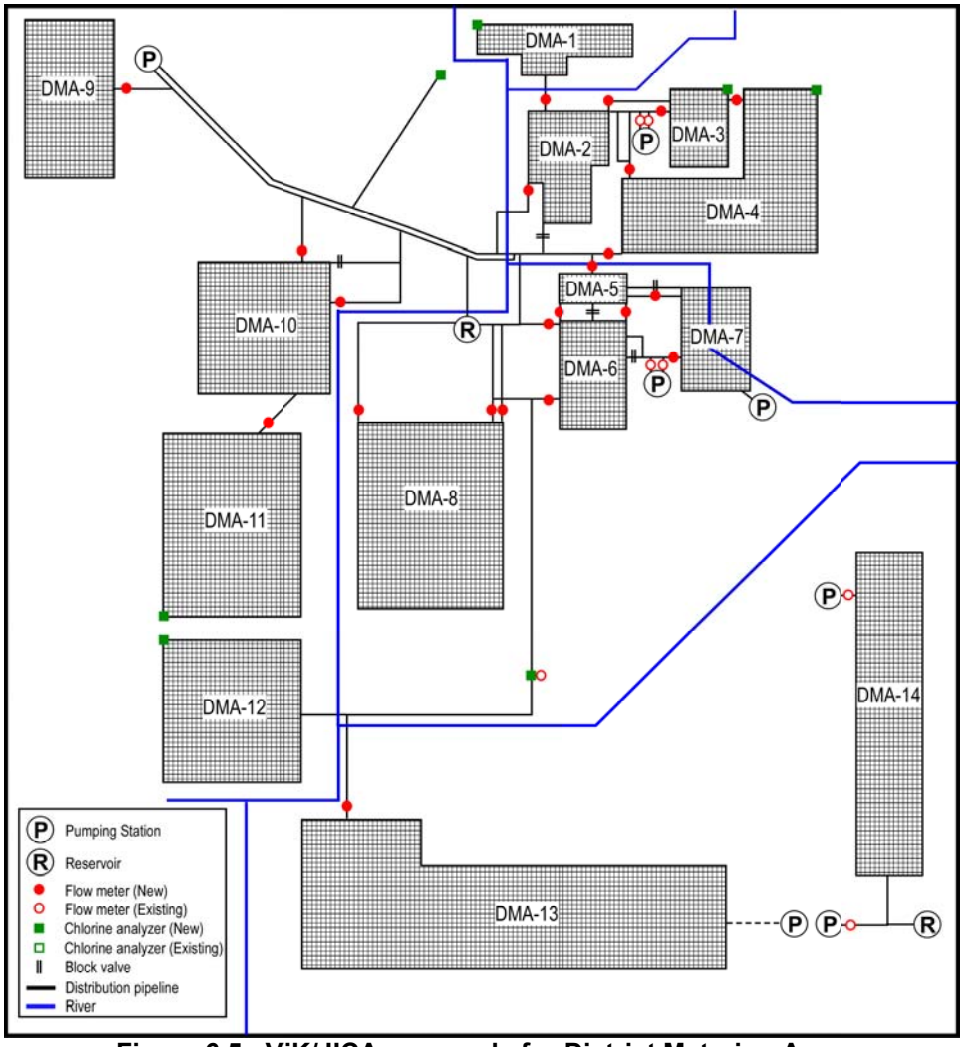


Figure 6.5: ViK/JICA proposals for District Metering Areas

(f) Active Leakage Control

Actively searching for leaks rather than the current procedure of repairing reported or visible leaks must be a priority for ViK. Analysis by DMA will help focus leak detection activities to the areas exhibiting the highest losses. Leak detection techniques should include:

- Night Flow Measurements
- Step Testing
- Sounding, and
- Correlation techniques

All leakages located in this way must be repaired in the shortest possible time and the details of the reported repair captured in purpose-made database.

The issue of 'on property' wastage also appears to be a significant issue in Podgorica. Upgrading consumer metering and increase domestic water tariffs should address this issue by encouraging consumers to reduce their bills by repairing internal plumbing.

(g) Pressure Control

Reducing supply pressures is an effective means of reducing losses; the flow through leaks being directly related to the pressure in the pipes. Certain parts of the network theoretically operate at quite high supply pressures due to their proximity to the pumping

stations. The topography of the city does not readily support the concept of lower pressure zones controlled by reservoirs so areas controlled by Pressure Reducing Valves are required. These valves can be quite effective but require close monitoring and frequent maintenance to ensure effective operation. Areas which could benefit from pressure control can be identified from the network model, e.g. the rural areas in the west; they should then be subject to proper design to ensure that minimum supply pressures are maintained throughout.

(h) Remote Areas

The supplies in rural areas are an issue for ViK. The remoteness of the areas, often with high pressures, lack of adequate consumer meeting and a tendency to use the water for irrigation results in high usage in these areas. ViK need to improve their system metering to allow monitoring of flows into these areas, improve consumer metering and engage in active leakage control to bring these areas under control. Where mains are old and leaking replacement mains are required.

Costing for this programme assumes that the majority of the manpower will be drawn from the current resources of ViK and that operational improvements could be funded from normal revenues.

6.3.3 Mains Replacement

In support of ViK's loss reduction programme it will be necessary to undertake the systematic replacement of old and leaking mains that are uneconomic to keep repairing. Similarly some of the older mains, particularly the AC and galvanised pipes are becoming increasingly problematical with high burst rates and high losses. Again ViK have identified sums to be used for replacing such mains.

The networks in the sparsely populated rural areas of Gornja and Donja Gorica are in need of upgrade and replacement. They comprise old AC pipes with a history of leakage and bursts.

Within ViK's Development Proposals they had included a sum for this – in reality this figures was deemed high based on current expenditure so has been reduced. The total has been increased pro-rata for the whole development period.

6.3.4 Source Development

Currently, water source capacity is generally adequate for the city's projected water demand. However, problems in dry years with the yield of Cemovsko Polje indicate that it would be prudent to investigate the development of Dinosa source in-line with ViK proposals. Additionally, there is fourth spring at Mareza which is to be captured yielding an estimated 150 l/s together with improved pumping capacity, which would also provide a margin against possible dry season deficits. The long term demand projections predict a decrease in overall demand as losses are reduced and tariffs rise. So no further source development should be required thereafter for the foreseeable future.

Replacement of the pump units at Mareza is already planned by ViK, partially at their own cost (Old Mareza) and partly funded by JICA (New Mareza), together with the implementation of a SCADA system. No further upgrades of pumping plant are required apart from routine maintenance replacements. ViK are also upgrading their laboratory facilities.

6.3.5 Provision of Service Reservoirs

This item is a priority within ViK development plans. Construction of service reservoirs within the network can offer a number of benefits:

- Balancing fluctuations in hourly demand on the source from the network thereby reducing pump switching
- Allowing more efficient pipe design upstream of the reservoir because pipes can be sized for average flows rather than peak flows
- Maintaining supplies in the event of power failures
- Stabilising pressures in pumped networks and hence pump delivery heads
- Providing reserve storage for fire fighting
- Providing acceptable contact time for chlorine absorption

In Podgorica where all supplies are pumped the use of service reservoirs will help to stabilise pump delivery pressures, allowing pumps to operate more efficiently. As a guide service reservoirs can be sized on the following basis:

Table 6.4: Service Reservoir General Requirements

Storage Requirements	Min (hrs)	Max (hrs)	
Balancing	3	4	*Depends upon demand patterns*
Provision for Shutdowns	6	12	*12 preferred for wholly pumped system*
Fire fighting Reserve	2	2	*Operating Company decision*
Total	11	18	
Design Year Demand	80000	*M^3/d*	*average daily demand (approx)*
Volume Required	36667	60000	
Say	**35000**	**60000**	

The final sizing of the reservoir is a strategic decision based upon the risk of different failure scenarios. Hydraulically the storage needed to balance flow fluctuations can be verified from the model but is normally equivalent to 3 – 4 hours of average daily demand. Additional storage can be provided as a reserve against power outages, plant shut-downs, large bursts etc. ViK have expressed their preference for an additional 20,000 m^3 of additional reservoir storage at this time – equivalent to about 6 hours storage.

The original distribution studies carried out in 1998 proposed a series of reservoirs around the city's edge helping to maintain and stabilise pressures within the network. These reservoirs were strategically located to improve network performance and to act as sources for the pumped sub-zones that will be necessary as development rises into the hills around the city. The study proposed four new reservoirs at Vrsak (15,000m^3), Momisici (5,000m^3), Masline (5,000m^3) and an increase to the existing capacity at Ljubovic (+5,000m^3), a total of 33,000m^3. The concept and siting of these additional storage reservoirs is logical in the light of the city's recent development, so a similar approach has been adopted in this Report when considering the long term development needs of the water network; their performance has been verified by network modelling.

6.3.6 System Reinforcements

The city is expanding fairly rapidly and new roads are being established in many locations. These roads and the areas they serve require new mains and ViK have identified a sum to be spent on such mains in their development proposals.

ViK's development proposals include provision for the expansion of the city into new areas and for the replacement/upgrade of mains associated with road improvement projects. However, historically the replacement of water pipes under these circumstances has been funded directly by the Municipality under the road contract.

Improvements in the Zeta and Tuzi area are also underway including linking existing networks with the new pipelines and the provision of existing service reservoirs.

6.3.7 Network Development Options

To address the problems experienced by Podgorica (see Chapter 3) ViK's objective was to construct a major service reservoir on a site which will improve supply pressures generally, but particularly in the city centre and around Gorica Hill. The intention is for the reservoir to be supplied directly by pumping from Mareza rather than 'floating' on the network.

Two alternative options were developed which were then compared to the current system which operates without significant storage. The alternative of providing additional pumping and transmission capacity in order to maintain supply pressures during times of peak demand was considered but rejected because the network layout which is not conducive to this approach as the higher elevations are at the extremities of the city eliminating the opportunity to reduce night time system pressures.

(a) Option 1

One of the key investments proposed by ViK is a new 20,000 service reservoir on near to the city centre. ViK proposals include a new dedicated 800mm delivery main from Mareza to the new reservoir. ViK's preferred location for service reservoir is Ljubovic Hill; (site of the existing 3,000 m^3 tank) the new tank is required to improve and maintain supply pressures in the city centre and around Gorica Hill. Under ViK's proposals the proposed tank would be supplied directly from Mareza source and would be connected to the network through the outlets.

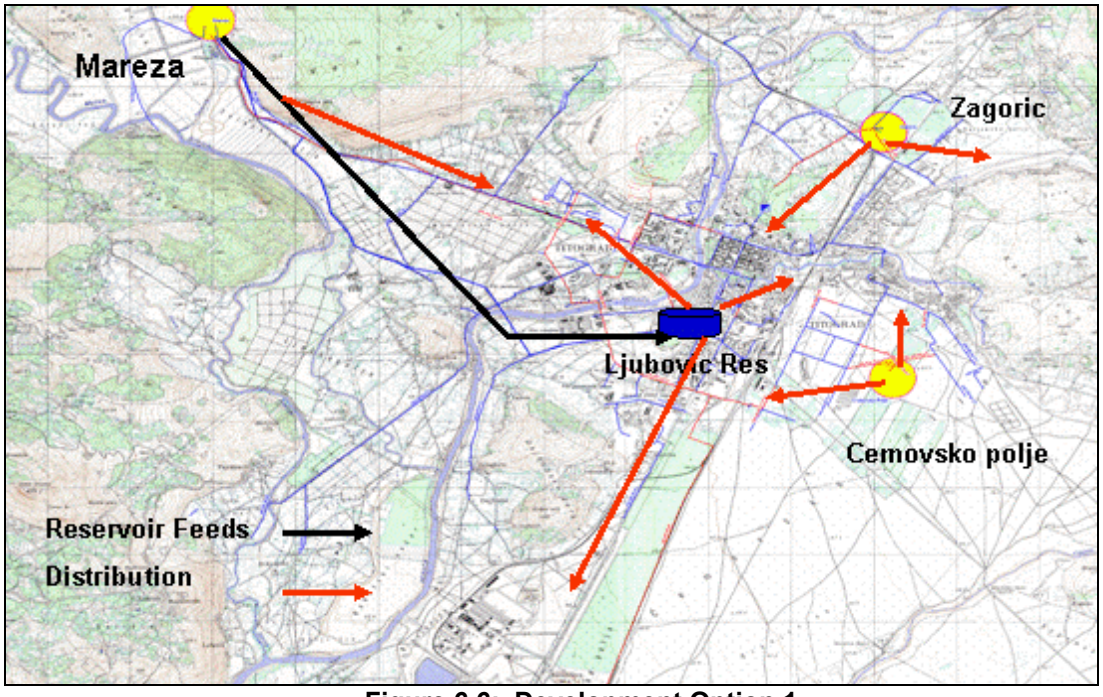


Figure 6.6: Development Option 1

The second stage development would be to add a second reservoir of 10,000 m^3 at Vrsak to the south. Such a development would bring the storage requirement into line with the 'minimum' requirement. Both reservoirs would ultimately be fed from the same new dedicated 800mm main from Mareza.

Figure 6.7: Proposed site of new Ljubovic Reservoir

This study considers the first stage development as Option 1, which also maintains the current operating philosophy of ViK with all sources feeding a single supply (pressure) zone.

(b) Long Term Strategy

In considering ViK's preferred solution (Option 1) concerns arose about the suitability of the Ljubovic site for such a large 20,000 m^3 reservoir; a 5m deep tank would have a plan area of 50 x 80m. To identify alternative proposals it was considered necessary to develop a longer term plan so that any option considered could be part of an integrated future development strategy.

The 'Technical Solution' presented in the 1998 report on the water distribution system included provision for additional service reservoirs at Vrsak in the south, Momisici in the north and Masline in the east with increased capacity at the existing site of Ljubovic. Reservoirs had been sited in these locations to achieve two principal objectives:

- To maintain system pressures at times of peak demand in areas local to the site
- To act as a source for smaller pumped schemes supplying new communities above the hydraulic level of the main system.

The requirement for these reservoirs is valid whatever option is adopted so they have been included in the long term development plan. Their operation was evaluated on the basis of recent development and the increasing demand for water. However, operationally it would be difficult to balance a system with four reservoirs so in analysing the network the city was divided into supply zones; each major source having a separate supply zone and reservoir.

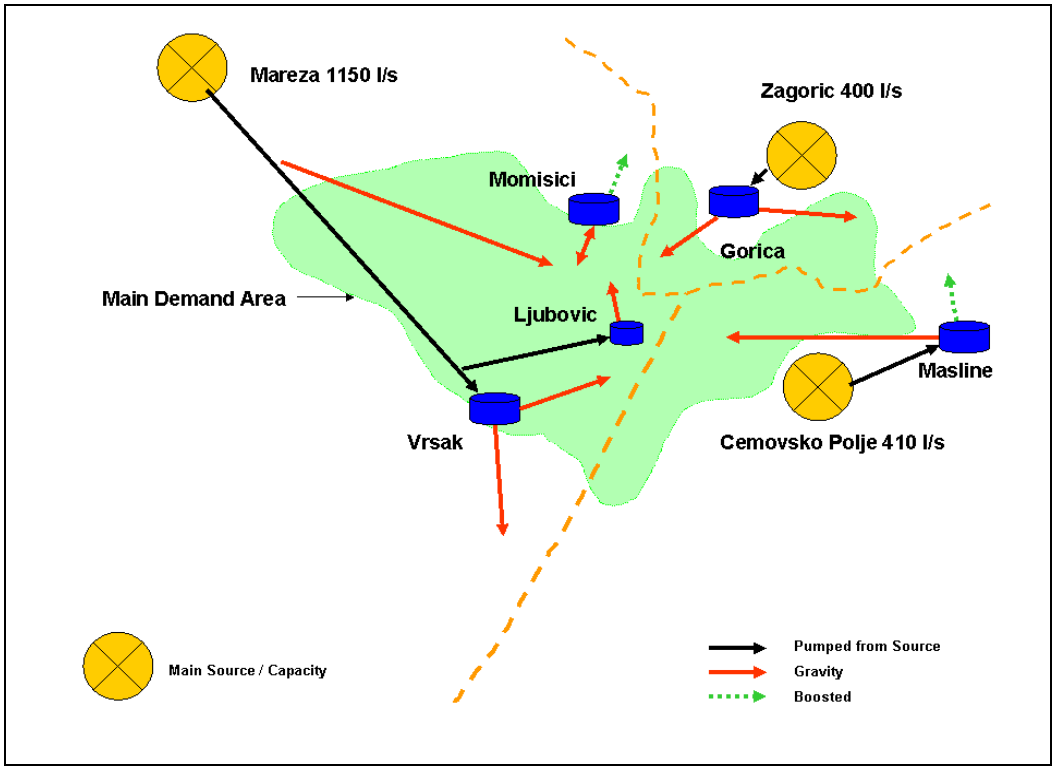


Figure 6.8: Long Term Strategic Plan – Main System

To verify the proposals in the 'Technical Solution' a computer model was used to analyse the system for the long term case. As a result, the original proposals were modified to move the additional storage proposed at Ljubovic onto a site at Gorica Hill in the north east of the city. This had the benefit of improving pressures in the immediate area around Gorica Hill one of the reported problem areas.

An initial review of potential technical reservoir sites shows Vrsak to be the most promising with a large area of relatively flat land completely unoccupied, i.e. suitable for a 20,000m^3 reservoir. The original site for Masline in the east is now occupied so an alternative site was identified further south; this is unoccupied but is undulating and rocky but is suitable for a 5–10,000m^3 reservoir.

The Gorica Hill site is also very rocky and slopes fairly steeply but is suitable for a 5-10,000m^3 reservoir. At Momisici there are a number of possibly locations within a small area which is rocky and undulating but could accommodate a 3–5,000m^3 reservoir. Ljubovic has an existing 3,000m^3 reservoir and could accommodate a similar sized tank along side or, if the existing one was demolished, a new 5–10,000m^3 reservoir. Gorica Hill and Ljubovic are sited on public amenity sites and may raise some environmental issues.

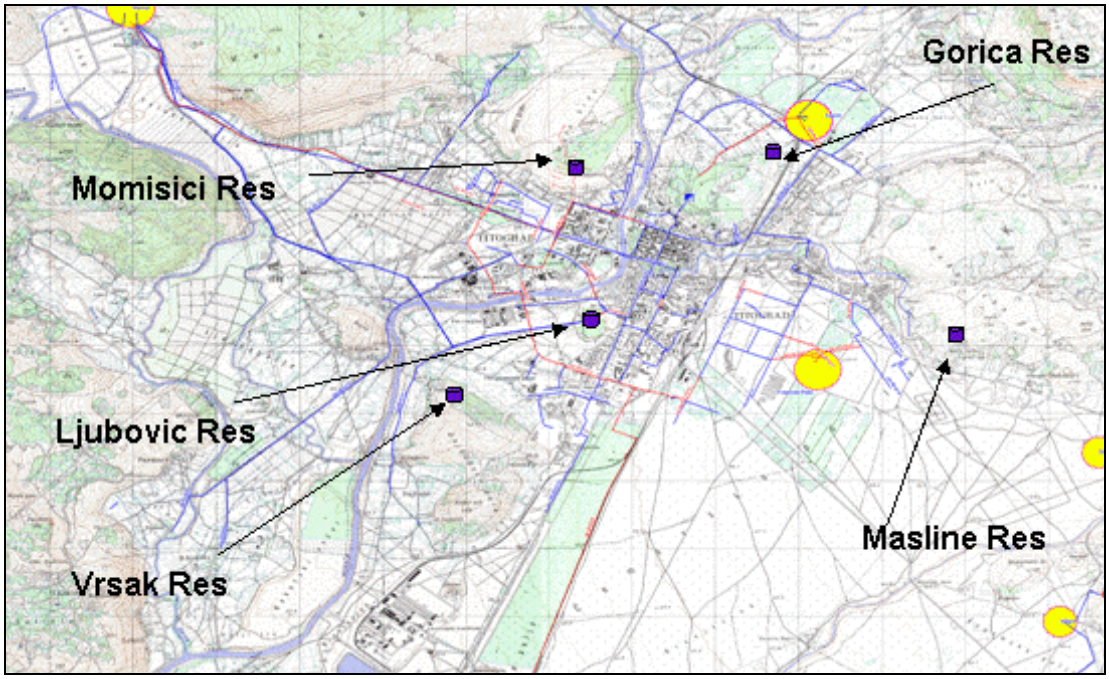


Figure 6.9: Proposed Reservoir Sites – Long Term Plan Strategy– Main System

All sites will require to be surveyed to confirm the actual ground levels and for comparison with the network model. Once confirmed ViK should begin negotiations with the Municipality and owners to secure these site for future construction of the strategic reservoirs as development is already encroaching these areas.

Table 6.5: Long Term Strategy - Future Reservoir Capacities

Location	Capacity m^3	Zone	Priority	Serving
Ljubovic (ex)	3,000	Mareza	Ex	City Centre south of River
Vrsak	20,000	Mareza	1	Central Southern areas of City
Momisici	5,000	Mareza	4	Eastern areas
Gorica	10,000	Zagoric	2	North Eastern areas
Masline	5,000	Cemovsko Polje	3	Northern area
Total	43,000			

(c) Option 2

Option 2 has been developed with a view to achieving similar hydraulic benefits to Option 1 but utilising a more suitable reservoir site. In this option the proposed new reservoir is sited further south at Vrsak with the existing small tank being retained at Ljubovic. The site at Vrsak is considered technically preferable (subject to survey and detailed geotechnical investigations) to that at Ljubovic for a 20,000m^3 reservoir. It is also better sited to meet the expanding demand in the south of the city.

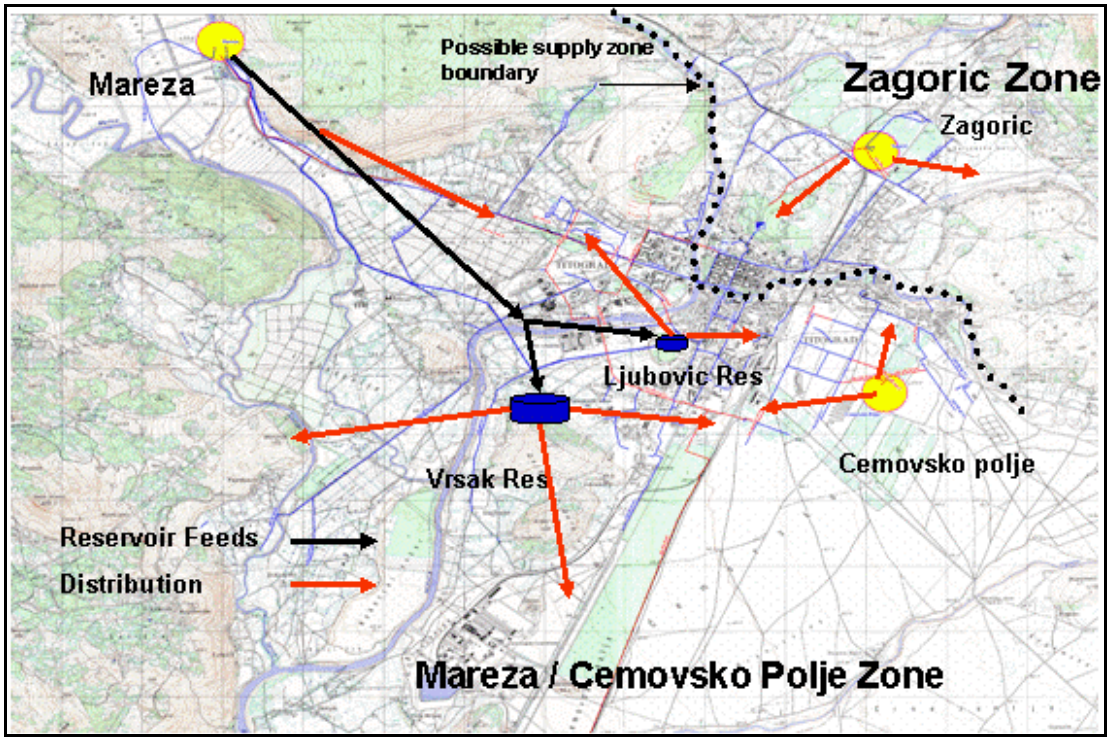


Figure 6.10: Development Option 2

In addition, this proposal divided the supply area into two pressure zones; Zone 1 covering the majority of the city and fed by both Mareza and Cemovsko Polje, and a second, Zone 2, covering the areas around Gorica Hill and the north east of the city fed from Zagoric – this zone would also include the city centre east of the Moraca River - and could operate at slightly higher pressures than Zone 1.

Figure 6.11: Proposed site of new Vrsak Reservoir

The justification for zoning is that it is easier to control pressures in a pumped system within a smaller zone than a larger one. Development for the zone would include a service reservoir in the future, preferred sited on Gorica Hill which would be beneficial in maintaining pressures in the higher elevation around Gorica Hill and the north east ot the

city. The zone boundary would be along the Moraca and Ribnica Rivers making zone isolation relatively straightforward.

Under this option Zone 1 would no longer influence the city centre pressures so the impact of a new reservoir at Ljubovic is reduced allowing a larger service reservoir to be sited further south at Vrsak. The Option 2 service reservoirs would be Vrsak at 20,000m^3 and the existing tank at Ljubovic would be retained at 3000m^3.

6.3.8 Evaluation of Options

Computer models were constructed, representing the first stage investment in each case, to evaluate the hydraulic performance of the proposals. Models were prepared for the peak day demands for 2009 which is the highest flows anticipated. The models were then checked using average and minimum flow conditions and for the peak projected 2035 demands to ensure satisfactory performance under all operating conditions.

In both options the tanks will be fed through dedicated inlet pumping mains from Mareza source with the network fed through a separate outlet pipe, pumping mains can therefore be sized for average flows. Ljubovic and Vrsak will be fed from Mareza using a new 800 mm main which will be isolated from the network;

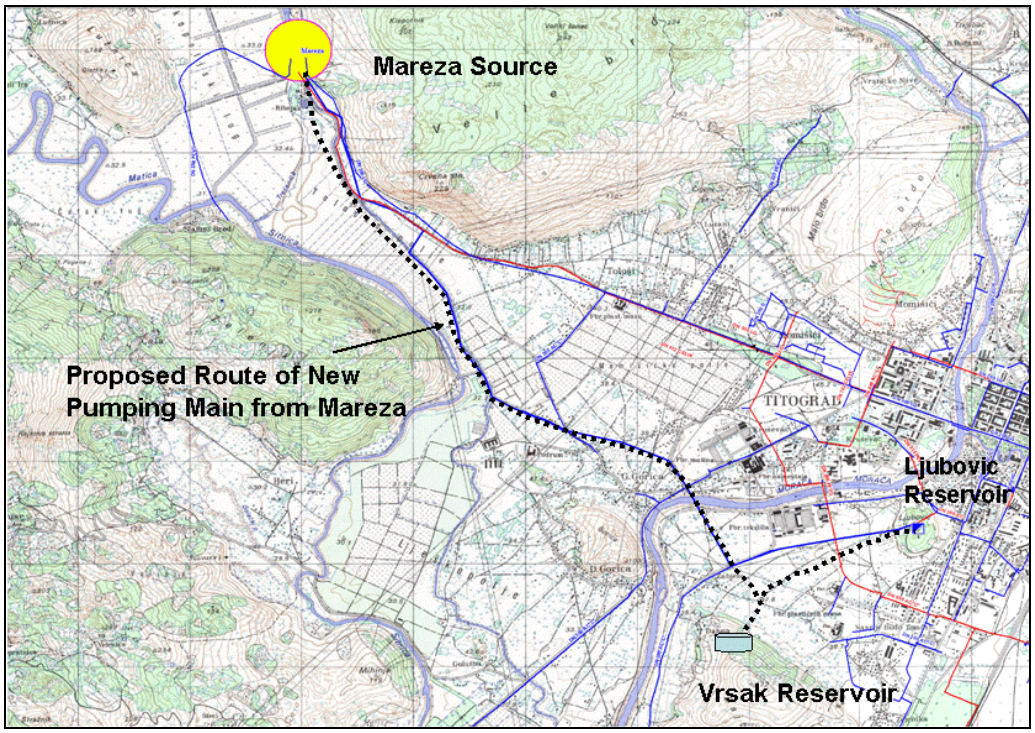


Figure 6.12: Route of new Pumping Main from Mareza (both Options)

The possibility of using the existing 800 mm main from Mareza to supply the tanks and a new pipe to supply the north city area was examined which would allow the new pipe from Mareza to be of a smaller diameter, however, the congested nature of the route means that any financial benefit from using a smaller pipe would be outweighed by much higher construction costs. This leaves some unutilised capacity in the existing 800mm pipe from Mareza, but this will provided useful strategic capacity in the event of an interruption to supplies through the pumping main.

Table 6.6: Development Option Details

Feature	Option 1	Option 2
Service Reservoirs	Ljubovic (20,000 m^3)	Vrsak (20,000 m^3), Ljubovic(3,000 m^3 existing)
Future Service Reservoirs[18]	Vrsak (10,000 m^3)	Gorica (10,000 m^3)
Total Storage	30,000 m^3	33,000 m^3
Feed To Reservoirs	Ljubovic –New Main from Mareza Vrsak –New Main from Mareza - future	Vrsak - New Main from Mareza Ljubovic - New Main from Mareza Gorica - New Main from Zagoric
Separate Pressure Zones	No	Yes

Computer models were constructed for each option and various improvements were made to try and optimise performance and minimise capital expenditure.

Option 1 - With a dedicated supply main from Mareza and new inlet and outlet mains the new tank at Ljubovic worked satisfactorily maintaining good system pressures, particularly in the strategically important city centre.

Option 2 – The reservoir at Vrsak was just as effective hydraulically as the reservoir when sited at Ljubovic and has the additional benefit of allowing the existing tank at Ljubovic to be retained. The analysis indicated only small pressure variations either side of the proposed boundary but the real benefit of this proposal is operational, allowing ViK more control over pressures in Zone 1. Additionally, with both reservoirs at the same elevation the inflows to the existing reservoir at Ljubovic were quite sensitive to small variations in head. The problem can be overcome by the inclusion of a flow control device on the inlet to Vrsak which can be used to balance flows between the two reservoirs.

At ViK's request, Vrsak was also modelled some 3m higher in elevation than Ljubovic to ensure that this reservoir would remain full for as long as practical in the event of a power outage. The final TWL should be confirmed at the detailed design stage.

The following Figure shows the improved performance of the network under Option 2 (Option 1 is very similar).

[18] not modelled in this comparison

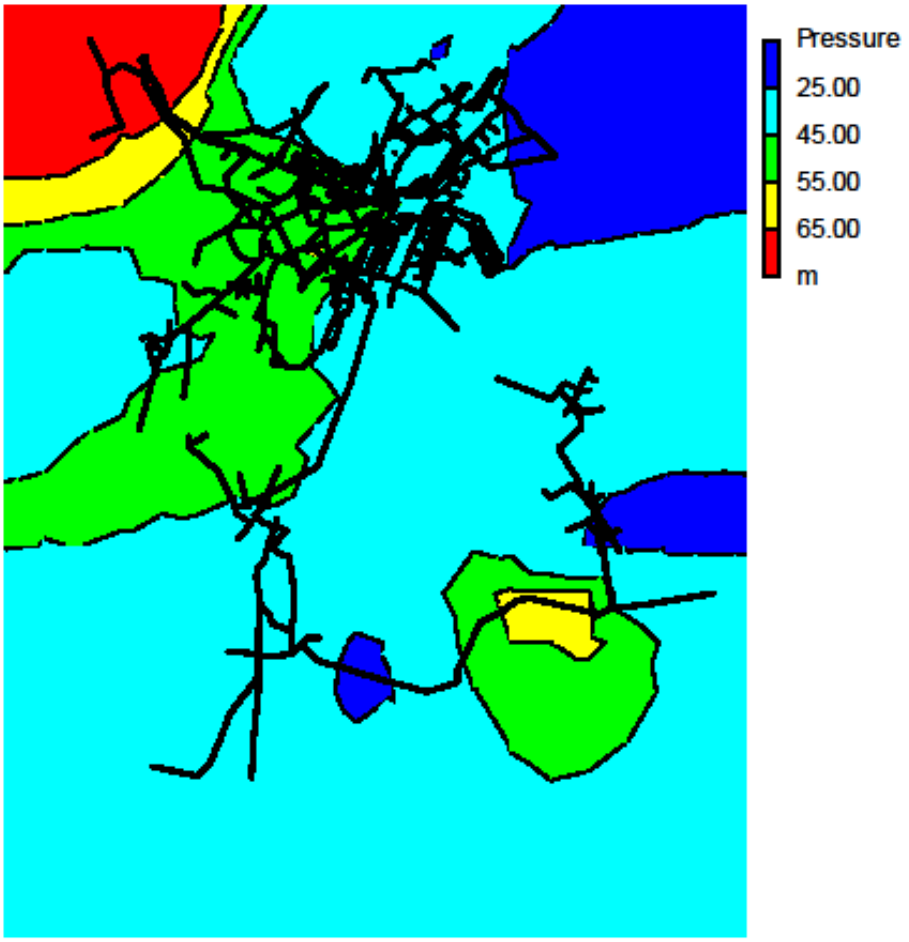


Figure 6.13: Option 2 – Pressure Contours – 2009 Peak Demand – 19.00

Table 6.7 compares the two development options considered with the existing situation.

Table 6.7: Option Comparison - Peak Day Demand

	Units	Existing[19]		Option 1		Option 2	
System Performance							
Source Production							
New Mareza	m^3/day	54,600		61,600		60,000	
Old Mareza	m^3/day	24,900		27,800		29,200	
Zagoric	m^3/day	33,500		30,600		30,700	
Cemovsko Polje	m^3/day	29,400		25,000		25,100	
Power Consumption							
New Mareza	€ / day	2,056		2,046		2,050	
Old Mareza	€ / day	881		851		924	
Zagoric	€ / day	1,110		1,004		1,004	
Cemovsko Polje	€ / day	1,088		919		919	
Total		5,135		4,820		4,897	
Reservoir Inflow							
Ljubovic	m^3/day	n/a		46,176		10,644	
Vrsak	m^3/day	n/a		n/a		35,323	
System Pressures							
		max	Min	max	min	max	min
Node 25-20 – Gorica Hill	m	49.5	27.7	46.2	38.4	46.1	38.0
Node SA - Eastern extremity	m	34.7	11.5	30.8	22.9	30.7	22.5
Node 24-16 - City Centre	m	55.7	33.0	52.7	46.5	53.6	46.0
Node 2-07 - Momisici	m	55.2	32.5	50.8	44.6	50.7	44.1
Node ZETA-AER - Zeta Supply	m	62.6	27.3	60.4	42.9	60.3	42.4
New Trunk Mains							
Pumped Main from Mareza	dia mm x m	n/a		800 x 9200		800 x 7700	
Inlet to site	dia mm x m	n/a		n/a		700 x 300	
Outlet	dia mm x m	n/a		800 x 900		800 x 1700	
Additional inlet to Ljubovic	dia mm x m	n/a		n/a		400 x 2400	
Costing (exc. VAT)							
Cost of Reservoirs – 20,000 m^3	€ '000	-		4,400[20]		4,000	
Cost of New Mains	€ '000	-		7,353		7,835	
Total Option Cost	€ '000	-		11,753		11,835	

For comparison purposes modular RC service reservoir were costed, similar to the typical design shown in Figure 6.14. Bills of Quantities were drawn up for the size of reservoir under consideration and priced using current construction rates. These were benchmarked using a recently constructed 20,000m^3 tank in Belgrade.

[19] The source production figures are lower for the existing case due to slight differences in the starting and finish levels of the reservoirs
[20] Estimate is higher due to difficulty of construction

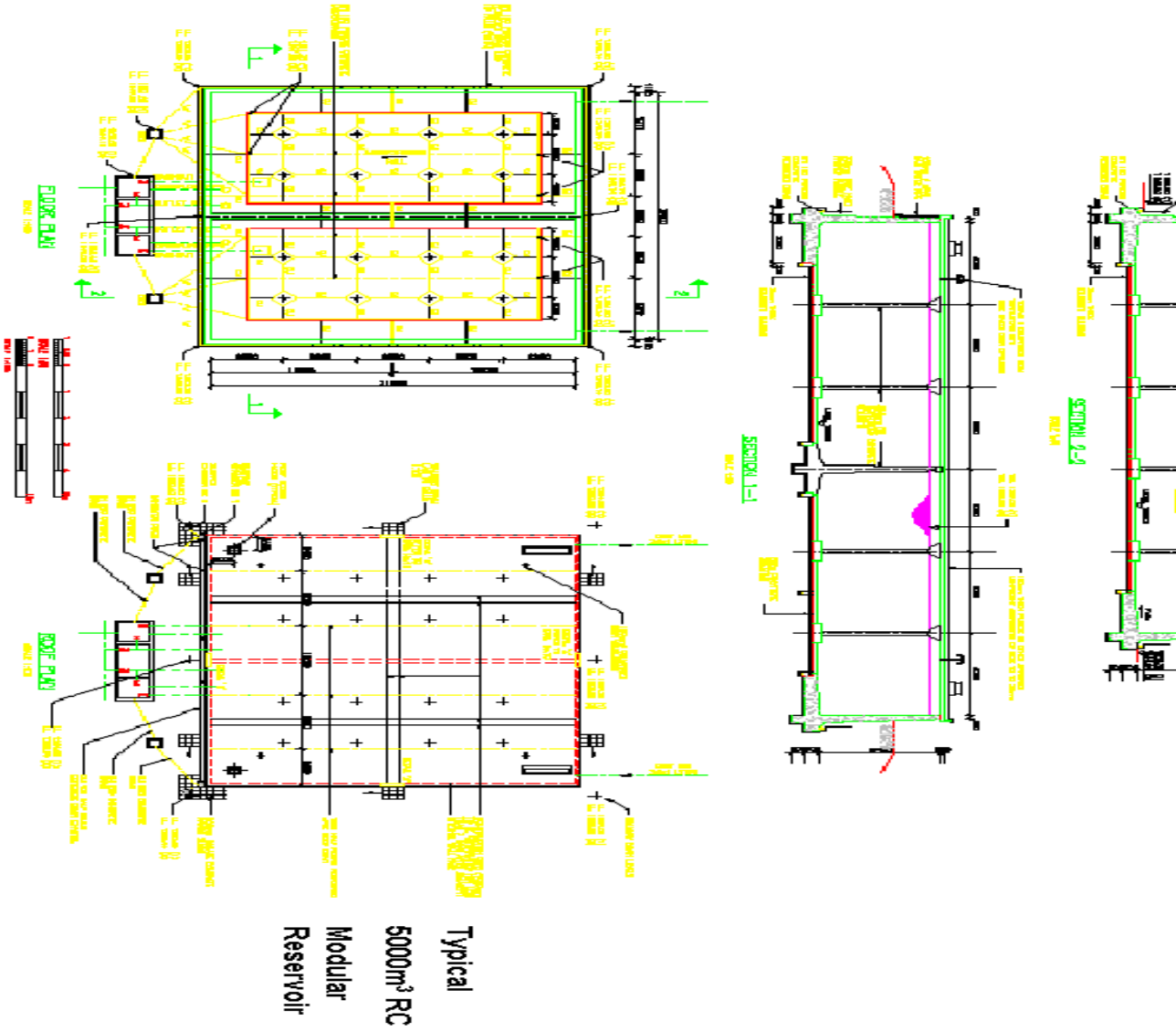


Figure 6.14: Typical RC Service Reservoir

Pipeline costs were developed from budget estimates obtained for ductile iron pipes using local costs for excavation, laying etc.

Conclusions

In summary, there was no compelling evidence supporting either option with both hydraulically similar and therefore having very similar energy consumptions. Option 1 was marginally cheaper in capital cost terms (but only because a new inlet is necessary to utilise the additional 3,000m^3 storage at Ljubovic effectively)). The final selection really comes down to a choice of reservoir sites between Ljubovic and Vrsak. The following table compares the two sites for their construction suitability.

This Study therefore considers the siting of the new service reservoir ay Vrsak whilst maintaining the existing tank at Ljubovic has some advantages in terms of ease of construction over a new large reservoir at Ljubovic.

Table 6.8: Comparison on Potential Reservoir Sites

Consideration	Ljubovic	Vrsak
Location	Centre of City – well placed for whole city Tank will cover the whole of the top of the hill	Southern City – well placed for city centre and southern area – Tuzi / Zeta Tank to be sited on open flat area on west side of hill
Current Use	Existing tank and public amenity	Unused
Access	Good - Existing asphalt road	Good - Existing unsurfaced road (for TV tower)
Space (50 x 80 - 4000 m^2 in area)	Limited by size of hill top and existing tank	No apparent restrictions[21] - space for future expansion
Ground Conditions	Considerable rock excavation needed to achieve a level site	Some rock may be encountered in foundations
Ease of Construction	Difficult – limited working space and need to demolish existing tank whilst maintaining system operation	Straight forward

6.3.9 Energy Consumption

Construction of new service reservoirs within the supply zones will reduce delivery head fluctuations considerably. Pumps can be set to deliver average flows with the daily demand variations catered for by the reservoirs. Each pump can then be evaluated against the hydraulic performance required and (for new pumps) duty points accurately assesses. If required the existing pumps can be throttled to maintain their operating efficiency. When replacement pump are required these can be selected to pump against a relatively stable delivery head.

Table 6.7 demonstrates a reduced operating cost for the schemes with reservoirs compared to the existing situation. This results from more efficient use of the pumps and a reduction in 'peak' pumping when demands are be met from the reservoir.

6.3.10 Distribution Zoning

Although the computer modelling indicated that there is little apparent hydraulic benefit from zoning the network, from a network management perspective it has a number of benefits.

- Water sources feed confined areas allowing speedier response to contamination incidents
- Allows greater control over the network and supply pressures
- Fits with DMA philosophy and Flow Data management

Downsides include:

- Possibility of 'dead ends' and stale water
- Can restricts supply flexibility

The proposals for the provision of future reservoir storage coincide well with the current water sources allowing each major source to have a reservoir in its zone as indicated in Table 6.5. To accommodate this only requires the establishment of two zone

[21] Subject to confirmation of land availability

boundaries; one for the Zagoric zone as described previously and a second for Cemovsko Polje probably running along the railway. It would be prudent if the DMAs proposed accommodated these zone boundaries. Zoning should be achieved by valving and loop mains, the original pipes should be retained to provide supply flexibility in the event of problems with a particular source.

6.3.11 Tuzi Supply Area

For the purposes of this study, the model checked the previous solutions derived in ViK's Preliminary design and these were found to be in order. However, to improve water supply of the town of Tuzi, which is not included in the above mentioned design, construction of a new reservoir on the Sipcanik hill with a capacity of 400m^3 is proposed. The network could, if desired be linked to the Dinosa source, and hence to the water supply system of Podgorica andTuzi. This would, in effect, create a ring main around the southern areas of Zeta and Tuzi and the main network of the city providing increase security of supply.

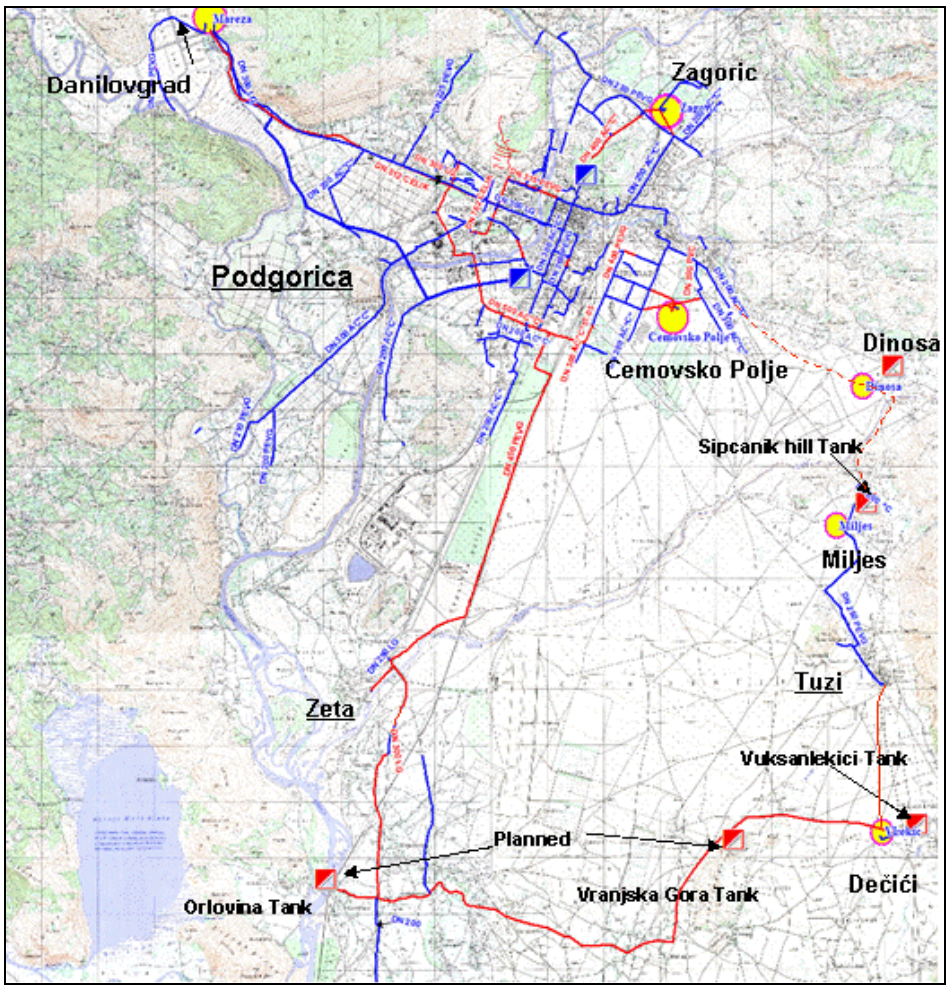


Figure 6.15: Supplies to Zeta and Tuzi

6.3.12 Strategic Investment Plan

The costs associated with the full strategic investment plan to 2035 are included in the following table. The plan contains proposals designed to provide more storage into the network which will improve the levels of service generally. No attempt has been made to predict a timescale for the implementation of these developments (other than the proposed immediate options) as they are not directly associated with specific changes in demand. They are essentially strategic decisions based upon operational needs.

Table 6.9: Long Term Strategic Investment Plan

	Description		Size / Capacity	Add Staff Reqd	Unit	Quantity	Rate Euro	Totals Euro	Tax @ 17% Euro	Cost inc. VAT Euro	Total Investment Plan
1	**Reduction in Losses**										
	Active Leakage Control Programme			1		1	1,000,000	1,000,000	170,000	1,170,000	
	DMA Programme	*JICA Funded*		0		1	1,000,000	1,000,000	170,000	1,170,000	
	Consumer Metering Programme			1		1	100,000	100,000	17,000	117,000	
	Illegal Connection Survey			1		1	50,000	50,000	8,500	58,500	
	Pressure Control Programme			0		1	100,000	100,000	17,000	117,000	
	Remote Areas Programme			0		1	50,000	50,000	8,500	58,500	
	Total			3				**2,300,000**	**391,000**	**2,691,000**	**2,691,000**
2	**Mains Replacement**										
	Mains in Gornja Zeta			0		1	700,000	700,000	119,000	819,000	
	Replacement Mains 2007 - 17			0		1	5,000,000	5,000,000	850,000	5,850,000	
	Replacement Mains 2018 - 35			0		1	8,500,000	8,500,000	1,445,000	9,945,000	
	Total			0				**14,200,000**	**2,414,000**	**16,614,000**	**16,614,000**
3	**Source Development**										
	Dinosa		200	3	l/s	1	2,000,000	2,000,000	340,000	2,340,000	
	Old Mareza PS and Laboratory	*Vik Funded*				1	3,500,000	3,500,000	595,000	4,095,000	
	New Mareza PS and Control System	*JICA Funded*		2		1	4,000,000	4,000,000	680,000	4,680,000	
	Mareza Spring No.4		150	0	l/s	1	300,000	300,000	51,000	351,000	
	Total			5				**9,800,000**	**1,666,000**	**11,466,000**	**11,466,000**
4	**Construction of Vrsak Reservoir**										
	Reinforced Concrete Reservoir		20000	2	m^3	1	4,000,000	4,000,000	680,000	4,680,000	
	Inlet Pipeline		800 mm	0	m	7700	728	5,605,600	952,952	6,558,552	
	Inlet Pipeline		700 mm	0	m	300	629	188,700	32,079	220,779	
	Outlet Pipeline		800 mm	0	m	1700	728	1,237,600	210,392	1,447,992	
	Total			2				**11,031,900**	**1,875,423**	**12,907,323**	**12,907,323**
5	**Improvements to Ljubovic Reservoir**										
	Replacement Valves and Fittings			0		1	100,000	100,000	17,000	117,000	
	Seal Concrete Tank			0		1	50,000	50,000	8,500	58,500	
	Inlet Pipeline		400 mm	0	m	2400	272	652,800	110,976	763,776	
	Total			0				**802,800**	**136,476**	**939,276**	**939,276**
6	**Construction of Gorica Reservoir**										
	Reinforced Concrete Reservoir		10000	2	m^3	1	2,200,000	2,200,000	374,000	2,574,000	
	Zoning			0		1	100,000	100,000	17,000	117,000	
	Inlet Pipeline		400 mm	0	m	1100	272	299,200	50,864	350,064	
	Outlet Pipeline		500 mm	0	m	900	347	312,300	53,091	365,391	
	Total			2				**2,911,500**	**494,955**	**3,406,455**	**3,406,455**
7	**Construction of Masline Reservoir**										
	Reinforced Concrete Reservoir		5000	2	m^3	1	1,000,000	1,000,000	170,000	1,170,000	
	Inlet Pipeline		400 mm	0	m	1500	272	408,000	69,360	477,360	
	Outlet Pipeline		500 mm	0	m	1000	347	347,000	58,990	405,990	
	Total			2				**1,755,000**	**298,350**	**2,053,350**	**2,053,350**
8	**Construction of Momisici Reservoir**										
	Reinforced Concrete Reservoir		5000	2	m^3	1	1,000,000	1,000,000	170,000	1,170,000	
	Inlet Pipeline		400 mm	0	m	600	272	163,200	27,744	190,944	
	Outlet Pipeline		500 mm	0	m	1000	347	347,000	58,990	405,990	
	Total			2				**1,510,200**	**256,734**	**1,766,934**	**1,766,934**
9	**Mains Reinforcements**										
	Pipelines along new roads 2007 - 17	*Municipality Direct*		0		1	-	-	-	-	
	Network for Donja Zeta			0		1	3,500,000	3,500,000	595,000	4,095,000	
	Additional Storage for Tuzi			2		1	1,000,000	1,000,000	170,000	1,170,000	
	Pipelines along new roads 2018 - 35	*Municipality Direct*		0		1	-	-	-	-	
	Total			2				**4,500,000**	**765,000**	**5,265,000**	**5,265,000**
									TOTAL PLAN		**57,109,338**

6.4 Long term investment requirements for wastewater collection and treatment

The completion of both wastewater collection systems and wastewater treatment to serve the whole urban area are regarded as priorities. The long term development needs for both of these are considered in the following sub- sections.

6.4.1 Wastewater collection

The extension of the wastewater system was been studied by IK Consulting Engineers from Belgrade who presented the Final Version of the 'Feasibility Study and General Design - Wastewater System' for Podgorica in December 2008.

The existing WWTP does not have sufficient capacity to treat the wastewaters that reach it now and the location and size of the present site does not allow the capacity of the WWTP to be increased to meet future loads. The concept for Podgorica sewerage network development therefore includes the construction of a new WWTP (for either part or all of the wastewater from the City). The location of the new WWTP is to the south of the City between the Aluminium Plant (KAP) and the River Moraca. This site has been accepted in planning documentation and is already owned by the Municipality. New main collectors will be needed to convey wastewater to the new WWTP and to collect wastewaters from the newly connected parts of the future sewerage system.

(a) Strategic options for collection and treatment system

In the 'Prefeasibility Study and General Design - Wastewater System', IK Consulting Engineers has considered two variants for the analysis of Podgorica sewerage network based on either one or two WWTPs in the Podgorica sewerage system:

- **Variant 1** – wastewater from the city of Podgorica would be divided in such way that one part (350 l/s) would go to the existing WWTP Podgorica, while the rest would be directed to the new WWTP, the construction of which was planned for the period 2011-2012 (phase I), while phase II for reaching its full capacity was planned for 2017-2018.

- **Variant 2**. – all the wastewater from the city of Podgorica would be directed to the new WWTP the construction of which was planned for the period 2011-2012 (phase I), while phase II for reaching its full capacity was planned for 2017-2018.

These variants were analysed using the long term average incremental cost method (AIC) with a discount rate of 6% and a whole life period of 35 years. The design, costing estimating and economic analysis of the variants is considered in detail in Books 5 and 6 of the IK Consulting Final Report. The basic techno economic parameters and results of economic analyses are summarised in the following Table.

Table 6.10: IK Consulting review of basic techno economic parameters – economic analysis

No	DESCRIPTION	VALUE	
		Variant I	**Variant II**
1	Average gross quantities of wastewaters at the WWTP (m^3/year)	17,970,273	21,698,009
2	Average gross quantities of wastewaters to be billed (m^3)	15,629,922	18,306,197
3	Investment structure (euro)		
	Construction works	61,190,572	61,664,609
	Pipelines	12,929,852	16,642,358
	Electro- mechanical equipment	155,250	155,250
	WWTP	18,665,570	42,259,021
	Founding investments	6,505,887	3,550,487
	Total	99,447,131	124,271,724
	Investment structure (euro)		
	Primary network (collectors)	23,121,063	27,292,378
	Secondary network	51,154,610	51,169,839
	WWTP	18,665,570	42,259,021
	Beneficiary investments	6,505,887	3,550,487
	Total	99,447,131	124,271,724
4	Construction period	17 yr	17 yr
5	Specific investments (total investments/average net quantities of wastewaters for billing) euro/m^3	6.36	6.79
6	Additional discounted costs for collecting and treating wastewaters (euro/m^3)	0,41	0,52

Based on the above calculations, Variant I (two WWTPs) has lower additional discounted costs for collecting and treating wastewaters than Variant II (one WWTP). However, IK Consulting concluded that if the expenses from existing system are included in the analysis the two variants are approximately equal. They argued that, for Variant I, the total existing operating costs of 0.44 €/m^3 should be added to the amount of 0.41 €/m^3 which represents the average incremental cost of new sewerage system. The overall AIC for Variant 1 is thus 0.85 €/m^3. For Variant II, the total existing operating costs of 0.44 €/m^3 have to be reduced due to the shutting down of the existing WWTP. The costs for the existing WWTP were estimated by IK Consulting to be 0.10 €/m^3. The overall AIC for Variant II was thus considered to be 0.86 €/m^3 (0.44 euro/m^3-0.10 euro/m^3 + 0.52 euro/m^3 – the average additional discounted costs of wastewaters collection and treatment in the Variant II).

IK Consulting also argued that the advantages of centralised treatment in comparison to treatment in two WWTPs would be lower operating costs, lower maintenance costs, fewer employees, etc. They pointed out that planned and on-going construction of apartment buildings in the immediate vicinity of the existing WWTP would make the application of spatial measures for sanitary protection more difficult. IK Consulting therefore recommended Variant II.

In fact we believe that Variant II should be clearly the preferred option for the following reasons:

- The actual capacity of the existing biological WWTP is 200 l/s rather than 350 l/s meaning that in Variant I more flow has to be transferred to the new WWTP and additional capacity is required at the new WWTP,
- It is considered that the construction costs for the treatment plants have been overestimated by IK Consulting,

- In Variant II, the value of the existing WWTP site for development, after closure and site clean up, has not been considered, and
- The differences in the operating costs for two WWTPs in comparison to one have not been fully considered.

A revised economic analysis taking these factors into account has been carried out for investment and operating costs between 2011 and 2035. The IK Consulting investment costs for the network have been used and WWTP investment costs and operating costs have been derived from preliminary designs for the various treatment scenarios. For Variant 2, after demolition of the existing WWTP and clean up of the site, the net income (after deduction of clean up costs) for the sale of the site has been taken as € 250/m^2. The results of the economic analyses for the two variants are summarised below.

Table 6.11: Economic analysis for Variant 1 – Two WWTPs

Year	Wastewater flow, 000 m^3/year	Investments, € 000		Operating costs, € 000			Total Costs, € 000
		Network investments	WWTP investments	Network	Existing WWTP	New WWTP	
2011	11,821	2,579		6	564		3,149
2012	12,411	4,112	5,994	17	564		10,687
2013	13,003	6,017	5,994	32	564		12,607
2014	13,588	4,791	5,994	44	564	616	12,009
2015	14,169	3,632		53	564	638	4,887
2016	14,746	3,840		62	564	694	5,160
2017	15,155	3,340		71	564	713	4,687
2018	15,529	4,652		82	564	731	6,029
2019	15,886	4,223		93	564	749	5,629
2020	16,229	2,820	6,213	100	564	767	10,464
2021	16,503	8,285	4,900	121	564	832	14,701
2022	16,632	6,301		136	564	843	7,844
2023	16,735	5,914		151	564	854	7,483
2024	17,006	7,229		169	564	866	8,828
2025	17,279	6,072		185	564	879	7,699
2026	17,553	0		185	564	892	1,640
2027	17,828	0	2,398	185	564	905	4,051
2028	18,104	0	2,398	185	564	918	4,064
2029	18,382	0	2,398	185	564	931	4,077
2030	18,661	0		185	564	945	1,693
2031	18,937	0		185	564	958	1,707
2032	19,215	0		185	564	972	1,720
2033	19,493	0		185	564	986	1,734
2034	19,773	0		185	564	1,000	1,748
2035	20,053	-36,904	-15,000	185	564	1,014	-50,141
NPV 8%	**163,998**						**66,553**
AIC in Euro/m^3							**0.406**

Table 6.12: Economic analysis for Variant 2 – One WWTP

Year	Wastewater flow, 000 m^3/year	Investments and income, € 000			Operating costs, € 000		**Total Costs, € 000**
		Network investments	WWTP investments	Net income from sale of old site	Network	WWTP	
2011	11,821	3,690			9		3,699
2012	12,411	2,323	8,714		15		11,052
2013	13,003	2,489	8,714		21		11,224
2014	13,588	2,064	8,714		26	1,392	12,197
2015	14,169	4,279		-10,050	37	1,415	-4,319
2016	14,746	4,346			48	1,434	5,828
2017	15,155	0			48	1,452	1,500
2018	15,529	0			48	1,470	1,518
2019	15,886	4,825			60	1,488	6,373
2020	16,229	6,877	8,472		77	1,639	17,065
2021	16,503	11,480			106	1,695	13,280
2022	16,632	11,406			134	1,703	13,244
2023	16,735	6,861			152	1,712	8,724
2024	17,006	5,270			165	1,721	7,156
2025	17,279	6,757			182	1,731	8,670
2026	17,553	0			182	1,741	1,923
2027	17,828	0	3,486		182	1,751	5,419
2028	18,104	0	3,486		182	1,762	5,429
2029	18,382	0	3,486		182	1,772	5,439
2030	18,661	0			182	1,783	1,964
2031	18,937	0			182	1,793	1,975
2032	19,215	0			182	1,804	1,986
2033	19,493	0			182	1,815	1,996
2034	19,773	0			182	1,826	2,007
2035	20,053	-36,334	-15,000		182	1,837	-49,315
NPV 8%	**163,998**						**62,909**
AIC in Euro/m^3							**0.384**

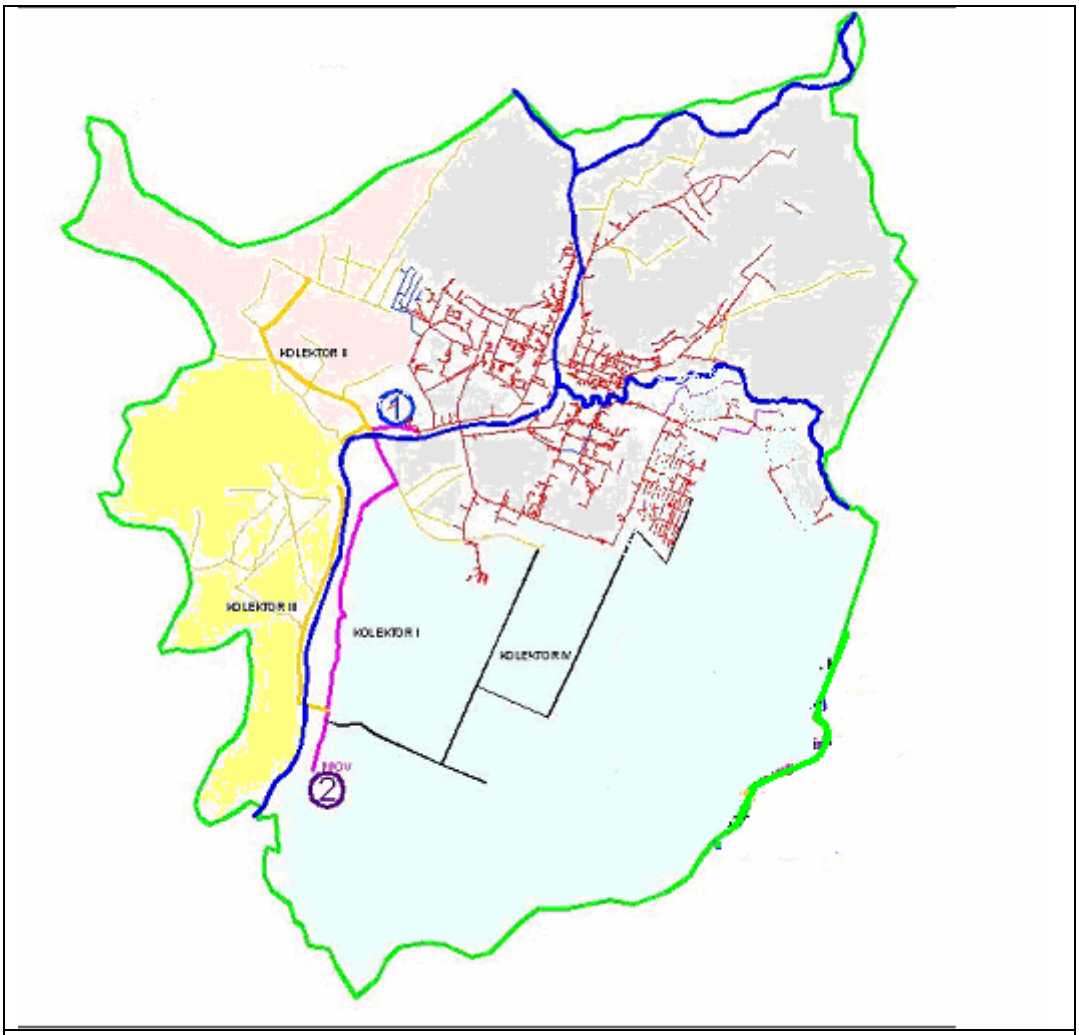
It can be seen that Variant 2 is the least cost solution and confirms the decision that a single new treatment plant should be used in future.

(b) Wastewater network requirements

The IK Consulting preliminary design for the sewerage network for Podgorica includes four collectors with a total length of 21,611m. The collector routes and their service areas are indicated as collectors I, II, III and IV in the figure below. All the main collectors operate by gravity.

A total length of 33,227m of primary network is proposed to accompany the collectors. The total length of the new secondary network required to collect wastewaters from the parts of the city that are not connected to the present sewerage system is estimated to be 195 km. The majority of the primary and secondary systems operate by gravity but two relatively small wastewater pumping stations are proposed on the western side of the City. Pumping Station 1 is at the junction of the road to Niksic and Majavecica Street in Tolosima field. Pumping Station 2 is at the road to Cetinje, south of the water channel. One pump station is planned to have two pumps and the other one is planned to have three, with powers between 1kW and 2kW

The preliminary design indicates that main collectors will cross the Moraca River at two locations. At the upstream crossing, the pipeline installation is proposed to be on the existing road/pedestrian bridge in Niksicka street. At the downstream river crossing, just upstream from the new WWTP, the pipeline is to be installed in a proposed new steel bridge construction, which can also be used as a pedestrian bridge. All wastewaters cross the river by gravity at both river crossing locations.



1 - Existing WWTP	
2 - Proposed WWTP	
	Collector I Service Area
	Collector II Service Area
	Collector III Service Area
	Collector IV Service Area

Figure 6.16: Main wastewater collectors and service areas

IK Consulting have modelled the existing and proposed future wastewater networks using Bentley SewerGEMS software. The existing system has been calibrated and verified for dry weather conditions in 2008 based on a connected population of 84,000 and per capita water consumption of 180 l/d. Calibration of wet weather conditions was not carried out due to a lack of rainfall during the monitoring period. However, an allowance for a 50 mm rain storm with 10% of it entering the sewer system has been included in all the design runs of the model.

The model with future extensions of the network included has been run for projected 2031 conditions with a connected population of 203,250 and a per capita consumption 180 l/d. The model was subsequently also run for the projected 2041 conditions with a connected population of 234,000 and increased industrial flows.

Hydraulic calculation for the future state of the sewage network shows that speeds predicted in the future sewage system are within allowed limits, from 0.3m/s-1m/s for

small diameter sewers and from 1m/s – 3m/s for large diameter collectors. Average flows in the network go from 0.5l/s in the small diameter pipelines up to slightly over 900 l/s in 2031. All pipes are less than 80 % full, except for the maximum hour in 2031, where it is acceptable to allow slight surcharge of existing pipes which, according to the hydraulic calculation, appears only in a few places in the network. The existing network, as part of the future network and with regular maintenance, is suitable to accept the predicted increased inflows of wastewater in 2031.

The models runs for 2041 conditions predict that at the most downstream point of the main collector that leads to the new WWTP the maximum calculated flow is 1515 l/s (compared to a pipe full capacity of the proposed collector of 1895 l/s). Inflow from the direction of old WWTP is 946 l/s and inflow from the collector from the direction of the Zetskih Vladara street (road to Golubovci) is 569 l/s. Almost all pipes in the planned Podgorica sewage network have not reached their full capacities by 2041. Only 8 out of 500 pipes in the model are more than 80% filled, and only two are 100 % filled and a solution has been proposed for relieving these two sections.

Based on technical-economic analyses IK Consulting have recommended PVC and GRP pipes as the optimal materials for construction of new pipelines. This study considers that the HDPE (high density polyethylene pipes) should be adopted as they provide a durable and watertight network. The projected depths of excavation are relatively small considering the topography and not more than 5m, except for the locations of the two future wastewater pumping stations where the maximum depth is 7.5m.

(c) Estimated cost for long term wastewater network

Details of the total lengths and estimated costs of wastewater networks in the various zones are given in the table below.

The estimated costs are based on the unit rates shown below. Unit rates are increase by 20 % because they are including all taxis (17% VAT and 3% duty). The unit rates are considered adequate for HDPE pipes as recommended by this study.

Table 6.13: Details and estimated costs of long term wastewater network requirements

Service Area	Diameter (mm)	Length (m)	Unit rate Inc. Taxes, (€/m)	Amount (€)
Collector I Service Area				
Main collector	1100	729	900	656100
	1000	4860	750	3645000
Primary collector	450	188	360	67680
	400	194	340	65960
	300	11485	300	3445500
Secondary network	250	59626	230	13713980
TOTAL for Service Area I				**21,594,220**
Collector II Service Area				
Main collector	800	120	590	70800
	500	467	380	177460
	400	445	340	151300
	350	555	320	177600
	300	1351	300	405300
Primary collector	500	1096	380	416480
	350	858	320	274560
	300	10720	300	3216000
Secondary network	250	42575	230	9792250
Pumping station (1 no)			100,000	100,000
TOTAL for Service Area II				**14,781,750**
Collector III Service Area				
Main collector	600	1200	430	516000
	500	1837	380	698060
Primary collector	400	1000	340	340000
	300	7686	300	2305800
Secondary network	250	57573	230	13241790
Pumping station (1 no)			100,000	100,000
TOTALfor Service Area III				**17,201,650**
Collector IV Service Area				
Main Collector	700	1654	500	827000
	600*	4983	430	0*
	500	900	380	342000
	400	600	340	204000
	350*	1910	320	0*
Secondary network	250	33685	230	7747550
TOTALfor Service Area IV				**9,120,550**
TOTAL for all Service Area				**62,698,000**
TOTAL excluding VAT				**53,588,180**

* These sewers are constructed or under construction as a part of new road works. However, the collector cannot be put into use until Collector I and the WWTP have been commissioned.

6.4.2 Wastewater treatment

As discussed in Section 6.4.1(a), it is recommended that a new wastewater treatment plant is provided for all wastewater from Podgorica. The proposed site has an area of approximately 10 ha and is between the Aluminium Plant (KAP) and the River Moraca (see Figure 6.17). The land is owned by the Municipality. The site has been contaminated to some extent by the aerial emission from KAP. However, ground water monitoring in the areas suggests that the contamination has not penetrated the ground and that the contamination is confined to the ground surface. A contaminated land investigation will be required to confirm this but, provided there is only surface contamination, any clean up costs should be relatively small and well within the normal physical contingency included in the cost estimates.

Figure 6.17: Site for new WWTP

The wastewater demand analysis indicates that by 2035 wastewater will be collected from approximately 200,000 people in Podgorica which, allowing for industry and institutional discharges, results in a population equivalent (p.e.) of approximately 268,000.

The Montenegrin Regulation (Official Gazette of the Republic of Montenegro, No 45/08, July, 31st 2008) on 'quality and sanitary technical conditions for wastewater discharge to the recipient and public sewer, methods and procedures for wastewater quality inspections, minimum number of inspections and the content of reports on determined wastewater quality' requires secondary (biological) treatment of the wastewater to the following standard for discharge to the Category II River Moraca:

Biochemical Oxygen Demand (BOD_5)*	40 mgO_2/l
Chemical Oxygen Demand*	125 mgO_2/l
Suspended Solids*	60 mg/l
Total Nitrogen	15 mgN/l
Total Phosphorus	2 mgP/l
Total coliform bacteria	10,000 TC/100 ml
Faecal coliform bacteria	5,000 FC/100 ml

*(These standards have to be met on a 95%ile basis)

(NB This Regulation was amended in Spring 2010 to remove the colifom bacteria standards)

These standards are generally slightly less rigorous than the EC Urban Wastewater Treatment Directive (91/271/EEC) standards for a p.e. of more than 100,000 discharging to a sensitive area. The standards for this situation are:

Biochemical Oxygen Demand (BOD_5)*	25 mgO_2/l
Chemical Oxygen Demand*	125 mgO_2/l
Suspended Solids*	35 mg/l
Total Nitrogen	10 mgN/l

Total Phosphorus	1 mgP/l

*(These standards have to be met on a 95%ile basis)
The EC Directive has no requirement for coliform limits.

In order to meet the Total N and P standards a high quality effluent will be required and should achieve BOD_5 and suspended solids standards of better than 15 and 20 mg/l respectively.

(a) Process options

The Feasibility Study for Podgorica Wastewater Treatment Plant by SOGREAH, February 2004 considered process options for the new WWTP and recommended the activated sludge process with biological nitrogen removal, chemical phosphorus removal, tertiary filtration and disinfection. Sludge treatment was to consist of dewatering and lime dosing for stabilisation (as used in the rehabilitation of the existing WWTP).

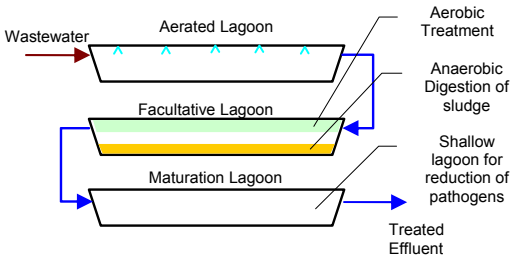
The Montenegrin standards for discharges to Category II surface waters have changed (generally relaxed) since the SOGREAH Report was prepared and therefore the available process options have been examined again.

Biological treatment is the preferred process for providing secondary treatment of urban wastewater and there are three main biological treatment methods:

- Lagoon;
- Attached growth;
- Suspended growth.

A short description of the possible processes and those which may be considered for Podgorica is presented below.

Lagoon
Aerated Lagoon



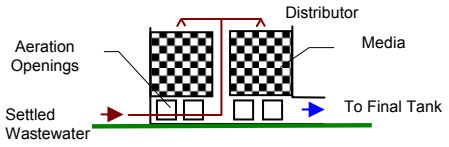
Process Description
Micro-organisms suspended in effluent
Aeration provided by surface aerator
Natural low intensity process used

Benefits
Stable and resistant to shock load
Low operating expenditure
Low volume stabilized sludge

Constraints
Large land area required
Cannot achieve desired effluent quality without effluent polishing

Not suitable for the Podgorica WWTP

Attached Growth
Biological Filter



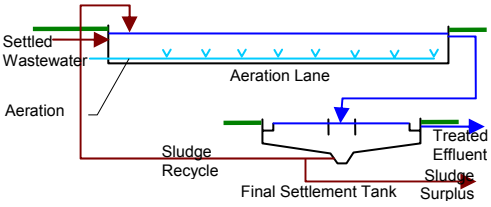
Process Description
Micro-organisms attached to natural or plastic media with natural ventilation
Primary and secondary settlement required

Benefits
Stable and resistant to shock load
Low operating expenditures

Constraints
Low treatment efficiency, especially in cold weather
Unstable sludge produced
Potential for odour and insect problems

Not recommended for Podgorica WWTP

Suspended Growth
Conventional Activated Sludge



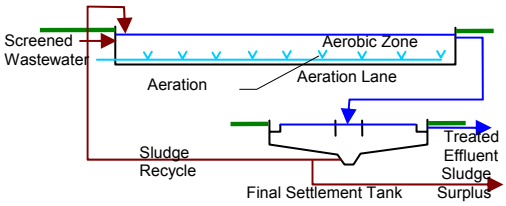
Process Description
Micro-organisms suspended in liquor
Aeration provided by diffusers/ surface aerators
Primary and secondary settlement required

Benefits
Well understood process widely used for large WWTPs
Average energy use
Can be difficult to operate

Constraints
Susceptible to shock load and high flows
Unstable surplus sludge requiring additional processing

Suitable for this size of WWTP
Additional sludge treatment using anaerobic and aerobic digestion can be considered

Suspended Growth
Extended Aeration



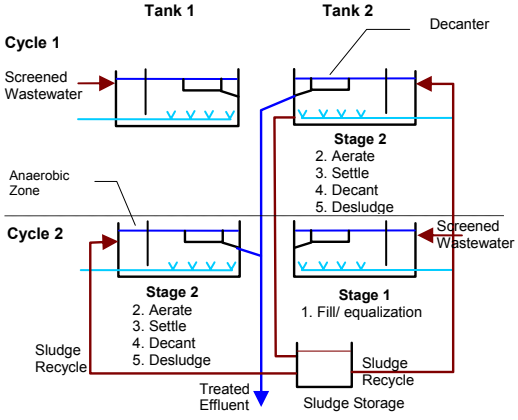
Process Description
Micro-organisms suspended in liquor
Aeration provided by diffusers/ surface aerators
Secondary settlement required

Benefits
Primary settlement not necessary
Stable and resistant to shock load/ flows
Low volume of stabilized sludge produced
Simple operation and maintenance

Constraints
Relatively high energy use

Consider together with oxidation ditch variant

Suspended Growth
Sequential Biological Reactor



Process Description
Micro-organisms suspended in liquor
Aeration provided by diffusers/ surface aerators
All processes are carried out in same tank

Benefits
Small footprint
Settlement tanks not necessary
Sludge recycle not necessary

Constraints
High automation requirement
Complex control system
Complicated decant system

Consider with anaerobic and aerobic sludge digestion

Outline designs for 7 suitable process options have been prepared for the long term capacity of 275,000 p.e. The estimated construction, equipment and operating costs of these options are summarised below. The costs for all options exclude disinfection.

Table 6.14: Comparison of costs for process options for WWTP

Option	Investment Costs*, EURO Thousand			Annual Running Costs, EURO Thousand					Average Incremental Cost***, EURO/m^3
	Civil Cost	Equipment Cost	Total Investment Cost	Maintenance Costs	Staff Costs	Power Costs**	Chemical and Sludge Disposal Costs***	Total Running Costs	
1. Conventional BNR with anaerobic sludge digestion	14,180	12,991	27,171	312	160	262	534	1,269	0.245
2. Low Rate Ditch BNR with Anaerobic Sludge Digestion	14,124	13,204	27,328	316	160	619	488	1,583	0.263
3. Oxidation Ditch (Extended Aeration)	17,306	10,252	27,558	283	128	1,182	547	2,140	0.291
4. Low Rate BNR (no primary settlement) with aerobic sludge stabilisation	15,455	11,580	27,035	295	128	873	624	1,920	0.277
5. Sequential Batch Reactor BNR (no Primary settlement) with aerobic sludge stabilisation	15,220	12,471	27,691	310	128	790	629	1,857	0.279
6. Sequential Batch Reactor BNR with anaerobic sludge digestion	13,350	13,760	27,110	321	160	255	534	1,270	0.246
7. Conventional BNR with lime sludge stabilization	12,409	11,376	23,785	274	128	682	1,076	2,160	0.271

* Cost estimates include contingencies but exclude VAT
** Electricity cost of 0.12€/kWh has been assumed
*** A disposal cost of €10 per tonne dewatered sludge has been applied. This approximately represents the cost of disposal to land
**** Discount rate of 8% has been assumed

Option 7 (Activated sludge with lime stabilisation of sludge) has the lowest construction costs. However, the high operating costs of this option (particularly for chemicals) mean that it is not the least cost option overall. In terms of Average Incremental Cost (or 'whole life cost') Option 1 (Activated sludge with biological nutrient removal and anaerobic sludge digestion) and Option 6 (SBR with anaerobic sludge digestion) have the lowest costs, with no significant difference between the two.

Both the least cost options are considered capable of producing a high quality effluent including biological Nitrogen and Phosphorus removal. As described above, the activated sludge BNR process has the advantages of relatively simple equipment requirements and wide operating experience whereas the SBR process has the benefit of a small foot print but is somewhat more complex to maintain due to the extensive automated control systems. Since the area of the selected site for the WWTP (10 ha) is adequate for an activated sludge BNR plant this is considered to be the most suitable

process for the new Podgorica WWTP. However, should land area become an issue, the SBR process would then be the favoured solution.

There are several variants of the activated sludge BNR process including are the A^2/O process, the five stage Bardenpho process, the University of Cape Town (UCT) process, and the Virginia Initiative Plant (VIP) process. Although there are differences in the numbers of stages and recycle locations in these processes, the principles are similar in all cases and there is little difference in costs or performance of good examples or in overall tank volume required. All the processes involve at least one high rate (normally 3 or 4 DWF) pumped mixed liquor recycle in addition to the normal return of activated sludge. The suggested variant for Podgorica is considered in the next Chapter.

The fact that the options with anaerobic sludge digestion have the lowest overall costs is not surprising. For plants of more than about 100,000 population, the energy that can be recovered from the methane gas produced in anaerobic digestion allows a significant reduction in power costs and results in lower overall costs. The analysis is based on the use of a modern but conventional anaerobic digestion system which is expected to destroy more than 40% of the volatile matter (VM) in the undigested sludge. There are pre-digestion processes that can be used to increase the VM destruction rate and hence bio gas production including thermal hydrolysis (the Cambi process) or enzymic hydrolysis (the Monsal process) and ultrasound treatment. These techniques have generally been shown to be effective but make the anaerobic digestion system more complex to operate and also increase the investment cost of the digestion system. It is therefore recommended that advanced pre treatment is not included in the first phase of the WWTP but it could be added in the second phase of the WWTP when operating experience of the anaerobic digestion system has been gained and the most suitable pre treatment process can be evaluated.

6.4.3 Sludge disposal

One of the by-products of a wastewater treatment works is sludge, which has to be treated and utilised, or disposed of, by some means. Disposal of sludge is already an issue at the existing WWTP and it will become an even more important consideration in the future as the quantity of wastewater treated increases some 3 times. All of the treatment processes evaluated will produce a stabilised sludge and all the plants include mechanical dewatering of sludge to produce a ‘solid’ sludge with a dry solids content of 20 to 30%. At full design capacity and assuming 30% dry solids content, the proposed activated sludge treatment plant should produce some 48 tonne of dewatered sludge per day. This quantity will be reduced in proportion to the population served, depending on when the whole collector scheme is provided and the rate at which new connections are made to the collector system.

The options normally considered for the use or disposal of sludge are:

- Agriculture and forestry/silviculture
- Land reclamation or restoration
- Composting
- Thermal or solar drying
- Landfill disposal
- Incineration
- Energy recovery
- Gasification
- Alternative technologies

Each of these options has individual advantages and disadvantages and there are environmental risks associated with all of them. The volumes of the dewatered sludge from Podgorica may in future mean that incineration, energy recovery and gasification can be considered but they are not thought to be viable options at present. However,

the potential of the viable options needs be considered in the context of providing secure and cost-effective short-term and long-term outlets for the sludge from the treatment plant.

(a) Agriculture and forestry/silviculture

The anaerobic digestion of sludge with mechanical dewatering, as proposed for the Podgorica treatment plant, produces sludge that will be stable and which, in some cases, can be disposed of to land without further treatment. For controlled disposal to agriculture (commercial rather than food crops) or silviculture, storage of dewatered sludge for a period of at least 90 days is advisable to remove the majority of pathogens. If sludge is to be used for food crops (salads and vegetables) further 'advanced' treatment, such as thermophilic digestion or thermal drying, would be necessary but these advanced treatment processes are expensive and are not considered appropriate for Podgorica at this stage.

The use of sewage sludge in agriculture needs the establishment of thorough controls for the application of sludge and also education of farmers and other end users. Sludges can contain substances from industrial processes whose waste stream enters the sewer system. Wastewater companies and authorities must exercise control on such trade effluents to ensure, amongst other things, that the sludge still meets the standard necessary for use on land. These controls would be of particular importance in Montenegro, given the karstic nature of the region.

Sewage sludge is recognised as an excellent soil conditioner and a useful fertiliser. There is a positive environmental benefit from recycling sludge to agricultural land or forestry to make use of the organic matter and plant nutrients that are in sewage sludge. However, the issue of use of sewage sludge in agriculture and forestry has become contentious in much of Europe and there is little or no consensus on what standards and controls should be applied. The existing EC legislation is Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture. The Directive contains regulations to prevent harmful effects on soil, vegetation, animals and man, while encouraging the correct use of the sludge. However, the provisions of the Directive are regarded as inadequate in some European countries but, despite debate over several years, there has been no agreement on an updated Directive. Some countries have introduced regulations (e.g. Denmark) or adopted voluntary agreements (e.g. United Kingdom) with requirements that are stringent enough to satisfy the various stakeholders but, at the same time, allow the use of sewage sludge in agriculture to continue. Certain countries (e.g. Netherlands) have introduced regulations that effectively prevent the use of sludge in agriculture. Several countries appear to be content to work within the existing EC Directive.

It is considered that it will be in the general interests of Montenegro to try to ensure that the option of disposal of sewage sludge in agriculture and forestry remains open. In this context, it is encouraging that transposition of Directive 86/278/EEC into Montenegrin legislation is underway.

(b) Land reclamation or restoration

The use of dewatered sludge for land reclamation or restoration (with proper controls) can be an attractive option, as is the use of dewatered sludge for daily cover in landfills. However, it is unlikely that these uses can provide a long term disposal route for all the sludge that will be produced in Podgorica.

(c) Composting

Composting of sewage sludge together with organic solid waste is an attractive option that is worthy of consideration. Composting with organic material increases the nutrient value and, most importantly, produces a material that is widely accepted by users (provided that the solid waste is properly screened to eliminate, for example, plastics, glass and metallic wastes).

Composting can be achieved in simple windrows if suitable sites are available or in more compact specially constructed composting cells with forced ventilation. Equipment and construction requirements for windrow composting are modest but relatively large sites distant from development are needed. Composting cells have much greater construction and equipment requirements but can be located nearer to development as they are normally covered.

(d) Thermal or solar drying of sludge

Thermal drying of sludge using direct or indirect heating can produce sludge of more than 90% dry solids content that can be used in agriculture or as a fuel. However, the equipment is expensive and the energy requirements are very high. Useless there is a plentiful source of waste heat available, e.g. from district heating, the operating costs are high. Therefore thermal drying is probably not a viable option for Podgorica at the present time.

The solar drying process is an alternative to thermal drying method which is based on the use of solar energy. The principle involves evaporating the sludge water by the means of solar heat enhanced and stored by a glasshouse or tunnel with translucent cover ("greenhouse effect"). Evaporation is helped by a mechanical mixing system which increases the exchange surface between sludge and warm air and the saturated air is evacuated by the means of an effectively regulated ventilation system. Mixing induces aerobic fermentation (composting-like process) which raises the sludge temperature and can thus pasteurize the sludge.

Mechanically dewatered sludge is placed as a quite thin layer (typically 10 to 50 cm) on the floor of the glasshouse and regularly mixed by a mechanical turner (mixing roll, "electric mole" or "windrow mixer"). The drying can be undertaken continuously or batch processed. In the later case, the insulated glasshouse is hermetically closed during the drying process (batch system) in order to accurately regulate the air flow through ceiling circulation fans, exhaust fans and flaps according to local meteorological conditions and the state of sludge.

Solar drying has the same advantages as thermal drying, i.e.: volume reduction, pasteurization, stabilization, odour abatement, increase of the calorific value of sludge, final product likely to be accepted by farmers but, in addition, it presents a far better environmental balance. The energy consumption per ton of evaporated water for solar drying is only 20 to 80 kWh of electrical energy against, for thermal drying, 70 to 120 kWh electrical energy + 700 to 1000 kWh thermal energy. In addition, the technology used is simple and reliable, and there is no risk of fire or explosion as possible with thermal drying technology.

Example of solar drying 'greenhouse'

'Electric mole'

Disadvantages of solar drying against thermal drying are the following:

- with solar drying, 90% dry solids is difficult to reach except in the hottest months, unless the drying period or the drying area is increased to an unrealistic extent. As a result, an average target of 75% DS sludge would be more easily achievable in Podgorica.
- the solar drying requires large surfaces of glasshouses. As a guideline value, the rate of 0.5 to 1 m^2 per tonne of dewatered sludge per year is commonly accepted for the climate of Podgorica.

Sludge production from the proposed Phase 1 WWTP (see Section 7) is estimated to be about 3,900 tonne DS/year, i.e. 15,600 tonne 25% DS/year, the surface area for solar drying (basic technology) will be of around 8,000 to 16,000 m^2. The sludge production for the Phase 2 (2035) WWTP is expected to be about 5,250 tonne DS/year or 21,000 tonne dewatered sludge at 25% DS, requiring an area of 10,500 to 21,000 m^2. This area is available at the proposed site for the Podgorica and if additional heat is supplied through a heat pump or from an on site CHP plant, the required surface can be reduced significantly.

The investment cost of solar drying system is quite high at about €300/m^2 but the operating cost is low at €30 to 50/t DS. The cost of providing a solar drying system for all the 2035 sludge production would be approximately €5 million.

(e) Landfill

The attitudes and practices in European countries regarding disposal of sludge in landfill are in stark contrast. The report 'Disposal and recycling routes for sewage sludge' prepared for the EC by SEDE and ARTHUR ANDERSON in 2001/2002 found that;

'The disposal of sludge in landfills is considered by most stakeholders to have the disadvantage of wasting the fertilising value of sludge. In addition, in several countries, disposal to landfill has become very costly and in certain cases it has become difficult to create new landfills due to strong resistance on behalf of the local inhabitants (Ireland, Denmark, France, etc.)……'

'However, the disposal of sludge in landfills is still an important disposal route today (2001) *for sludge (and concerns about 25% of the sludge produced in the EU), mainly because, in some cases, it is the only possibility…… and because one of the major advantages of this disposal route perceived by most players is that it presents very limited risks for health and the environment.'*

It should be noticed that in most EU countries, disposal to landfill of sludge should progressively be reduced, in application of the Directive on the landfill of waste (1999/31/EEC) which recommends to reduce the quantities of biodegradable waste going to landfills, and prohibits the landfilling of both liquid wastes and untreated wastes. Indeed the SEDE/ARTHUR ANDERSEN reports notes that *'In Sweden, from 2005 onwards, no organic waste (including sludge) will be accepted in landfills, by application of waste regulations'*. Germany also effectively prohibited sludge disposal to landfill from 2005. These elements explain the widely shared perception of a future decline of disposal to landfill as an option for sludge.

Nevertheless, if disposal of sludge to land cannot be achieved in Podgorica, it may be that landfill disposal will be the only viable option for sludge disposal, at least in the short term. There are two possibilities in terms of sludge landfilling: mono-deposits, where only sludge is disposed of, and mixed-deposits (most commonly observed), when the landfill is also used for municipal wastes. Given the karstic conditions in the Podgorica region it would be important to ensure that any landfills used for sludge are properly engineered and lined.

(f) Alternative technologies

The threat that the agricultural route for beneficial recycling may not continue to be available has led to a number of companies seeking alternative uses. These include ideas such as the use of sludge in lightweight aggregates manufacture. It is anticipated that other uses will be developed in coming years. However, it is unlikely that, in the short term, these uses will be applicable to Podgorica.

6.4.4 Main findings from an economic analysis of sludge disposal methods

The results from economic analyses in 'Disposal and recycling routes for sewage sludge' prepared for the EC by SEDE and ARTHUR ANDERSON in 2001/2002 may be summarised as follows.

Landspreading routes rank best overall, landfilling and incineration routes worst

Landspreading of solid and landspreading of semi-solid sludge entail on average the lowest cost (110-160 €/ton of dry matter) from an overall economic point of view, i.e. accounting for both internal and external costs and benefits.

Landfilling, mono-incineration and co-incineration of sludge with other wastes entail the highest costs (260-350 €/ton of dry matter) from an overall economic point of view.

Landspreading of composted sludge, use of sludge in land reclamation, and use of sludge in silviculture record intermediate total costs (210-250 €/ton of dry matter).

These findings reinforce the desirability of sludge disposal to land if possible. In the first instance, it is recommended that efforts should be made to encourage the use dewatered sludge with a dry solids content of 25 – 30%. However, it must be recognised that it can prove difficult to dispose of all the sludge in this manner and the addition of solar sludge facilities to reduce sludge volume and make it easier to dispose of may well be necessary for the second phase of the WWTP.

6.4.5 Summary of long term wastewater investment requirements

Based on the foregoing analyses, the long term wastewater investment requirements have been identified as follows:

Table 6.15: Summary of long term wastewater investment requirements

Component	Amount, Euro without VAT	Amount, Euro with VAT
Podgorica collector system and extensions	53,588,000	62,698,000
New Podgorica WWTP (275,000 p.e.) Including solar drying of sludge	32,171,000	37,640,000
Total (including 10%including physical contingency)	**85,759,000**	**100,338,000**

The WWTP includes an allowance of €5 million for solar sludge drying facilities. This is a large investment that will undoubtedly take several years to complete. The next Section therefore considers investment priorities and possible development options.

7 Prioritisation and development options

7.1 Development options for water supply

The Study considers three development scenarios selecting priority items from the Strategic Investment Plan presented in Chapter 6, as follows:

i. Minimum Project – the smallest investment considered worthwhile under the Project which would achieve an improvement in the general levels of service.
ii. Base Project – the preferred option incorporating the recommended immediate investments to achieve a significant improvement in the water service
iii. Long Term Programme – further investments in the water system for the long tern benefit of the water system

The long term strategy includes programmes currently under preparation, namely, the ViK funded upgrade to Old Mareza pumping station and laboratory, and the JICA funded project to upgrade New Mareza pumping station, install a SCADA system and implement a District Metering Programme as 'ongoing projects'.

7.1.1 ViK Development Projects

ViK have their own programme of water supply improvements and these are not considered in the development scenarios under the project but have been itemised in the long term strategic Investment Plan given in table 6.8.

Table 7.1: ViK Ongoing Projects

ViK Ongoing Projects	Amount exc VAT	Amount inc VAT
Reduction in Losses	1,000,000	1,170,000
Mains Replacement	14,200,000	16,614,000
Source Development	9,800,000	11,466,000
System Reinforcement	4,500,000	5,265,000
Total ViK Ongoing Projects	**29,500,000**	**34,515,000**

7.1.2 Minimum Project

The existing water supply system delivers clean water to the majority of the population. The minimum project therefore comprises basically a 'do nothing' situation as it is feasible that the system could continue to operate on the present basis. This would not address the current operational issues of variable pump delivery and supply pressures nor would it address reliability concerns caused by the lack of system storage. The project includes the measures identified to reduce the system losses from their current unacceptably high level.

Table 7.2: Minimum Project Investment

Minimum Project	Amount exc VAT	Amount inc VAT
Reduction in Losses	1,300,000	1,521,000
Total for Minimum Project	**1,300,000**	**1,521,000**

7.1.3 Base Project

This project is based ViK's basic proposals but with the proposed new 20,000 m^3 reservoir on Vrsak Hill rather than the originally proposed Ljubovic Hill where the existing tank will be retained after refurbishment. As explained in Chapter 6, there is little difference in investment cost should a new 20,000 m^3 reservoir at Ljubovic be preferred to one at Vrsak. The items from the minimum case are maintained. Implementation of these investments would improve supply pressures generally at times of peak demand by around 10m, particularly in the city centre. Source pressure variations are reduced from their current 20m to less than 5m.

Table 7.3: Base Project Investment

Base Project	Amount exc VAT	Amount inc VAT
Reduction in Losses	1,300,000	1,521,000
Construction of Vrsak Reservoir and pumping main	11,031,900	12,907,323
Improvements to Ljubovic Reservoir	802,800	939,276
Total for Base Project	**13,134,700**	**15,367,599**

7.1.4 Long Term Programme

This Long Term Programme case takes development of the system to the next stage by including for the construction of a second reservoir on Gorica Hill and the isolation of the Zagoric supply zone. Implementation of these investments would improve supply pressures and source pressure variations as for the base case but will give greater stability to pressures in the north-east of the city and give more operational control at Zagoric source.

Table 7.4: Long Term Programme Investment

Long Term Programme	Amount exc VAT	Amount inc VAT
Reduction in Losses	1,300,000	1,521,000
Construction of Vrsak Reservoir and pumping main	11,031,900	12,907,323
Improvements to Ljubovic Reservoir	802,800	939,276
Construction of Gorica Reservoir	2,911,500	3,406,455
Total for Maximum Case	**16,046,200**	**18,774,054**

It should be noted that the Long Term Programme Investment considered for the Project and the ViK on-going projects exclude the construction of Masline and Momisici reservoirs which are included in the Long Term Strategic Investment Plan list in Section 6 (Table 6.9). This is because the need for these reservoirs will have to be re-evaluated when the other measures implemented by ViK and under the Project have been completed.

7.2 Development options for wastewater sector

7.2.1 Wastewater collectors

The general designs for wastewater collectors prepared by the IK Consulting, Belgrade and outlined in the previous Chapter are considered to be satisfactory both in terms of layout and design capacity. However, the costs of providing all the collectors are substantial at € 63 million (including VAT) and it is therefore advisable to consider phasing of the implementation of the system and the options for how much of the planned works are included in the initial project for which international funding is sort.

(a) Minimum Project for wastewater collectors

Collector I is needed to transport wastewaters from the City centre and the existing WWTP to the site of the new WWTP. It is therefore considered that Collector I has the highest priority and is the minimum that can be included in Phase 1 of implementation. The figure below shows the Collector I (as a purple line) as well as the existing wastewater network plus those sewers that are already planned and under construction. The estimated cost of Collector I is detailed in Table 7.5

Table 7.5: Details and estimated costs of Minimum Project

Wastewater Collector Network						
Service Area	Diameter (mm)	Length (m)	Unit rate Exc. Taxes (€/m)	Unit rate Inc. Taxes (€/m)	Amount exc VAT (€)	Amount inc VAT (€)
Collector I						
Main collector	1100	729	769	900	561,000	656,000
	1000	4860	641	750	3,115,000	3,645,000
TOTAL					**3,676,000**	**4,301,000**

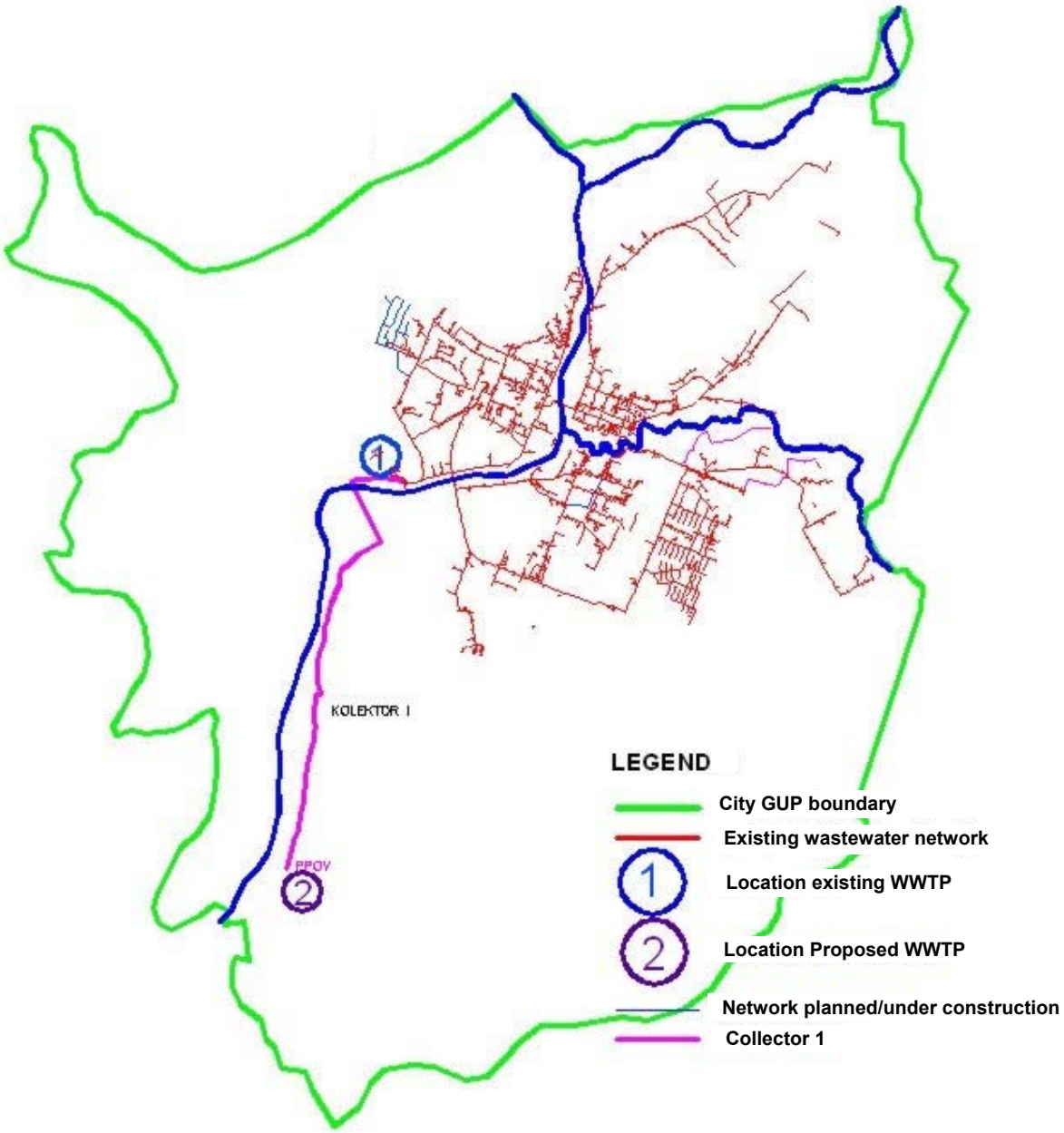


Figure 7.1: Layout of wastewater collectors for Minimum Project

(b) Base Project for wastewater collectors

The Minimum Project will ensure that all wastewater collected from the existing wastewater network receives full treatment and will therefore significantly reduce the pollution load discharged to the Moraca River and hence to Lake Skadar. However, to reduce pollution to the ground, particularly from private houses, it is necessary to extend the wastewater network so that the population connected can be increased significantly. The extensions that will connect the largest numbers in the short to medium term are within the Collector I zone and in the Collector II zone (along the Niksic road and Boska Buhe to the north). The Base Project therefore includes Collectors I and II, the primary networks in Collector I and II zones, plus 50% of the secondary network in Collector I and II zones. Details of the wastewater collector components included in the Base Project are given in Table 7.6 and the layout of the main collectors and primary sewers are shown on Figure 7.2.

Table 7.6: Details and estimated costs of Base Project

Wastewater Collector Network						
Service Area	Diameter (mm)	Length (m)	Unit rate Exc. Taxes (€/m)	Unit rate Inc. Taxes (€/m)	Amount exc VAT (€)	Amount inc VAT (€)
Collector I zone						
Main collector	1100	729	769	900	560,800	656,100
	1000	4860	641	750	3,115,400	3,645,000
Primary Network	450	188	308	360	57,800	67,700
	400	194	291	340	56,400	66,000
	300	11485	256	300	2,944,900	3,445,500
Secondary network	250	29813	197	230	5,860,700	6,857,000
Sub total Collector I zone					**12,596,000**	**14,737,000**
Collector II zone						
Main collector	800	120	504	590	60,500	70,800
	500	467	325	380	151,700	177,400
	400	445	291	340	129,300	151,300
	350	555	274	320	151,800	177,600
	300	1351	256	300	346,400	405,300
Primary Network	500	1096	325	380	356,000	416,500
	350	858	274	320	234,700	274,600
	300	10720	256	300	2,748,700	3,216,000
Secondary network	250	21288	197	230	4,184,700	4,896,100
Pumping Station					85,500	100,000
Sub total Collector II zone					**8,449,000**	**9,786,000**
Total for Base Project Wastewater Collector Network					**21,045,000**	**24,523,000**

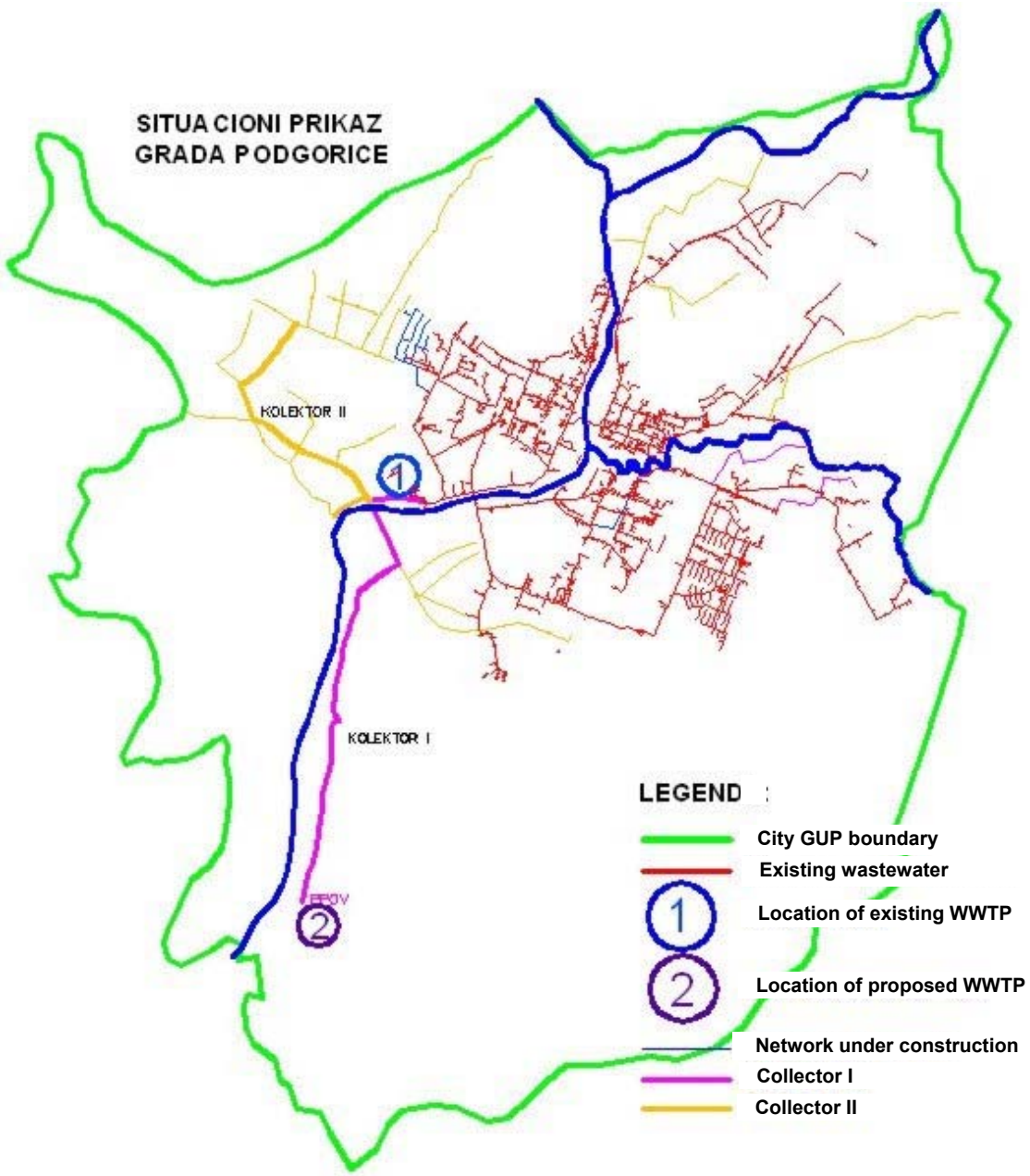


Figure 7.2: Layout of wastewater collectors for Base Project

(c) Long Term Programme for wastewater collectors

The Long Term Programme for wastewater collectors includes all the main collectors and primary sewers in Collector Zones I, II, III and IV as well as 50% of the secondary sewers.

The total of this programme is less than the estimated costs of long term wastewater network requirements given in Section 6 (Table 6.13). This is because Table 6.13 includes all the primary and secondary sewers in the IK Consulting Engineers 'Prefeasibility Study and General Design - Wastewater System'. The Long Term Programme considered for the Project includes the primary sewers plus 50% of the secondary sewers. The reasoning behind this is partly because it is considered that the length of secondary sewer was overestimated by IK Consulting and partly because some secondary sewers will be provided by developers.

Table 7.7: Details and estimated costs for Long Term Programme

Wastewater Collector Network						
Service Area	Diameter (mm)	Length (m)	Unit rate Exc. Taxes (€/m)	Unit rate Inc. Taxes (€/m)	Amount exc VAT (€)	Amount inc VAT (€)
Collector I zone						
Main collector	1100	729	769	900	560,800	656,100
	1000	4860	641	750	3,115,400	3,645,000
Primary Network	450	188	308	360	57,900	67,700
	400	194	291	340	56,400	66,000
	300	11485	256	300	2,944,900	3,445,500
Secondary network	250	29813	197	230	5,860,700	6,857,000
Sub total Collector I zone					**12,596,000**	**14,737,000**
Collector II zone						
Main collector	800	120	504	590	60,500	70,800
	500	467	325	380	151,700	177,500
	400	445	291	340	129,300	151,300
	350	555	274	320	151,800	177,600
	300	1351	256	300	346,400	405,300
Primary Network	500	1096	325	380	356,000	416,500
	350	858	274	320	234,700	274,600
	300	10720	256	300	2,748,700	3,216,000
Secondary network	250	21288	197	230	4,184,700	4,896,100
Pumping Station					85,500	100,000
Sub total Collector II zone					**8,449,000**	**9,886,000**
Collector III zone						
Main collector	600	1200	368	430	441,000	516,000
	500	1837	325	380	596,600	698,100
Primary Network	400	1000	291	340	290,600	340,000
	300	7686	256	300	1,970,800	2,305,800
Secondary network	250	28787	197	230	5,658,900	6,620,900
Pumping Station					85,500	100,000
Sub total Collector III zone					**9,043,000**	**10,581,000**
Collector IV zone						
Main collector	700	1654	427	500	706,800	827,000
	600	0	368	430	0	0
	500	900	325	380	292,300	342,000
	400	600	291	340	174,400	204,000
Primary network	350	0	274	320	0	0
Secondary network	250	16843	197	230	3,310,900	3,873,800
Sub total Collector IV zone					**4,484,000**	**5,247,000**
Total for Maximum Project wastewater network					**34,572,000**	**40,451,000**

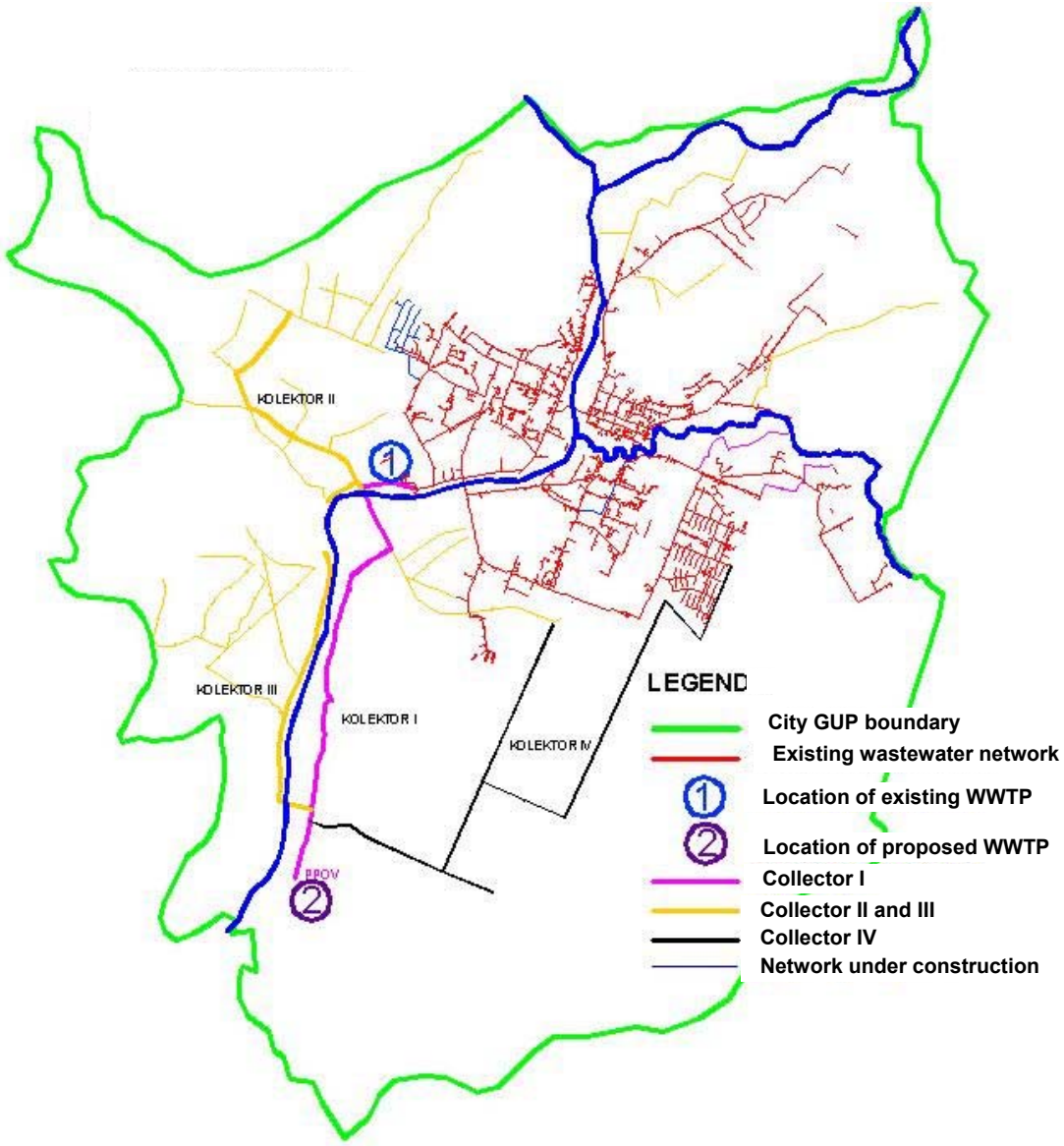


Figure 7.3: Layout of wastewater collectors for Maximum Project

7.2.2 Wastewater Treatment

The design for the wastewater treatment plant analysed in the previous Section is based on a population equivalent of 275,000 and a connected population for the domestic wastewater contribution of 200,000 (see Appendix F for details). The connected population at present is approximately 83,000 and this expected to increase to 115,000 by 2015 by which time the new WWTP is expected to be operational. However, it will be desirable to phase the implementation of the WWTP to avoid providing excessive overcapacity, particularly if the wastewater flows and loads received at the treatment plant do not increase as fast as assumed. A design has therefore been prepared for Phase 1 of the WWTP which is designed for the projected 2020 flows and loads. This results in a design population equivalent of 200,000 and a connected population of 143,400 for the domestic wastewater contribution.

The design calculations for the Phase 1 WWTP are included in Appendix G and a preliminary layout of the WWTP including schematic flow systems is shown on Figure 7.4. Further details of the process units are included in Chapter 11. The Phase 1 design includes 75% of the 2035 capacity of the main process units (e.g. primary settlement

tanks, aeration tanks, final settlement tanks and anaerobic digesters). However, the inlet pump station, inlet works, anaerobic tank, sludge return pump station, and the sludge treatment components (apart from anaerobic digesters) would be provided to the 2035 capacity).

As described in Section 6.4.2, the Montenegrin Regulation in force at the time of carrying out the Study for discharges to a Category 2 river include total coliform bacteria and faecal coliform bacteria limits of 10,000 TC/100 ml and 5,000 FC/100 ml respectively. No information has been provided on the bacteria concentrations in Podgorica wastewater but raw wastewater typically has 10^7 – 10^9 MPN/100 ml and a nitrified effluent, as will be produced by the proposed treatment plant, typically has 10^4 – 10^6 MPN/100 ml[22]. The proposed biological treatment process cannot be expected to meet the Montenegrin bacteriological standards at all times (although they may be met at times) and tertiary filtration and/or disinfection would have to be provided to guarantee compliance. However, it is not recommended that tertiary treatment and/or disinfection be included in the Phase 1 WWTP for the following reasons:

- treated effluent will be discharged in the vicinity of the Aluminium Plant and the Moraca River is not likely to be used for swimming or recreational purposes for a considerable downstream of the outfall.
- unlike Nitrogen and Phosphorus which are conservative contaminants, bacteria will decay in fresh water and particularly in sunlight,
- tertiary filtration and/or disinfection are processes that can be added after biological treatment at any time.
-

It is therefore recommended that the need for tertiary filtration/disinfection be reviewed in the future when the treatment plant is operational. If is deemed necessary to disinfect effluent, it is strongly recommended for safety and environmental reasons that this should be provided by UV radiation rather than chlorination.

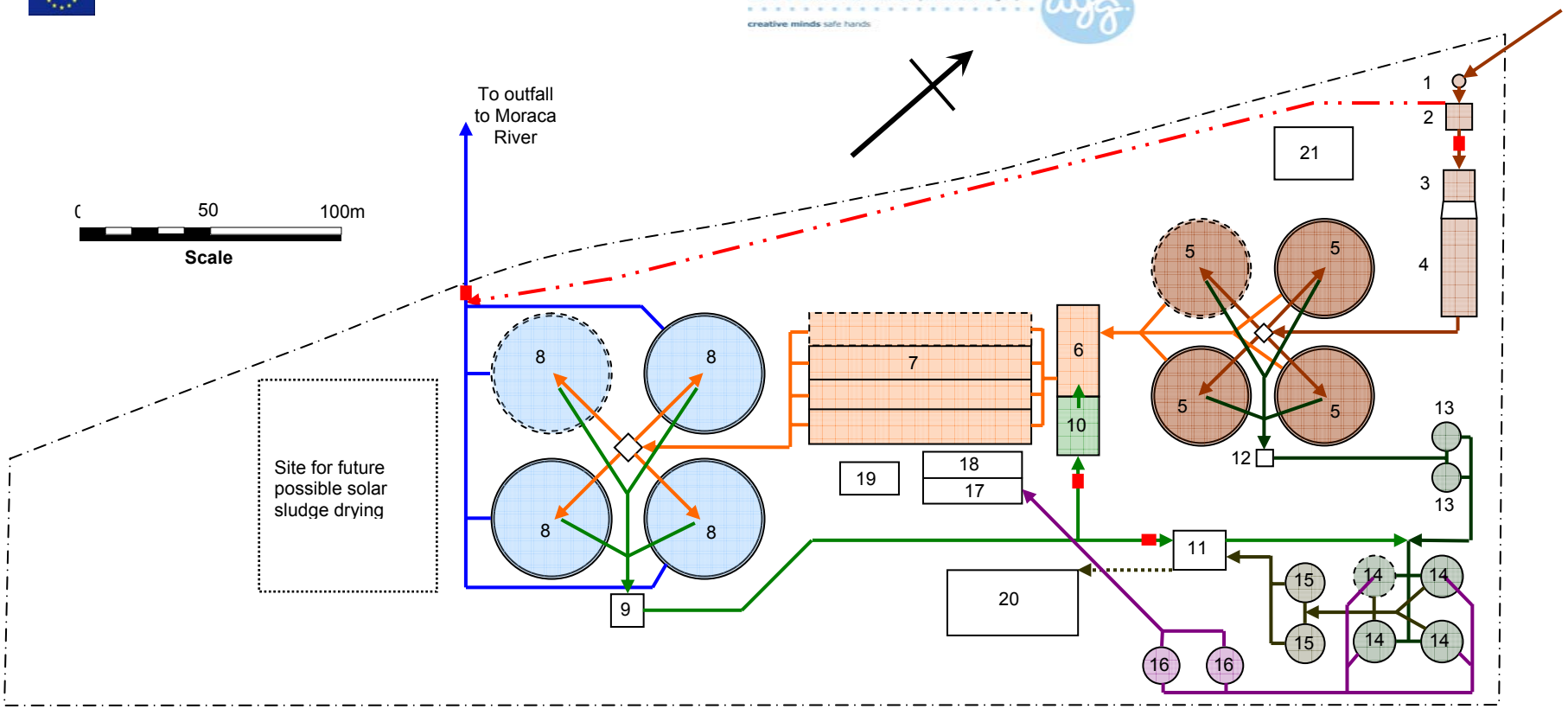
(NB the coliform bacteria limits were removed from the Montenegrin Regulations in 2010)

Details the estimated costs of the Phase 1 WWTP are included in Appendix B and these are summarised in the Table below.

Table 7.8: Estimated cost of Phase 1 WWTP

Phase	Population equivalent p.e.	Civil Works (€)	Equipment (€)	Amount exc VAT (€)	Amount inc VAT (€)
Phase 1 WWTP	200,000	11,513,000	10,831,000	**22,344,000**	**26,142,480**

[22] Table 12-13, Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Fourth Edition.



Legend

1	Reception chamber	11	Sludge thickening and dewatering	21	Office and Laboratory
2	Inlet pumping station	12	Primary sludge PS		Site boundary
3	Screens	13	Gravity thickening tanks		Raw sewage
4	Grit and grease removal	14	Anaerobic sludge digesters		Settled sewage
5	Primary settlement tanks	15	Sludge buffer storage tanks		Final effluent
6	Anaerobic tank	16	Gas holders		Emergency bypass
7	Aeration tanks	17	Combined heat and power house		Activated sludge
8	Final settlement tanks	18	Blower house		Primary sludge
9	Return activated sludge PS	19	Electricity sub station		Digested sludge
10	Pre anoxic tank	20	Dewatered sludge storage		Bio gas
					Flow monitoring

Figure 7.4: Layout of Phase 1 WWTP (Phase 2 extensions shown dotted)

7.2.3 Summary of options for wastewater sector development

The estimated costs of the three development options for the wastewater sector are summarised in the Table below.

Table 7.9: Summary of estimated costs for wastewater development options

Minimum Project	**Amount exc VAT**	**Amount inc VAT**
Wastewater collector sewers	3,676,000	4,301,000
Phase 1 WWTP	22,344,000	26,143,000
Total for Minimum Project	**26,020,000**	**30,444,000**
Base Project	**Amount exc VAT**	**Amount inc VAT**
Wastewater collector sewers	21,045,000	24,622,000
Phase 1 WWTP	22,344,000	26,143,000
Total for Base Project	**43,389,000**	**50,765,000**
Long Term Programme		
Wastewater collector sewers	34,573,000	40,450,000
Full WWTP	32,171,000	37,640,000
Total for Long Term Programme	**66,744,000**	**78,090,000**

7.3 Overall summary of options for Priority Investment Project

The estimated costs for the combined water and wastewater development options for the Priority Investment Project are summarised in Table 7.10.

Table 7.10: Summary of estimated costs for overall Projects

Minimum Project	**€ exc VAT**	**€ inc VAT**
Water component	1,300,000	1,521,000
Wastewater component	26,020,000	30,444,000
Total for Minimum Project	**27,320,000**	**31,965,000**

Base Project	**€ exc VAT**	**€ inc VAT**
Water component	13,135,000	15,368,000
Wastewater component	43,389,000	50,765,000
Total for Base Project	**56,524,000**	**66,123,000**

Long Term Programme	€ exc VAT	€ inc VAT
Water component	16,046,000	18,774,000
Wastewater component	66,744,000	78,090,000
Total for Maximum Project	**82,790,000**	**96,864,000**

7.4 Proposed Priority Project

The cost of the Minimum Project is just over 50% less than the Base Project while the Long Term Programme is nearly 70% more than the Base Project. It needs to be recognised that the full benefits, in terms of improved water supplies and reduced surface and groundwater pollution will not be realised unless reservoir capacity with dedicated supply from the main water source is provided and the wastewater collection service area is increased together with increased wastewater treatment capacity.

With regard to water supply, the Minimum Project only reduces unaccounted for water and does not improve supply pressures or security of supplies. The Base Project includes the reservoir capacity to improve supply pressures (particularly in the central area of the City) and also the security of supplies. The Maximum Project includes further reservoir capacity which also allows some improve to supply pressures in higher elevation areas to the north east of the City.

In terms of wastewater collection, the Minimum Project does not extend service area to any significant extent. However, the capacity of the Minimum Project (Phase 1) WWTP would be adequate for many years. The Base Project does increase the sewerage coverage in the developed areas in the north and north east of the City and will allow the percentage of population connected to be increased significantly. The first phase of the wastewater treatment plant will still provide sufficient capacity for the City for many years. The Base Project therefore meets a large part of the conditions for providing environmental benefits in the short to medium term for Podgorica. The Long Term Programme will further increase the sewerage coverage area, particularly to the less densely developed areas to the west of the City, but the extra wastewater treatment capacity will not be needed for at least 10 years.

It is therefore recommended that, should it prove to be financially viable, the Base Project should constitute the Priority Project.

8 Financial appraisal

8.1 Introduction

The financial situation of ViK, the municipal water and wastewater company of Podgorica, is relatively satisfactory after the tariff increases of November 2008. The operating costs of water and wastewater services have been recovered from revenues together with the provisions for depreciation in 2009 which has enabled the ViK to undertake limited capital investments. However, collection rate is relatively poor as accounts receivables are currently equivalent to 8 months income. A significant level of investment in water supply and wastewater has been undertaken over the last few years financed by the Municipality. The current tariffs, especially after an average increase of 46% in November 2008, are sufficient to enable ViK to recover its operating costs and generate adequate surplus to undertake urgently needed investments in replacement of old and inefficient network. Nevertheless, a significant improvement in the operating environment is needed for ViK to provide satisfactory level of water supply and wastewater services and support investments in the development of wastewater collection and treatment infrastructure.

8.1.1 Focus of Financial Analysis

The financial appraisal examines:

- the capital costs of the investments of alternative development options for wastewater infrastructure and potential sources of finane
- the assumptions used for projecting future operating costs of ViK
- the impact of the costs of development and cost recovery tariffs
- the affordability of increased tariffs for domestic consumers
- the financial capacity of ViK to help the Municipality by repaying the debt commitments to fund the investments in water and wastewater infrastructure

The results of the financial appraisal are presented in Appendix H, which gives projections for annual income statement, balance sheet and cash flow statement over a 15 year period. The financial projections are made using a financial model and the IMF macroeconomic forecasts for the economy of Montenegro. The financial results of the ViK operations for the years 2007 to 2009 are used as the basis for calibrating the financial operations over the last three years. The future projections for the 15 year period from 2010 to 2024 are based on the assessment of anticipated development in water and wastewater services and changes in operating cost trends and efficiencies.

8.1.2 Key Macro Economic Assumptions

The key macro assumptions used in the financial model are summarised in Table 8.1

Table 8.1: Key Macro Economic Assumptions

Variable	Assumption
Real GDP	A real GDP growth forecast of 4% per annum throughout the period to 2024
Local inflation	Inflation rate is forecast to remain steady at 3% throughout the period
Real wages	Real wages growth is projected to match the growth of GDP at 4% per annum throughout of the period to 2024
Foreign Inflation	A Euro inflation rate of 1.5% per annum is applied throughout the period
Exchange Rate	The € exchange rate is forecast to remain stable or appreciate against the currencies of the neighbouring.

8.2 Capital Costs and Funding Arrangements

8.2.1 Capital Costs

In terms of capital expenditure, all the alternative development options would be scheduled for the construction contracts to be implemented between 2011 and 2014. The costs of each of the options including physical and price contingencies, and VAT and taxes are shown in Table 8.2.

Table 8.2. Escalated Costs of the Alternative Development Options – € 000

Development Option	Total Costs	2011	2012	2013	2014
Minimum Project					
Water supplies -loss reduction measures. Wastewater - Phase: 1 WWTP and main collector	35,885	848	11899	12,256	10,882
Base Case					
Water supplies –same as above plus, source development and construction of two service reservoirs. Wastewater- same as above plus collector II and primary and secondary network -	74,057	1755	26678	27,478	18,146
Long Term Project					
Water supplies same as above and one more service reservoir and mains reinforcement. Wastewater - same as above and collectors for zones III and IV, primary and secondary network and Phase II WWTP	108,640	2478	36724	39599	29839

8.2.2 Financing Arrangements for Priority Investment Programme

The Base Case project is proposed as the priority, which comprises improvements to address reliability, efficiency and pressure problems in water supplies by construction of service reservoirs implementation of loss reduction measures for the City, construction of wastewater collectors to cover most of the densely populated areas of Podgorica and a new phase 1 wastewater treatment plant to meet the foreseeable needs. This would be instrumental in controlling the growing threat of pollution in the City from untreated discharges into the open streams and water courses. .Furthermore, leaking or overflowing septic tanks used by the households not connected to the City's wastewater collection system, pollute groundwater or discharge into various small streams and rivers. There is a growing concern that uncontrolled discharges into the streams and rivers may lead to further water quality deterioration and environmental degradation of economically and ecologically valuable tourist areas along the downstream reaches of the Moraća River, Lake Skarda National Park (Ramsar listed), and the coastline adjoining the lake outlet, with attendant cross border issues affecting neighbouring Albania The Municipality considers it an urgent priority to address these threats by development of adequate wastewater collection and treatment facilities.

The appraisal is based on the assumption that 50% of the external debt finance for the proposed project would be provided through a loan from the European Investment Bank (EIB). This is one of the standard conditions associated with EIB financing. The remaining 50% of the capital investments costs, including VAT would therefore need to be contributed by the stakeholders to demonstrate a commitment to the project. However, the counterpart contribution by the beneficiaries can include costs of recent investments such as the water supply improvements financed by the ViK and the Municipality. These aspects could be finalised at the negotiation stage with EIB. A brief review of the potential sources of finance is provided below:

- Debt finance

The source of debt finance would be the EIB. For the Base Case it is assumed that debt finance of € 37.0m will be provided to ViK. Debt servicing obligations will be recovered through user charges for water supply and wastewater services. The terms and conditions under which the loan is to be provided have yet to be determined. For the purposes of the analysis, the following assumptions have been made which are in line with current EIB financing terms:

Loan Amount	€ 37.028 million
Interest rate	A fixed interest rate of 4.7% per annum ;
Repayment period	25 years including a six year grace period.

Repayment of principle is assumed to be applied on a straight line basis. As such higher debt servicing costs are incurred during the initial repayment period. Annual debt servicing obligations are € 1,527,054 in 2014, peaking at € 3,689,058 in 2017 with the start of loan repayment and gradually reducing to € 2,040,838 in the last year of repayment in 2035. Total debt servicing costs amount to € 60,803,572 over the 25 year period.

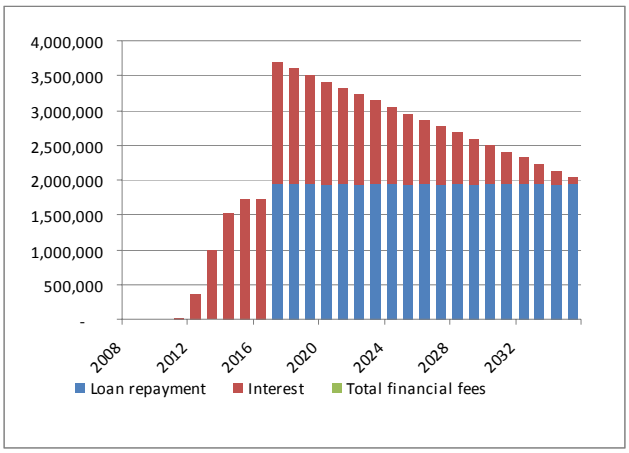


Figure 8.1: Debt Servicing Obligations (Euro)

- Equity Contribution

The beneficiaries should also provide around 50% of the investment costs of about € 37.024 million as equity finance. Potential sources include the Municipality of Podgorica and the Federal Government. The financial status of ViK is such that it cannot be considered as a potential source of equity finance at present. The main sources of local counterpart contributions are therefore considered to be the other stakeholders. Commitments to provide this support have yet to be made

- Grant Finance

It is understood that EIB is currently engaged in trying to attract multilateral and bilateral donors to support the project by providing grant funding. The proposed project is also eligible for grant funding by the European Commission under the instrument for Pre-Accession (IPA). Contributions from these external sources would greatly help to ease the burden of counterpart financing, which is one of the major constraints facing the successful implementation of the proposed project.

For the purposes of the analysis, the project is assumed to be financed by a debt of 50% of the total investment costs, with the local equity, and potentially external donor contributions making up the remaining 50% of the investment costs including VAT. However, there is a significant scope for increasing the total proportion of debt for from the EIB at the stage of loan negotiations as the Municipality and the ViK have undertaken a significant volume of investments for improvements in both water supply and wastewater services.

Table 8.3: Summary of Financing Structure (€ 000 – Escalated prices)

Use of Funds	€ 000	%	Sources of Funds	€ 000	%
Capital expenditure	63,296	85.5%	EIB loan	37,028	50%
			Local Contribution	37,028	50%
VAT	10,761	14.5%			
Total Project Costs	74,056	100%	Total Financing	74056	100%

The financing plan for the Base Case Project is shown below

Table 8.4: Capital Costs and Financing Plan for Base Case Project (€ 000)

Escalated Prices	Total	2011	2012	2013	2014
Capital Costs					
Construction	**63,296**	1,499	22,801	23,486	15,509
VAT & Duties	**10,760**	255	,3876	3,992	2,637
Total (€ 000)	**74.056**	**1,754**	**26,678**	**24,478**	**18,146**
Financed By					
EIB	**37,027**	877	13,339	13,738	9,073
Equity Contribution	**37,027**	877	13,339	13,738	9,073
Total (€ 000)	**74,056**	**1,754**	**26,678**	**27,478**	**18,146**

8.3 Projections for Future Operating Costs

8.3.1 Basis for Projecting Operating Costs

Total direct operating costs (excluding depreciaton) of ViK were € 4.618m in 2009. The operating costs for water supplies were € 3.331m while for wastewater they were € 0.987m. Total operating costs increased from € 4.421 in 2007 to € 4.618 in 2009 largely as a result of general increases in the costs of major cost items such as staff salaries, costs of electricity, and other direct operating costs. In projecting the operating costs for the future, specific consideration has been given to:

- Electricity costs, which accounted for about 20% of the total operating costs in 2009, will increase significantly in the future as a result of the planned extension of water supply system and commissioning of the proposed wastewater treatment plant. It is anticipated that the costs of electricity will also increase in real terms by € cents 0.5 / kWh per annum over the long term together with increases linked to the local inflation rate of 3% per annum to catch up with real increases in the global price of energy. The electricity consumption is projected to vary with the volume of water production and wastewater treatment.
- Staff salaries together with social taxes and contributions currently account for 45% of the total direct operating costs. ViK has a firm plan to reduce staff numbers through rationalisation and automation of operating activities. However, real increases in staff salaries are projected at 4% per annum in line with IMF projections together with adjustments for local inflation rate.
- The other remaining items of the operating costs are projected to vary in line with water production and the impact of proposed investments in wastewater collection and treatment. These are also linked to the projected local inflation rate.
- Depreciation allowances for new and existing assets are applied according to Montenegrin and international accounting standards.

8.3.2 Summary of Projected Operating Costs for Water and Wastewater Services

Figure 8.2 summarises the projections for annual operating costs for water and wastewater services over the period under consideration.

The total annual operating costs for water and wastewater services are projected to increase in escalated prices from € 4.618m in 2009 to € 10.517m by 2024 to take account of real increases in costs and local inflation. In real terms, the costs are projected to increases from € 4.616 to € 7.176m by 2024. The direct operating costs per unit of water supplied and wastewater services increase from € 0.20 per m^3 in 2009 to € 0.40 per m^3 in nominal terms by 2024

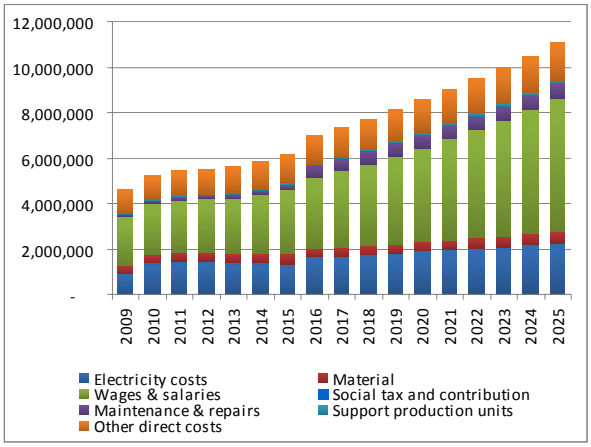


Figure 8.2: Projected Total Annual Operating Costs (€ -escalated prices)

8.4 Tariff Implications

8.4.1 Policies for Cost Recovery and Tariff Strategy

The terms of reference for this assignment state that it is expected that the consumers should, depending on affordability constraints, meet the cost of servicing the debt made available for the priority investment programme. Full cost recovery is taken to be recovery of operating costs including appropriate provisions for depreciation and maintenance allowances, and that sufficient return on assets is made to enable the operating entity to meet the associated financing costs of the proposed capital investment programme.

8.4.2 Projected Tariff Levels

The existing tariffs for water for domestic consumers of € 0.24 per m^3 in 2009 are equal to the direct operating costs (excluding depreciation but including normal maintenance) per m^3 of water supplied of € 0.24 in 2009. They have been set for ViK to fully recover the direct costs of operations and with significantly higher tariffs of € 1.15 per m^3 and € 1.33 per m^3 for institutional and commercial consumers respectively allow sufficient funds to be generated to finance the some of the necessary investment or to carry out essential repairs and maintenance of water supply infrastructure. The picture is almost the same for wastewater. The existing tariffs for domestic consumers of € 0.12 per m^3 are only marginally lower than the direct operating costs of wastewater services of € 0.13 m^3, while those for institutional and commercial at € 0.57 per m^3 and € 0.67 per m^3 are significantly higher than the direct operating costs for these services. It should be emphasised that these broad observations should not be treated as precise cost and revenue correlations. They simply demonstrate the order of magnitude of costs and charges and do not take into account the impact of collection rates and bad debt write-offs

The viability of the current tariff structure has mainly resulted from an overall average increase in tariffs of 46% in November 2008 after a along period of unchanged tariffs. This has created the opportunity for ViK to recover its direct operating costs and

make provisions for depreciation and still generate sufficient surplus to undertake essential repair and maintenance.

ViK can provide sustainable water and wastewater services and undertake the proposed priority investments if the tariffs are increased in line with the projected rate of inflation of 3% per annum over the long term. This regime of tariff increases would be adequate to ensure smooth and stable operating environment for ViK compared with the past practice of ad hoc increases in tariffs periodically. The proposed tariff increases for domestic consumers are shown below.

The combined average tariffs for domestic water supplies and wastewater services are projected to increase from € 0.36 per m^3 in 2009 to € 0.56 by 2024. These increases reflect the impact of nominal increases at the projected rate of inflation of 3% per annum. These gradual increases also help to ensure affordable water supply and wastewater services for households

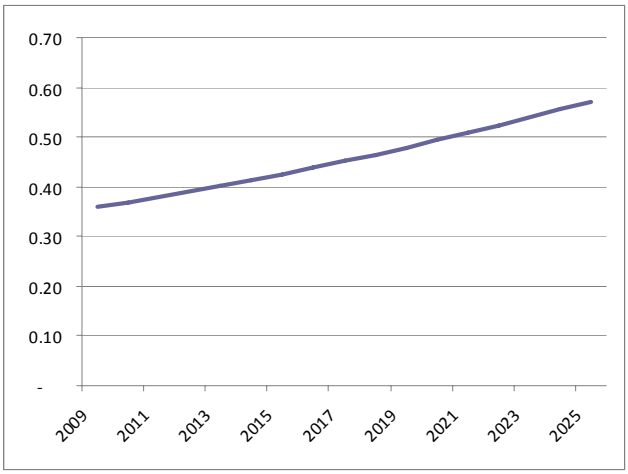


Figure 8.3: Projected Domestic Tariff Increases for Water and Wastewater (€ per m3)

Table 8.5: Projected Consumer Tariff Levels Excluding VAT (€ per m3)

Consumer Category	2009	2014	2019	2024
Domestic				
Water	0.24	0.28	0.32	0.37
Wastewater	0.12	0.14	0.16	0.19
Combined	0.36	.042	0.48	0.56
Institutional				
Water	1.15	1.32	1.53	1.77
Wastewater	0.57	0.66	0.76	0.88
Combined	1.72	1.98	2.29	2.67
Commercial				
Water	1.33	1.53	1.77	2.05
Wastewater	0.67	0.76	0.89	1.03
Combined	2.00	2.29	2.66	3.08

The tariff increases for institutional and commercial consumers are also projected to increase in line with the inflation rate of 3% per annum for water and wastewater services. While the tariff differential between domestic and non-domestic consumers is maintained throughout the period under consideration, it would be more equitable to narrow this differential and increase the domestic tariffs by a much greater margin without significantly increasing the burden on domestic consumers. However, there is usually a considerable political sensitivity about increasing domestic tariffs to bring them in line with non-domestic tariffs.

The number of consumers for the sewerage connections, limited to the urban areas, remains significantly lower in comparison with that for the water supply consumers

throughout the period under consideration. A lot of consumers in the outlying, less densely populated areas, will not be conncted to the Podgorica system in the planning period

8.4.3 Comparison of Existing Tariff Levels

The existing water tariff for domestic consumers in Podgorica of € 0.24 per m^3 is amongst the lower range of tariffs in the municipalities of Montenegro as shown in Table 8.6. There is a significant variation in domestic tariffs for water supplies between the municipalities. The larger municipalities, such as Podgorica with larger consumer base, apply relatively low tariff in the group in 2009. In general, this is feasible for larger systems with higher economies of scale and lower operating costs per m^3. However, for the smaller systems such as those in Kolasin and Pluzine, the prevailing tariffs do not adequately cover the operating costs. Some of the municipalities in the group do not have sewerage systems or only limited collection facilities and consequently do not have wastewater tariffs. Tariffs for non-domestic consumers are usually twice as high as the domestic tariffs in most municipalities. In addition, all consumers pay VAT of 17%, which adds this amount to a typical household bill. In some of the municipalities including Bar, Bijelo Polje, Danilovgrad and Plav a small fixed monthly charge of € 1 to 2 per month per connection is also applied to domestic consumers and variable charge according to size of the meter is used for non-domestic consumers.

Table 8.6 Comparison of Domestic Tariff Levels (excluding VAT, € / m3)

Location	Water	Wastewater	Combined
Andrijevica	0.14	0.06	0.22
Bar	0.54	0.27	0.81
Berane	0.18	-	0.18
Bijelo Polje	0.21	0.11	0.32
Budva	1.05	0.16	1.21
Cetinje	0.78	-	0.78
Danilovgrad	0.43	0.22	0.65
Herceg Novi	0.80	-	0.80
Kolasin	0.25	0.13	0.38
Kotor	1.18	-	1.18
Mojkovac	0.14	-	0.14
Niksic	0.32	-	0.32
Plav	0.20	0.10	0.30
Pljevlja	0.34	-	0.34
Pluzine	0.12	0.08	0.20
Podgorica	0.24	0.12	0.36
Rozaje	0.15	-	0.15
Tivat	0.60	-	0.60
Ulcinj	0.57	0.20	0.77

Zabljak	0.26	0.13	0.39

Sources: Association of ViKs of Montenegro

8.5 Affordability of Projected Increases in Tariff Levels

8.5.1 Basis of Establishing Affordability

The affordability of potential tariff levels is assessed as a percentage of household income that is accounted for by the cost of water supply and wastewater services. The international financing institutions generally recommend that the affordable cost of water supply and wastewater services should not exceed 4% - 5% of household income.

8.5.2 Household Income

The information concerning employment and average monthly net wage levels is summarised in Table 8.7. The employment and income statistics are for those formally registered as employed in the Municipality of Podgorica. It excludes members of the family employed overseas. It is a well established fact that a significant proportion of families in the Municipality, and particularly in the City of Podgorica, have family members resident in Western Europe who provide regular financial support

Table 8.7: Employment and Income in Municipality of Podgorica 2009

Total Population	Total Number Employed	Labour Participation Ratio	Economically Active Population (15-64)	Employment Rate	Average Monthly Wages EUR
169,132	61,032	36	114,781	53.2%	652

Source: Monthly Statistical Review of Montenegro

In an average middle income economy, labour participation ratio is usually around 30 and employment rates amongst economically active population are between 50% and 60%. The statistics summarised above show the labour participation ratio and employment rate to be typical of an average middle income economy. However, City of Podgorica is the capital and seat of government administration. It is also a thriving commercial centre for the fast growing tourism areas of the coast, which helps to boast the employment and income levels compared with the rest of the country.

It is widely accepted that the actual size of the economy of any town or city in Montenegro is significantly greater than reflected by the “registered activities”. In practice, when assessing affordability of services, household income should also include non-monetary earnings, remittances from family members working and living outside the town, and earnings from the “shadow economy” where people are engaged in economic activities without being formally registered as employed.

The data necessary to determine the extent of this income in Podgorica is not available. Unofficial estimates have indicated that estimates of household incomes should be at least doubled to take account of the non-monetary contributions, remittances, and earnings from the shadow economy. This would be confirmed by the quality of consumer products in the shops, standard of housing and those under construction and cars etc in Podgorica. As there is considerable uncertainty regarding these factors, no additional allowance is made to increase the average household income, and it assumed that there is only 1.0 wage earner per household. In most assessments of household affordability, a ratio of average wage earners per

household of 1.0 to 1.5 is more common. However, more cautious estimates contribute to the robustness of the analysis.

Average net monthly wages are projected to increase from € 652 per month in 2009 to € 911 by year 2014, and € 1,812 per month by year 2024. The projections are based on IMF forecasts for real increases in average wage rates of 4% per annum over the period under consideration. The projected average household income is the same as the projected average wage rate as a result of the assumption of 1.0 wage earner per household

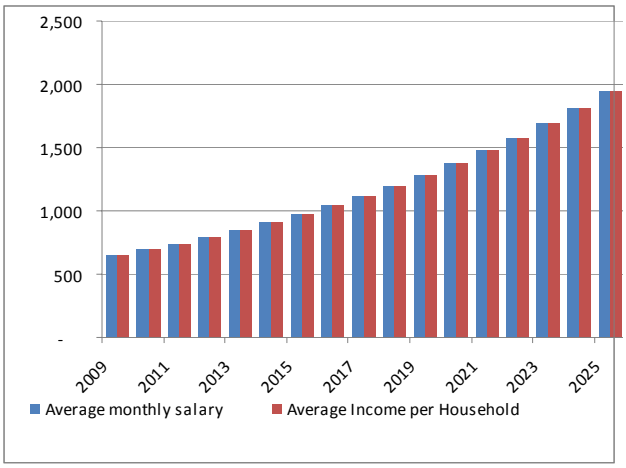


Figure 8.4: Projected Average Net Wages and Household Income (€ per month)

8.5.3 Affordability of Water Supply and Wastewater Services

With modest, inflation linked, increases in tariffs for water supplies and wastewater services, the cost of water and wastewater services are shown to remain well within the affordability boundaries of less than 1% of the average disposable household incomes, which would not be a burden even for the low income households. Evidence also shows that lower income households would tend to reduce their average consumption and manage their demands more effectively to counter the affordability difficulties.

The acceptable consumer affordability parameters largely result from favourable prospects for future growth of national economy and household incomes. Table 8.8 summarises the results of consumer affordability analysis.

Table 8.8: Affordability of Water and Wastewater Services (Percentage of Average Household Incomes)

	2009	2014	2019	2024
Average Household Income € / month	652	911	1,284	1,812
Household consumption m3 / month	23.083	19.588	16.951	15.380
Water supply tariff € / m3	0.28	0.33	0.37	0.43
Household bill € / month	6.48	6.31	6.33	6.66
Costs of water supplies	1.0%	0.7%	0.5%	0.4%
Wastewater tariff € / m3	0.14	0.17	0.19	0.22
Household bill € / month	3.24	3.16	3.17	3.33
Costs of wastewater services	0.5%	0.3%	0.2%	0.2%
Costs of combined services	1.5%	1.0%	0.7%	0.6%

Note: Analysis are based on tariffs including VAT at 17%

8.6 Financial Position of ViK

8.6.1 Overview

With the projected real increases in water and wastewater tariff levels ViK is shown to:

- Maintain a cash surplus;
- Meet all debt servicing obligations as they fall due;
- Continue to meet all operating costs including maintenance and depreciation
- Undertake discretionary capital expenditure works of over € 2.0m per annum in the short term and reducing to around € 1.5m per annum in escalated prices in the longer term.

8.6.2 Profitability

Revenues from the provision of water supply and wastewater services are sufficient for ViK to meet all operating costs including maintenance, depreciation, debt service obligations and undertake some discretionary capital expenditure.

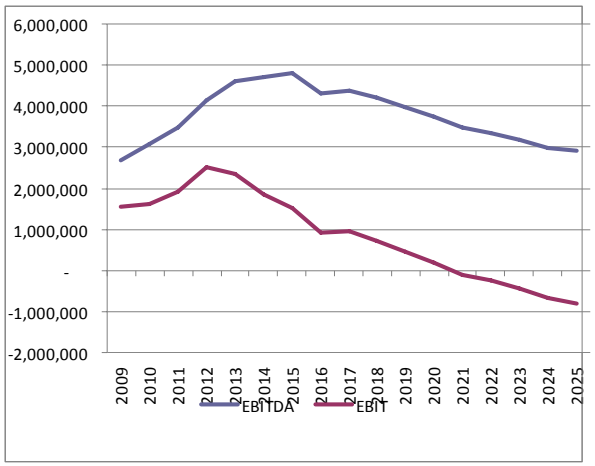


Figure 8.5 Profitability of Vodovd Operations EUR

8.6.3 Debt Servicing Obligation

Sufficient revenues are realised by ViK to meet the debt servicing obligations for the finance provided by the EIB. Annual debt servicing obligations are € 1,527,054 in 2015, peaking at € 3,689,058 in 2017 and gradually reducing thereafter throughout the remaining period. Debt servicing costs account for around 32% of the cash available from operations in 2017 and gradually reduce to below 25% by 2024. Repayments, as shown by the debt service coverage ratio (DSCR), which remains well above 1.4 for the debt repayment

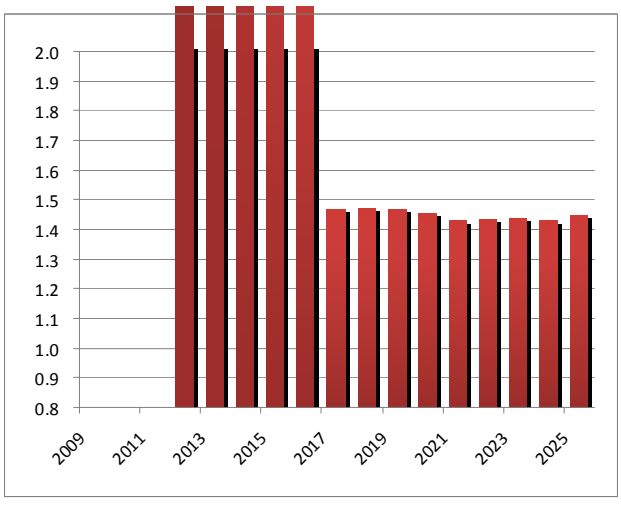


Figure 8.6 - Debt Service Coverage Ratio

period comfortably satisfy the benchmark criteria that are adopted by EIB

8.6.4 Cash Position

Vodvod is projected to remain in a cash positive position throughout the period under consideration and meet all its operating costs and debt service obligations.

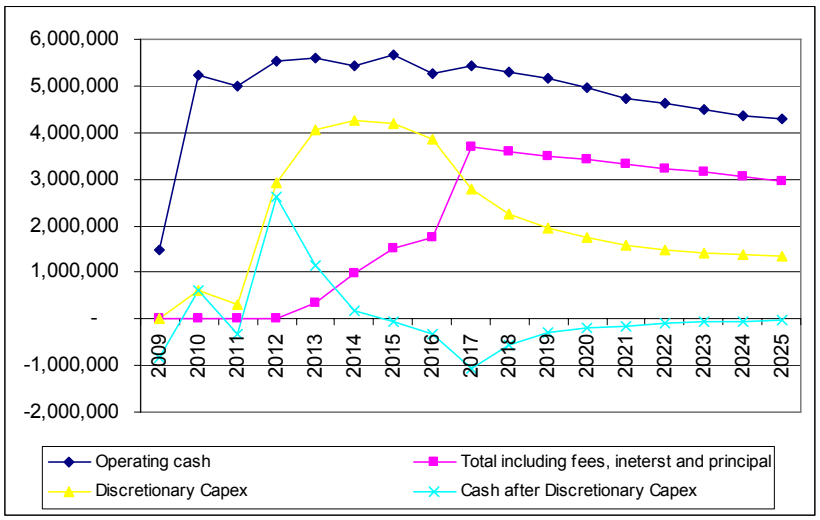


Figure 8.7 Cash Position of ViK

The details are presented in profit and loss, cash flow statement and balance sheet below

Podgorica Vodovod
Podgorica Water and Wastewater Project

Profit & Loss Statement		2007 -2 Actual	2008 -1 Actual	2009 0 Actual	2010 1 Projections	2011 2 Projections	2012 3 Projections	2013 4 Projections	2014 5 Projections	2015 6 Projections	2016 7 Projections	2017 8 Projections	2018 9 Projections	2019 10 Projections	2020 11 Projections	2021 12 Projections	2022 13 Projections	2023 14 Projections	2024 15 Projections
Revenues																			
Water	EUR	5,073,000	5,339,000	6,766,000	7,370,992	7,610,876	7,853,571	8,107,985	8,367,410	8,627,436	8,889,239	9,154,096	9,261,112	9,352,049	9,438,481	9,523,474	9,766,003	10,013,714	10,252,692
Waste water	EUR	1,379,000	1,447,000	1,782,000	1,818,182	1,989,589	2,094,730	2,208,559	2,327,061	2,449,123	2,575,149	2,705,601	2,811,078	2,915,054	3,020,931	3,129,696	3,236,795	3,328,862	3,418,512
Total revenues	**EUR**	**6,452,000**	**6,786,000**	**8,548,000**	**9,189,174**	**9,600,465**	**9,948,300**	**10,316,544**	**10,694,472**	**11,076,559**	**11,464,388**	**11,859,697**	**12,072,191**	**12,267,104**	**12,459,412**	**12,653,170**	**13,002,798**	**13,342,575**	**13,671,204**
Bad debt costs																			
Bad debt cost	EUR	1,863,000	1,749,000	1,240,824	895,790	716,354	288,564	119,955	124,617	129,348	134,166	139,093	142,049	144,823	147,591	150,400	154,658	158,657	162,521
Revenues after bad debt cost	**EUR**	**4,589,000**	**5,037,000**	**7,307,176**	**8,293,383**	**8,884,110**	**9,659,737**	**10,196,588**	**10,569,854**	**10,947,211**	**11,330,222**	**11,720,604**	**11,930,142**	**12,122,281**	**12,311,821**	**12,502,770**	**12,848,140**	**13,183,919**	**13,508,683**
Operating costs																			
Electricity	EUR	1,142,000	1,144,000	942,558	1,383,353	1,468,683	1,445,695	1,387,439	1,370,556	1,355,216	1,673,279	1,685,087	1,750,632	1,816,939	1,885,582	1,957,089	2,029,666	2,104,766	2,181,281
Material	EUR	538,000	519,000	360,412	367,620	378,649	390,008	401,709	413,760	426,173	360,459	374,267	388,325	402,761	417,701	433,195	446,848	460,924	475,416
Wages & salaries	EUR	1,541,000	1,827,000	2,100,580	2,228,295	2,296,585	2,368,101	2,443,108	2,642,748	2,858,432	3,150,391	3,374,699	3,614,978	3,872,364	4,148,076	4,443,419	4,759,791	5,098,688	5,461,715
Social tax and contribution	EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maintenance & repairs	EUR	167,000	116,000	115,191	117,495	121,020	124,650	147,800	172,226	197,986	516,703	532,204	548,171	564,616	581,554	599,001	616,971	635,480	654,544
Support production units	EUR	168,000	115,000	54,349	55,436	57,099	58,812	60,576	62,394	64,265	66,193	68,179	70,225	72,331	74,501	76,736	79,038	81,410	83,852
Other direct costs	EUR	865,000	895,000	1,045,744	1,066,659	1,098,659	1,131,618	1,165,567	1,200,534	1,236,550	1,258,597	1,306,844	1,355,968	1,406,409	1,458,611	1,512,752	1,560,435	1,609,600	1,660,215
Total operating costs	**EUR**	**4,421,000**	**4,616,000**	**4,618,834**	**5,218,858**	**5,420,674**	**5,518,885**	**5,606,199**	**5,862,218**	**6,138,621**	**7,025,624**	**7,341,281**	**7,728,298**	**8,135,421**	**8,566,026**	**9,022,193**	**9,492,750**	**9,990,868**	**10,517,023**
EBITDA	EUR	**168,000**	**421,000**	**2,688,342**	**3,074,525**	**3,463,437**	**4,140,852**	**4,590,389**	**4,707,636**	**4,808,590**	**4,304,598**	**4,379,323**	**4,201,843**	**3,986,860**	**3,745,795**	**3,480,578**	**3,355,391**	**3,193,051**	**2,991,660**
Depreciation	EUR	936,000	1,034,000	1,121,000	1,444,723	1,548,773	1,640,220	2,242,902	2,864,766	3,302,556	3,378,269	3,433,036	3,477,089	3,515,236	3,549,445	3,580,455	3,609,665	3,637,697	3,664,490
EBIT	**EUR**	**-768,000**	**-613,000**	**1,567,342**	**1,629,802**	**1,914,664**	**2,500,632**	**2,347,487**	**1,842,870**	**1,506,034**	**926,329**	**946,287**	**724,755**	**471,624**	**196,350**	**-99,878**	**-254,275**	**-444,646**	**-672,830**
Other income	EUR	2,245,000	2,478,000	1,136,000	916,980	944,489	972,824	1,002,009	1,032,069	1,063,031	1,094,922	1,127,770	1,161,603	1,196,451	1,232,344	1,269,315	1,307,394	1,346,616	1,387,015
Other cost	EUR	1,532,911	1,697,393	1,665,272	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial costs																			
EIB loan interest	EUR	0	0	0	0	0	20,610	354,686	990,995	1,527,054	1,740,269	1,740,269	1,648,676	1,557,083	1,465,490	1,373,897	1,282,303	1,190,710	1,099,117
EIBloan financial fees	EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Profit before profit tax	EUR	**-55,911**	**167,607**	**1,038,070**	**2,546,782**	**2,859,153**	**3,452,846**	**2,994,810**	**1,883,944**	**1,042,011**	**280,982**	**333,788**	**237,682**	**110,992**	**-36,795**	**-204,459**	**-229,184**	**-288,740**	**-384,933**
Profit Tax	EUR	0	0	0	229,210	257,324	310,756	269,533	169,555	93,781	25,288	30,041	21,391	9,989	0	0	0	0	0
Profit after profit tax	EUR	**-55,911**	**167,607**	**1,038,070**	**2,317,572**	**2,601,829**	**3,142,090**	**2,725,277**	**1,714,389**	**948,230**	**255,694**	**303,747**	**216,290**	**101,003**	**-36,795**	**-204,459**	**-229,184**	**-288,740**	**-384,933**
PROFIT TAX																			
Start balance	EUR	0	0	0	0	229,210	257,324	310,756	269,533	169,555	93,781	25,288	30,041	21,391	9,989	0	0	0	0
Profit tax for the year	EUR	0	0	0	229,210	257,324	310,756	269,533	169,555	93,781	25,288	30,041	21,391	9,989	0	0	0	0	0
Profit tax paid	EUR	0	0	0	0	229,210	257,324	310,756	269,533	169,555	93,781	25,288	30,041	21,391	9,989	0	0	0	0
Profit tax Payable	EUR	0	0	0	229,210	257,324	310,756	269,533	169,555	93,781	25,288	30,041	21,391	9,989	0	0	0	0	0

Podgorica Vodovod
Podgorica Water and Wastewater Project

Cashflow Statement		2007 -2 Actual	2008 -1 Actual	2009 0 Actual	2010 1 Projections	2011 2 Projections	2012 3 Projections	2013 4 Projections	2014 5 Projections	2015 6 Projections	2016 7 Projections	2017 8 Projections	2018 9 Projections	2019 10 Projections	2020 11 Projections	2021 12 Projections	2022 13 Projections	2023 14 Projections	2024 15 Projections
Revenues																			
Water	EUR	5,073,000	5,339,000	6,766,000	7,370,992	7,610,876	7,853,571	8,107,985	8,367,410	8,627,436	8,889,239	9,154,096	9,261,112	9,352,049	9,438,481	9,523,474	9,766,003	10,013,714	10,252,692
Waste water	EUR	1,379,000	1,447,000	1,782,000	1,818,182	1,989,589	2,094,730	2,208,559	2,327,061	2,449,123	2,575,149	2,705,601	2,811,078	2,915,054	3,020,931	3,129,696	3,236,795	3,328,862	3,418,512
Bad debt cost and change in receivables	EUR	-1,863,000	-2,077,000	-1,530,824	454,227	86,343	384,489	178,408	-186,742	-192,157	-197,919	-204,075	-176,980	-176,864	-179,203	-182,251	-212,131	-214,510	-216,542
Cash from customers	**EUR**	**4,589,000**	**4,709,000**	**7,017,176**	**9,643,401**	**9,686,807**	**10,332,789**	**10,494,951**	**10,507,729**	**10,884,402**	**11,266,469**	**11,655,622**	**11,895,211**	**12,090,240**	**12,280,209**	**12,470,919**	**12,790,667**	**13,128,065**	**13,454,662**
Operating costs																			
Materials	EUR	538,000	519,000	360,412	367,620	378,649	390,008	401,709	413,760	426,173	360,459	374,267	388,325	402,761	417,701	433,195	446,848	460,924	475,416
Electricity	EUR	1,142,000	1,144,000	942,558	1,383,353	1,468,683	1,445,695	1,387,439	1,370,556	1,355,216	1,673,279	1,685,087	1,750,632	1,816,939	1,885,582	1,957,089	2,029,666	2,104,766	2,181,281
Social tax and contribution	EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wages & salaries	EUR	1,541,000	1,827,000	2,100,580	2,228,295	2,296,585	2,368,101	2,443,108	2,642,748	2,858,432	3,150,391	3,374,699	3,614,978	3,872,364	4,148,076	4,443,419	4,759,791	5,098,688	5,461,715
Maintenance & repairs	EUR	167,000	116,000	115,191	117,495	121,020	124,650	147,800	172,226	197,986	516,703	532,204	548,171	564,616	581,554	599,001	616,971	635,480	654,544
Support production units	EUR	168,000	115,000	54,349	55,436	57,099	58,812	60,576	62,394	64,265	66,193	68,179	70,225	72,331	74,501	76,736	79,038	81,410	83,852
Other direct costs	EUR	865,000	895,000	1,045,744	1,066,659	1,098,659	1,131,618	1,165,567	1,200,534	1,236,550	1,258,597	1,306,844	1,355,968	1,406,409	1,458,611	1,512,752	1,560,435	1,609,600	1,660,215
Decrease/increase in payables	EUR	0	-787,000	382,000	117,851	-12,071	-5,874	-5,222	-15,313	-16,532	-33,805	2,098	146	-21,004	-22,216	-23,535	-24,277	-25,699	-27,146
Cash to suppliers	**EUR**	**4,421,000**	**3,829,000**	**5,000,834**	**5,336,709**	**5,408,603**	**5,513,011**	**5,600,977**	**5,846,905**	**6,122,089**	**6,991,819**	**7,343,379**	**7,728,444**	**8,114,416**	**8,543,810**	**8,998,658**	**9,468,472**	**9,965,169**	**10,489,878**
Profit tax	EUR	0	0	0	0	-229,210	-257,324	-310,756	-269,533	-169,555	-93,781	-25,288	-30,041	-21,391	-9,989	0	0	0	0
Other income and costs	EUR	712,089	780,607	-529,272	916,980	944,489	972,824	1,002,009	1,032,069	1,063,031	1,094,922	1,127,770	1,161,603	1,196,451	1,232,344	1,269,315	1,307,394	1,346,616	1,387,015
Operating cash	**EUR**	**880,089**	**1,660,607**	**1,487,070**	**5,223,671**	**4,993,484**	**5,535,279**	**5,585,227**	**5,423,360**	**5,655,789**	**5,275,791**	**5,414,724**	**5,298,329**	**5,150,884**	**4,958,754**	**4,741,577**	**4,629,589**	**4,509,512**	**4,351,799**
EIB/Grant/City investment programme	EUR	0	0	0	0	0	1,754,000	26,678,000	27,476,000	18,146,000	0	0	0	0	0	0	0	0	0
Existing CAPEX program	EUR	1,501,000	1,904,000	2,299,000	4,000,000	5,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0
Investing cash flow	**EUR**	**1,501,000**	**1,904,000**	**2,299,000**	**4,000,000**	**5,000,000**	**1,754,000**	**26,678,000**	**27,476,000**	**18,146,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Operations less investments	EUR	**-620,911**	**-243,393**	**-811,930**	**1,223,671**	**-6,516**	**3,781,279**	**-21,092,773**	**-22,052,640**	**-12,490,211**	**5,275,791**	**5,414,724**	**5,298,329**	**5,150,884**	**4,958,754**	**4,741,577**	**4,629,589**	**4,509,512**	**4,351,799**
Loan drawdown	EUR	0	0	0	0	0	877,000	13,339,000	13,738,000	9,073,000	0	0	0	0	0	0	0	0	0
Grant and City Funding drawdown	EUR	0	0	0	0	0	877,000	13,339,000	13,738,000	9,073,000	0	0	0	0	0	0	0	0	0
Cash available for Debt service	**EUR**	**-620,911**	**-243,393**	**-811,930**	**1,223,671**	**-6,516**	**5,535,279**	**5,585,227**	**5,423,360**	**5,655,789**	**5,275,791**	**5,414,724**	**5,298,329**	**5,150,884**	**4,958,754**	**4,741,577**	**4,629,589**	**4,509,512**	**4,351,799**
EBRD Debt Service												32.1%	31.1%						25.3%
EIB loan repayment	EUR	0	0	0	0	0	0	0	0	0	0	1,948,789	1,948,789	1,948,789	1,948,789	1,948,789	1,948,789	1,948,789	1,948,789
EIB loan interest	EUR	0	0	0	0	0	20,610	354,686	990,995	1,527,054	1,740,269	1,740,269	1,648,676	1,557,083	1,465,490	1,373,897	1,282,303	1,190,710	1,099,117
EIB loan financial fees	EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash after Debt service	**EUR**	**-620,911**	**-243,393**	**-811,930**	**1,223,671**	**-6,516**	**5,514,669**	**5,230,542**	**4,432,365**	**4,128,736**	**3,535,522**	**1,725,666**	**1,700,863**	**1,645,011**	**1,544,475**	**1,418,890**	**1,398,496**	**1,370,012**	**1,303,892**
Discretionary Capex																			
Discretionary Capex	EUR	0	0	0	623,836	308,660	2,911,664	4,071,103	4,251,734	4,190,235	3,862,878	2,794,272	2,247,568	1,946,289	1,745,382	1,582,136	1,490,316	1,430,164	1,367,028
Cash after Discretionary Capex	**EUR**	**-620,911**	**-243,393**	**-811,930**	**599,836**	**-315,176**	**2,603,005**	**1,159,439**	**180,631**	**-61,499**	**-327,356**	**-1,068,606**	**-546,704**	**-301,278**	**-200,907**	**-163,246**	**-91,820**	**-60,152**	**-63,136**
Cash Brought Forward	EUR	0	71,000	7,000	24,000	623,836	308,660	2,911,664	4,071,103	4,251,734	4,190,235	3,862,878	2,794,272	2,247,568	1,946,289	1,745,382	1,582,136	1,490,316	1,430,164
Cash Carried Forward	EUR	71,000	7,000	24,000	623,836	308,660	2,911,664	4,071,103	4,251,734	4,190,235	3,862,878	2,794,272	2,247,568	1,946,289	1,745,382	1,582,136	1,490,316	1,430,164	1,367,028
Debt Service Cover Ratio																			
Cash available for debt service	EUR	-620,911	-243,393	-811,930	1,223,671	-6,516	5,535,279	5,585,227	5,423,360	5,655,789	5,275,791	5,414,724	5,298,329	5,150,884	4,958,754	4,741,577	4,629,589	4,509,512	4,351,799
Debt service	EUR	0	0	0	0	0	20,610	354,686	990,995	1,527,054	1,740,269	3,689,058	3,597,465	3,505,872	3,414,279	3,322,686	3,231,093	3,139,500	3,047,907
DSCR	-	N/A	N/A	N/A	N/A	N/A	268.58	15.75	5.47	3.70	3.03	1.47	1.47	1.47	1.45	1.43	1.43	1.44	1.43

Podgorica Vodovod
Podgorica Water and Wastewater Project

Balance Sheet		2007 -2 Actual	2008 -1 Actual	2009 0 Actual	2010 1 Projections	2011 2 Projections	2012 3 Projections	2013 4 Projections	2014 5 Projections	2015 6 Projections	2016 7 Projections	2017 8 Projections	2018 9 Projections	2019 10 Projections	2020 11 Projections	2021 12 Projections	2022 13 Projections	2023 14 Projections	2024 15 Projections
Fixed Assets																			
Fixed Assets	EUR	25,991,000	25,871,000	26,933,000	30,112,113	33,871,999	36,897,444	65,403,644	94,266,613	113,300,291	113,784,901	113,146,137	111,916,616	110,347,669	108,543,606	106,545,287	104,425,938	102,218,406	99,920,944
Intangible Assets	EUR	1,512,000	1,285,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000	2,455,000
Other Non-Current Assets	EUR	3,546,000	3,504,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000	3,536,000
Total Non-Current Assets	**EUR**	**31,049,000**	**30,660,000**	**32,924,000**	**36,103,113**	**39,862,999**	**42,888,444**	**71,394,644**	**100,257,613**	**119,291,291**	**119,775,901**	**119,137,137**	**117,907,616**	**116,338,669**	**114,534,606**	**112,536,287**	**110,416,938**	**108,209,406**	**105,911,944**
Current Assets																			
Inventories	EUR	699,000	510,000	483,000	545,746	566,850	577,120	586,251	613,023	641,927	753,931	807,917	871,683	917,602	966,171	1,017,622	1,070,697	1,126,880	1,186,226
Receivables	EUR	4,202,000	4,530,000	4,820,000	3,469,983	2,667,286	1,994,233	1,695,870	1,757,995	1,820,804	1,884,557	1,949,539	1,984,470	2,016,510	2,048,122	2,079,973	2,137,446	2,193,300	2,247,321
Short-Term Investments	EUR	555,000	55,000	302,000	302,000	302,000	302,000	302,000	302,000	302,000	302,000	302,000	302,000	302,000	302,000	302,000	302,000	302,000	302,000
Other Current Assets	EUR	62,000	17,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000
Cash	EUR	71,000	7,000	24,000	623,836	308,660	2,911,664	4,071,103	4,251,734	4,190,235	3,862,878	2,794,272	2,247,568	1,946,289	1,745,382	1,582,136	1,490,316	1,430,164	1,367,028
Total Current Assets	**EUR**	**5,589,000**	**5,119,000**	**5,657,000**	**4,969,564**	**3,872,795**	**5,813,017**	**6,683,224**	**6,952,752**	**6,982,966**	**6,831,366**	**5,881,729**	**5,433,720**	**5,210,402**	**5,089,676**	**5,009,732**	**5,028,459**	**5,080,345**	**5,130,575**
Current Liabilities																			
Payables	EUR	724,000	1,322,000	913,000	857,894	891,070	907,214	921,567	963,652	1,009,088	1,154,897	1,206,786	1,270,405	1,337,329	1,408,114	1,483,100	1,560,452	1,642,334	1,728,826
Other Current Liabilities	EUR	280,000	217,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000
Total Current Liabilities	**EUR**	**1,004,000**	**1,539,000**	**1,036,000**	**980,894**	**1,014,070**	**1,030,214**	**1,044,567**	**1,086,652**	**1,132,088**	**1,277,897**	**1,329,786**	**1,393,405**	**1,460,329**	**1,531,114**	**1,606,100**	**1,683,452**	**1,765,334**	**1,851,826**
Net Current Assets	**EUR**	**4,585,000**	**3,580,000**	**4,621,000**	**3,988,669**	**2,858,725**	**4,782,804**	**5,638,657**	**5,866,100**	**5,850,878**	**5,553,469**	**4,551,943**	**4,040,315**	**3,750,073**	**3,558,562**	**3,403,632**	**3,345,007**	**3,315,010**	**3,278,750**
Liabilities																			
EIB Loan	EUR	0	0	0	0	0	877,000	14,216,000	27,954,000	37,027,000	37,027,000	35,078,211	33,129,421	31,180,632	29,231,842	27,283,053	25,334,263	23,385,474	21,436,684
Long Term Debt	EUR	0	0	575,000	575,000	575,000	575,000	575,000	575,000	575,000	575,000	575,000	575,000	575,000	575,000	575,000	575,000	575,000	575,000
Tax liability	EUR	0	0	0	229,210	257,324	310,756	269,533	169,555	93,781	25,288	30,041	21,391	9,989	0	0	0	0	0
Total Liabilities	**EUR**	**0**	**0**	**575,000**	**804,210**	**832,324**	**1,762,756**	**15,060,533**	**28,698,555**	**37,695,781**	**37,627,288**	**35,683,251**	**33,725,812**	**31,765,621**	**29,806,842**	**27,858,053**	**25,909,263**	**23,960,474**	**22,011,684**
Total Assets less total Liabilities	**EUR**	**35,634,000**	**34,240,000**	**36,970,000**	**39,287,572**	**41,889,401**	**45,908,491**	**61,972,768**	**77,425,158**	**87,446,388**	**87,702,081**	**88,005,828**	**88,222,118**	**88,323,121**	**88,286,326**	**88,081,866**	**87,852,682**	**87,563,942**	**87,179,009**
Capital and Reserves																			
Shareholders Capital	EUR	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000	28,728,000
APIC	EUR	6,614,000	4,974,000	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602	7,702,602
Grants and City Funding Received	EUR	0	0	0	0	0	877,000	14,216,000	27,954,000	37,027,000	37,027,000	37,027,000	37,027,000	37,027,000	37,027,000	37,027,000	37,027,000	37,027,000	37,027,000
Retained Earnings	EUR	292,000	538,000	539,398	2,856,970	5,458,799	8,600,889	11,326,166	13,040,556	13,988,786	14,244,479	14,548,226	14,764,516	14,865,519	14,828,724	14,624,264	14,395,080	14,106,340	13,721,407
Total Capital and Reserves	**EUR**	**35,634,000**	**34,240,000**	**36,970,000**	**39,287,572**	**41,889,401**	**45,908,491**	**61,972,768**	**77,425,158**	**87,446,388**	**87,702,081**	**88,005,828**	**88,222,118**	**88,323,121**	**88,286,326**	**88,081,866**	**87,852,682**	**87,563,942**	**87,179,009**
Check	EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference	EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

8.7 Risk Analysis

8.7.1 Basis of Analysis

Base Case analysis shows that the priority investment programme is sustainable and affordable, and that the projected tariff levels are capable of realising sufficient revenues:

- To meet all operating costs, depreciation, debt servicing obligations and required performance benchmarks;
- To realise modest cash surpluses to contribute towards additional investments that are required in the long term for water supply and wastewater services

The risk analysis considers the impact of adverse changes in key parameters in the priority investment programme and examines the extent to which these can vary before creating the issues of sustainability of ViK operations. The risk analysis considers the main factors that can influence project viability:

- Projected tariff increases
- Increase in capital cost of the priority investment programme
- Reduction in Demand
- Increase in bad debt ratio
- Increase in cost of funds

8.7.2 Results of Risk Analysis

The results of the risk analysis are summarised in Table 7.9 below. It is evident that the sustainability of the ViK operations would be exposed to significant risk under the adverse impact of each of the sensitivity tests and none greater than if the projected tariff increases are not increased annually in line with local inflation. This largely results from the fact that the projected tariffs increases are just sufficient to sustain ViK operations enabling it to meet all its operating and debt service obligations. The projected increases are also within the acceptable boundary of international criteria for consumer affordability. Higher tariff increases would be feasible from the point of view of consumer affordability and sustainability of ViK operation but they may not be acceptable politically.

Table 8.9 - Results of Risk Analysis

Sensitivity		Impact	Impact
Tariff Increases	Increases reduced by 20%	If the tariff increases are reduced by 20% compared to the projected levels it would jeopardise the sustainability of operations in a relatively short time. ViK operating cash position would deteriorate rapidly and it would not be able to meet its debt service obligations. The debt service coverage ratio would fall well below 1.0 for most of the period and eventually become negative.	Vodovd would not meet its debt service obligations
Increases in Capital Costs	20% increase in priority investment costs	It is assumed that the existing financing structure would remain, with debt finance providing the increased 20% costs of the investments at the same terms and conditions and an increased counterpart contribution of 20% by the beneficiaries. This would increase the annual debt servicing costs from € 1.527m to € 1.832 in 2014 and from € 3.689m to € 4.426m in 2017. The DSCR would drop to around 1.2 and remain at that level for most of the period.	Marginal impact on debt service obligation and DSCR
Reduction in Demand	20% reduction in demand	The projections already assumes significantly reduced per capita domestic demand over the planning period as a consequence of improved metering and projected increases in tariffs. The non-domestic demand is projected to increase modestly in line with increased economic activity. However, in the case of a further 20% reduction in demand by all consumers, ViK would have difficulty in managing sustainable operations and meet all its operating and debt service obligations. Its cash position would deteriorate in a short time and consequently the DSCR would fall to below 1.0 in 2017 and to well blow 0.5 in the later years	Significant impact on cash position and on DSCR
Increase in Bad Debt Ratio	Bad debt ratio of 5% for all consumers	It was noted that ViK has made make a concerted effort to improve its collection ratio in the past few years. . The base case assumes that the collection performance improves to around 98% over the next 4 years. However, a bad debt ratio of 5% for all consumers applied in 2010 and retained at this level over the long term would still enable ViK to undertake sustainable operations and meet all its debt service obligations. The DSCR would fall marginally but it would remain around 1.3 for most of the period.	Marginal impact on cash position and on DSCR
Increase in Cost of Funds	Interest Rate increased from 4.7% to 6% per annum	There are growing concerns about inflation rates in the EU countries but there is also the desire not to increase interest rates in the near future in case the early signs of economic recovery are stalled. The overall interest rate for EIB loan, with appropriate margin, is presently assumed to be 4.7%. The risk analysis, however, examines the impact of increasing the interest rate to 6% per annum, effective immediately. This would increase ViK's annual debt servicing obligations from € 1.527m in 2015 to € 1.949m and from € 3.689m to € 4.170 in the peak year of 2017. In such a situation ViK would have only a marginal impact on its operating cash and debt service obligations. The DSCR would remain above 1.3 for the period under consideration	Marginal impact on cash position and on DSCR

8.8 Comparative Analysis of Alternative Development Options

The Base Case examined the financial implications for ViK of EIB loan commitment of € 37.028m for improvements to water supplies and construction of wastewater collectors and new Phase 1 wastewater treatment plant. The remaining 50% of the investment costs were to be provided by the beneficiaries as counterpart contribution. This section analyses the consequences for the Municipality, the ViK and the consumers of taking on debt finance and providing counterpart contribution for implementation of the Minimum Project development options. All options are summarised below in Table 8.10 below. The Long Term Project is not recommended for implementation in the short term as most of the proposed investments would not be needed for the next 15 to 20 years and consequently it is not evaluated in terms of a financial appraisal

Table 8.10 Escalated Costs of the Alternative Development Options– (€ 000)

Development Option	Total Costs	2011	2012	2013	2014
Minimum Project					
	35,885	848	11899	12,256	10,882
Base Case					
	74,057	1755	26678	27,478	18,146
Long Term Project					
	108,640	2478	36724	39599	29839

8.8.1 Loan Commitments and Counterpart Contributions for Minimum Project

The main impact of the counterpart contributions for the Municipality and the loan commitments for will therefore be as follows.

(a) Minimum Project - Debt Service Obligations

Financing Plan	€ million
Loan	17.943
Counterpart Contribution	17.943
Total	35.886

Annual debt servicing costs over this period are € 0.715m in 2014 peaking at € 1.788m in 2017 and gradually reducing to € 0.989m in the last year of repayment in 2035. Total debt servicing costs amount to € 29.391m over the 25 year period.

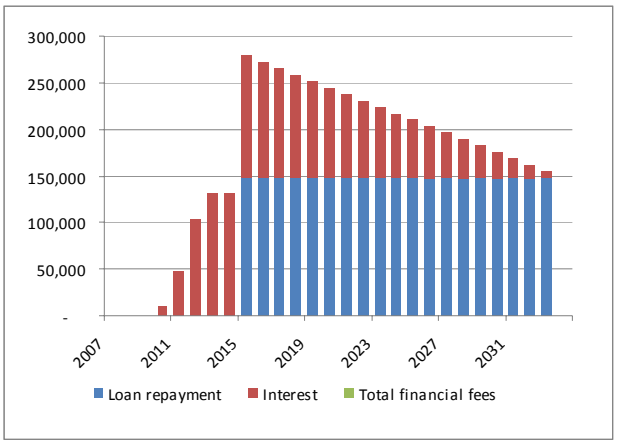


Figure 8.8: Debt Servicing Obligations for Minimum Project EUR

8.8.2 Rationale for Implementing Minimum or Long Term Project

The rationale for implementing the Minimum Project Option is weak as the lower capital investment costs result from not implementing measures aimed at operating efficiency for water supplies and not extending sewage collection network to unconnected areas in Podgorica. The benefits of constructing the new wastewater treatment plant (WWTP) are therefore not fully realised by not connecting additional consumers from these areas which also reduces the revenue stream for the ViK. Consequently, the increases in tariffs proposed for the Base Case option would have to be largely retained to make up for the potential loss in revenues from additional consumers especially as there is no reduction in the investment costs or the capacity of the new WWTP. The savings only result from not extending the sewage network. It is therefore concluded that the savings in investment costs for the Minimum Project Option are significantly outweighed by the loss in benefits both in terms of reduced pollution abatement and lower revenues from potential loss of additional customers.

The case for the implementation of the Long Term Project is also weak on the grounds that it essentially represents the long term development programme which includes extension of sewers to outlying districts and construction of phase 1 and 2 capacity of the WWTP at the same time. These investments would not be needed for the next 15 to 20 years

8.8.3 Projected Tariff Levels

The projected tariff levels which would fully recover the costs of operations including all debt service obligations and contribute to sustainability of ViK operations over the long term for the Base Case development option are shown in Table 8.11.

Table 8.11: Projected Increases in Nominal Tariff Levels (Excluding VAT - € per m3)

	Base Case Project EUR /m3		
	Water	Wastewater	Combined
2009			
Domestic	0.24	0.12	0.36
Institutional	1.15	0.57	1.72
Commercial	1.33	0.67	2.00
2014			
Domestic	0.28	0.14	0.42
Institutional	1.32	0.66	1.98
Commercial	1.53	0.76	2.29
2019			
Domestic	0.32	0.16	0.48
Institutional	1.53	0.76	2.29
Commercial	1.77	0.89	2.66
2024			
Domestic	0.37	0.19	0.56
Institutional	1.77	0.88	2.67
Commercial	2.05	1.03	3.08

8.8.4 Affordability of Water Supply and Wastewater Services

After allowing for inflation linked increases in water and wastewater tariffs, the costs of water and wastewater services remain well within the affordability boundaries for the average and potentially low income households for the Base Case Project. The analysis is based on the IMF forecast that average household incomes in Montenegro would increase by 4% per annum in real terms over the period under consideration. In such a case, the costs of water and wastewater services would remain below 1% of the average household income throughout the period.

8.8.5 Financial Position of ViK

With the projected increases in water and wastewater tariff levels ViK is shown to:

- Meet all costs of operations including depreciation
- Maintain a cash surplus;
- Meet all debt servicing obligations as they fall due; maintaining a DSCR of 1.4 or above throughout the period
- Be able to undertake some discretionary capital expenditure for essential replacements.

8.8.6 Concluding Remarks

The fact that the analysis demonstrates that ViK could undertake stable and sustainable operations and meet debt commitments for the the Base Case Project, and the projected tariff increases to remain well within the threshold of acceptable consumer affordability should not come as a surprise. The tariffs are currently above the operating cost recovery levels and the scope for increasing them in the future to full cost recovery levels in the context of significant real increases in household incomes is much greater than often realised.

It should be emphasised that without the projected increases in water and wastewater tariffs linked to the local inflation rate, ViK would not be able to meet the debt service obligations for even the Minimum Project loan commitments let alone take on the responsibility for additional debt finance for the implementation of more ambitious development options. The prospects for implementing the proposed tariff increases and sustainability of operations of ViK would ultimately depend not only on the “willingness of the consumers to pay” for improved services but it would also be determined by the “willingness of the authorities to charge”

8.9 Financial internal rate of return

The results of the FIRR analysis for the priority project are shown in Table 8.12. The bases for determining project costs and resource sources are summarised below.

8.9.1 Project costs

The financial costs are the estimated investment costs at 2009 prices allowing for the income expected in 2015 from the sale of the existing wastewater treatment plant site. The costs of house connection and decommissioning of septic tanks where existing properties are connected to the extended sewerage network have also been considered. An average cost of € 750 per house has been assumed. This amounts to a total of € 4.40 million at 2009 prices spent over the period 2014 – 2020.

Incremental operating costs have been determined from the water and wastewater operating costs (at 2009 prices) derived for the financial analysis.

8.9.2 Incremental Revenues

The incremental revenues are defined as the revenues from incremental increases in household, industry and institution water and wastewater billings plus the savings that will arise from the incremental reduction of electricity consumption for water supply and the incremental reduction in water production due to reduction of losses.

The incremental water and wastewater revenues have been calculated from the incremental billed volumes using tariffs based on the current 2009/10 tariffs (see Table 5.1 - November 2008 increase). After 2010 it is assumed that there will be no real increase in tariffs.

Incremental energy savings for the with project case have been based on a 2010 unit electricity cost of €0.12/kWh. It is also assumed that this unit cost will increase in real terms by 3% per annum after 2010.

The savings in water production costs for the with project case have been calculated from the reduction in water production and a production cost (in 2010) of €0.3/m^3. This production cost is assumed to increase in real terms by 2% per annum.

8.9.3 Summary

The FIRR analysis shows that, based on the tariff and cost assumptions above and at 5% discount rate, there is an internal rate of return of 5% and a revenue to cost ratio of 1.0.

Table 8.12: Financial internal rate of return analysis for the Priority Investment Project

Year	Project Costs, €				Revenue sources, €									Net revenue, € thousand
	Financial Costs	Cost of house connections removal of septic tanks	Incremental Operating Cost	**Total Costs**	Household water revenue	Industry water revenue	Institution water revenue	Household wastewater revenue	Industry wastewater revenue	Institution wastewater revenue	Water energy saving	Water production saving (reduction of losses)	**Total revenue**	
2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	1413097	0	0	1413097	0	0	0	0	0	0	0	0	0	-1413097
2012	20866225	0	17538	20883762	0	0	0	0	0	0	0	0	0	-20883762
2013	20866225	0	51075	20917300	93268	5600	3406	0	0	0	92473	567370	762117	-20155183
2014	13378329	565261	84613	14028203	181286	8384	5722	35404	5056	2642	184517	1118306	1541316	-12486887
2015	-10050000	570539	330620	-9148841	264685	8925	7166	70802	9518	4925	276263	1654462	2296745	11445586
2016	0	579222	343305	922527	344071	7776	7951	106297	13526	6936	367817	2177362	3031738	2109210
2017	0	616034	354952	970986	366904	7776	7951	141514	2461	6936	406794	2285939	3226276	2255290
2018	0	656861	366081	1022941	382994	7776	7951	175260	2461	6936	449602	2400355	3433335	2410394
2019	0	692841	377160	1070000	396434	7776	7951	208593	2461	6936	494600	2517559	3642310	2572310
2020	0	718410	388316	1106725	408327	7776	7951	241790	2461	6936	541386	2636773	3853402	2746676
2021	0	0	405185	405185	426007	7776	7951	249762	2461	6936	567434	2721068	3989395	3584210
2022	0	0	407175	407175	443081	7776	7951	254461	2461	6936	594592	2807488	4124746	3717571
2023	0	0	409087	409087	459163	7776	7951	258685	2461	6936	624876	2899185	4267035	3857948
2024	0	0	411699	411699	479726	7776	7951	265483	2461	6936	641269	2969607	4381210	3969510
2025	0	0	414332	414332	500298	7776	7951	272285	2461	6936	658075	3041766	4497549	4083217
2026	0	0	416985	416985	520878	7776	7951	279092	2461	6936	675306	3115705	4616107	4199122
2027	0	0	419657	419657	541468	7776	7951	285904	2461	6936	692970	3191470	4736937	4317279
2028	5495962	0	422350	5918313	562067	7776	7951	292721	2461	6936	711079	3269105	4860096	-1058216
2029	5083765	0	425064	5508829	582676	7776	7951	299542	2461	6936	729642	3348658	4985643	-523187
2030	0	0	427798	427798	603296	7776	7951	306369	2461	6936	748670	3430175	5113634	4685836
2031	0	0	430477	430477	623351	7776	7951	312999	2461	6936	768539	3514201	5244215	4813737
2032	0	0	433176	433176	643412	7776	7951	319634	2461	6936	788917	3600303	5377390	4944214
2033	0	0	435895	435895	663479	7776	7951	326272	2461	6936	809817	3688531	5513224	5077329
2034	0	0	438635	438635	683554	7776	7951	332914	2461	6936	831251	3778939	5651783	5213149
2035	-25612073	0	441394	-25170679	703636	7776	7951	339560	2461	6936	853233	3871581	5793135	30963814
Discount Rate	**Net Present Values, €**													
5%	36,344,049	2,966,042	4,099,200	43,409,290	4,941,062	90,152	86,572	2,376,722	41,818	70,249	6,094,170	29,791,431	43,492,176	82,886
												Financial Internal Rate of Return		**5.0%**
												Revenue/Cost Ratio		**1.00**

9 Economic evaluation

This Section considers the economic justification for undertaking the priority investment project. The investment programme is based on the Base Case Project and comprises improvements to the water distribution system plus a new wastewater treatment plant, two main wastewater collectors and extension of the wastewater collection system in the north and northwest of the City of Podgorica. The water components of the project are intended to improve supply pressure, improve the security of the water supply and reduce losses. One of the quantifiable benefits of the water project will be slightly reduced energy consumption and this has been taken into account in the analysis. However, most of the benefits of the water project are either intangible or very difficult to quantity. For this reason, the economic analysis in this Section considers only the wastewater components

The proposed wastewater project will address the following shortcomings of the present situation:

- The discharge of untreated and partially treated wastewater to the Moraca river. These discharges are an environmental nuisance and are adding to the eutrophication of Lake Skadar;
- The use of septic tanks in some urban areas. These generally discharge to the ground causing groundwater pollution and, sometimes, to surface channels;

After implementation of the project the following benefits should be realised:

1. Reduction of pollution loads in the Moraca river;
2. Reduction in the pollution of groundwater;
3. Reduction in resource costs to consumers/industries through no longer having to provide their own septic tank/treatment system;
4. Elimination of public health risks from discharges from septic tank overflows; and
5. Increase in industrial/commercial development potential due to the provision of improved sewerage infrastructure.

The approach to undertaking the analysis is outlined in section 9.1. A summary of project costs is provided in section 9.2 and a description of the monetary valuation of project economic benefits is given in section 9.3. The main conclusions of the evaluation are presented in section 9.4.

9.1 Approach to the Economic Evaluation

9.1.1 Objectives of the Evaluation

The fundamental aim of the economic evaluation is to establish whether the proposed project's contribution to future improvements in social and economic welfare of the community is of greater value than the resource costs incurred by the national economy. The basis for establishing project viability is the comparison of the "with project" scenario against the "without project" scenario. The "with project" option is represented by the implementation of the proposed priority investment programme. The "without project" scenario is taken as the continuation of existing situation. Other factors such as the environmental and social impact of the proposed project are also taken into consideration in assessing its viability. However, many of these benefits and costs cannot be readily quantified in monetary terms.

9.1.2 Opportunity Cost of Capital

The project is fundamentally for social and environmental purposes. The opportunity cost of capital used in the analysis therefore takes an appropriate rate for the provision of

social infrastructure. This is assumed to be 5%. The rate takes into account the economic welfare of the proposed investment for the provision of essential economic infrastructure that primarily produces environmental, health and social welfare benefits. The criteria used to judge the economic viability of the project are therefore the economic net present value at a discount rate of 5% and the economic internal rate of return.

9.1.3 Economic Pricing

Project capital and operating costs have been derived using local rates and separately show allowances for taxation and price contingencies. These transfer elements, which do not represent resource costs to the national economy, are not considered in the economic costs. For the purpose of converting financial prices into economic resource costs a standard conversion factor of 0.95 has been used which is largely attributable to a labour conversation factor to take account of the relatively high unemployment in Montenegro.

9.2 Costs of the Proposed Project

9.2.1 Capital Cost

The cost of the Base Case wastewater project including the wastewater treatment plant is € 43.39 million at 2009 prices including physical contingencies but excluding VAT and price escalation. The overall investment will be phased with construction from 2012 to 2014. It is assumed that the completion of the new WWTP will allow the existing WWTP to be decommissioned and, after clean up of the site, the land to be sold for residential and commercial development. The area of the existing WWTP site is approximately 4.02 hectare and the net value of the land (after deduction of clean up costs) is assumed to be €250 /m^2.

It is also necessary to consider the costs of house connection and decommissioning of septic tanks where existing properties are connected to the extended sewerage network. An average cost of € 750 per house has been assumed. This amounts to a total of € 4.40 million at 2009 prices spent over the period 2014 – 2020.

9.2.2 Operating Costs

The provision of a new larger wastewater treatment and new wastewater sewers will lead to an increase in the present costs for the operation and maintenance of the existing wastewater system. The incremental operating and maintenance costs attributable to the project start at € 0.018 million in 2012, increase to €0.331 million in 2015 when the new WWTP becomes fully operational, and reach € 0.425 million per year by 2029 (all in constant 2009 prices).

9.3 Project Benefits

In considering the environmental and economic benefits arising from the priority investment project the following particular impacts of the investment need to be considered:

- the contribution of the project to the overall implementation of European Union environmental legislation and the attendant benefits which this brings;
- the reduction in the pollution of the rivers and groundwater resources;
- increase in industrial/commercial development potential due to the provision of sewerage infrastructure; and
- reduction in resource costs to consumers/industries through no longer having to provide their own septic tank/treatment system.

9.3.1 Compliance with the acquis and improvement of the environment

The current situation in Podgorica city does not comply with the requirements of European Union environmental legislation. In particular, the absence of a full collection system for wastewater and associated full treatment is in direct non-compliance with the Urban Waste Water Treatment Directive (91/271/EEC) which requires all agglomerations with more than 2000 population equivalent to be provided with wastewater collection systems and secondary treatment of collected wastewater. Since Podgorica is over 100,000 p.e. and discharges to what must be considered as a sensitive area, it should also have Nitrogen and Phosphorus removal to 10 and 1 mg/l respectively.

The benefits of implementation of European Union environmental legislation in the recent accession countries were assessed on behalf of the European Commission by Ecotec. The benefits arising from the implementation of the Urban Waste Water Treatment Directive include health benefits from reduced water contamination, ecosystem benefits and resource benefits.

The benefits identified in the Ecotec report 'The Benefits of Compliance with the Acquis for the Candidate Countries' for Bulgaria, Czech Republic, Hungary, Romania, Slovakia and Slovenia include:

- Non-use values associated with general improvements in the environment;
- Use values associated with improved quality of water which, in this instance, are fishing, swimming, and general enjoyment of the Moraca river by the residents of Podgorica.

(a) Non Use Benefits

The Ecotec report approaches the quantification of benefits by assigning a single value to the use benefits associated with achievement of compliance. This approach is followed here. The willingness to pay figures for use valuations are in the region of 10 euros per capita per year for the lower income countries such as Montenegro. This valuation figure has been used for this analysis based on a present population in the Municipality of approximately 181,150 and a projected population in 2029 of 220,100.

(b) Direct benefits to recreational users

Willingness of recreational users to pay for water quality improvement has been studied for various locations in Europe and the most appropriate results for use in Montenegro are considered to be from the willingness to pay estimate for Lake Balaton (Mourato, 1999). This study estimated the benefit at € 22.5/person/year at 1999 prices and, taking account of real price increases since 1999, the 2009 value of the benefit can be taken as € 30/person/year. It is assumed that 20% or the Municipality population will benefit through direct use of the Moraca river in one form or another.

9.3.2 Increase in industrial/commercial development potential

The provision of an effective wastewater collection and treatment system is an important element in the strategy to attract high quality industrial/commercial development. Attraction of such development will directly benefit the city of Podgorica and the residents of Podgorica. One method for evaluating this benefit is to assume that the availability of a municipal sewerage system in the "with project" scenario increases the value of economic rent for the development land compared to the "without project" scenario. A modest increase in the value of economic rent for land of € 10.00/m2 can be taken for the analysis and it is assumed that land for the developments will be rented/ leased at a rate of 10 ha/year from 2014 onwards.

9.3.3 Reduction in Resource Costs to Consumers

The extension of wastewater collection in the town will enable septic tanks and private wastewater connections to be gradually taken out of service with a consequent reduction in costs to households. A more detailed economic analysis would require a survey of consumer willingness to pay to for the improved services and analysis of consumer surplus. However, this is outside the scope and the context of the present study. The approach adopted is to use resource costs savings in not having to construct and maintain the septic tanks or direct connections and subtract the real tariffs paid by the consumers for the wastewater services, thus giving net savings in resource costs to the economy. It has been estimated that the cost for maintaining and emptying a household septic tank is €190/year. Direct wastewater connections cost considerably less to operate than a septic tank and there is a significant resource cost saving even after deducting wastewater tariff charges. The number households who would be able to stop using septic tanks permanently will increase from 750 per year in 2014 to a peak of nearly 5,900 per year in 2020 and remain at that number afterwards.

9.4 Conclusions

The main economic benefits attributable to the project are:

- Non Use Benefits From Compliance with UWWTD

The annual benefits are evaluated as € 1.930 million in 2014 rising to € 2.201 million by 2029 using the method described above.

- Direct Benefit to Recreational Users

As described above, this benefit can be evaluated at € 30/person/year and assuming that 20% of the Municipality population would use the river facilities each year, this equates to an annual benefit of € 1.158 million (at 2009 prices) in 2014 increasing to € 1.321 million by 2029.

- Increase in Development Potential

This benefit has been estimated as explained above and amounts to € 1.000 million per year.

- Resource Savings to Consumers

The resource saving to consumers as a result of cessation of use of septic tanks is estimated to be € 0.119 million in 2014 rising to € 0.926 million in 2020 and continuing at that level afterwards.

9.4.1 Justification for the Project

Benefits from implementing the project exceed costs and therefore provide economic justification for its implementation. The base case project investment programme will ensure the improvement of wastewater services and river quality as well as a reduction of groundwater contamination. The project will also provide related benefits including increased development potential. In the absence of the project, environmental conditions in Podgorica city would deteriorate, inhibiting development and causing increased pollution of rivers, streams and groundwater.

The project is shown to realise a relatively modest rate of economic internal rate of return (EIRR) of 9.8% (see Table 9.1) and a benefit cost ratio of 1.36. However, it must also be remembered that there are intangible benefits in addition to those quantified and these further justify the project. The EIRR remains above 5% if the there is a 25% reduction in benefits or a 15% increase in capital investment costs. The project is therefore considered to satisfy economic viability criteria.

Table 9.1: Benefit/Cost Analysis for the Priority Project

Year	Project Costs, € thousand				Project Benefits, € thousand					Net Benefits, € thousand
	Economic Costs	Cost of house connections removal of septic tanks	Incremental Operating Cost	**Total Costs**	Direct benefit to recreational users	Contribution to UWWTD compliance, non use benefit	Increase in development potential	Resource cost saving to consumer	**Total Benefits**	
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0
2012	13740	0	18	13757	0	0	0	0	0	-13757
2013	13740	0	51	13791	0	0	0	0	0	-13791
2014	13740	565	85	14390	1158	1930	1000	119	4207	-10182
2015	-10050	571	331	-9149	1172	1953	1000	239	4364	13513
2016		579	343	923	1185	1976	1000	361	4522	3599
2017		616	355	971	1198	1997	1000	490	4686	3715
2018		657	366	1023	1209	2015	1000	629	4853	3830
2019		693	377	1070	1219	2032	1000	774	5026	3956
2020		718	388	1107	1229	2049	1000	926	5203	4097
2021			405	405	1239	2065	1000	926	5230	4825
2022			407	407	1249	2082	1000	926	5256	4849
2023			409	409	1259	2098	1000	926	5283	4874
2024			412	412	1269	2115	1000	926	5310	4898
2025			414	414	1279	2132	1000	926	5337	4923
2026			417	417	1290	2149	1000	926	5364	4947
2027			420	420	1300	2166	1000	926	5392	4972
2028			422	422	1310	2184	1000	926	5420	4997
2029			425	425	1321	2201	1000	926	5448	5022
Discount Rate	**Net Present Values, € million**									
5%	26,439	2,966	3,269	32,674	10,986	18,309	8,916	6,129	44,340	11,666
									Economic Internal Rate of Return	**9.8%**
									Benefit/Cost Ratio	**1.36**

10 Environmental review of proposed development

10.1 Overview

This section discusses the issues identified in the assessment of the existing environmental situation (Section 4) and the way in which these issues are addressed by the long term investment programme, and by the priority investment project. It also discusses the potential environmental health and safety issues arising from implementation of the proposals.

The technical and economic studies identified two main water supply project options and one wastewater system modernization project and these are the focus of the Environmental Analysis. They are described in detail in Sections 6 and 7 of this report.

10.2 Environmental review of proposals

This section discusses the issues identified in the assessment of the existing environmental situation (Section 4) and the way in which these issues are addressed by the long term investment programme, and by the priority investment project. It also discusses the potential environmental health and safety issues arising from implementation of the proposals.

10.3 Approach

The environmental aspects of the proposed investment programme have been analysed and the following tasks completed:

- Identification of the key adverse and beneficial environmental impacts for each project component;
- An outline of how environmental issues should be taken into account during detailed planning and design stages;
- Identification of areas where further work is required to support the effective implementation of the investment;
- Identification of regulatory compliance issues and permit approval procedures for the project;
- Identification of areas of additional work which could build on the environmental and health benefits of the project.

10.4 Environmental review of proposal

It is of key importance that a wastewater collection system is completed within the municipality of Podgorice as soon as possible so as to reduce the risk of environmental pollution to the surface water and groundwater.

The Priority Investment Project will include construction of a new sewerage system and wastewater treatment plant for the town (Base Case Scenario) and construction of new water supply reservoir Vrsak and improvement to the existing water reservoir Ljubovici.

The following options have been considered; a base case, minimum case, and full project, as indicated in the Table 10.1 below.

Table 10.1: Options considered in the Study

Components	Minimum Case	Base Case	Maximum Case
Reduction in Water Losses	Yes	Yes	Yes
Mains Replacement Programme	NA	NA	Yes
New Vrsak reservoir and pipelines			
20,000 reinforced concrete reservoir	NA	Yes	Yes
800/700mm x 8000 pumping main from Mareza	NA	Yes	Yes
800mm x 1700m outlet pipeline	NA	Yes	Yes
Repairs and improvements to existing Ljubovic reservoir			
Seal existing concrete reservoir	NA	Yes	Yes
Replace valves and fittings	NA	Yes	Yes
New 800mm x 1700m supply pipeline	NA	Yes	Yes
New Gorica reservoir and pipelines			
10,000 reinforced concrete reservoir	NA	NA	Yes
400mm x 1100 inlet main	NA	NA	Yes
500mm x 900m outlet pipeline	NA	NA	Yes
Collectors			
Connected population equivalent	132,500	164,900	196,700
33.1 km of primary collectors for Zones I and II to maximise ncrease in connected population, minimise groundwater contamination	5.6 km	33.1 km	47.9 km
51.1 km (50%) development of secondary collectors in zones I and II	0 km	51.1 km	96.7 km
Sewage pumping station	Yes	Yes	Yes
New WWTP			
Phase I conventional activated sludge WWTP with anaerobic sludge digestion and CHP generation	200,000 p.e.	200,000 p.e	275,000 p.e.
Existing WWTP			
Existing WWTP taken out of service on commisioning of new WWTP	Yes	Yes	Yes
Existing WWTP site well situated for redevelopment, decommissioning and clearance cost passed to developer	Yes	Yes	Yes
Sludge disposal			
Thickening and mechanical dewatering of digested sludge to 30% dry solids, 35,000 T/y	Yes	Yes	Yes
Non-agricultural use of sludge for soil conditioning and fertilisation	Yes	Yes	Yes

The direct and indirect effects of all components of the development have been assessed with regard to the following aspects:

- Human beings,
- Fauna and flora,
- Soil, water, air, climate and the landscape,
- Material assets and cultural heritage
- Interaction between the above factors[23]

As construction of new reservoir at Gorica hill is not considered a priority and no detailed description of its location on the hill was available at the time of this review, the environmental assessment of this component will need to be undertaken at later stage of the design. The main issues are however determined below.

(a) Human Beings

Potential impacts comprise the following:

- Socio-economic impacts (labour, land purchase and compensation, welfare, severance)
- Nuisance due to noise, odour, dust, light pollution, wind-blown litter, pests and vermin
- Traffic & access and associated disruption
- Health & safety

Socio-Economic Considerations

The socio-economic impacts of the project are considered to be moderately positive. The proposed upgrading of the existing sewerage network and construction of the WWTP, as well as upgrading of water supply system (construction of new reservoir and network extension) will result in local employment opportunities during the construction phases and to a lesser extent during the operational phase. Nevertheless, the impact is likely to be positive.

The impact of tariff changes is assessed elsewhere in this report.

Nuisance Impacts

WWTP

The proposed WWTP site has significant advantages in relation to minimising potential nuisance impacts, in that it is located in a valley floor, with only a few allotments located at a distance of approximately 100m south –west from the site. These developments could experience some negative impacts from the WWTP (mainly odour and, to minor extent, noise). The prevailing wind is either from

[23] Interaction between the different impacts is limited, and this aspect has not therefore been treated separately in this review

the northeast or north therefore the residential houses could be affected. It is understood that the proposed WWTP will generate almost no noise and odour in comparison with other types and it is likely that the nuisance will not be significant. Further, those sites are already impacted by the particles of red mud and other contaminants carried with the wind from the KAP Aluminium Plant. “Center for Eco-toxicological Research” CETI has disclosed information that inhabitants of those dwellings are to be relocated due to the health risks causes by such air contamination. If those dwellings were not relocated, the compensation to the owners of those properties would be envisaged as required.

The site of the proposed WWTP can be seen from the:

- road to north
- KAP Aluminium Plant manufacturer located 100m north west of adjoining the site (will be partially screened by the shrubs)
- from the residential properties located ca 100m south - west of the site

As the WWTP will be located on already degraded land the overall visual impact will be positive. The site will become more attractive and will partially screen the views on KAP facilities. Construction of the screening belt (buffer zone) with appropriate landscaping will further enhance the visual impact of WWTP.

Considerations similar in respect of both noise and odour apply to pumping stations.

Water supply reservoirs

Detailed description of the sites is presented in Chapter 6. Key points for and against construction of the reservoirs are presented below.

Vrsak hill is to be located in Southern City. New reservoir would be sited on open flat area on west side of hill. It is well placed for supplying city centre and southern area of Podgorica.

Ljubovici reservoir extension will eliminate the existing health path public amenity which is environmentally less favourable. With either option thorough surveys, consultation, careful planning, responsive design and good construction practices should avoid or substantially mitigate many potential long term impacts and minimise disturbance from construction activities. Reinstatement of soils will be a key factor, and will be addressed in the Contract Documents

Figure 10.1 Vrsak Hill- potential site for proposed water reservoir

Figure 10.2 Ljubovici Hill – view from the existing water reservoir towards the health path

Gorica Hill is located within City centre and it is widely used by the inhabitants of Podgorica as a health path public amenity, it is a popular place for walks and recreation. Construction of the reservoir would cause mainly construction impacts, whereas the impacts resulting from the operation of the reservoir would be considered negligible. Reservoir would be visually noticeable to the recipients; however careful landscaping and placing of the reservoir would offer room for mitigation of such impact. There are protected flora species found on Gorica hill, the ecological survey would need to be conducted prior to construction of the reservoir at this location

Figure 10.3 Gorica Hill – potential site for proposed water reservoir

Some degree of disruption will arise in the course of the proposed construction work. This will have a temporary negative impact on visual amenity and, in some instances on traffic.

However it is also of importance to note that the project provides the opportunity to enhance the existing landscape and visual amenity. Improvements that are being considered, while still maintaining the existing landscape, include clearing the area from rubbish and debris and planting an appropriate tree/shrubs belt.

Some degree of disruption will arise in the course of the proposed construction work. This will have a temporary negative impact on visual amenity and, in some instances on traffic.

However it is also of importance to note that the project provides the opportunity to enhance the existing landscape and visual amenity. Improvements that are being considered, while still maintaining the existing landscape, include appropriate tree/shrubs belt, water reservoirs design and fitting into the current landscape.

Visual amenity is unlikely to arise an issue in respect of the water supply pipelines, wastewater collection and transport constructions associated with the priority investment plan, since the majority of the assets will be underground.

(i).1 Odour

The impact during construction of pipelines and new water reservoir is assessed as negligible.

The likelihood of odour nuisance from the WWTP and sewage pumping stations to the residential properties, is remote. However, it is possible that odour impacts may be detected, depending on meteorological conditions and site operation. Odour is likely to be negligible to passing traffic. The scale and nature of this impact was not considered sufficient to require further detailed investigation, but should be subject to mitigation as discussed below.

(i).2 Noise

Construction work will result in significant, but temporary increase in noise levels. This needs to be addressed via adequate mitigation measures.

Noise from the waste water treatment plant and sewage pumping stations is not considered a significant problem in view of the type of plant and pumping stations proposed, the local industry (KAP Aluminium Plant), road traffic and the number of receptors. Modern aluminium plants are not excessively noisy; however the level of noise from their operations is still considered higher than the noise from operation of the WWTP, especially that the mechanical plant at the treatment plant will be housed. It is therefore concluded highly unlikely that noise nuisance will be significant.

Traffic, access and associated disruption

The sewers and water supply pipeline being laid within the boundaries of the town will result in a significant level of disruption, which will present a moderate negative impact. Adequate mitigation measures will need to be adapted.

The access to the WWTP site will be via the existing road as shown below. This road is not heavily used, but vehicles using the road already include heavy commercial vehicles such as logging wagons and trucks. The additional traffic which will arise during the construction phase will result in a significant local increase in traffic volumes which will present a minor negative impact. However this impact can be mitigated as described below. Once operational the likely traffic movements will be low. Apart from the movements of personnel coming to and from the site, a small number of vehicle movements will arise from tankers bringing septage to the site and tankers removing sludge from the site.

Figure 10.4: Road which will be used as access road to the new WWTP

Additional traffic that will arise during the construction phase will result in a local increase in traffic volumes on mains roads in Podgorica, which will present a minor negative impact. This impact can be mitigated as described below. Once operational, the likely traffic movements will be low. Apart from the movements of personnel coming to and from the site, a small number of vehicle movements will arise from tankers bringing septage to the site and tankers removing sludge from the site.

Health & Safety

During the operational phase of the project health and safety issues for the population relate mainly to potential contamination of air and water as discussed below. During the construction phase of the project a wider range of health and safety issues arise, particularly from the construction of new underground infrastructure in the town centre. Measures will include traffic control and road safety issues. The application of construction codes of practice and other similar measures will be incorporated into the project specification so as to minimise the adverse impact of these works.

(b) Flora and Fauna / Biodiversity

The closest internationally significant Nature Protection site is Skadar Lake (Ramsar Site). Due to the decrease in volume of untreated effluent discharged to the Moraca river which flows into the lake, the organic load to the lake will decrease which will prevent the lake from eutrophication.

A site reconnaissance of the WWTP site and surrounding area indicated that there has been little recent management of the site, and flora remains relatively undiversified.

The project will not result in significant land take (for WWTP, pumping stations and Vrsak reservoir site), and therefore no significant impacts on terrestrial biodiversity are expected.

(c) Soil, Geology, Hydrogeology

Land take associated with the wastewater treatment site and Vrsak water reservoir will not be extensive, impacts at those locations on soil resources are considered to be minor. However, negative impacts could arise in green areas of the town in the course of excavations for underground assets. In accordance with good practice, top soil from these excavations will be required to be conserved and reused for backfilling and reinstatement.

The proposed WWTP site is not at risk from flooding of the Moraca and no river protection is required.

The site for proposed WWTP is located in close vicinity to the land contaminated with heavy metals, PCB's, red much. No tests were available for the site itself during the time of the study. It is recommended to perform the contaminated land assessment prior to commissioning of any work on the site. The construction of th WWTP offers a opportunity for soils rehabilitation which is considered beneficial.

(d) Air Quality and Climate

Air Quality

Apart from emissions at WWTPs, the operation of water supply and wastewater systems do not generally give rise to significant emissions to air other than those associated with energy use.

In the construction phase the main sources of pollution will be from traffic and construction dust. Neither impact is considered to be major, but mitigation measures should be employed. Traffic will comprise delivery of materials, construction equipment and construction workers. It is however considered that traffic will have a negligible effect on air quality in the town given the existing levels of pollution arising from other sources – i.e. existing traffic.

Dust can arise from vehicle movements and material stockpiles. However, the scale of works is such that this should not be significant. Any excavated material is likely to be wet so large amounts of wind-blown dust are not anticipated. This consideration will be of particular importance during construction works within the urbanized areas of town.

(e) Waste Management

Waste arising from both the implementation phase of the project and the operational phase of the project needs to be considered.

As part of the construction and demolition works, waste will be generated and will need to be disposed of. In some areas of the town this could possibly include contaminated soil. Arrangements for identifying such waste and its safe removal and disposal will need to be determined.

Other than possible areas of existing contaminated land, the majority of waste which will occur during the construction phase will be inert, which can be used for infill or site roads at the wastewater treatment plant site. Other materials which are not suitable for such use, including broken pipes and fittings will need to be separated and disposed of, as appropriate, to the existing landfill.

During the operational phase of the project the main generator of waste will be the wastewater treatment plant. This will generate:

- Screenings and contraries from the screens
- Grit, sand and grease from the traps
- Stabilised and dewatered sewage sludge

The first two items are of low volume, but will need to be disposed of to landfill. Given that these items are usually associated with oils, greases, pathogens and other potentially harmful contaminants they should be disposed of to a sanitary landfill.

The disposal of sewage sludge presents a different problem as its disposal to landfill cannot be considered a sustainable solution. The alternative uses, such as agriculture or composting need to be considered (discussed in detail in Section 6).

(f) Water

The main impact of the project will be the improvement of the water environment. This is discussed in more detail below.

The Priority Investment Project (Base case) includes provision for the construction of a new sewerage system, including the main collector network and part of the secondary sewer network (see Table 10.1). This will have a significant positive environmental impact as it will eliminate the use of the septic tanks and leakages.

The elimination of untreated discharges by constructing a WWTP will have significant environmental benefits. The improvements to the water quality of the Moraca will clearly have positive impacts downstream – on Skadar Lake.

(g) Groundwater quality

Figure 10.5: location of the KAP Aluminium Plant wells upstream of the proposed WWTP site (white structures encircled on the photo below).

Whilst quantitative analysis of the impact of the project on groundwater quality has not been possible, it is clear that the project will have a positive impact on groundwater quality. Firstly, the improvements to the sewerage system including eradication of septic tanks and construction of the sewage system will substantially

reduce the pollution of shallow groundwater by elimination of infiltration and inflow between sewage and groundwater. Moreover, in reducing the level of pollution in the local rivers the state of the shallow aquifer will also be improved.

The impact of the construction of the new WWTP on the existing KAP water supply wells has been studied. As the WWTP will be constructed downstream from the wells (site directly adjacent to the north and northeast of the WWTP site boundary) and the groundwater's movement is from north and northwest to south and south-east it will not pose significant impact to the groundwater

Residual issues which will remain and will need to be addressed over time include the eradication of fly tipping of solid waste.

(h) Material assets and cultural heritage

The construction of the water supply pipelines and reservoirs as well as wastewater treatment plant and the sewer network and associated works within the town has the potential to uncover buried remains of archaeological interest. Although no documentary evidence is currently available concerning the likelihood of this occurring it is well known that there are a number of archeological remains within the municipality boundary. Therefore the potential for such remains being encountered cannot be ruled out.

Concerning the proposed wastewater treatment plant site, current information suggests that the proposed site has only been used for agricultural purposes and later was left idle as located in too close vicinity to KAP Aluminium Plant. No evidence has come to light to suggest that there are any historic remains at the site. It is not therefore proposed that any pre-construction excavations be made for archaeological purposes.

10.4.2 Mitigation measures

Implementation and Construction

The detail to which mitigation measures can be specified at this stage is constrained by the outline nature of the current design. The detailed design stage will need to address these mitigation matters in correspondingly greater detail. However, it is clear that the detailed design process will need to address the following:

- Landscaping, including:
  - The removal of solid waste deposits from the river beds
  - Planting indigenous tree and shrubs species including hawthorn and similar to screen the WWTP from the nearest residential receptors located 100m from the site and other recipients including the users of the adjacent road.

During the construction phase there are a number of potential impacts which need to be mitigated. Works in the Podgorica itself will need to be organised and planned to:

- Minimise the risk of groundwater contamination which may arise from the disturbance of existing wastewater collection systems
- Minimise the level of traffic disruption in the town by careful scheduling of the works and the provision of advanced warnings of works, signage, diversions and alternative route provisions
- Restrict work to standard working hours to reduce noise nuisance; particular care should be taken in the vicinity of sensitive noise receptors including the medical points and schools in the town
- Follow health and safety provisions including the application of good construction practice. Conditions requiring the application of good construction practice including the potential for fines to be imposed for breaches of such should be incorporated into the works contracts - especially protection of the deep excavations needed for sewer lines.
- Include dust suppression techniques in the list of appropriate practices to be adopted
- Include provision in the works contracts to take account of the potential for archaeological remains to be discovered in the course of excavations. A set procedure whereby works are suspended pending an expert assessment by local museum personnel upon discovery of such remains will be required.

Other considerations in respect of implementation should include the provision of information to the public, in particular:

- Providing information about the project to the population so that they understand what is happening and the purpose of the works, so that the population is aware of the long-term benefits which will result from any short-term negative impacts.
- Provision of information concerning the risks and damage which arises from miss-connection of surface and foul water pipes
- Provision of information concerning the disposal of hazardous household liquid wastes to sewers such as solvents, paints, oils, used chemicals and similar

Podgorica municipality and the ViK may wish to consider delegation of these tasks to a specific member of their staff.

Operation

The efficient and effective operation of the wastewater treatment plant in the short, medium and long term is essential to ensure its proper functioning and to achieve the environmental benefits outlined above. This will require operational staff to be thoroughly trained and for adequate management, health and safety and environmental procedures to be put in place. It is advisable that ViK, after completion of the sewage system and construction of the WWTP should adopt a programme for the implementation of an environmental management system such as ISO 14001 in order to adequately manage the whole operation of the company.
Although well trained and competent staff will be capable of operating the site, their jobs will be made considerably easier, and the process thereby made more reliable if there are operational monitoring devices and procedures in place which are capable of detecting operational abnormalities and alerting staff to the problem. Continuous monitoring of process parameters devices for continuous monitoring of indicators of effluent quality are becoming increasingly available and should be employed at the site.

The potential level of environmental risk associated with the various components of the aspects of the proposed water supply investment options are summarised briefly in Table 10.2 below.

Potential sources of environmental impacts	Potential adverse impact Rating: Negative: High, Medium to Low, Negligible; Positive: High, Medium to Low, Negligible. During construction [C]; Operation [O]											
	Receptors											
	Natural resources				Socio/cultural/economic					Sustainability		
	Protected/ important habitats /species	Landscape character	Water resources/ quality	Soils/ geology	Cultural heritage	Public health target beneficiaries	Community disruption/ nuisance	Land use - cultivation/ grazing/forestry	Disruption to other water users	Energy efficiency	Resource use	Waste material land generated
Option 1	C/O	C/O	C/O	C	C	O	C/O	C/O	C/O	O	C/O	C
Pipeline from Mareza to Vrsak, construction of Vrsak reservoir	Design to take account of further surveys to identify any sensitive and valuable species/habitat likely to be affected on the reservoir site, along pipeline and access roads - for example; detailed design of structures, location of structures, maintaining a minimum flow, design and alignment of access road and construction access and pipeline - of particular importance will be management of construction works to minimise damage and ensure good reinstatement of soils and land use/habitat				Potential damage to archaeological remains from any ground works in undisturbed area	Benefits from continuous, safe and reliable water supply	Local disruption of access and urbanized area near to the route but will be temporary and good practice and consultation can minimise nuisance	Disruption to land and access during construction of pipeline and reservoir- good reinstatement should minimise long term effects also losses from provision of permanent access road	Potential impacts on water users: downstream of source impacts expected to be insignificant but should be confirmed	Pipeline diameter optimised to provide least cost transmission capacity	Surface water source - no concern over sustainability and impact downstream unlikely but needs to be confirmed. Materials required for new structures	Waste materials from pipeline and reservoir construction
Option 2	C/O	C/O	C/O	C	C	O	C/O	C/O	C/O	C/O	C/O	C
Pipeline from Mareza to Ljubovici, extension of Ljubovici reservoir	Design to take account of further surveys to identify any sensitive and valuable species/habitat likely to be affected on the reservoir site, along pipeline and access roads - for example; detailed design of structures, location of structures, maintaining a minimum flow, design and alignment of access road and construction access and pipeline - of particular importance will be management of construction works to minimise damage and ensure good reinstatement of soils and land use/habitat				Potential damage to archaeological remains from any ground works in undisturbed area	Benefits from safe and reliable water supply	Local disruption of access and settlements near to the route but will be temporary and good practice and consultation can minimise	Disruption to land and access during construction of pipeline and extension of the reservoir- good reinstatement should minimise long term effects. permanent access road already exists	Potential impacts on water users: - downstream of water intake impacts expected to be insignificant	Pipeline diameter optimised to provide least cost transmission capacity	Surface water source - no concern over sustainability and impact downstream unlikely but needs to be confirmed. Materials required for	Waste materials from pipeline and extension of the reservoir construction

				nuisance. Public health path amenity will be eliminated permanently. New area under a health path will need to be designated		but should be confirmed		new structures	

Table 10.3 summarises the identified potential impacts of construction of the WWTP and sewage network by receptor group. Impacts are classed as temporary or permanent, and as positive (✓), negative (✘) or neutral (⭘). The scale or significance of impacts has also been characterised as low moderate and high. All evaluations represent the impacts prior to mitigation.

Element	Description of effect	Duration	Impact Direction	Scale of Impact	Comments	Description of mitigation measure required
Land Use	Land take	Permanent	⭘	0	Removal of land from current use	N/A
Community and Socio-economics	Disruption and loss of amenity	Permanent	✓	Moderate	Strongly positive due removal of pollution from private and public land within the urban areas	N/A
	Tariff changes	Permanent	⭘	0	Significant increase in tariffs, however it will still be affordable by the local community	N/A
	Support of the socio-economic climate	Permanent	✓	Low	Employment opportunities in water and wastewater sector	N/A
	Public Health	Permanent	✓	M	Benefits from more reliable system less prone to contamination. Removal of sewage pollution from urban areas	N/A
Ecology	Disturbance of habitats	Permanent	✘	Low	Fauna and flora not diversified, relatively small land take, with surrounding area of similar characteristics	Specification of standards of workmanship in the contract, and careful supervision of the work to minimise disruptions
	Improvements in water quality leading to improvements in fish habitat	Permanent	✓		Water quality improvements will lead to recreation of fish habitats along the perennial rivers,	N/A

Element	Description of effect	Duration	Impact Direction	Scale of Impact	Comments	Description of mitigation measure required
Landscape and Visual	Site clearance, construction, operations and construction traffic	Temporary	✘	Low	Construction phase – impacts connected with excavation works, reduced to the vicinity of the pipe routes WWTP - Mainly viewed from the road. Currently site is left idle.	Specification of standards of workmanship in the contract, and careful supervision of the work to minimise disruptions and to ensure quality of workmanship and reinstatement of pipe trenches Construction of the screening belt with appropriate landscaping will minimize the visual impact of WWTP
	Change to landscape character of site due to removal of vegetation, construction of new WWTP and provision of additional planting	Permanent	✓	Very Low	There Is a potential of enhancement through proper landscaping and planting native plants (tree belt around the WWTP plant)	N/A
	Visual impacts for communities	Permanent	✘	Low	Mainly views from the road and nearest households and KAP Aluminium Plant	Screening, proper landscaping, as above.
Cultural Heritage	Disturbance of potential remains through construction of WWTP and pipeline	Permanent	✘	Very Low	Potential damage to archaeological remains from any ground works in undisturbed areas – this is thought unlikely in the case of the WWTP, but may be more applicable in the vicinity of the town	Construction specification to warn of possibility of encountering archaeological remains, and to specify appropriate action when encountered + Close supervision.
Geology, Groundwater, Hydrogeology,	Mobilisation of contaminants during construction	Temporary	✘	Low	WWTP Site now idle, sit close to existing aluminium plant which soils are provent to be contaminated by heavy metals, PCB's, red mud particles	Construction contract to specify removal of any hazardous material to approved site for disposal + Close supervision.
Energy Efficiency, material use	Reduced leakage, upgraded system	Permanent	✓	Moderate	Benefits from upgraded system /reduced leakage etc. Wherever possible materials will be recycled (overburden). All wood will come from a sustainable source. All plants used will be native non-invasive species	N/A
Reduced groundwater contamination	Reduction in interaction between groundwater and wastewater collection system	Permanent	✓	High in urban area	Reduced risk of groundwater contamination by discharges from septic tanks	N/A

Element	Description of effect	Duration	Impact Direction	Scale of Impact	Comments	Description of mitigation measure required
Hydrology and Flooding	Protection from flooding	Permanent	⊙	Moderate	WWTP site is properly protected	N/A.
Traffic and Transport	Traffic delays due to construction traffic and during construction	Temporary	✘	Moderate	Could be significant at height of construction works	Construction specification to avoid traffic disruptions + Close supervision.
	Increased traffic, congestion and associated effects	Permanent	✘	Very low	Likely to be negligible	N/A
Local Air Quality	Release of dust	Temporary	⊙	Low	The release of dust during construction of pipelines needs to be controlled. Dust levels in the town are already high and their further elevation should be avoided where possible	Construction contract to include clauses to minimise impact of dust to maintain roads in a clean condition+ Close supervision
Local Air Quality	Emissions from oxidation processes and gas engines	Permanent	✘	Low	The WWTP site is 100 m from the nearest receptor, residential dwellings and an industrial premises of KAP.	Proper process design of the WWTP, and close supervision and monitoring during operation of the plant.
Climate change	Greenhouse gas emissions	Permanent	✘	Very low		Proper process design of the WWTP, and close supervision and monitoring during operation of the plant.
Noise	Construction noise	Temporary	✘	Moderate	Construction noise could be a significant source of disturbance to local residents in urban areas. At the WWTP – residential buildings located 500m from site, one manufacture building within 100m radius.	Construction contract to limit work close to residential properties to normal working hours.
	Increase in noise levels at WWTP site	Permanent	✘	Very Low	WWTP is a compact plant designed and built to reduce operational noise and vibration	Design of noise suppression features into WWTP.
Waste	Production of sewage sludge	Permanent	✘	L/M	Beneficial uses will need to be identified to ensure the overall impact is neutral. In the absence of a suitable disposal route the sludge will need to be transported to a suitable disposal site (the new landfill), which would be an environmental disbenefit	Monitoring and control of WWTP operations.

Element	Description of effect	Duration	Impact Direction	Scale of Impact	Comments	Description of mitigation measure required
	Construction and demolition waste	Temporary	✘	Moderate	Waste generated during construction	Construction contract to ensure safe waste handling and disposal Demolition of the existing WWTP is not a part of this project, separate contract will be designed for this part of the work.
Surface Water Quality	Improvement in river conditions	Permanent	✓✓	High - Moderate	Monitoring effluent quality, downstream surface water and groundwater quality.	N/A

(a) Analysis of Alternatives

The 'do nothing' scenario compared to the proposed project would have a number of negative impacts, including:

- Increasing risk to drinking water quality due to widespread and increasing contamination of water supply from groundwater being polluted through broken and unsealed septic tanks and contaminated land
- Increased risk to public health due to the above – it should be noted that the poorer most vulnerable sections of society are likely to be most at risk

The potential level of environmental risk associated with the various components of the aspects of the proposed investment options are summarised briefly in Tables 10.4 and 10.5 below.

Table 10.4: Impact table for water supply investment options in Podgorica

Components	Minimum Case			Base Case			Maximum Case		
		C	O		C	O		C	O
Reduction in Water Losses									
DMAs and active leakage control programme etc	Y	+	+	Y	+	+	Y	+	+
Mains Replacement Programme									
Replace old leaking pipes	NA			NA			Y	-	+
Increased capacity at Mareza and Dinosa sources									
Extra capacity at the Dinosa source	NA			NA			Y	-	+
Mareza pumping station improvements	Y	-	+	Y	-	+	Y	-	+
Capture of Mareza Spring No. 4	NA			NA			Y	-	+
New Vrsak reservoir and pipelines									
20,000 reinforced concrete reservoir	NA			Y	-	+	Y	-	+
800/700mm x 8000 pumping main from Mareza	NA			Y	-	+	Y	-	+
800mm x 1700m outlet pipeline	NA			Y	-	+	Y	-	+
Repairs and improvements to existing Ljubovic reservoir									
Seal existing concrete reservoir	NA			Y	-	+	Y	-	+
Replace valves and fittings	NA			Y	-	+	Y	-	+
New 800mm x 1700m supply pipeline	NA			Y	-	+	Y	-	+
New Gorica reservoir and pipelines									
10,000 reinforced concrete reservoir	NA			NA			Y	-	+
400mm x 1100 inlet main	NA			NA			Y	-	+
500mm x 900m outlet pipeline	NA			NA			Y	-	+
Mains Reinforcement Programme									
New pipeline extensions	NA			NA			Y	-	+
Network for Donja Gorica	NA			NA			Y	-	+
Additional Storage for Tuzi (bigger reservoir)	NA			NA			Y	-	+

Risk of significant impact	
High adverse	--
Minor to Moderate adverse	-
Negliable/minor	o
Moderate beneficial	+
High beneficial	++
C – temporary construction	
O – long term/operational	

Table 10.5: Impact table for wastewater system modernization options in Podgorica

Components	Minimum case			Base case			Maximum case		
		C	O		C	O		C	O
Collectors									
Connected population equivalent	132,500			164,900			196,700		
33.1 km of primary collectors for Zones I and II to maximise ncrease in connected population, minimise groundwater contamination	5.6 km	-	+	33.1 km	-	+	47.9 km	-	+
51.1 km (50%) development of secondary collectors in zones I and II	0 km	-	+	51.1 km	-	+	96.7 km	-	+
Sewage pumping station	Y	-	+	Y	-	+	Y	-	+
New WWTP									
Phase I conventional activated sludge WWTP with anaerobic sludge digestion and CHP generation	200,000 p.e	-	+	200,000 p.e	-	+	275,000 p.e	-	+
Existing WWTP									
Existing WWTP taken out of service on commisioning of new WWTP	Y	-	+	Y	-	+	Y	-	+
Existing WWTP site well situated for redevelopment, decommissioning and clearance cost passed to developer	Y	-	++	Y	-	++	Y	-	++
Sludge disposal									
Thickening and mechanical dewatering of digested sludge to 30% dry solids, 35,000 T/y	Y	0	+	Y	0	+	Y	0	+
non-agricultural use of sludge for soil conditioning and fertilisation	Y	0	++	Y	0	++	Y	0	++

Risk of significant impact	
High adverse	--
Minor to Moderate adverse	-
Negliable/minor	0
Moderate beneficial	+
High beneficial	++
C – temporary construction	
O – long term/operational	

*C - Construction Impacts
*O – Operational Impact

After assessing alternative strategies, options and technologies, the Priority Investment Programme (Base Case Scenario), has been designed to address the most urgent needs and environmental issues within the financial limitations of the municipality and population.

It is worth mentioning that, without the WWTP, there will be no benefit of improving surface water quality, the lack of the treatment will on the other hand result in increased risk of contamination of surface water courses as higher quantities of sewage will be discharged into the Moraca river and the pollution load will continue to increase.

The level of treatment will be designed to meet the Water Directive objectives for sensitive waters – this is described in detail in Section 6 of this report.

10.5 Institutional and wider environmental issues

There are a number of institutional issues which could influence the success of the project.

1.	Lack of effective long term environmental management of operations and maintenance activities - A key issue is the protection of **water** from contamination. For **both options** this will mean introducing effective management and enforcement of the protection zone around the water intake. For Option **2 additionally the protection of the irrigation canal needs to be enforced.** - Improved and effective maintenance of the network system to improve reliability and safeguard water supplies from the risk of contamination.
2.	Lack of adequate environmental, health and safety and accident response management controls and procedures in the operating institutions.
3.	Management/monitoring of any specific mitigation measures identified for the operation of the project; eg. monitoring of key water quality parameters for example to check chlorine dosing.
4.	These aspects have been addressed in the proposals for the Environmental Action Plans/ investment programme supporting effective project implementation.

10.6 Data gaps and uncertainties and further studies required

For this analysis, impacts have been identified through qualitative expert assessment and knowledge of impacts from similar developments rather than quantitative measurement or detailed field survey. This level of assessment is considered to be satisfactory for the feasibility stage of the project and adequate for the comparison of options and for highlighting areas where further work should be undertaken at more detailed planning and design stages.

Although no significant impacts are expected, further work is required to identify environmental constraints and impacts for the development of all the components of the project. This should include ecological surveys (including aquatic ecology), landscape/land use surveys, soil surveys, cultural heritage assessment (including identification of archaeological potential), and sociological/community surveys.

Information on protected areas and monuments within the study area should be collated.

Land use/ownership information will need to be collected and compensation compulsory purchase/planning approval requirements determined.

No resettlement of residents or business is expected to be required.

Consultation will be required with all relevant stakeholders including villages along the pipelines routes.

10.7 Mitigation, management and monitoring

10.7.1 Environmental issues in project development

This section outlines how environmental management, mitigation and monitoring will be integrated into project implementation phases.

Planning and Design

Undertake **EIA** and develop **EAP/EMP for Option 1/Option 2e**

Key issues for both options will be to ensure that the EIA process is integrated with the planning and design development. Consultation with stakeholders including public and NGO and relevant government agencies will be an important part of the EIA. Key elements will include

Ecological survey – to identify any protected, rare, endemic species etc and inform design - two

phases initial habitat survey and scoping study identifying any additional species specific studies required.
Reduction of environmental impact by influencing design eg through choice of structures, particularly the head water structures, pipeline (option 1),water treatment plant - architectural considerations, landscaping, and screening in keeping with rural remote location.
Minimise impacts by provision for minimum ecological flow, design to ensure protection of water quality from pollution, and implementation of water protection zone.
Minimise long term and construction impacts by careful alignment of access roads and pipeline
Consider additional off takes in design if feasible and locally desirable- eg to benefit villages affected by construction.
Ensure river/stream crossings are environmentally appropriate and do not impede flow of water or movement of fauna or canal use.
Aim to maximise use of local materials and designs requiring minimum or simple maintenance.
Include a requirement for percentage of local labour for construction related contracts.
Provide for monitoring and analysis of surface water quality, spring source water quality and receiving water quality (and equipment and training).
Consider health and safety aspects for operators – eg security issues in remote location.
Undertake **Environmental audits** of any existing facilities to be rehabilitated or made redundant to identify hazardous materials, liabilities, and waste disposal issues.
Further inform detailed design, construction and operation and document preparation and provide consultation and the basis for the environmental assessment required for permitting.

Construction
Tender Documents to be written to ensure the Contractor is obligated to prepare Health and Safety and Environmental Management Plans for each site **and through these to apply good construction practice**.
Relevant issues identified from the environmental impact assessment and audits will be addressed in the tender/contract documents
Independent full time qualified and experienced supervisory staff with **specific tasks to evaluate implementation of HS Plan and EMPs .**
Tender Documents to ensure that the Contractor is obliged to liaise with all appropriate authorities to ensure that all aspects of the works will be in accordance with applicable laws, including obtaining construction permits, wayleaves, traffic management, public consultation etc.
Client to ensure that, from his part, all necessary permits and public consultations are implemented on time.

Operation and maintenance
Adequate provisions for monitoring performance of plants in terms of water quality, quantity and costs.
Adequate budgetary provision must be made in advance of commissioning of the plant to ensure that it is staffed by appropriately trained specialists, and that it has an adequate budget to meet the expected annual costs of power, chemicals, spare parts, etc.
Monitoring and analysis of water and wastewater quality
Adequate provision to ensure mitigation provisions are maintained

10.7.2 Institutional and wider environmental issues

There are a number of institutional issues which could influence the success of the project:

- Lack of effective long term environmental management of operations and maintenance activities

- Improved and effective maintenance of the network system to improve reliability and safeguard water supplies from the risk of contamination.
- Lack of adequate environmental, health and safety and accident response management controls and procedures in the operating institutions.
- Management/monitoring of any specific mitigation measures identified for the operation of the project; eg. monitoring of key water quality parameters for example to check chlorine dosing.

10.7.3 Environmental Action Plan

Key tasks for the EAP supporting project implementation for should include:

Environmental management plan for the construction phase - to control construction impacts such as noise, traffic. construction waste, especially of hazardous materials such as asbestos and contaminated soil
Health and safety plan for trench excavation along roads
Environmental Management Plan (An outline to be further developed and implemented by the client) for the operation and maintenance of the facilities covering monitoring, accident/incident response, management systems responsibilities, training, reporting etc. The environmental audit would be an appropriate first step for this.
Review of long-term investment strategy and provisions for taking environmental aspects into account.
Implementation of Public information/consultation plan

10.8 Conclusion

Assuming good design and construction practices, none of the project components have an unacceptable environmental impact.

The overall project will have a significant beneficial impact through the removal of the risk of pollution from the groundwater and reduction in pollution in the network settlements. Long-term benefits will arise from improvement of the effluent quality being discharged to the Moraca river and consequently Skadar Lake . Without the project, significant adverse risks to water courses and public health would continue and deteriorate.

Targeted improvements to drinking water quality are highlighted in the water supply section of this report as one of its priorities. Both potential options considered (construction of reservoir Vrsak or extension of reservoir Ljubovici) will have a beneficial impact through the improvement of reliability of drinking water supply and connection of areas located outlying parts of Podgorice.

The principal potential adverse environmental impacts have been identified as temporary impacts during the construction phase due to installation of access roads, pipelines and water treatment facilities. The extent of these impacts cannot be determined at this stage due to data gaps and uncertainties.

Assuming good design and construction practices, including appropriate mitigation measures where necessary, neither of the options should result in unacceptable environmental impacts. However the Option 2 – extending water supply reservoir Ljubovici will result in elimination of health path public amenity which is environmentally less favorable than Option 1 and therefore Option 1 is preferred.

Provisions for monitoring and control of water supply (through, amongst others, enforcement of appropriate water protection zones) need to be strengthened.

11 The Project

11.1 Objectives

The Project comprises both water and wastewater components. The main objectives of the water components are to reduce non-revenue water, improve efficiency, and improve security of supply by increasing storage capacity. These improvements will allow supply pressures to be stabilised and improved in several areas of the Municipality.

The main objective of the wastewater components is to reduce pollution in the city of Podgorica and in the Moraca river caused by the lack of a complete wastewater collection system and particularly by inadequate wastewater treatment capacity. A major problem is the discharge of untreated and partially treated wastewater to the Moraca river which, apart from causing notable pollution (particularly when the river flow is low), also poses a threat to Lake Skadar and the potential water resources for coastal towns. There are also a large number of septic tanks in parts of the city discharging effluent to the ground and sometimes to open streams.

11.2 Component parts and cost estimates

11.2.1 Water supply components

As described in Section 7, there are several water supply components and these are summarised in the Table below. The major items are the new 20,000 m^3 reservoir on Vrsak hill (see Figure 6.14 for typical construction details) and the new pumping main from Mareza (see Figure 6.12 for details of the route).

Table 11.1: Water supply components

Base Project	Amount exc VAT	Amount inc VAT
Reduction in Losses		
Active Leakage Control Programme	1,000,000	1,170,000
Consumer Metering Programme	100,000	117,000
Illegal Connection Survey	50,000	58,500
Pressure Control Programme	100,000	117,000
Remote Areas Programme	50,000	58,500
Total	**1,300,000**	**1,521,000**
Construction of Vrsak Reservoir and pumping main		
Reinforced Concrete Reservoir	4,000,000	4,680,000
Inlet Pipeline - 800 mm diameter	5,605,600	6,558,552
Inlet Pipeline – 700 mm diameter	188,700	220,779
Outlet Pipeline – 800 mm diameter	1,237,600	1,447,992
Total	**11,031,900**	**12,907,323**
Improvements to Ljubovic Reservoir		
Replacement Valves and Fittings	100,000	117,000
Seal Concrete Tank	50,000	58,500
Inlet Pipeline	652,800	763,776
Total	**802,800**	**939,276**
Total for Base Project	**13,134,700**	**15,367,599**

11.2.2 Wastewater components

(a) Extension of collection system

As described in Section 7, the wastewater main collection system for the Base Project is designed to connect the existing collection system to the new WWTP (Collector 1), extend the service area in collector zone 1, provide Collector 2 to serve the northwest area of Podgorica city, including the primary and secondary sewer networks. The proposed works are summarised in the Table below.

Table 11.2: Summary of wastewater collector components

Wastewater Collector Network				
Service Area	Diameter (mm)	Length (m)	Amount exc VAT (€)	Amount inc VAT (€)
Collector I zone				
Main collector	1100	729	560,800	656,100
	1000	4860	3,115,400	3,645,000
Primary Network	450	188	57,800	67,700
	400	194	56,400	66,000
	300	11485	2,944,900	3,445,500
Secondary network	250	29813	5,860,700	6,857,000
Sub total Collector I zone			**12,596,000**	**14,737,000**
Collector II zone				
Main collector	800	120	60,500	70,800
	500	467	151,700	177,400
	400	445	129,300	151,300
	350	555	151,800	177,600
	300	1351	346,400	405,300
Primary Network	500	1096	356,000	416,500
	350	858	234,700	274,600
	300	10720	2,748,700	3,216,000
Secondary network	250	21288	4,184,700	4,896,100
Pumping Station			85,500	100,000
Sub total Collector II zone			**8,449,000**	**9,786,000**
Total for Base Project Wastewater Collector Network			**21,045,000**	**24,523,000**

(b) Wastewater treatment

The wastewater treatment plant for the Base Project has been designed as a biological nutrient removal plant with a capacity of 200,000 p.e. The schematic layout of the treatment plant is shown in Figure 7.4 and the process design and cost estimate details are included in Appendix B The estimated cost of the wastewater treatment plant (excluding land costs) is summarised in Table 11.3.

Table 11.3: Estimated cost of wastewater treatment plant

Phase	Population equivalent p.e.	Civil Works (€)	Equipment (€)	Amount exc VAT (€)	Amount inc VAT (€)
Phase 1 WWTP	200,000	11,513,000	10,831,000	**22,344,000**	**26,142,480**

(i) Basic Facilities and Equipment

The implementation of Phase 1 of the new Podgorica WWTP will involve the provision of the following facilities and equipment:

Reception chamber

- Emergency overflow with fine screen
- Coarse grid screen for protection of pumps
- Chamber covered with odour control facilities

Inlet pumping station

- 4 duty plus 2 standby pumps rated at 960 m^3/h (with provision for 5^{th} duty pump for phase 2)
- Station and sump covered with odour control facilities
- Flow measurement

Fine screens

- 6 mm mesh fine screens
- Sreenings dewatering
- Screenings building covered with odour control facilities

Grit and grease removal

- Aerated grit and grease removal channels with collection equipment
- Duty and standby compressors
- Grit classifier

Primary settlement tanks

- Three 36 m diameter settlement tanks
- Half bridge scrapers
- Desludging facilities and primary sludge pumps

Process tanks

The process tanks comprise the following components:

- 4,300 m^3 anaerobic tank with submersible mixers
- Pre-anoxic tank for return activated sludge to ensure anaerobic conditions can be established in the anaerobic tank for phosphorus removal
- 4,500 m^3 denitrication (anoxic) tank with submersible mixers
- 13,500 m^3 nitrification (aerobic) tank with fine bubble membrane diffusers
- Internal recycle pumping system between outlet of nitrification tanks and inlet of denitrification tanks

The figure below shows the schematic layout of the tanks which is based on a modified A^2O process.

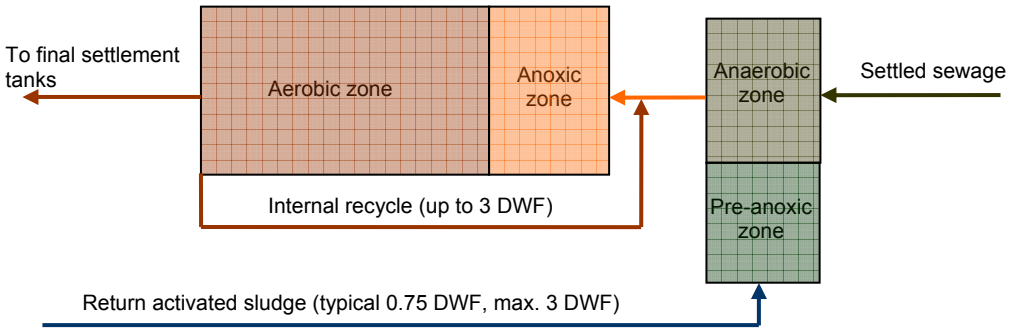


Figure 11.1: Schematic layout and flow diagram for process tanks

Final settlement tanks

- Three 44 m diameter settlement tanks
- Half bridge scrapers

- Flow measurement

Return and surplus activated sludge pumping station

- 2 duty plus one standby RAS pumps each rated 1,334 m^3/h with variable speed inverter drives for two pumps
- 1 duty plus standby SAS pump with variable speed drive
- Flow measurement

Blower House

- 3 duty plus 1 standby variable output centrifugal turbo blowers
- Acoustic enclosures
- Provision for 4^{th} duty blower

Recycle pumps

- 4 duty plus 2 standby low head recycle pumps
- Recycle pipework (depending on final layout)

Sludge Treatment

The sludge treatment process includes the following facilities:

Surplus Activated Sludge Thickening

- 2 belt thickeners with polyelectrolyte dosing
- Thickened SAS pumps and pipework to deliver to digester tanks

Primary Sludge Gravity Thickeners

- 2 gravity thickeners with picket fence stirrers
- Thickened primary sludge pumps and pipework to deliver to digester tanks

Anaerobic Sludge Digesters

- 3 closed 16 m diameter digestion tanks
- Digestion equipment including pumps, gas mixing, heat exchanger, and gas collection with necessary safety features

Gas Storage

- 2 spherical gas storage tanks
- Flare system for emergency use

Combined heat and power

- Boilers for digester heating and dual fuel generator combined cycle set with silencer for power generation and heating
- Switch gear to allow generated power to be used on the treatment plant

Sludge Dewatering

- 2 centrifuge decanters with polyelectrolyte dosing
- It will be necessary to precipitate the phosphorus from the filtrate water before it is returned to the treatment plant. Ferric salt storage and dosing facilities, together with a small settlement tank will be required

(ii) Sludge Production

The projected sludge production from the Phase 1 and Phase 2 treatment plants (at full design capacity) are detailed in Table 11.4.

Table 11.4: Predicted sludge production

Process Stage	Phase 1 WWTP	Phase 2 WWTP
Primary Sludge production, kg DS/d	5,724	7,807
Biological Sludge production, kg DS/d	8,020	11,077
Volume of thickened sludge (6% DS for thickened primary and 4% for thickened SAS)	316	428
DS of sludge after anaerobic digestion, kg/d	10,601	14,404
Volume of sludge dewatered to 25%, m3/d	42	58
Volume of sludge dewatered to 30%, m3/d	35	48

Anaerobic digestion reduces the quantity of organic matter in the sludge and reduces the overall quantity of sludge by nearly 25%. The volumes of dewatered sludge are shown at two dry solids contents; 30% which is best that can be expected from a biological nutrient removal plant, and 25% which is the worst that should be achieved from a well operated system.

(iii) Automation, Control and Measurement System

An extensive automation, control and measurement system together with a central control room will be provided for the new WWTP. The system will include measurement of influent, effluent and sludge flows together with automatic sampling and inline sampling for temperature, pH, solids content, TOC and Ammonia. The process units will include dissolved oxygen measurement for automatic control of air blowers as well as redox measurement to aid control of anoxic and anaerobic zones. Pumps and dosing equipment, etc. will be controlled by local programmable logical controllers (PLCs) and/or the central control centre.

12 Implementation

12.1 Procurement

12.1.1 Policies and Principles

The EIB's Policy towards procurement is to ensure that the resultant projects are of appropriate quality and acquired at economic prices in a timely manner. It requires that, for projects financed by the EIB:

- The principles of the EC procurement Directives are followed,
- Procurement procedures are publicised in the Official Journal of the European Union,
- Open international competition is preferred,
- Firms from all countries of the world are eligible to tender, unless constrained by co-financing arrangements,
- In the case of pre-qualification, the Promoter must send to the Bank for "non-objection" the prequalification report and the proposed list of pre-qualified candidates,
- Procurement documents and tender evaluation reports are to be sent to the EIB for "non-objection", however;
- Promoters remain fully responsible for implementing projects financed by the Bank. The involvement of the Bank is confined solely to verifying whether the conditions attached to its financing are met.

Most international funding agencies have adopted similar policies and principles that will define the procurement and implementation strategies, including:

Principles/objectives	Measures to achieve objectives
• Open and fair competition	Open tendering using of standard tendering procedures, and International Conditions of Contract.
• Fit for purpose	Whole life costs to be evaluated to determine the most economical and efficient tender.
• Borrower contribution	Borrower to contribute a significant proportion of project costs. These usually include, as a minimum, the cost of local Taxes and land purchase
• Administration efficiency	• Each contract to be funded by a single agency • Number of contracts to be minimised
• Currency risk	Risk to be borne by contractors
• Transfer of technology • Monitoring and control	Formation of a Project Implementation Unit supported by International consultants.

Multilateral funding for large contracts is possible and acceptable to most international funding agencies. However, wherever possible, it is preferable that each contract should be funded from a single source. This will reduce the complexity and difficulties resulting from, for example, late or non-payment by one source of funds.

To show commitment on behalf of the Borrower, funding agencies expect the Borrower to provide a significant proportion of the project costs. It has been assumed that this amount will include the duties and taxes that may be applicable to the project.

12.2 Implementation

12.2.1 Type of contracts

The type of contract through which the works, goods or services are procured depend upon the nature and size of the project. The different types of contract relevant to this project are defined as follows:

Works contracts	Works contracts are appropriate for most civil engineering work, where there is a potential element of uncertainty, such as the laying of underground services and structural modifications. The majority of civil engineering works are implemented under this type of contract. Works contracts can include either the execution, or both the design and execution of components. The provision of electrical and mechanical work manufactured by specialized suppliers is normally implemented under this type of contract, to ensure open and fair competition.
Supply contracts	Supply contracts can be used for the purchase of standard manufactured goods. Such goods include water meters, maintenance equipment and chemicals.
Consultancy	Consultancy contracts can be for all types of consultancy services, including planning, design, procurement, contract management, supervision, institutional strengthening, etc.

The most appropriate type and number of contracts will be fixed when designs have been finalized and tender documents prepared. However, tentative suggestions for contract contents and type of contracts are included in the following Section

12.2.2 Contract packaging

To reduce administration and the risk of procurement delays, it is advisable to have one consultancy contract responsible for the design and supervision of all the Works.

The proposed project is a combination of a number different types of construction; construction of a water reservoir and water pumping mains, construction wastewater collectors and network; a construction of the new wastewater treatment plant.

These different types of construction require a different type of specialisation and only a few contractors would have sufficient experience in all areas. To enable sufficient number of contractors to bid for the work, it would in any case be recommended to split the work into three different works contracts as follows:

1. Construction of Vrsak reservoir, rehabilitation of Ljubovic reservoir and new pumping mains from Mareza,
2. Construction of the sewerage systems, including sewers, manholes and pumping station, and
3. Construction of the wastewater treatment plant.

The first two contracts are appropriate to a traditional approach, with the Employer, or his consultant (The Engineer) preparing the design. In this case it is recommended to use the

Federation Internationale des Ingenieurs Conseils (FIDIC) Conditions of Contract for Building and Engineering Works Designed by the Employer (The Red Book).

The treatment plant contract includes substantial equipment components and requires specialist design knowledge. For this reason it is recommended (and normally adopted for EC or IFI funded contracts) that the FIDIC Conditions of Contract for Plant and Design-Build (The Yellow Book) is used. An outline design with carefully drafted and comprehensive functional requirements and specifications is necessary for inclusion in the tender documents, rather than a full detailed design, as required by the Red Book. This approach can shorten the time required for preparation of tender documents although the contract period may be longer to allow time for the contractor's design preparation and its approval. In addition to the normal monitoring of construction, supervision of such Contracts is also oriented to ensuring that the contractor's design is compliant with the contract and that the functional requirements are achieved on commissioning.

12.3 Procurement plan

Procurement using Open Tendering for Works contracts generally requires at least six months from completion of the tender package to the beginning of contract work to allow for sufficient time for tender preparation and for the evaluation and award processes. It is prudent to allow a further month for the documents to be checked by end-users and other stakeholders.

The times required for the various steps of the procurement process are listed in the table below, and are included in the Implementation schedule attached at the end of this chapter.

The programme takes account of the time required for the EIB to review the tender documents and tender evaluation reports before issuing a "no objection". Time also needs to be allowed for any internal review procedures required by the Promoter and Beneficiary.

Activity	Days required for activity	Cumulative days required
Completion of Tender dossier		0
Review and No Objection by EIB	10	10
Issue of Advertisement and Tender dossier	5	15
Tender period	60 (minimum 45)	60 - 75
Clarification period	During Tender period	
Pre-Tender meeting	During Tender period	
Receipt and opening of Tenders	End of Tender period	
Preliminary examination of Tenders	2	62 – 77
Technical and commercial examination of Tenders	40	102 - 117
Preparation of Report on Tenders and Recommendation	4	106 - 121
Review and No Objection by EIB	13	119 - 134
Signature of Contract	4	123 - 138
Contract becomes effective and work starts	30	153 - 168

12.4 Implementation Schedule

Due to the time required for design, preparation of tender documents and contract tendering and award procedures it is estimated that construction will commence at the earliest in 2012, and could be completed by end 2014, as indicated below. This programme should be regarded as the best that is likely to be achieved.

Figure 12.1: Implementation Schedule