MDG ACHIEVEMENT FUND

INVESTOR:
MDG-F DEMOCRATIC ECONOMIC WATER SUPPLY GOVERNANCE

PROJEKAT: STUDIJA U OBLASTI VODOSNABDIJEVANJA ZA PARTNERSKE OPĆINE
PROJECT: WATER SUPPLY STUDY FOR PARTNER MUNICIPALITIES

WATER SUPPLY STUDY FOR MUNICIPALITY GRAČANICA

Voding-92 d.o.o.

AUGUST 2011

Voding-92 d.o.o.

Engineering, Design and Consulting Company
Bijeljina

INVESTOR:

UNDP BIH / MDG-F DEMOCRATIC ECONOMIC GOVERNANCE

WATER SUPPLY STUDY

FOR GRAČANICA MUNICIPALITY

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WATER SUPPLY STUDY

FOR GRAČANICA MUNICIPALITY

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2.1 INTRODUCTION

2.1.1 INTRODUCTORY EXPLANATIONS

The issue of Gračanica Municipality water supply is solved with the town water supply system and seversl smaller water supply systems. Concerning the organized water supplying of Gračanica Municipality area, we can not talk about unique water supply system, because there are several smaller local systems operating which are independent of town water supply system. Gračanica is Municipality where the big percent of inhabitants are out of urban center, so the town water supply system coverage is relatively low.

Utility company **JP „Vodovod i kanalizacija“ Ltd. Gračanica** is the company that manages the **Water supply and sewerage system of Gračanica town**.

2.1.2 BASIC DATA ABOUT GRAČANICA MUNICIPALITY

2.1.2.1 INTRODUCTION

Gračanica is a town and municipality in the North-Eastern part of Bosnia and Herzegovina, Federation BiH Entity, part of the Tuzla canton.

It borders with 4 municipalities from FBiH (Gradačac, Srebrenik, Tuzla and Doboj East), as well as with 2 municipalities from Republic of Srpska (RS) (Petrovo and Doboj).

It involves bigger part of Spreca river valley in its lower flow and the part of Trebava valley.

Data for 1991

According to the last official census from 1991, Gračanica municipality had **59.050 inhabitants (17.056 households)**, allocated into 28 settlements. Of that number, 12.712 inhabitants lived in town Gračanica, and **48.372 inhabitants** lived in the area of municipality. Based on the data from 1991, prewar municipality Gračanica covered the surface of 387 km^2. Population density was 152,58 inhabitant/km^2.

Data for 2000

In the begining of 1992, and after the war in BiHand the Dayton Agreement, one part of the municipality became Petrovo municipality, which belongs to Republic of Srpska, so now the municipality teritorry surface is 219,5 km^2. Based on the statistics from 2000, there are 55.144 inhabitants living in this area in 18 local communities.

Data for 2011

According to the data from 2011, there are

GRAČANICA

Country	Bosnia and Herzegovina
Entuty	Federation of Bosnia and Herzegovina
Canton	Tuzla
Settlement	Gračanica
Surface area	219,5 km²
Municipality population	59.134 (1991 census)
	56.006 (2011 estimation)
Town population	12.712 (1991 census)
	17.140 (2011 census)
Coordinates	44° 41' 21" NGW 18° 18′ 08" EGL

58.926 inhabitants (16.578 households) living in Gracanica at the moment. Population density is 268,46 inhabitants/km^2.

Gračanica is urban settlements and the center of the municipality.

After signing the Dayton Agreement, the biggest part of Gračanica municipality was given to the Federation BiH and the settlements are: Babići, Doborovci, Donja Lohinja, Džakule, Gornja Lohinja, Gračanica, Lendići, Lukavica, Malešići, Miričina, Orahovica Donja, Orahovica Gornja, Piskavica, Pribava, Prijeko Brdo, Rašljeva, Skipovac Donji, Skipovac Gornji, Soko, Stjepan Polje, Škahovica and Vranovići. The settlements given to Republic of Srpska, Petrovo municipality, are: Boljanić, Petrovo, Kakmuž, Karanovac, Porječina i Sočkovac, te dijelovi naselja Skipovac Donji and Skipovac Gornji.

Table 1: Municipality population number

Population number	Year				
	1971.	1981.	1991.	2000.	2011.
Municipality	46.950	54.311	59.134	55.144	58.926
Town			12.712		17.760

2.1.2.2HISTORICAL DEVELOPMENT OF GRAČANICA

Gracanica is first mentioned in Ottoman sources in 1528. The village belonged to Soko, and was known for its iron mines. Soko center was represented by Soko medieval fortress, which is located about 4 km from center.

The original Gračanica settlement was situated at current location of Drafnići town part, and the statute of town was gained in 1548. More significant development comes at the end of 17th century, during Budimlija Ahmed Pasha period, who built a mosque, bazaar, hamam (public bath) and the clock tower.

In the 18th century the water utility was constructed. Gračanica was significant trading, a bit bigger settlement. In 1879, it had 613 houses and 3.012 inhabitants. Gračanica had a post office in 1878, and elementary school in 1887.

HYSTORICAL DEVELOPMENT OF GRACANICA

Gračanica municipality spreads at the surface of 219,5 km^2, what makes 14,2% of Tuzla canton teritory or 0,428% of Bosnia and Hrzegovina terotory. In 20 settlements, Gračanica municipality has 56.006 inhabitants, what makes around 18 % of Tuzla canton population.

Population density in Gračanica municipality area is 255,15 inhabitants per km^2, what is significantly more even than in canton - 210 per km^2, as well as Bosnia-Herzegovina average which is 75 inhabitants per one km^2.

With Gračanica, as municipal center, some settlements gor trully developped into significant micro-urban and infrastructure cenetrs, of 2.000 to 3.500 inhabitants: Lukavica, Stjepan Polje, Malešići, Doborovci, Džakule, Babići, Sokol, Gornja Orahovica, Miričina, while Donja Orahovica has near to 5.000 inhabitants.

2.1.2.3GEOGRAPHIC POSITION AND CLIMATE

In the recent period, there are extensively developed forms of small businesses, family businesses, shops, catering, craft production and service activities.

Gracanica municipality releif gradually rises from Sprečko polje, ranging from 150 MASL. It is composed of units, and nominated as Spreca and Trebava units.

However, Trebava mountaineous unit rises from Panonska-Posavska valley. The highest peaks are Vis - 692 MASL, Sijedi Krš - 664 MASL, Monj - 532 MASL.

Gračanica municipality teritory spreads between 44° and 45° of North Geographic Width, in the belt of moderate-continental climate with moderately warm summers and moderately cold winters. The autumn months are warmer than the spring. The highest rainfall in this area is in spring and summer. Development of towns and villages favors moderate parish air, conditionally sheltered by Trebava hills at the north and Ozren boulders, from the harsh mountain climate in the central part of Bosnia, from the south.

Gračanica has the average temperature of 10° C and 830 mm of precipitation per m^2 during the year.

The lowest temperatures are in January, and highest in July.

Ground and surface waters from Gracanica municipality areaflow into the basins of rivers: Spreča, Tinja, Bosna, i.e. into the Sava Basin and further to the Black Sea. As its right tributaries in Gracanica municipality area, Spreča river has Miričanska river, Kamenički potok (spring), Orahovička river, Zmajevac, Lohinjska river, Pribavska river, Hajdarovac, Sokoluša and Klašnica.

Sokoluša 10,5 km long and has the highest spring capacity of 26 l/s. Bosna accepts Lukavička river, of total stream lenght of 34 km, of which throught Gracanica municipality the stream lenght is 16 km. Džakulska river, 22 km long, at Gracanica municipality area is 15 km long, it’s a tributary of Tinja river.

The most significant springs in Gračanica municipality area are **Vrela and Ilidža** near Sokola, and **Javor, Velika voda and Krečnička voda** in Škahovica. The municipality area is rich with thermo-mineral waters. Exploitation boreholes capacity is 100 l/s.

2.1.2.4 ECONOMY

Gračanica economy is now composed of a lot of small and big companies based on the undoubtedly rich merchant-craft tradition that dates far back from the past of Gracanica, the center of the former widespread Turkish, Austrian and Yugoslav county district.

With 25 different trades in the late 16th century Gracanica was real guild workshop for the army and an important trading center on the crossroads of caravan routes that led from the Adriatic Sea towards the Brčko scaffold.

Gracanica Economic development starts after the withdrawal of the Ottoman and the establishment of the Austro-Hungarian authorities in Bosnia and Herzegovina, after the 1878.

By constructing the roads, particularly connecting Gracanica with the railway - "Ciro" in 1898, opening quarries, exploitation of forest resources, adjusting craft-guild production and trade requirements of the European markets, Gracanica has stepped into the modern era of development.

All the way to 1992 it was well known by its large manufacturing companies and the products quality. Of 11.000 employed people, 8.000 worked in municipality area, of which 6.000 worked in the economy (industry). Based on the official data, the number of unemplyed people was around 5.000.

Economy structure of the current Gračanica is composed of over 400 legal bodies (private companies, public companies and institutions) and around 6000 individuals (independent crafts and other activities.

Therefore, the municipality has around 1,000 businesses. Conditionally can be divided into service and crafts - production. Among the services dominated are trade, catering and transportation, and manufacturing the civil engineering, wood processing, plastic processing, metal, clothing and footwear industry, food (poultry, livestock, fruit, vegetables and meat). From a total of 7279 employees in the municipality, in the economy (for legal entities and individuals) there are around 6600 empleyed (data from October 2006). The most populous firms are: „Fortuna“, „Olimp“, „Jadrina“ and Company „Širbegović“.

2.1.2.5 LOCAL SELFGOVERNANCE

Local selfgovernance is the right of every citizen to directly participate in decision-making in certain local matters that directly affect their daily life and work.

Local selfgovernance is established in the local comunity. The local comunity can be established for one settlement, few smaller settlements which are bounded or for a bigger part of a settlement, that (comparing to other parts of the settlement) form a unit. Initiation for local comunity establishment can be made by at least 50% of voters of the settlement for ehich area the new local comunity establishment is suggested, than by Municipal Council and Municipality Mayor.

21 local comunities were established in Gračanica municipality area. The list of local comunities with the settlements and population number is shown in the following table.

Table 2: Local comunities with settlements and population number

No.	Local community	Population	Households number	Settlements within local community
1	Lendići			Included in Gracanica
2	Gornji Skipovac			
3	Donji Skipovac			
4	Gornja Lohinja	159	42	Gornja Lohinja
5	Buk	375	106	Ibrići, Mašići, Meškići and Točak.
6	Prijeko Brdo	675	170	Rijeka, Drndići, Huskići, Džinići, Cikote, Hadžići, Jahići, Okići, Sabitovići, Straševići and Šarići.
7	Trnovci	737	202	Nalići, Šabići, Bećirovići
8	Gornji Doborovci	740	177	Hodžići, Rijeka, Piragići, Jukići, Šabići, Džanani, Sališta, Vinjišta, Serhatlije and Begovići
9	Piskavica	924	220	Centar, Spahići, Brkići, Delići, Rajčevac, Ćorići and Hrvići
10	Vranovići	1.042	270	Alibegovići, Centar, Nasići, Plane, Nurikići and Karići
11	Rašljeva	1.092	246	Osmanovići, Omerbašići, Brdo, Mehići and Mahala
12	Donja Lohinja	1.316	375	Mehanovići, Bajrići, Šestani, Ahmetaši, Durać, Smailbašići, Novo Naselje and Novo Naselje Škola.
13	Škahovica	1.480	340	Spahići, Centar, Delići, Čozalovo Brdo and Ahmetagići
14	Doborovci	1.750	483	Alibegovići, Centar, Rijeka, Moštanica, Panđurište, Spomenik, Vilakići, Džafići, Alići and Avdići
15	Soko	2.120	750	Guvna, Begovići, Ilidža, Osmanagići, Mehići, Orašje, Oštrikovac, Ćetovulja, Bušište and Bukva
16	Gornja Orahovica	2.250	547	Džafići, Husičići, Birkovac, Ajkići, Avdići, Dobrnjići, Bara-Đurđuša, Mujići, Džinići, Mehići, Gazibegovići, Brđani and Manovići
17	Pribava	2.300	585	Stjepanovac, Kapetančići, Kadići, Jukani, Centar, Kamarići, Softići, Džafići, Zelenkići, Meraje, Tahirovići and Straževac
18	Džakule	2.550	680	Rijeka, Gornje Džakule, Kulovići and Mehmedovići.
19	Babići	2.700	750	Karići, Kahvedžije, Omerbašići, Mustafići, Centar, Fazlići and Borici

20	Miričina	2.756	865	Polje, Brezici, Lipovci, Sjerkovine, Babljak, Srednja Miričina, Gornja Miričina, Durakovići, Brda, Mujačići and Kurtovići
21	Lukavica	3.200	1.000	Prnjavor Ograđenica, Bijeli Potok, Centar, Devedžije, Delići, Zolje and Čamdžije
22	Malešići	3.500	850	Mešići, Hodžići, Mujkići, Kalesije, Kovači, Hamzići, Čalići, Šakići and Brezje.
23	Stjepan Polje	4.000	950	Potok Mahala, Mejremići, Ibrahimovići, Hadžići, Dživraci, Polje, Polje Luke, Mustafići, Dedići, Muratovići, Avdići, Džebe Memići
24	Donja Orahovica	5.500	2.000	Dom, Kamenica-Bajići, Rijeka, Makovci and Turkovići
25	Gračanica grad	17.760	4.970	Lipa I, Lipa II, Luke, Hajdarovac, Riječka, Ritošići, Potok Mahala, Stubo, Centar, Mejdan, Drafnići, Varoš, Pašalići, Javor, Bahići, Seljanuša and Čiriš.
	Total:	**58.926**	**16.578**	

Local comunity can perform the following local services:

- Constructing and maintaning the roads, sewerage, water supply systems and other utility needs
- Arranging the settlements, constructing and maintaning the parks, playgrounds, sport facilities, etc.
- Constructing and maintaning the graveyards
- Cleaning the public surfaces, transporting the waste, removal of atmospheric waters and environment protection
- Performing som eother local services of interest for lofe and work of citizens in the place of living, established by the local comunity statute, which has to be in accordance with the Statute and regulations of municipality that contribute to life improvement in local comunity area
- Cooperation with municipal services.

Satisfaction of needs and interests of citizens in local comunity is financed by the following:

- Through local voluntary
- Services fees which the local comunity achieves by its activities
- Revenues that the municipality gives to the local community to fund certain activities in the amount of 1/3 of municipal budget from gifts and donations, and other means achieved in accordance with law and regulations by local communities: Babići, Doborovci, Donja Orahovica, Gornja Orahovica, Džakule, Mirčina, Piskavica**,** Pribava, Rašljeva, Stjepan Polje, Škahovica, Vranovići, Buk, Malešići, Trnovci, Donja Lohinja, Prijeko Brdo, Soko, Lukavica, Gornji Doborovci, Gračanica.

2.1.2.6 GRAČANICA MUNICIPALITY URBAN AREAS

Based on the ***"Tuzla canton spatial plan"*** 17 (seventeen) urban areas were established in Gračanica municipality area, as follows:

1. **Gračanica urban area – municipality center**

   The urban area is located in the southern part of the municipality and occupies an area north and south of the highway DobojTuzla-Zvornik (M-4). P = 738.56 ha. At the east it borders with agricultural land and small parts of the forest belt, at the north. At the west and south it borders with agricultural land, at the southeast with area Pribava.

2. **Pribava urban area**

The urban area is located in the southern part of the municipality and occupies an area northeast and southwest of the main road Doboj-Tuzla-Zvornik (M-4). Surface P=222.08 ha. At the east, north and south it borders with agricultural land and smaller parts of the forest; at the northeast side with Gračanica urban area; at the southeast with Donja Lohinja urban area.

3. **Donja Lohinja urban area**

The urban area is located in the southeast part of the municipality and occupies the area northeast of the main road Doboj-Tuzla-Zvornik (M-4). Surface P=86.81 ha. At the east, southeast and south it borders with the forest belt and smaller parts of agricultural land; at the north side it borders with agricultural land; at the northwest with Pribava urban area; at the west and south with a main road DobojTuzla-Zvornik (M-4).

4. **Donja Orahovica urban area**

The urban area is located in the southeast part of the municipality and occupies the area north of the main road DobojTuzla-Zvornik (M-4). Surface P=237.17 ha. At the east, north and west it borders with the forests and agricultural land; at the south with a main road Doboj-Tuzla-Zvornik (M-4).

5. **Miričina urban area**

The urban area is located in the southeast part of the municipality and occupies the area northeast and southwest of the main road Doboj-Tuzla-Zvornik (M-4). Surface P=136.46 ha. At the east and west it borders with the Canton border; at the north forest belt; at the south with agricultural land.

6. **Gornja Orahovica urban area**

The urban area is located in the southeast part of the municipality and occupies the area east (by its bigger part) and west of the local road Donja Orahovica-Gornja Orahovica-Blagalište (L-18). Surface P=111.29 ha. At the east, north and west it borders with the forest belt.

7. **Vranovići urban area**

The urban area is located in the east part of municipality, nearby the Canton border and occupies the area south of the regional road Bukva-Srebrenik (R-461). Surface P=61.06 ha. The entire area borders with the agricultural land and smaller parts of forests belt at the northeast and south.

8. **Doborovci urban area**

The urban area is located in the northeast part of municipality and occupies the area north (by its bigger part) and south of the regional road Gračanica - Ormanica (R-460). Surface P=146.67 ha. At the east, northeast, west and south it borders with the forest belt; from the southwest with the part of the construction land Doborovci and parts of the forest belt.

9. **Džakule urban area**

The urban area is located in the northeast part of municipality and occupies the area north and south of the Džakulska river. Surface P=107.26 ha. The entire area borders with the agricultural land and smaller parts of forests belt at the northeast and southeast.

10. **Soko urban area**

The urban area is located in the central part of municipality and occupies the area north of the regional road Gračanica - Ormanica (R-460). Surface P=87.32 ha. The entire area borders with the agricultural land and smaller parts of forests belt at the southwest and southeast, and the construction land Soko on the west.

11. **Škahovica urbano area, Škahovica settlement**

The urban area is located in the central part of municipality and occupies the area northwest of the regional road Gračanica-Ormanica (R-460). Surface P=84.89 ha. At the east it borders with agricultural land; at southeast and northeast forest belt; at the north, south and southwest agricultural land; at the west it borders with construction land Babići and smaller parts of forests area.

12. Babići urban area, Babići settlement

The urban area is located in the central part of municipality and occupies the area west of the regional road Gračanica - Ormanica (R-460). Surface P=48.09 ha. At the east it borders with the agricultural land and some smaller surfaces of the forest land. At the north it borders with agricultural land, at the south the bigger part is forests and some smaller part is agricultural land, while at the west side it borders with the agricultural and forest land.

13. Malešići urban area

The urban area is located in the west part of municipality and occupies the area northeast and southwest of the local road Gračanica - Malešići - Lukavica - Lukavica Rijeka – Canton border (L-9). Surface P=170.37 ha. At the east, north and west it borders with the agricultural land; at the northeast with the construction land Malešići; at southwest and southeast it borders with the forest belt parts.

14. Lukavica urban area

The urban area is located in the northwest part of municipality, nearby the Cabton border and occupies the area north and south of the local road Gračanica-Malešići-Lukavica-Lukavica river-Canton border (L-9). Surface P=102.58 ha. At the east it borders with the agricultural land and smaller part of the forest belt; at the northeast, west and south with agricultural land; at northwest with the forest belt.

15. Stjepan Polje urban area

The urban area is located in the southwest part of municipality and occupies the area northeast of the main road Doboj-Tuzla-Zvornik (M-4). Surface P=216.49 ha. From east it borders with the parts of the forest belt; northeast, north and west with agricultural land and smaller parts of forest belt; northwest it borders with the construction land Stjepan Polje; at southwest and south with the agricultural land.

16. Rašljeva urban area

The urban area is located at the end of southeast part of municipality and occupies the area northeast of the main road Doboj-Tuzla-Zvornik (M-4). Surface P=19.72 ha. At east, north and west it borders with agricultural land and the smaller part of forest belt, while at the south it borders with both, agricultural and forest land.

17. Piskavica urban area

The urban area is located in the central part of municipality and occupies the area at both sides of regional road Gračanica-Ormanica (R-460), and at the both sides of the local road towards east. Surface P=97.24 ha. Enitre area borders with agricultural and forest land, with the woodland prominent from the eastern side of urban areas.

2.1.2.7 GRAČANICA MUNICIPALITY IN FIGURES

The following table shows basic data about municipality.

Bosna i Hercegovina
Federacija Bosne i Hercegovine
Tuzlanski kanton
Općina Gračanica

Bosnia and Herzegovina
Federation of Bosnia and Herzegovina
Canton of Tuzla
Gračanica Municipality

Identification card

	1991.	**2009.**
Municipality area	387 km^2	219,5 km^2
Number of settlements	28	21
Population in total	59.050	56.006

Natural resources: non-metallic minerals, bentonite, kaolin, quartz sand, tuff, clay and refractory clay and limestone. Thermo mineral water (1 exploitation well of the average capacity of 80 liters per second per hole). Land Resources: suitable for the production of healthy food.

Privreda- businesses by organizational form .

Legal entities	432
Natural persons	690
Public institutions	27
Banks	10
Microcredit organizations	9
Insurances	9

Employment	
Employment in total	**8.650**
Unemployed – date 30 September 2009	8.246

At the municipality level there are 54 Citizens Associations, and 23 are active

Livestock	
Big cattle : (cows-4700,steers-1200,calfs-1400)	**7300**
Small cattle : (sheep-7000,goats-800, horses-100)	**7900**
Poultry : Broilers (fattening)	**800250**
Laying poultry	**15000**
In Gračanica municipality there are 40 private poultry farms, 1 company for steers fattening of 500 steers capacity yearly, 1 company with 120 milch cows.	
Beekeeping: behives	**2000** pcs.

Agriculture	
Arable land (fields)	9.039 ha
Orchards	1.749 ha
Meadows	1.015 ha
Pastures	1.462 ha
Forests	6.603 ha
Westlands	39 ha
Ponds, marshes, swamps	4 ha

Education

Elementary schools in Gračanica area		11
Secondary schools		2
	Employed	**No. of pupils**
Elementary schools	471	5.491
Gymnasium	43	560
Mixed school	119	1.948
Total:	633	7.999

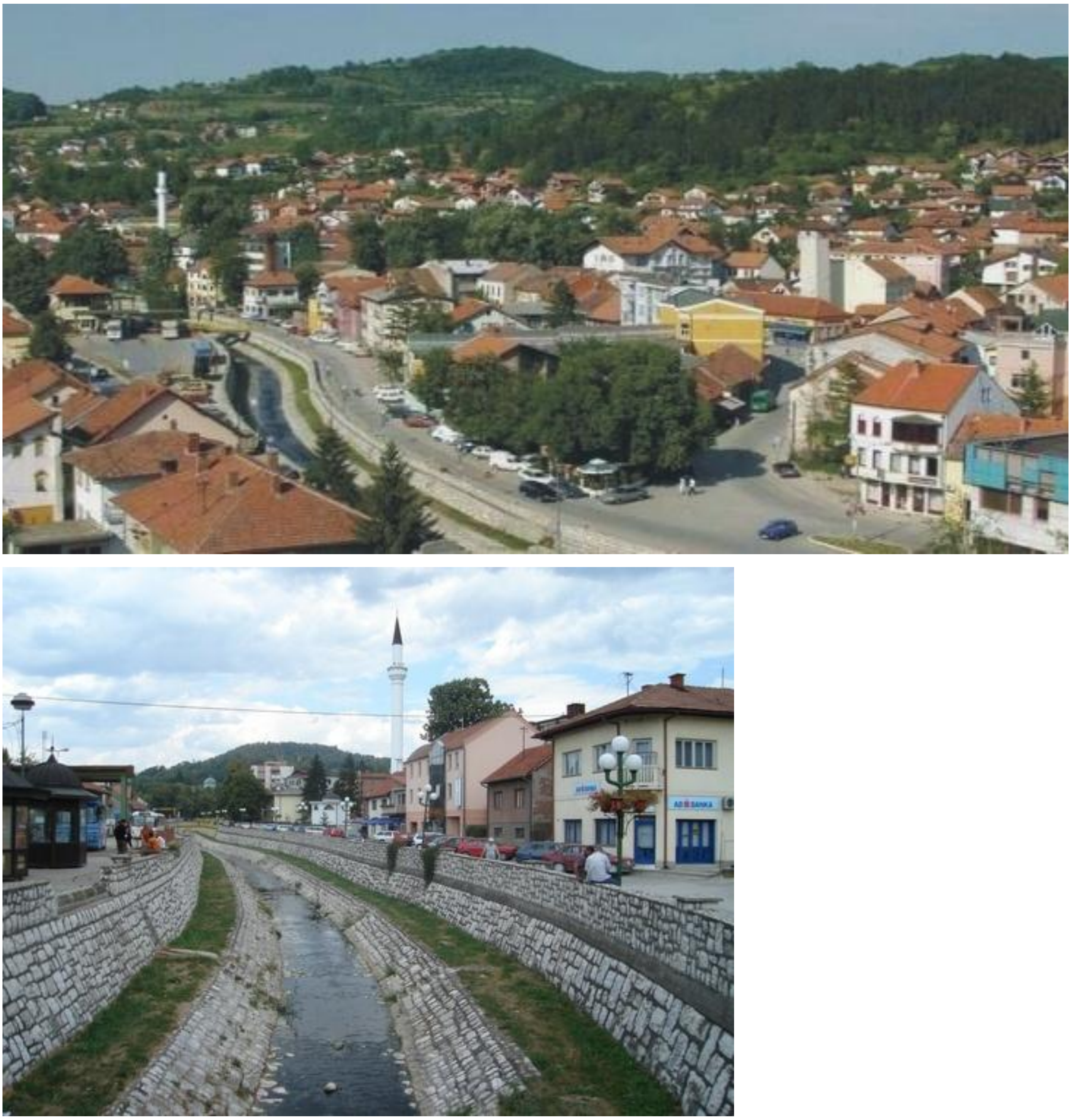


Figure 1: Gračanica town

Figure 2: Gračanica Municipality map

2.1.3 BACKGROUNDS

Backgrounds for the Master Plan draft are consisted of the following:

GEODESIC BACKGROUNDS

For the Master Plan drafts, geodesic maps of Gracanica municipality were used in the scale of 1:25.000 and 1:10.000, as well as geodesic plans in the scale of 1:2.500.

SPATIAL PLAN OF TUZLA CANTON, 2001

2.1.4 PROJECT DOCUMENTATION

Strategy – project documentation

Organization/Institution needs to comprise the Study of Gračanica municipality water suplying with the following documents:

- Integrated strategy of Gračanica municipality development (2010-2020 – in progress);
- Economy strategy of Gračanica municipality development (2005-2010);
- Communication strategy (2006-2009);
- Strategy for partnership with the citizens (2008);
- Spatial plan of Gračanica municipality (2000-2021).

Beside the mentioned strategic project design documentation, the organization /Institution will have the access to all spatial project design documents, such as zoning plans and projects, regulation plans, plotting plans, etc.

Organization/Institution will use and take over the results, reports and found data of the mentioned documents, or it will require to conduct additional investigation, which needs to be approved my Municipality.

Studies, projects and levels

Organization/Institution will have access to and use the following documentation:

- The Main project – Reconstruction of water supply distributive network in local community Pribava," ING-PROJEKAT" Doboj South (2008);
- Study with hydro-geological work program for groundwater abstraction for the purpose of water supply in Gračanica, Institute for Water, Sarajevo (2008);
- Report on the sanitary protection zone for water supply system sources in Gračanica, Institute for Water (2008).

All above mentioned documents will be available as soft or hard copy.

Some other documentation was, also, used, made for Gracanica water supply system.

2.1.5 OBJECTIVE AND TASK OF THE STUDY

2.1.5.1 TASK 1: INCEPTION REPORT INCLUDING CURRENT CONDITION ANALYSIS

As part of the Inception Report, the Organization/Institution will address the following:

a) Current situation analysis:

- defining the area covered by the water supply service and specifying the number of users and connections in each relevant category, e.i. households in individual residential units, households in collective residential units, industry, public institutions, businesses, farms for raising cattle, chickens...

- analysis of consumption, or needs for water; overview of current situation by user category, average consumption per inhabitant, needs of industry and cattle-raising, public consumption; analysis of the quantities of captured water at the sources and assessment of total losses.
- description of existing network, including sources and water supply zones, measure of protection of sources, water treatment, water quality, length, diameter and material of main water pipes, reservoir space, pumping and re-pumping stations, including installed equipment;
- map of existing systems, facilities and assets;
- assessment of system components in terms of capacities, efficiency, performance, reliability, adequacy, maintenance practices, age and quality of material and equipment, quality and quantity of raw water at the sources and treated water at the sources and in the network, source protection measures...
- description and assessment of the management system, assessment of losses by water supply zones
- assessment of the functioning of the water supply network;
- analysis and assessment of the capacities of the partner municipality and associated Water Utility Company in terms of management and running the existing and future infrastructural facilities, considering technical capacities, human and financial resources. The Organization/Institution should make a critical assessment of the current management of the system, human resources, organization, availability of technical equipment, operation and maintenance concept. Where necessary, the Organization/Institution should identify a need for future reforms, capacity building and propose concepts for future management (organization, needs for human resources, needs for equipment, enhancement of operation and maintenance...);
- socio-economic situation, financial analysis of the company's operation, analysis of current tariff system;
- analysis of institutional and legal regulatory framework – laws, regulations, rule books, standards, norms and directives which will be applied during the drafting of the Study and with which the Study will be aligned.

b) Analysis of development projects, studies, project solutions and harmonization of development of water supply systems with development plans and projects.

2.1.5.2WATER SUPPLY MASTER PLAN FOR PARTNER MONICIPALITIES

Water Supply Master Plan contains the following elements:

a) Demographic projection for the planning period of 20 years based on an analysis of strategic planning documentation from the aspect of ensuring necessary quantities of drinking water and industrial water. Defining the area covered by the water supply service provided via water utility company and specification of the number of users and connections in each relevant category, e.i. households in individual residential units, households in collective residential units, industry, public institutions, businesses, farms for raising cattle, chickens...Defining potential scenarios for development of the areas, number of inhabitants and industrial, commercial and public activities.

b) Balance of available and required water quantities for the 20 year planning period (drinking and industrial water). Capacities of available resources. Assessment of future needs for the planning period by zones and consumption groups. Assessment of possibility to provide industrial water from alternative sources (pumping water from water flows, using sources that cannot be used for drinking...).

c) Quality of drinking water at the sources and in the network. Detailed analysis and interpretation of existing physical and chemical and bacteriological findings; Sampling and extended physical and chemical and bacteriological analyses of water from the sources on three occasions in the course of drafting the Study in different hydrological conditions. Interpretation of all results and proposal of measures – types of water treatment for each of the listed sources.

d) Analysis of existing water protection measures (documentation on water source protection zones, municipal decision on water source protection zones, as well as current situation regarding protection of the water sources). Report on findings and set of recommendations.

e) Drafting two to three variants of conceptual solutions for the water supply system which ensure achievement of the overall goal in the 20 year planning period, including cost assessment, investment into construction, management and maintenance. Long-term financial comparisons of proposed solutions and proposal for adoption of one of the solutions. The conceptual solution should define the complete system, including water source, water treatment, main pipelines, pumping and re-pumping stations, reservoir capacity and other system elements. For each solution, the Organization/Institution will provide hydraulic modeling or appropriate hydraulic calculations.

f) Macro-available assessment and socio-economic analysis, investment capability to invest into the water supply system. The Organization/Institution should asses the macro-available amount of investment for implementation of measures. This indicative value will lead the Organization/Institution in the definition of an acceptable technical framework of measures. The total price should include the cost of investment and reinvestment, cost of functioning and maintenance and cost of general management.

   The assessment of macro-availability should be based on the assessment of the real capacity of users within local community to pay, which will be based on a socio-economic analysis, including all users (households, commercial, industrial and institutional), with a view to having an integrated approach to water supply systems, sewage systems and waste water treatment. An assessment of overall capacities in terms of community contribution should be made for the period used in the Master Plan, based on the current situation and results of the socio-economic evaluation, assessment of household reception needs and a projection of commercial and industrial development. These scenarios should be studied: „optimistically“, „averagely“ and „pessimistically“. Each scenario should contain a forecast of the state, entity, cantonal and municipal gross product in absolute values and in percentages of the GDP and gross income per capita in partner municipality.

   The analysis of availability should end with an assessment of users’ will to pay for water supply, sewage system and waste water treatment services. This assessment should be based on existing data, including all user categories. User community’s will and their contribution capacities should be taken into account, which may give rise to a situation that the necessary investments would be carried out in time phases.

g) Long-term water supply development plan. The plan will be based on the adopted concept – conceptual solution with defined water management facilities, water supply delineated by systems, zones and subzones, calculated maximum needs for water, defined water treatment at source locations, locations and capacities of reservoirs, pumping and re-pumping stations, main pipelines, hydraulic calculations, management system and other technical elements. The long-term development plan will identify facilities and costs and provide criteria for prioritization of the project, including risk assessment and mitigation of consequences for realization of full efficiency of the project.

2.1.5.3 TASK 3: PRIOROTIZED PLAN OF INVESTMENT MEASURES FOR THE PERIOD OF 10 YEARS

On the basis of the criteria developed in the long-term water supply plan and taking into consideration macro-available assessment and investment capability, the Organization/Institution will define:

- Prioritized project list with dynamic implementation plan;
- Funding sources (delineated external and internal funding sources), time lines, expected outputs and risks in implementation.

2.1.5.4 TASK 4: FEASIBILITY STUDY FORPRIORITY INVESTMENT MEASURES

Inception and implementation of this stage will follow as a result of the findings of the Master Plan. For the priority investment component/components identified as investment measure/measures, the Organization/Institution should ensure that adequate considerations and alternative solutions are given. The Organization/Institution should pay special attention to the assumptions for engineering (input data) and ensure that designing of plants and networks is in accordance with the current situation and realistic forecasts. The Organization/Institution will be asked to draft a Feasibility Study for the proposed priorities for the investment measure(s) in order to prove that the proposed solutions are the best possible solutions feasible in the planned period. The Feasibility Study should consider all technical, socio-economic, financial and environmental aspects of measures.

The Organization/Institution should ensure that the partner municipality and Water Utility Company be informed on the progress of the Feasibility Study.

Sub-task 1- Identifying technical scope for investment measures

The Organization/Institution should prepare a short summary of the technical scope of work for identification of investment measures and submit it to Project Steering Board for discussion. The short summary should be detailed enough to describe the background, proposed solutions and possible benefits/enhancements. The summary should be corroborated with location maps and drawings where necessary.

Sub-task 2 – Cost assessment

After an appropriate technical solution is made, which will lead to the goals of investment measures, the Organization/Institution should ensure that the protection measures, network and facilities are designed in line with the assumed projection. It also needs to be ensured that the proposed technical solutions are the best value for money during the operational period of the facilities and network.

The cost assessment should be based on a conceptual solution. An accurate cost assessment is an important element of the Feasibility Study. It should show clearly unforeseen physical and financial situations in the course of implementation / construction.

Sub-task 3- Financial analysis

The Organization/Institution will be required to construct a financial model which will cover the exploitation period of the project (10 year period). The financial model should contain all elements of costs, capital expenditures, all additional operational costs and maintenance costs.

The analysis of cost recovery should contain an assessment of investment costs, operation and maintenance and an assessment of expected revenues based on specification of tariffs to be applied to main user categories (households, commercial, industrial). These revenues should cover, as a minimum, investment, operation and maintenance costs, as well as costs of depreciation of the building, assets and equipment.

It will probably be possible to increase tariffs during the project implementation period. There are specified and acceptable limitations in terms of maximum percentage of the financial load on households' income (it is usually 3-5% of the household income for water supply services and collection and treatment of waste waters, based on instructions of the Council of Europe).

The financial system needs to be used to determine appropriate adjustments of policies and tariffs/prices, which will ensure financial sustainability of water utility company operation, provide enough room to those providing loans and ensure that tariffs remain within acceptable boundaries and are raised each year up to acceptable limits. The Organization/Institution should consider impact of all agreed and specified types of subsidies for socially excluded categories (differential prices according to revenues, subsidies by the partner municipality...).

Results of the analysis should manifest through several indicators (e.g. financial internal return rate and net current value). The Organization/Institution should discuss the interpreted indicators generated by the financial model and stated assumptions with the UNDP/MDG-F, partner municipality, associated Water Utility Companies and other parties the Organization/Institution thinks need to be involved in this project phase. The financial analysis will show sustainability of the proposed investment measures(s) in different scenarios. It should also contain an assessment of work of the Water Utility Company in charge of rendering services of water supply and the burden the proposed investment measure(s) can cause with their financial adjustment. This assessment should contain a projection of cash flow which is based on a sensible assumption of cost recovery, examine under which circumstances the Water Utility Company will have sufficient resources to render services, maintain the system and realize investments in the future.

Sub-task 4 – Economic analysis

The economic impact should be described in a quantifying form, as much as possible. Economic benefit, together with social, environmental and health benefits, generated by the Project should be described. If all relevant expenses and benefits could be quantified, the results of the analysis should be presented with the use of accepted indicators, such as financial and internal return rate, net current value, and benefit – cost ratio.

It is usually difficult to quantify all economic benefits of an infrastructural project. In this case, other kinds of quantifying analyses can be used such as multi-criterion analysis and cost effectiveness analysis.

The cost effectiveness analysis should presume that the Project should achieve the level of rendering services and standards set by relevant environmental analyses. Therefore, relevant EU standards can be treated as objective goals that need to be achieved with optimal economic effectiveness during the operational period of the project.

Sub-task 5 - Preliminary assessment of environmental impact

The preliminary assessment of environmental impact will be performed in accordance with the Rule Book on production plants requiring a mandatory environmental impact assessment and plants that may be built and become operational only with an environmental approval.

The Organization/Institution will be obliged to analyze the environmental impact of the works that should be undertaken within the Project and verify whether the works can lead to soil degradation, jeopardize the sources and water courses, environment and natural habitats, as well as neighboring areas.

Sub-task 6 - Implementation plan and strategy

The Organization/Institution will be obliged to prepare an implementation plan and strategy for investment measure(s) which the study proves to be feasible. The implementation plan should contain:

- Deadlines to carry out implementation measures with mandatory accompanying management and maintenance measures;
- Management of implementation of investment measures;
- Financial plan and funding sources;
- Technical standards and alignment with development projects;

- Public procurement procedures;
- Monitoring and reporting systems.

2.2 POPULATION AND SPATIAL COVERAGE

2.2.1 POPULATION

2.2.1.1 POPULATION OF THE SUBJECT AREA THROUGH THE HISTORY

In the item 2.1.2 BASIC DATA ABOUT GRAČANICA the basic data on Neum Municipality and it's settlements are given. Considering the fact that the last census was conducted in 1991, there is no exact number of inhabitants, for the settlements and municipality. The following table presents the number of inhabitants per settlements for 1991 (census) and for 2009 (estimation).

Table 3: Population in Gračanica municipality by settlements

Settlement	Census in 1991	Estimation based on municipality data for 2009
Gornji Skipovac		
Donji Skipovac		
Gornji Doborovci		740
Buk		375
Trnovci		737
Lendići	318	0
Prijeko Brdo	464	675
Skipovac Gornji	481	0
Gornja Lohinja	614	159
Rašljeva	758	1.092
Piskavica	808	924
Vranovići	1074	1.042
Donja Lohinja	1091	1.316
Škahovica	1423	1.480
Pribava	1682	2.300
Babići	1831	2.700
Soko	1920	2.120
Doborovci	1999	1.750
Orahovica Gornja	2035	2.250
Džakule	2306	2.550
Mirićina	2517	2.756
Malešići	2964	3.500
Lukavica	3231	3.200
Stjepan Polje	3347	4.000
Orahovica Donja	4304	5.500
Gračanica	12712	17.760
Total population:	**47879**	**58.926**

According to the last official census in 1991, Gračanica municipality had **59.050 inhabitants (17.056 households)**, allocated into 28 settlements. Of that number, 12.712 inhabitants lived in the town

Gračanici. Considering the fact that in 1991 the municipality was divided into 2 municipalities – Gračanica and Petrovo, in the area of current municipality there was **48.372 inhabitants**.

Gračanica municipality belongs to Federation BiH, it's within Tuzla Canton, with the surface area of 219,5 km2 and population density of 268 inhabitants/km^2.

Untill 1991 it spreaded to the both sides of Spreča river, between two economy (industry) regions Doboj and Tuzla with the surface area of 387 km^2.

According to municipal administration estimated data from 2009, there are **58.926 inhabitants** living in Gracanica, of which 30% of inhabitants live in urban municipality part.

With population density of 268 inhabitants per km^2 Gračanica municipality has intensive population comparing to Tuzla Canton average of 168 inhabitants/km^2 and Federation BiH of 90 inhabitants/km^2.

Gračanica municipality is organized and includes 25 local communities (1 urban and 24 rural LC) of which 21 are registred and active, and 4 unregistered and inactive , but have neighboring local communities working for.

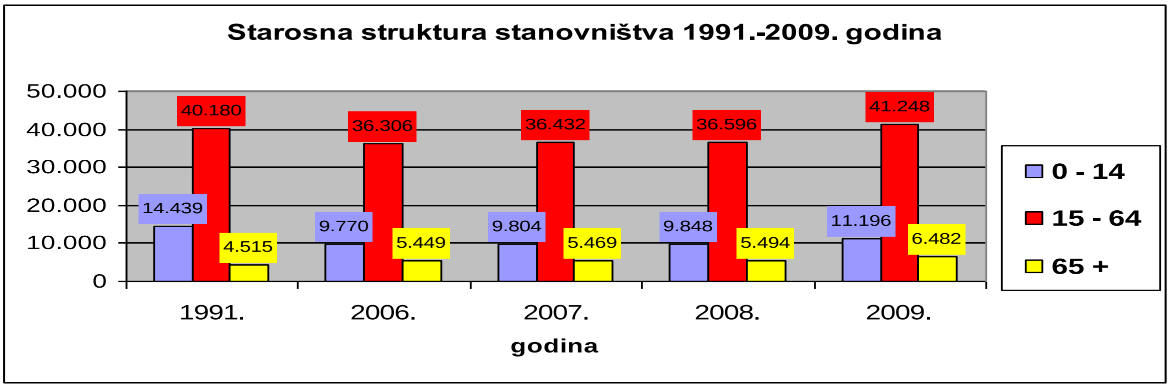
Registeres and active local communities are: MZ Babići, MZ Buk, MZ Doborovci, MZ Gornji Doborovci, MZ Donja Lohinja, MZ Donja Orahovica, MZ Džakule, MZ Gornja Orahovica, MZ Gračanica, MZ Lukavica, MZ Malešići, MZ Miričina, MZ Piskavica, MZ Pribava, MZ Prijeko Brdo, MZ Rašljeva, MZ Soko, MZ Stjepan Polje, MZ Škahovica, MZ Trnovci and MZ Vranovići, and unregistered and inactive are: MZ Lendići, MZ Gornja Lohinja MZ Donji Skipovac and MZ Gornji Skipovac.

2.2.1.2 DATA FOR THE STRATEGY OF GRAČANICA MUNICIPALITY ECONOMY DEVELOPMENT 2011-2015 – DATA ON POPULATION

POPULATION STRUTCURE

Population age structure has changed in recent years, in line with general trends typical for the aging process. The population in which young people under 14 years of age make more than 30% of the total population and old population of less than 6% is considered as "young" population. In the opposite case we speak of an aging population.

Chart 1: Population age structure



Data source: Federal institution for statistics FBiH (for 1991, 2005, 2006, 2007 and 2008). Data of LC for 2009

If we compare the age structure of Gracanica municipality with other municipalities, we see that Gracanica municipality is among the municipalities with the largest percentage of age groups of working age (from 15 to 65) in the total population (70%), and the percentage of this age group is higher than Tuzla Canton average.

Gracanica is one of the municipalities with the lowest rate of population aging. Aging rate of 57.8% indicates that for every 100 inhabitants aged 0-14 years there are 58 people older than 65 years.

The rate of aging of the population in the municipality of Gracanica (57.8%) was significantly lower than Tuzla Canton average rates of aging population (68,9%), FBiH (71,5%) and BiH (86,4%).

Rate of dependence gives us the information of every working age person who needs to support economically inactive persons.

In addition to municipalities Banovići and Kladanj, Gracanica municipality has the lowest depending population rate. In Gračanica municipality area, for every 100 working age inhabitants there are 43 economically inactive inhabitants, which is for around 5% less than BiH average.

GEOGRAPHICAL DISTRIBUTION OF POPULATION

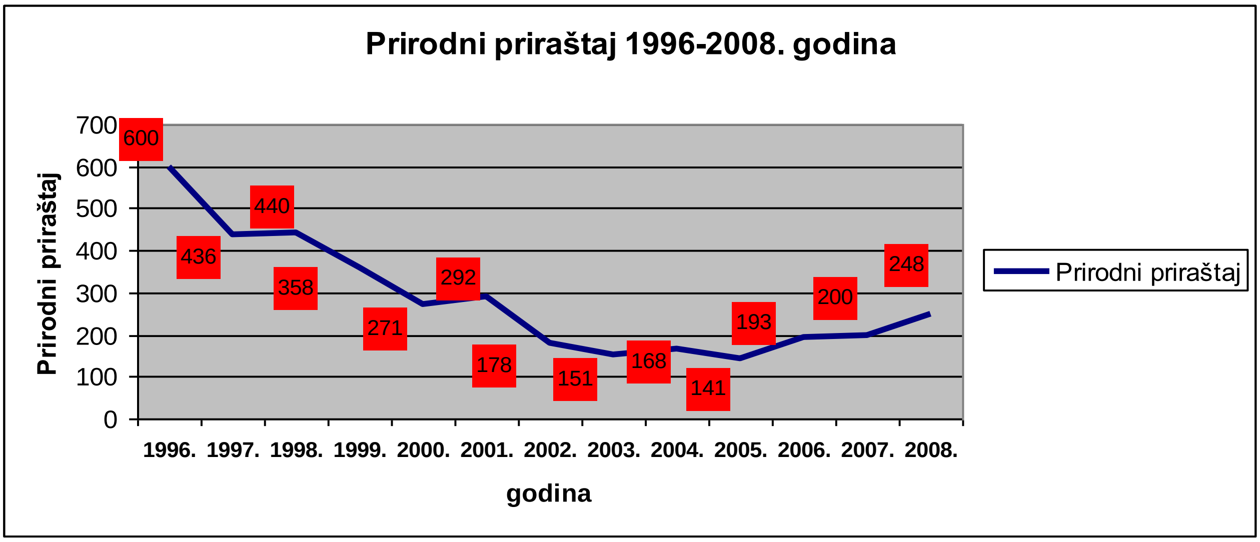
Gracanica is one of the most densely populated municipalities in BiH. Gracanica municipality density is greater than two and half times the average population density in Bosnia and significantly higher than the average population density in Tuzla Canton. This implies the need for a developed infrastructure, and careful spatial management. There is a problem of lack of sites for the further industry development.

According to the census in 1991, 88.5% of the population lived in Gracanica municipalitiy rural parts. According to data collected by the local communities in 2009, that percentage decreased to 69.8%. The obvious is the pressure on urban local community Gracanica with very high density of 925 inhabitants/km^2.

NATURAL POPULATION GROWTH

Data on population growth show a positive population growth. Average natural population growth in the period 1996 - 2009 amounted to 283 inhabitants. In the period 1961-1981, the annual growth rate was 1.5%, and in the period 1981-1991 it was reduced to 0.87%. In the period from 1991 to 2009, the population of the municipality has manifested an increasing tendency but was less pronounced than in the previous period. Direct and the biggest impact on the overall increase in population had the component of natural population, i.e. birth and mortality and their resultant natural increase and migration of population from the period 1992-1995.

Chart 2: Natural migration of population in the period 1996 - 2008



Data source: Statistical year book FBiH for 2001 and 2009

Although still positive, the natural increase of population has declined continuously until 2005, after which continued growth can be noticed.

POPULATION MIGRATIONS

The main migratory movements in Gracanica area untill 1991 were from rural to urban areas. According to the census, in 1991 Gracanica had 59 134 inhabitants; by the Dayton Agreement, aurface area of Gracanica municipality was reduced by 43.28% and population by 18.2%. Part of Gracanica municipality was in Republic of Srpska, and the population was reduced from 59 134 to 48 372 inhabitants.

At the same time in 1995 in Gracanica has found refuge for 7291 displaced people from other populated areas-municipalities such as Zvornik, Srebrenica, Bratunac, Vlasenica, Doboj, Grapska, Derventa, etc. Most of the population has returned, so now other 821 people who do not have the conditions for return are located mainly in the refugee settlements within the municipality.

Following tables show the data on population. The data were taken from Tuzla Canton Spatial plan and from the Institute for Statistics.

Table 4: Municipality demographic data – data from Tuzla Canton Spatial plan

Year	Population	Births	Deaths	Natural population growth	Birthrate	Mortality	Natural increase
					(‰)	(‰)	(‰)
1996	54.025	844	244	600	15,62	4,52	11,11
1997	47.820	737	301	436	15,41	6,29	9,12
1998	51.829	733	293	440	14,14	5,65	8,49
1999	52.440	609	251	358	11,61	4,79	6,83
2000	52.772	560	289	271	10,61	5,48	5,14
2001	53.040	573	281	292	10,80	5,30	5,51
2002	53.226	497	319	178	9,34	5,99	3,34
2003	53.381	530	379	151	9,93	7,10	2,83
		5083	2357	2726			

Table 5: Estimated population in Gračanica municipality by age

	Estimated population in Gracanica municipality by age			
Year	1998	2004	2015	2025
Population	51.829	52.364	54.568	56.816

Table 6: Number of households and households members

Municipality	1991			2005			2015			2025		
	Inhabitants	Households	Estimated number of household members	Inhabitants	Households	Estimated number of household members	Inhabitants	Households	Estimated number of household members	Inhabitants	Households	Estimated number of household members
Gračanica	47868	16821	2.8	52434	16914	3.1	54568	17053	3.2	56816	17755	3.2

Table 7: Data on settlements and the type of settlements - data from Tuzla Canton Spatial plan

Settlement	1991			2001			2025		
	Population	% of population in agriculture	Type of settlement	Population	% of population in agriculture	Type of settlement	Population	% of population in agriculture	Type of settlement
Gračanica Municipality	41.962			50.378			62.335		
Babići	1.830	49.3	S	2.012	40.4	S	2.620	39.8	M
Doborovci	2.000	56.8	S	2.712	49.7	S	3.260	48.7	M
Donja Lohinja	1.091	65.2	S	1.587	56.1	S	2.315	39.2	M
Džakule	2.303	54.2	S	2.422	48.3	S	3.185	45.4	M
Gračanica	12.771	25.8	G	17.397	23.6	G	20.156	16.8	G
Lukavica	3.218	61.3	M	4.119	45.2	M	4.449	39.1	M
Malešići	2.958	57.2	S	3.210	53.4	M	4.125	47.2	M
Miričina	2.510	64.3	S	2.614	58.3	S	3.426	53.2	M
Orahovica Donja	4.303	54.3	M	4.540	48.6	M	6.030	36.4	M
Orahovica Gornja	2.027	65.2	S	2.257	60.3	S	3.120	51.4	M
Pribava	1.682	41.6	S	1.897	39.7	M	2.867	26.5	M
Soko	1.920	57.6	S	1.967	53.2	S	2.430	39.3	M
Stjepan Polje	3.349	58.0	M	3.644	46.2	M	4.352	37	M

Table 8: Involvement of urban area – data from the Tuzla Canton Spatial plan

	Area in km^2 of municipality	Area in km^2 of urban part	Percentage
Gračanica	215,34	26.74	12.42

Given the lack of accurate data on population for the past 20 years, all data in this period have been estimated. We can, also, notice some inconsistencies in the documentation where you have different information about the number of inhabitants in the same document. However, for the preparation of this Master Plan, estimates that were made in the Regional Plan have been taken as a point load for the planned water supply.

The

Table 7: gives the estimation of population for the planning period utnill 2025. With estimates of population growth, these results were used as a point load.

2.2.1.3 PLANNED POPULATION NUMBER IN GRAČANICA MUNICIPALITY

For the subjected Master plan, the planning period is 20 – 25 years. Due to the recent experiance regarding the slowness of realization some certain projects, the expert team increased the planning period from 20 years to 25 years. Talking about results this increase will not have any significant impact.

In the previous text, there are the data on population, but, also, on population migration through time, as well as the estimation of population for the future period.

Using the mentioned data, expert team gave the estimations on population migration during the planning period. In the item **Error! Reference source not found.Error! Reference source not found.** there are data on population for all local communities, individualy and in total for Gračanica municipality.

Table 9: Current and planned population number by local communities in Gračanica municipality

Local community	Perspective population number in municipality area						
	2010	2012	2015	2020	2025	2030	2035
	58.926	**60.264**	**62.327**	**65.924**	**69.729**	**73.753**	**78.010**
	Perspective population number in local communities						
Gračanica	17.760	18.062	18.525	19.324	20.156	21.025	21.931
Škahovica	1.480	1.495	1.517	1.556	1.595	1.635	1.677
Donja Orahovica	5.500	5.568	5.671	5.848	6.030	6.218	6.411
Stjepan Polje	4.000	4.045	4.114	4.231	4.352	4.476	4.604
Lukavica	3.200	3.344	3.571	3.986	4.449	4.965	5.542
Malešići	3.500	3.578	3.697	3.905	4.125	4.358	4.603
Miričina	2.756	2.837	2.963	3.186	3.426	3.684	3.961
Džakule	2.550	2.627	2.746	2.958	3.185	3.430	3.694
Orahovica Gornja	2.250	2.350	2.509	2.798	3.120	3.480	3.880
Doborovci	1.750	1.901	2.153	2.650	3.260	4.012	4.936
Soko	2.120	2.159	2.219	2.322	2.430	2.544	2.662
Babići	2.700	2.711	2.727	2.754	2.782	2.810	2.838
Pribava	2.300	2.369	2.475	2.664	2.867	3.085	3.320
Donja Lohinja	1.316	1.329	1.349	1.383	1.418	1.454	1.491
Vranovići	1.042	1.052	1.068	1.095	1.123	1.151	1.180
Piskavica	924	933	947	971	996	1.021	1.047
Rašljeva	1.092	1.103	1.120	1.148	1.177	1.207	1.237
Gornja Lohinja	159	161	163	167	171	176	180
Trnovci	737	744	756	775	794	814	835
Prijeko Brdo	675	682	692	710	727	746	765
Buk	375	379	384	394	404	414	425
Gornji Doborovci	740	747	759	778	797	818	838
Population in total	**58.926**	**60.176**	**62.128**	**65.603**	**69.387**	**73.522**	**78.057**

This table shows the population number estimation of **78.000 inhabitants** in municipality in **2035** and in Gračanica town around **22.000 of inhabitants**. The medium coefficient of population growth is **1,13 %.**

Population growth coefficients are different for all settlements. The following table shows coefficient growth changes through the time. The drop of this coefficient is in the most of the settlements is noticable from 1971.

Following table shows the data for several local communities, regarding the population number in the period from 1971 from 2009.

From the Table 4: we can see that in the period 1996 – 2003 the natural population growth decreased. Unfortunaltelly, we don’t have data for the last 7 years. Based on data obtained from municipality, the population number significantly increased in this period. We don’t know the reason for that, wheather the natural population growth or migrations and the return of inhabitants. However, the population increase is very significant in the last 20 years, althought there was a war what was the reason of population migrations. According to the census in 1991 there was **48.372 inhabitants** living in this area, while in 2009, based on the estimations, there was **59.170 inhabitants**. The reason for this huge change of population number, besides the natural population growth, is, aslo, the population movements during ninetees.

Table 10: Population number change for bigger settlements in Gračanica municipality

Area	Population growth coefficients				
		1,46715	0,8543		1,1025
	Year				
	1971	1981	1991	1991[1]	2009
	Population number based on censuses and estimations				
Gračanica municipality	46950	54311	59134	48372	58926
Gračanica town			12712	12712	17760
Percentage of town population:			21,50%	26,28%	30,14%

Area	Population growth coefficients			
		2,457	1,035	-0,054
	Year			
	1971	1981	1991	2009
	Population number based on censuses			
LC Lukavica	2287	2915	3231	3200

Area	Population growth coefficients			
		2,705	1,042	0,929
	Year			
	1971	1981	1991	2009
	Population number based on censuses			
LC Malešić	2046	2672	2964	3500

Area	Population growth coefficients			
		1,375	1,031	0,505
	Year			
	1971	1981	1991	2009
	Population number based on censuses			
LC Miričina	1982	2272	2517	2756

Area	Population growth coefficients			
		1,63	1,09	0,995
	Year			
	1971	1981	1991	2009
	Population number based on censuses			
LC Stjepan Polje	2555	3003	3347	4000

Area	Population growth coefficients			
		1,25	1,09	2,035
	Year			
	1971	1981	1991	2009
	Population number based on censuses			
LC Babići	1.489	1686	1879	2700

Estimations for the future period of 25 years concerning the increase of population are maybe optimistic. However, the expert team for Master plan draft accepted estimations given in Tuzla Canton Spatial plan.

[1] After dividing the municipality in 1991

2.2.2 SPATIAL COVERAGE

Gračanica municipality does not have unique water supply system. Besides the central Gračanica town water supply system in the area of municipality, there is a number of smaller or bigger local systems. In the area of one local community, there are several water supply systems.

Considering the spatial coverage, we o0nly talk about the town central water supply system. Due to the available water amounts at the sources, this system will not be able to cover other settlements out of this system in the future.

2.3 EXISTING WATER SUPPLY SYSTEM – CENTRAL TOWN WATER SUPPLY SYSTEM GRAČANICA

2.3.1 INTRODUCTION

Population and industry water supply in Gračanica municipality area is not adequatelly solved. In municipality atrea there is one central water supply system of Gračanica settlement and a number of smaller and bigger local water supply systems.

Water supply system managed by Public Company „Vodovod i kanalizacija“ (water and sewerage utility) Gračanica includes two local communities:

- LC Gračanica (urban LC), with 17.760 inhabitants
- LC Pribava (suburban LC), with 2.300 inhabitants

This means that the town water supply system supplies around 20.060 inhabitants of the total of 58.926 inhabitants. So, the town water supply system covers 34,04 %, what makes the percentage very low.

Gračanica municipality has a lot of settlements and a huge population number not living in the urban part of municipality.

Considering water supply in the town system and LC Pribava area, maintaned and managed by public company „Vodovod i kanalizacija“ Ltd. Gračanica, that was never completelly solved, first of all because of the missing drinking water amounts. Currently, the system is water supplied from natural sources (Vrela, Ilidža and Zmajevac from Soko and the source Škahovica, as well as the drilled wells Sklop, Seljanuša and Hadžijina voda).

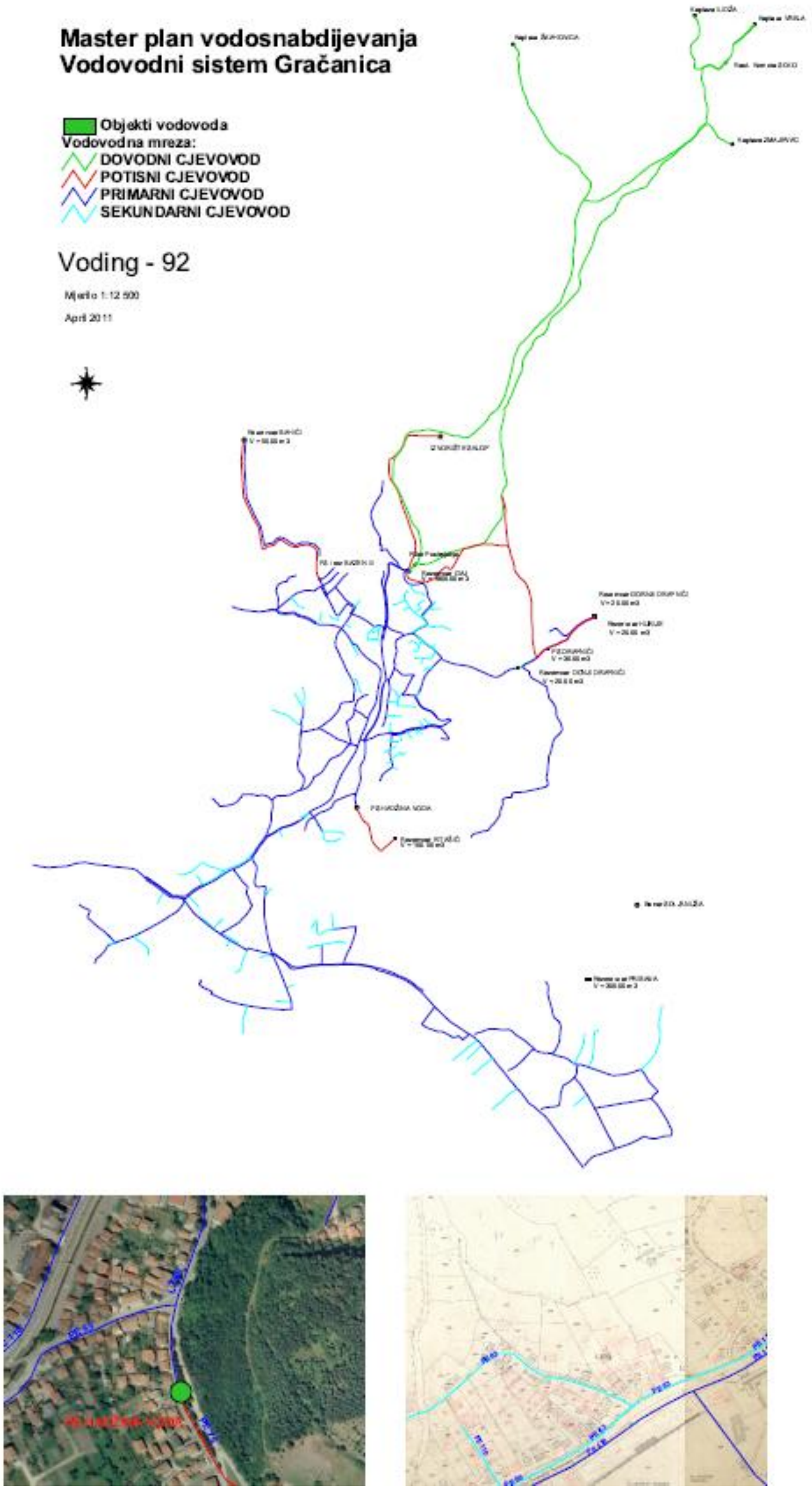
Insufficient water amount in the system result with the consequence of water supply reduction, as well as the problem of imposibility of water supply expansion to some new settlements.

Considering villages, the situation is lot worse, and we can say that the water supply very poor and that there are the reductions of regular water supplying in those villages, especially during summer months. We, also, have to mention that water distribution systems are very old and with high losses

Part of the local water supply systems is reconstructed and new water supply systems are constructed (for instance, water supply system for settlement Stjepan Polje).

During the previous period, some certain hydrogeological researches were conducted, which showed the potential areas for ground waters abstraction. During 2008 the Study with the program of hidrogeological ground waters abstraction was drafted, in the aim of Gračanica municipality water supply improvement. This is, also, the most imprtant document which makes the base for application according which we expect the complete solving of implementing the additional water amounts in the area of entire municipality, where it is missing.

In the town system area and LC Pribava there are more precisely defined the potential areas forr drilling the research-exploitation wells, so the certain activities allready begun.



Scheme 1: WSS Gracanica scheme

2.3.2 WATER SUPPLY SYSTEM GRAČANICA – BASIC DATA

Water supply system Gračanica, covers the town Gračanica, as well as the settlement Pribava with the population number of 20.060. Besides the population, this water supply system, also, supplies the industry in the area of these two local comunities.

The construction of WSS Gračanica begun in 1962.

Talking about the sources and water distribution system, it is a combination of gravitational and pumping system.

Municipal water supply system is conceptually resolved as follows:

Available water quantities from natural sources Ilidza, Vrela, Skahovica and Zmajevac are transported by gravity to the central town reservoirs, "Gaj" of the total volume V = 1800 m^3. Depending on the yield and quality of water in natural sources, as well as the consumption in the system, the pumping is done at the source Sklop and, also, the transport to reservoir "Gaj". The largest part of the system is supplied with water gravitationally from the town reservoir (about 87%), but there are zones in which water is additionally pumped (Ritašići and Bahići).

The supply zone Gornji and Donji Drafnići and Hurije is partially supplied gravitationally (gravitational separation of water from the supply system from Sokola at the surge tank Lepar or by pumping the water from reservoir "Gaj" when water is turbed). In settlement Gornji Drafnići there is a pumping station for pumping the water from higher zone of this settlement and settlement Hurije.

In the period of natural sources turbidity (all of them) water at the source is disscharged into the slurry outlet and it is not used, and then the entire water supply of population is „taken“ by the source – drilled well Sklop.

Water supply system in LC Pribava is supplied from drilled well Soljanuša by pumping the available water amounts to the reservoir „Pribava“ V=300 m^3.

Water supply system is located in a belt of 154 MASL to 350 MASL, i.e. in the belt of altitude difference of 200 m.

At both distribution networks there is a pressure regulation system established in the system (in the town system it is dynamic, and in the system Pribava two degrees of fixed regulation). In the shaft of pressure automatic regulation there is a fixed regulation of 5,2 bar to 3,5 bar, while the second regulation degree is in the shaft „Grin“ and the entrance pressure is additionally lowered for 2,0 bar. In water supply system Pribava there is a fixed regulation rom 7,5 bar to 4,0 bar. In this way, the optimal pressures are established at consumers and losses in the network are reduced.

Distribution network Gračanica is divided into 10 supply zones, and in 6 zones there is a remote monitoring by Data logger with GSM data transmission till the Dispatching center.

Data on distribution network, number of consumers, consumption, etc. are given in the tables, as well as in charts.

2.3.3 SOURCES IN WSS GRAČANICA

Considering the water supply system Gračanica managed by public company „Vodovod i kanalizacija“ Ltd. Gračanica, the fresh water sources are combined :

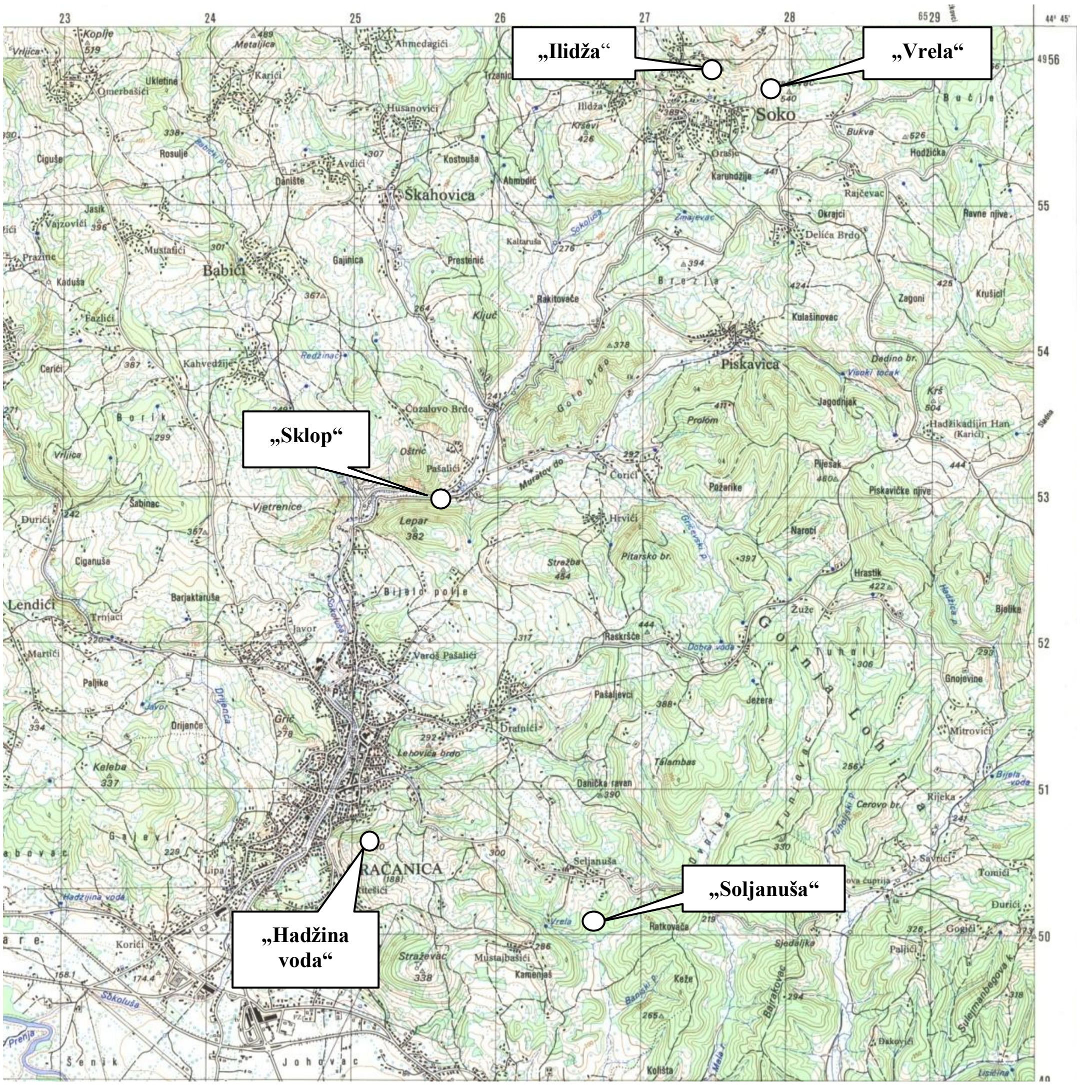
- Natural sources from the limestone areas, self-disscharge (Vrela, Ilidža, Zmajevac and Škahovica)
- Drilled wells (Sklop 150 m deep, Soljanuša 100 m deep, and Hadžijina voda 80 m deep).

Sources for supplying town water supply system are given in the Table 14: .

The sources Sklop, Vrela, Ilidža, Soljanuša and Hadžina voda are located north-east and south-east of Gračanica. Source Sklop is around 1 km far away from Gračanica (at the north side) and it’s basin area includes wider area of Pašalići and Piskavica settlements, and, also, the part of Škahovica and Soko settlements. Source Vrela and Ilidža are located in settlement Soko appr. 4 km north-east from

Gračanica with th ebasin area that spreads to the surface border at Cerovi-Glavičica-Glavica direction. Sources Soljanuša and Hadžina voda are located south-east from Gračanica; Soljanuša appr. 2 km from the town center, and Hadžina voda almost in the town. From administrative point of view, all of the mentioned sources, with their belonging basin area, belong to Gračanica Municipality, i.e. Tuzla Canton.

Minimum capacity of all sources is **Q_{min}=32,60 l/s**. however, in high precipitation periods, all of the natural sources are being turbid, so, very they have to be excluded from the system, untill the turbidity is gone. That is the most unfavorable period of year, regarding the capacities. At natural sources there are no plants for drinking water treatment which would enable the use of water even in the turbidity periods. This means that during these periods there is only the use of wells left, with the capacity of **Q_{min}=23,60l/s**.



Scheme 2: Situational position of Gračanica water supply system sources

Basic data about sources:

- Facility volume at the source (reservoir, etc.)
    - At the natural sources there are classical capturing facilities constructed, without significant chambers volume
- The position of flow meter
    - At the natural sources there are trapezodial overflows for measuring the flow , without the flow meter

- At the drilled wellls there are electromagnetic flow meters installed

- Data on water quality and sources yield analysis
  - Water quality control is performed regularly, and the data about source capacity are mentioned above,
- Report on the source protection zones
- It was made in 2008 and includes all of the sources in water supply systemGračanica.

2.3.3.1 WELLS SKLOP

The main source are the wells Sklop II and Sklop III which are located north of town. Capacity of these wells is **Q_{min}=17,0 l/s**.

The area where the wells are located is fenced. It is situated at the left side of the spring, by which it is periodically jeopardized during high precipitations. The source is not regulated, so it is necessary to protect these sources by regulating them.

Well Sklop I

Exploitation well Sklop I is located between Sokoluša river and Gračnica road -Srebrenik. Technical characteristics of the well and the data about it's testing pumping are taken from the Report about this well construction.

Basic characteristics of the well:

Depth of the well: 180,30 m

Well's profile:

- 0,00 - 7,60 m ∅ 17 ½"
- 7,60 - 50,00 m ∅ 12 ½"
- 50,00 - 180,30 m ∅ 7 $^{5}/_{8}$ "

Down to the well's depth of 7,6 m there is a cement column installed ∅ 355 mm.

Well's construction:

- 0,00 - 49,65 m full steel column ∅ 273 mm
- 48,50 - 73,60 m full steel column ∅ 168 mm
- 73,60 - 180,30 m perforated column ∅ 168 mm

There is a sinking pump in the well, and test pumping was performed with three capacities and lowering Q1=4,9 l/s , Q2= 9,5 l/s and Q3= 25,0 l/s.

It is important to mention that the water temperature was Tv=15,5ºC which, having in mind the hydrogeological source model, gives the thermal character to Sklop sources drinking water, what is very important to know while assesing the good natural conditions of this source protection. In addition, besides the complete bacteriological regularity of water in the Sklop source during some longer term period (1980-2002.), there are the test pumping data of the borehole S-1 Vjetrenica, which is located near to Sklop, and which water temperature is Tv=18ºC. The mentioned temperature characteristics of Sklop source water are, also, very similar to the groundwaters of Soljanuša source with bacteriologically regular water temperature is Tv=17,5 oC , and what confirmes the fact that these two source belong to the same hydrogeological unit.

Well Sklop I is protected against unauthorized access to the facilities, and the well area is planted with vegetation and very well arranged.

Well Sklop II

Exploitation well Sklop II is, also, located between Sokoluša river and Gračnica road - Srebrenik. It is situated 50 m west of the well Sklop I. Technical characteristics of the well and the data about it's testing pumping are taken from the Report about this well construction.

Basic characteristics of the well:

Depth of the well: 250,00 m

Well's profile:

- 0,00 - 8,00 m ∅ 17 ½"
- 8,00 - 40,60 m ∅ 12 1⁄4"
- 40,60 - 62,60 m ∅ 7 $^5/_8$ "
- 62,60 – 250,00 ∅ 7 ½"

Down to the well's depth of 8,0 m there is a cement column installed ∅ 355 mm.

Well's construction:

- 0,00 - 40,60 m full steel column ∅ 273 mm, cemented
- 40,00 - 150,00 m full steel column ∅ 168 mm
- 150,00 - 250,00 m perforated column ∅ 168 mm

Well Sklop III

Exploitation well Sklop III is located nearby the well Sklop I appr. 15 m far away, west side. Technical characteristics of the well and the detail data about it's testing pumping are taken from the Report about this well construction.

Basic characteristics of the well:

Depth of the well: 165,0 m

Well's profile:

- 0,00 - 3,00 m ∅ 500 mm
- 3,00 - 6,00 m ∅ 444,5 mm cemented inlet column
- 6,00 - 67,50 m ∅ 381 mm
- 67,50 - 165,00 m ∅ 215,9 mm

Well's construction:

- + 0,10 - 3,0 m full steel column ∅ 500/488 mm
- 3,50 - 6,00 m inlet steel column ∅ 406 mm
- 6,00 – 67,50 m meta-filter steel column ∅ 273/259 mm
- 65,0 – 69,00 m meta-filter zinc column ∅ 168/156 mm
- 69,0 – 158,50 msloted zinc filter ∅ 168/156 mm
- 158,00 - 164,50 m sludge tank, zinc column ∅ 168/156 mm

After the cleaning and accessing the well, the sinking pump was installed and the test pumping was performed with three capacities and lowering Q1=15 l/s , Q2= 30,6 l/s and Q3= 43,85 l/s.

Figure 3: Wells "Sklop"

EXPLOITATION POSIBILITIES OF THE SKLOP SOURCE

The source "Sklop" is exploited only by the well Sklop III because the two other wells (Sklop I and II) are excluded from exploitation due to the age and insuitable technical characteristics.

Exploitation capacity of the well Sklop III and the source Sklop, is determined by the constant pumping test in the period from 22/03. to 28/03/2002, and the pumping step test with three capacities and three dynamic lowerings perfomred on 29/03/2002 by the company FIL.B.IS. Zagreb.

Pumping test of the well by the step test was performed by the following capacities:

Sklop III	Capacity (l/s)	Lowering (m)
capacity	15	0,74
capacity	30,6	1,99
capacity	43,85	3,69

Constant test pumping of the well, lasting for 5 (five) days was performed by the capacity Q = 37 l/s with lowering of 4,61 m. 19.824,84 m^3 of groundwater was pumped out.

In conclussion of the Report it is emphasized that, based on the results interpretation of the test pumping, the optimum capacity of well Sklop III is in the constant exploitation:

$$Q = 30\ l/s$$

In accordance with the pumping results in source Sklop, nowadays the well Sklop III exploits groundwaters with the capacity of around **Q = 30 l/s**. Mentioned exploitation capacity is around 50 % of the total water amount captured for Gracanica water supply system. Exploitation capacity of this and other existing sources in Gracanica is not satisfying needs in the planning period.

2.3.3.2 WELL SOLJANUŠA

Well Soljanuša is located south of town, in the area of Pribava local community and serves for water supply of this local community. Capacity of these wells is Q_{min}**=5,70 l/s**.

The source Soljanuša is located around 2,5 km south-east from Gračanica, nearby the spring Soljanuša. There was the source Vrela in the zone of the source, but it dried up after the exploitation wells construction.

The source is formed in the zone of fault creep northwest-southeast direction at the contact of limestone Paleocene-Eocene and Middle Miocene Sarmatian marls. The primary groundwater aquifer is limestone, Paleocene-Eocene.

The roof of the primary aquifers are layers of middle Miocene-Badenian; places talus deposits less thick in the basement, mostly tight complex of Upper Cretaceous flysch.

The aquifer is fed by the infiltration of precipitation in the wider area of distribution of limestone in the Paleocene-Eocene zone Seljanuše, Drafnići, and Gornja Lohinja.

The assumed direction of groundwater flow in the aquifer, with minor deviations, are the northwest-southeast and the northeast-southwest.

The level of groundwater in the aquifer is sub-artesian.

In the zone of the sources there are two exploitation wells derived that have affected ground water in cracked high-level limestones of Upper Cretaceous flysch.

In 1980 "Geological Institute" Ljubljana constructed the well P-1 which was included in Gracanica water supply system for a long time, untill 2003 when the company FIL.B.IS. Zagreb constructed the well P-2.

Exploitation well P-2 is located nearby the well P-1, i.e. 8 m west from the spring Soljanuša. In the Report on well’s construction, we can see technical characteristics of the well and the data on it’s test pumping.

Basic characteristics of the well:

Depth of the well: 120 m

Well’s profile:

- 0,00 - 16,00 m ∅ 444,5 mm;
- 16,00 - 69,00 m ∅ 381 mm;
- 69,00 - 120,00 m ∅ 219 mm;

Well’s construction:

- 0,00 - 16,00 m steel column ∅ 406 mm;
- 0,00 - 68,00 m steel column ∅ 273 mm;
- 67,43 - 68,00 m meta-filter zinc pipe ∅ 200 mm;
- 68,00 - 116,20 m sloted zinc filter ∅ 168 mm, and
- 116,20 - 120,00 m zinc sludge tank ∅ 168 mm.

Annular gap between the steel column ∅ 273 mm and well’s chanel ∅ 381 mm is cemented.

The well has the sinking pump installed and the test pumping was performed with three capacities and lowering $Q1$ = 15,85 l/s $S1$ = 0,63 m; $Q2$ = 19,75 l/s $S2$ = 0,92 m; $Q3$ = 24,93 l/s $S3$ = 1,37 m.

The water temperature in Soljanuša is Tv=17,5ºC which gives thermal character to the source. It is important to bear in mind because it indicates a favorable natural conditions for the protection of water resources in favor of monitoring a complete bacteriological water source Soljanuša for a longer period of time.

Water temperature and hydrogeological model of Soljanuša source are very similar to the groundwaters and model of the source Sklop, which indicates that these two groundwater sources, most probably belong to the same hydrogeological unit.

Well P-2 Soljanuša is protected against unauthorized access by a concrete shaft and fence, and the space around well is vegetation sown and well arranged.

EXPLOITATION CAPACITIES OF THE SOURCE SOLJANUŠA

Source "Soljanuša" is exploited by the well P-2 because the other well P-1 constructed in 1981 is excluded from exploitation, due to it's age and unsuitable technical characteristics.

Capacity of the well P-2 is determined by the test pumping with three capacities and three common dynamic lowerings wgich lasted for 168 hours and which was performed in 2003 by company FIL.B.IS. Zagreb.

Well's test pumping was performed by the following capacities:

Soljanuša	Capacity (l/s)	Lowering (m)
I - capacity	15,85	0,63
II - capacity	19,75	0,92
III - capacity	24,93	1,37

In the conclussion of the Report it is emphasized that, based on the test pumping interpretation results, the optimum well's capacity is in constant exploitation:

Qex. = 22,5 l/s

With the lowering of S = 1,14 m.

Well P-2 in the source Soljanuša nowadays exploit groundwaters in capacity of **Q = 8,0 l/s**. The mentioned exploitation capacity participates with appr. 15 % of the total abstracted water for the needs of Gracanica water supply system.

2.3.3.3 NATURAL SOURCES „VRELA“ AND "ILIDŽA"

NATURAL SOURCE „VRELA“

Natural source Vrela and Ilidža are located in the settlement Soko. They are formed in the Paleocene-Eocene limestone in which roof there are layers of middle-Baden, and talus deposits of less thickness, and at at the bottom ophiolitic Melange.

Aquifier of the sources Vrela and Ilidža is fed by precipitation infiltration, and it's disscharge is done through the 'same-name' sources.

General assumed groundwater flow direction is northeast-southwest and north-south. The level of groundwater in the aquifer is free.

Sources Vrela and Ilidža are captured by capture facilties construction in sixtees of the XX century. Documentation on the mentioned works is not saved.

Natural source "Vrelo" is located in the settlement Soko. The source capacity is $\mathbf{Q_{min}=4,50\ l/s}$. Source medium yield is $\mathbf{Q_{sr}=12,0\ l/s}$.

There is a capture facility at this source, as it is shown at the following figure. Water is chlorinated, because part of the water from this chamber is sent into the WSS Gračanica and part is flowing to the pumping station used for water supply of settlement. Pumping station facility is constructed near the capture. Capture facility and pumping station are fenced.

During the period of high precipitations or snow melting, water in the source is slurry. There is no plant for water treatment, so the water can not be used in that period. The water is shut for the WSS Gračanica, but not for the settlement Soko, because that is the only water supply source for this settlement.

Figure 4: Capture of the source "Vrelo" and pumping station for Soko settlement

NATURAL SOURCE „ILIDŽA“

Natural source "Ilidža" " is located in settlement Soko. Sorce capacity is **Q_{min}=4,0 l/s**. Source medium yield is **Q_{sr}=9,50 l/s**.

There is a capture facility at this source, as it is shown on a figure. From this chamber, the water is sent into the WSS Gračanica gravitationally.

The capture facility is located at the bottom of the hill, as it is shown on a figure.

Figure 5: Natural source "Ilidža"

EXPLOITATION CAPACITIES OF THE SOURCES "VRELO" AND "ILIDŽA"

As allready mentioned in the previous presentations, the documentation on hydrogeological researches and research-capture works at sources Ilidža and Vrelo is not saved and available.

User of the sources still doesn't have established measurement profiles for groundwaters regime monitoring, i.e. sources yield monitoring. Sources quality monitoring is performed regularly, by controling the physical-chemical and bacteriological composition of water.

Sources yield measurement in different hydrogeological conditions in longer term period were not performed, so the evaluations of quantitative characteristics of the sources were done based on the data shown in the Study (I. Žigić,et al 2008).

According to the available data from the Study, and the data from utility company in Gračanica, the average yield of the sources Ilidža and Vrela – Soko are:

- **Source Ilidža** $Q_{pr.}$ **= 12 l/s**
- **Source Vrela** $Q_{pr.}$ **= 9,5 l/s**

2.3.3.4 NATURAL SOURCE „ŠKAHOVICA"

Natural source "Škahovica" is located in settlement Škahovica. Sorce capacity is Q_{min}**=1,0 l/s**. Source medium yield is Q_{sr}**=3,50 l/s**.

2.3.3.5 NATURAL SOURCE „ZMAJEVAC"

Natural source "Zmajevac" is located in settlement Soko. Sorce capacity is Q_{min}**=0,4 l/s**. Source medium yield is Q_{sr}**=1,0 l/s**.

2.3.3.6 WELL „HADŽINA VODA"

Source "Hadžina voda" is located in the urban part of Gračanice between the road for Ritešiće and Ulice.

Sorce capacity is Q_{min}**=0,4 l/s**. Source medium yield is Q_{sr}**=1,0 l/s**. Water from this well is pumped into the reservoir "Ritašići ".

The source was formed inside of mostly impermeable flysch complex of the upper cretaceous, i.e. marl limestones of the upper cretaceous higher level with the bigger widespread in the source "Hadžina voda" background, i.e. Muderizova hills part.

In the aquifier bottom there are impermeable rocks of lower Upper Cretaceous flysch and "ophiolitic Melange. The level of groundwater in the aquifer is free.

Aquifier is fed by precipitation infiltration, and it’s disscharge, with it’s bigger part, is done at the sources "Hadžina voda" and "Pribrešak" in Gracanica.

General assumed groundwaters flow direction in the aquifier is east-west.

In 1982 „Geoinženjering“ Sarajevo made made two research boreholes in the sources zone (G-1 and G-2). Borehole G-1 as very productive, although of a low yield, was transformed into the well and included in Gracanica water supply system.

Borehole G-1

Borehole G-1 was made nearby the former source Hadžina voda, between the road for Ritešiće and town streets.

The borehole engulfed the groundwaters in a cracked limestone, in the intervals of 6,5-42 m and the crack in the depth of 71,3 m. The borehole was turned into a well.

Basic technical characteristics of the well :

Depth of the well: 117,6 m

Well’s profile:

- 0,00 - 30,00 m ∅ 444 mm
- 30,00 - 84,50 m ∅ 245 mm
- 84,50 - 88,50 m ∅ 210 mm
- 88,50 - 92,90 m ∅ 155 mm
- 92,90-117,6 m ∅ 131 mm

Well’s construction:

- 0,00 - 30,00 m full steel column ∅ 300 mm (cement)
- 30,00 - 32,70 m full steel column ∅ 150 mm sa „šeširom“
- 32,70- 50,7 m filter ∅ 150 mm
- 50,70 - 60,70 m full steel column ∅ 150 mm
- 60,70 - 86,50 m filter ∅ 150 mm
- 86,50 - 88,50 m sediment tank- full steel column ∅ 150 mm

EXPLOITATION CAPACITIES OF THE SOURCES"HADŽINE VODE"

Source "Hadžina voda" is exploited by the well G-1. The source’s yield, i.e. exploitation capacity of the well G-1, is determined by the test pumping with four pumping capacities for 48 hours, performed in the period 14-15/03/1982 by the company „Geoinženjering“ Sarajevo.

Well’s test pumping was performed by the following capacities:

"Hadžine vode"	Capacity (l/s)	Lowering (m)

capacity	3,0	5,59
capacity	5,0	17,67
capacity	7,5	20,46
IV - capacity	8,75	29,98

In the conclussion of the Report it is emphasized that, based on the test pumping interpretation results, the optimum capacity of well G-1 in the conditions without the hydrological minimum, it is:

$$Q_{op.} = 5\text{-}6 \ l/s$$

As can be seen from the pumping data wells G-1, wells optimal capacity of Q = 5-6 l / s is not optimal because the reduction of the stated yield is greater than 10 m with very unfavorable conditions of nutrition and reduction.

The well G-1 in the source Hadžina voda now exploits groundwater in the capacity of Q = 2.5 l / s. This exploitation capacity is less than 5% of the total amount of water that is abstracted for Gracanica water supply system needs. Taking into account the low yield of the source Hadžina voda, which is situated in very bad physical condition of the unfavorable aspects of the city center, it is necessary in the future, after the completion of hydrogeological research in the study, plan the closing of this source.

2.3.3.7 SOURCE WATER QUALITY

- **Sources**
  - How often the water quality is analysed
    - Within the regulated periods
  - Who performes the water quality analysis
    - Mycrobiological: Hospital Gračanica
    - Physical-Chemical: Institute for Public Health Tuzla
  - Which parameters are analysed by ViK (water and sewerage utility)
    - Regulated by the Law
  - Water quality in the source
    - In the turbidity periods at the natural sources water is not good, so the sources are out of order, while water in the wells is of a good quality
- **Distribution network**
  - Where in the system the residual chlorine is analysed
  - in all system zones

During higher turbidities, water in the natural sources is not of a good quality. At that time, the sources are excluded from the system. However, „Ilidža“ source supplies the settlement Soko, and that is the only source for this settlement. One of the priority measures at these sources will be the water treatment. The location of these sources is very unfavorable in terms of construction of filter fields, but the decision should be provided on how to solve the problem of sources turbidity. It is, also, necessary to implement all protection measures of the sources, due to the fact that there are settlements above these sources.

CHLORINATION OF WATER

As a preventive, the chlorination of water is performed.

Chlorination is performed at some certain sources, central reservoir Gaj, Drafnići sub-system reservoir, Ritašići reservoir, as well as in PS Soljanuša.

- **Chlorine stations**
  - Equipment in chlorine stations – type, age and basic characteristics
    - Reservoir Gaj: Bovje Zagreb 2007, process, dosing with the analyzer
    - PS Soljanuša: Bovje Zagreb 2007, dosing at the pressure line
    - Reservoir Ritošići: 2003, automatic dosing, processor managed
    - Natural sources: gravitational
  - Data on injection pumps
    - Aldos, Prominent, Končar
  - Data on regular and emergency maintanance of equipment
    - Regular annual maintanance

According to the data in Elaborate: ***The sources protection sanitary zones of Gračanica water supply system*** drafted in 2009, we have the water quality by the sources.

2.3.3.7.1 QUALITY OF GROUNDWATERS IN THE SOURCES SKLOP AND SOLJANUŠA

As previously mentioned, the groundwaters of the sources Sklop and Soljanuša, most probably, belong to the same hydrogeological unit. In addition, they are, also, of very similar physical-chemical water characteristics, so in the following presentation the water quality of this sources will be considered surpassingly.

Groundwaters quality analysis in the sources Sklop i Soljanuša is done continiously for years, what is, actually, the legal obligation of the company preforming the ground water exploitation for public water supply needs. Water quality analysis from the exploitation wells Sklop III in Sklop and P-2 Soljanuša are performed as shortened physical-chemical and bacteriological analysis. Water quality is regularly monitored in laboratories of Tuzla Cnaton Institution for Public Health in Tuzla. We have to emphasize that the complete analysis are done within limited scope, differing from the regular water quality monitoring at the level of shortened physical-chemical and bacteriological analysis.

Physical-chemical water characteristics

Physical-chemical analysis results of water parameters taken from the wells Sklop III in Sklop and P-2 Soljanuša show that the waters are of very similar composition and that they origin rom the same aquifier, and the waters are as follows:

- potable,
- no colour, smell or taste,
- pH ~ 7
- temperature is 15,5 – 17,5^{o} C, i
- electro-conductivity is 440-530 μS/cm.

In the chemical composition of water, the bigger precentage is of hydro-carbonates and calcium, what indicates that the water origins from limestone sediment. Water quality in the sources Sklop and Soljanuša **is** completely suitable to the conditions of drinking water**,** what is confirmed by the analysis in 2001, 2003, 2007 and 2008 from the capture facilities of well Sklop III Sklop and P-2 Soljanuša, as shown in the following table.

Table 11: Samples taken at the sources Sklop III and Soljanuša

Indicators	**Well Sklop III**	**Well Sklop III**	**Well Sklop III**	**Well P-2 Soljanuša**	**Well P-2 Soljanuša**	**Well P-2 Soljanuša**
Sampling date	*29.03.'01*	*27.01'03*	*07.02.'08*	*27.01'03*	*18.10.'07.*	*15.02.'08.*

Water colour °CoPt	without	without	without	without	without	without
Smell	without	without	without	without	without	without
Taste	0	0	0	0	0	0
Turbidity NTU	1.43	0.28	0,00	0.28	0,00	0,00
PH value	7.38	7.20	7,27	7.20	7,08	7,20
Consumption of KM_nO_4 mg/l	10.85	1.9	3,20	1.9	1,60	3,20
Evaporation remain mg/l	342.8		318		253	349
Amonium mg/l N	0	0.002	0,00	0.002	0,00	0,00
Chlorides mg/l	11.5	8.5	10,0	8.5	11,0	11,0
Nitrates mg/l N	0	0.0	0,00	0.0	0,002	0,00
Nitrates mg/l N	1.23	0.8	0,42	0.8	1,51	1,04
Iron mg/l	0	0.014	0,00	0.014	0,05	0,00
Manganese mg/l	0.010	0.004	< 0,05	0.004	< 0,05	< 0,05
Sulfates mg/l	12.69	12.4	0,00	12.4	0,00	21,45
Calcium mg/l	81.65	101.8	87,25	101.8	100,0	97,66
Magnesium mg/l	-	-	16,04	-	4,37	16,52

According to the available physical-chemical analysis, it can be concluded that the content of sulfate in water is relativelly low and it does not exceed 20 mg/l, as well as **chlorides** which values are around 10 mg/l.

In the analysed water samples there is very low content of **nitrites** (< 0,002 mg/l). The content of nitrites monitored for years was very low and acceptable for drinking water, as well as the **amonium**. Absence and very low content of **nitrites, nitrates and amonium** indicates to the absence of the direct organic water pollution. Consumption of **KMnO4**, monitored for years, has relatively low value that also indicates the absence of organic water pollution.

Iron content in water is very low. In most samples it was not determined, while in some samples it's values were less than 0.05 mg / l. **Manganese** content investigated on a smaller number of samples is very low (< 0,05 mg/l).

Based on the **physical-chemical parameters** it can be concluded that the **water quality in the sources Sklop and Soljanuša is in accordance with the Regulations**, and that it indicates the stability during the long term of analysis.

Bacteriological analysis of groundwaters

Bacteriological analysis of the sources Sklop and Soljanuša were performed by long term sampling of the wells Sklop III Sklop and P-2 Soljanuša. The sampling analysis show that groundwaters of these sources **completelly comprise with the Regulations on drinking water hygiene regularity**.

2.3.3.7.2 GROUNDWATERS QUALITY IN THE SOURCES ILIDŽA AND VRELA - SOKO

Groundwaters quality analysis in the sources Ilidža and Vrela is done continiously for years, by sampling from the capture facilities.

Water quality is regularly monitored in laboratories of Tuzla Cnaton Institution for Public Health in Tuzla. The analysis are performed as shortened physical-chemical and bacteriological analysis.

Physical-chemical water characteristics

Physical-chemical analysis results of water parameters taken from the sources Ilidža and Vrela show that the waters are of very similar composition and that they origin rom the same aquifier, and the waters are as follows:

- potable,
- no colour, smell or taste,

- pH ~ 7
- temperature is around 11 oC, and
- electro-conductivity is 500-515 µS/cm.

In the chemical composition of water, the bigger precentage is of hydro-carbonates and calcium, what indicates that the water origins from limestone sediment. **Water quality of sources Ilidža and Vrela is completely suitable to the conditions of drinking water,** what is confirmed by the analysis in 2007 and 2008 from capture facilities, as shown in the following table.

Table 12: Samples taken at the sources Vrela and Ilidža

Indicators	Sources	Sources	Sources	Ilidža
Sampling date	18.10.2007.	07.02.2008.	14.08.2008	14.08.2008.
Water colour °CoPt	without	without	without	without
Smell	without	without	without	without
Taste	-	-	-	-
Turbidity NTU	0,00	0,00	0,00	0,00
PH value	7,20	7,37	7,57	7,40
Consumption of KM_nO_4 mg/l	3,20	3,20	3,52	1,92
Evaporation remain mg/l	257	311	273	226
Amonium mg/l N	0,00	0,00	0,00	0,00
Chlorides mg/l	11,0	10,0	18,0	12,0
Nitrates mg/l N	0,00	0,00	0,001	0,00
Nitrates mg/l N	3,53	1,06	3,81	3,76
Iron mg/l	0,00	0,00	0,00	0,00
Manganese mg/l	< 0,05	< 0,05	< 0,05	< 0,05
Sulfates mg/l	0,00	0,00	0,00	0,00
Calcium mg/l	72,84	102,46	87,25	36,02
Magnesium mg/l	2,92	5,35	6,32	27,22

According to the available physical-chemical analysis, it can be consluded that **sulfates are absent** and that the **chloride** content is around 11 mg/l.

Analysed water samples show very low content of **nitrites** (< 0,001 mg/l), as well as **nitrates** that are within permissible limits for drinking water. It is veru important to mention the absence of **amonium** in water. Absence and very low content of nitrites, nitrates and amonium indicates the absence ofthe direct organic water pollution. Consumption of **KMnO4**, monitored for years, has relatively low value that also indicates the **absence of organic water pollution**.

Water does not contain **iron** nor **mangenese** which is very low (< 0,05 mg/l).

Based on the **physical-chemical parameters** it can be concluded that the **water quality in the sources Vrela and Ilidža - Soko is in accordance with the Regulations**, and that it indicates the stability during the long term of analysis.

2.3.3.7.3 GROUNDWATERS QUALITY AT THE SOURCE HADŽINA VODA

Groundwaters quality analysis in the source Hadzina voda is done continiously for years. Water quality analysis are conducted from the exploitation well G-1 at the level of shortened physical-chemical analysis, and bacteriological water analysis. Water quality is regularly monitored in laboratories of Tuzla Cnaton Institution for Public Health in Tuzla. We have to emphasize that the complete analysis are done within limited scope.

Physical-chemical water characteristics

The results of physical-chemical parameters analysis of water taken from the well G-1 Hadžina voda show that the waters are:

- potable,
- no colour, smell or taste,
- pH 7,15 – 7,43
- temperature around 12 oC, and
- electro-conductivity is 440-608 μS/cm.

In the chemical composition of water, the bigger precentage is of hydro-carbonates and calcium, what indicates that the water origins from limestone sediment. **Water quality of the source Hadzina voda is completely suitable to the conditions of drinking water,** what is confirmed by the analysis in2006, 2007 and 2008, as shown in the following table.

Table 13: Samples taken at the source "Hadžina voda"

Indicators	**Well G-1**	**Well G-1**	**Well G-1**	**Well G-1**
Sampling date	16.11.2006.	18.10.2007.	07.02.2008	14.08.2008.
Water colour °CoPt	without	without	without	without
Smell	without	without	without	without
Taste	-	-	-	-
Turbidity NTU	0,00	0,00	0,00	0,00
PH value	7,43	7,27	7,15	7,37
Consumption of KM_nO_4 mg/l	1,60	3,20	3,20	3,20
Evaporation remain mg/l	221,5	244	392	345
Amonium mg/l N	0,00	0,00	0,00	0,00
Chlorides mg/l	11,0	13,00	13,0	17,0
Nitrates mg/l N	0,00	0,00	0,001	0,00
Nitrates mg/l N	2,30	0,76	0,4	1,45
Iron mg/l	0,00	0,00	0,00	0,00
Manganese mg/l	< 0,05	< 0,05	< 0,05	< 0,05
Sulfates mg/l	0,00	0,00	58,60	7,85
Calcium mg/l	89,66	71,24	96,86	52,83
Magnesium mg/l	22,36	6,80	26,24	42,77

According to the available physical-chemical analysis, it can be concluded that the **sulfate** content in water is very variable (0,00 – 58,6 mg/l) what, according to some authors, can be caused by some certain pollution, because the electro-conductivity significantly increases at the same time. The **chloride** content is relativelly low, 11-17 mg/l.

The **nitrites** content is very low (< 0,001 mg/l), as well as **nitrates** (max.2,3 mg/l) in analysed samples, and **amonium** is absent. Absence and very low content of nitrites, nitrates and amonium indicates the absence ofthe direct organic water pollution. Consumption of **KMnO4**, monitored for years, has relatively low value (less than 3,2 mg/l) which, also, indicates the **absence of organic water pollution**.

Water does not contain **iron** and **manganese is very low** (< 0,05 mg/l).

2.3.3.8 ELABORATE OF THE SOURCES PROTECTION ZONES IN WSS GRAČANICA [2]

2.3.3.8.1 GENERAL PRINCIPLES OF THE SOURCES PROTECTION

LEGAL FRAME OF THE SOURCES PROTECTION

Federal Law on Water - hereinafter Act (Official Gazette of F BiH, No. 70/06), among other things, regulated the manner and conditions of management, use and protection of water. Article 66, paragraph 1 of the Act provides that the areas where there are water sources that the quantity and quality can be used, or used for public drinking water supply must be protected from pollution and other impacts that may adversely affect the safety of water or yield of the source. In areas used for public water supply, source protection is implemented by establishing sanitary protection zones, which size, border, sanitary regime and other conditions are determined in accordance with regulations establishing sanitary protection zones and protection measures, and research studies.

Current legislation on establishing sanitary protection zones and protection measures, the Ordinance on conditions for determining the sanitary protection zones and protection measures for water resources that are used or intended to be used for drinking water (Official Gazette of F BiH "br.51/02 in further referred to as the Ordinance), which are prescribed for determining the sanitary protection zones and protection measures for drinking water sources.

Article 68, paragraph 1 of the Act (Decision on the protection of water sources) provides that the sanitary protection zones and protective measures are determined by the municipal authority responsible for water administration in whose territory is the source. Article 68 paragraph 2 of the Act provides that the decision to protect sources whose sanitary protection zones extending in a city or community are issued by the city or municipal council.

The sources Sklop, Vrela, Ilidža, Soljanuša and Hadžina voda, i.e. the protection zones of the mentioned sources, are located in Gračanica Municipality teritorry, so according to the article 68 item 2 Law on protection zones and protection measures Decision for the sources Sklop, Vrela, Ilidža, Soljanuša and Hadžina voda (hereinafter Decision) issues the Gračanica Municipal Council.

APPROACH TO THE SOLUTIONS

In the aim of protection the sources Sklop, Vrela, Ilidža, Soljanuša and Hadžina voda against all kinds of pollutions and risks that can infavourably impact the water health regularity or the sources yield, sanitary protectio zones and protection measures are established.

Approach to determining the sanitary protection zonesn of the sources Sklop, Vrela, Ilidža, Soljanuša and Hadžina voda was conducted by the perception of geological, structural-tectonic and hydrogeological characteristics of the terrain in the catchment area, the quantitative and qualitative characteristics of the source, characteristics of existing and potential pollution of groundwater, hydrogeological and hydrodynamic parameters aquifers and other relevant characteristics of the catchment areas and water source.

The basic characteristics of the mentioned sources are as follows:

Sources Sklop and Soljanuša

- sources are situated in fractured rock-cavernous porosity,
- sources recharge is atmospheric,
- groundwater levels in the aquifer are under sub-artesian pressure,

[2] Izvod iz Elaborata zaštitnih zona u VDS Gračanica. 2008. godina

- groundwater flow direction is, generally, northeast-southwest (Sklop) and north-south (Soljanuša)
- groundwater exploitation is done vertically, by drilled wells,
- the total source capacity is around 40 l/s (Sklop 30 l/s; Soljanuša 8-10 l/s),
- groundwater quality meets the requirements of the applicable Regulations,
- groundwaters have the thermal water character (Sklop 15,5 oC; Soljanuša 17 oC) which indicates the favorable natural conditions for their protection,
- groundwaters are bacteriologically sterile and completely regular, corresponding to the formation model of groundwater thermal character, which also indicates a very favorable natural conditions for their protection,
- potential sources of contaminants are people, livestock, agricultural production, construction materials and traffic.

Sources Ilidža and Vrela – Soko

- sources are situated in fractured rock-cavernous porosity,
- sources recharge is atmospheric,
- groundwater level in the sources is free, and the part is under the slight sub-artesian pressure,
- groundwater flow direction is, generally, northeast-southwest (Vrela) and north-south (Ilidža)
- groundwater exploitation is done from the captured sources,
- the total source capacity is around 10-15 l/s (Vrela 10 l/s; Ilidža 5 l/s),
- groundwater quality meets the requirements of the applicable Regulations,
- groundwaters have the karst water character, and the sources variable yield and periodical turbidity, which indicates relatively unfavorable natural conditions for their protection,
- groundwaters are periodically bacteriologically irregular, which indicates the need for their better protection,
- potential sources of contaminants are people, livestock, agricultural production, construction materials and traffic.

Sources Hadžina voda

- sources are situated in fractured rocks porosity,
- source recharge is atmospheric,
- groundwater level in the sources is free,
- groundwater flow direction is, generally, east-west,
- groundwater exploitation is done vertically, by drilled wells,
- exploitation capacity of the source is around 2,5 l/s,
- groundwater quality meets the requirements of the applicable Regulations,
- geological-hydrogeological terrain characteristics, as well as the natural conditions (urban area) are very infavourable for groundwater protection,
- potential sources of contaminants are people and traffic.

Protection zones borders of the sources Sklop, Vrela, Ilidža, Soljanuša and Hadžina voda and in order to coordinate with the spatial-planning documentation and realistic assumptions for their establishment, are presented at an investor meeting in Gracanica Municipality.

2.3.3.8.2 PROTECTION ZONES OF THE SOURCES

Protection zones of the sources Sklop, Vrela, Ilidža, Soljanuša and Hadžina voda are established according to the article 25. Regulations relating to the origin of groundwater in karst aquifers, and Article 19 which refers to the sources of drinking water that have thermal character.

In accordance with the above mentioned, the following three protection zones of the water supply system Gračanica are established:

Sources Sklop, Soljanuša and Hadžina voda:

First protection zone

Sources Vrela and Ilidža – Soko:

First, second and third protection zone

Protection zones of the sources Sklop, Soljanuša, Hadžina voda, Vrela and Ilidža are shown at the map in the Reports, 1:10.000, and the first protection zone of the sources are shown at the situational plan, 1: 2.500.

SOURCE SKLOP

The first protection zone

The first protection zone of the source Sklop covers the are between Sokoluša river and and the road Gračanica-Bukva-Srebrenik.

It includes the parcels at th eleht side of the road Gračanica-Bukva-Srebrenik to: no.84, no.85 and no.87 .

The first protection zone of the sources is regularly fenced and protected against unauthorized access. The land of the first protection zone of the sources is in a ownership of Gračanica Municipality.

Inside of the first protection zone of the sources there are exploitation wells Sklop I, Sklop II and Sklop III, as well as the equipment installed for the needs of pumps agregates operation in water supply system.

The first protection zone of the sources represents the zone of the most strict groundwaters protection regime.

SOURCE SOLJANUŠA

The first protection zone

The first protection zone of the source Soljanuša includes narrow terrain belt at the right side of the spring Soljanuša. It includes the parcel no.613/2 (encl.17) which is a property of Gračanica Municipality.

The first protection zone of the source Soljanuša is regularly fenced and protected against unauthorized access. Inside of the first protection zone of the sources there are exploitation wells P-1 i P-2, as well as the equipment installed for the needs of pumps agregates operation in water supply system.

The first protection zone of the sources represents the zone of the most strict groundwaters protection regime.

SORCE HADŽINA VODA

The first protection zone

The first protection zone of the source Hadžina voda covers the area between the road Gračanica-Rітešići and Majevičkih brigada Street (old name).

It includes the parcel in between the two mentioned roads without a parcel number.

The first protection zone of the source is not regularly fenced, nor protected against unauthorized access.

Inside of the first protection zone of the sources there is the exploitation borehole G-1, the equipment installed for the needs of pumps agregates operation in water supply system, as well as the old spring Hadžina voda which dried out after the drilling the borehole.

The first protection zone of the source Hadzina voda represents the zone of the most strict groundwaters protection regime.

SOURCES ILIDŽA AND VRELA - SOKO

The first protection zone

Source Vrela

The first protection zone includes the area nearby Vrela source zone.

The first protection zone covers a part of the parcel no.2450 which is a property of Gračanica Municipality.

The first protection zone of the source is regularly fenced and protected against unauthorized access.

Inside of the first protection zone of the sources there is capture facility, i.e. source capture and the additional facility that enables water supply.

The first protection zone of the source Vrela represents the zone of the most strict groundwaters protection regime.

Source Ilidža

The first protection zone includes the area in the immediate hinterland of the source and capture Ilidža.

The first protection zone covers a part of the parcels no.2346 which is a property of Gračanica Municipality and no.2345 which is a private property.

The first protection zone of the source is not regularly fenced, nor protected against unauthorized access.

Inside of the first protection zone of the sources there is capture facility, i.e. source capture and the additional facility that enables water supply.

The first protection zone of the source Ilidza represents the zone of the most strict groundwaters protection regime.

Second protection zone

Second protection zone of the Vrela and Ilidza sources represents a connected space that comprises the first protection zones of the Vrela and Ilidza sources.

The outer boundary of the second protection zone, to the north, north-east and north-west (the assumed general direction of flow of the ground waters), is at the distance of about 1 km from water capture facilities at the regarded sources, which is in line with Article 31, Paragraph 2 of the Rulebook. Bearing in mindthat there is lack of data on speed of flow of ground waters, the distance of outer boundary of second protection zone from the water capture facilities should by sufficient safety factor satisfy requirements related to length of ground watercourse and purification processes.

Eastern outer boundary of the second protection zone goes along the hydro-geological watershed; from the Vrela source via level 540 where it changes its direction to north - north-east via the Osoja source and continues to the area above the Kasimove forests. From the Kasimove forests the boundary of second protection zone makes its turn towards the west where it goes along an occasional stream to the local road and further over the mounts of Cerovi and Brda, and continues along the road to Ostrikovac.

From Ostrikovac the boundary of the second protection zone is changing its direction and goes south and south-east over 534 and 457 level mounts towards the Ilidza source where it ends.

Within the second zone of protection against potential pollutants there are: individual residential buildings in the Soko settlement with the local road network.

Second protection zone of the Vrela and Ilidza water sources represents a zone of limited ground water protection regime.

Third protection zone

Third protection zone covers the area which spreads from the outer boundary of the second protection zone to the hydro-geological (underground) watershed of the Vrela and Ilidza water sources.

Boundary of the third protection zone in the east spreads from the Kasumove forests along the local road to Duge Njive, and continues via occasional stream to Mackovci. From Mackovci it spreads towards west to the area above Cikota where it makes its turn towards south-west to the area above Ostrikovci where it meets the boundary of second protection zone.

Third protection zone of the Vrela and Ilidza water sources represents a zone of mild ground water protection regime.

2.3.3.8.3 SOURCE PROTECTION MEASURES

SOURCE SKLOP

Protection measures within the first protection zone of the Sklop water source

Area of the first protection zone of the Sklop water source must be protected against unauthorized access by a strong and safe fence, including also other necessary measures of physical protection and safety.

Access to the first protection zone is allowed to expert personnel only and the employees assigned by the user of owner of the water capture facilities and the authorised inspection bodies during the control activities. Access to the first protection zone is possible to other persons only with special permission and registration with the user of water capture facilities.

WIthin the area of the first protection zone, provided that the necessary protection measures are taken, there can be water capture facilities - wells, capture facilities, reservoirs, pumping stations, water purification plant, plant and administration buildings, access and internal roads and other objects necessary for the operation of the water supply system.

User or owner of the water capture facilities has the obligation to maintain the fence to keep it functional and secure this zone and the objects in it, in line with the provisions given in previous paragraphs.

User or owner of teh water capture facilities has to, in an appropriate manner, mark the first protection zone of the water well and put up a visible sign prohibiting unauthorized access.

In the area of first protection zone all activities that are no directly linked to the regular operation and maintenance of the water supply system are prohibited. Activities that are taking place with the purpose of regular operation and maintenance of the water supply system must not have a harmful effect on the water source. Exceptionally, in the area of the first protection zone of water source the following activities can take place:

1. growing grass without the use of fertilizers and other agricultural resources,
2. laying pipelines and other installations used for the normal operation of water supply facilities, provided that the appropriate design and construction decision ensure that the installations could not compromise the source,

3. installation of transformer stations that are equipped with environmentally friendly materials or have a watertight tanks, which prevent oil and pyralene leakage into the soil,
4. storage of chemicals by applying the necessary security measures that prevent their harmful effect on the source, and
5. installation of diesel generators (as a backup source of electricity) with the application of necessary security measures and the increased level of security in relation to the used fuel.

The Sokolusa river that flows in immediate vicinity of the first protection zone of the Sklop water source needs to be regulated in the length of about 500 m.

In the part of the road communication Gracanica-Bukva-Srebrenik which runs right next to the first protection zone of the Sklop water source, in the length of about 500 m, drainage channels must be made for taking up atmospherilia, grease, fuel and salt from the road; retaining walls should also be built with the purpose of prevention of direct leakage of fuel, oil and other harmful chemicals, which can appear on the road in the cases of incident situations, into the water source.

Road transportation of chemicals, liquid fuels, lubricants and other dangerous materials in the section of the road Gracanica-Bukva-Srebrenik, which passes by the first protection zone of the Sklop water source must be performed with application of measures of caution and protection of ground waters and water capture facilities. In this section of the road the speed of movement of passenger and transport vehicles must be limited to 40 km/hour.

For the Sklop water source, in accordance with Article 47, special control of monitoring of water quality at the water source is established (water source monitoring), including the monitoring of all activities in the area of the water source, that can have a harmful effect on the regime and quality of water at the source.

In case that by special water source control it is determined that certain activities in the area of the water source Sklop watershed are causing changes in the regime and quality of water at the source, it is necessary to take emergency measures to eliminate negative activities, with application of adequate measures for protection of ground and surface waters.

In the watershed area of the Sklop water source, especially for parts of settlements Piskavica, Soko and Škahovica, activities of collecting, draining and purification of waste waters must be planned through construction of sewerage system.

Sewage system should be located outside the spatial catchments of the protection zone of the Sklop water source, i.e. downstream from the regarded source.

SOURCE SOLJANUŠA

Protection measures in the first protection zone of the Soljanusa water source

The area of the first protective zone Soljanuša sources must be protected from unauthorized access by secure and solid fence, and by other measures of physical protection and security.

Access to the area of the first protection zone is only allowed to qualified persons and employees designated by the user or owner of the water capture facilities and to competent inspection bodies during the exercise of control. Access to the area of the first protection zone by other persons is possible only with special permission, and registration with the user of water capture facilities.

Within the first protection zone, with the application of the necessary protective measures, there can be water capture facilities - wells, capture buildings, reservoirs, pumping stations, water treatment plants, plant and administration buildings, access and internal roads and other facilities necessary for the operation of water supply system.

The user or owner of water capture facilities has the obligation to maintain the fence in functional condition and to ensure security of the zone and the facilities located in it, in accordance with the provisions set in previous paragraphs.

The user or owner of the water capture facilities has to, in an appropriate manner, mark the first source protection zone and put up a sign of warning against unauthorized access.

In the area of first protection zone all activities that are no directly linked to the regular operation and maintenance of the water supply system are prohibited. Activities that are taking place with the purpose of regular operation and maintenance of the water supply system must not have a harmful effect on the water source. Exceptionally, in the area of the first protection zone of water source the following activities can take place:

1. growing grass without the use of fertilizers and other agricultural resources,
2. laying pipelines and other installations used for the normal operation of water supply facilities, provided that the appropriate design and construction decision ensure that the installations could not compromise the source,
3. installation of transformer stations that are equipped with environmentally friendly materials or have a watertight tanks, which prevent oil and pyralene leakage into the soil,
4. storage of chemicals by applying the necessary security measures that prevent their harmful effect on the source and
5. installation of diesel generators (as a backup source of electricity) with the application of necessary security measures and the increased level of security in relation to the used fuel.

The Soljanusa stream, which runs right next to the first protection zone, needs to be regulated in the length of about 150 m.

For the Soljanusa water source, in accordance with Article 47, special control of monitoring of water quality at the water source is established (water source monitoring), including the monitoring of all activities in the area of the water source that can have a harmful effect on the regime and quality of water at the source.

In case that by special water source control it is determined that certain activities in the area of the water source Soljanusa watershed are causing changes in the regime and quality of water at the source, it is necessary to take emergency measures to eliminate negative activities, with application of adequate measures for protection of ground and surface waters.

In the watershed area of the Soljanusa water source, especially for parts of the Soljanusa settlement, activities of collecting, draining and purification of waste waters must be planned through construction of sewerage system.

Sewage system should be located outside the spatial catchments of the protection zone of the Soljanusa water source, i.e. downstream from the regarded source.

SOURCE HADŽINA VODA

Protection measures in the first protection zone of the source Hadžina voda

The area of the first protective zone of the Hadzina Voda sources must be protected from unauthorized access by secure and solid fence, and by other measures of physical protection and security.

Access to the area of the first protection zone is only allowed to qualified persons and employees designated by the user or owner of the water capture facilities and to competent inspection bodies during the exercise of control. Access to the area of the first protection zone by other persons is possible only with special permission, and registration with the user of water capture facilities.

Within the first protection zone, with the application of the necessary protective measures, there can be water capture facilities - wells, capture buildings, reservoirs, pumping stations, water treatment plants, plant and administration buildings, access and internal roads and other facilities necessary for the operation of water supply system.

The user or owner of water capture facilities has the obligation to maintain the fence in functional condition and to ensure security of the zone and the facilities located in it, in accordance with the provisions set in previous paragraphs.

The user or owner of water capture facilities has to, in an appropriate manner, mark the first source protection zone and put up a sign of warning against unauthorized access.

In the area of first protection zone all activities that are no directly linked to the regular operation and maintenance of the water supply system are prohibited. Activities that are taking place with the purpose of regular operation and maintenance of the water supply system must not have a harmful effect on the water source. Exceptionally, in the area of the first protection zone of water source the following activities can take place:

1. growing grass without the use of fertilizers and other agricultural resources,
2. laying pipelines and other installations used for the normal operation of water supply facilities, provided that the appropriate design and construction decision ensure that the installations could not compromise the source,
3. installation of transformer stations that are equipped with environmentally friendly materials or have a watertight tanks, which prevent oil and pyralene leakage into the soil,
4. storage of chemicals by applying the necessary security measures that prevent their harmful effect on the source, and
5. installation of diesel generators (as a backup source of electricity) with the application of necessary security measures and the increased level of security in relation to the used fuel.

In the part of road communication Gracanica-Ritesic which runs right next to the first protection zone of the source of Hadzina Voda, in the length of about 100 m, drainage channels need to be built with the purpose of collecting atmospherilia, oil, fuel and salt from the road; also, retaining walls with the function to prevent direct leakage of fuel, oil and other harmful chemicals, which can appear on the road as a result of incident situations, from the road into the water source.

Road transportation of chemicals, liquid fuels, lubricants and other dangerous materials in the section of the road Gracanica-Ritesic, which passes by the first protection zone of the Hadzina Voda water source, must be performed with application of measures of caution and protection of ground waters and water capture facilities. In this section of the road the speed of movement of passenger and transport vehicles must be limited to 40 km/hour.

For the Hadzina Voda water source, in accordance with Article 47, special control of monitoring of water quality at the water source is established (water source monitoring), including the monitoring of all activities in the area of the water source, that can have a harmful effect on the regime and quality of water at the source.

In case that by special water source control it is determined that certain acitivities in the area of the water source Hadzina Voda watershed are causing changes in the regime and quality of water at the source, it is necessary to take emergency measures to eliminate negative activities, with application of adequate measures for protection of ground and surface waters.

In the watershed area of the Hadzina Voda water source, especially for parts of settlement Ritesic, activities of collecting, draining and purification of waste waters must be planned through construction of sewerage system.

Sewage system should be located outside the spatial catchment of the protection zone of the Hadzina Voda water source, i.e. downstream from the regarded source.

SOURCES ILIDŽA AND VRELA

Protection measures in the first protection zone of the Ilidza and Vrela-Soko water sources

The area of the first protective zone Ilidza and Vrela sources must be protected from unauthorized access by secure and solid fence, and by other measures of physical protection and security.

Access to the area of the first protection zone is only allowed to qualified persons and employees designated by the user or owner of the water capture facilities and to competent inspection bodies during the exercise of control. Access to the area of the first protection zone by other persons is possible only with special permission, and registration with the user of water capture facilities.

Within the first protection zone, with the application of the necessary protective measures, there can be water capture facilities - wells, capture buildings, reservoirs, pumping stations, water treatment plants, pl;ant and administration buildings, access and internal roads and other facilities necessary for the operation of water supply system.

The user or owner of water capture facilities has the obligation to maintain the fence in functional condition and to ensure security of the zone and the facilities located in it, in accordance with the provisions set in previous paragraphs.

The user or owner of water capture facilities has to, in an appropriate manner, mark the first source protection zone and put up a sign of warning against unauthorized access.

In the area of first protection zone all activities that are no directly linked to the regular operation and maintenance of the water supply system are prohibited. Activities that are taking place with the purpose of regular operation and maintenance of the water supply system must not have a harmful effect on the water source. Exceptionally, in the area of the first protection zone of water source the following activities can take placei:

1. growing grass without the use of fertilizers and other agricultural resources,
2. laying pipelines and other installations used for the normal operation of water supply facilities, provided that the appropriate design and construction decision ensure that the installations could not compromise the source,
3. installation of transformer stations that are equipped with environmentally friendly materials or have a watertight tanks, which prevent oil and pyralene leakage into the soil,
4. storage of chemicals by applying the necessary security measures that prevent their harmful effect on the source, and
5. installation of diesel generators (as a backup source of electricity) with the application of necessary security measures and the increased level of security in relation to the used fuel.

Protectopn measures in the second protection zone of the Ilidza and Vrela – Soko water sources

Within the area of second protection zone it is forbidden to carry out works, construct objects and perform activities that that can cause pollution to the water sources of Ilidza and Vrela, especially the following activities:

1. building new settlements and construction and operation of sewage network, except in the case that the water-impermeability of sewage pipelines is secured and controlled;
2. construction and uncontrolled operation of sports and recreational facilities without water-impermeable sewage system;
3. establishment of construction sites and construction camps without sanitation system and water-impermeable sewage system;
4. construction and exploitation of water sources and wells that are used for public water supply;
5. excavation in aquifer layers, except for a very short period of time and with the control of quality of ground waters;
6. disposition of all types of solid waste and construction of landfills, including sanitary landfills;
7. construction and operation of industrial and trade plants;
8. construction and operation of railway and ranging stations and terminals and bus stations, unless special measures for prevention of pollution to the water sources are undertaken;
9. construction and use of storages for dissolvable matters that are dangerous and harmful to the water;

10. construction and operation of cattle and poultry farms, except for up to 10 animals of large cattle and poultry for personal use in individual households, if there is a constructed and well functioning water-impermeable sewage system, i.e. water-impermeable septic tanks;
11. construction and exploitation of pipelines for transportation of chemicals, liquid fuels, lubricants and other dangerous matters;
12. road transportation of chemicals, liquid fuels, lubricants and other dangerous matters, without approvals and escort;
13. carrying out investigation boreholes for oil, natural gas and other dangerous matters, as well as mineral water;
14. exploitation of mineral raw materials;
15. exploitation of gravel;
16. other activities that are perceived as possibly having negative impact on the water source.

In the area of the second protection zone, all existing residential and other buildings remain where they are; their reconstruction is allowed in the case of damage or deterioration. Disposition of waste waters must be resolved in an appropriate manner for all objects. For parts of the settlement of Soko that are located within the second protection zone, disposition of waste waters must be done through construction of sewage network. The sewage network must be constructed outside the catchment area of protection zone of the Ilidza and Vrela water sources.

Protection measures in the third protection zone of the Ilidza and Vrela water sources

Within the area of third protection zone it is forbidden to carry out works, construct objects and perform activities that that can cause pollution to the water sources of Ilidza and Vrela, especially the following activities:

1. construction and operation of plants for waste water treatment and plants for burning solid waste;
4. direct or indirect release of purified waste waters into the ground;
5. construction and exploitation of pipelines for transportation of chemicals, liquid fuels, lubricants and other dangerous liquids, unless special measures are taken to prevent infiltration of these liquids into the ground waters;
6. carrying out investigative boreholes for oil, natural gas, and other dangerous and harmful matters, as well as for mineral water, unless special measures are taken to prevent infiltration or leakage of these matters into the ground waters, i.e. horizon(s) communication with mineral raw materials and aquifer horizon of the water source;
7. open storage and application of chemical substances that are dangerous and harmful to the water, which are used for protection and growing of plants and for weed extermination;
8. construction and operation of cattle and poultry farms, unless special measures are taken to prevent pollution to the ground waters;
9. construction and usage of take-off - landing runways for forced landing in air traffic;
10. construction and usage of maneuvering and military training grounds;
11. road transportation of chemicals, liquid fuels, lubricants and other dangerous matters without measures of protection of ground waters;
12. processing, manipulation and storage of chemicals, liquid fuels, lubricants and other dangerous and harmful matters;
13. exploitation of mineral raw materials, unless it is determined that the activity does not undermine the quality of ground waters in water sources;
14. direct or indirect release of waste waters, as well as release of non-treated waste waters onto

the ground, including emptying the vehicles for cleaning and disposal of faeces;

15. construction and operation of industrial and trades plants with impure technology, which release radioactive and other matters dangerous and harmful for water (nuclear reactors, petrochemical industry, metal processing plants, chemical factories, leather industry, etc.);
16. economy and other activities that distort natural regime of ground water recharge of water sources;
17. disposal of all types of solid waste;
18. construction of new cemeteries and broadening and usage of the existing ones, except when they are located in areas composed of low-water-permeability formations;
19. deforestation, road construction, construction of earth excavation and other activities which cause or accelerate erosion;
20. and other activities for which it is found that can have negative consequences for karst water sources.

Within the third protection zone of the Ilidža and Vrela water sources, all existing housing and other facilities can be retained; allow the construction of new residential buildings and reconstruction of existing ones in the event of deterioration or damage. Disposition of waste waters must be appropriately resolved for all objects.

2.3.3.8.4 PROGRAM OF MEASURES AND ACTIVITIES FOR PROTECTION OF SOURCES

In accordance with a legally regulated system of care, measures must be taken for its immediate practical implementation, which should be determined by the Program of measures: The Program of measures and activities should include specific commitments to carry out certain activities, the holders of actions and deadlines, sources and methods of funding the measures and actions to be taken to fully protect the source area. Programme of measures for the protection of sources should particularly provide for:

SOURCE SKLOP

- Creating a Project for regulation of the Sokoluša river.
- Creating the Project rehabilitation works (leveling the field, draining water from the road communications).
- Repair of fences and water capture facilities.

SOURCE SOLJANUŠA

- Carrying out of agro-pedological research with the aim of identifying optimum conditions for processing and use of soil in the protection zone.
- Develop a hydro-geological map of the source area (scale 1:1000) with the marked places of intake, and all other hydro-geological phenomena, for rehabilitation purposes.
- Perform regulation of stream in its full length from the direction of the Soljanusa settlement.
- Repair the existing facilities and the protective fence.

SOURCES ILIDŽA AND VRELA

- Development of project design for construction of sewage system for the local community of Soko, with the waste water purifier.
- Development of Project design for potable water purification plant (based on the obtained data on quality and capacity of the source).
- Development of Project for regulation of the stream at the Ilidza source.

- Carrying out of agro-pedological research with the aim to establish optimum conditions for processing and use of soil within the protection zones.
- Establish the basic principles for forest management within the water protection zones.
- Develop hydro-geological map of the source area (scale 1:1000) with marking of all intake points and other hydro-geological phenomena, for rehabilitation purposes.

SOURCE HADŽINA VODA

- Develop Project for rehabilitation of road communication and drainage of precipitation waters from the roads.
- Develop Project for rehabilitation and partial relocation of sewage system of the Ritesici settlement.
- Rehabilitation of the existing facility.

Table 14: Sources in WSS Gračanica

Name of the source	Location	Minimum capacity of the source (l/s)	Average annual capacity (l/s)	Average annual capacity (m3)	Average annual capacity in hydrologically favorable year (l/s)	Average annual capacity in hydrologically favorable year (m3)	Water transport to the reservoir
Natural source „Ilidža“	LC Soko	4,5	12,0	380.000,0	12,0	380.000,0	gravitation
Natural source „Vrela“	LC Soko	4,0	9,5	300.000,0	9,5	300.000,0	gravitation
Natural source „Škahovica“	LC Škahovica	1,0	3,5	110.000,0	3,5	110.000,0	gravitation
Natural source „Zmajevac“	LC Soko	0,4	1,0	30.000,0	1,0	30.000,0	gravitation
Source "Hadžijina voda"	LC Gračanica	2,2	2,2	69.379,2	2,2	69.379,2	Pumping
Drilled wells „Sklop“ (Sklop II and Sklop III)	LC Gračanica	17,0	17,1	540.000,0	22,2	700.000,0	Pumping
Well Soljanuša	LC Pribava	5,70	6,50	179.755,20	6,50	204.984,00	Pumping
Total:		**34,8**	**51,8**	**1.609.134,4**	**56,9**	**1.794.363,2**	

2.3.4 RESERVOIRS IN WSS GRAČANICA

In Gračanica water supply system area there are 6 reservoirs. List of the basic data is given in the following table.

Volume and shape of reservoirs and surge tanks (dimensions)

- Reservoir Gaj: V=1400+400 m^3 (round D=20 m+square),
- Reservoir Pribava: V=300 m^3 (round),
- Reservoir Ritošići: V=100 m^3 (square),
- Reservoir D. Drafnići: V=30 m^3 (square)
- Reservoir PS Drafnići: V=30 m^3 (square)
- Reservoir G. Drafnići i Hurije: V=20+20 m^3 (square)
- Reservoir Bahići: V=50 m^3 (square)

Position of flow meters (at the inlet, at the outlet of the reservoir)

- Reservoir Gaj: Electromagnetic at the exhaust pipelines (2x DN150 and 1x DN200)
- Reservoir Pribava: Electromagnetic at the outlet of PS Soljanuša (because of electricity)
- System Drafnići: at the supply pipeline (DN 80)
- Reservoir Bahići: DN 50 at the outlet of PS Bazen III (because of electricity)

Condition of reservoir facilities and protection fence

- Reservoir Gaj: regular,
- Reservoir Pribava: regular,
- Reservoir Ritošići: regular,
- Reservoir D. Drafnići: minor construction rehabilitation needed
- Reservoir PS Drafnići: minor construction rehabilitation needed
- Reservoir G. Drafnići and Hurije: construction of a new reservoir from PS is planned
- Reservoir Bahići: regular

The Main reservoir in the system, and practically the central facility in Gračanica water supply system is **reservoir "Gaj"** whit the volume V=1.800 m^3. Reservoir is consisted of cylindrical chamber, basic diameter D=20 m and depth H=8 m, volume V=1.400 m^3 and rectangular shaped chamber with the volume V=400 m^3. Reservoir "Gaj" receives the water from all sources, except of the sources "Soljanuša" and "Hadžina voda". Reservoir is located north from town, at the exit towards settlement Soko. Reservoir position with the bottom elevation K_{dn}=256 MASL and elevation gradient K_{pr}=264 MASL is such that the biggest part of the system can be covered. Urban part of the town is supplied from this reservoir, as well as the Ćiriš. Reservoir position, related to Donji Grad and partially Srednji Grad, is too high, so it is necessary to lower the pressures in this part of the town, in the aim of losses reduction. It can be achieved by reducer valve.

Part of the town - **Mejdanić** (Drafnići and Hurije) are supplied from the sources Ilidža and Vrelo, gravitationally through the pressure release chamber which is located north from the settlement. Water is gravitationally transported to the reservoir "Donji Drafnići" supplying lower settlements parts. Higher settlements parts, as well as the settlement Hurije, are supplied from the reservoir "Gornji Drafnići" and reservoir "Hurije" in which the water is transported by the pumping station "Drafnići".

Reservoir "Pribava"'s volume is V=300 m^3. Reservoir is consisted of cylindrical chamber, basic diameter D=10 m and water depth H=3,5 m. This reservoir supplies population and industry of settlement Pribava. Pribava settlement is practically completely separated system, although the pipeline is connected to the WSS Gracanica, and water is supplied from the reservoir "Pribava". Volume of this reservoir is sufficient for current needs.

Part of the town occasionally supplied from the well "Hadžijina voda", is connected to the **reservoir "Ritošići"** with the volume V=100 m^3. Reservoir is recharged by the pumping station "Hadžijina voda" or if the wells are not in function, gravitationally from reservoir "Gaj".

Settlement **Bahići** is supplied from the reservoir "Bahići" recharged by the PS "Bahići".

Figure 6: Reservoir "Gaj"

The following table shows data about reservoirs, as well as the number of users supplied by these reservoirs.

Total reservoirs volume in WSS Gračanica is V=2.350 m^3. Currently, the reservoir space volume is satisfying.

Table 15: Reservoirs in WSS Gračanica

Reservoir	Reservoir position coordinates		Gradient elevation	Reservoir depth	Bottom elevation	Volume	Number of inhabitants in the zone of reservoirs	Number of households in the zone of reservoirs	Number of economy users in the zone of reservoirs	Water consumed in the zone of reservoirs
	x	y	MASL	m	MASL	m^3				l/s
Gornji Drafnići	6.526.380,82	4.951.813,02	370,00	2,00	368,00	20,00	971	272	2	4,61
Donji Drafnići	6.525.873,83	4.951.467,14	288,00	2,00	286,00	30,00				
PS Drafnići	6.526.066,26	4.951.590,67	322,00	2,00	320,00	30,00				
Hurije	6.526.382,72	4.951.798,37	370,00	2,00	368,00	20,00				
Bahići	6.524.089,01	4.952.978,66	256,00	3,00	253,00	50,00	482	135	2	
Ritošići	6.525.067,88	4.950.333,17	246,00	3,00	243,00	100,00	678	190	1	
Gaj	6.525.156,99	4.952.122,32	262,00	8,00	254,00	1.800,00	13.248	3.711	675	35,93
Pribava	6.526.326,69	4.949.414,29	243,50	3,50	240,00	300,00	2.128	596	20	6,31
					Total:	**2.350**	**17.507**	**4.904**	**700**	**46,86**

2.3.5 PUMPING STATIONS IN WSS GRAČANICA

Water supply system Gračanica is combined – gravitational-pumping.

Volume and shape of the pumping stations (dimensions)

- PS Soljanuša: well shaft with the facility for electrical equipment,
- PS Sklop: well shaft with the facility for electrical equipment,
- PS Bazen III: reservoir V=8 m^3 with overhead facility for electrical equipment,
- PS Drafnići: reservoir V=30 m^3 with overhead facility for electrical equipment,
- PS Hadžina voda: two separated facilities for pumping and electrical equipment,

Position of flow meters (at the inlet, and oulet of the pumping stations)

- PS Soljanuša: Electromagnetic DN 150 at the outlet of PS Soljanuša,
- PS Sklop: Electromagnetic DN 150 in well shaft,
- PS Bazen III: DN 50 at the pressure line
- PS Hadžina voda: at the pressure line.

Pumps

- Bunar Sklop III: Caprari, N=51 kw
- Bunar Soljanuša: Caprari, N=15 kw
- PS Gaj: N=11,0 kw
- PS Drafnići: N=3,0 kw
- PS Bahići: N=7,5 kw

Pumps age

- Bunar Sklop III: Caprari, 2003,
- Bunar Soljanuša: 2004,
- PS Gaj: 2009,
- PS Drafnići: 1990-2000,
- PS Bahići: 2008.

2.3.6 PIPELINES IN WSS GRAČANICA

All pipelines in WSS Gračanica are shown in the following table. They are, also, shown at the maps. For th eneeds of Study, the water supply system's map is made in Arc view and Map Info program, and then the hydraulic model of water supply system in Epanet.

The total pipeline lenght in WSS Gračanica is around **L=73,8 km**. Of that lenght 80,47 % of the pipeline is plastic or made of PE. Cast iron and asbestos cement pipes are 17,94 % and steel 1,59 %. There is a big percent of pipelines in the system smaller than Ø 80 mm. Those are the pipeline profiles not satisfying technical regulations, and which need to be replaced. Lenght of these pipelines is up to Ø 50 mm, L=7,7 km or 10,44 % and profile Ø 50 mm to Ø 66 mm, L=20,1 km or 27,20 % of the total pipeline lenght. So, the total pipeline lenght of profiles smaller than Ø 80 mm is L=27,8 km or 37,64 % of the total pipeline lenght.

Table 16: Pipelines in WSS Gračanica by profiles and materials

Inside diameter	Outside diameter for PE pipes	Lenght		Percentage	
mm	mm	m	m	%	%
20,00		93,47		0,13%	
26,00		3.527,77		4,78%	
32,00		175,10	7.705,68	0,24%	10,44%
40,00		1.076,14		1,46%	
50,00		2.833,20		3,84%	
55,40	63	13.666,02		18,52%	
60,00		888,67	20.069,45	1,20%	27,20%
65,00		125,53		0,17%	
66,00	75	5.389,23		7,30%	
79,00	90	4.309,35		5,84%	
80,00		2.228,16	30.090,47	3,02%	40,78%
97,00	110	22.365,85		30,31%	
100,00		1.187,10		1,61%	
123,40	140	1.292,15		1,75%	
141,00	160	6.118,64	7.506,75	8,29%	10,17%
149,00	180	47,03		0,06%	
150,00		48,92		0,07%	
198,20	225	6.178,06		8,37%	
200,00		1.057,59	8.423,36	1,43%	11,41%
277,60	315	15,56		0,02%	
300,00		1.172,15		1,59%	
	Total:	**73.795,70**		**100,00%**	

Inside diameter	Type of material	Lenght		Percentage	
mm		**m**	**m**	**%**	**%**
20,00		93,47		0,13%	
26,00		3.527,77		4,78%	
32,00	Z / CI	175,10	7.705,68	0,24%	10,44%
40,00		1.076,14		1,46%	
50,00		2.833,20		3,84%	
55,40	PE/PVC	13.666,02	13.666,02	18,52%	18,52%
60,00	CI	888,67	1.014,20	1,20%	1,37%
65,00	CI	125,53		0,17%	
66,00	PE/PVC	5.389,23	9.698,58	7,30%	13,14%
79,00		4.309,35		5,84%	
80,00	CI	2.228,16	2.228,16	3,02%	3,02%
97,00	PE/PVC	22.365,85	22.365,85	30,31%	30,31%
100,00	CI/ACC	1.187,10	1.187,10	1,61%	1,61%
123,40		1.292,15		1,75%	
141,00	PE/PVC	6.118,64	7.457,83	8,29%	10,11%
149,00		47,03		0,06%	
150,00	CI/ACC	48,92	48,92	0,07%	0,07%
198,20	PE/PVC	6.178,06	6.178,06	8,37%	8,37%
200,00	CI/ACC	1.057,59	1.057,59	1,43%	1,43%
277,60	PE/PVC	15,56	15,56	0,02%	0,02%

300,00	Steel	1.172,15	1.172,15	1,59%	1,59%
Total:		**73.795,70**		**100,00%**	

Table 17: Pipelines by the material

Pipelines by the type of material				
	PE / PVC	CI / ACC	Steel	Total
%	80,47%	17,94%	1,59%	100,00%
m	59.381,91	13.241,65	1.172,15	73.795,70

Table 18: Pipelines in WSS Gračanica- taken from the model

Pipeline	Lenght	Internal diameter	Roughness D/W	Diameters lenght
	m	mm	mm	m
P234	47,39	20,00	0,40	93,47
P253	46,08		0,40	
P85	105,12	26,00	0,40	3.527,77
P87	89,43		0,40	
P100	51,57		0,40	
P102	90,12		0,40	
P104	105,04		0,40	
P125	88,62		0,40	
P209	128,83		0,40	
P210	38,53		0,40	
P211	35,85		0,40	
P212	132,20		0,40	
P213	46,16		0,40	
P214	40,42		0,40	
P215	29,46		0,40	
P216	40,07		0,40	
P217	45,37		0,40	
P218	61,35		0,40	
P219	43,63		0,40	
P220	34,49		0,40	
P221	45,96		0,40	
P222	58,72		0,40	
P229	78,22		0,40	
P242	44,89		0,40	
P245	40,09		0,40	
P246	67,23		0,40	
P247	87,26		0,40	
P249	28,43		0,40	
P256	63,76		0,40	
P257	39,80		0,40	
P262	211,70		0,40	
P264	140,49		0,40	
P267	171,80		0,40	
P269	216,22		0,40	
P283	220,54		0,40	
P284	268,27		0,40	
P289	115,17		0,40	
P313	422,94		0,40	
P251	175,10	32,00	0,40	175,10
P128	59,77	40,00	0,40	1.076,14

P145	139,14		0,40	
P196	118,09		0,40	
P197	313,40		0,40	
P198	65,47		0,40	
P199	117,50		0,40	
P200	125,91	40,00	0,40	
P241	50,42		0,40	
P252	86,44		0,40	
P12	409,87		0,40	
P13	56,30		0,40	
P56	72,05		0,40	
P57	55,30		0,40	
P58	141,84		0,40	
P69	401,41		0,40	
P81	135,55		0,40	
P94	106,59		0,40	
P120	154,88	50,00	0,40	2.833,20
P123	436,05		0,40	
P143	118,25		0,40	
P144	111,66		0,40	
P152	103,91		0,40	
P228	80,00		0,40	
P230	64,22		0,40	
P306	20,33		0,40	
P307	88,93		0,40	
P308	276,06		0,40	
P34	364,50		0,10	
P35	8,13		0,10	
P40	154,47		0,10	
P50	2.207,74		0,10	
P52	79,88		0,10	
P62	15,13		0,10	
P64	169,45		0,10	
P67	444,00		0,10	
P74	214,93		0,10	
P78	69,19		0,10	
P80	464,90		0,10	
P93	268,79		0,10	
P96	99,63		0,10	
P97	165,38		0,10	
P101	136,65		0,10	
P103	87,39	55,40	0,10	13.666,02
P106	171,18		0,10	
P108	84,84		0,10	
P109	702,22		0,10	
P110	90,92		0,10	
P118	71,88		0,10	
P119	86,27		0,10	
P121	337,39		0,10	
P130	138,81		0,10	
P137	148,66		0,10	
P138	239,06		0,10	
P142	212,57		0,10	
P163	9,72		0,10	
P187	383,50		0,10	
P188	13,11		0,10	
P193	154,00		0,10	

P194	36,01		0,10	
P195	300,89		0,10	
P203	140,58		0,10	
P204	124,76		0,10	
P207	127,02		0,10	
P223	126,20		0,10	
P225	26,30		0,10	
P226	75,64		0,10	
P227	55,44		0,10	
P231	122,76		0,10	
P232	53,35		0,10	
P233	93,02		0,10	
P235	73,10		0,10	
P238	148,78		0,10	
P254	91,38		0,10	
P255	66,65		0,10	
P292	31,16		0,10	
P293	58,75		0,10	
P301	385,52		0,10	
P302	2,18		0,10	
P309	245,10		0,10	
P312	141,64		0,10	
P319	1.363,17		0,10	
P338	182,54		0,10	
P339	488,38		0,10	
P340	207,91		0,10	
1	10,00		0,10	
Pi16	95,94		0,10	
Pi32	42,41		0,10	
Pi33	94,26		0,10	
Pi3	346,93		0,10	
Pi35	513,95		0,10	
P133	97,86		0,40	
P139	148,48		0,40	
P276	482,30	60,00	0,40	888,67
P297	59,04		0,40	
P298	101,00		0,40	
P10	125,53	65,00	0,40	125,53
P31	454,36		0,10	
P76	110,01		0,10	
P86	53,80		0,10	
P89	145,64		0,10	
P90	565,82		0,10	
P92	147,59		0,10	
P95	131,49		0,10	
P98	70,04		0,10	
P105	205,31		0,10	
P112	236,78	66,00	0,10	5.389,23
P126	61,56		0,10	
P127	7,79		0,10	
P129	112,21		0,10	
P141	77,28		0,10	
P150	62,68		0,10	
P151	56,38		0,10	
P155	257,89		0,10	
P172	128,09		0,10	
P173	51,92		0,10	

P240	121,54		0,10	
P320	1.176,53		0,10	
P322	419,83		0,10	
P325	112,69		0,10	
P326	235,05		0,10	
P328	25,97		0,10	
P329	3,38		0,10	
P337	342,60		0,10	
Pi2	2,00		0,10	
Pi4	0,01		0,10	
Pi5	2,00		0,10	
Pi40	11,02		0,10	
P33	336,39		0,10	
P51	789,44		0,10	
P65	154,85		0,10	
P83	404,27		0,10	
P88	355,63		0,10	
P136	213,39		0,10	
P146	294,58		0,10	
P156	119,49		0,10	
P208	33,28		0,10	
P224	118,12		0,10	
P248	5,30	79,00	0,10	4.309,35
P250	36,62		0,10	
P299	36,90		0,10	
P300	88,16		0,10	
P321	1.125,52		0,10	
Pi19	11,02		0,10	
Pi21	40,33		0,10	
Pi22	8,35		0,10	
Pi23	37,70		0,10	
Pi24	17,25		0,10	
Pi25	50,06		0,10	
Pi26	32,70		0,10	
P66	85,87		0,40	
P68	365,91		0,40	
P114	245,36		0,40	
P132	289,54		0,40	
P140	249,52		0,40	
P149	149,09	80,00	0,40	2.228,16
P153	66,10		0,40	
P323	403,35		0,40	
P324	320,99		0,40	
Pi13	51,45		0,40	
Pi38	0,99		0,40	
P7	298,90		0,10	
P8	139,91		0,10	
P9	258,81		0,10	
P16	385,88		0,10	
P17	408,28		0,10	
P18	322,63	97,00	0,10	22.365,85
P25	100,46		0,10	
P27	210,33		0,10	
P28	218,36		0,10	
P43	187,81		0,10	
P45	188,94		0,10	
P49	850,93		0,10	

P59	72,11		0,10	
P63	55,64		0,10	
P70	17,42		0,10	
P71	82,52		0,10	
P72	253,01		0,10	
P73	60,30		0,10	
P75	103,54		0,10	
P77	70,73		0,10	
P84	188,65		0,10	
P91	260,89		0,10	
P107	138,34		0,10	
P115	22,70		0,10	
P116	10,74		0,10	
P117	194,54		0,10	
P122	1.058,46		0,10	
P124	10,14		0,10	
P131	151,50		0,10	
P134	116,76		0,10	
P135	416,38		0,10	
P148	39,04		0,10	
P154	79,16		0,10	
P157	1,24		0,10	
P158	210,73		0,10	
P159	44,06		0,10	
P166	6,32		0,10	
P167	401,29		0,10	
P168	13,58		0,10	
P169	229,46		0,10	
P170	104,84		0,10	
P171	43,86		0,10	
P174	145,60		0,10	
P175	160,72		0,10	
P176	229,35		0,10	
P177	113,38		0,10	
P180	1,40		0,10	
P181	17,04		0,10	
P182	171,95		0,10	
P183	10,22		0,10	
P184	1,69		0,10	
P201	241,44		0,10	
P202	136,94		0,10	
P205	42,02		0,10	
P206	5,96		0,10	
P258	120,79		0,10	
P259	498,32		0,10	
P260	288,89		0,10	
P261	69,49		0,10	
P263	43,95		0,10	
P265	112,37		0,10	
P266	219,89		0,10	
P268	39,80		0,10	
P270	689,83		0,10	
P271	241,21		0,10	
P272	674,12		0,10	
P273	378,93		0,10	
P274	298,44		0,10	
P275	243,67		0,10	

P277	447,37		0,10	
P278	221,01		0,10	
P279	131,01		0,10	
P280	309,00		0,10	
P281	148,99		0,10	
P282	32,41		0,10	
P285	76,79		0,10	
P286	357,35		0,10	
P287	93,15		0,10	
P288	139,73		0,10	
P290	107,68		0,10	
P291	346,70		0,10	
P304	278,60		0,10	
P305	32,75		0,10	
P314	369,00		0,10	
P315	132,83		0,10	
P316	1.625,33		0,10	
P317	208,76		0,10	
P318	1.357,10		0,10	
P333	517,29		0,10	
P334	535,44		0,10	
P335	326,72		0,10	
P336	454,33		0,10	
Pi18	128,93		0,10	
Pi20	138,46		0,10	
Pi27	54,04		0,10	
Pi28	51,41		0,10	
Pi29	56,21		0,10	
Pi30	17,98		0,10	
Pi31	142,48		0,10	
Pi34	83,23		0,10	
Pi36	217,18		0,10	
P11	205,76	100,00	0,40	1.187,10
P113	463,94		0,40	
P327	495,40		0,40	
Pi6	10,00		0,40	
Pi7	2,00		0,40	
Pi8	10,00		0,40	
P48	1.053,20	123,40	0,10	1.292,15
P55	56,32		0,10	
P99	182,63		0,10	
P3	266,51	141,00	0,10	6.118,64
P4	44,64		0,10	
P5	380,65		0,10	
P6	148,76		0,10	
P14	75,36		0,10	
P15	88,59		0,10	
P23	44,30		0,10	
P24	305,75		0,10	
P26	1.074,11		0,10	
P38	190,42		0,10	
P42	55,42		0,10	
P44	140,82		0,10	
P54	147,54		0,10	
P60	23,93		0,10	
P61	74,62		0,10	
P147	175,58		0,10	

P160	62,38		0,10	
P161	197,73		0,10	
P162	22,57		0,10	
P164	79,05		0,10	
P165	85,35		0,10	
P178	1,53		0,10	
P179	29,94		0,10	
P189	8,99		0,10	
P190	248,07		0,10	
P236	120,95		0,10	
P237	351,60		0,10	
P239	64,46		0,10	
P243	80,50		0,10	
P244	119,94		0,10	
P310	58,11		0,10	
P311	503,60		0,10	
P330	323,23		0,10	
P331	328,22		0,10	
Pi9	20,59		0,10	
Pi10	42,77		0,10	
Pi11	32,57		0,10	
Pi12	75,11		0,10	
Pi14	1,67		0,10	
Pi15	14,50		0,10	
Pi37	8,24		0,10	
P41	47,03	149,00	0,40	47,03
P111	46,92		0,40	
Pi1	1,00	150,00	0,40	48,92
Pi39	1,00		0,40	
P2	318,67		0,10	
P19	122,72		0,10	
P20	353,06		0,10	
P21	159,53		0,10	
P22	277,81		0,10	
P30	895,79		0,10	
P36	565,31		0,10	
P37	189,10		0,10	
P39	434,65	198,20	0,10	6.178,06
P185	124,20		0,10	
P186	20,36		0,10	
P191	65,68		0,10	
P192	248,81		0,10	
P294	797,45		0,10	
P295	620,81		0,10	
P296	342,29		0,10	
P332	641,81		0,10	
Pi17	0,01		0,10	
P32	1.057,59	200,00	0,40	1.057,59
P1	15,56	277,60	0,10	15,56
P29	1.172,15	300,00	0,40	1.172,15
Total:	**73.795,70**			**73.795,70**

When we talk about th epercent of losse at the transport and distribution pipelines, related to some other water supply systems, the condition is satisfying. Still, there is posibility for losses reduction in the system. There are no more accurate data about the pipeline lenght for households connections, which diameter is mostly Ø 13 mm, Ø 20 mm, Ø 26 mm and Ø 32 mm, but the estimation is that their lenght is **L=50,0 km**. It is assumed that **the biggest percent of losses** is exactly at these pipelines which are very old, and haven't been reconstructed for ages.

2.3.7 TRANSPORT PIPELINES IN WSS GRAČANICA

Transport pipelines are given in the following table. Total lenght of the transport pipelines is appr. **L=16,2 km**. Related to the total pipeline lenght in WSS Gračanica which is L=73,8 km, the percent is 21,92 %.

Table 19: Transport pipelines in WSS Gračanica given by the profiles

Pipeline	Lenght	Internal diameter	Roughness D/W	Diameters lenght
	m	mm	mm	m
P35	8,13	55,4	0,1	2.002,26
P40	154,47			
P52	79,8786			
P187	383,5			
P188	13,11			
P319	1363,17			
P33	336,39	79	0,1	2.251,35
P51	789,44			
P321	1125,52			
P43	187,81	97	0,1	3.702,83
P45	188,94			
P206	5,96			
P316	1625,33			
P317	208,76			
P318	1357,1			
Pi18	128,93			
P48	1053,2	123,4	0,1	1.053,20
P38	190,418	141	0,1	386,66
P42	55,42			
P44	140,82			
P41	47,03	149	0,4	47,03
P30	895,79	198,2	0,1	4.487,22
P36	565,309			
P37	189,1			
P39	434,65			
P294	797,45			
P295	620,81			
P296	342,29			
P332	641,81			
Pi17	0,01			
P32	1057,59	200	0,4	1.057,59
P1	15,56	277,6	0,1	15,56
P29	1172,15	300	0,4	1.172,15
Total:	**16.175,85**			**16.175,85**

2.3.8 DISTRIBUTION PIPELINES IN WSS GRAČANICA

According to the model, the total lenght of distribution pipelines is appr. **L=57,6 km**. We allready gave the description of these pipelines in the previous items, when it was mentioned that the biggest problem with distribution pipelines is insufficient diameter with the big percent of pipelines.

Table 20: Distribution pipelines in WSS Gračanica

Pipeline	Lenght	Internal diameter	Roughness D/W	Diameters lenght
	m	mm	mm	m
P234	47,39	20,00	0,40	93,47
P253	46,08	20,00	0,40	
P85	105,12	26,00	0,40	3.527,77
P87	89,43	26,00	0,40	
P100	51,57	26,00	0,40	
P102	90,12	26,00	0,40	
P104	105,04	26,00	0,40	
P125	88,62	26,00	0,40	
P209	128,83	26,00	0,40	
P210	38,53	26,00	0,40	
P211	35,85	26,00	0,40	
P212	132,20	26,00	0,40	
P213	46,16	26,00	0,40	
P214	40,42	26,00	0,40	
P215	29,46	26,00	0,40	
P216	40,07	26,00	0,40	
P217	45,37	26,00	0,40	
P218	61,35	26,00	0,40	
P219	43,63	26,00	0,40	
P220	34,49	26,00	0,40	
P221	45,96	26,00	0,40	
P222	58,72	26,00	0,40	
P229	78,22	26,00	0,40	
P242	44,89	26,00	0,40	
P245	40,09	26,00	0,40	
P246	67,23	26,00	0,40	
P247	87,26	26,00	0,40	
P249	28,43	26,00	0,40	
P256	63,76	26,00	0,40	
P257	39,80	26,00	0,40	
P262	211,70	26,00	0,40	
P264	140,49	26,00	0,40	
P267	171,80	26,00	0,40	
P269	216,22	26,00	0,40	
P283	220,54	26,00	0,40	
P284	268,27	26,00	0,40	
P289	115,17	26,00	0,40	
P313	422,94	26,00	0,40	
P251	175,10	32,00	0,40	175,10
P128	59,77	40,00	0,40	1.076,14
P145	139,14	40,00	0,40	
P196	118,09	40,00	0,40	
P197	313,40	40,00	0,40	
P198	65,47	40,00	0,40	
P199	117,50	40,00	0,40	
P200	125,91	40,00	0,40	
P241	50,42	40,00	0,40	

P252	86,44	40,00	0,40	
P12	409,87	50,00	0,40	2.833,20
P13	56,30	50,00	0,40	
P56	72,05	50,00	0,40	
P57	55,30	50,00	0,40	
P58	141,84	50,00	0,40	
P69	401,41	50,00	0,40	
P81	135,55	50,00	0,40	
P94	106,59	50,00	0,40	
P120	154,88	50,00	0,40	
P123	436,05	50,00	0,40	
P143	118,25	50,00	0,40	
P144	111,66	50,00	0,40	
P152	103,91	50,00	0,40	
P228	80,00	50,00	0,40	
P230	64,22	50,00	0,40	
P306	20,33	50,00	0,40	
P307	88,93	50,00	0,40	
P308	276,06	50,00	0,40	
P34	364,50	55,40	0,10	11.663,76
P50	2.207,74	55,40	0,10	
P62	15,13	55,40	0,10	
P64	169,45	55,40	0,10	
P67	444,00	55,40	0,10	
P74	214,93	55,40	0,10	
P78	69,19	55,40	0,10	
P80	464,90	55,40	0,10	
P93	268,79	55,40	0,10	
P96	99,63	55,40	0,10	
P97	165,38	55,40	0,10	
P101	136,65	55,40	0,10	
P103	87,39	55,40	0,10	
P106	171,18	55,40	0,10	
P108	84,84	55,40	0,10	
P109	702,22	55,40	0,10	
P110	90,92	55,40	0,10	
P118	71,88	55,40	0,10	
P119	86,27	55,40	0,10	
P121	337,39	55,40	0,10	
P130	138,81	55,40	0,10	
P137	148,66	55,40	0,10	
P138	239,06	55,40	0,10	
P142	212,57	55,40	0,10	
P163	9,72	55,40	0,10	
P193	154,00	55,40	0,10	
P194	36,01	55,40	0,10	
P195	300,89	55,40	0,10	
P203	140,58	55,40	0,10	
P204	124,76	55,40	0,10	
P207	127,02	55,40	0,10	
P223	126,20	55,40	0,10	
P225	26,30	55,40	0,10	
P226	75,64	55,40	0,10	
P227	55,44	55,40	0,10	
P231	122,76	55,40	0,10	
P232	53,35	55,40	0,10	
P233	93,02	55,40	0,10	

P235	73,10	55,40	0,10	
P238	148,78	55,40	0,10	
P254	91,38	55,40	0,10	
P255	66,65	55,40	0,10	
P292	31,16	55,40	0,10	
P293	58,75	55,40	0,10	
P301	385,52	55,40	0,10	
P302	2,18	55,40	0,10	
P309	245,10	55,40	0,10	
P312	141,64	55,40	0,10	
P338	182,54	55,40	0,10	
P339	488,38	55,40	0,10	
P340	207,91	55,40	0,10	
1	10,00	55,40	0,10	
Pi16	95,94	55,40	0,10	
Pi32	42,41	55,40	0,10	
Pi33	94,26	55,40	0,10	
Pi3	346,93	55,40	0,10	
Pi35	513,95	55,40	0,10	
P133	97,86	60,00	0,40	
P139	148,48	60,00	0,40	
P276	482,30	60,00	0,40	888,67
P297	59,04	60,00	0,40	
P298	101,00	60,00	0,40	
P10	125,53	65,00	0,40	125,53
P31	454,36	66,00	0,10	
P76	110,01	66,00	0,10	
P86	53,80	66,00	0,10	
P89	145,64	66,00	0,10	
P90	565,82	66,00	0,10	
P92	147,59	66,00	0,10	
P95	131,49	66,00	0,10	
P98	70,04	66,00	0,10	
P105	205,31	66,00	0,10	
P112	236,78	66,00	0,10	
P126	61,56	66,00	0,10	
P127	7,79	66,00	0,10	
P129	112,21	66,00	0,10	
P141	77,28	66,00	0,10	
P150	62,68	66,00	0,10	
P151	56,38	66,00	0,10	5.389,23
P155	257,89	66,00	0,10	
P172	128,09	66,00	0,10	
P173	51,92	66,00	0,10	
P240	121,54	66,00	0,10	
P320	1.176,53	66,00	0,10	
P322	419,83	66,00	0,10	
P325	112,69	66,00	0,10	
P326	235,05	66,00	0,10	
P328	25,97	66,00	0,10	
P329	3,38	66,00	0,10	
P337	342,60	66,00	0,10	
Pi2	2,00	66,00	0,10	
Pi4	0,01	66,00	0,10	
Pi5	2,00	66,00	0,10	
Pi40	11,02	66,00	0,10	
P65	154,85	79,00	0,10	2.058,00

P83	404,27	79,00	0,10	
P88	355,63	79,00	0,10	
P136	213,39	79,00	0,10	
P146	294,58	79,00	0,10	
P156	119,49	79,00	0,10	
P208	33,28	79,00	0,10	
P224	118,12	79,00	0,10	
P248	5,30	79,00	0,10	
P250	36,62	79,00	0,10	
P299	36,90	79,00	0,10	
P300	88,16	79,00	0,10	
Pi19	11,02	79,00	0,10	
Pi21	40,33	79,00	0,10	
Pi22	8,35	79,00	0,10	
Pi23	37,70	79,00	0,10	
Pi24	17,25	79,00	0,10	
Pi25	50,06	79,00	0,10	
Pi26	32,70	79,00	0,10	
P66	85,87	80,00	0,40	2.228,16
P68	365,91	80,00	0,40	
P114	245,36	80,00	0,40	
P132	289,54	80,00	0,40	
P140	249,52	80,00	0,40	
P149	149,09	80,00	0,40	
P153	66,10	80,00	0,40	
P323	403,35	80,00	0,40	
P324	320,99	80,00	0,40	
Pi13	51,45	80,00	0,40	
Pi38	0,99	80,00	0,40	
P7	298,90	97,00	0,10	18.663,02
P8	139,91	97,00	0,10	
P9	258,81	97,00	0,10	
P16	385,88	97,00	0,10	
P17	408,28	97,00	0,10	
P18	322,63	97,00	0,10	
P25	100,46	97,00	0,10	
P27	210,33	97,00	0,10	
P28	218,36	97,00	0,10	
P49	850,93	97,00	0,10	
P59	72,11	97,00	0,10	
P63	55,64	97,00	0,10	
P70	17,42	97,00	0,10	
P71	82,52	97,00	0,10	
P72	253,01	97,00	0,10	
P73	60,30	97,00	0,10	
P75	103,54	97,00	0,10	
P77	70,73	97,00	0,10	
P84	188,65	97,00	0,10	
P91	260,89	97,00	0,10	
P107	138,34	97,00	0,10	
P115	22,70	97,00	0,10	
P116	10,74	97,00	0,10	
P117	194,54	97,00	0,10	
P122	1.058,46	97,00	0,10	
P124	10,14	97,00	0,10	
P131	151,50	97,00	0,10	
P134	116,76	97,00	0,10	

P135	416,38	97,00	0,10	
P148	39,04	97,00	0,10	
P154	79,16	97,00	0,10	
P157	1,24	97,00	0,10	
P158	210,73	97,00	0,10	
P159	44,06	97,00	0,10	
P166	6,32	97,00	0,10	
P167	401,29	97,00	0,10	
P168	13,58	97,00	0,10	
P169	229,46	97,00	0,10	
P170	104,84	97,00	0,10	
P171	43,86	97,00	0,10	
P174	145,60	97,00	0,10	
P175	160,72	97,00	0,10	
P176	229,35	97,00	0,10	
P177	113,38	97,00	0,10	
P180	1,40	97,00	0,10	
P181	17,04	97,00	0,10	
P182	171,95	97,00	0,10	
P183	10,22	97,00	0,10	
P184	1,69	97,00	0,10	
P201	241,44	97,00	0,10	
P202	136,94	97,00	0,10	
P205	42,02	97,00	0,10	
P258	120,79	97,00	0,10	
P259	498,32	97,00	0,10	
P260	288,89	97,00	0,10	
P261	69,49	97,00	0,10	
P263	43,95	97,00	0,10	
P265	112,37	97,00	0,10	
P266	219,89	97,00	0,10	
P268	39,80	97,00	0,10	
P270	689,83	97,00	0,10	
P271	241,21	97,00	0,10	
P272	674,12	97,00	0,10	
P273	378,93	97,00	0,10	
P274	298,44	97,00	0,10	
P275	243,67	97,00	0,10	
P277	447,37	97,00	0,10	
P278	221,01	97,00	0,10	
P279	131,01	97,00	0,10	
P280	309,00	97,00	0,10	
P281	148,99	97,00	0,10	
P282	32,41	97,00	0,10	
P285	76,79	97,00	0,10	
P286	357,35	97,00	0,10	
P287	93,15	97,00	0,10	
P288	139,73	97,00	0,10	
P290	107,68	97,00	0,10	
P291	346,70	97,00	0,10	
P304	278,60	97,00	0,10	
P305	32,75	97,00	0,10	
P314	369,00	97,00	0,10	
P315	132,83	97,00	0,10	
P333	517,29	97,00	0,10	
P334	535,44	97,00	0,10	
P335	326,72	97,00	0,10	

P336	454,33	97,00	0,10	
Pi20	138,46	97,00	0,10	
Pi27	54,04	97,00	0,10	
Pi28	51,41	97,00	0,10	
Pi29	56,21	97,00	0,10	
Pi30	17,98	97,00	0,10	
Pi31	142,48	97,00	0,10	
Pi34	83,23	97,00	0,10	
Pi36	217,18	97,00	0,10	
P11	205,76	100,00	0,40	1.187,10
P113	463,94	100,00	0,40	
P327	495,40	100,00	0,40	
Pi6	10,00	100,00	0,40	
Pi7	2,00	100,00	0,40	
Pi8	10,00	100,00	0,40	
P55	56,32	123,40	0,10	238,95
P99	182,63	123,40	0,10	
P3	266,51	141,00	0,10	5.731,98
P4	44,64	141,00	0,10	
P5	380,65	141,00	0,10	
P6	148,76	141,00	0,10	
P14	75,36	141,00	0,10	
P15	88,59	141,00	0,10	
P23	44,30	141,00	0,10	
P24	305,75	141,00	0,10	
P26	1.074,11	141,00	0,10	
P54	147,54	141,00	0,10	
P60	23,93	141,00	0,10	
P61	74,62	141,00	0,10	
P147	175,58	141,00	0,10	
P160	62,38	141,00	0,10	
P161	197,73	141,00	0,10	
P162	22,57	141,00	0,10	
P164	79,05	141,00	0,10	
P165	85,35	141,00	0,10	
P178	1,53	141,00	0,10	
P179	29,94	141,00	0,10	
P189	8,99	141,00	0,10	
P190	248,07	141,00	0,10	
P236	120,95	141,00	0,10	
P237	351,60	141,00	0,10	
P239	64,46	141,00	0,10	
P243	80,50	141,00	0,10	
P244	119,94	141,00	0,10	
P310	58,11	141,00	0,10	
P311	503,60	141,00	0,10	
P330	323,23	141,00	0,10	
P331	328,22	141,00	0,10	
Pi9	20,59	141,00	0,10	
Pi10	42,77	141,00	0,10	
Pi11	32,57	141,00	0,10	
Pi12	75,11	141,00	0,10	
Pi14	1,67	141,00	0,10	
Pi15	14,50	141,00	0,10	
Pi37	8,24	141,00	0,10	
P111	46,92	150,00	0,40	48,92
Pi1	1,00	150,00	0,40	

Pi39	1,00	150,00	0,40	
P2	318,67	198,20	0,10	1.690,84
P19	122,72	198,20	0,10	
P20	353,06	198,20	0,10	
P21	159,53	198,20	0,10	
P22	277,81	198,20	0,10	
P185	124,20	198,20	0,10	
P186	20,36	198,20	0,10	
P191	65,68	198,20	0,10	
P192	248,81	198,20	0,10	
Total:	**57.619,86**			**57.619,86**

The following table shows distribution pipelines in the zone of reservoir "Gaj" based on the lenght and age of the pipeline. Data were obtained from the water company and they differ from the model data. Reason forthat could be the pipelines of small profiles, which are not drawn into GIS and hydraulic model.The total pipeline lenght in this zone is **L=70,1 km**. Important data is that around 57,68 % of the pipelines is younger than 20 years and that 42,32 % of the pipelines is older than 20 years.

Table 21: Distribution pipelines in WSS Gračanica in the zone of reservoir "Gaj"

Zone Ćiriš	**Network lenght (m)**	**%**
To 7 years:	6.763,00	43,18%
From 7 to 20 years:	5.140,00	32,82%
Over 20 years:	3.758,00	24,00%
Zone Ćiriš in total:	**15.661,00**	**100,00%**
Zone Gornji Grad	**Network lenght (m)**	**%**
To 7 years:	1.950,00	16,53%
From 7 to 20 years:	3.030,00	25,68%
Over 20 years:	6.820,00	57,80%
Zone Gornji Grad in total:	**11.800,00**	**100,00%**
Zone Srednji Grad	**Network lenght (m)**	**%**
To 7 years:	2.170,00	12,53%
From 7 to 20 years:	3.130,00	18,08%
Over 20 years:	12.015,00	69,39%
Zone Srednji Grad in total:	**17.315,00**	**100,00%**
Zone Donji Grad	**Network lenght (m)**	**%**
To 7 years:	6.515,00	35,57%
From 7 to 20 years:	6.950,00	37,95%
Over 20 years:	4.850,00	26,48%
Zone Donji Grad in total:	**18.315,00**	**100,00%**
Zone Mejdanić	**Network lenght (m)**	**%**

To 7 years:	1.480,00	21,13%
From 7 to 20 years:	3.300,00	47,11%
Over 20 years:	2.225,00	31,76%
Zone Mejdanić in total:	**7.005,00**	**100,00%**
Zone of the reservoir Gaj in total	**Network lenght (m)**	**%**
To 7 years:	18.878,00	26,93%
From 7 to 20 years:	21.550,00	30,74%
Over 20 years:	29.668,00	42,32%
Total pipeline length in the zone of reservoir Gaj:	**70.096,00**	**100,00%**

Distribution system in the zone of reservoir Pribava is appr. **L=12,29 km**.

Table 22: Distribution network in the zone of reservoir Pribava

Pipeline	Lenght	Internal diameter	Roughness D/W	Diameters lenght
	m	mm	mm	m
P262	211,70	26,00	0,40	1.344,19
P264	140,49	26,00	0,40	
P267	171,80	26,00	0,40	
P269	216,22	26,00	0,40	
P283	220,54	26,00	0,40	
P284	268,27	26,00	0,40	
P289	115,17	26,00	0,40	
P338	182,54	55,40	0,10	670,92
P339	488,38	55,40	0,10	
P276	482,30	60,00	0,40	482,30
P328	25,97	66,00	0,10	371,95
P329	3,38	66,00	0,10	
P337	342,60	66,00	0,10	
P259	498,32	97,00	0,10	8.261,08
P260	288,89	97,00	0,10	
P261	69,49	97,00	0,10	
P263	43,95	97,00	0,10	
P265	112,37	97,00	0,10	
P266	219,89	97,00	0,10	
P268	39,80	97,00	0,10	
P270	689,83	97,00	0,10	
P271	241,21	97,00	0,10	
P272	674,12	97,00	0,10	
P273	378,93	97,00	0,10	
P274	298,44	97,00	0,10	

P275	243,67	97,00	0,10	
P277	447,37	97,00	0,10	
P278	221,01	97,00	0,10	
P279	131,01	97,00	0,10	
P280	309,00	97,00	0,10	
P281	148,99	97,00	0,10	
P282	32,41	97,00	0,10	
P285	76,79	97,00	0,10	
P286	357,35	97,00	0,10	
P287	93,15	97,00	0,10	
P288	139,73	97,00	0,10	
P290	107,68	97,00	0,10	
P291	346,70	97,00	0,10	
P333	517,29	97,00	0,10	
P334	535,44	97,00	0,10	
P335	326,72	97,00	0,10	
P336	454,33	97,00	0,10	
Pi36	217,18	97,00	0,10	
P327	495,40	100,00	0,40	495,40
P330	323,23	141,00	0,10	
P331	328,22	141,00	0,10	659,69
Pi37	8,24	141,00	0,10	
Total:	**12.285,53**			**12.285,53**

Bigger part of distribution network in Pribava settlement is finished this year and it will soon start operating.

2.3.9 CONNECTING PIPELINES IN WSS GRAČANICA

The total length of the connecting pipelines is approximately L = 50 km. As in the description of the pipelines mentioned above, the assumption is that the biggest percentage losses in the system are exactly at the pipelines. Most pipes are old. Nearly 100% of pipelines end with water meters reading the consumption of final consumer. Given the relatively low specific consumption of the population, the assumption is that the home installations are with no major losses.

2.3.10 MATERIALS AND EQUIPMENT

- **Flow meters at the sources**
  - Type and age of flow meters at the sources
    - PS Soljanuša: Electromagnetic Meinecke DN 150 at the outlet of PS Soljanuša, 1998
    - PS Sklop: Electromagnetic Meinecke DN 150 in the well shaft, 1998
  - Flow meter diameter
  - Results recording type at the flow meter
    - at the display + transmission itno the dispatche center of GPS

- how often the instruments are calibrated
- current condition of the instruments
  - good

- **Flow meters at the pumping stations**
  - Type and age of flow meters at the pumping stations
    - PS Soljanuša: Electromagnetic Meinecke DN 150 at the outlet of PS Soljanuša, 1998
    - PS Sklop: Electromagnetic Meinecke DN 150 in the well shaft , 1998
    - PS Bazen III: DN 50 at the pressure pipeline, 2008
    - PS Hadžina voda: DN 65 at the pressure pipeline, 2008
  - Results recording type at the flow meter
    - at the display + transmission itno the dispatche center of GPS
    - visual reading
  - how often the instruments are calibrated
    - within the deadlines
    - current condition of the instrument
    - good

- **Flow meters in reservoirs**
    - Type and age of flow meters in reservoirs
    - Reservoir Gaj: Electromagnetic at the outle pipelines (2x DN150 zone Čiriš and Mejdanić i 1x DN200 town zone), 1998
    - Reservoir Pribava: Electromagnetic at the outlet of PS Soljanuša (because of electricity), 1998
    - Reservoir Bahići: turbine DN 65, 2008
  - Flow meter diameter
    - Previously mentioned
  - Results recording type at the flow meter
    - at the display + transmission itno the dispatche center of GPS
    - visual reading
  - how often the instruments are calibrated
  - current condition of the instrument
    - good

- **Zone(control) flow meters**
  - Type and age of flow meters
    - Reduction station at the zone Gornji grad: turbine DN 150, 2005
    - Zone flow meter Srednji Grad: turbine DN 150, 2008
    - Zone flow meter Donji Grad: turbine DN 100, 2008
    - Reduction station Pribava: turbine DN 100, 2009

- Zone flow meter Drafnići: turbine DN 150, 2008

- Flow meter diameter
  - Above mentioned
- Results recording type at the flow meter
  - preko red inpulsa, snimanje na Data liger sa GSM prenosom podataka
- how often the instruments are calibrated
  - within the deadlines
- current condition of the instrument
  - good

Flow meters at the consumers connections

- Type and age of flow meters at the consumers connections
  - The oldest water meters at the system are installed in 1998, when all of the active water meters are replaced, after which the annual replacement of a certain number of meters is being conducted, but there is still significant number of water meters which part are older than 5 years
- Flow meter diameter
  - od DN 15 do DN 100
- Results recording type at the flow meter
- how often the instruments are calibrated
  - above mentioned
- current condition of the instruments
  - good

2.4 PRODUCTION AND CONSUMPTION OF WATER IN WSS GRAČANICA

2.4.1 CONSUMERS IN WSS GRAČANICA

Gračanica water supply system covers settlments Gračanica and Pribava. Total population number supplied by WSS Gračanica is 17.507. The following table shows data on connections and consumers in WSS Gračanica.

Table 23: Connections to WSS Gračanica

ZONES	Number of connections			Number of consumers		
	households	Industry and other	TOTAL	households	No. of consumers (inhabitants) - estimation	Industry and other
Gornji Grad	807	324	1.131	984	3.513	343
Srednji Grad	982	135	1.117	1.197	4.273	140
Donji Grad	251	143	394	285	1.017	149
Čiriš	647	17	664	789	2.817	17
Mejdanić	374	24	398	456	1.628	26
Pribava	465	17	482	596	2.128	20
Drafnići-Hurije	235	2	237	272	971	2
Ritošići	171	1	172	190	678	1
Ostalo	105	2	107	135	482	2
Total	**3.931**	**665**	**4.701**	**4.904**	**17.507**	**700**

In Gračanica wider area, the following industry is developped:

- Wood industry (primar and final wood procession); „Jadrina“ d.d. , „Isowood“ d.o.o., „Mlinoles“ d.o.o. , „Obrt-comerc“ d.o.o. , „Tursun-prom“ d.o.o. , etc.
- Metal industry: „Fering“ d.o.o. , „GMT Konstrukcije“ d.o.o., „Europrost“ d.o.o. etc.
- Leather and textile industry: „Fortuna“ d.d. , „Euro-galant“ d.o.o. , „Olimp“ d.d. etc.
- Plastics processing industry: „Variplast“ d.o.o. , „Zim-plast“ d.o.o. , „Plastex“ d.o.o. , „Helioplast“ d.o.o. , „Fragmat izolirka“ d.o.o. etc.
- Production of construction prefabrication: „Širbegović“ d.o.o , „GMT Prefabrikacija“ d.o.o. , „AB-beton“ d.o.o. , „Fining“ d.o.o. , „Klauslehmann“ d.o.o. etc.

2.4.2 PRODUCTION AND CONSUMPTION OF WATER IN WSS GRAČANICA IN 2009 AND 2010

The following table shows water production in WSS Gračanica. Data are given for the period 2004 - 2010.

It can be noticed that the produced water is less every year. The reason for that is the planned reduction of losses in the system.

In 2004, non-revenue water percent was 56,71 %, and in 2010 the percent fell to 44,75 %. Physical losses in the system are the part of mentioned water amount. Assumption is that it is the largest part of non-revenue water.

It can, also, be noticed that there are no high oscilations in revenue water during this period. The slight sccreation of water consumption is noticeable, what can be explained by population increase in water supply area.

Table 24: Water production, revenue and non-revenue water in WSS Gračanica in the period 2004-2010

Year	Delivered-produced	Revenued water amount		Non-revenued water amount	
	(m3/year)	(m3/year)	(%)	(m3/year)	(%)
2004	1.756.820	760.449	43,29%	996.371	56,71%
2005	1.698.459	792.244	46,64%	906.215	53,36%
2006	1.558.625	765.467	49,11%	793.158	50,89%
2007	1.511.254	806.338	53,36%	704.916	46,64%
2008	1.477.800	816.465	55,25%	661.335	44,75%
2009	1.437.289	838.422	58,33%	598.867	41,67%
2010	1.339.465	793.711	59,26%	545.754	40,74%

The ***Table 25: Production of water, revenued and non-revenued water in WSS Gračanica in 2010***, shows data from 2010.

Total water production is 1,339,465 m^3/year, of which 22,10 % of water is produced at the wells "Sklop", 61.58 % of water is taken from the natural sources, 2.73 % at H.Voda and 13.58 % from the well Soljanuša.

It is noticeable that there are no large fluctuations in the amounts of water during the year.

Table 25: Production of water, revenued and non-revenued water in WSS Gračanica in 2010

Water supply system	2010								
	Month	Produced water amounts		Revenued water amount			Non-revenued water amount		
		Average in l/s	m³/monthly	Average in l/s	Average in l/s	m³/monthly	Average in l/s	Average in l/s	m³/monthly
WSS Gračanica	January	41,10	110.078,26	23,19	62.103,00	56,42%	17,91	47.975,26	43,58%
	February	42,00	101.597,34	24,64	59.606,00	58,67%	15,68	41.991,34	41,33%
	March	40,56	108.626,08	23,09	61.836,00	56,93%	17,47	46.790,08	43,07%
	April	42,82	110.980,06	23,96	62.108,00	55,96%	18,25	48.872,06	44,04%
	May	42,10	112.765,44	27,03	72.404,00	64,21%	15,07	40.361,44	35,79%
	June	43,95	113.914,74	29,53	76.531,00	67,18%	13,96	37.383,74	32,82%
	July	44,52	119.246,99	27,46	73.554,00	61,68%	17,06	45.692,99	38,32%
	August	45,71	122.433,39	27,15	72.713,00	59,39%	18,56	49.720,39	40,61%
	September	44,12	114.369,19	28,64	74.244,00	64,92%	14,98	40.125,19	35,08%
	October	41,29	110.601,97	22,47	60.187,00	54,42%	18,82	50.414,97	45,58%
	November	41,31	107.070,35	25,03	64.881,00	60,60%	15,75	42.189,35	39,40%
	December	40,24	107.781,08	19,99	53.544,00	49,68%	20,25	54.237,08	50,32%
Total in 2010:		**42,47**	**1.339.464,89**	**25,17**	**793.711,00**	**59,26%**	**17,31**	**545.753,89**	**40,74%**

Average abstracted water from the sources is **Q=42.47 l/s**.

It can be seen that during March and April more water amount was taken from natural sources, and that the water amount from well "Sklop" was reduced. That is understandable because the water production at natural sources is lot cheaper, than the one from the well where the electricity needs to be used. We can, also, conclude that in that period thenatural sources water was clean, i.e. that beside the snow melting there was no turbidity in the sources.

The following table shows the data obtained from ViK experts.

This table shows water supply system managing level. Water losses are still very high, but further reduction demands lot more efforts and means. However, it is very important to mention that in WSS Gračanica ViK employees have quite good control over the. Without the water balance, there is no quality management of the system.

Table 26: Water balances in WSS Gračanica

SIMPLIFIED IWA WATER BALANCE – CALCULATIONS for				Water and sewerage utility Gračanica		Water utility Gračanica	
Period from	**01.01.2010**	to	**31.12.2010**		=	**365**	days
Water amounts	WATER AMOUNT FROM ITS OWN RESOURCES					**1339**	$m^3 \times 10^3$ in the period
	Taken water in the system					**0**	$m^3 \times 10^3$ in the period
	Delivered water in the system					**0**	$m^3 \times 10^3$ in the period
	RETRIEVED WATER IN THE SYSTEM					**1339**	$m^3 \times 10^3$ in the period
	Invoiced measured consumption					**793**	$m^3 \times 10^3$ in the period
	Invoiced unmeasured consumption					**0**	$m^3 \times 10^3$ in the period
	NON-REVENUE WATER AMOUNT (NRW)					**546**	$m^3 \times 10^3$ in the period
	Unbilled authorized consumpyion		**1,25%**			17	$m^3 \times 10^3$ in the period
	WATER LOSSES					529	$m^3 \times 10^3$ in the period
	Unauthorized consumtpion		**0,25%**			3	$m^3 \times 10^3$ in the period
	Inaccuracies of consumers water meter		**2,00%**			16	$m^3 \times 10^3$ in the period
	APPARENT LOSSES					20	$m^3 \times 10^3$ in the period
	REAL ANNUAL LOSSES CARL					**510**	$m^3 \times 10^3$ in the period
	INEVITABLE REAL ANNUAL LOSSES UARL					126	$m^3 \times 10^3$ in the period
	POTENTIAL OF REAL LOSSES REDUCTION = CARL - UARL					**384**	$m^3 \times 10^3$ in the period
After you finish with balance water calculation, go to the work sheet “**Indicators”** >>>>							

2.4.2.1 WATER PRODUCTION IN 2009 AND 2010

Based on data obtained from public company „Vodovod i kanalizacija" Gračanica, We got the data about water production in WSS Gračanica.

Data are related to the years 2009 and 2010

Average water production was:

- For the period in **2009** Q=45,46 l/s;
- For the period in **2010** Q=42.47 l/s.
- For the period in **2010** Q=42.47 l/s.

In the chapters ***2.4.2.2 Production and consumption of water in 2009*** i ***2.4.2.3 Production and consumption of water in 2010*** we gave the data on measured water amounts. For 2009 and 2010 there are data on water consumption for 365 days, which is good, because in the accordance with those data we can see the coefficient of seasonal nonlinearity. There are, also, data per months for both years.

PC „Vodovod i kanalizacija" have large number of data, measurements in the system are quite extensive, so it means that this is one of the rear companies in BiH that can provide quite good water balance.

2.4.2.2 PRODUCTION AND CONSUMPTION OF WATER IN 2009

Water production in 2009 was **Q=45,58 l/s**, i.e. V=**1.437.289 m^3.** The **Error! Reference source not found.**, shows us the data on water production by the sources. Here, we have data on wells "Sklop", "Soljanuša" and "Hamzina voda". For natural springs we have summary information because the water in all sources is not individually measured each day, but measured is the amount of water that comes into the reservoir "Gaj".

The most water amount comes from the well "Sklop", around 45,42 %, natural sources around 40,03 %, the well "Soljanuša" around 12,83 % and the well "Hamzina voda" around 1,73 %.

The results are, also, shown in the **Error! Reference source not found.**,

In the ***Table 30:*** , these results are given in l/s and they are given for the entire year measurements, per days. Besides all, these results are important for determing the coefficient of daily nonlinearity. It can be seen that the water amount during the year does not vary a lot. That means that the seasonal nonlinearity coefficient is, also, relativelly low. If we take the biggest annual consumption (23rd of May 4.018,0 m^3/day) and average consumption (V=3.203,20 m^3/day), the conclussion is that daily nonlinearity coefficient is **K_{dn}=1,25**.

Table 27: Nonlinearity coefficient

Max V=	4.018,00 m^3/day	23.05.2009.
Min V=	2.772,00 m^3/day	29.12.2009.
Vsr=	3.203,20 m^3/day	
Daily nonlinearity coefficient		**1,25**

The results are, also, shown in the ***Chart 5: Consumption of water in reservoir "Gaj" by zones in 2009, expressed in l/s***.

The table and the chart show that there was no source turbidity in that period, practically the sources were not excluded from the system not even for a day. In March and April, it is noticeable that more water was captured from the natural sources than from the wells "Sklop". The reason for that is sufficient water at the sources with the good quality, which was gravitationally inserted into the reservoir "Gaj". It can be seen from the chart that the water during the autumn months, i.e. during hydrologically favourable parts of the year, is more often taken from the natural sources than from the wells.

The percent of **NRW is 41,67 %** as it can be seen in the **Error! Reference source not found.**.

Revenue water amount is 58,33 % what is relativelly high percent for our conditions. Of that percent, the invoiced water is: **households 80,51 %, public institutions and economy 19,49 %**.

Unbilled authorized consumption is:

- Measured water amount is ,52 %;
- Unmeasured water amount is ,46 %.

Estimation is that the **physical losses are 37,55 %** of total amount of produced water. However, this percent is quite good for our conditions, considering the fact that in most of our water supply systems is over 50 %.

SPECIFIC WATER CONSUMPTION

Annual consumption in WSS Gračanica is V=1.437.288,50 m^3. This water supply system supplies 17.507 inhabitants. That means that specific water consumption is **224,92 l/c/day**.

Annual revenue is V=838.422,0 m^3. Specific consumption is **q=131,21 l/c/day** including the economy production. If we consider only the household consumption which is V=663.676,0 m^3/year, that means that the specific population consumption is **q=103,86 l/c/day**. This i srelativelly low specific consumption.

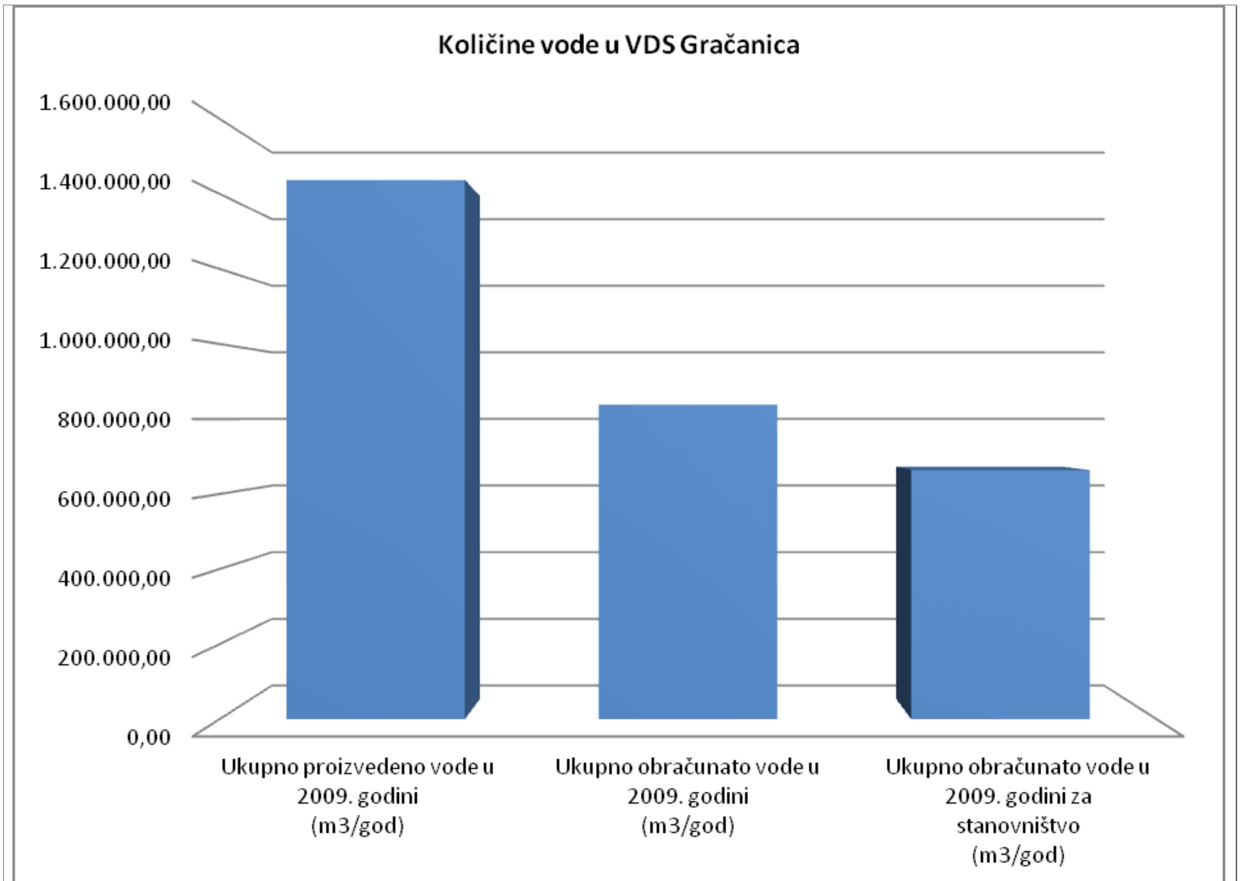
The following table shows specific consumptions in WSS Gračanica.

Table 28: Specific water consumption

Population number in water supply system	Water produced in 2009 (m^3/year)	Specific water production (l/c/day)		
17.507	1.437.288,50	224,92		
Population number in water supply system	Revenue water in 2009 (m^3/year)	Specific water production (l/c/day)	Revenue water in 2009 for population (m^3/year)	Specific water production without economy (industry) (l/c/day)
17.507	838.422,00	131,21	663.676,00	103,86

The following chart shows produced and invoiced water amounts.

Chart 3: Water quantities in WSS Gračanica



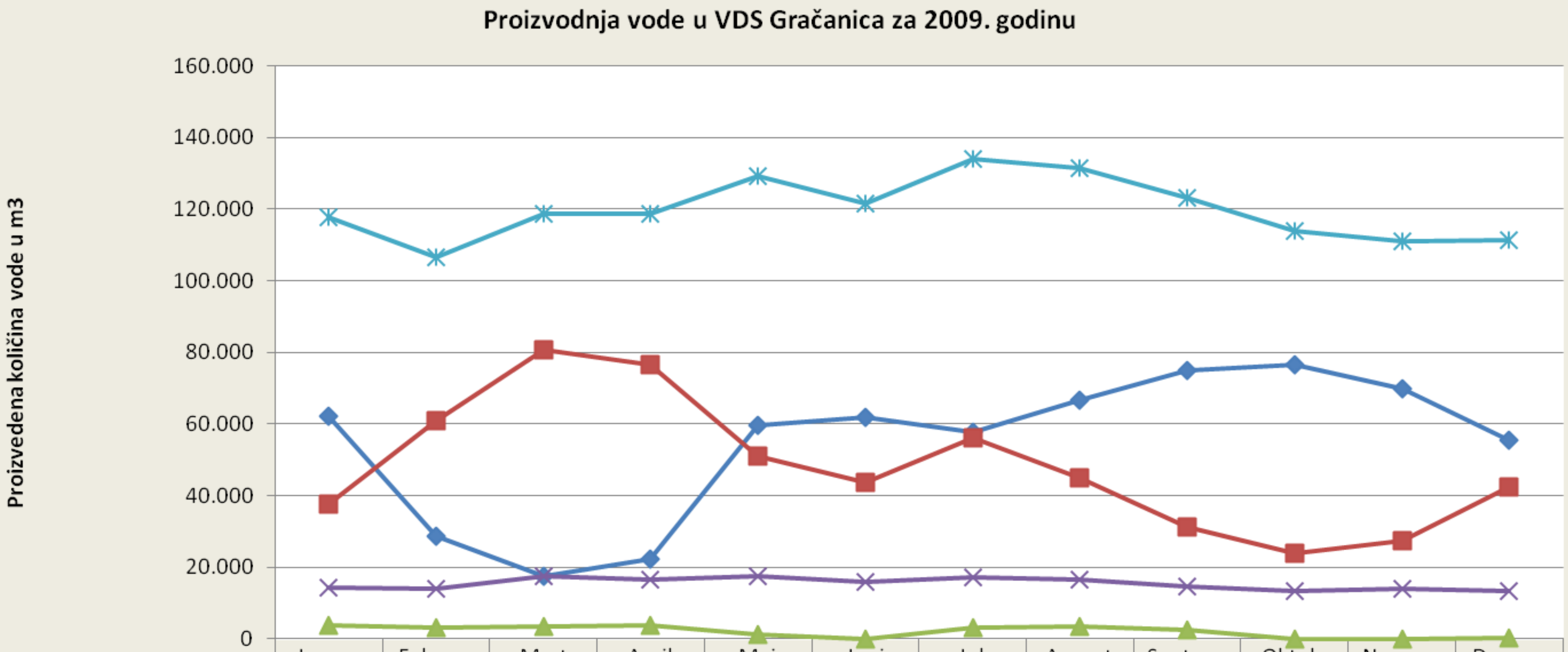
	Ukupno proizvedeno vode u 2009. godini (m3/god)	Ukupno obračunato vode u 2009. godini (m3/god)	Ukupno obračunato vode u 2009. godini za stanovništvo (m3/god)
Količine vode u VDS Gračanica	1.437.288,50	838.422,00	663.676,00

Of total produced water quantity, the authorized consumption is 58,48 % of water, and 46,29 % is authorized consumption only for the households.

Table 29: Produced, revenue and non-revenue water in 2009 per months

Month	PRODUCED m³					AUTHORIZED CONSUMPTION (m3)						WATER LOSSES (m3)		
						Invoiced authorized consumption				Unbilled authorized consumption		Apparent losses		Real losses
	Sklop	Natural sources	H. Voda	Soljanuša	**TOTAL**	Population	Public institutions	Economy	**TOTAL**	Measured water amount	Unmeasured water amount	Water meter inaccuracy	Ilegal connections	Leakage at the pipelines
January	62.138	37.425	3.847	14.356	**117.766**	55.128	3.503	8.910	**67.541**	515	*400*	*3.583*	*1.119*	44.608
February	28.655	60.725	3.185	13.898	**106.463**	49.793	3.164	8.048	**61.005**	455	*400*	*3.237*	*1.011*	40.355
March	17.369	80.612	3.296	17.406	**118.683**	43.945	3.068	7.425	**54.438**	398	*600*	*2.856*	*909*	59.481
April	22.217	76.400	3.699	16.436	**118.752**	51.468	3.237	7.656	**62.361**	682	*600*	*3.345*	*1.026*	50.738
May	59.486	51.120	1.271	17.436	**129.313**	62.270	3.302	12.355	**77.927**	754	*700*	*4.048*	*1.310*	44.574
June	61.820	43.575	0	15.980	**121.375**	59.326	3.642	13.686	**76.654**	720	*800*	*3.856*	*1.316*	38.029
July	57.758	56.001	3.206	16.989	**133.954**	57.384	3.324	11.908	**72.616**	815	800	*3.730*	*1.230*	54.763
August	66.550	44.954	3.385	16.658	**131.547**	69.570	3.528	14.272	**87.370**	835	650	*4.522*	*1.472*	36.698
Septem.	74.805	31.158	2.592	14.647	**123.202**	62.044	3.853	10.669	**76.566**	678	650	*4.033*	*1.275*	40.000
Octob.	76.505	23.912	0	13.468	**113.885**	51.112	3.763	8.983	**63.858**	605	350	*3.322*	*1.072*	44.677
Novem.	69.898	27.203	0	13.803	**110.904**	50.814	3.408	7.948	**62.170**	540	350	*3.303*	*1.029*	43.511
Decem.	55.558	42.259	325	13.303	**111.445**	50.822	3.092	7.904	**61.818**	501	300	*3.303*	*1.019*	44.503
TOTAL	**652.759**	**575.344**	**24.806**	**184.380**	**1.437.289**	663.676	40.884	119.764	**824.324**	7.498	6.600	43.139	13.790	**541.938**
	45,42%	40,03%	1,73%	12,83%	**100,00%**	80,51%	4,96%	14,53%	**100,00%**					
Percentage related to the produced water:						46,18%	2,84%	8,33%	**57,35%**					
									57,35%	**0,52%**	**0,46%**	**3,00%**	**0,96%**	**37,71%**
									100,00%					

Chart 4: Produced water quantities in 2009 per months – expressed in m^3



	Januar	Februar	Mart	April	Maj	Juni	Jul	August	Septem.	Oktob.	Novem.	Decem.
Bunari "Sklop"	62.138	28.655	17.369	22.217	59.486	61.820	57.758	66.550	74.805	76.505	69.898	55.558
Prirodna vrela	37.425	60.725	80.612	76.400	51.120	43.575	56.001	44.954	31.158	23.912	27.203	42.259
Bunar "Hadžijina voda"	3.847	3.185	3.296	3.699	1.271	0	3.206	3.385	2.592	0	0	325
Bunar "Soljanuša"	14.356	13.898	17.406	16.436	17.436	15.980	16.989	16.658	14.647	13.468	13.803	13.303
Ukupno proizvedena voda	117.766	106.463	118.683	118.752	129.313	121.375	133.954	131.547	123.202	113.885	110.904	111.445

2009. godina

Bunari "Sklop" — Prirodna vrela — Bunar "Hadžijina voda" — Bunar "Soljanuša" — Ukupno proizvedena voda

Table 30: Produced water quantities in 2009 per months – expressed in l/s

Month	PRODUCED (l/s)				
	Sklop	**Natural sources**	H. Voda	Soljanuša	**Total**
January	23,20	13,97	1,44	5,36	**43,97**
February	11,84	25,10	1,32	5,74	**44,01**
March	6,48	30,10	1,23	6,50	**44,31**
April	8,57	29,48	1,43	6,34	**45,81**
May	22,21	19,09	0,47	6,51	**48,28**
June	23,85	16,81	0,00	6,17	**46,83**
July	21,56	20,91	1,20	6,34	**50,01**
August	24,85	16,78	1,26	6,22	**49,11**
Septem.	28,86	12,02	1,00	5,65	**47,53**
Octob.	28,56	8,93	0,00	5,03	**42,52**
Novem.	26,97	10,49	0,00	5,33	**42,79**
Decem.	20,74	15,78	0,12	4,97	**41,61**
TOTAL	**20,70**	**18,24**	**0,79**	**5,85**	**45,58**

Table 31: Production and consumption of water in reservoir zones "Gaj" for 2009

Days	Q(l/s)	ĆiriŠ Q(l/s)	Grad Q(l/s)	Mejdanić Q(l/s)	Month	Date	Level in the well	Sklop		Natural sources Inflow to Gaj (m3)	TOTAL "GAJ" (m3)	Čiriš	Town	Mejdanić
								Pump operation	Produced (m3)			Delivered (m3)	Delivered (m3)	Delivered (m3)
1	29,90	4,39	22,49	3,02		1.	33,40	13,50	1.759,00	824,00	2.583,00	379,00	1.943,00	261,00
2	32,95	5,79	23,95	3,22		2.	33,30	13,50	1.610,00	1.237,00	2.847,00	500,00	2.069,00	278,00
3	35,05	6,42	25,29	3,33		3.	33,40	14,00	2.069,00	959,00	3.028,00	555,00	2.185,00	288,00
4	34,47	6,00	25,00	3,47		4.	33,60	16,00	2.332,00	646,00	2.978,00	518,00	2.160,00	300,00
5	34,31	5,74	25,45	3,11		5.	33,80	15,00	2.227,00	737,00	2.964,00	496,00	2.199,00	269,00
6	33,89	5,59	25,09	3,21		6.	34,00	14,00	2.261,00	667,00	2.928,00	483,00	2.168,00	277,00
7	34,07	5,72	25,14	3,22		7.	34,10	15,00	2.250,00	694,00	2.944,00	494,00	2.172,00	278,00
8	33,61	5,57	24,85	3,19		8.	34,00	14,50	2.295,00	609,00	2.904,00	481,00	2.147,00	276,00
9	34,42	5,81	25,30	3,31		9.	34,20	15,50	2.296,00	678,00	2.974,00	502,00	2.186,00	286,00
10	34,77	6,18	25,21	3,38		10.	34,30	16,00	2.338,00	666,00	3.004,00	534,00	2.178,00	292,00
11	35,60	6,34	25,75	3,51	January	11.	34,40	16,00	2.494,00	582,00	3.076,00	548,00	2.225,00	303,00
12	34,39	5,71	25,44	3,24		12.	34,50	16,00	2.535,00	436,00	2.971,00	493,00	2.198,00	280,00
13	34,29	5,67	25,43	3,19		13.	34,90	15,50	2.342,00	621,00	2.963,00	490,00	2.197,00	276,00
14	34,59	5,83	25,50	3,26		14.	34,80	16,00	2.346,00	643,00	2.989,00	504,00	2.203,00	282,00
15	34,84	5,82	25,63	3,39		15.	35,00	16,00	2.413,00	597,00	3.010,00	503,00	2.214,00	293,00
16	36,40	5,93	26,88	3,60		16.	34,90	16,00	2.271,00	874,00	3.145,00	512,00	2.322,00	311,00
17	37,64	6,25	27,78	3,61		17.	35,10	12,50	2.049,00	1.203,00	3.252,00	540,00	2.400,00	312,00
18	36,27	6,46	26,26	3,55		18.	35,10	16,00	2.626,00	508,00	3.134,00	558,00	2.269,00	307,00
19	39,38	6,49	29,40	3,48		19.			2.812,00	590,00	3.402,00	561,00	2.540,00	301,00
20	37,80	5,94	28,17	3,69		20.	33,50	8,00	1.456,00	1.810,00	3.266,00	513,00	2.434,00	319,00
21	38,96	6,13	29,49	3,33		21.	33,20	11,00	1.810,00	1.556,00	3.366,00	530,00	2.548,00	288,00
22	37,77	5,76	28,74	3,26		22.	34,20	11,00	1.743,00	1.520,00	3.263,00	498,00	2.483,00	282,00

23	37,31	5,67	28,31	3,33		23.	34,20	16,00	2.406,00	818,00	3.224,00	490,00	2.446,00	288,00
24	37,38	5,98	27,88	3,52		24.	34,20	15,00	2.418,00	812,00	3.230,00	517,00	2.409,00	304,00
25	38,19	6,32	28,28	3,60		25.	34,00	16,00	2.391,00	909,00	3.300,00	546,00	2.443,00	311,00
26	37,48	6,16	27,96	3,36		26.	33,40	7,00	854,00	2.384,00	3.238,00	532,00	2.416,00	290,00
27	37,56	6,19	27,80	3,56		27.	33,00	5,00	1.125,00	2.120,00	3.245,00	535,00	2.402,00	308,00
28	33,97	5,91	24,99	3,07		28.	32,80	5,00	777,00	2.158,00	2.935,00	511,00	2.159,00	265,00
29	35,95	6,63	26,39	2,93		29.	32,60	7,50	1.242,00	1.864,00	3.106,00	573,00	2.280,00	253,00
30	36,34	7,30	26,03	3,01		30.	32,70	8,00	1.360,00	1.780,00	3.140,00	631,00	2.249,00	260,00
31	36,81	7,21	26,26	3,33		31.	32,70	10,00	1.231,00	1.949,00	3.180,00	623,00	2.269,00	288,00
32	38,09	7,43	27,06	3,60		1.	32,60	7,50	1.377,00	1.914,00	3.291,00	642,00	2.338,00	311,00
33	35,43	5,89	26,33	3,21		2.	32,30	10,00	1.676,00	1.385,00	3.061,00	509,00	2.275,00	277,00
34	35,30	5,81	26,32	3,17		3.	32,10	6,00	1.063,00	1.987,00	3.050,00	502,00	2.274,00	274,00
35	35,05	5,86	25,90	3,29		4.	32,10	7,50	1.222,00	1.806,00	3.028,00	506,00	2.238,00	284,00
36	36,04	6,17	26,53	3,34		5.	27 st.	0,00	0,00	3.114,00	3.114,00	533,00	2.292,00	289,00
37	35,36	5,78	26,37	3,22		6.	30,90	4,00	881,00	2.174,00	3.055,00	499,00	2.278,00	278,00
38	35,96	6,08	26,59	3,30		7.	30,80	4,50	1.014,00	2.093,00	3.107,00	525,00	2.297,00	285,00
39	36,91	6,63	26,72	3,55		8.	30,50	5,50	454,00	2.735,00	3.189,00	573,00	2.309,00	307,00
40	34,77	5,59	26,05	3,13		9.	30,30	6,00	1.014,00	1.990,00	3.004,00	483,00	2.251,00	270,00
41	34,58	5,75	25,90	2,93	February	10.	30,10	6,00	992,00	1.996,00	2.988,00	497,00	2.238,00	253,00
42	34,42	5,35	25,86	3,22		11.	30,00	4,50	695,00	2.279,00	2.974,00	462,00	2.234,00	278,00
43	34,21	5,19	25,91	3,11		12.	30,00	4,50	721,00	2.235,00	2.956,00	448,00	2.239,00	269,00
44	34,16	5,22	25,87	3,07		13.	30,00	7,00	1.183,00	1.768,00	2.951,00	451,00	2.235,00	265,00
45	33,76	5,45	25,28	3,03		14.	29,80	6,00	883,00	2.034,00	2.917,00	471,00	2.184,00	262,00
46	35,15	5,98	25,76	3,40		15.	29,70	9,00	1.469,00	1.568,00	3.037,00	517,00	2.226,00	294,00
47	34,59	5,57	25,84	3,18		16.	29,50	7,00	1.043,00	1.946,00	2.989,00	481,00	2.233,00	275,00
48	34,70	5,69	25,75	3,25		17.	29,50	7,00	1.073,00	1.925,00	2.998,00	492,00	2.225,00	281,00
49	33,07	4,95	25,36	2,75		18.	29,40	5,00	640,00	2.217,00	2.857,00	428,00	2.191,00	238,00
50	33,80	5,41	25,36	3,03		19.	29,30	7,00	1.030,00	1.890,00	2.920,00	467,00	2.191,00	262,00

51	33,43	5,22	25,12	3,09		20.	29,10	8,00	1.863,00	1.025,00	2.888,00	451,00	2.170,00	267,00
52	34,27	5,52	25,22	3,53		21.	28,90	8,00	1.229,00	1.732,00	2.961,00	477,00	2.179,00	305,00
53	36,56	6,31	26,61	3,65		22.	28,90	9,00	1.486,00	1.673,00	3.159,00	545,00	2.299,00	315,00
54	34,06	5,43	25,52	3,11		23.	28,70	8,00	1.320,00	1.623,00	2.943,00	469,00	2.205,00	269,00
55	34,18	5,35	25,83	3,00		24.	29,00	8,00	1.068,00	1.885,00	2.953,00	462,00	2.232,00	259,00
56	33,89	5,56	25,25	3,08		25.	28,80	4,50	774,00	2.154,00	2.928,00	480,00	2.182,00	266,00
57	35,05	5,68	25,84	3,52		26.	28,60	5,00	810,00	2.218,00	3.028,00	491,00	2.233,00	304,00
58	34,13	5,43	25,35	3,36		27.	28,40	5,00	789,00	2.160,00	2.949,00	469,00	2.190,00	290,00
59	37,30	6,37	26,92	4,02		28.	28,00	4,00	886,00	2.337,00	3.223,00	550,00	2.326,00	347,00
60	37,13	6,63	26,70	3,80	March	1.	28,50	15,00	2.274,00	934,00	3.208,00	573,00	2.307,00	328,00
61	35,87	6,16	26,18	3,53		2.	28,30	5,50	1.071,00	2.028,00	3.099,00	532,00	2.262,00	305,00
62	33,84	5,36	25,41	3,08		3.	28,00	4,00	533,00	2.391,00	2.924,00	463,00	2.195,00	266,00
63	33,90	5,43	25,36	3,11		4.	23,1 st.	0,00	0,00	2.929,00	2.929,00	469,00	2.191,00	269,00
64	34,64	5,58	25,96	3,10		5.	22,7 st	0,00	0,00	2.993,00	2.993,00	482,00	2.243,00	268,00
65	35,42	5,67	26,57	3,17		6.	26,10	3,00	599,00	2.461,00	3.060,00	490,00	2.296,00	274,00
66	33,88	5,72	25,00	3,16		7.	28,00	11,00	1.731,00	1.196,00	2.927,00	494,00	2.160,00	273,00
67	35,86	6,37	25,95	3,54		8.	27,70	17,00	2.648,00	450,00	3.098,00	550,00	2.242,00	306,00
68	34,13	5,58	25,38	3,17		9.	23 st	6,00	801,00	2.148,00	2.949,00	482,00	2.193,00	274,00
69	34,21	5,64	25,45	3,13		10.	21,5 st	8,00	903,00	2.053,00	2.956,00	487,00	2.199,00	270,00
70	33,85	5,44	25,22	3,19		11.	21,8 st.	2,00	942,00	1.983,00	2.925,00	470,00	2.179,00	276,00
71	34,66	5,57	26,04	3,06		12.	25,00	2,00	313,00	2.682,00	2.995,00	481,00	2.250,00	264,00
72	33,83	5,36	25,38	3,09		13.	21,5 st.	0,00	0,00	2.923,00	2.923,00	463,00	2.193,00	267,00
73	35,22	5,83	25,94	3,45		14.	21,5 st.	0,00	0,00	3.043,00	3.043,00	504,00	2.241,00	298,00
74	36,60	6,54	26,48	3,58		15.	20,0 st.	0,00	0,00	3.162,00	3.162,00	565,00	2.288,00	309,00
75	33,58	5,37	25,10	3,10		16.	19 st.	0,00	0,00	2.901,00	2.901,00	464,00	2.169,00	268,00
76	34,10	5,54	25,39	3,16		17.	18,50	0,00	0,00	2.946,00	2.946,00	479,00	2.194,00	273,00
77	34,50	5,22	26,22	3,07		18.	18,35	0,00	0,00	2.981,00	2.981,00	451,00	2.265,00	265,00
78	34,98	5,53	26,35	3,09		19.	18 st.	0,00	0,00	3.022,00	3.022,00	478,00	2.277,00	267,00

79	33,69	5,25	25,37	3,07		20.	18 st.	0,00	0,00	2.911,00	2.911,00	454,00	2.192,00	265,00
80	34,16	5,54	25,38	3,23		21,00	17,8 st.	0,00	0,00	2.951,00	2.951,00	479,00	2.193,00	279,00
81	36,50	6,27	26,60	3,63		22.	18,50	3,00	464,00	2.690,00	3.154,00	542,00	2.298,00	314,00
82	34,73	5,76	25,73	3,24		23.	18,4 st.	2,50	384,00	2.617,00	3.001,00	498,00	2.223,00	280,00
83	33,95	5,43	25,45	3,07		24.	21,40	0,00	1.069,00	1.864,00	2.933,00	469,00	2.199,00	265,00
84	34,46	5,38	26,04	3,03		25.	21,30	7,00	1.131,00	1.846,00	2.977,00	465,00	2.250,00	262,00
85	34,42	5,56	25,81	3,06		26.	21,20	6,50	1.104,00	1.870,00	2.974,00	480,00	2.230,00	264,00
86	34,19	5,39	25,76	3,03		27.	18 st.	1,00	187,00	2.767,00	2.954,00	466,00	2.226,00	262,00
87	36,39	6,23	26,63	3,53		28.	18,1 st.	3,00	459,00	2.685,00	3.144,00	538,00	2.301,00	305,00
88	34,69	6,00	25,21	3,48		29.	20,30	2,50	356,00	2.641,00	2.997,00	518,00	2.178,00	301,00
89	34,88	5,80	25,87	3,22		30	20,10	2,50	400,00	2.614,00	3.014,00	501,00	2.235,00	278,00
90	33,36	5,25	25,16	2,94		31.	18 st.	2,50	0,00	2.882,00	2.882,00	454,00	2.174,00	254,00
91	34,71	5,72	25,88	3,11	April	1.	20,10	2,00	598,00	2.401,00	2.999,00	494,00	2.236,00	269,00
92	35,52	5,81	26,18	3,53		2.	0,00	2,00	550,00	2.519,00	3.069,00	502,00	2.262,00	305,00
93	34,55	5,56	25,94	3,06		3.	19,80	1,00	256,00	2.729,00	2.985,00	480,00	2.241,00	264,00
94	37,16	6,41	27,16	3,59		4.	20,20	2,00	192,00	3.019,00	3.211,00	554,00	2.347,00	310,00
95	39,29	7,07	28,52	3,70		5.	20,50	3,00	1.225,00	2.170,00	3.395,00	611,00	2.464,00	320,00
96	36,27	6,19	26,70	3,38		6.	20,20	3,00	671,00	2.463,00	3.134,00	535,00	2.307,00	292,00
97	35,79	6,08	26,44	3,28		7.	20,00	2,00	468,00	2.624,00	3.092,00	525,00	2.284,00	283,00
98	36,62	6,26	26,99	3,37		8.	19,10	2,00	93,00	3.071,00	3.164,00	541,00	2.332,00	291,00
99	36,82	6,42	27,01	3,38		9.	19,00	2,50	210,00	2.971,00	3.181,00	555,00	2.334,00	292,00
100	36,83	6,28	27,14	3,40		10.	19,10	4,00	1.030,00	2.152,00	3.182,00	543,00	2.345,00	294,00
101	37,93	6,75	27,45	3,73		11.	19,20	4,00	816,00	2.461,00	3.277,00	583,00	2.372,00	322,00
102	38,89	7,33	28,10	3,46		12.	19,00	5,00	797,00	2.563,00	3.360,00	633,00	2.428,00	299,00
103	34,53	5,61	25,45	3,46		13.	18,90	4,50	574,00	2.409,00	2.983,00	485,00	2.199,00	299,00
104	34,42	5,61	25,66	3,15		14.	18,90	2,50	533,00	2.441,00	2.974,00	485,00	2.217,00	272,00
105	35,52	6,09	26,02	3,41		15.	19,00	2,50	541,00	2.528,00	3.069,00	526,00	2.248,00	295,00
106	36,26	6,26	26,54	3,46		16.	18,80	4,50	957,00	2.176,00	3.133,00	541,00	2.293,00	299,00

107	34,61	5,57	25,86	3,18		17.	18,50	4,00	910,00	2.080,00	2.990,00	481,00	2.234,00	275,00
108	36,01	6,20	26,34	3,46		18.	18,60	4,00	507,00	2.604,00	3.111,00	536,00	2.276,00	299,00
109	36,28	6,37	26,30	3,62		19.	18,60	6,00	981,00	2.154,00	3.135,00	550,00	2.272,00	313,00
110	34,09	5,60	25,28	3,21		20.	18,70	4,00	711,00	2.234,00	2.945,00	484,00	2.184,00	277,00
111	34,70	5,79	25,69	3,22		21.	18,60	4,00	525,00	2.473,00	2.998,00	500,00	2.220,00	278,00
112	33,99	5,47	25,28	3,24		22.	18,00	5,50	882,00	2.055,00	2.937,00	473,00	2.184,00	280,00
113	35,03	5,84	25,71	3,48		23.	18,60	6,50	1.080,00	1.947,00	3.027,00	505,00	2.221,00	301,00
114	35,12	5,97	25,69	3,45		24.	18,25	5,50	875,00	2.159,00	3.034,00	516,00	2.220,00	298,00
115	37,55	6,57	27,33	3,65		25.	18,60	7,00	1.266,00	1.978,00	3.244,00	568,00	2.361,00	315,00
116	38,67	6,92	27,74	4,00		26.	18,80	8,00	1.255,00	2.086,00	3.341,00	598,00	2.397,00	346,00
117	36,41	6,46	26,44	3,52		27.	18,50	6,50	1.028,00	2.118,00	3.146,00	558,00	2.284,00	304,00
118	33,83	5,49	25,05	3,30		28.	18,40	5,00	732,00	2.191,00	2.923,00	474,00	2.164,00	285,00
119	35,36	5,91	26,05	3,39		29.	18,60	5,00	996,00	2.059,00	3.055,00	511,00	2.251,00	293,00
120	34,04	5,51	25,27	3,26		30.	18,50	5,00	958,00	1.983,00	2.941,00	476,00	2.183,00	282,00
121	32,75	5,76	23,74	3,25	May	1.	18,90	5,00	790,00	2.040,00	2.830,00	498,00	2.051,00	281,00
122	35,19	6,23	25,32	3,63		2.	19,00	7,50	1.350,00	1.690,00	3.040,00	538,00	2.188,00	314,00
123	38,19	7,09	27,16	3,94		3.	19,20	8,00	1.608,00	1.692,00	3.300,00	613,00	2.347,00	340,00
124	36,27	6,09	26,81	3,38		4.	19,20	8,00	1.303,00	1.831,00	3.134,00	526,00	2.316,00	292,00
125	35,84	6,03	26,59	3,23		5.	18,60	9,00	1.589,00	1.508,00	3.097,00	521,00	2.297,00	279,00
126	37,11	6,53	27,08	3,50		6.	18,60	8,00	1.312,00	1.894,00	3.206,00	564,00	2.340,00	302,00
127	35,97	6,34	26,17	3,46		7.	18,70	7,00	1.280,00	1.828,00	3.108,00	548,00	2.261,00	299,00
128	37,74	6,72	27,30	3,72		8.	18,90	9,00	1.599,00	1.662,00	3.261,00	581,00	2.359,00	321,00
129	40,27	7,74	28,47	4,05		9.	19,00	11,00	1.855,00	1.624,00	3.479,00	669,00	2.460,00	350,00
130	42,69	8,18	30,27	4,24		10.	19,00	14,00	2.537,00	1.151,00	3.688,00	707,00	2.615,00	366,00
131	40,44	7,34	29,17	3,94		11.	19,00	10,00	1.588,00	1.906,00	3.494,00	634,00	2.520,00	340,00
132	40,13	7,29	28,99	3,84		12.	19,00	12,00	2.155,00	1.312,00	3.467,00	630,00	2.505,00	332,00
133	35,81	6,32	26,13	3,36		13.	19,20	7,00	1.257,00	1.837,00	3.094,00	546,00	2.258,00	290,00
134	37,62	6,98	27,04	3,60		14.	19,50	11,50	1.768,00	1.482,00	3.250,00	603,00	2.336,00	311,00

135	41,11	7,53	29,83	3,75		15.	20,00	15,00	2.433,00	1.119,00	3.552,00	651,00	2.577,00	324,00
136	41,53	7,92	29,68	3,94		16.	20,00	12,50	2.120,00	1.468,00	3.588,00	684,00	2.564,00	340,00
137	42,95	8,46	30,06	4,43		17.	20,20	15,00	2.503,00	1.208,00	3.711,00	731,00	2.597,00	383,00
138	42,60	7,69	30,79	4,13		18.	20,30	12,00	2.236,00	1.445,00	3.681,00	664,00	2.660,00	357,00
139	42,82	7,52	31,25	4,05		19.	13,70	8,00	1.857,00	1.843,00	3.700,00	650,00	2.700,00	350,00
140	40,63	7,03	29,79	3,81		20.	20,60	16,00	2.350,00	1.160,00	3.510,00	607,00	2.574,00	329,00
141	43,61	7,81	31,69	4,11		21.	20,80	15,00	2.555,00	1.213,00	3.768,00	675,00	2.738,00	355,00
142	43,39	7,45	31,71	4,22		22.	20,80	16,00	2.510,00	1.239,00	3.749,00	644,00	2.740,00	365,00
143	46,50	8,51	33,55	4,44		23.	21,50	14,00	2.464,00	1.554,00	4.018,00	735,00	2.899,00	384,00
144	44,86	8,53	31,93	4,40		24.	21,70	17,00	2.694,00	1.182,00	3.876,00	737,00	2.759,00	380,00
145	44,66	8,50	31,71	4,46		25.	21,30	14,00	2.214,00	1.645,00	3.859,00	734,00	2.740,00	385,00
146	38,89	6,81	28,56	3,52		26.	21,50	13,00	2.328,00	1.032,00	3.360,00	588,00	2.468,00	304,00
147	38,00	6,35	28,14	3,51		27.	21,70	12,50	1.987,00	1.296,00	3.283,00	549,00	2.431,00	303,00
148	36,64	5,58	27,69	3,38		28.	21,20	9,50	1.577,00	1.589,00	3.166,00	482,00	2.392,00	292,00
149	36,27	5,72	27,19	3,37		29.	21,50	10,00	1.728,00	1.406,00	3.134,00	494,00	2.349,00	291,00
150	37,41	6,12	27,41	3,88		30.	21,60	11,00	1.960,00	1.272,00	3.232,00	529,00	2.368,00	335,00
151	38,32	6,55	27,67	4,10		31.	21,60	12,50	1.979,00	1.332,00	3.311,00	566,00	2.391,00	354,00
152	36,30	5,68	26,85	3,76		1.	21,30	10,00	1.701,00	1.435,00	3.136,00	491,00	2.320,00	325,00
153	36,34	5,57	27,20	3,58		2.	21,30	12,50	1.430,00	1.710,00	3.140,00	481,00	2.350,00	309,00
154	36,47	5,96	27,14	3,37		3.	21,30	12,00	2.534,00	617,00	3.151,00	515,00	2.345,00	291,00
155	36,44	5,73	27,37	3,33		4.	21,20	10,00	1.629,00	1.519,00	3.148,00	495,00	2.365,00	288,00
156	36,31	5,94	26,98	3,39		5.	21,00	6,00	1.033,00	2.104,00	3.137,00	513,00	2.331,00	293,00
157	37,40	6,30	27,38	3,72	June	6.	20,50	8,50	1.571,00	1.660,00	3.231,00	544,00	2.366,00	321,00
158	40,03	7,49	28,59	3,96		7.	20,60	12,00	1.969,00	1.490,00	3.459,00	647,00	2.470,00	342,00
159	39,99	7,04	29,20	3,75		8.	21,50	13,00	2.067,00	1.388,00	3.455,00	608,00	2.523,00	324,00
160	40,52	7,00	29,63	3,89		9.	21,50	11,00	2.077,00	1.424,00	3.501,00	605,00	2.560,00	336,00
161	39,72	6,61	29,29	3,82		10.	21,80	15,00	2.524,00	908,00	3.432,00	571,00	2.531,00	330,00
162	40,82	6,90	29,95	3,97		11.	22,00	11,00	1.826,00	1.701,00	3.527,00	596,00	2.588,00	343,00

163	39,29	6,48	28,92	3,89		12.	22,00	13,00	2.201,00	1.194,00	3.395,00	560,00	2.499,00	336,00
164	39,58	7,09	28,33	4,16		13.	22,10	13,00	2.341,00	1.079,00	3.420,00	613,00	2.448,00	359,00
165	42,13	7,55	30,56	4,03		14.	22,30	15,00	2.147,00	1.493,00	3.640,00	652,00	2.640,00	348,00
166	42,14	7,43	30,76	3,95		15.	22,30	17,00	2.262,00	1.379,00	3.641,00	642,00	2.658,00	341,00
167	43,65	7,89	31,68	4,07		16.	22,50	19,00	2.779,00	992,00	3.771,00	682,00	2.737,00	352,00
168	39,70	6,71	29,22	3,76		17.	22,60	17,00	2.526,00	904,00	3.430,00	580,00	2.525,00	325,00
169	41,90	7,66	30,31	3,92		18.	22,60	15,00	2.300,00	1.320,00	3.620,00	662,00	2.619,00	339,00
170	41,47	6,82	30,65	4,00		19.	22,80	17,00	3.086,00	497,00	3.583,00	589,00	2.648,00	346,00
171	40,31	7,70	28,82	3,80		20.	23,60	14,00	2.411,00	1.072,00	3.483,00	665,00	2.490,00	328,00
172	36,57	6,20	26,74	3,63		21.	23,50	12,50	2.001,00	1.159,00	3.160,00	536,00	2.310,00	314,00
173	36,16	5,76	27,04	3,36		22.	23,50	10,00	1.712,00	1.412,00	3.124,00	498,00	2.336,00	290,00
174	36,11	5,87	26,82	3,43		23.	23,60	11,00	1.875,00	1.245,00	3.120,00	507,00	2.317,00	296,00
175	36,84	6,05	27,27	3,52		24.	23,60	13,00	1.976,00	1.207,00	3.183,00	523,00	2.356,00	304,00
176	36,84	5,89	27,25	3,70		25.	23,80	12,00	2.029,00	1.154,00	3.183,00	509,00	2.354,00	320,00
177	34,73	5,73	25,65	3,36		26.	23,30	13,00	1.967,00	1.034,00	3.001,00	495,00	2.216,00	290,00
178	36,71	5,91	27,21	3,59		27.	23,30	13,00	2.068,00	1.104,00	3.172,00	511,00	2.351,00	310,00
179	38,13	6,53	27,71	3,89		28.	23,20	13,00	2.008,00	1.286,00	3.294,00	564,00	2.394,00	336,00
180	37,45	5,97	27,94	3,54		29.	23,50	12,00	1.973,00	1.263,00	3.236,00	516,00	2.414,00	306,00
181	38,17	6,12	28,43	3,62		30.	23,60	12,00	1.797,00	1.501,00	3.298,00	529,00	2.456,00	313,00
182	37,65	6,09	27,92	3,65	July	1.	23,40	14,00	2.376,00	877,00	3.253,00	526,00	2.412,00	315,00
183	36,99	6,12	27,16	3,70		2.	23,70	13,00	2.073,00	1.123,00	3.196,00	529,00	2.347,00	320,00
184	37,00	6,08	27,34	3,59		3.	23,60	16,50	2.259,00	938,00	3.197,00	525,00	2.362,00	310,00
185	39,10	7,03	28,13	3,95		4.	23,80	24,00	3.889,00	-511,00	3.378,00	607,00	2.430,00	341,00
186	39,94	7,65	28,18	4,11		5.	23,90	17,00	2.256,00	1.195,00	3.451,00	661,00	2.435,00	355,00
187	40,31	6,94	29,46	3,91		6.	24,00	15,00	2.632,00	851,00	3.483,00	600,00	2.545,00	338,00
188	37,49	6,34	27,42	3,73		7.	24,00	8,50	1.588,00	1.651,00	3.239,00	548,00	2.369,00	322,00
189	36,82	6,24	26,90	3,68		8.	23,80	11,00	1.792,00	1.389,00	3.181,00	539,00	2.324,00	318,00
190	37,81	6,49	27,58	3,74		9.	24,00	11,50	1.894,00	1.373,00	3.267,00	561,00	2.383,00	323,00

191	36,48	5,94	26,84	3,70		10.	24,00	7,00	1.391,00	1.761,00	3.152,00	513,00	2.319,00	320,00
192	35,42	5,95	25,76	3,70		11.	24,00	17,00	3.213,00	-153,00	3.060,00	514,00	2.226,00	320,00
193	35,01	5,93	25,56	3,53		12.	24,50	15,00	1.343,00	1.682,00	3.025,00	512,00	2.208,00	305,00
194	37,01	6,55	26,54	3,92		13.	24,60	13,50	2.048,00	1.150,00	3.198,00	566,00	2.293,00	339,00
195	40,27	7,27	28,88	4,12		14.	24,40	9,00	1.547,00	1.932,00	3.479,00	628,00	2.495,00	356,00
196	41,82	7,72	29,91	4,19		15.	23,30	6,00	818,00	2.795,00	3.613,00	667,00	2.584,00	362,00
197	42,60	7,69	30,47	4,44		16.	23,50	8,00	967,00	2.714,00	3.681,00	664,00	2.633,00	384,00
198	41,82	7,51	29,87	4,43		17.	23,00	9,00	1.517,00	2.096,00	3.613,00	649,00	2.581,00	383,00
199	40,42	7,22	29,00	4,19		18.	22,80	6,00	849,00	2.643,00	3.492,00	624,00	2.506,00	362,00
200	40,39	7,36	28,82	4,21		19.	22,50	7,50	1.108,00	2.382,00	3.490,00	636,00	2.490,00	364,00
201	40,67	7,22	29,21	4,24		20.	22,70	8,00	1.267,00	2.247,00	3.514,00	624,00	2.524,00	366,00
202	40,88	7,47	29,22	4,19		21.	22,80	9,00	1.490,00	2.042,00	3.532,00	645,00	2.525,00	362,00
203	43,66	8,67	30,84	4,14		22.	22,90	11,00	1.939,00	1.833,00	3.772,00	749,00	2.665,00	358,00
204	44,72	8,63	31,44	4,65		23.	22,90	12,00	1.974,00	1.890,00	3.864,00	746,00	2.716,00	402,00
205	44,51	7,91	32,03	4,58		24.	23,10	13,00	2.083,00	1.763,00	3.846,00	683,00	2.767,00	396,00
206	42,21	7,47	30,65	4,10		25.	23,30	12,50	1.841,00	1.806,00	3.647,00	645,00	2.648,00	354,00
207	43,29	7,85	30,98	4,46		26.	23,40	12,50	2.071,00	1.669,00	3.740,00	678,00	2.677,00	385,00
208	41,93	7,08	30,61	4,24		27.	23,60	13,00	1.958,00	1.665,00	3.623,00	612,00	2.645,00	366,00
209	42,35	7,47	30,56	4,33		28.	33,70	11,50	1.741,00	1.918,00	3.659,00	645,00	2.640,00	374,00
210	41,55	7,26	30,15	4,14		29.	23,70	12,00	1.904,00	1.686,00	3.590,00	627,00	2.605,00	358,00
211	43,15	7,89	30,95	4,31		30.	24,00	14,00	2.198,00	1.530,00	3.728,00	682,00	2.674,00	372,00
212	42,57	7,88	30,34	4,35		31.	24,00	11,00	1.732,00	1.946,00	3.678,00	681,00	2.621,00	376,00
213	43,90	8,80	30,73	4,38	August	1.	24,30	16,50	2.935,00	858,00	3.793,00	760,00	2.655,00	378,00
214	45,07	8,88	31,54	4,65		2.	24,40	16,00	1.719,00	2.175,00	3.894,00	767,00	2.725,00	402,00
215	43,25	8,15	30,94	4,17		3.	24,50	14,00	2.535,00	1.202,00	3.737,00	704,00	2.673,00	360,00
216	39,51	7,26	28,31	3,95		4.	24,50	11,00	1.697,00	1.717,00	3.414,00	627,00	2.446,00	341,00
217	38,16	7,06	27,45	3,65		5.	24,70	12,50	1.785,00	1.512,00	3.297,00	610,00	2.372,00	315,00
218	36,74	6,42	26,78	3,53		6.	24,70	12,00	1.725,00	1.449,00	3.174,00	555,00	2.314,00	305,00

219	38,33	6,48	28,01	3,84		7.	24,70	11,00	2.355,00	957,00	3.312,00	560,00	2.420,00	332,00
220	39,10	6,98	28,22	3,90		8.	24,60	12,50	1.937,00	1.441,00	3.378,00	603,00	2.438,00	337,00
221	39,38	7,37	27,87	4,13		9.	24,70	11,50	1.864,00	1.538,00	3.402,00	637,00	2.408,00	357,00
222	40,47	7,36	29,07	4,04		10.	24,80	12,50	2.003,00	1.494,00	3.497,00	636,00	2.512,00	349,00
223	37,41	6,96	26,61	3,84		11.	24,80	11,00	1.781,00	1.451,00	3.232,00	601,00	2.299,00	332,00
224	39,63	7,44	28,34	3,84		12.	24,90	12,00	2.056,00	1.368,00	3.424,00	643,00	2.449,00	332,00
225	38,29	7,36	26,78	4,14		13.	24,90	13,50	2.052,00	1.256,00	3.308,00	636,00	2.314,00	358,00
226	35,74	6,46	25,61	3,67		14.	24,80	11,50	1.607,00	1.481,00	3.088,00	558,00	2.213,00	317,00
227	37,05	7,55	25,56	3,95		15.	24,90	12,50	1.955,00	1.246,00	3.201,00	652,00	2.208,00	341,00
228	36,10	7,53	24,68	3,89		16.	24,90	12,00	1.889,00	1.230,00	3.119,00	651,00	2.132,00	336,00
229	39,86	7,80	27,97	4,09		17.	25,20	15,00	2.534,00	910,00	3.444,00	674,00	2.417,00	353,00
230	40,14	7,70	28,34	4,10		18.	25,30	13,00	1.941,00	1.527,00	3.468,00	665,00	2.449,00	354,00
231	41,32	7,95	29,21	4,16		19.	25,50	15,00	2.309,00	1.261,00	3.570,00	687,00	2.524,00	359,00
232	40,78	7,74	28,75	4,28		20.	25,40	12,00	1.949,00	1.574,00	3.523,00	669,00	2.484,00	370,00
233	41,01	7,59	29,19	4,22		21.	25,60	13,50	2.319,00	1.224,00	3.543,00	656,00	2.522,00	365,00
234	41,06	7,99	28,77	4,31		22.	25,70	15,00	2.327,00	1.221,00	3.548,00	690,00	2.486,00	372,00
235	38,73	7,41	27,08	4,24		23.	25,80	14,00	2.238,00	1.108,00	3.346,00	640,00	2.340,00	366,00
236	39,06	7,25	27,73	4,09		24.	26,00	13,00	1.982,00	1.393,00	3.375,00	626,00	2.396,00	353,00
237	38,99	7,40	27,60	3,99		25.	26,20	13,50	2.611,00	758,00	3.369,00	639,00	2.385,00	345,00
238	40,88	7,91	28,77	4,20		26.	26,30	16,00	2.474,00	1.058,00	3.532,00	683,00	2.486,00	363,00
239	42,00	8,14	29,53	4,34		27.	26,50	15,00	2.275,00	1.354,00	3.629,00	703,00	2.551,00	375,00
240	40,86	8,01	28,56	4,28		28.	26,60	16,50	2.389,00	1.141,00	3.530,00	692,00	2.468,00	370,00
241	40,24	7,79	28,22	4,24		29.	26,80	17,00	2.712,00	765,00	3.477,00	673,00	2.438,00	366,00
242	39,34	7,58	27,52	4,24		30.	26,90	11,00	2.421,00	978,00	3.399,00	655,00	2.378,00	366,00
243	38,72	7,25	27,45	4,02		31.	27,00	11,00	2.174,00	1.171,00	3.345,00	626,00	2.372,00	347,00
244	39,56	7,67	27,92	3,97	September	1.	27,20	15,00	2.373,00	1.045,00	3.418,00	663,00	2.412,00	343,00
245	40,41	7,49	28,62	4,29		2.	27,30	15,00	2.228,00	1.263,00	3.491,00	647,00	2.473,00	371,00
246	40,89	7,73	28,88	4,28		3.	27,40	15,50	2.548,00	985,00	3.533,00	668,00	2.495,00	370,00

247	41,16	7,87	29,12	4,17		4.	27,60	20,00	3.026,00	530,00	3.556,00	680,00	2.516,00	360,00
248	38,31	7,37	26,92	4,02		5.	27,90	14,00	2.493,00	817,00	3.310,00	637,00	2.326,00	347,00
249	39,68	7,88	27,75	4,04		6.	28,00	12,50	1.910,00	1.518,00	3.428,00	681,00	2.398,00	349,00
250	38,95	7,38	27,89	3,67		7.	28,30	14,00	2.577,00	788,00	3.365,00	638,00	2.410,00	317,00
251	38,81	7,26	27,77	3,78		8.	28,30	16,00	2.243,00	1.110,00	3.353,00	627,00	2.399,00	327,00
252	39,25	7,16	27,86	4,22		9.	28,40	15,50	2.259,00	1.132,00	3.391,00	619,00	2.407,00	365,00
253	39,06	7,58	27,22	4,26		10.	28,60	15,30	2.707,00	668,00	3.375,00	655,00	2.352,00	368,00
254	37,85	7,29	26,61	3,95		11.	28,70	15,50	2.514,00	756,00	3.270,00	630,00	2.299,00	341,00
255	38,50	7,50	27,00	3,99		12.	28,80	15,50	2.199,00	1.127,00	3.326,00	648,00	2.333,00	345,00
256	40,03	7,95	27,82	4,26		13.	28,80	16,50	2.552,00	907,00	3.459,00	687,00	2.404,00	368,00
257	40,08	7,63	28,41	4,04		14.	28,90	15,00	2.254,00	1.209,00	3.463,00	659,00	2.455,00	349,00
258	39,47	7,70	27,75	4,02		15.	29,00	17,00	2.589,00	821,00	3.410,00	665,00	2.398,00	347,00
259	42,92	7,77	30,79	4,36		16.	29,30	19,00	2.734,00	974,00	3.708,00	671,00	2.660,00	377,00
260	37,89	7,63	26,20	4,06		17.	29,40	16,00	2.357,00	917,00	3.274,00	659,00	2.264,00	351,00
261	37,84	7,03	26,77	4,04		18.	29,50	15,50	2.294,00	975,00	3.269,00	607,00	2.313,00	349,00
262	42,93	8,58	29,56	4,79		19.	29,70	18,00	3.053,00	656,00	3.709,00	741,00	2.554,00	414,00
263	36,28	7,45	24,77	4,06		20.	29,80	15,00	2.504,00	631,00	3.135,00	644,00	2.140,00	351,00
264	37,00	7,48	25,41	4,12		21.	30,10	14,50	2.176,00	1.021,00	3.197,00	646,00	2.195,00	356,00
265	37,71	7,50	26,20	4,00		22.	30,20	16,00	2.325,00	933,00	3.258,00	648,00	2.264,00	346,00
266	38,39	7,69	26,69	4,02		23.	30,30	16,00	2.351,00	966,00	3.317,00	664,00	2.306,00	347,00
267	39,11	7,47	27,59	4,05		24.	30,30	17,00	3.216,00	163,00	3.379,00	645,00	2.384,00	350,00
268	37,69	7,05	26,74	3,90		25.	30,60	16,50	2.525,00	731,00	3.256,00	609,00	2.310,00	337,00
269	39,05	7,50	27,25	4,31		26.	30,90	15,50	2.297,00	1.077,00	3.374,00	648,00	2.354,00	372,00
270	37,22	7,45	25,58	4,19		27.	31,10	17,50	2.705,00	511,00	3.216,00	644,00	2.210,00	362,00
271	37,97	7,29	26,57	4,11		28.	31,20	17,00	2.553,00	728,00	3.281,00	630,00	2.296,00	355,00
272	37,62	7,23	26,27	4,11		29.	31,40	17,00	2.704,00	546,00	3.250,00	625,00	2.270,00	355,00
273	37,47	6,98	26,74	3,75		30.	31,50	15,00	2.539,00	698,00	3.237,00	603,00	2.310,00	324,00
274	39,58	7,47	28,28	3,84	October	1.	31,80	17,00	2.681,00	739,00	3.420,00	645,00	2.443,00	332,00

275	38,44	7,19	27,75	3,50		2.	31,90	16,50	2.519,00	802,00	3.321,00	621,00	2.398,00	302,00
276	38,78	7,53	27,42	3,83		3.	32,00	17,50	2.697,00	654,00	3.351,00	651,00	2.369,00	331,00
277	39,79	8,16	27,55	4,09		4.	32,50	17,50	2.894,00	544,00	3.438,00	705,00	2.380,00	353,00
278	38,17	7,29	27,20	3,68		5.	32,60	18,00	2.779,00	519,00	3.298,00	630,00	2.350,00	318,00
279	37,51	7,06	26,86	3,59		6.	32,70	18,00	2.564,00	677,00	3.241,00	610,00	2.321,00	310,00
280	37,84	7,26	26,90	3,68		7.	32,70	16,00	2.393,00	876,00	3.269,00	627,00	2.324,00	318,00
281	37,41	7,41	26,23	3,77		8.	32,80	18,50	2.973,00	259,00	3.232,00	640,00	2.266,00	326,00
282	37,49	7,03	26,76	3,70		9.	33,00	17,00	2.389,00	850,00	3.239,00	607,00	2.312,00	320,00
283	38,10	7,31	26,91	3,88		10.	33,10	17,50	2.634,00	658,00	3.292,00	632,00	2.325,00	335,00
284	37,93	7,48	26,60	3,85		11.	33,30	17,00	2.478,00	799,00	3.277,00	646,00	2.298,00	333,00
285	36,35	6,69	26,09	3,58		12.	33,50	20,00	2.956,00	185,00	3.141,00	578,00	2.254,00	309,00
286	35,86	6,71	25,69	3,45		13.	33,50	10,00	1.115,00	1.983,00	3.098,00	580,00	2.220,00	298,00
287	35,79	6,82	25,64	3,33		14.	33,50	15,00	2.403,00	689,00	3.092,00	589,00	2.215,00	288,00
288	36,33	7,07	26,06	3,19		15.	33,00	13,00	2.460,00	679,00	3.139,00	611,00	2.252,00	276,00
289	36,03	6,75	26,17	3,11		16.	33,10	16,00	2.508,00	605,00	3.113,00	583,00	2.261,00	269,00
290	37,13	7,31	26,46	3,36		17.	33,60	16,50	2.323,00	885,00	3.208,00	632,00	2.286,00	290,00
291	36,90	7,33	26,24	3,33		18.	33,70	17,00	2.517,00	671,00	3.188,00	633,00	2.267,00	288,00
292	35,94	6,71	26,20	3,02		19.	33,80	17,00	2.586,00	519,00	3.105,00	580,00	2.264,00	261,00
293	36,64	6,91	26,62	3,11		20.	33,80	13,00	1.989,00	1.177,00	3.166,00	597,00	2.300,00	269,00
294	36,62	6,94	26,54	3,14		21.	33,90	15,50	2.246,00	918,00	3.164,00	600,00	2.293,00	271,00
295	37,72	7,20	27,44	3,08		22.	34,00	16,50	2.694,00	565,00	3.259,00	622,00	2.371,00	266,00
296	36,04	6,60	26,46	2,99		23.	33,90	16,50	2.896,00	218,00	3.114,00	570,00	2.286,00	258,00
297	36,00	7,00	25,87	3,13		24.	34,00	16,00	2.315,00	795,00	3.110,00	605,00	2.235,00	270,00
298	38,78	7,85	27,43	3,51		25.	34,20	12,00	1.963,00	1.388,00	3.351,00	678,00	2.370,00	303,00
299	35,94	6,77	26,16	3,01		26.	34,20	16,00	2.386,00	719,00	3.105,00	585,00	2.260,00	260,00
300	35,10	6,69	25,49	2,93		27.	34,30	17,00	2.679,00	354,00	3.033,00	578,00	2.202,00	253,00
301	35,52	6,77	25,81	2,94		28.	34,40	15,50	2.308,00	761,00	3.069,00	585,00	2.230,00	254,00
302	36,19	6,84	26,28	3,07		29.	34,50	16,50	2.902,00	225,00	3.127,00	591,00	2.271,00	265,00

303	33,75	6,18	24,72	2,85		30.	34,60	14,50	1.621,00	1.295,00	2.916,00	534,00	2.136,00	246,00
304	36,71	6,91	26,60	3,21		31.	34,70	16,50	2.358,00	814,00	3.172,00	597,00	2.298,00	277,00
305	36,92	7,18	26,42	3,32	November	1.	34,90	17,00	2.398,00	792,00	3.190,00	620,00	2.283,00	287,00
306	34,66	6,48	25,23	2,95		2.	35,00	16,00	3.025,00	-30,00	2.995,00	560,00	2.180,00	255,00
307	34,75	6,47	25,30	2,97		3.	35,10	18,00	2.796,00	206,00	3.002,00	559,00	2.186,00	257,00
308	35,31	6,63	25,64	3,04		4.	34,50	11,00	1.736,00	1.315,00	3.051,00	573,00	2.215,00	263,00
309	35,91	6,70	26,17	3,04		5.	34,50	5,00	777,00	2.326,00	3.103,00	579,00	2.261,00	263,00
310	32,14	6,08	22,92	3,15		6.	34,00	11,00	2.121,00	656,00	2.777,00	525,00	1.980,00	272,00
311	35,91	6,93	25,79	3,19		7.	34,00	13,00	2.603,00	500,00	3.103,00	599,00	2.228,00	276,00
312	35,72	6,72	25,63	3,37		8.	33,80	9,00	1.355,00	1.731,00	3.086,00	581,00	2.214,00	291,00
313	34,91	6,19	25,64	3,08		9.	34,30	20,00	2.860,00	156,00	3.016,00	535,00	2.215,00	266,00
314	34,13	6,11	25,17	2,85		10.	33,90	13,00	1.915,00	1.034,00	2.949,00	528,00	2.175,00	246,00
315	34,93	6,32	25,41	3,21		11.	34,00	14,50	2.121,00	897,00	3.018,00	546,00	2.195,00	277,00
316	35,76	6,72	25,71	3,33		12.	34,00	12,00	1.988,00	1.102,00	3.090,00	581,00	2.221,00	288,00
317	34,61	6,47	25,12	3,02		13.	34,20	16,00	2.475,00	515,00	2.990,00	559,00	2.170,00	261,00
318	35,28	6,71	25,27	3,30		14.	34,30	16,00	1.947,00	1.101,00	3.048,00	580,00	2.183,00	285,00
319	36,23	7,30	25,57	3,36		15.	34,40	14,50	2.220,00	910,00	3.130,00	631,00	2.209,00	290,00
320	34,79	6,62	24,94	3,23		16.	34,00	16,00	2.426,00	580,00	3.006,00	572,00	2.155,00	279,00
321	35,34	6,37	25,54	3,43		17.	34,20	16,00	2.467,00	586,00	3.053,00	550,00	2.207,00	296,00
322	35,60	6,39	26,11	3,10		18.	34,30	16,00	2.468,00	608,00	3.076,00	552,00	2.256,00	268,00
323	35,29	6,42	25,71	3,16		19.	34,40	16,00	2.436,00	613,00	3.049,00	555,00	2.221,00	273,00
324	34,09	6,12	25,00	2,96		20.	34,50	16,00	2.565,00	380,00	2.945,00	529,00	2.160,00	256,00
325	35,95	6,85	25,89	3,21		21.	34,60	15,50	2.356,00	750,00	3.106,00	592,00	2.237,00	277,00
326	37,84	7,41	26,78	3,65		22.	34,80	18,00	2.817,00	452,00	3.269,00	640,00	2.314,00	315,00
327	35,02	6,45	25,49	3,09		23.	34,90	15,00	2.326,00	700,00	3.026,00	557,00	2.202,00	267,00
328	34,19	6,12	25,07	3,00		24.	35,00	17,00	2.602,00	352,00	2.954,00	529,00	2.166,00	259,00
329	36,82	6,94	26,39	3,48		25.	35,20	16,00	2.454,00	727,00	3.181,00	600,00	2.280,00	301,00
330	38,24	7,50	26,83	3,91		26.	35,40	17,00	2.521,00	783,00	3.304,00	648,00	2.318,00	338,00

331	33,61	6,37	24,25	3,00		27.	35,80	20,00	2.963,00	-59,00	2.904,00	550,00	2.095,00	259,00
332	33,22	6,55	23,61	3,06		28.	35,40	14,00	2.206,00	664,00	2.870,00	566,00	2.040,00	264,00
333	35,73	7,28	25,03	3,41		29.	35,50	17,00	2.454,00	633,00	3.087,00	629,00	2.163,00	295,00
334	34,94	6,48	25,44	3,02		30.	35,60	17,50	2.500,00	519,00	3.019,00	560,00	2.198,00	261,00
335	33,32	6,27	24,11	2,94		1.	35,70	16,50	2.225,00	654,00	2.879,00	542,00	2.083,00	254,00
336	34,20	6,13	25,13	2,94		2.	35,70	15,00	2.493,00	462,00	2.955,00	530,00	2.171,00	254,00
337	34,24	6,38	24,92	2,94		3.	35,80	16,00	2.277,00	681,00	2.958,00	551,00	2.153,00	254,00
338	34,36	6,37	25,09	2,91		4.	35,60	13,50	2.569,00	400,00	2.969,00	550,00	2.168,00	251,00
339	34,50	6,50	24,92	3,08		5.	35,70	16,00	2.511,00	470,00	2.981,00	562,00	2.153,00	266,00
340	36,02	7,18	25,44	3,40		6.	35,90	18,00	2.685,00	427,00	3.112,00	620,00	2.198,00	294,00
341	33,95	6,49	24,56	2,89		7.	36,00	17,00	2.412,00	521,00	2.933,00	561,00	2.122,00	250,00
342	33,26	6,08	24,26	2,93		8.	35,80	16,00	2.339,00	535,00	2.874,00	525,00	2.096,00	253,00
343	33,76	6,23	24,50	3,03		9.	35,70	17,50	2.502,00	415,00	2.917,00	538,00	2.117,00	262,00
344	33,72	6,59	24,02	3,11		10.	35,90	12,00	2.625,00	288,00	2.913,00	569,00	2.075,00	269,00
345	32,73	6,05	23,69	2,99		11.	35,80	6,00	1.116,00	1.712,00	2.828,00	523,00	2.047,00	258,00
346	33,82	6,39	24,22	3,21	**December**	12.	35,70	12,00	2.243,00	679,00	2.922,00	552,00	2.093,00	277,00
347	34,38	6,79	24,31	3,28		13.	34,50	6,00	929,00	2.041,00	2.970,00	587,00	2.100,00	283,00
348	32,95	6,35	23,50	3,10		14.	34,00	7,00	1.120,00	1.727,00	2.847,00	549,00	2.030,00	268,00
349	32,09	5,86	23,43	2,81		15.	33,70	6,00	897,00	1.876,00	2.773,00	506,00	2.024,00	243,00
350	33,38	6,28	24,21	2,88		16.	33,30	5,00	701,00	2.183,00	2.884,00	543,00	2.092,00	249,00
351	33,38	6,22	24,26	2,91		17.	33,20	6,50	959,00	1.925,00	2.884,00	537,00	2.096,00	251,00
352	32,72	6,15	23,72	2,86		18.	33,10	5,00	769,00	2.058,00	2.827,00	531,00	2.049,00	247,00
353	33,58	6,40	24,12	3,06		19.	33,00	6,50	1.122,00	1.779,00	2.901,00	553,00	2.084,00	264,00
354	35,36	6,88	25,16	3,32		20.	33,20	7,50	1.161,00	1.894,00	3.055,00	594,00	2.174,00	287,00
355	33,99	6,46	24,46	3,08		21.	32,50	8,50	1.107,00	1.830,00	2.937,00	558,00	2.113,00	266,00
356	37,25	6,90	27,01	3,33		22.	31,70	5,00	871,00	2.347,00	3.218,00	596,00	2.334,00	288,00
357	41,37	6,93	30,31	4,12		23.	33,00	22,00	3.048,00	526,00	3.574,00	599,00	2.619,00	356,00
358	35,13	6,64	25,44	3,04		24.	33,00	19,00	2.820,00	215,00	3.035,00	574,00	2.198,00	263,00

359	35,63	6,76	25,74	3,13		25.	32,80	11,00	1.501,00	1.577,00	3.078,00	584,00	2.224,00	270,00
360	34,93	6,75	25,02	3,16		26.	32,70	6,00	991,00	2.027,00	3.018,00	583,00	2.162,00	273,00
361	35,21	6,93	24,91	3,37		27.	33,00	15,00	2.477,00	565,00	3.042,00	599,00	2.152,00	291,00
362	33,28	6,49	23,75	3,03		28.	33,00	10,00	1.874,00	1.001,00	2.875,00	561,00	2.052,00	262,00
363	32,08	6,27	22,86	2,95		29.	30,90	4,50	864,00	1.908,00	2.772,00	542,00	1.975,00	255,00
364	32,64	6,61	23,06	2,97		30.	30,50	5,00	957,00	1.863,00	2.820,00	571,00	1.992,00	257,00
365	33,14	6,85	23,07	3,22		31.	31,00	14,00	2.324,00	539,00	2.863,00	592,00	1.993,00	278,00
					Total			**4.079,80**	**651.411,00**	**517.757,00**	**1.169.168,00**	**209.152,00**	**847.750,00**	**112.266,00**

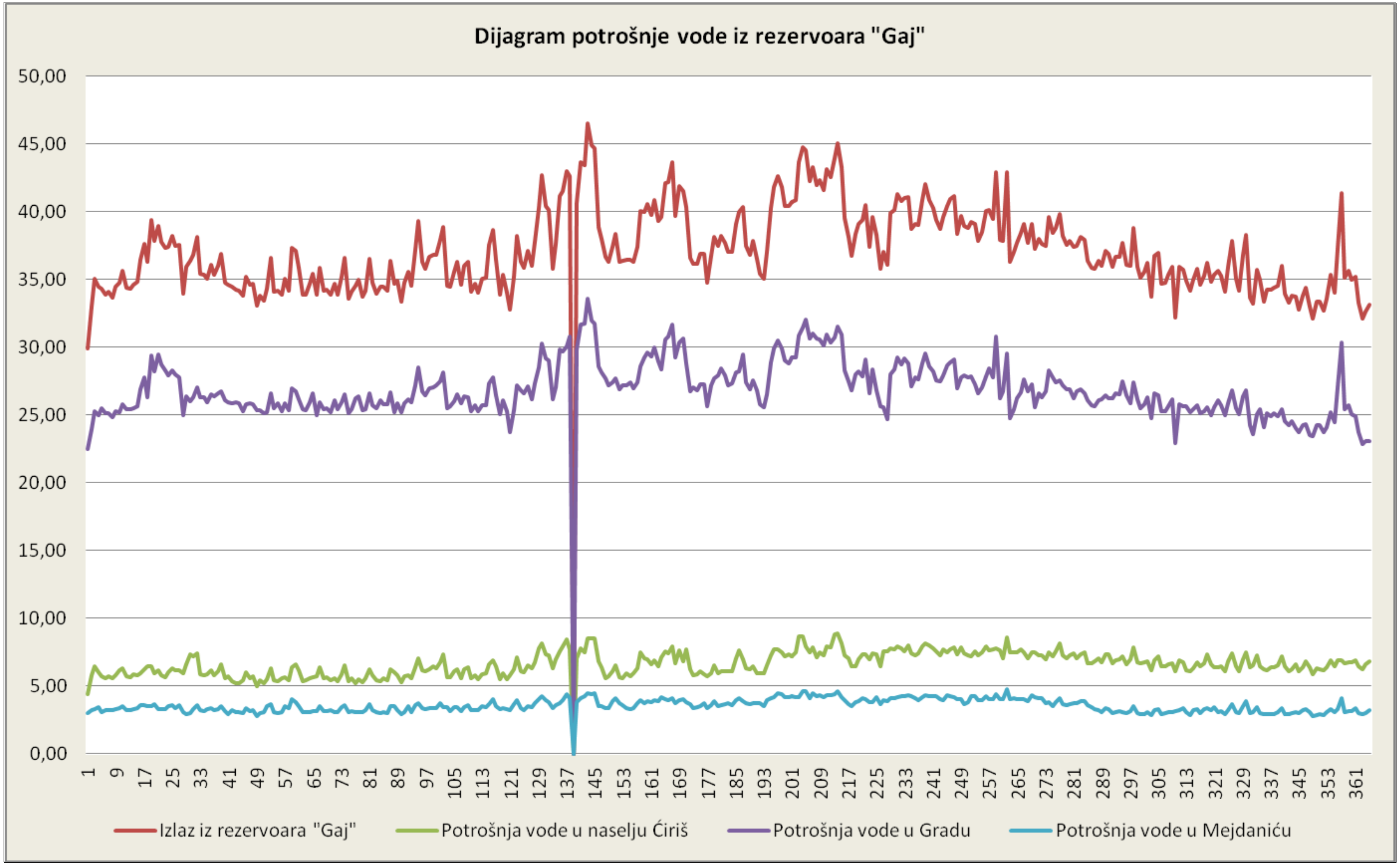
Max V= **4.018,00 m^3/day** **23.05.2009.**

Min V= **2.772,00 m^3/day** **29.12.2009.**

Vav= **3.203,20 m^3/day**

Daily nonlinearity coefficient **1,25**

Chart 5: Consumption of water in reservoir "Gaj" by zones in 2009, expressed in l/s



2.4.2.3 PRODUCTION AND CONSUMPTION OF WATER IN 2010

Water production in 2010 was **Q=46,86 l/s,** i.e. **V=1,339,464.89 m^3.** The ***Table 38:*** shows data on production and consumption of water. Also, the ***Table 33: , Table 34: , Table 35: , Table 36:*** i ***Table 37:*** show the production and consumption of water in the part of Gračanica water supply system in 2010.

The results are, also, given in the ***Chart 7:* , Error! Reference source not found.,**
Chart 9: , Chart 10: , Chart 11: , Chart 12: , Chart 13: , Chart 14: , Chart 15: and **Error! Reference source not found.**.

The percent of **non-revenue water is 39.05 %** as it can be seen in the **Table 38:** .

The revenue water is 59.26 % which is relativelly high percent for our conditions.

Estimation is that the **physical losses are 37,55 %** of total amount of produced water. However, this percent is quite good for our conditions, considering the fact that in most of our water supply systems is over 50 %.

SPECIFIC WATER CONSUMPTION

Water consumption is the water quantity by certain categorries, or in total, expressed in a time unit.

So, water consumption analysis relates to defining the needed water quantities of certain users, i.e.:

(1) For house needs (population water supply),

(2) For industry needs,

(3) For fire extinguishing or water utility needs.

The basic data for determining the water consumption needs of the population are:

(1) Water consumption norm expressed by **specific water consumption**,

(2) Population number.

Specific water consumption, q_{sp} [l/inhabitant/day], we define as a water consumption per one onhabitant in one day (24^h).

That water quantity is consisted of the consumption for many different needs and it depends on sanitary-technical appartments equipment, inhabitants standards, quality and price of water, settlements arrangement, sewerage, climate conditions, etc.

Specific water consumption is a base for functional dimensioning of the water supply system.

It is determined primarily on the basis of experience in the exploitation of existing water supply system. In most countries it is regulated by the legal regulations in accordance with the size of the village (town). These rules do not exist in our country, but the recommendations are used in practice. These values should not be taken as completely accurate, because in specific cases there are significant deviations.

We have to mention that they are quite often in the literature of specific water consumptions and cover for other categories of consumers. However, this notion of specific water consumption is more a matter of methodological approaches, but some important conceptual differences. It is only important that you determine the specific water consumption, is it only used by population or some other categories of consumers are included, especially industries (agriculture).

Specific water consumption + economy of produced water

Anual water production in WSS Gračanica is **V=1,339,464.89 m^3**. This water supply system supplies 17.507 inhabitants. That means that specific water production is **$q_{spec.}$=209.61 l/capita/day** (in 2009 ***q_{sp}=224,92 l/capita/day***).

Specific water consumption + economy

Annual revenue is **V=793,711.00 m^3**. Specific water consumption is **$q_{spec.}$=124.21 l*/capita/day*** including the economy consumption (in 2009 ***q_{sp}=131,21 l/capita/day***).

<u>Specific water consumption + economy</u>

If we take only the consumption in the households which is **V=634,968.80 m^3/year**, that means that specific water consumption of population is **$q_{spec.}$=99.37 *l/capita/day*** (in 2009 ***q_{sp}=103,86 l/capita/day***). This is relativelly low specific consumption.

Comparations of specific consumption for 2009 and 2010 show that it is almost the same. That, also, proves the accuracy of measurements in the system.

There is a lot of deviances in this specific consumption comparing to recommandations from literature where, according which, this water supply system type needs to have specific consumption of 150-230 l/capita/day. This indicates that every water supply system is specific and that it takes a lot of data and especially measurements to obtain more accurate data.

These kind of conclussions, also, go for determiantion water consumption nonlinearity coefficients. During the planning and hydraulic calculations it is very important to determine daily and hourly nonlinearity coefficients more precisaly. As with the specific consumption, we can use the recommandations from literature, but the only proper way is using the data of water consumption measurements. To determine the daily nonlinearity coefficients, we need to have data on consumption and production of water for at least 1 year, for every day. To determine the hourly nonlinearity coefficients, we need continious water consumption measurements during 24 hours. It is desireble to have these kinds of measurements for different seasons, wheather it's a working or non-working day, etc.

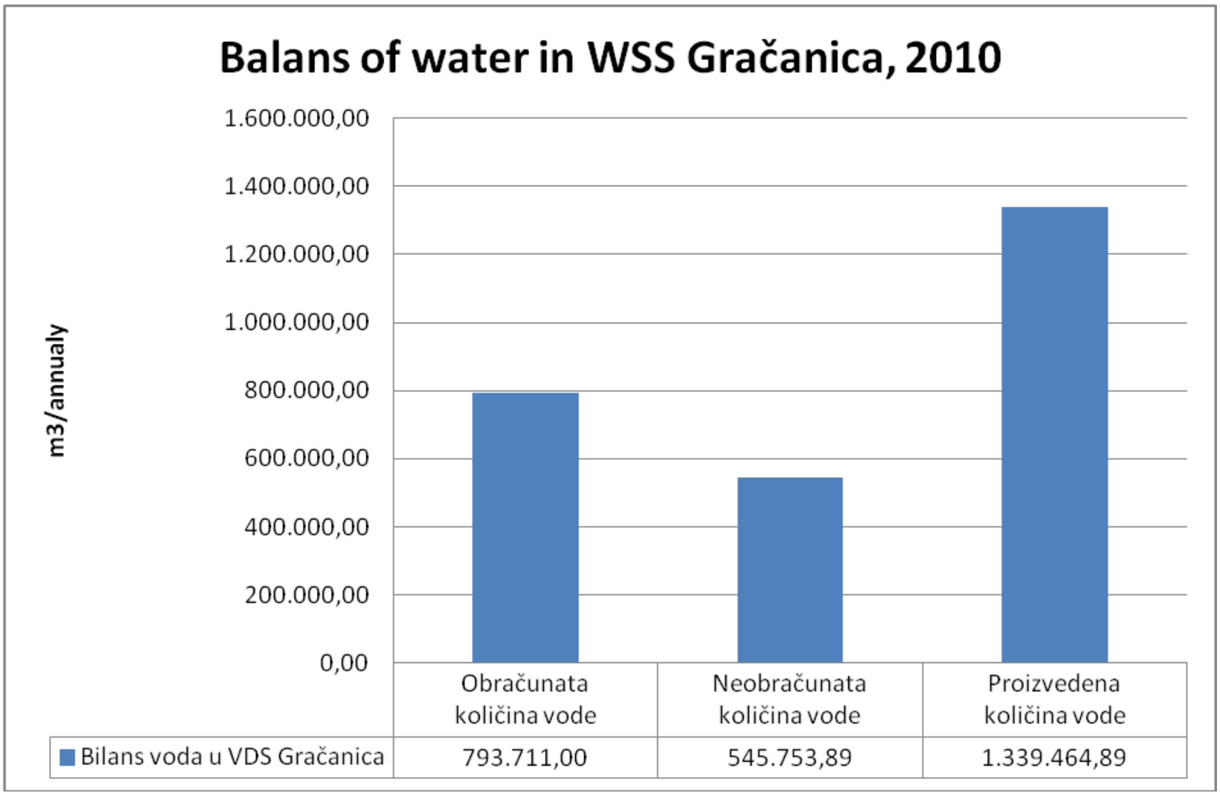
The following table shows specific consumptions in WSS Gračanica.

Table 32: Specific water consumption

No. of inhabitants connected to the water supply system	Water produced in 2010 (m^3/year)	Specific water production (l/inh/day)		
17.507	1,339,464.89	209.61		
No. of inhabitants connected to the water supply system	Revenuein 2010 (m^3/year)	Specific water production (l/inh/day)	Revenuein 2010 for population (m^3/year)	Specific water consumption without economy (l/inh/day)
17.507	793,711.00	124.21	634,968.80	99.37

The following chart shows produced and invoiced water quantities.

Chart 6: Water quantities in WSS Gračanica



Of produced water total quantity, the authorized consumption is 59.26 % of water and 34.20 % is authorized only for the households.

Table 33: Revenue water for settlements by months in 2010

ZONE	No. of connections			No. of users			Revenue water (m^3/year)	Water quantity in the parts of the system (l/s)					No. of inhabitants in the parts of the system	No. of industry connections in the parts of the system	Specific consumption of population with losses (l/inh/day)
	Households	Industry and other	Total	Households	No. of users (inhabitants) - estimation	Industry and other		Total	Population		Industry				
Gornji Grad	807	324	1.131	984	3.513	343	712.769,58	22,60	6,04	15,13	4,06	7,47	8.804	632	148,47
Srednji Grad	982	135	1.117	1.197	4.273	140			7,34		1,66				
Donji Grad	251	143	394	285	1.017	149			1,75		1,76				
Čiriš	647	17	664	789	2.817	17	190.609,00	6,04	5,84	5,84	0,20	0,20	2.817	17	179,23
Mejdanić	374	24	398	456	1.628	26	102.799,00	3,26	2,95	2,95	0,31	0,31	1.628	26	156,69
Pribava	465	17	482	596	2.128	20	181.937,00	5,77	5,53	5,53	0,24	0,24	2.128	20	224,66
Drafnići-Hurije	235	2	237	272	971	2	151.350,31	4,80	2,16	4,74	0,02	0,06	971	2	192,16
Ritošići	171	1	172	190	678	1			1,51		0,01		678	1	
Other	105	2	107	135	482	2			1,07		0,02		482	2	
Total	**3.931**	**665**	**4.701**	**4.904**	**17.507**	**700**	**1.339.464,89**	**42,47**	**34,20**	**34,20**	**8,28**	**8,28**	**17.507**	**700**	

Table 34: Produced, revenue and non-revenue water by months and system zones – reservoir zone „Gaj“

Source	Month	Produced water in the town zone		Produced water in the Ćiriš zone		Produced water in the Mejdanić zone		Produced water in town, in total		Revenue water			Non-revenue water		
		Average in l/s	m^3/month	Average in l/s	m^3/month	Average in l/s	m^3/month	Average in l/s	m^3/month	Average in l/s	m^3/month	Expressed in percents	Average in l/s	m^3/month	Expressed in percents
Reservoir zone Gaj	January	21,82	58.450,26	6,63	17.756,00	2,93	7.852,00	31,38	84.058,26	17,90	47.942,00	57,03%	13,48	36.116,26	42,97%
	February	22,02	53.274,34	6,62	16.018,00	3,12	7.542,00	31,76	76.834,34	17,50	46.865,00	60,99%	11,19	29.969,34	39,01%
	March	21,68	58.068,08	6,26	16.757,00	3,25	8.717,00	31,19	83.542,08	18,68	50.020,00	59,87%	12,52	33.522,08	40,13%
	April	21,97	56.937,06	6,33	16.406,00	3,38	8.768,00	31,68	82.111,06	18,88	50.561,00	61,58%	11,78	31.550,06	38,42%
	May	22,15	59.317,44	5,89	15.782,00	3,57	9.561,00	31,61	84.660,44	19,70	52.772,00	62,33%	11,91	31.888,44	37,67%
	June	23,67	61.344,74	6,18	16.009,00	3,30	8.542,00	33,14	85.895,74	22,14	59.297,00	69,03%	9,93	26.598,74	30,97%
	July	24,07	64.472,99	6,57	17.593,00	3,43	9.194,00	34,07	91.259,99	21,33	57.132,00	62,60%	12,74	34.127,99	37,40%
	August	21,68	58.068,08	6,26	16.757,00	3,25	8.717,00	31,19	83.542,08	21,21	56.816,00	68,01%	9,98	26.726,08	31,99%
	September	23,66	61.330,19	5,85	15.151,00	3,63	9.410,00	33,14	85.891,19	21,95	58.795,00	68,45%	10,12	27.096,19	31,55%
	October	22,89	61.304,97	5,30	14.193,00	3,23	8.644,00	31,42	84.141,97	17,38	46.562,00	55,34%	14,03	37.579,97	44,66%
	November	22,85	59.223,35	5,32	13.783,00	3,26	8.454,00	31,43	81.460,35	18,97	50.804,00	62,37%	11,45	30.656,35	37,63%
	December	22,77	60.978,08	5,38	14.404,00	2,76	7.398,00	30,91	82.780,08	15,92	42.649,00	51,52%	14,98	40.131,08	48,48%
Total in 2010:		**22,60**	**712.769,58**	**6,04**	**190.609,00**	**3,26**	**102.799,00**	**31,91**	**1.006.177,58**	**19,67**	**620.215,00**	**61,64%**	**12,24**	**385.962,58**	**38,36%**

Table 35: Water consumption by months and system zones in WSS Gračanica

Water supply system	Part of the system	Podaci za 2010. godinu													
	Settlement	January	February	March	April	May	June	July	August	September	October	November	December	In total	
Town zone	Gornji grad	58.450,26	53.274,34	58.068,08	56.937,06	59.317,44	61.344,74	64.472,99	58.068,08	61.330,19	61.304,97	59.223,35	60.978,08	712.769,58	1.006.177,58
	Srednji grad														
	Donji grad														
	Čiriš	17.756,00	16.018,00	16.757,00	16.406,00	15.782,00	16.009,00	17.593,00	16.757,00	15.151,00	14.193,00	13.783,00	14.404,00	190.609,00	
	Mejdanić	7.852,00	7.542,00	8.717,00	8.768,00	9.561,00	8.542,00	9.194,00	8.717,00	9.410,00	8.644,00	8.454,00	7.398,00	102.799,00	
Pribava	Pribava	15.373,00	13.078,00	13.524,00	16.928,00	16.607,00	15.972,00	15.750,00	14.616,00	15.923,00	17.409,00	13.841,00	12.916,00	181.937,00	181.937,00
Other	Drafnić - Hurije														
	Ritošići														
	Other	10.647,00	11.685,00	11.560,00	11.941,00	11.498,00	12.047,00	12.237,00	24.275,31	12.555,00	9.051,00	11.769,00	12.085,00	151.350,31	151.350,31
In total:		***110.078,26***	***101.597,34***	***108.626,08***	***110.980,06***	***112.765,44***	***113.914,74***	***119.246,99***	***122.433,39***	***114.369,19***	***110.601,97***	***107.070,35***	***107.781,08***	**1.339.464,89**	**1.339.464,89**

Table 36: Produced, revenue and non-revenue water in the zone Pribava

Source	Month	Produced water in the Pribava settlement zone		Revenue water			Non-revenue water		
		average l/s	m^3/month	average l/s	m^3/month	Expressed in percents	average l/s	m^3/month	Expressed in percents
Pribava zone	January	5,74	15.373,00	3,15	8.426,00	54,81%	2,59	6.947,00	45,19%
	February	5,41	13.078,00	3,07	7.425,00	56,77%	2,11	5.653,00	43,23%
	March	5,05	13.524,00	2,47	6.622,00	48,96%	2,58	6.902,00	51,04%
	April	6,53	16.928,00	2,40	6.233,00	36,82%	3,99	10.695,00	63,18%
	May	6,20	16.607,00	3,75	10.032,00	60,41%	2,45	6.575,00	39,59%
	June	6,16	15.972,00	3,71	9.626,00	60,27%	2,37	6.346,00	39,73%
	July	5,88	15.750,00	3,55	9.502,00	60,33%	2,33	6.248,00	39,67%
	August	5,46	14.616,00	3,30	8.841,00	60,49%	2,16	5.775,00	39,51%
	September	6,14	15.923,00	3,24	8.410,00	52,82%	2,81	7.513,00	47,18%
	October	6,50	17.409,00	2,90	7.767,00	44,61%	3,60	9.642,00	55,39%
	November	5,34	13.841,00	3,18	8.234,00	59,49%	2,09	5.607,00	40,51%
	December	4,82	12.916,00	2,11	5.653,00	43,77%	2,71	7.263,00	56,23%
Total in 2010:		**5,77**	**181.937,00**	**3,07**	**96.771,00**	**53,19%**	**2,70**	**85.166,00**	**46,81%**

Table 37: Produced, revenue and non-revenue water for the other parts of WSS Gračanica

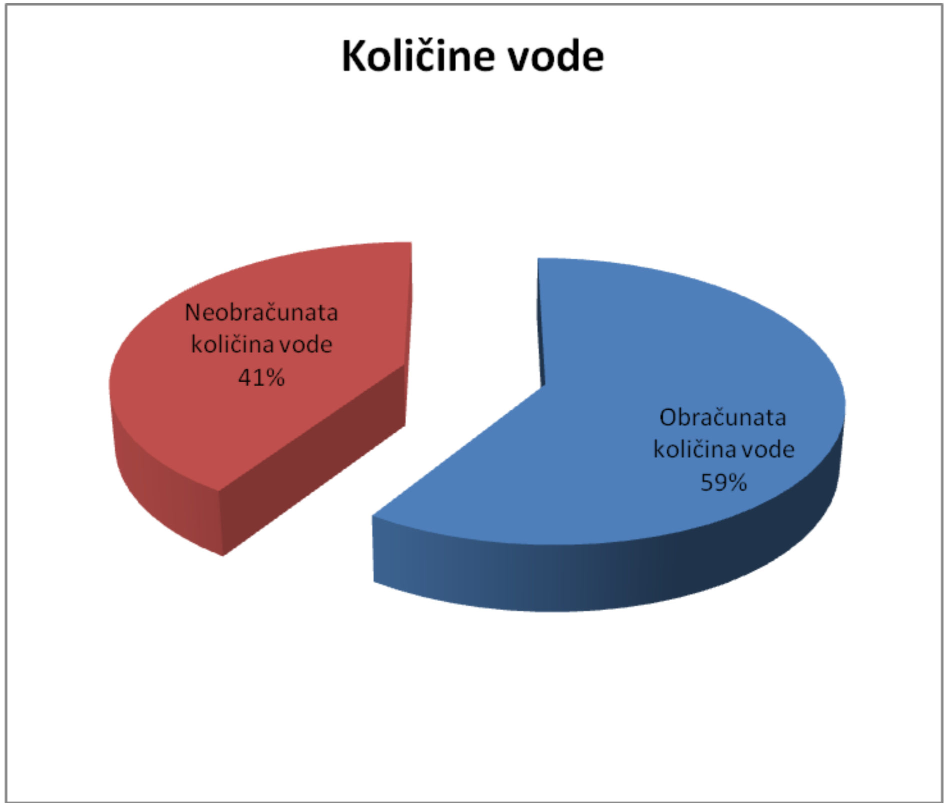
Source	Month	Produced water for the zones of other settlements		Revenue water			Non-revenue water		
		average l/s	m^3/month	average l/s	m^3/month	Expressed in percents	average l/s	m^3/month	Expressed in percents
Other	January	3,98	10.647,00	2,14	5.735,00	53,86%	1,83	4.912,00	46,14%
	February	4,83	11.685,00	2,20	5.316,00	45,49%	2,38	6.369,00	54,51%
	March	4,32	11.560,00	1,94	5.194,00	44,93%	2,38	6.366,00	55,07%
	April	4,61	11.941,00	2,05	5.314,00	44,50%	2,47	6.627,00	55,50%
	May	4,29	11.498,00	3,58	9.600,00	83,49%	0,71	1.898,00	16,51%
	June	4,65	12.047,00	2,94	7.608,00	63,15%	1,66	4.439,00	36,85%
	July	4,57	12.237,00	2,58	6.920,00	56,55%	1,99	5.317,00	43,45%
	August	9,06	24.275,31	2,63	7.056,00	29,07%	6,43	17.219,31	70,93%
	September	4,84	12.555,00	2,72	7.039,00	56,07%	2,06	5.516,00	43,93%
	October	3,38	9.051,00	2,19	5.858,00	64,72%	1,19	3.193,00	35,28%
	November	4,54	11.769,00	2,25	5.843,00	49,65%	2,21	5.926,00	50,35%
	December	4,51	12.085,00	1,96	5.242,00	43,38%	2,55	6.843,00	56,62%
Total in 2010:		**4,80**	**151.350,31**	**2,43**	**76.725,00**	**50,69%**	**2,37**	**74.625,31**	**49,31%**

Table 38: Produced, revenue and non-revenue water by months in 2010 for WSS Gračanica

Water supply system	2010								
	Month	Produced water in WSS Gračanica		Revenue water			Non-revenue water		
		average l/s	m^3/month	average l/s	m^3/month	Expressed in percents	average l/s	m^3/month	Expressed in percents
WSS Gračanica	January	41,10	110.078,26	23,19	62.103,00	56,42%	17,91	47.975,26	43,58%
	February	42,00	101.597,34	24,64	59.606,00	58,67%	15,68	41.991,34	41,33%
	March	40,56	108.626,08	23,09	61.836,00	56,93%	17,47	46.790,08	43,07%
	April	42,82	110.980,06	23,96	62.108,00	55,96%	18,25	48.872,06	44,04%
	May	42,10	112.765,44	27,03	72.404,00	64,21%	15,07	40.361,44	35,79%
	June	43,95	113.914,74	29,53	76.531,00	67,18%	13,96	37.383,74	32,82%
	July	44,52	119.246,99	27,46	73.554,00	61,68%	17,06	45.692,99	38,32%
	August	45,71	122.433,39	27,15	72.713,00	59,39%	18,56	49.720,39	40,61%
	September	44,12	114.369,19	28,64	74.244,00	64,92%	14,98	40.125,19	35,08%
	October	41,29	110.601,97	22,47	60.187,00	54,42%	18,82	50.414,97	45,58%
	November	41,31	107.070,35	25,03	64.881,00	60,60%	15,75	42.189,35	39,40%
	December	40,24	107.781,08	19,99	53.544,00	49,68%	20,25	54.237,08	50,32%
Total for 2010:		**42,47**	**1.339.464,89**	**25,17**	**793.711,00**	**59,26%**	**17,31**	**545.753,89**	**40,74%**

Water quantities	Unit		
	average l/s	m^3/year	Expressed in %
Revenue water	25,17	793.711,00	59,26%
Non-revenue water	17,31	545.753,89	40,74%
Total:	42,47	1.339.464,89	100,00%

Chart 7: Revenue and non-revenue water ratio in 2010



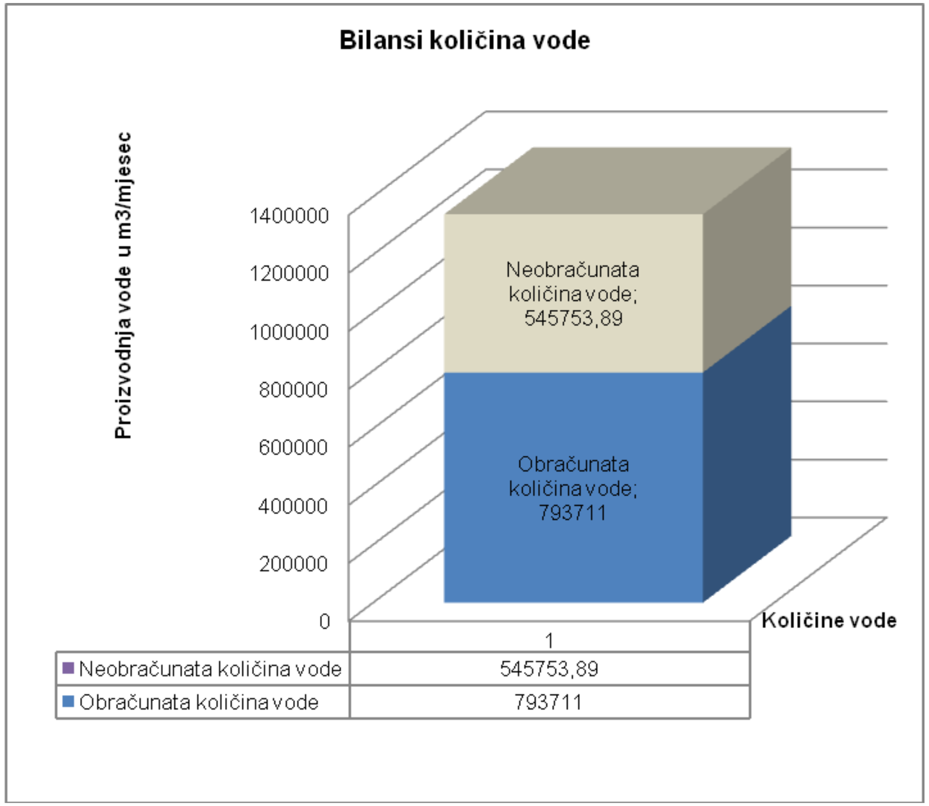
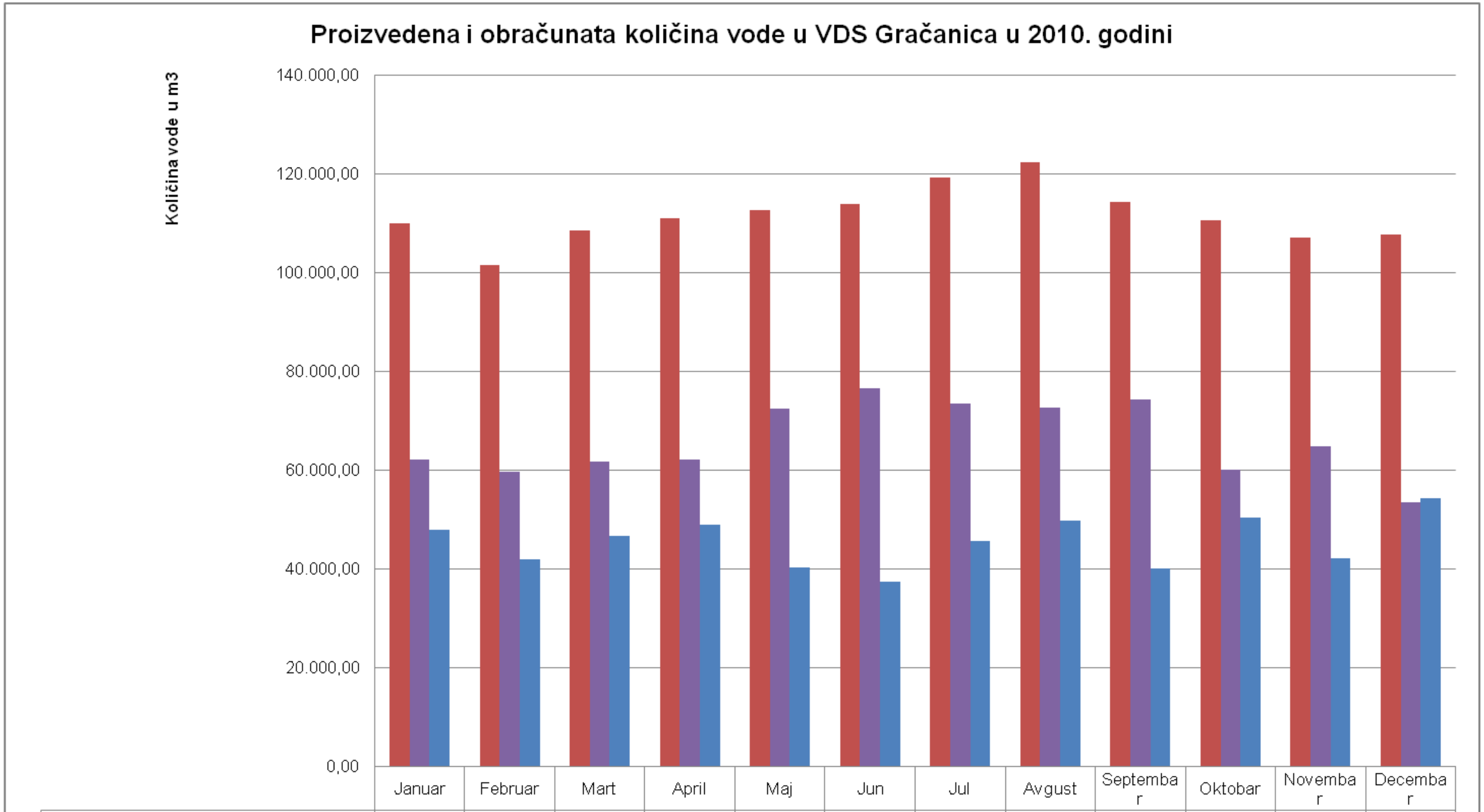
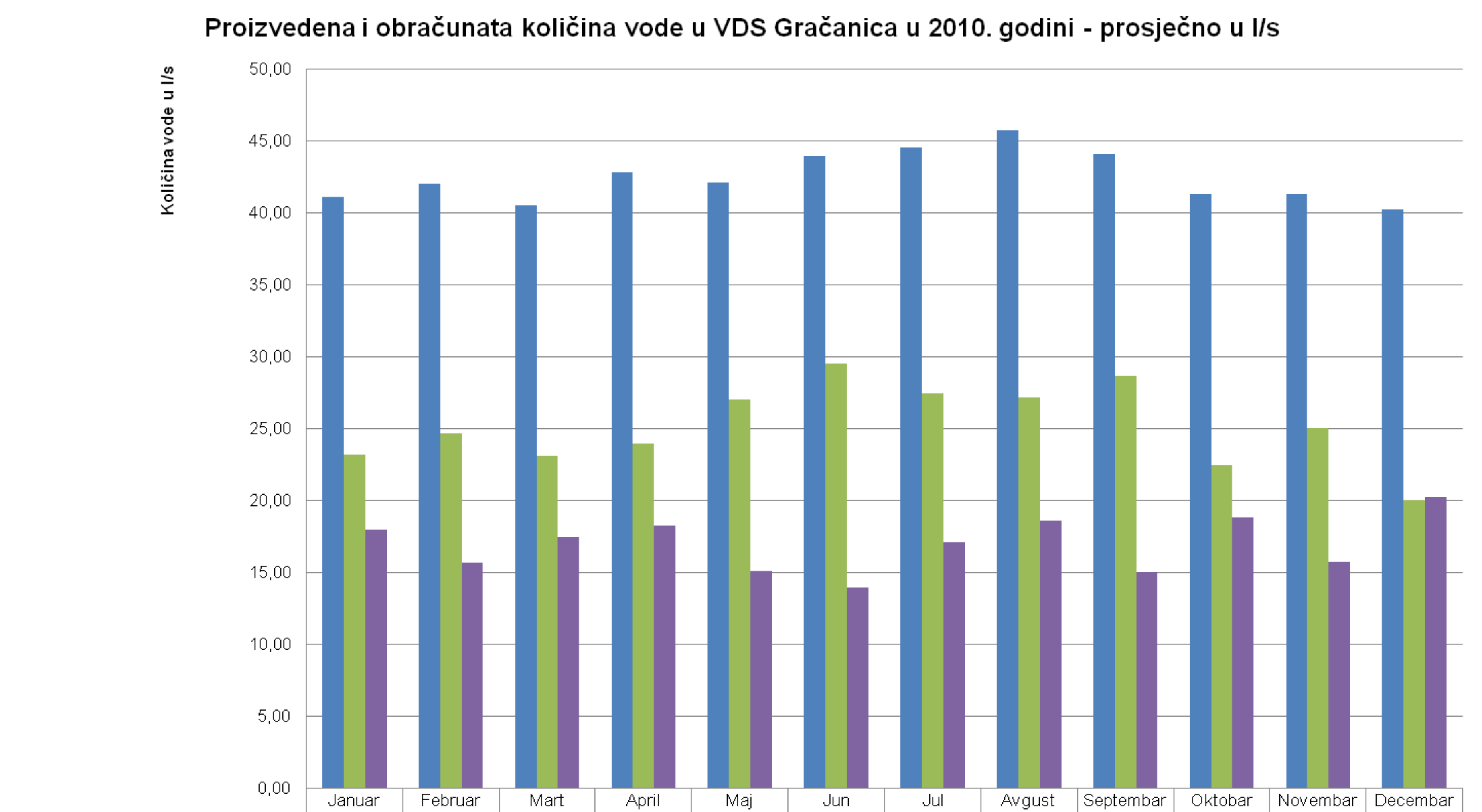


Chart 8: Produced and revenue water in WSS Gračanica by months in 2010



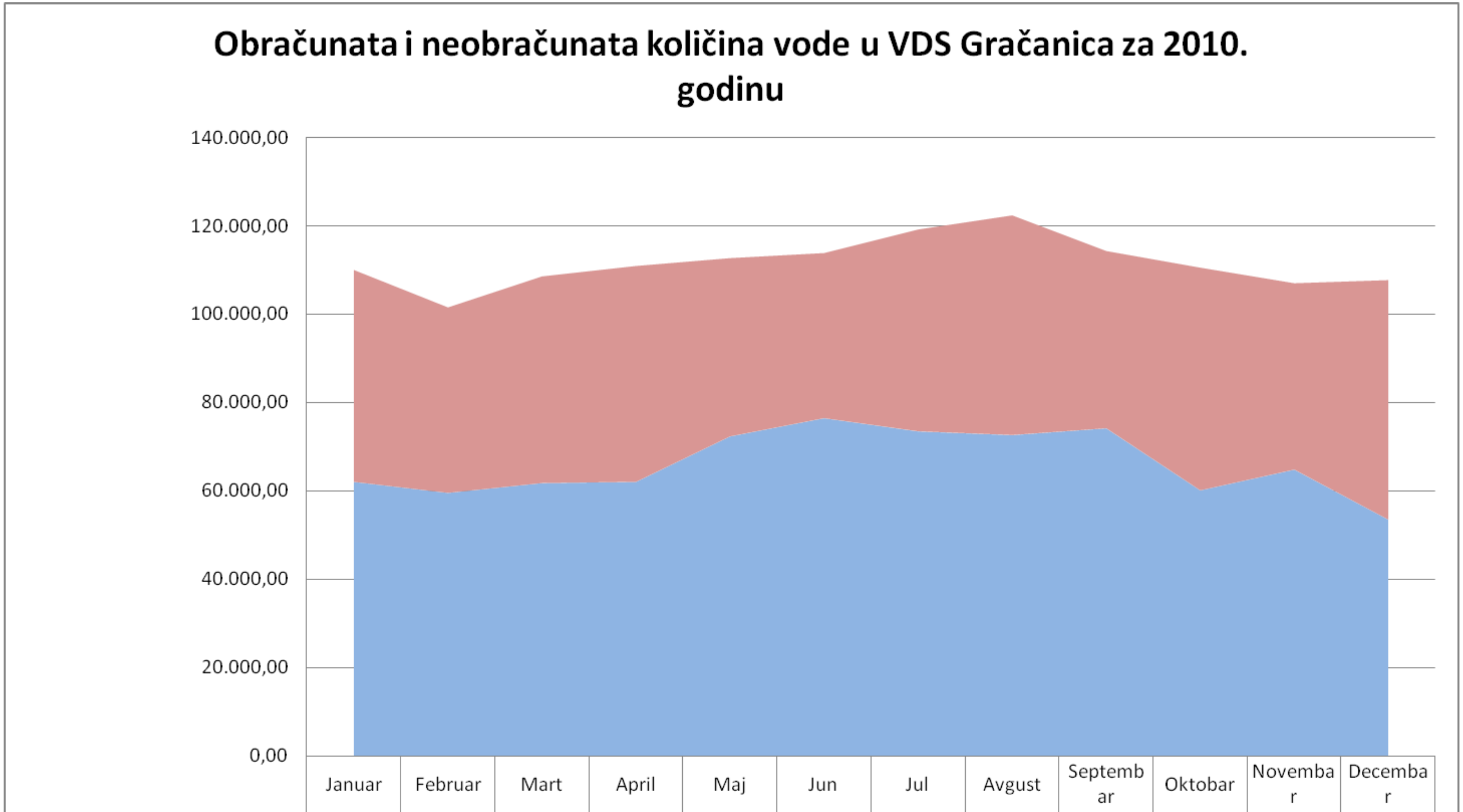
	Januar	Februar	Mart	April	Maj	Jun	Jul	Avgust	Septembar	Oktobar	Novembar	Decembar
Proizvodnja vode u m3/mjesec	110.078,26	101.597,34	108.626,08	110.980,06	112.765,44	113.914,74	119.246,99	122.433,39	114.369,19	110.601,97	107.070,35	107.781,08
Obračunata količina vode u m3/mjesec	62.103,00	59.606,00	61.836,00	62.108,00	72.404,00	76.531,00	73.554,00	72.713,00	74.244,00	60.187,00	64.881,00	53.544,00
Neobračunata količina vode u m3/mjesec	47.975,26	41.991,34	46.790,08	48.872,06	40.361,44	37.383,74	45.692,99	49.720,39	40.125,19	50.414,97	42.189,35	54.237,08

Chart 9: Produced and revenue water in WSS Gračanica by months in 2010- average in l/s



	Januar	Februar	Mart	April	Maj	Jun	Jul	Avgust	Septembar	Oktobar	Novembar	Decembar
Proizvodnja vode u l/s	41,10	42,00	40,56	42,82	42,10	43,95	44,52	45,71	44,12	41,29	41,31	40,24
Obračunata količina vode u l/s	23,19	24,64	23,09	23,96	27,03	29,53	27,46	27,15	28,64	22,47	25,03	19,99
Neobračunata količina vode u l/s	17,91	15,68	17,47	18,25	15,07	13,96	17,06	18,56	14,98	18,82	15,75	20,25

Chart 10: Produced and non-revenue water in WSS Gračanica by months in 2010



	Januar	Februar	Mart	April	Maj	Jun	Jul	Avgust	Septembar	Oktobar	Novembar	Decembar
Neobračunata količina vode	47.975,26	41.991,34	46.790,08	48.872,06	40.361,44	37.383,74	45.692,99	49.720,39	40.125,19	50.414,97	42.189,35	54.237,08
Obračunata količina vode	62.103,00	59.606,00	61.836,00	62.108,00	72.404,00	76.531,00	73.554,00	72.713,00	74.244,00	60.187,00	64.881,00	53.544,00

Chart 11: Water production in WSS Gračanica in 2010 by months - average in l/s

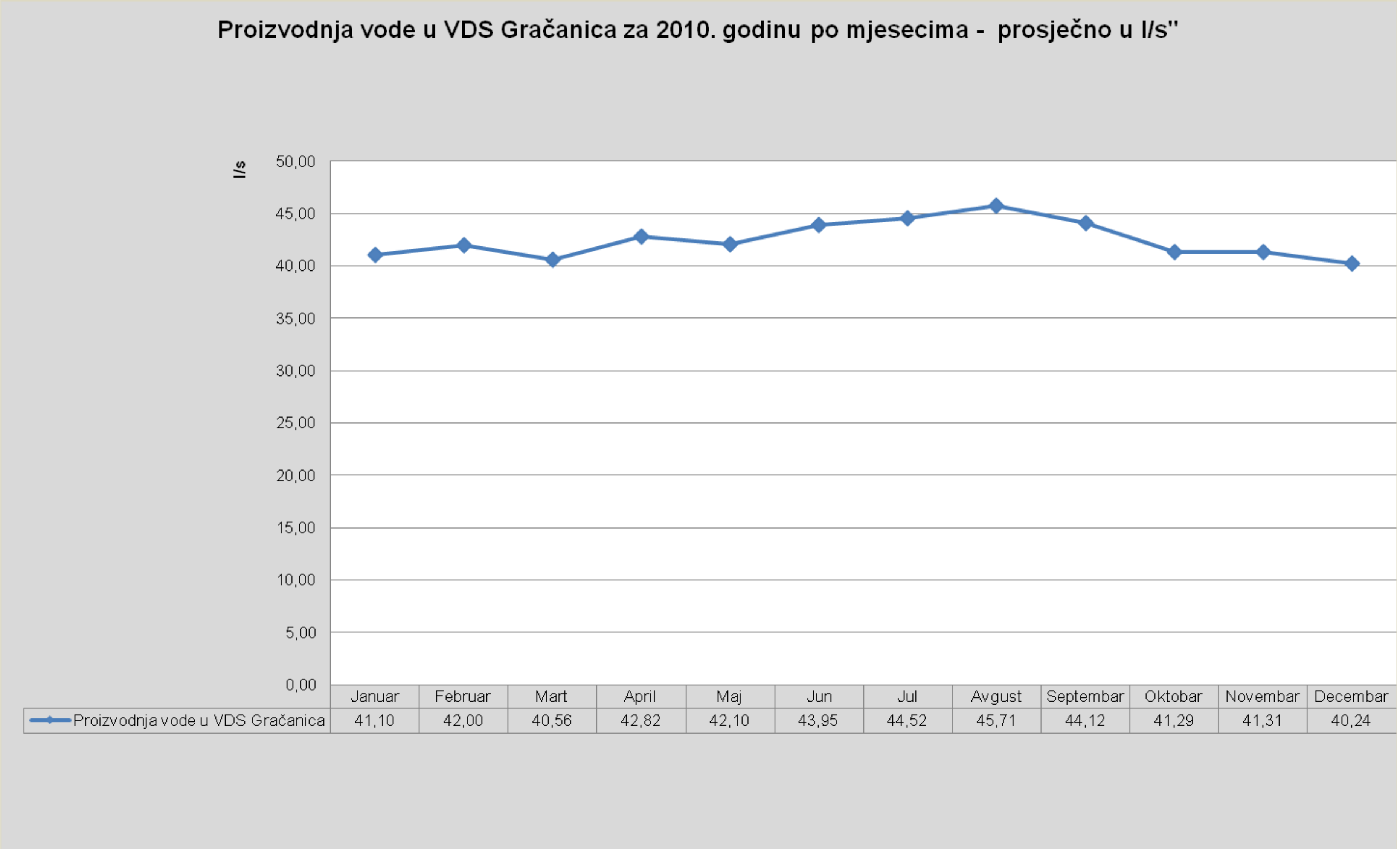


Chart 12: Chart of the flow in town - Kusturica

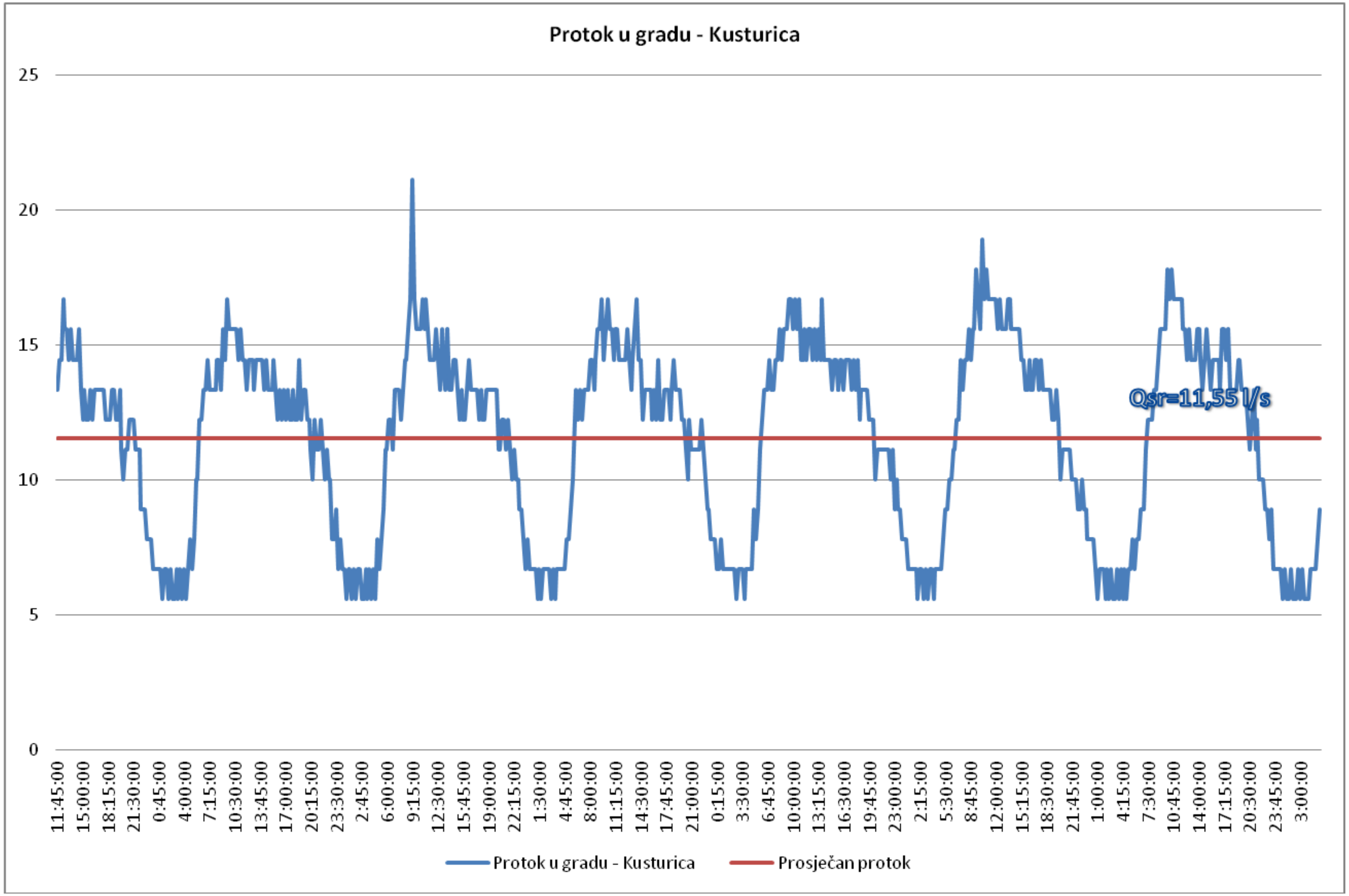
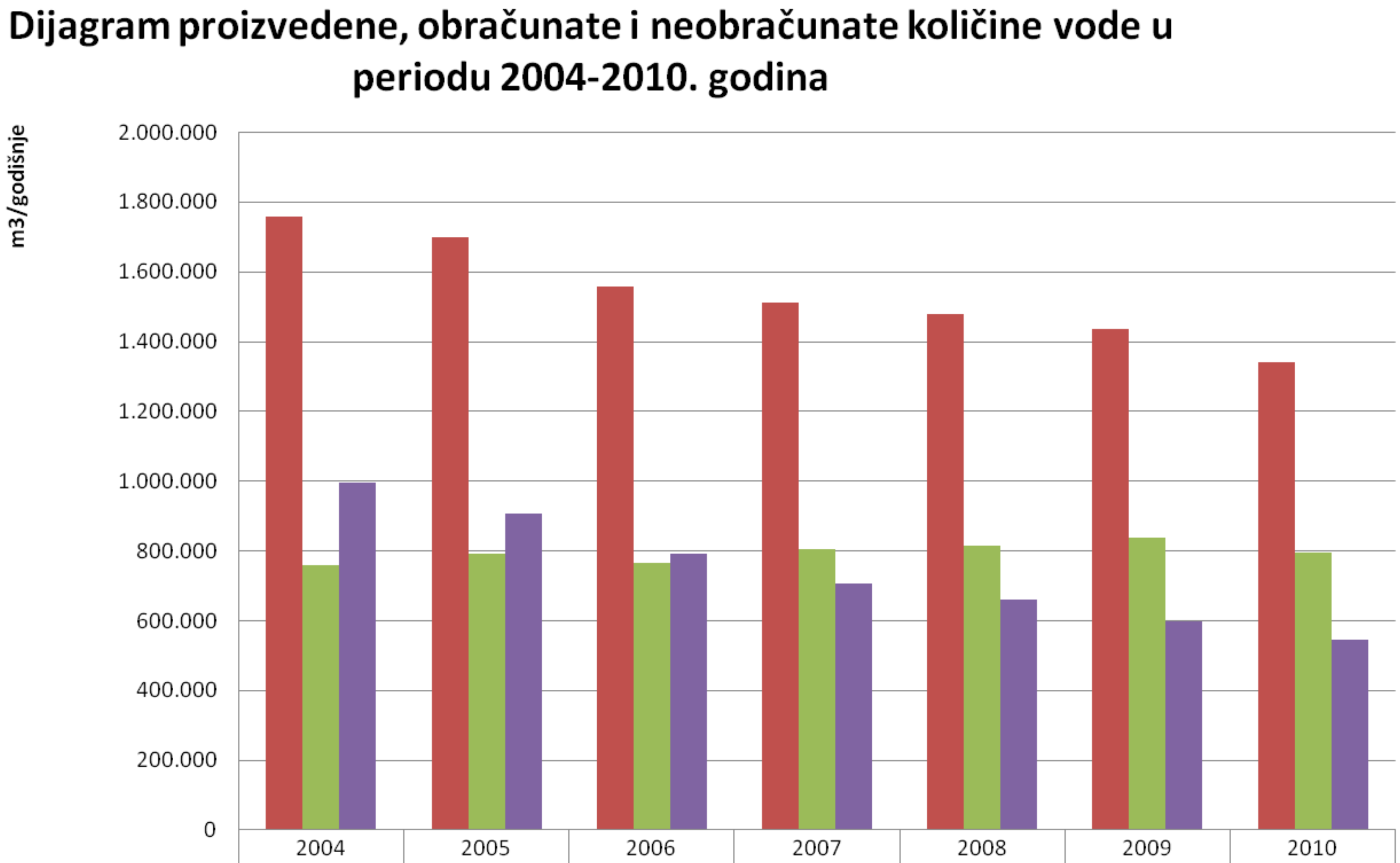


Table 39: Produced, revenue and non-revenue water in the period 2004- 2010

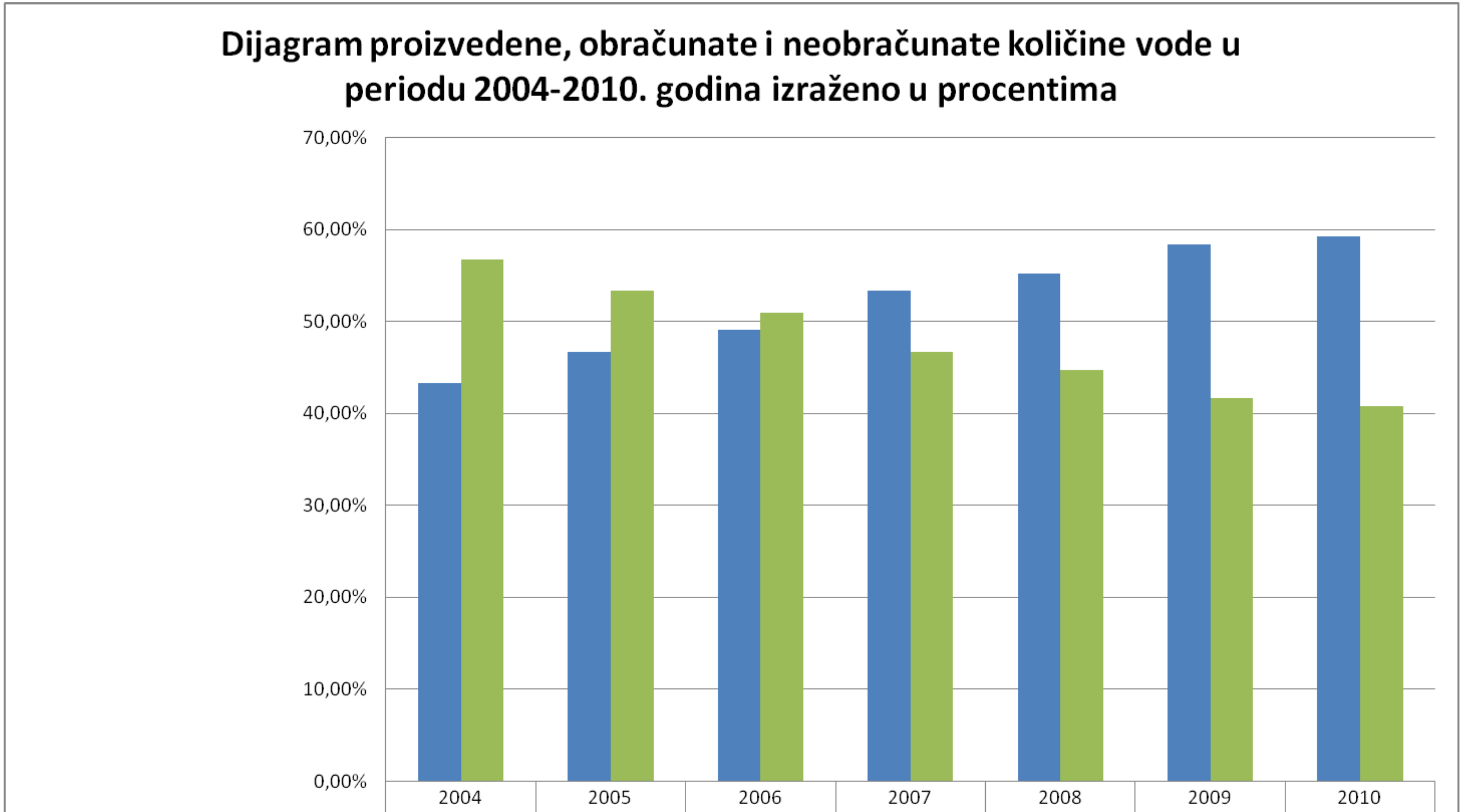
Year	Delivered-produced	Revenue water		Non-revenue water	
	(m^3/year)	(m^3/year)	(%)	(m^3/year)	(%)
2004	1.756.820	760.449	43,29%	996.371	56,71%
2005	1.698.459	792.244	46,64%	906.215	53,36%
2006	1.558.625	765.467	49,11%	793.158	50,89%
2007	1.511.254	806.338	53,36%	704.916	46,64%
2008	1.477.800	816.465	55,25%	661.335	44,75%
2009	1.437.289	838.422	58,33%	598.867	41,67%
2010	1.339.465	793.711	59,26%	545.754	40,74%

Chart 13: Chart of produced, revenue and non-revenue water in the period 2004-2010



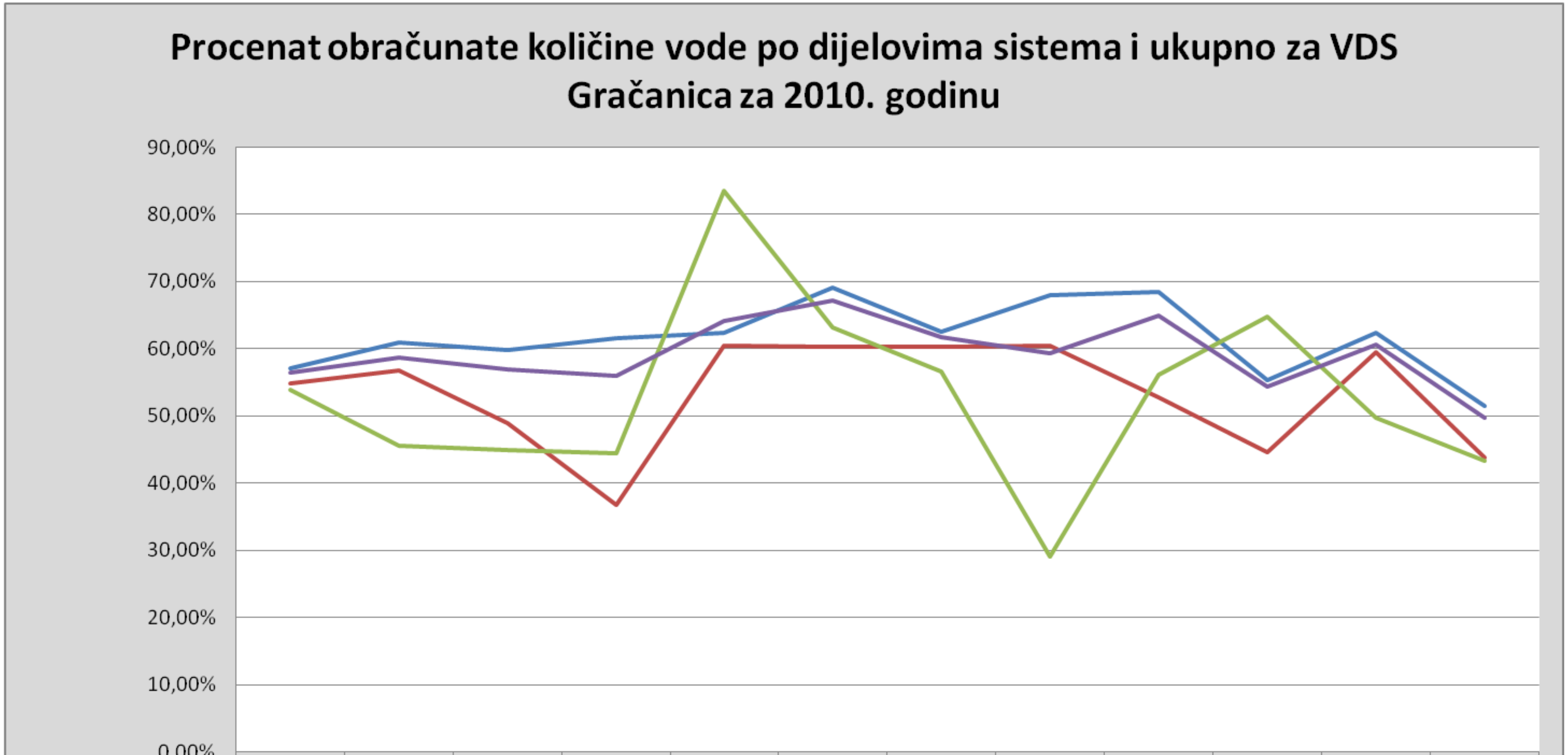
	2004	2005	2006	2007	2008	2009	2010
Proizvodnja vode po godinama	1.756.820	1.698.459	1.558.625	1.511.254	1.477.800	1.437.289	1.339.465
Obračunata količina vode po godinama	760.449	792.244	765.467	806.338	816.465	838.422	793.711
Neobračunata količina vode po godinama	996.371	906.215	793.158	704.916	661.335	598.866	545.754

Chart 14: Chart of produced, revenue and non-revenue water in the period 2004-2010 expressed in percents



	2004	2005	2006	2007	2008	2009	2010
Procenat obračunate količine vode	43,29%	46,64%	49,11%	53,36%	55,25%	58,33%	59,26%
Procenat neobračunate količine vode	56,71%	53,36%	50,89%	46,64%	44,75%	41,67%	40,74%

Chart 15: Revenue water percent in the system parts and in total for WSS Gračanica in 2010



	Januar	Februar	Mart	April	Maj	Jun	Jul	Avgust	Septembar	Oktobar	Novembar	Decembar
Zona R."Gaj"	57,03%	60,99%	59,87%	61,58%	62,33%	69,03%	62,60%	68,01%	68,45%	55,34%	62,37%	51,52%
Pribava	54,81%	56,77%	48,96%	36,82%	60,41%	60,27%	60,33%	60,49%	52,82%	44,61%	59,49%	43,77%
Ostali dijelovi	53,86%	45,49%	44,93%	44,50%	83,49%	63,15%	56,55%	29,07%	56,07%	64,72%	49,65%	43,38%
VDS Gračanica	56,42%	58,67%	56,93%	55,96%	64,21%	67,18%	61,68%	59,39%	64,92%	54,42%	60,60%	49,68%

Generally, we can say that the company “Vodovod i kanalizacija” makes great efforts reduction of losses in the system. Company has experts introduced with these problems, but they don’t have enough devices for flow and pressures measurements.

Losses can be kept under control, but there is necessity for financial means and, above all, well trained team for finding losses, as well as stimulation for staff involved in this hard and demanding work.

Finding and removal of losses in water supply system needs to be systematic work, continiously performed. Only in that way the results can be good.

The ***Table 29: Produced, revenue and non-revenue water in 2009 per months*** and show the review of water quantity in years, in the period from 2004 to 2010. We can notice the fall of production and non-revenue water, and growth of revenue water. This is the indicator of succesfull activities for finding deficiencies and the revenue of more water quantities.

We can, also, see that the results untill 2010 were better and better every year. When some certain condition in the system is reached, i.e. when the losses are reduced to some certain percent, further actions to reduce failures are much more difficult and demanding. Non-revenue water percent of 41 % is still high and needs to be reduced. This relates especially to the systems where there are no sufficient water quantities at the sources, as the case is in Gračanica.

Non-revenue water is given in the chart.

This chart shows that the non-revenue water percent in Pribava settlement zone is less than in town. We can, also, notice the oscillations through months in percents. The possible reason for this can be failures in water supply system, but it can also be the problem of consumption reading.

2.4.3 NON-REVENUE WATER

The following text presents issues often encountered in the operation of the water supply systems related to non-revenue water amounts, as well as the principles related to the reduction of non-revenue water. Namely, it has already been noted that water utility with existing water price and non-revenue water amounts is not economically viable. The following text presents the losses in company business, which are not only the cause of physical losses of water in the system, and which are, also, the main subject of this project.

DEFINITIONS

Non-revenue water can be roughly defined as the difference between the volumes of water inserted into distribution network against the volume of revenue water for users. In this way non-revenue water presents water utility revenue loss. Main categories of non-revenue water are, as follows:

I Physical water losses:

- Losses in the main pipelines and connections
- Reservoir leakage
- Other technical losses

II Unmeasured delivered water free of charge:

- water delivered to the fountains, market, etc.
- water used by military, official institutions and religious societies
- water used in households of company employees and government officials whit exemption of payment
- water used by municipal services (fire fighting, cisterns and premises cleaning, streets cleaning, sewerage cleaning)
- unmeasured water used in the processing plants (using large flow meters)

III Unmeasured water delivered to the consumers with obligation to pay:

- insufficient measurement by water gauges with poorly functioning or not functioning at all
- inaccurate routine water gauge reading
- consumers that cheat by breaking or destroying the water gauges
- illegal unmeasured consumers connections

IV Insufficient payments:

- lump sum billing by uniform tariffs instead of water metering (underestimating consumption)
- failure in sending bills

Additional category of financial losses is the bills being sent but remained unpaid (or only partially paid). It should be noted that these payment losses are not strictly the part of non-revenue water, because all revenue water is by definition included in the bill. Otherwise, reduction of these payment losses is included as part of non-revenue water reduction program.

Water calculation ratios

NRW in the given distribution system can be expressed as a ratio between different water volume types. Since the water volumes are always measured during the given time period, the relevant units are, i fact, the volume per time (such as m^3/per day).

Water volumes of our interest are as follows:

Available water = water that can be taken

Abstracted water = water abstracted from the sources

Consumed water = delivered to the consumers

Measured water = measured by consumers water gauges

Calculated water = invoiced water

Paid water = water for which the payment received

The first ratio can be expressed for any production and distribution system. This ratio will express the losses in the production system, which may depend on processing methods, loss or expenditure systems, etc.:

$$\textbf{Water production efficiency} = \frac{\text{Inserted water}}{\text{Produced water}}$$

The rest of the four ratios can be measured at any water supply distribution system. That system can be the entire municipal network or it's smaller part, such as the pilot zone. All four ratios are expressed since the water amount volume inserted into the system is the same. The inserted water is measured by a large flow meter or estimated (for instance, based on the prescribed pumping amount). Inserted water can be lost in the following way:

Inserted water = Consumed water + Water losses

″Consumed water″ in the mentioned formula is the water that flows into the consumer's water connection and goes to the consumer's water gauge, if any. ″Losses″ are the losses of water from the pipeline upstream of consumer's water gauge. Losses in the private part of consumer's connection downstream of the consumer's water gauge can be called ″waste″. In the mentioned formula, "the waste of consumed water″.

First ratio is ″Distribution system efficiency″, which compares the volume that goes to the consumers connections with the volume inserted into the network:

$$\textbf{Distribution system efficiency} = \frac{\text{Consumed water}}{\text{Abstracted water}}$$

Transforming the above formula given for the loss of inserted water, the network efficiency can be written as follows:

$$\textbf{Network efficiency} = \mathbf{1} - \frac{\text{Water losses}}{\text{Abstracted water}}$$

If there are a lot of physical losses in distribution system, the total amount of consumed water will be significantly less than the water inserted into the system, and network efficiency will be low. It is, also, important to know that there can be additional losses or waste after the consumer's water gauge in the private network and inland water supply systems.

Second ratio is the ″Measurement ratio″, which compares the total volume at the consumers water gauges with the volume inserted into the network:

$$\textbf{Measurement ratio} = \frac{\text{Measured water}}{\text{Abstracted water}}$$

The mentioned ratio can be performed using automatic data logger connected to the large flow meter at the pilot zone entrance, between two routine reading the consumers water gauges.

Third ratio is the ″Calculation ratio″, which estimates the water volumes which were actually invoiced. Calculation system must not consider only the measured consumption, but also other calculations which can be performed without measurements, such as the calculation based on the uniform price:

$$\textbf{Calculation ratio} = \frac{\text{Calculated water (measured+uniform price)}}{\text{Abstracted water}}$$

Fourth ratio is the ″Payment ratio″, which estimates the water amount for which the payment is received:

$$\textbf{Payment ratio} = \frac{\text{Paid water}}{\text{Abstracted water}}$$

Plan for reducing the quantity of non-revenue water

In order to begin preparing a plan for the reduction of the amount of non-revenue water in water supply system Gracanica, one should clarify the existing situation of losses, leakage from the network and other components of non-revenue water.

It is necessary to develop a project of rehabilitation of water supply system Bosanski Petrovac with the development of hydraulic model. In order to prepare a detailed plan for effective reduction of non-revenue water quantity at least these following procedures should be performed:

1. Metering of inserted water in the network (investments)

2. Study, training and loss detection plan
3. Active consumption metering policy and service management plan

In future, one must make arrangements for regular measurements of both produced water and consumption in certain parts of the system and consumer consumption.

Measuring the water inserted into the network

One of the first tasks is certainly establishing a measurement system. It is necessary to install water gauges at the sources, at the reservoir outlet, as well as at some certain system sections. Larger water gauges should be installed at some certain points in distribution network, to enable the calculation of NRW in every part that could be considered as a separated whole. It is, also, necessary to install missing water gauges for the final users, or calibrate the existing once.

Ratio calculation

From the data obtained, we will first calculate N**etwork efficiency ratio.** This ratio describes the current state of the network. Long-term measurement process and concurrent consumers' water gauge reading would provide data for calculation of another important ratio, the **Measurement ratio**.

Using the calculation ratio from the same process, we can calculate the third ratio which is the **Calculation ratio**, and by further use of payment data it can be developed into the **Payment ratio**.

Speaking about water supply system Tilava, the **Efficiency payment ratio** can be obtained**.** Other ratios cannot be calculated at this point, due to lack of water gauges at the sources and reservoirs. Only by establishing measurements, we will be able to talk about all the necessary ratios.

2.5 LOCAL WATER SUPPLY SYSTEMS IN GRAČANICA MUNICIPALITY AREA

In Gračanica Municipality area there are a lot of local water supply systems. During the preparation of this Study, we found out that there are over 80 local water supply systems. General situation is the lack of water at the sources, questionable water quality at the sources, old transport and distribution network with high percent of pipelines with small profiles and losses in the system. There are no measurements of produced and consumed water. A lot of means and projects are needed to put these systems into the condition, required by regulations.

Basic data on local water supply systems in Gračanica Municipality area

Table 40: Basic data on local water supply systems

Basic data on local water supply systems in Gračanica Municipality			
Number of local water supply systems	app. 80		
Minimum yield of captured sources	59,76 l/s	39,76 l/s	Well in Stjepan Polje is out of order Q=20 l/s
Number of connections	8.111		
Population connected to the systems	30.528		
Population number in local communities	38.866		
Number of PS	19		
Reservoir space volume	2.796,00 m^3		
Transport pipelines enght	162.198,00 m	417.898,00 m	No available data for all systems
Distribution pipelines lenght	255.700,00 m		

There is no data on yield and capacity of sources. For the most of the sources, there is only estimation of minimum yield which can not be taken for granted. While providing with this data, bigger water amount is usually given than the real source minimum yield.

In all of the local water supply systems, the total of 14 sources with the yield over 1 l/s registered. This shouldn't be taken for granted, either. Assumption is that the number is less than mentioned.

Only significant sources are:

- Well in Stjepan Polje, with the yield of around Q=20,0 l/s,
- source Vrelo in Soko, which is used in Gračanica town water supply system, as well, with the abstracted water amount for settlement Soko of Q_{min}=5,0 l/s,
- Well Paraslica in LC Miričina, Q_{min}=4,80 l/s.

Table 41: Bigger sources in local water supply systems

Local community	Water supply systems	Name of the source	Type	Q_{min} (l/s)
Doborovci	Doborovci	Serhatlije	Capture	1,42
		Slanska Voda	Capture	
Vranovići	Korita I	Korita I	Capture	1,00
	Grab	Grab-jaka voda	Capture	1,00
Soko	Soko	Vrela	Capture	5,00

Stjepan Polje	Stjepan Polje	Vrelo Malešići	Capture	2,00
		Vrelo	Capture	1,50
		Bunari	Well	20,00
Lukavica	Bijeli potok	Vrela, Sedra	Capture	1,00
	Lukavica	Racenovac, Višnjovača, Hasanovača	Capture	1,00
Gornja i Donja Lohinja	Bjelivoda i Smajlovac	Bjelivoda i Smajlovac	Well	3,00
Donja Orahovica	Banja	Banja	Capture	1,60
	Bunar	BUNAR or-1	Well	2,40
Gornja Orahovica	Gornja Orahovica	Zasjeka	Well	1,50
Miričina	Paraslica	Paraslica	Well	4,80
	Total:			**47,22**

Talking about source yield, the biggest problem is in LC Lukavica.

Water quality is mostly analysed only occasionally. At the most of the sources, the problem is turbidity. There are no devices for water treatment. There is only preventive water chlorination, with the systems "drop by drop".

The total reservoir volume in local water supply systems is **V=2.796,0 m^3**.

The total number o f the **pumping stations is 19**.

In local water supply systems in Gračanica municipality area, there are over **400 km water supply pipes installed**. Around **162 km are transport pipelines** which indicates to bigger distance of th esource from thhe settlement.

Pipelines are mostly of the small profiles. Profiles **equal to or bigger than Ø 80 mm is only 49 km**. That is only **11,8 %** of the total pipeline lenght, which is very low percent. Pipelines with diameter smaller than Ø 32 mm are very long.

However, we can conclude that the big percent of the pipelines do not satisfy with its diameter.

Most of the pipelines are over 30 years old.

Pipelines were made out of PE and PVC pipes.

Table 42: Pipelines in the local water supply systems

Existing pipelines in local water supply systems			
Pipeline diameter	**Pipeline lenght**	**Pipeline**	**Percentage by profiles**
(mm)	**(m)**		
do Ø 63 mm	129.264,00	Transport pipelines	79,70%
Ø 80 mm	8.204,00		5,06%
Ø 100 mm	13.211,00		8,14%
Ø 125 mm	4.290,00		2,64%
Ø 150 mm	7.229,00		4,46%

Transport pipelines in total:	*162.198,00*		*100,0%*
do Ø 63 mm	239.200	Distribution pipelines	93,55%
Ø 80 mm	14.000		5,48%
Ø 100 mm	500		0,20%
Ø 125 mm			0,00%
Ø 150 mm	2.000		0,78%
Distribution pipelines in total:	*255.700,00*		*100,0%*
do Ø 63 mm	368.464	Distribution and transport pipelines	88,17%
Ø 80 mm	22.204		5,31%
Ø 100 mm	13.711		3,28%
Ø 125 mm	4.290		1,03%
Ø 150 mm	9.229		2,21%
Transport and distribution pieplines in total:	***417.898,00***		*100,0%*

In the area of local communities with local water supply systems there are around **38.866 inhabitants**. Local water supply systems supply around **30.528 inhabitants**. Rest of the population is supplied from very small sources.

If we take that the minimum water quantity captured from the sources is **q_{sp}=112,53 l/capita/day** and that this is the specific consumption that includes economy needs and losses, than it is very low specific consumption. It means that it is **q_{sp}=60 l/capita/day**. This consumption relates to the period of source's minimum yield, i.e. in august and september. These water quantities are, certanly, bigger during the year and in some period when there is enough water in the sources, **q_{sp}=259,45 l/capita/day**.

Produced water quantity is not measured. In most cases, there are no water meters at end users, and even if there are, those water meters are not calibrated and we can not say that the measurements can be taken as accurate.

Only the water supply system Stjepan Polje is at the level for which we can say that comprises with the regulations in this branch. In the further text of this Study, more attention will be paid to this water supply system.

Data about all local water supply systems is shown in the enclosed table.

2.6 PLANNING DOCUMENTATION FOR GRAČANICA MUNICIPALITY

2.6.1 INTRODUCTION

During the preparation of the Study, the following documentation was used:

- Integrated strategy of Gračanica Municipality development (2010-2020 – in process);
- Economic strategy of Gračanica Municipality development (2005-2010);
- Communication strategy (2006-2009);
- Strategy for partnership with the citizens (2008);
- Spatial plan of Gračanica Municipality (2000-2021).
- Study with hydro-geological work program for capturing the groundwater for the purpose of water supplying in Gračanica, Institute for waters, Sarajevo (2008);
- Sanitary protection zone Report for water supply system sources in Gracanica, Institute for waters (2008).

Tuzla Canton Spatial plan was, also, used.

Data from the ***Study with hydro-geological work program for capturing the groundwaters for the purpose of water supplying in Gračanica, Institute for waters, Sarajevo (2008)*** and ***Sanitary protection zone Report for water supply system sources in Gracanica, Institute for waters (2008)*** in the description of condition in water supply system Gračanica. This documentation was well made and the results were taken over.

In further text there are the results taken from other documentation. The aim is to plan the development of water supply system based on more realistic assumptions. In the following text there are some basic parameters that should be used in hydraulic calculations of the development of water supply systems Gracanica. It can be seen that the actual calculated parameters are different from those used in the aforementioned documents. When we talk about the specific energy consumption, it is mentioned that we still use literature and the proposed size of certain values which are calculated 40-50 years ago. This leads to incorrect estimates of water demand and hence to a inaccuratelly sized objects in the water supply system.

2.6.2 EXTRACT FROM THE PLANNING DOCUMENTATION

<u>Water needs – population according to the Tuzla Canton Spatial plan</u>

Table 43: Population number ratio according to the „Longterm plan“ and Tuzla Canton Spatial plan

	Longterm plan			Tuzla Canton Spatial plan		
	2005	2015	2025	2005	2015	2025
Population number in Gračanica Municipality	35.570	39.333	44.072	52.434	54.568	56.816

Table 44: Water needs – Tuzla Canton Spatial plan

	Water needs – Tuzla Canton Spatial plan					
	2005		**2015**		**2025**	
	m^3/day	l/s	m^3/day	l/s	m^3/day	l/s

Population number in Gračanica Municipality	13.824	160	16.330	189	19.526	226

Table 45: Water needs – Tuzla Canton Spatial plan – coverage percent

	Water needs – Tuzla Canton Spatial plan – coverage percent			
Settlement categorry	2000.	2010.	2020.	2030.
Municipal center	97%	100%	100%	100%
Other settlements	60%	60%	65%	65%

Table 46: Specific consumption values by the settlements categorries in the planning period q (l/inh./day)

	Water needs – Tuzla Canton Spatial plan – population specific consumption			
Settlement categorry	2000.	2010.	2020.	2030.
Municipal center	290	300	320	330
Other settlements	250	260	280	300

Table 47: Daily nonlinearity coefficient values by the settlements categorries in the planning period K dn

	Water needs – Tuzla Canton Spatial plan – daily nonlinearity coefficient			
Settlement categorry	2000.	2010.	2020.	2030.
Municipal center	1.50	1.50	1.40	1.40
Other settlements	1.60	1.60	1.50	1.50

All results from the planning documents are reviewed and given the extent of documentation, there is no individual feedback in this document. The general conclusion is that all planning documents needs to be reviewed and that it has a lot of vague and unrealistic values.

Sources by water kinds in Tuzla Canton area

Ground water resources as sources of water supply of the population in Tuzla Canton were related to karst aquifers with cracking and intergranular porosity type.

In addition, each aquifer has its own specificity in terms of hydro-geological conditions of formation, hydrodynamic and balance of relations within it and the conditions to preserve the quality and quantity of water. Review existing sources of water supply by belonging to a certain type of aquifer is as follows:

Intergrannular porosity sources:

- Sprečko polje (Tuzla regional system)
- Okanovići (Gradačac)
- Krušik (Kalesija)
- Wells Brijesnica-Klokotnica (Doboj East)
- Wells Spreča (Lukavac)
- Brnjik 2 (Čelić)

• ***Well MSPBF***	***(Gračanica-Stjepan Polje)***
• Frigos. Tukovi	(Čelić)

<u>Cracking karst porosity sources:</u>

• Studešnica. Krabašnica	(Banovići)
• Stupari (Zatoča. Tarevčica. 7 sorces)	(Tuzla regional system)
• Toplica	(Tuzla regional system)
• Vlahulje	(Srebrenik)
• Stariška rijeka. G.Bukovica	(Kladanj)
• ***Sklop I i II. Soljanuša***	***(Gračanica)***
• Domažić	(Gradačac. Vučkovci)
• Vrelo-Mionica	(Water Utility Mionica)

<u>Planning documentation</u>

The planning period includes expansion of the existing system, especially the capacity of the source and the reservoir area. It is planned to expand the source Soljanuša, by the construction of adequate supporting facilities (pumping stations and treatment plants).

We planned the development stages of a new reservoir "Gracanica", which capacity in 2025 would be up to 5000 m3, while in the subsequent period it’s expansion would go up to 1,000 m3

During the reservoir construction, pumping stations would be constructed, as well. We also planned the construction of water treatment “Gaj”.

Expansion of the municipal water supply Gracanica will go parallel with the reconstruction of damaged water supply network, as well as the special replacement of asbestos-cement pipeline. In this way, losses in water mains will be significantly reduced. It is, also, essential in the planning period to do the studies on the protection zones for all drinking water sources.

Within urban area borders and at the construction land out of urban areas of GRAČANICA Municipality , 3 industry zones are planned of total surface P=128.62 ha.

- Gračanica urban area: 1 (one) industry zone - P=95.58 ha
- Settlements Doborovci and Vranovići: 1 (one) industry zone - P=19.30 ha
- Settlement Stjepan Polje: 1 (one) industry zone - P=13.74 ha

<u>Guidelines for water supply system development</u>

In order to reduce the current deficit reported in the void of individual municipalities, and thereby improve the conditions of drinking water, the guidelines are as follows:

- Optimization of existing drinking water sources until reaching the full capacity
- Reduction of losses at the supply pipelines and the network.

Gračanica

With the implementation of necessary preliminary hydrogeologic study that would define the possibility of expanding the existing water sources Soljanuša and find optimal technical solutions abstraction thereof, will lead to the expansion and upgrade of existing water supply facilities Gracanica, which would enable the acceptance of new quantities of water.

Regional water supply system “Tuzla region”

Regardless of the implementation of the above activity, some of the municipalities, most likely, will not solve the deficit problem of drinking water in the planning period. For this reason, and because of the purpose of development after 2025, it is necessary to plan the implementation of regional water supply system in the period from 2015 to 2030, which origins can only be Krivaja River (at the current documentation), as alternative procedure to adopt.

In the I phase it was planned to turn some rivers from the basin of Krivaja river into the basin of Spreca river, after which the accumulations would be formed in the mentioned waterway.

According to the longterm water supply program, there are two solutions: Regional water utility "Tuzla region" which would include water utilities Tuzla, Lukavac and Živinice, and municipal water utilities Banovići, Kalesija and Srebrenik, and **eventually Gračanica**.

2.6.3 CONCLUSSIONS

All information given in the planning documents, which were made in the municipality of Gracanica and Tuzla Canton, should be taken with caution, or, if it is possible, to check calculations. It is evident from the above given table that the data on the population vary in relation to the actual situation.

The spatial planning documents are very questionable from the point of view of water supply, what is very important for planning, particularly population estimates and population growth, and the estimated specific consumption. It can be seen that the number of people already does not match the data collected during this year. Regarding the second element of the planning, the specific consumption in this documentation is solely used, due to the fact that no research was conducted.

Regarding the use of space, it is given, so we know where it will be a residential zone, and where the commercial zone. However, the industry zone can not be precisely discussed, given the fact that, at the moment, we can not guess what kind of industry will develop in this area. According to literature, they need more water than actually measured Gracanica (20% of the total calculated amount of water).

2.7 ACTUAL BALANCE OF WATER QUANTITIES IN WSS GRAČANICA

Actual balance of water quantities in WSS Gračanic can not be made precisely.

To make the actual balance, more measurements are needed in the system, as well as the hydraulic model. At this moment, it is very hard to do the waer balance for any water supply system in BiH.

Chart 16: Water balance

<table>
<tr><td rowspan="9">Produced water</td><td rowspan="4">Authorized water consumption</td><td rowspan="2">Revenue authorized water consumption</td><td>Revenue measured water consumption</td><td rowspan="2">Revenue water quantity</td><td>Paid water</td></tr>
<tr><td>Revenue unmeasured water</td><td>Unpaid water</td></tr>
<tr><td rowspan="2">Non-revenue authorized water consumption</td><td>Non-revenue measured water</td><td rowspan="7">Non-revenue water</td><td rowspan="7">Non-revenue water</td></tr>
<tr><td>Non-revenue unmeasured water</td></tr>
<tr><td rowspan="5">Water losses</td><td rowspan="2">Commercial water losses</td><td>Ilegalna potrošnja vode</td></tr>
<tr><td>Mistakes at water-meters and water-meters reading</td></tr>
<tr><td rowspan="3">Physical water losses</td><td>Losses at the pipelines – transport and distribution</td></tr>
<tr><td>Losses and overflow at the reservoirs</td></tr>
<tr><td>Losses at the households connections on the way to the water-meters</td></tr>
</table>

2.8 CAPACITY ANALYSIS AND ASSESMENT OF PARTNER MUNICIPALITY GRAČANICA AND UTILITY COMPANY

2.8.1 CAPACITY ANALYSIS AND ASSESMENT OF PARTNER MUNICIPALITIES AND UTILITY COMPANIES

In the aim of improving the life quality of population, Gračanica Municipality established the following local strategies:

- **Strategy of Gračanica Municipality economic development (2010-2020)**[3]

Strategy for the period 2010-2020 with the vision that: „Gračanica Municipality is economically leading, ecologically well arranged, socially organized community of happy and satisfied citizens“. In the aim of reaching the municipality development vision, five strategy objectives were identified:

Strategy objective 1: To attract investors, increase the employment

Strategy objective 2: Clean water for everyone, arranged waterways, ecological waste disposed, Gračanica without mines

Strategy objective 3: Quality solved utility infrastrucure and traffic

Strategy objective 4: Faster development of tourism, by using the thermo-mineral waters and other resources

Strategy objective 5: Better management, health and social care, well done culture and sport educational system.

- **Capital investments program for Gracanica Municipality (2010 -2014)**
- **Partnership strategy between non-government organizations and Gracanica Municipality**
- **Strategy for Gracanica Municipality youth**.

Gracanica municipality (according to statistics) employs about 8409 persons, which is somewhere in the prewar level. The same number of unemployed, with an increase, which indicates that the overall socio-economic situation in the municipality is more complicated. Gracanica economic structure is: 1177 subjects of various activities of which 432 are legal entities, 690 of various independent craft-service activities (so-called natural persons), 27 public institutions and companies, 10 banks, 9 micro-credit organizations and 9 insurances.

Table 48: Unemployment percent (2006-2009)[4]

Year	labour			Percent	
	Total	Of which		Employment	Unemployment
		Employed	Unemployed		
2006	16.517	7.988	8.529	48,3 %	51,7 %
2007	16.951	8.648	8.303	51,0 %	49,0 %
2008	16.706	8.904	7.802	53,3 %	46,7 %
2009	16.622	8.213	8.409	50,6 %	49,4 %

Data source: Gračanica Municipality statistics for emplyed persons in municipality, and Federal Institute for statistics for unemplyed persons.

[3] Data source: Strategy of Gračanica Municipality economic development (2005-2010)
[4] Data source: Gračanica Municipality

Table 49: Gračanica Municipality budget in 2009

Data taken from Gračanica Municipality budget report for 2009	
1. REVENUE IN TOTAL	9.388.355 KM
1.1. Taxes revenue	6.520.847 KM
1.2. Non-Taxes revenue	1.805.334 KM
1.3. Current support - grants	1.322.489 KM
2. REALIZED INCOMES IN TOTAL	2.464.432 KM
REALIZED BUDGET IN TOTAL (1+2)	11.852.787 KM
3. EXPENDITURES IN TOTAL	10.494.032 KM
3.1. Current expenditures	6.022.345 KM
3.2. Capital expenditures	4.471.687 KM
4. DIFFERENCE BETWEEN REVENUE AND INCOMES AND EXPENDITURES ((1+2)-3)	
(Budget surplus)	1.358.755 KM
4.1. Loan repayments	1.051.352 KM
4.2. Net budget surplus	307.403 KM

Annual average investments in water and sewerage infrastructure from the municipal budget is 450.000,00 KM.

Water supply services in Gračanica Municipality are obligation of public company JP "Vodovod i kanalizacija" d.d. Gračanica. Utility company isorganized and operates in accordance with the "Law on utility services" TK SG 11/2005, Gračanica Municipality relevant decisions, utility company status, as well as other legal acts.

JP „Vodovod i kanalizacija“ dd Gračanica has 51% of Gracanica Municipality state capital and 49% of private capital in the ownership of 23 employees – capital owners. JP „Vodovod i kanalizacija“ manages the town water supply system and water utility in one local community. Local water supply systems are managed by local community and people, if company does not have the contract with mentioned.

The Sources Protection Report is made, but only partially applied.

Besides other planning documentation JP „Vodovod i kanalizacija“ dd Gračanica regularly prepares annual financial plans and reports.

The company has 19 employees.

2.8.2 UTILITY COMPANY FINANCIAL ESTIMATION

Total (revenue) incomes of water supply and sewerage services are 1.023.477 KM, but expenditures are almost the same, 1.022.125 KM.

It can generally be concluded that operation of the utility company JP „Vodovod i kanalizacija“ dd Gračanica is sustainable. Current income level is enough to secure the satisfying operation conditions. Price policy is socialy oriented, but thanks to good work of the company JP „Vodovod i kanalizacija“

dd Gračanica which can be seen in reduction of expences and losses, as well as the high degree of billing, what enables succesfull performance of their duty.

Table 50: Prices of water supply service in Gračanica Municipality

	Households	Public institutions	Industry
Water component	0,60	1,20	2,20
Sewerage component	0,20	0,20	0,20
Water abstraction tax	0,01	0,01	0,01
Pollution tax	0,04	0,04	0,20; 0,1; 0,04
Development component (planned for investments)	0,09	0,10	0,10
VAT	17%	17%	17%
TOTAL COMBINED PRICE (KM)	0,94+PDV	1,55+PDV	2,61+PDV

Incomes and expenditures in 2009

Table 51: Incomes (2009)

Type of income	**Value (KM)**
Water income	710.140
Waste water disposal income	128.886
Water-meter tax income	15.316
Additional service income	79.001
Other incomes	90.134
TOTAL INCOMES	**1.023.477**

Table 52: Expenditures (2009)

Type of expenditure	**Value (KM)**
Water and sewerage system maintanance	114.837
Power	105.544
Employees salaries	423.029
Amortization	121.623
Other expenditures	257.092
TOTAL EXPENDITURES	**1.022.125**

2.8.3 INSTITUTIONAL AND REGULATION FRAME

At the Canton level (Tuzla Canton) water supply branch is regulated by the following legal acts: Law on waters („Official gazette TC“,no. 11/08), Law on utility services TC SG 11/2005; Decision on water polluters cadastre („Official gazette TC“,no. 2/05).

2.9 ANALYSIS OF WSS GRAČANICA

2.9.1 TOWN WATER SUPPPLY SYSTEM COVERAGE

WSS Gračanica partially satisfies th eneeds of population and industry. Percent of municipality population supplied from town water supply system and water supply systems maintaned by ViK Gračanica is very low - 29,71 %, as shown in the following table. That is less than average in Bosnia and Herzegovina where this percent is over 50 %.

Table 53: Population supplied from WSS Gračanica

Municipality	Total population in municipality in 2010	Population connected to WSS Gračanica	Percent of population connected to WSS Gračanica
Gračanica	58.926	17.507	29,71%

Some of the local water supply systems not connected to the town system at the moment will, in the future, be connected to WSS Gračanica, while some system will remain independent.

2.9.2 SOURCES AND BALANCES OF WATER

2.9.2.1 ABSTRACTED WATER IN GRAČANICA MUNICIPALITY

2.9.2.1.1 ABSTRACTED WATER IN WSS GRAČANICA

Review of existing sources in WSS Gračanica is shown in the following table.

Table 54: Sources in WSS Gračanica with various capacities

Source	Minimum source capacity (l/s)	Average annual capacity (l/s)	Average annual capacity in hydrologically favourable year (l/s)
Natural source „Ilidža“	4,5	12,0	12,0
Natural source „Vrela“	4,0	9,5	9,5
Natural source „Škahovica“	1,0	3,5	3,5
Natural source „Zmajevac“	0,4	1,0	1,0
Source Hadžijina voda	2,2	2,2	2,2
Drilled wells „Sklop“ (Sklop II and Sklop III)	17,0	17,1	22,2
Well Soljanuša	5,70	6,50	6,50
Total:	**34,8**	**51,8**	**56,9**

According to the data, the minimum yield for all affected sources in the area of WSS Gracanica is Qmin = 34.8 l / s. The average water production is approximately Q = 50 l / s. In hydrologically favorable years, water sources capacity is Q = 56.9 l / s. It should be noted that the source "Ilidža" and "Vrela" are, also, in the water supply system of LC Soko. At a minimum capacity of water sources, priority in water supply have people in local communities. Thus the total minimum amount of water at the sources would be even less for WSS Gracanica. However, what is good is that the minima do not appear at all the sources at the same time. At a time when the minima occur at natural sources, the exploitation of wells Sklop and Soljanuša is increased. There is no data on actual measured minima of water at the sources. These are definitely more water than **Q_{min}=34,8 l/s**.

After recovery of losses in recent years, the reduction of water were not recorded even during minimum source yield. This is certainly the reason why people rationally use water because the lack of water in water supply system is a long-term problem.

In the future we must find new sources of drinking water to decrease water deficit in the future. It is certain that the amount of water available to the municipality of Gracanica is the basic problem of supply of population and industry and it can be a serious brake development of the municipality in the future.

2.9.2.1.2 ABSTRACTED WATER IN LOCAL WATER SUPPLY SYSTEMS IN GRAČANICA MUNICIPALITY

In Gračanica Municipality area, besides town water supply system, there are a lot of local water suppply systems. Percent of population connected to the town water supply system is very low, 29,71 %. However, the biggest number of inhabitants is supplied by local systems which are not well managed and with a big problem of water capacity and water quality.

According to the data from municipality and local communities, the number of local water supply systems is 80. Water supply sources for theese systems are mostly unresearched and with low capacities. In the item ***2.5 Local water supply systems in Gračanica*** , as well as in ***enclosures***, there are data on local water supply systems.

The total abstracted water is **Q_{min}=59,76 l/s**. Theses quantities include the well in Stjepan polje, which is not being exploited and which capacity is **Q_{min}=20 l/s**. That means that the actual water quantity used for water supplying in local systems is **Q_{min}=39,76 l/s**. All sources of local water supply systems are unexplored and data on the minimum yield are approximate. To be able to make any plans for water supply in the future, we must know information about the minimum source yield, because that is the basic data for any planning and design. Estimated water quantity abstracted during the year is **Q_{sr}=111,67 l/s**.

As one of the priorities will be installation of flow meters at all sources, so the actual water abstracted can be determined.

Data about local water supply systems can be found in spatial planning documentation, as well, drafted in the previous period. The information that we have about the source yield in local water supply systems is Q_{min}=101,58 l/s. Sources “Ilidža” and “Vrelo” are included in these quantities in LC Soko used in town water supply system, as well. This only indicates the need for exploring the existing sources and determining their minimum yield.

It can be concluded that the existing sources do not satisfy th needs ofpopulation and industry in local water supply systems.

2.9.2.2WATER QUALITY AT THE SOURCES

2.9.2.2.1 WATER QUALITY AT THE SOURCES IN WSS GRAČANICA

For this Study, the samples are taken at the sources "Ilidža", "Vrelo" and from the well in Stjepan Polje.

Water quality in the wells Sklop and Soljanuša is good, it satisfies all drinking water regulations, so there was no need for further analysis of this water.

Because of the water turbidity at the sources "Ilidža", "Vrelo", the additional water quality analysis urađena was conducted.

2.9.2.2.2 WATER QUALITY AT THE SOURCES IN LOCAL WATER SUPPLY SYSTEMS

In the item ***2.5 Local water supply systems in Gračanica*** we gave the data about water quality at the sources. One of the biggest problems is, certanly, water quality at the sources which very often does not satisfy regulated drinking water quality. Although, the big problem is irregular analysi of the water quality at the sources.

2.9.2.3 PROTECTION OF SOURCES

2.9.2.3.1 PROTECTION OF SOURCES IN WSS GRAČANICA

The reports on all sources protection zones are drafted. It is necessary ti implement the protection measures given in the items ***2.3.3 Sources in WSS Gračanica*** and ***2.13 Priced Bill of Quantities***.

2.9.2.3.2 PROTECTION OF SOURCES IN LOCALWATER SUPPLY SYSTEMS

The reports on sources protection zones are not drafted for the local water supply systems and the sources are mostly protected only at the capture point.

2.9.2.4 WATER BALANCES IN 2010

It is certain that the biggest problem in water supplying the population and industry in Gračanica Municipality is water quantity at the sources, as well as the water quality.

2.9.2.4.1 WATER BALANCE IN WSS GRAČANICA - 2010

The following table shows review of minimum source yield in WSS Gračanica, water needs and water deficite at the sources.

Losses reduction activities in WSS Gračanica provided the positive results, so currently there is no water reduction. However, if we consider the fact that maximum daily water needs are $Q_{max\ dn}$=53,3 l/s and that the source yield minimum is Q_{min}=34,8 l/s, the water deficite at the sources is obviou. This deficite is currently being solved by increased water exploitation at the wells Sklop. In that period the water pumping is increased, which lowers the groundwaters level, even more than it is allowed. Current water deficite in WSS Gračanica is appr.Q=20 l/s.

Table 55: Water balances – sources capacities and water needs in 2010

Water supply system	Needs (maximum daily water quantities) (l/s)	Enabled from the source - Q_{min} (l/s)		Water quantity which is missing during the minimum source yield (l/s)
	2010	Source	2010	2010
Gračanica	53,3	Natural source „Ilidža“	4,5	
		Natural source „Vrela“	4,0	
		Natural source „Škahovica“	1,0	
		Source Hadžijina voda	2,2	
		Natural source „Zmajevac“	0,4	
		Drilled wells „Sklop“ (Sklop II i Sklop III)	17,0	
		Well Soljanuša	5,7	
		Existing sources in total	**34,8**	**18,5**

2.9.2.4.2 WATER BALANCE IN LOCAL WATER SUPPLY SYSTEMS - 2010

Considering the local water supply systems, situation is even harder than in WSS Gračanica. The exception is LC Stjepan Polje with the capacity of Q=20 l/s, so the usage of this well would solve the water quantities problem. Talking about other local communities, the water deficite problem exists. In several local communities this deficite is not that big: Soko, Miričina, Lohinja and Vranovići.

The following table shows review by local communities, regarding water needs and minimum source yield.

Table 56: Water needs and minimum source yield in Gracanica Municipality, 2010

Water supply systems	No. of inhabitants in municipality area 2010	Q_{min} at the sources	Water deficit 2010
	58.926		
	Maximum daily water needs (l/s)	(l/s)	(l/s)
Calculation of required water quantities for town Gračanica and settlement Pribava	53,28	29,80	23,48
Calculation of required water quantities for Soko	8,55	5,00	3,55
Calculation of required water quantities for Škahovica	5,97	1,23	4,73
Calculation of required water quantities for Donju Orahovicu	23,87	4,30	19,57
Calculation of required water quantities for Stjepan Polje	16,13	23,50	-7,37
Calculation of required water quantities for Lukavicu	12,90	2,94	9,97
Calculation of required water quantities for Malešiće	14,11	2,20	11,91
Calculation of required water quantities for Mirićinu	11,11	6,30	4,81
Calculation of required water quantities for Džakule	10,28	0,53	9,75
Calculation of required water quantities for Orahovica Gornja	9,07	1,50	7,57
Calculation of required water quantities for Dobrovci	7,06	2,42	4,64
Calculation of required water quantities for Babići	10,89	0,67	10,22
Calculation of required water quantities for Donja Lohinja	5,31	3,00	2,95
Calculation of required water quantities for Gornja Lohinja	0,64		
Calculation of required water quantities for Vranoviće	4,20	3,27	0,93
Calculation of required water quantities for Piskavica	3,73	0,64	3,09
Calculation of required water quantities for Rašljevu	4,40	0,31	4,09
Calculation of required water quantities for Trnovce	2,97	0,20	2,77
Calculation of required water quantities for Prijeko Brdo	2,72	0,50	2,22
Calculation of required water quantities for Buk	1,51	0,23	1,28
Calculation of required water quantities for Gornje Doborovce	2,98	1,02	1,97
Maximum daily water needs with losses in total	**211,7**	**89,56**	**122,14**

The total water deficit in Gračanica Municipality is currently **Q=122,14 l/s**., of which in local water supply systems is around Q=100 l/s of water.

2.9.2.5 PLANNED WATER NEEDS IN WSS GRAČANICA AND GRAČANICA MUNICIPALITY

Water needs in water supply system depend on specific consumption of population and industry and losses in water supply systems, at the first place.

2.9.2.5.1 SPECIFIC WATER CONSUMPTION

Water consumption is water quantity by certain category of users, or i total, expressed in time utni.

However, water consumption analysis relates to defining the needed water quantities of certain users, i.e:

(1) For house needs (water supplying of population),

(2) For industrial needs,

(3) For fire extinguishing and needs of water utility.

As a basic data while determining the water consumption, the following is used:

(1) Water consumption norm expressed by specific water consumption,

(2) Number of inhabitants.

Specific water consumption, q_{sp} [l/inh./day], we define as water consumption per one inhabitant during one day (24^h).

That water quantity is consisted of consumption for different needs, and it depends on sanitary – technically equipped appartments, population standard, water price and water quality, settlements arrangement, sewerage, climate conditions, etc.

Specific consumption is a basic value for fthe function dimensioning of water supply system.

If it is regularly determined, the designed water supply system will satisfy required needs during it's designed period.

At first place, it is determined based on previous experiance. In most of the countries it is regulated by legal acts in accordance with the settlement's size. Since we don't have those kinds of regulations, only recommandations are used in practice. These values are not completelly reliable, because there are some deviations in some certain cases.

Unfortunatelly, while designing, we still use recommandations made in the analysis 40 – 50 years ago. Also, in those recommandations, the values are given in a big volume, so **the only regular way of determining the specific consumption is using water consumption measurements results**. Population specific consumption decreases in the last few years in the plans, as well. Due to more rational water usage in future, it is considered that the specific consumption will be between 150 and 200 l/inhabitant/day.

In the following text, there is a specific water consumption in WSS Gračanica and in local water supply systems in Gračanica Municipality.

SPECIFIC WATER CONSUMPTION IN WSS GRAČANICA

Specific consumption of population + industry of produced water quantity

Annual water production in WSS Gračanica is **V=1,399,464.89 m^3**. This system supplies 17.507 inhabitants. That means that specific water production is **$q_{spec.}$=209.61 l/capita/dan** (in 2009 ***q_{sp}=224,92 l/capita/day***).

Specific consumption of population + industry

Annual revenue is **V=793,711,00 m^3**. Specific water consumption is **$q_{spec.}$=124.21 l/capita/day** including the industry consumption (in 2009 ***q_{sp}=131,21 l/capita/day***).

Specific consumption of population + industry

If we consider only the consumption of the households **V=634,968.80 m^3/year**, that means that specific consumption of population is **$q_{spec.}$=99.37 l/capita/day** (in 2009 ***q_{sp}=103,86 l/capita/day***). This is relativelly low specific consumption.

Compering specific consumptions in 2009 and 2010, we came to the conclussion that they are almost the same. That, also, shows the accuracy of the measuring in the system.

This shows that almost every water supply system is the same and that a lot of data is needed, especially the measurements to have results more accurate.

In the plans of Gračanica water supply system development, the calculations started with actual specific consumption, specific consumption of population **$q_{spec.}$=99.37 l/capita/day**. Over time, this specific consumption was being increased, so at the end of the planning period 2035 the planned specific consumption of only population is **$q_{spec.}$=150 l/capita/day**. This is the lower limit of specific consumption, which is being planned in European Union countries. Expert estimates that it will be enough for this area.

These conclusions are valid for determining the coefficients in irregularities in water consumption. In planning and hydraulic calculation, it is very important to accurately determine what are the daily and hourly irregularity. As with the specific energy can be used and recommendations from the literature, but the only right way is to use data from measurements of water consumption. To determine the coefficient of daily irregularity, it requires data on consumption and production of water for at least 1 year and daily data. When determining the hourly irregularities, it will require continuous measurements of water consumption in 24 hours. It is desirable to have such measurements for different seasons, whether it's working or not working days, etc.

SPECIFIC WATER CONSUMPTION IN LOCAL WATER SUPPLY SYSTEM IN GRAČANICA MUNICIPALITY

If we take that the minimum water captured at the sources is **Q_{min}=39,76 l/s** then for 30.528 inhabitants specific consumption is **q_{sp}=112,53 l/capita/day**. If we take that this specific consumption includes the industry, as well, with the losses, that means it is very low specific consumption. It is **q_{sp}=60 l/capita/day** if we consider only needs of population and what population actually consumes. This consumption relates to the period when the source yield is at the minimum, i.e. in august and september. These water quantities are, certanly, bigger during the year and in some period when there is enough water at the sources, **q_{sp}=259,45 l/capita/day**.

Due to the lack of water in the systems, we can not calculate the specific consumption at the moment. That is why we are taking the values from WSS Gračanica. At the beggining of the planning period, will take specific consumption of population **$q_{spec.}$=100 l/capita/day** and at the end of the planning period 2035 only consumption ofpopulation is planned, **$q_{spec.}$=150 l/capita/day**.

2.9.2.5.2 PLANNED POPULATION NUMBER IN THE PLANNING PERIOD

Population in areas of water supply depends on local and general socio - economic factors, and it's not constant over time. As pointed out, designing water supply systems are conducted for a project period that usually ranges from 20 to 25 (50) years and where it is mostly assumed population growth. So, the problem boils down to defining the number of inhabitants of the area of water supply for the authorized project period, or for the final stage of development.

This kind of information comes primarily from the spatial plan, and in case it does not exist, or in terms of forecasts of population deems unrealistic, applies to some of the methods of population estimation.

For example, assuming a geometric growth, the population of, N_k, at the end of the project period it is defined by the formula:

whereas:

$$N_k = N_0 \times \left(1 + {}^{p}/_{100}\right)^{R_p}$$

N_o – current population number, [inhabitant],

p – annual growth percent, [%]. This parameter depends on the settlements size, economy development (primarily industry and tourism), migrations, etc.,

R_p – project period, [year].

In the item ***2.2.1.3 Planned population number in Gračanica*** MUNICIPALITY we gave the calculation of population in the planning period 2035. Calculation principle is used for all local communities and results are given for every local community.

During the estimation of the population number for the planning period, we used data from the spatial planning documentation made for Gračanica and Tuzla Canton.

The following table shows population number by local communities with the planned population growth untill 2035.

Table 57: Planned population in the area of Gračanica Municipality

Local community	Perspective number of inhabitants in municipal area						
	2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
	58.926	**60.264**	**62.327**	**65.924**	**69.729**	**73.753**	**78.010**
	Perspective number of inhabitants by local communities						
Gračanica	17.760	18.062	18.525	19.324	20.156	21.025	21.931
Škahovica	1.480	1.495	1.517	1.556	1.595	1.635	1.677
Donja Orahovica	5.500	5.568	5.671	5.848	6.030	6.218	6.411
Stjepan Polje	4.000	4.045	4.114	4.231	4.352	4.476	4.604
Lukavica	3.200	3.344	3.571	3.986	4.449	4.965	5.542
Malešići	3.500	3.578	3.697	3.905	4.125	4.358	4.603
Miričina	2.756	2.837	2.963	3.186	3.426	3.684	3.961
Džakule	2.550	2.627	2.746	2.958	3.185	3.430	3.694
Orahovica Gornja	2.250	2.350	2.509	2.798	3.120	3.480	3.880
Doborovci	1.750	1.901	2.153	2.650	3.260	4.012	4.936
Soko	2.120	2.159	2.219	2.322	2.430	2.544	2.662
Babići	2.700	2.711	2.727	2.754	2.782	2.810	2.838
Pribava	2.300	2.369	2.475	2.664	2.867	3.085	3.320
Donja Lohinja	1.316	1.329	1.349	1.383	1.418	1.454	1.491
Vranovići	1.042	1.052	1.068	1.095	1.123	1.151	1.180
Piskavica	924	933	947	971	996	1.021	1.047
Rašljeva	1.092	1.103	1.120	1.148	1.177	1.207	1.237
Gornja Lohinja	159	161	163	167	171	176	180
Trnovci	737	744	756	775	794	814	835
Prijeko Brdo	675	682	692	710	727	746	765
Buk	375	379	384	394	404	414	425
Gornji Doborovci	740	747	759	778	797	818	838
Inhabitants in total	**58.926**	**60.176**	**62.128**	**65.603**	**69.387**	**73.522**	**78.057**

It is planned that the population would increase at the end of the planning period 2035 from 58.926 to 78.057 inhabitants.

2.9.2.5.3 PLANNING WATER REQUIREMENTS IN GRAČANICA MUNICIPALITY AREA

With the determined specific consumptions, current and planned, population number for the planning period, we can calculate necessary water quantity for water supply systems. Necessary water quantities are calculated from 2010 untill the end of the planning period 2035, in the continuity of 5 years.

Based on the data on **specific water consumption, q_{sp}**, and **population number, N_k**, it is possible to determine **average daily water consumption, Q_{sr}**, by applying the following formula:

$$Q_{sr} = q_{sp} * N_k$$

Average daily water consumption was first calculated only for population. In the previous items with production and consumption of water data, we determined population specific consumption without industry and losses. We separately determined the industry consumption and population specific consumption where, besides population consumption, we included the economy consumption. At the end we, also, determined the population specific consumption where we included all losses, i.e. non-revenue water quantities.

However, it is obvious that for hydraulic dimensioning of water supply systems certain facilities (capacity of the capture facilities and pumps, reservoir volume, water conditioning devices capacity, transport and distribution pipelines dimensions) we, also, need to know the water consumption regime.

Above mentioned depends on the number of factors connected to the life regime and people's proffesions. That is the reason why the water consumption varies, i.e. oscilates (more or less) from previously mentioned values. This fact is more expressed if the period is decreased form year or month to day or hour and in case of a smaller settlement, i.e. less population. In smaller settlements (mostly of suburban or village character) significantly less water is consumed during the night than during the day, and during the day the consumption is bigger during the morning, afternoon and late afternoon hours veća potrošnje u jutarnjim, during the noon and early afternoon hours. In big towns the oscilation is lower, not only during the day, but, also, comparing to the night water consumption.

For dimensioning the certain facilities in the systems, it is necessary to determine the maximum daily water quantities. Water quantity spent annually in the days of the biggest consumption is called the maximum daily water consumption, $Q_{max\ daily}$. This water quantity we get by multiplying the average daily water with daily nonlinearity coefficient.

Nonlinearity coefficient of the biggest daily consumption

Empirical value of this coefficient are in function of the size of settlements and population. There are theoretically assumed values of this coefficient. However, as for the specific consumption, there is no need to take values from the theory if we have measuring in the system. In WSS Gračanica there is enough measuring to calculate this coefficient. According to data on production and consumption of water in 2009, with recorded value of daily water production, the coefficient of daily nonlinearity is determined. Have in mind that this calculation includes the system losses.

Nonlinearity coefficient of the biggest hourly consumption

Water quantity spent annually in the hour of the biggest consumption is called the maximum hourly water consumption. To determine the coefficient of hourly nonlinearity, it is necessary to continuously measure the consumption with mobile flow meters for a period of at least 24 hours. Consumption should, also, be measured for various types of connections - individual housing, collective housing, commercial buildings, etc.

Water consumption for industrial purposes

When determining the water consumption for industrial purposes with only using the literature we should be very cautious, because the water consumption per unit production varies and it is very often different even in the analog companies, since it depends on the type of applied equipment, technological processes and schedules of local conditions.

Therefore, the water consumption in the industry is best determined by the survey of manufacturing technologists, therefore, on the spot (especially on a case by case basis), respecting the specific requirements, because the differences from the normal average values can be multiple.

Also, very often the amount of water needed for the industry must be calculated for each group of firms that set different requirements in terms of water quality. That is why (especially when it comes to large quantities) it is economically unacceptable and water for industrial consumption is conditioned to the required standards for drinking water if the level of quality is required.

In WSS Gračanica there is the accurate measuring of the water consumption in the economy, and it is around 20 % of the total revenue water. Therefore the calculated needs for water consumption of the population in the tables is increased by the amount of water consumed by the economy and thus to reach the average daily consumption of water calculations.

Non-revenue water quantity

To the average water quantity which is calculated in the tables, we, also, added the non-revenue water which is 44,75 %. Our first objective is, certainly, the reduction of this percent to 20 %. This is a very difficult job that requires extensive knowledge, time and resources, but the most effective way to reduce the deficit of water in the system.

During the hydraulic dimensioning of water facilities, the following water quantities are considered:

(1) The highest daily consumption, Q_{max}, for hydraulic dimensioning of:

- Capture facilities – sources capacity,
- Pumping stations (for all water supply systems exept of the pressure ones),
- Water conditioning devices,
- reservoirs,
- main supply pipelines connecting all objects.

(2) The highest hourly consumption, Q_{max}, for hydraulic dimensioning of:

- Pumping stations (pressure systems),
- Main distribution pipelines,
- Main supply – distribution pipelines,
- Distribution network.

However, for measurements of the necessary water quantities in the system, there is maximum daily water consumption. On the other hand, for measurements of the water quantities at the sources, there is minimum daily water consumption.

The tables 53 - 79, show the necessary water estimation in WSS Gračanica, but, also, for the local water supply systems. There is, also, summary review of water requirements.

The ***Table 80:*** shows the review of water requirements through the planning period untill 2035 for Gračanica Municipality, in every settlement.

The following table shows values only for 2010, 2020 2035.

Table 58: Estimation of maximum daily water quantities in the planning period till 2035

Water supply systems	Unit	Perspective no. of inhabitants in municipal area		
		2010	**2020**	**2035**
		58.926	65.442	77.577
		Mazimum daily water needs		
Town WSS Gračanica				
Calculation of required water quantities for town Gračanica and settlement Pribava	**l/s**	**53.28**	**64,16**	**86,01**
Local WSS of Gračanica Municipality				
Calculation of required water quantities for Soko	l/s	8,55	8,06	10,83
Calculation of required water quantities for Škahovica	l/s	5,97	5,40	6,82
Calculation of required water quantities for Donju Orahovicu	l/s	23,87	20,30	26,09
Calculation of required water quantities for Stjepan Polje	l/s	16,13	14,69	18,73

Calculation of required water quantities for Lukavicu	l/s	12,90	13,84	22,55
Calculation of required water quantities for Malešiće	l/s	14,11	13,56	18,73
Calculation of required water quantities for Mirićinu	l/s	11,11	11,06	16,12
Calculation of required water quantities for Džakule	l/s	10,28	10,27	15,03
Calculation of required water quantities for Orahovica Gornja	l/s	9,07	9,72	15,79
Calculation of required water quantities for Dobrovci	l/s	7,06	9,20	20,08
Calculation of required water quantities for Babići	l/s	10,89	9,56	11,55
Calculation of required water quantities for Donja Lohinja	l/s	5,31	4,80	6,07
Calculation of required water quantities for Gornja Lohinja	l/s	0,64	0,58	0,73
Calculation of required water quantities for Vranoviće	l/s	4,20	3,80	4,80
Calculation of required water quantities for Piskavica	l/s	3,73	3,37	4,26
Calculation of required water quantities for Rašljevu	l/s	4,40	3,99	5,03
Calculation of required water quantities for Trnovce	l/s	2,97	2,69	3,40
Calculation of required water quantities for Prijeko Brdo	l/s	2,72	2,46	3,11
Calculation of required water quantities for Buk	l/s	1,51	1,37	1,73
Calculation of required water quantities for Gornje Doborovce	l/s	2,98	2,70	3,41
Local WSS in total:	**l/s**	**158,42**	**151,44**	**214,87**
Maximum daily required water quantities with losses in Gračanica Municipality	**l/s**	**211,7**	**215,61**	**300,88**

Maximum daily required water quantities in WSS Gračanica:

- **2010 $Q_{max\ dn.}$=53,28 l/s**
- **2020 $Q_{max\ dn.}$=64,16 l/s**
- **2035 $Q_{max\ dn.}$=86,01 l/s**

Maximum daily required water quantities in Gračanica Municipality:

- **2010 $Q_{max\ dn.}$=211,70 l/s**
- **2020 $Q_{max\ dn.}$=215,61 l/s**
- **2035 $Q_{max\ dn.}$=300,88 l/s**

Maximum daily required water quantities in local WSS of Gračanica Municipality:

- **2010 $Q_{max\ dn.}$=158,42 l/s**
- **2020 $Q_{max\ dn.}$=151,44 l/s**
- **2035 $Q_{max\ dn.}$=214,87 l/s**

According to the results, we can see that the necessary maximum daily water quantity in 2020 is less than the current needs. The reason for this kind of result is tha plan of reducing non-revenue water from current 45 - 50 % to the acceptable 20 %. So, as the first measure for decreasing the water deficite in the system is, certainly, non-revenue water quantities reduction.

The required water quantities in Gračanica Municipality at the end of the planning period is **$Q_{max\ daily.}$=300,88 l/s.**

According to the **Tuzla Canton Spatial plan** the maximum daily water requirements for 2026 is **$Q_{max\ daily}$=226,0 l/s**. That means that this value comprises with the value obtained in the Study.

Calculating the needs for the town water supply system, we obtained **$Q_{max\ daily}$=86,01 l/s**.

The estimation for water needs in some certain planning period are very sensitive, especially in smaller towns. Based on the current consumption, the economy involvement is around 20 %. However, the construction of a single plant with significant needs for water (this applies particularly to the food industry), this ratio can change significantly. Unfortunately, at this moment one can not assume if there will be such consumers in the system.

Table 59: Estimation of required water quantities for WSS Gračanica

Percentage of population growth: **0,85** **%**

Consumption description	Meausrement unit	Projected population in the system scope						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		20.060	**20.401**	**20.924**	**21.826**	**22.767**	**23.748**	**24.771**
Population connected to the system		**17.507**	**18.361**	**20.924**	**21.826**	**22.767**	**23.748**	**24.771**
Average specific water consumption of the population	l/cap/day	99,37	110	115	120	130	140	150
Percentage of population connected to the system	%	87,27%	90,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	20,14	23,38	27,85	30,31	34,26	38,48	43,01
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	5,03	5,84	6,96	7,58	8,56	9,62	10,75
Total average water consumption of population + economy	**l/s**	**25,17**	**29,22**	**34,81**	**37,89**	**42,82**	**48,10**	**53,76**
Specific consumption of population + economy	l/cap/day	**124,21**	**137,50**	**143,75**	**150,00**	**162,50**	**175,00**	**187,50**
Total daily average water consumption of population + economy	m^3/day	2.175	2.525	3.008	3.274	3.700	4.156	4.645
Total monthly average water consumption population + economy	m^3/ month	66.144	76.792	91.490	99.582	112.530	126.408	141.274
Total average annual water consumption population+ economy	m^3/year	793.727	921.507	1.097.881	1.194.984	1.350.354	1.516.897	1.695.285
Coefficient of seasonal consumption variation of population		1,25	1,25	1,25	1,25	1,25	1,25	1,25
Maximum daily water consumption of the population	l/s	25,26	29,22	34,81	37,89	42,82	48,10	53,76
Coefficient of seasonal variation of economy		1,25	1,25	1,30	1,35	1,40	1,40	1,40
Maximum daily water consumption of economy	l/s	6,31	7,31	9,05	10,23	11,99	13,47	15,05
Total maximum daily water consumption (population+economy)	**l/s**	**31,57**	**36,53**	**43,87**	**48,12**	**54,81**	**61,57**	**68,81**
Total average water losses in the system(non-revenue water amount)	%	40,74	44,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**42,48**	**52,18**	**49,73**	**50,52**	**57,09**	**60,13**	**67,20**
Total of needed average daily water quantity with losses	m^3/month	111.624	137.129	130.700	132.776	150.039	158.010	176.592
Specific water consumption population + economy with losses	l/cap/day	**209,62**	**245,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**53,28**	**65,22**	**62,66**	**64,16**	**73,08**	**76,96**	**86,01**

Table 60: Estimation of required water quantities for LC Donja Orahovica

Percentage of population growth: **0,62** **%**

Consumption description	Measurement unit	Projected population in the system scope						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		5.500	**5.568**	**5.671**	**5.848**	**6.030**	**6.218**	**6.411**
Population connected to the system		**5.500**	**5.568**	**5.671**	**5.848**	**6.030**	**6.218**	**6.411**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	6,37	7,09	7,55	8,12	9,07	10,07	11,13
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	1,59	1,77	1,89	2,03	2,27	2,52	2,78
Total average water consumption of population + economy	**l/s**	**7,96**	**8,86**	**9,44**	**10,15**	**11,34**	**12,59**	**13,91**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**688**	**766**	**815**	**877**	**980**	**1.088**	**1.202**
Total monthly average water consumption population + economy	**m^3/month**	**20.911**	**23.286**	**24.797**	**26.680**	**29.804**	**33.095**	**36.563**
Total average annual water consumption population+ economy	**m^3/year**	**250.938**	**279.437**	**297.562**	**320.165**	**357.643**	**397.144**	**438.758**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	9,55	10,63	11,32	12,18	13,61	15,11	16,70
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	2,39	2,66	2,83	3,05	3,40	3,78	4,17
Total maximum daily water consumption (population+economy)	**l/s**	**11,94**	**13,29**	**14,15**	**15,23**	**17,01**	**18,89**	**20,87**
Total average water losses in the system(non-revenue water amount)	%	50,00	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**15,91**	**13,63**	**13,48**	**13,54**	**15,12**	**15,74**	**17,39**
Total of needed average daily water quantity with losses	m^3/month	41.823	35.825	35.424	35.574	39.738	41.369	45.704
Specific water consumption population + economy with losses	l/cap/day	**250,00**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**23,87**	**20,45**	**20,22**	**20,30**	**22,68**	**23,61**	**26,09**

Table 61: Estimation of required water quantities for LC Stjepan Polje

Percentage of population growth: **0,56** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		4.000	**4.045**	**4.114**	**4.231**	**4.352**	**4.476**	**4.604**
Population connected to the system		**4.000**	**4.045**	**4.114**	**4.231**	**4.352**	**4.476**	**4.604**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	4,63	5,15	5,48	5,88	6,55	7,25	7,99
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	1,16	1,29	1,37	1,47	1,64	1,81	2,00
Total average water consumption of population + economy	**l/s**	**5,79**	**6,44**	**6,84**	**7,35**	**8,19**	**9,07**	**9,99**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**500**	**556**	**591**	**635**	**707**	**783**	**863**
Total monthly average water consumption population + economy	**m^3/month**	**15.208**	**16.918**	**17.988**	**19.306**	**21.511**	**23.827**	**26.256**
Total average annual water consumption population+ economy	**m^3/year**	**182.500**	**203.021**	**215.861**	**231.670**	**258.133**	**285.918**	**315.078**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	6,94	7,73	8,21	8,82	9,82	10,88	11,99
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	1,74	1,93	2,05	2,20	2,46	2,72	3,00
Total maximum daily water consumption (population+economy)	**l/s**	**8,68**	**9,66**	**10,27**	**11,02**	**12,28**	**13,60**	**14,99**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**10,75**	**9,90**	**9,78**	**9,79**	**10,91**	**11,33**	**12,49**
Total of needed average daily water quantity with losses	m^3/month	28.260	26.028	25.698	25.741	28.681	29.783	32.821
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**16,13**	**14,86**	**14,67**	**14,69**	**16,37**	**17,00**	**18,73**

Table 62: Estimation of required water quantities for LC Lukavica

Percentage of population growth: **2,22** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		3.200	**3.344**	**3.571**	**3.986**	**4.449**	**4.965**	**5.542**
Population connected to the system		**3.200**	**3.344**	**3.571**	**3.986**	**4.449**	**4.965**	**5.542**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	3,70	4,26	4,75	5,54	6,69	8,05	9,62
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,93	1,06	1,19	1,38	1,67	2,01	2,41
Total average water consumption of population + economy	**l/s**	**4,63**	**5,32**	**5,94**	**6,92**	**8,37**	**10,06**	**12,03**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**400**	**460**	**513**	**598**	**723**	**869**	**1.039**
Total monthly average water consumption population + economy	**m^3/month**	**12.167**	**13.984**	**15.616**	**18.187**	**21.990**	**26.430**	**31.606**
Total average annual water consumption population+ economy	**m^3/year**	**146.000**	**167.813**	**187.392**	**218.241**	**263.875**	**317.164**	**379.269**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	5,56	6,39	7,13	8,30	10,04	12,07	14,43
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	1,39	1,60	1,78	2,08	2,51	3,02	3,61
Total maximum daily water consumption (population+economy)	**l/s**	**6,94**	**7,98**	**8,91**	**10,38**	**12,55**	**15,09**	**18,04**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**8,60**	**8,19**	**8,49**	**9,23**	**11,16**	**12,57**	**15,03**
Total of needed average daily water quantity with losses	m^3/month	22.608	21.514	22.309	24.249	29.319	33.038	39.507
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**12,90**	**12,28**	**12,73**	**13,84**	**16,73**	**18,86**	**22,55**

Table 63: Estimation of required water quantities for LC Malešić

Percentage of population growth: **1,10** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		3.500	**3.578**	**3.697**	**3.905**	**4.125**	**4.358**	**4.603**
Population connected to the system		**3.500**	**3.578**	**3.697**	**3.905**	**4.125**	**4.358**	**4.603**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	4,05	4,55	4,92	5,42	6,21	7,06	7,99
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	1,01	1,14	1,23	1,36	1,55	1,77	2,00
Total average water consumption of population + economy	**l/s**	**5,06**	**5,69**	**6,15**	**6,78**	**7,76**	**8,83**	**9,99**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**438**	**492**	**531**	**586**	**670**	**763**	**863**
Total monthly average water consumption population + economy	**m^3/month**	**13.307**	**14.962**	**16.165**	**17.818**	**20.391**	**23.196**	**26.253**
Total average annual water consumption population+ economy	**m^3/year**	**159.688**	**179.549**	**193.985**	**213.821**	**244.687**	**278.352**	**315.033**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	6,08	6,83	7,38	8,14	9,31	10,59	11,99
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	1,52	1,71	1,85	2,03	2,33	2,65	3,00
Total maximum daily water consumption (population+economy)	**l/s**	**7,60**	**8,54**	**9,23**	**10,17**	**11,64**	**13,24**	**14,98**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**9,41**	**8,76**	**8,79**	**9,04**	**10,35**	**11,03**	**12,49**
Total of needed average daily water quantity with losses	m^3/month	24.727	23.019	23.093	23.758	27.187	28.995	32.816
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**14,11**	**13,14**	**13,18**	**13,56**	**15,52**	**16,55**	**18,73**

Table 64: Estimation of required water quantities for LC Mirićina

Percentage of population growth: **1,46** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		2.756	**2.837**	**2.963**	**3.186**	**3.426**	**3.684**	**3.961**
Population connected to the system		**2.756**	**2.837**	**2.963**	**3.186**	**3.426**	**3.684**	**3.961**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	3,19	3,61	3,94	4,43	5,15	5,97	6,88
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,80	0,90	0,99	1,11	1,29	1,49	1,72
Total average water consumption of population + economy	**l/s**	**3,99**	**4,52**	**4,93**	**5,53**	**6,44**	**7,46**	**8,59**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**345**	**390**	**426**	**478**	**557**	**645**	**743**
Total monthly average water consumption population + economy	**m^3/month**	**10.479**	**11.866**	**12.957**	**14.537**	**16.933**	**19.607**	**22.588**
Total average annual water consumption population+ economy	**m^3/year**	**125.743**	**142.388**	**155.480**	**174.443**	**203.195**	**235.284**	**271.051**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	4,78	5,42	5,92	6,64	7,73	8,95	10,31
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	1,20	1,35	1,48	1,66	1,93	2,24	2,58
Total maximum daily water consumption (population+economy)	**l/s**	**5,98**	**6,77**	**7,40**	**8,30**	**9,66**	**11,19**	**12,89**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**7,41**	**6,95**	**7,04**	**7,38**	**8,59**	**9,33**	**10,74**
Total of needed average daily water quantity with losses	m^3/month	19.471	18.255	18.510	19.383	22.577	24.509	28.235
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**11,11**	**10,42**	**10,56**	**11,06**	**12,89**	**13,99**	**16,12**

Table 65: Estimation of required water quantities for LC Džakule

Percentage of population growth: **1,49** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		2.550	**2.627**	**2.746**	**2.958**	**3.185**	**3.430**	**3.694**
Population connected to the system		**2.550**	**2.627**	**2.746**	**2.958**	**3.185**	**3.430**	**3.694**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	2,95	3,34	3,66	4,11	4,79	5,56	6,41
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,74	0,84	0,91	1,03	1,20	1,39	1,60
Total average water consumption of population + economy	**l/s**	**3,69**	**4,18**	**4,57**	**5,13**	**5,99**	**6,95**	**8,02**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**319**	**361**	**395**	**444**	**518**	**600**	**693**
Total monthly average water consumption population + economy	**m^3/month**	**9.695**	**10.986**	**12.008**	**13.494**	**15.744**	**18.260**	**21.070**
Total average annual water consumption population+ economy	**m^3/year**	**116.344**	**131.831**	**144.093**	**161.930**	**188.926**	**219.118**	**252.839**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	4,43	5,02	5,48	6,16	7,19	8,34	9,62
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	1,11	1,25	1,37	1,54	1,80	2,08	2,41
Total maximum daily water consumption (population+economy)	**l/s**	**5,53**	**6,27**	**6,85**	**7,70**	**8,99**	**10,42**	**12,03**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**6,86**	**6,43**	**6,53**	**6,85**	**7,99**	**8,69**	**10,02**
Total of needed average daily water quantity with losses	m^3/month	18.016	16.901	17.154	17.992	20.992	22.825	26.337
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**10,28**	**9,65**	**9,79**	**10,27**	**11,98**	**13,03**	**15,03**

Table 66: Estimation of required water quantities for LC Orahovica Gornja

Percentage of population growth: **2,20** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		2.250	**2.350**	**2.509**	**2.798**	**3.120**	**3.480**	**3.880**
Population connected to the system		**2.250**	**2.350**	**2.509**	**2.798**	**3.120**	**3.480**	**3.880**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	2,60	2,99	3,34	3,89	4,69	5,64	6,74
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,65	0,75	0,83	0,97	1,17	1,41	1,68
Total average water consumption of population + economy	**l/s**	**3,26**	**3,74**	**4,17**	**4,86**	**5,87**	**7,05**	**8,42**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**281**	**323**	**361**	**420**	**507**	**609**	**728**
Total monthly average water consumption population + economy	**m^3/month**	**8.555**	**9.830**	**10.971**	**12.766**	**15.423**	**18.522**	**22.131**
Total average annual water consumption population+ economy	**m^3/year**	**102.656**	**117.954**	**131.651**	**153.195**	**185.075**	**222.265**	**265.567**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	3,91	4,49	5,01	5,83	7,04	8,46	10,11
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,98	1,12	1,25	1,46	1,76	2,11	2,53
Total maximum daily water consumption (population+economy)	**l/s**	**4,88**	**5,61**	**6,26**	**7,29**	**8,80**	**10,57**	**12,63**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**6,05**	**5,75**	**5,96**	**6,48**	**7,82**	**8,81**	**10,53**
Total of needed average daily water quantity with losses	m^3/month	15.896	15.122	15.673	17.022	20.564	23.153	27.663
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**9,07**	**8,63**	**8,95**	**9,72**	**11,74**	**13,21**	**15,79**

Table 67: Estimation of required water quantities for LC Doborovci

Percentage of population growth: **4,24 %**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	2012	2015	2020	2025	2030	2035
		1.750	1.901	2.153	2.650	3.260	4.012	4.936
Population connected to the system		**1.750**	**1.901**	**2.153**	**2.650**	**3.260**	**4.012**	**4.936**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	2,03	2,42	2,87	3,68	4,91	6,50	8,57
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,51	0,61	0,72	0,92	1,23	1,63	2,14
Total average water consumption of population + economy	**l/s**	**2,53**	**3,03**	**3,58**	**4,60**	**6,13**	**8,13**	**10,71**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**219**	**261**	**310**	**397**	**530**	**702**	**926**
Total monthly average water consumption population + economy	**m^3/month**	**6.654**	**7.952**	**9.415**	**12.089**	**16.114**	**21.353**	**28.151**
Total average annual water consumption population+ economy	**m^3/year**	**79.844**	**95.425**	**112.981**	**145.063**	**193.369**	**256.236**	**337.809**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	3,04	3,63	4,30	5,52	7,36	9,75	12,85
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,76	0,91	1,07	1,38	1,84	2,44	3,21
Total maximum daily water consumption (population+economy)	**l/s**	**3,80**	**4,54**	**5,37**	**6,90**	**9,20**	**12,19**	**16,07**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**4,70**	**4,66**	**5,12**	**6,13**	**8,18**	**10,16**	**13,39**
Total of needed average daily water quantity with losses	m^3/month	12.364	12.234	13.450	16.118	21.485	26.691	35.188
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**7,06**	**6,98**	**7,68**	**9,20**	**12,26**	**15,23**	**20,08**

Table 68: Estimation of required water quantities for LC Soko

Percentage of population growth: **0,92 %**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		2.120	**2.159**	**2.219**	**2.322**	**2.430**	**2.544**	**2.662**
Population connected to the system		**2.120**	**2.159**	**2.219**	**2.322**	**2.430**	**2.544**	**2.662**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	2,45	2,75	2,95	3,23	3,66	4,12	4,62
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,61	0,69	0,74	0,81	0,91	1,03	1,16
Total average water consumption of population + economy	**l/s**	**3,07**	**3,44**	**3,69**	**4,03**	**4,57**	**5,15**	**5,78**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**265**	**297**	**319**	**348**	**395**	**445**	**499**
Total monthly average water consumption population + economy	**m^3/month**	**8.060**	**9.029**	**9.701**	**10.595**	**12.013**	**13.539**	**15.182**
Total average annual water consumption population+ economy	**m^3/year**	**96.725**	**108.353**	**116.417**	**127.139**	**144.151**	**162.473**	**182.189**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	3,68	4,12	4,43	4,84	5,49	6,18	6,93
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,92	1,03	1,11	1,21	1,37	1,55	1,73
Total maximum daily water consumption (population+economy)	**l/s**	**4,60**	**5,15**	**5,54**	**6,05**	**6,86**	**7,73**	**8,67**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**5,70**	**5,29**	**5,27**	**5,38**	**6,09**	**6,44**	**7,22**
Total of needed average daily water quantity with losses	m^3/month	14.978	13.891	13.859	14.127	16.017	16.924	18.978
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**8,55**	**7,93**	**7,91**	**8,06**	**9,14**	**9,66**	**10,83**

Table 69: Estimation of required water quantities for LC Babići

Percentage of population growth: **0,20 %**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		2.700	**2.711**	**2.727**	**2.754**	**2.782**	**2.810**	**2.838**
Population connected to the system		**2.700**	**2.711**	**2.727**	**2.754**	**2.782**	**2.810**	**2.838**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	3,13	3,45	3,63	3,83	4,19	4,55	4,93
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,78	0,86	0,91	0,96	1,05	1,14	1,23
Total average water consumption of population + economy	**l/s**	**3,91**	**4,31**	**4,54**	**4,78**	**5,23**	**5,69**	**6,16**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**338**	**373**	**392**	**413**	**452**	**492**	**532**
Total monthly average water consumption population + economy	**m^3/month**	**10.266**	**11.337**	**11.924**	**12.567**	**13.751**	**14.958**	**16.187**
Total average annual water consumption population+ economy	**m^3/year**	**123.188**	**136.049**	**143.088**	**150.808**	**165.016**	**179.494**	**194.245**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	4,69	5,18	5,44	5,74	6,28	6,83	7,39
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	1,17	1,29	1,36	1,43	1,57	1,71	1,85
Total maximum daily water consumption (population+economy)	**l/s**	**5,86**	**6,47**	**6,81**	**7,17**	**7,85**	**8,54**	**9,24**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**7,26**	**6,64**	**6,48**	**6,38**	**6,98**	**7,11**	**7,70**
Total of needed average daily water quantity with losses	m^3/month	19.075	17.442	17.034	16.756	18.335	18.697	20.234
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**10,89**	**9,96**	**9,72**	**9,56**	**10,47**	**10,67**	**11,55**

Table 70: Estimation of required water quantities for LC Škahovica

Percentage of population growth: **0,50** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		1.480	**1.495**	**1.517**	**1.556**	**1.595**	**1.635**	**1.677**
Population connected to the system		**1.480**	**1.495**	**1.517**	**1.556**	**1.595**	**1.635**	**1.677**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	1,71	1,90	2,02	2,16	2,40	2,65	2,91
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,43	0,48	0,50	0,54	0,60	0,66	0,73
Total average water consumption of population + economy	**l/s**	**2,14**	**2,38**	**2,52**	**2,70**	**3,00**	**3,31**	**3,64**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**185**	**206**	**218**	**233**	**259**	**286**	**314**
Total monthly average water consumption population + economy	**m^3/month**	**5.627**	**6.252**	**6.635**	**7.098**	**7.883**	**8.704**	**9.562**
Total average annual water consumption population+ economy	**m^3/year**	**67.525**	**75.022**	**79.615**	**85.174**	**94.602**	**104.451**	**114.738**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	2,57	2,85	3,03	3,24	3,60	3,97	4,37
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,64	0,71	0,76	0,81	0,90	0,99	1,09
Total maximum daily water consumption (population+economy)	**l/s**	**3,21**	**3,57**	**3,79**	**4,05**	**4,50**	**4,97**	**5,46**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**3,98**	**3,66**	**3,61**	**3,60**	**4,00**	**4,14**	**4,55**
Total of needed average daily water quantity with losses	m^3/month	10.456	9.618	9.478	9.464	10.511	10.880	11.952
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**5,97**	**5,49**	**5,41**	**5,40**	**6,00**	**6,21**	**6,82**

Table 71: Estimation of required water quantities for LC Donja Lohinja

Percentage of population growth: **0,50** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	2012	2015	2020	2025	2030	2035
		1.316	1.329	1.349	1.383	1.418	1.454	1.491
Population connected to the system		1.316	1.329	1.349	1.383	1.418	1.454	1.491
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	1,52	1,69	1,80	1,92	2,13	2,36	2,59
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,38	0,42	0,45	0,48	0,53	0,59	0,65
Total average water consumption of population + economy	**l/s**	**1,90**	**2,12**	**2,24**	**2,40**	**2,67**	**2,95**	**3,24**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**165**	**183**	**194**	**207**	**230**	**254**	**280**
Total monthly average water consumption population + economy	**m^3/month**	**5.004**	**5.559**	**5.899**	**6.311**	**7.010**	**7.740**	**8.502**
Total average annual water consumption population+ economy	**m^3/year**	**60.043**	**66.709**	**70.792**	**75.736**	**84.119**	**92.877**	**102.024**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	2,28	2,54	2,69	2,88	3,20	3,53	3,88
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,57	0,63	0,67	0,72	0,80	0,88	0,97
Total maximum daily water consumption (population+economy)	**l/s**	**2,86**	**3,17**	**3,37**	**3,60**	**4,00**	**4,42**	**4,85**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**3,54**	**3,25**	**3,21**	**3,20**	**3,56**	**3,68**	**4,04**
Total of needed average daily water quantity with losses	m^3/month	9.297	8.552	8.428	8.415	9.347	9.675	10.627
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**5,31**	**4,88**	**4,81**	**4,80**	**5,33**	**5,52**	**6,07**

Table 72: Estimation of required water quantities for LC Vranovići

Percentage of population growth: **0,50** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	2012	2015	2020	2025	2030	2035
		1.042	**1.052**	**1.068**	**1.095**	**1.123**	**1.151**	**1.180**
Population connected to the system		**1.042**	**1.052**	**1.068**	**1.095**	**1.123**	**1.151**	**1.180**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	1,21	1,34	1,42	1,52	1,69	1,87	2,05
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,30	0,33	0,36	0,38	0,42	0,47	0,51
Total average water consumption of population + economy	**l/s**	**1,51**	**1,67**	**1,78**	**1,90**	**2,11**	**2,33**	**2,56**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**130**	**145**	**154**	**164**	**182**	**201**	**221**
Total monthly average water consumption population + economy	**m^3/month**	**3.962**	**4.402**	**4.671**	**4.997**	**5.550**	**6.128**	**6.732**
Total average annual water consumption population+ economy	**m^3/year**	**47.541**	**52.820**	**56.053**	**59.967**	**66.605**	**73.539**	**80.782**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	1,81	2,01	2,13	2,28	2,53	2,80	3,07
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,45	0,50	0,53	0,57	0,63	0,70	0,77
Total maximum daily water consumption (population+economy)	**l/s**	**2,26**	**2,51**	**2,67**	**2,85**	**3,17**	**3,50**	**3,84**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**2,80**	**2,58**	**2,54**	**2,54**	**2,82**	**2,91**	**3,20**
Total of needed average daily water quantity with losses	m^3/month	7.362	6.772	6.673	6.663	7.401	7.660	8.415
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**4,20**	**3,87**	**3,81**	**3,80**	**4,22**	**4,37**	**4,80**

Table 73: Estimation of required water quantities for LC Piskavica

Percentage of population growth: **0,50** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		924	**933**	**947**	**971**	**996**	**1.021**	**1.047**
Population connected to the system		**924**	**933**	**947**	**971**	**996**	**1.021**	**1.047**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	1,07	1,19	1,26	1,35	1,50	1,65	1,82
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,27	0,30	0,32	0,34	0,37	0,41	0,45
Total average water consumption of population + economy	**l/s**	**1,34**	**1,49**	**1,58**	**1,69**	**1,87**	**2,07**	**2,27**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**116**	**128**	**136**	**146**	**162**	**179**	**196**
Total monthly average water consumption population + economy	**m^3/month**	**3.513**	**3.903**	**4.142**	**4.431**	**4.922**	**5.434**	**5.969**
Total average annual water consumption population+ economy	**m^3/year**	**42.158**	**46.838**	**49.705**	**53.176**	**59.062**	**65.211**	**71.634**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	1,60	1,78	1,89	2,02	2,25	2,48	2,73
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,40	0,45	0,47	0,51	0,56	0,62	0,68
Total maximum daily water consumption (population+economy)	**l/s**	**2,01**	**2,23**	**2,36**	**2,53**	**2,81**	**3,10**	**3,41**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**2,48**	**2,28**	**2,25**	**2,25**	**2,50**	**2,58**	**2,84**
Total of needed average daily water quantity with losses	m^3/month	6.528	6.005	5.917	5.908	6.562	6.793	7.462
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**3,73**	**3,43**	**3,38**	**3,37**	**3,75**	**3,88**	**4,26**

Table 74: Estimation of required water quantities for LC Rašljeva

Percentage of population growth: **0,50 %**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		1.092	**1.103**	**1.120**	**1.148**	**1.177**	**1.207**	**1.237**
Population connected to the system		**1.092**	**1.103**	**1.120**	**1.148**	**1.177**	**1.207**	**1.237**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	1,26	1,40	1,49	1,59	1,77	1,96	2,15
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,32	0,35	0,37	0,40	0,44	0,49	0,54
Total average water consumption of population + economy	**l/s**	**1,58**	**1,76**	**1,86**	**1,99**	**2,21**	**2,44**	**2,68**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**137**	**152**	**161**	**172**	**191**	**211**	**232**
Total monthly average water consumption population + economy	**m^3/month**	**4.152**	**4.613**	**4.895**	**5.237**	**5.817**	**6.422**	**7.055**
Total average annual water consumption population+ economy	**m^3/year**	**49.823**	**55.354**	**58.743**	**62.845**	**69.801**	**77.068**	**84.658**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	1,90	2,11	2,24	2,39	2,66	2,93	3,22
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,47	0,53	0,56	0,60	0,66	0,73	0,81
Total maximum daily water consumption (population+economy)	**l/s**	**2,37**	**2,63**	**2,79**	**2,99**	**3,32**	**3,67**	**4,03**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**2,94**	**2,70**	**2,66**	**2,66**	**2,95**	**3,05**	**3,36**
Total of needed average daily water quantity with losses	m^3/month	7.715	7.097	6.993	6.983	7.756	8.028	8.819
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**4,40**	**4,05**	**3,99**	**3,99**	**4,43**	**4,58**	**5,03**

Table 75: Estimation of required water quantities for LC Gornja Lohinja

Percentage of population growth: **0,50 %**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	2012	2015	2020	2025	2030	2035
		159	161	163	167	171	176	180
Population connected to the system		**159**	**161**	**163**	**167**	**171**	**176**	**180**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	0,18	0,20	0,22	0,23	0,26	0,28	0,31
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,05	0,05	0,05	0,06	0,06	0,07	0,08
Total average water consumption of population + economy	**l/s**	**0,23**	**0,26**	**0,27**	**0,29**	**0,32**	**0,36**	**0,39**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**20**	**22**	**23**	**25**	**28**	**31**	**34**
Total monthly average water consumption population + economy	**m^3/month**	**605**	**672**	**713**	**763**	**847**	**935**	**1.027**
Total average annual water consumption population+ economy	**m^3/year**	**7.254**	**8.060**	**8.553**	**9.150**	**10.163**	**11.221**	**12.327**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	0,28	0,31	0,33	0,35	0,39	0,43	0,47
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,07	0,08	0,08	0,09	0,10	0,11	0,12
Total maximum daily water consumption (population+economy)	**l/s**	**0,35**	**0,38**	**0,41**	**0,44**	**0,48**	**0,53**	**0,59**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**0,43**	**0,39**	**0,39**	**0,39**	**0,43**	**0,44**	**0,49**
Total of needed average daily water quantity with losses	m^3/month	1.123	1.033	1.018	1.017	1.129	1.169	1.284
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**0,64**	**0,59**	**0,58**	**0,58**	**0,64**	**0,67**	**0,73**

Table 76: Estimation of required water quantities for LC Trnovci

Percentage of population growth: **0,50 %**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	2012	2015	2020	2025	2030	2035
		737	744	756	775	794	814	835
Population connected to the system		737	744	756	775	794	814	835
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	0,85	0,95	1,01	1,08	1,20	1,32	1,45
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,21	0,24	0,25	0,27	0,30	0,33	0,36
Total average water consumption of population + economy	**l/s**	**1,07**	**1,18**	**1,26**	**1,34**	**1,49**	**1,65**	**1,81**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**92**	**102**	**109**	**116**	**129**	**143**	**157**
Total monthly average water consumption population + economy	**m^3/month**	**2.802**	**3.113**	**3.304**	**3.535**	**3.926**	**4.334**	**4.761**
Total average annual water consumption population+ economy	**m^3/year**	**33.626**	**37.359**	**39.646**	**42.414**	**47.109**	**52.014**	**57.136**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	1,28	1,42	1,51	1,61	1,79	1,98	2,17
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,32	0,36	0,38	0,40	0,45	0,49	0,54
Total maximum daily water consumption (population+economy)	**l/s**	**1,60**	**1,78**	**1,89**	**2,02**	**2,24**	**2,47**	**2,72**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**1,98**	**1,82**	**1,80**	**1,79**	**1,99**	**2,06**	**2,26**
Total of needed average daily water quantity with losses	m^3/month	5.207	4.790	4.720	4.713	5.234	5.418	5.952
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**2,97**	**2,73**	**2,69**	**2,69**	**2,99**	**3,09**	**3,40**

Table 77: : Estimation of required water quantities for LC Prijeko Brdo

Percentage of population growth: **0,50 %**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		675	**682**	**692**	**710**	**727**	**746**	**765**
Population connected to the system		**675**	**682**	**692**	**710**	**727**	**746**	**765**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	0,78	0,87	0,92	0,99	1,09	1,21	1,33
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,20	0,22	0,23	0,25	0,27	0,30	0,33
Total average water consumption of population + economy	**l/s**	**0,98**	**1,08**	**1,15**	**1,23**	**1,37**	**1,51**	**1,66**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**84**	**94**	**99**	**106**	**118**	**131**	**143**
Total monthly average water consumption population + economy	**m^3/month**	**2.566**	**2.851**	**3.026**	**3.237**	**3.596**	**3.970**	**4.361**
Total average annual water consumption population+ economy	**m^3/year**	**30.797**	**34.216**	**36.311**	**38.846**	**43.146**	**47.638**	**52.330**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	1,17	1,30	1,38	1,48	1,64	1,81	1,99
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,29	0,33	0,35	0,37	0,41	0,45	0,50
Total maximum daily water consumption (population+economy)	**l/s**	**1,46**	**1,63**	**1,73**	**1,85**	**2,05**	**2,27**	**2,49**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**1,81**	**1,67**	**1,64**	**1,64**	**1,82**	**1,89**	**2,07**
Total of needed average daily water quantity with losses	m^3/month	4.769	4.387	4.323	4.316	4.794	4.962	5.451
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**2,72**	**2,50**	**2,47**	**2,46**	**2,74**	**2,83**	**3,11**

Table 78: Estimation of required water quantities for LC Buk

Percentage of population growth: **0,50** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	2012	2015	2020	2025	2030	2035
		375	379	384	394	404	414	425
Population connected to the system		**375**	**379**	**384**	**394**	**404**	**414**	**425**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	0,43	0,48	0,51	0,55	0,61	0,67	0,74
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,11	0,12	0,13	0,14	0,15	0,17	0,18
Total average water consumption of population + economy	**l/s**	**0,54**	**0,60**	**0,64**	**0,68**	**0,76**	**0,84**	**0,92**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**47**	**52**	**55**	**59**	**66**	**73**	**80**
Total monthly average water consumption population + economy	**m^3/month**	**1.426**	**1.584**	**1.681**	**1.798**	**1.998**	**2.205**	**2.423**
Total average annual water consumption population+ economy	**m^3/year**	**17.109**	**19.009**	**20.173**	**21.581**	**23.970**	**26.466**	**29.072**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	0,65	0,72	0,77	0,82	0,91	1,01	1,11
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,16	0,18	0,19	0,21	0,23	0,25	0,28
Total maximum daily water consumption (population+economy)	**l/s**	**0,81**	**0,90**	**0,96**	**1,03**	**1,14**	**1,26**	**1,38**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**1,01**	**0,93**	**0,91**	**0,91**	**1,01**	**1,05**	**1,15**
Total of needed average daily water quantity with losses	m^3/month	2.649	2.437	2.402	2.398	2.663	2.757	3.028
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**1,51**	**1,39**	**1,37**	**1,37**	**1,52**	**1,57**	**1,73**

Table 79: Estimation of required water quantities for LC Gornji Doborovci

Percentage of population growth: **0,50** **%**

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		740	**747**	**759**	**778**	**797**	**818**	**838**
Population connected to the system		**740**	**747**	**759**	**778**	**797**	**818**	**838**
Average specific water consumption of the population	l/cap/day	100	110	115	120	130	140	150
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	0,86	0,95	1,01	1,08	1,20	1,32	1,46
Share of economy in water consumption	%	20,00	20,00	20,00	20,00	20,00	20,00	20,00
Average water consumption of economy	l/s	0,21	0,24	0,25	0,27	0,30	0,33	0,36
Total average water consumption of population + economy	**l/s**	**1,07**	**1,19**	**1,26**	**1,35**	**1,50**	**1,66**	**1,82**
Specific consumption of population + economy	l/cap/day	**125,00**	**168,70**	**144,60**	**120,50**	**120,50**	**96,40**	**96,40**
Total daily average water consumption of population + economy	**m^3/day**	**93**	**103**	**109**	**117**	**130**	**143**	**157**
Total monthly average water consumption population + economy	**m^3/month**	**2.814**	**3.126**	**3.317**	**3.549**	**3.942**	**4.352**	**4.781**
Total average annual water consumption population+ economy	**m^3/year**	**33.763**	**37.511**	**39.807**	**42.587**	**47.301**	**52.226**	**57.369**
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	1,28	1,43	1,51	1,62	1,80	1,99	2,18
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	0,32	0,36	0,38	0,41	0,45	0,50	0,55
Total maximum daily water consumption (population+economy)	**l/s**	**1,61**	**1,78**	**1,89**	**2,03**	**2,25**	**2,48**	**2,73**
Total average water losses in the system(non-revenue water amount)	%	46,18	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**1,99**	**1,83**	**1,80**	**1,80**	**2,00**	**2,07**	**2,27**
Total of needed average daily water quantity with losses	m^3/month	5.228	4.809	4.739	4.732	5.256	5.440	5.976
Specific water consumption population + economy with losses	l/cap/day	**232,27**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**2,98**	**2,74**	**2,70**	**2,70**	**3,00**	**3,11**	**3,41**

Table 80: Estimation of required water quantities for Gračanica Municipality

Water supply systems	Measurement unit	Projected population number in the municipal area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		58.926	60.147	62.052	65.442	69.130	73.159	77.577
		Maximum daily water needs						
Estimation of required water quantities for town Gračanica and settlement Pribava	l/s	53,28	65,22	62,66	64,16	73,08	76,96	86,01
Estimation of required water quantities for Soko	l/s	8,55	7,93	7,91	8,06	9,14	9,66	10,83
Estimation of required water quantities for Škahovica	l/s	5,97	5,49	5,41	5,40	6,00	6,21	6,82
Estimation of required water quantities for Donju Orahovicu	l/s	23,87	20,45	20,22	20,30	22,68	23,61	26,09
Estimation of required water quantities for Stjepan Polje	l/s	16,13	14,86	14,67	14,69	16,37	17,00	18,73
Estimation of required water quantities for Lukavicu	l/s	12,90	12,28	12,73	13,84	16,73	18,86	22,55
Estimation of required water quantities for Malešiće	l/s	14,11	13,14	13,18	13,56	15,52	16,55	18,73
Estimation of required water quantities for Mirićinu	l/s	11,11	10,42	10,56	11,06	12,89	13,99	16,12
Estimation of required water quantities for Džakule	l/s	10,28	9,65	9,79	10,27	11,98	13,03	15,03
Estimation of required water quantities for Orahovica Gornja	l/s	9,07	8,63	8,95	9,72	11,74	13,21	15,79
Estimation of required water quantities for Dobrovci	l/s	7,06	6,98	7,68	9,20	12,26	15,23	20,08
Estimation of required water quantities for Babići	l/s	10,89	9,96	9,72	9,56	10,47	10,67	11,55
Estimation of required water quantities for za Donja Lohinja	l/s	5,31	4,88	4,81	4,80	5,33	5,52	6,07
Estimation of required water quantities for Gornja Lohinja	l/s	0,64	0,59	0,58	0,58	0,64	0,67	0,73
Estimation of required water quantities for Vranoviće	l/s	4,20	3,87	3,81	3,80	4,22	4,37	4,80
Estimation of required water quantities for Piskavica	l/s	3,73	3,43	3,38	3,37	3,75	3,88	4,26
Estimation of required water quantities for Rašljevu	l/s	4,40	4,05	3,99	3,99	4,43	4,58	5,03
Estimation of required water quantities for Trnovce	l/s	2,97	2,73	2,69	2,69	2,99	3,09	3,40
Estimation of required water quantities for Prijeko Brdo	l/s	2,72	2,50	2,47	2,46	2,74	2,83	3,11
Estimation of required water quantities for Buk	l/s	1,51	1,39	1,37	1,37	1,52	1,57	1,73
Estimation of required water quantities for Gornje Doborovce	l/s	2,98	2,74	2,70	2,70	3,00	3,11	3,41
Required daily maximum water quantities with losses in total	**l/s**	**211,70**	**211,19**	**209,29**	**215,61**	**247,48**	**264,61**	**300,88**

Table 81: Projected population number in Gračanica Municipality area

Local community	Projected population number in the municipal area						
	2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
	58.926	**60.237**	**62.257**	**65.777**	**69.496**	**73.425**	**77.577**
	Projected population number in local communities						
Gračanica	17.760	18.062	18.525	19.324	20.156	21.025	21.931
Škahovica	1.480	1.495	1.517	1.556	1.595	1.635	1.677
Donja Orahovica	5.500	5.568	5.671	5.848	6.030	6.218	6.411
Stjepan Polje	4.000	4.045	4.114	4.231	4.352	4.476	4.604
Lukavica	3.200	3.344	3.571	3.986	4.449	4.965	5.542
Malešići	3.500	3.578	3.697	3.905	4.125	4.358	4.603
Miričina	2.756	2.837	2.963	3.186	3.426	3.684	3.961
Džakule	2.550	2.627	2.746	2.958	3.185	3.430	3.694
Orahovica Gornja	2.250	2.350	2.509	2.798	3.120	3.480	3.880
Doborovci	1.750	1.901	2.153	2.650	3.260	4.012	4.936
Soko	2.120	2.159	2.219	2.322	2.430	2.544	2.662
Babići	2.700	2.711	2.727	2.754	2.782	2.810	2.838
Pribava	2.300	2.339	2.399	2.503	2.611	2.724	2.842
Donja Lohinja	1.316	1.329	1.349	1.383	1.418	1.454	1.491
Vranovići	1.042	1.052	1.068	1.095	1.123	1.151	1.180
Piskavica	924	933	947	971	996	1.021	1.047
Rašljeva	1.092	1.103	1.120	1.148	1.177	1.207	1.237
Gornja Lohinja	159	161	163	167	171	176	180
Trnovci	737	744	756	775	794	814	835
Prijeko Brdo	675	682	692	710	727	746	765
Buk	375	379	384	394	404	414	425
Gornji Doborovci	740	747	759	778	797	818	838
Population in total	**58.926**	**60.147**	**62.052**	**65.442**	**69.131**	**73.161**	**77.579**

Table 82: Projected population number in WSS Gračanica town area

Town WSS	Projected population number in the municipal area						
	2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
	20.060	**20.402**	**20.925**	**21.827**	**22.768**	**23.749**	**24.773**
	Projected population number in local communities						
Gračanica	17.760	18.062	18.525	19.324	20.156	21.025	21.931
Pribava	2.300	2.339	2.399	2.503	2.611	2.724	2.842
Population in total	**20.060**	**20.402**	**20.925**	**21.827**	**22.768**	**23.749**	**24.773**
Expressed in percents of total population number in municipality:	**34,04%**	**33,92%**	**33,72%**	**33,35%**	**32,93%**	**32,46%**	**31,93%**

Table 83: Estimation of required water quantities in local WSS Gračanica

Estimation of required water quantities in local WSS Gracanica

Percentage of population growth: 1,23 %

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		38.866	**39.745**	**41.127**	**43.616**	**46.364**	**49.412**	**52.806**
Population connected to the system		**38.866**	**39.745**	**41.127**	**43.616**	**46.364**	**49.412**	**52.806**
Average specific water consumption of the population	l/cap/day	100,00	110,00	115,00	120,00	130,00	140,00	150,00
Percentage of population connected to the system	%	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	**44,98**	**50,60**	**54,74**	**60,58**	**69,76**	**80,06**	**91,68**
Share of economy in water consumption	%	25,00	25,00	25,00	25,00	25,00	25,00	25,00
Average water consumption of economy	l/s	**11,25**	**12,65**	**13,69**	**15,14**	**17,44**	**20,02**	**22,92**
Total average water consumption of population + economy	**l/s**	**56,23**	**63,25**	**68,43**	**75,72**	**87,20**	**100,08**	**114,60**
Specific consumption of population + economy	l/cap/day	**125,00**	**137,50**	**143,75**	**150,00**	**162,50**	**175,00**	**187,50**
Total daily average water consumption of population + economy	**m^3/day**	4.858	5.465	5.912	6.542	7.534	8.647	9.901
Total monthly average water consumption population + economy	**m^3/month**	147.772	166.226	179.826	198.996	229.162	263.013	301.159
Total average annual water consumption population+ economy	**m^3/year**	1.773.261	1.994.718	2.157.907	2.387.952	2.749.948	3.156.160	3.613.908
Coefficient of seasonal consumption variation of population		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of the population	l/s	**67,48**	**75,90**	**82,11**	**90,87**	**104,64**	**120,10**	**137,52**
Coefficient of seasonal variation of economy		1,50	1,50	1,50	1,50	1,50	1,50	1,50
Maximum daily water consumption of economy	l/s	**16,87**	**18,98**	**20,53**	**22,72**	**26,16**	**30,02**	**34,38**
Total maximum daily water consumption (population+economy)	**l/s**	**84,34**	**94,88**	**102,64**	**113,58**	**130,80**	**150,12**	**171,89**
Total average water losses in the system(non-revenue water amount)	%	46,76	35,00	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**105,61**	**97,31**	**97,75**	**100,96**	**116,27**	**125,10**	**143,25**
Total of needed average daily water quantity with losses	m^3/month	277.551	255.733	256.894	265.328	305.550	328.767	376.449
Specific water consumption population + economy with losses	l/cap/day	**234,78**	**211,54**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**158,42**	**145,97**	**146,63**	**151,44**	**174,40**	**187,65**	**214,87**

Table 84: Estimation of required water quantities in Gračanica Municipality are for the planning period untill 2035

Procenat prirasta stanovništva: 1,106 %

Consumption description	Measurement unit	Projected population number in the system area						
		2010	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
		58.926	**60.147**	**62.052**	**65.442**	**69.130**	**73.159**	**77.577**
Population connected to the system		**56.373**	**58.107**	**62.052**	**65.442**	**69.130**	**73.159**	**77.577**
Average specific water consumption of the population	l/cap/day	99,80	110,00	115,00	120,00	130,00	140,00	150,00
Percentage of population connected to the system	%	95,67	96,61	100,00	100,00	100,00	100,00	100,00
Average water consumption of population	l/s	**65,12**	**73,98**	**82,59**	**90,89**	**104,02**	**118,55**	**134,68**
Share of economy in water consumption	%	25,00	25,00	25,00	25,00	25,00	25,00	25,00
Average water consumption of economy	l/s	**16,28**	**18,49**	**20,65**	**22,72**	**26,00**	**29,64**	**33,67**
Total average water consumption of population + economy	**l/s**	**81,40**	**92,47**	**103,24**	**113,61**	**130,02**	**148,18**	**168,35**
Specific consumption of population + economy	l/cap/day	**124,75**	**137,50**	**143,75**	**150,00**	**162,50**	**175,00**	**187,50**
Total daily average water consumption of population + economy	**m^3/day**	7.033	7.990	8.920	9.816	11.234	12.803	14.546
Total monthly average water consumption population + economy	**m^3/month**	213.916	243.019	271.316	298.578	341.692	389.421	442.433
Total average annual water consumption population+ economy	**m^3/year**	2.566.989	2.916.224	3.255.788	3.582.936	4.100.302	4.673.057	5.309.193
Coefficient of seasonal consumption variation of population		1,42	1,42	1,42	1,42	1,42	1,42	1,42
Maximum daily water consumption of the population	l/s	**92,73**	**105,12**	**116,93**	**128,76**	**147,46**	**168,20**	**191,27**
Coefficient of seasonal variation of economy		1,42	1,42	1,43	1,45	1,47	1,47	1,47
Maximum daily water consumption of economy	l/s	**23,18**	**26,28**	**29,58**	**32,95**	**38,15**	**43,49**	**49,43**
Total maximum daily water consumption (population+economy)	**l/s**	**115,92**	**131,40**	**146,51**	**161,71**	**185,61**	**211,69**	**240,70**
Total average water losses in the system(non-revenue water amount)	%	45,03	38,14	30,00	25,00	25,00	20,00	20,00
Total of needed average daily water quantity with losses	**l/s**	**148,09**	**149,49**	**147,49**	**151,49**	**173,36**	**185,23**	**210,44**
Total of needed average daily water quantity with losses	m^3/month	389.176	392.862	387.594	398.104	455.589	486.777	553.041
Specific water consumption population + economy with losses	l/cap/day	**226,97**	**222,28**	**205,36**	**200,00**	**216,67**	**218,75**	**234,38**
Total of needed maximum daily water quantity with losses	**l/s**	**211,7**	**212,43**	**209,29**	**215,61**	**247,48**	**264,61**	**300,88**

2.9.2.6 WATER BALANCES IN THE PLANNING PERIOD UNTILL 2035

The items **Error! Reference source not found. Error! Reference source not found.**, ***2.5 Local water supply systems*** IN GRAČANICA ***Municipality*** and ***2.9.2.1 Abstracted water in Gračanica***show the data on water production, i.e. sources capacities.

The previous tables show the estimation of required water quantities in the planning period untill 2035. The data are given separatelly for all systems, as well as for Gračanica Municipality.

With these data we can make the water balances estimation, i.e. needs, sources capacities, as well as the water quantities deficit at the sources.

The ***Table 87:*** shows the reviw of minimum source yield in Gračanica Municipality, water requirements and water quantities deficit at the sources.

The total new water quantity that needs to be inserted into the system until the end of the planning period is **Q=218,40 l/s**.

2.9.2.6.1 WATER BALANCE IN WSS GRAČANICA - UNTILL 2035

The ***Table 85:*** shows the reviw of minimum source yield in WSS Gračanica, water requirements and water quantities deficit at the sources.

While calculating the sources yield, it was planned that the natural sources "Ilidža" and "Vrelo" of total minimum yield $\mathbf{Q_{min}}$**=8,5 l/s**, should be used for supplying the settlement Soko.

However, tha lack of water in the system, besides non-revenue water reduction, should be solved by finding the new source. Dynamic of implementation of new water quantities in the system is following:

- untill **2015** the additional **Q=30,0 l/s** of water,
- untill **2020** the additional **Q=20,0 l/s** of water , and
- untill **2030** the additional **Q=15,0 l/s** of water.

That means that the new water quantity which needs to be inserted into the system utnill the end of the planning period is **Q=65,0 l/s**.

In this moment it is not know which source will be used. It is a matter of the investigation works which will indicate the location of these new water quantities.

2.9.2.6.2 WATER BALANCE IN LOCAL WATER SUPPLY SYSTEMS IN GRAČANICA MUNICIPALITY – UNTILL 2035

The ***Table 86: Water balance in Gračanica Municipality – without the town*** i ***2.5 Local water supply systems in Gračanica Municipality area*** shows the reviw of minimum source yield in Gračanica Municipality, water requirements and water quantities deficit at the sources.

However, tha lack of water in the system, besides non-revenue water reduction, should be solved by finding the new source.

The total new water quantity that needs to be inserted into the system until the end of the planning period is **Q=155,0 l/s**.

Table 85: Balance of water quantities in WSS Gračanica – current and planned

<table>
<tr><th colspan="20">Water balance in the area of WSS Gračanica</th></tr>
<tr><th rowspan="2">Water supply system</th><th colspan="6">Needs (maximum daily water quantities) (l/s)</th><th colspan="7">Provided from the source - Q_{min} (l/s)</th><th colspan="6">Missing water amount during the minimum source yield (l/s)</th></tr>
<tr><th>2010</th><th>2015</th><th>2020</th><th>2025</th><th>2030</th><th>2035</th><th>Source</th><th>2010</th><th>2015</th><th>2020</th><th>2025</th><th>2030</th><th>2035</th><th>2010</th><th>2015</th><th>2020</th><th>2025</th><th>2030</th><th>2035</th></tr>
<tr><td rowspan="12">Gračanica</td><td rowspan="12">53,3</td><td rowspan="12">62,7</td><td rowspan="12">64,2</td><td rowspan="12">73,1</td><td rowspan="12">77,0</td><td rowspan="12">86,0</td><td>Natural source „Ilidža“</td><td>4,5</td><td>4,5</td><td>0,0</td><td>0,0</td><td>0,0</td><td>0,0</td><td rowspan="7"></td><td rowspan="7"></td><td rowspan="7"></td><td rowspan="7"></td><td rowspan="7"></td><td rowspan="7"></td></tr>
<tr><td>Natural source „Vrela“</td><td>4,0</td><td>4,0</td><td>0,0</td><td>0,0</td><td>0,0</td><td>0,0</td></tr>
<tr><td>Natural source „Škahovica“</td><td>1,0</td><td>1,0</td><td>0,0</td><td>0,0</td><td>0,0</td><td>0,0</td></tr>
<tr><td>Source Hadžijina voda</td><td>2,2</td><td>2,2</td><td>0,0</td><td>0,0</td><td>0,0</td><td>0,0</td></tr>
<tr><td>Natural source „Zmajevac“</td><td>0,4</td><td>0,4</td><td>0,0</td><td>0,0</td><td>0,0</td><td>0,0</td></tr>
<tr><td>Drilled wells „Sklop“</td><td>17,0</td><td>17,0</td><td>17,0</td><td>17,0</td><td>17,0</td><td>17,0</td></tr>
<tr><td>Well Seljanuša</td><td>5,7</td><td>5,7</td><td>5,7</td><td>5,7</td><td>5,7</td><td>5,7</td></tr>
<tr><td>Exisitng sources in total</td><td>34,8</td><td>34,8</td><td>22,7</td><td>22,7</td><td>22,7</td><td>22,7</td><td>18,5</td><td>27,9</td><td>41,5</td><td>50,4</td><td>54,3</td><td>63,3</td></tr>
<tr><td>New source 1</td><td></td><td>30,0</td><td>30,0</td><td>30,0</td><td>30,0</td><td>30,0</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>New source 2</td><td></td><td></td><td>20,0</td><td>20,0</td><td>20,0</td><td>20,0</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>New source 3</td><td></td><td></td><td></td><td></td><td>15,0</td><td>15,0</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sources in total</td><td>34,8</td><td>64,8</td><td>72,7</td><td>72,7</td><td>87,7</td><td>87,7</td><td>18,5</td><td>-2,1</td><td>-8,5</td><td>0,4</td><td>-10,7</td><td>-1,7</td></tr>
</table>

Table 86: Water balance in Gračanica Municipality – without the town

Water balance in Gračanica Municipality area without a central part																			
WSS	Needs (maximum daily) (l/s)						Provided from the source - Q_{min} (l/s)							Missing water amount (l/s)					
	2010	2015	2020	2025	2030	2035	Source	2010	2015	2020	2025	2030	2035	2010	2015	2020	2025	2030	2035
Local WSS	158,4	146,6	151,4	174,4	187,7	214,9	All sources	59,8	59,8	59,8	59,8	59,8	59,8	98,7	86,9	91,7	114,6	127,9	155,1
In total:	**158,4**	**146,6**	**151,4**	**174,4**	**187,7**	**214,9**	***In total:***	**59,8**	**59,8**	**59,8**	**59,8**	**59,8**	**59,8**	**98,7**	**86,9**	**91,7**	**114,6**	**127,9**	**155,1**

Table 87: Water balance in Gračanica Municipality

WSS	Needs (maximum daily) (l/s)						Provided from the source - Q_{min} (l/s)							Missing water amount (l/s)					
	2010	2015	2020	2025	2030	2035	Source	2010	2015	2020	2025	2030	2035	2010	2015	2020	2025	2030	2035
WSS Gračanica	53,3	62,7	64,2	73,1	77,0	86,0	All sources	34,8	34,8	22,7	22,7	22,7	22,7	18,5	27,9	41,5	50,4	54,3	63,3
Local WSS	158,4	146,6	151,4	174,4	187,7	214,9	All sources	59,8	59,8	59,8	59,8	59,8	59,8	98,7	86,9	91,7	114,6	127,9	155,1
In total:	**211,7**	**209,3**	**215,6**	**247,5**	**264,6**	**300,9**	***In total:***	**94,6**	**94,6**	**82,5**	**82,5**	**82,5**	**82,5**	**114,2**	**114,7**	**133,1**	**165,0**	**182,2**	**218,4**

2.9.3 PIPELINES IN THE SYSTEM

2.9.3.1PIPELINES IN WSS GRAČANICA

The chapter **Error! Reference source not found.** ***Existing water supply system***, tables - ***Table 16: , Table 17: type pipelines, Pipelines by*** the material

Pipelines by the type of material				
	PE / PVC	CI / ACC	Steel	Total
%	80,47%	17,94%	1,59%	100,00%
m	59.381,91	13.241,65	1.172,15	73.795,70

Table 18: **,** ***Table 19:*** **,** ***Table 20***: **,** ***Table 21: and Table 22:*** , show the reviw of existing pipelines in WSS Gračanica.

The total pipelines length is **L=73,80 km**. Pipelines are made of different materials, but the newer pipelines are mostly made of PE, which is good. This material is of a good quality and the price is acceptable.

The basic pipelines characteristics are:

- Pipelines capacity mostly satisfy the system's requirements,
- Big percent of the pipelines have diameter smaller than Ø 80 mm, which does not satisfy the technical regulations. The total lenght of these pipelines is **L=27,77 km**. Expressed in percents, it is around 37,64 % of the total pipelines lenght which is very big percent.
- Age structure of the pipelines is satisfactory. Big percent of the pipelines is **younger than 20**, around **57,67 %**.
- Percent of losses in transport and distribution pipelines is satisfactory, related to the BiH situation. Still, losses can be reduced.
- There is a small percent of asbestos cement pipelines in the system, which are old and needs to be replaced.
- The lenght of **connecting pipelines** is around **L=50 km**, and talking about losses, the biggest problem is exactly with these pipelines.

System's coverage by pipelines is quite good. However, the biggest problem is, certainly, with the losses in the system. This problem is present in the entyre BiH. This problem needs to be solved systematically, because the losses reduction activities in the system are permanent. Even if the losses are reduced in one year, the same quantity of losses will be back if nothing is done in the next year.

We already mentioned that these losses need to be reduced to minimu in the future period, if we don't want to include some new sources in the system, which we do not have in this area, anyway. Only by system maintanance, losses reduction, we can have regular water supplying.

In the aim of better system control, besides GIS that begun with this project, we need to make the hydraulic model. Hydraulic model was made within this Study, in the aim of better system analysis. However, this model needs to be calibrated in the future, which needs a lot of flow measurements, as well as the pressures in the systems according to the plan.

DISTRIBUTION NETWORK EFFICIENCY

Operation efficiency of one system can be expressed with ratio može. For WSS Gračanica we can approximately give the network efficiency ratio. Network efficiency is:

Network efficiency = **1** - Water losses = **1** - 545.753,89 = **0,59**

Inserted water	1.339.464,89

Efficiency of network is 0.59, which represent very low coefficient. Namely, in the European Union countries this coefficient ranges from **0.80** to **0.85**. However, compared to other water supply systems in Republika Srpska, where this coefficient is lower than 0.4, this coefficient is good. These are data for the year 2010.

The following activities are the responsibility of Water utility company:

- construction and maintenance of Water Supply System,
- detection and reduction of water losses from the source to Consumer Water Meters,
- water billing for end users.

In this part of the system there are various categories of losses. One of the possible divisions is on:

- visible, i.e. those easily detected without any complex research,
- and invisible, i.e. those whose detection requires various measurements, analysis of research, etc.

In the part of water supply system from the Water Meter to the Consumer i.e. at the individual consumer point, there are water losses. This part of network i.e. these losses are responsibility of owners of associated facilities or Housing Funds responsible for maintenance of residential buildings. In circumstances when water meters operate properly or when the water has an economic cost, Water Utility company has no interest in reducing this consumption or losses.

But in present circumstances, when the price of water charged by water utility is unrealistically low, it is in the utility company's best interest to reduce these losses, because unnecessary waste of water or water leakage in some consumer connections have resulted in irregular water supply of other, than irregular payments all leading to a 'vicious circle'. Therefore, water losses after the water meter are not responsibility of water utility company, but it is in its best interest to reduce them. Water utility can affect it by education of the population through the media and forums as well as educational institutions.

Moreover, water utility should organise its own team for repair of these defects at minimum maintenance costs. This would also have a favourable impact on citizens' trust in water supply company.

Invisible water losses occur in the following points in the system:

- water leakage in the water supply network, underground,
- losses due to defective water meter,
- losses due to unauthorized consumption,
- losses in household installations.

2.9.3.2 PIPELINES IN LOCAL WATER SUPPLY SYSTEMS

The item 2.5 LOCAL WATER SUPPLY SYSTEMS IN GRAČANICA MUNICIPALITY AREA, as well as the tables in enclosures, shows data about the pipelines of the local water supply systems in Gračanica Municipality. The length of these pipelines is appr. **L=418,0 km**. Thereis no the exact data on these pipelines because there is no underground installations cadastre, and the projects of performed works do not exist. The data about the pipelines are estimated, but according to experience and obtained data we can conclude that the biggest percent of these pipelines need to be replaced or reconstructed. The biggest percent of these pipelines is old and of a small diameter, which do not satisfy the technical regulations. When we talk about house connections, the situation is probably even worse, and there is only a small percent of water meters at the house connections.

2.9.4 RESERVOIRS

2.9.4.1 RESERVOIRS IN WSS GRAČANICA

The item ***2.3.4 Reservoirs in WSS Gračanica*** shows data about reservoirs in WSS Gračanica. By analysing the condition in WSS Gračanica, we came to the following conslusions:

- The existing **reservoir space** is sufficient in this moment and it's volume is V=2.350,0 m^3.
- According to the current abstracted water quantities, the necessary reservoir volume for the entire system would be as follows:

Table 88: Required reservoir space in WSS Gračanica

Required amount of water (lps)	Required reservoir volume (m^3)	Existing reservoir capacity (m^3)	Needs for new reservoir capacity
53,28	1,361.00	2.350,00	-969.00

Dakle rezervoarski prostor prevazilazi trenutne potrebe.

- Deficit rezervoarskog prostora u budućnosti je dat u narednoj tabeli.

2020. godina

Required amount of water (lps)	Required reservoir volume (m^3)	Existing reservoir capacity (m^3)	Needs for new reservoir capacity
64,16	1.663,16	2.350,00	-686,84

I 2020. godine, postojeći rezervoarski prostor je zadovoljavajući.

2035. godina

Required amount of water (lps)	Required reservoir volume (m^3)	Existing reservoir capacity (m^3)	Needs for new reservoir capacity
86,01	2.229,42	2.350,00	-120,58

These estimates show that the volume of reservoir space is sufficient for future needs.

Potrebe za novim rezervoarskim prostorom će biti izražene u slučaju da **se nove količine vode ubace u sistem sa južne strane grada, odnosno iz pravca Stjepan Polja ili Orahovice**. U ovom trenutku možemo samo da napravimo kalkulaciju potrebnog rezervoarskog prostora koji bi bio potreban u tom slučaju.

2.9.4.2 RESERVOIRS IN LOCAL WATER SUPPLY SYSTEMS

The data on reservoirs are given in the item 2.5 LOCAL WATER SUPPLY SYSTEMS IN GRAČANICA, as well as in tables and enclosures. The total reservoir volume in local water supply systems is appr. V=2.800,0 m^3. According to the currently abstracted minimum water quantities in all local supply systems, this volume is sufficient. However, in certain systems is bigger, and in some smaller.

The following table shows review of necessary reservoir space for 2010, 2020, and for the end of the planning period, 2035.

Calculation is given for the needs of entire population in Gračanica Municipality arae, as well as out of town area.

Table 89: Reservoir space requirements in local water supply systems

2010

Required amount of water (lps)	Required reservoir volume (m^3)	Existing reservoir capacity (m^3)	Needs for new reservoir capacity
158,42	4.106,24	2.796,00	1.310,24
2020			
Required amount of water (lps)	**Required reservoir volume (m^3)**	**Existing reservoir capacity (m^3)**	**Needs for new reservoir capacity**
151,44	3.925,40	2.796,00	1.129,40
2035			
Required amount of water (lps)	**Required reservoir volume (m^3)**	**Existing reservoir capacity (m^3)**	**Needs for new reservoir capacity**
214,87	5.569,38	2.796,00	2.773,38

We can notice the lack of reservoir space in this moment, but, also, at the end of the planning period. The lack of reservoir space at the end of the planning period is V=2.800,0 m^3.

2.9.5 PUMPING STATIONS

In this moment, all of the pumping stations satisfy the system's needs. In case of increased water quantities at the sources, the pumping stations capacity should be increased.

2.9.6 MEASUREMENTS IN THE SYSTEM

2.9.6.1MEASUREMENTS IN WSS GRAČANICA

Comparing to the most of the systems in BiH, in WSS Gračanica we have a lot of measurements. The water production is measured at the sources. The measurements in the reservoirs are missing, which is very important. In this way we can see nonlinearity consumption which is very important for a water supply system. In parts of the system it is measured by the consumption of water. The frequent continuous measurements of water consumption are missing, which would give much better picture of the distribution network. At the end users connections, there are water meters installed, so the readings of water consumption are regularly performed.

If we want to control the water supply system, it is necessary to have more measurements in the system. Only in this way can control the operation of water supply system. In the future we need the water system hydraulic model calibration measurements, a hydraulic model would also give the plan of measurement points which were permanent and temporary metering points through which we would conduct control of the hydraulic model. Timely intervention in the system can bring huge financial benefits, as well as regular water supply. This is of the special interest for WSS Gračanica, considering the lack of water in the system.

2.9.6.1 MEASUREMENTS IN THE LOCAL WATER SUPPLY SYSTEMS

There is no measurements in local water supply systems. The water is not measured at the sources, reservoirs, and in the most systems not even at the end users. In this way, it is very hard to manage the water supply systems. It is, also, very hard to plan the current and future water needs.

2.9.7 HYDRAULIC ANALYSIS OF WSS GRAČANICA

2.9.7.1 INTRODUCTION

Based on the data collected during the development of this Study, we made the hydraulic model of WSS Gračanica. The model is not calibrated, but we used all of the measurements in the aim of showing the precise model. This model can serve as a good base for development of that model in the future. In the modern designing, only in this way we can get the guidelines for th esystem development. It is, also, much easier to get more scenarios to the system development. This is very important for WSS Gračanica, considering the fact that no new sources were determined, but only the posibility to have new water quantities from more directions.

Production and consumption of water the system parts

Water production - 2010			
Sklop	$Q_{sr.god.}$=	19,12	l/s
Natural sources	$Q_{sr.god.}$=	16,86	l/s
Hadžina voda	$Q_{sr.god.}$=	0,73	l/s
Soljanuša	$Q_{sr.god.}$=	5,77	l/s
In total:	$Q_{sr.god.}$=	**42,47**	

Water production - 2009			
Sklop	$Q_{sr.god.}$=	20,70	l/s
Natural sources	$Q_{sr.god.}$=	18,24	l/s
Hadžina voda	$Q_{sr.god.}$=	0,79	l/s
Soljanuša	$Q_{sr.god.}$=	5,85	l/s
In total:	$Q_{sr.god.}$=	**45,58**	

Water consumption - 2010			
Gaj reservoir outlet	$Q_{sr.god.}$=	**31,91**	**l/s**
Ćiriš	$Q_{sr.god.}$=	6,04	l/s
Grad	$Q_{sr.god.}$=	22,60	l/s
Mejdanić	$Q_{sr.god.}$=	3,26	l/s
Zone Pribava	$Q_{sr.god.}$=	**5,77**	**l/s**
Other settlements	$Q_{sr.god.}$=	**4,80**	**l/s**
In total:	$Q_{sr.god.}$=	42,47	**l/s**

January 2011 – measurements by mobile flow meter			
Gaj reservoir outlet	$Q_{sr.god.}$=	**37,07**	**l/s**
Ćiriš	$Q_{sr.god.}$=	6,63	l/s
Grad	$Q_{sr.god.}$=	26,88	l/s
Mejdanić	$Q_{sr.god.}$=	3,56	l/s
Measured at the well Sklop	$Q_{sr.god.}$=	**20,66**	**l/s**

For the model needs, we used the water production in 2010.

- Data on revenue and non-revenue water. Non-revenue water is divided proportianally according to the water consumption in the system.

The calculation results are shown in the enclosures.

Hydraulic model for Pribava settlement was made with the new pipelines ought to start operating.

Hydraulic model was, also, used for system development for the period untill 2035.

The following parameters were determined for hydraulic model:

- Nodal load is calculated based on measurements of the solar system in certain parts of the system. The position of objects and consumers in the supply system was, also, taken into account. The specific nodal load was determined in this way.
- The model shows **charts of daily consumption nonlinearity - Demand Patterns**. Determining the nonlinearity of consumption is very important because, based on the maximum hourly consumption, the distribution system can be dimensioned. Multiplying the base nodal consumption and nonlinearity consumption, we get the energy in each node, depending on the weather. So we get the diagram of consumption in node during the one day or more depending on what is assigned in the model.
- Pipelines were determined by its lenght and diameter. The first and the last node were given. Roughness coefficients are given according to the Darcy - Waisbach. For PE and PVC pipelines we took the coefficient 0,1 and for steel, cast iron and asbestos cement the coefficient 0,4. The coefficiens for the other group of materials can be even up to 1.
- Besides the geometry x,y,z the sources were, also, determined based on the water quantity givning to the system.
- For the reservoirs there are reservoir position (x,y), bottom elevation, početna water depth in reservoir and maximum water depth in reservoir.
- Pumping stations are determined by the pumping curve, which determines the pumped water quantity and th eheight of water pumping.
- The caps are determined according to the function in the system. There are th ecaps which are completelly closed due to the separation of the supply zones, and there are two caps regulating the system’s pressure (the pressure is being lowered in Srednji and Donji Grad).
- The rules for the operation of the pumps, reservoirs and caps are as follows:

  RULE 1

  IF TANK T7-R.Pribava LEVEL >= 3.49

  THEN PUMP Pu2-PSSoljanuša STATUS IS CLOSED

  RULE 2

  IF TANK T7-R.Pribava LEVEL <= 1

  THEN PUMP Pu2-PSSoljanuša STATUS IS OPEN

  RULE 3

  IF TANK T5-R.Ritosici LEVEL > 2.95

  THEN PUMP Pu4-HVoda STATUS IS CLOSED

  RULE 4

  IF TANK T5-R.Ritosici LEVEL <= 2

  THEN PUMP Pu4-HVoda STATUS IS OPEN

  RULE 5

  IF TANK T1-R.Gaj LEVEL > 7.9

THEN PUMP Pu5-Sklop STATUS IS CLOSED

RULE 6

IF TANK T1-R.Gaj LEVEL <= 2

THEN PUMP Pu5-Sklop STATUS IS OPEN

RULE 7

IF TANK RK1-Rasteretnakomora LEVEL > 2.9

THEN VALVE V8 STATUS IS CLOSED

RULE 8

IF TANK RK1-Rasteretnakomora LEVEL <= 2.8

THEN VALVE V8 STATUS IS OPEN

RULE 9

IF TANK RK1-Rasteretnakomora LEVEL > 2.9

THEN VALVE V9 STATUS IS CLOSED

RULE 10

IF TANK RK1-Rasteretnakomora LEVEL <= 2.8

THEN VALVE V9 STATUS IS OPEN

RULE 11

IF TANK RK2 LEVEL > 2.9

THEN PIPE Pi17 STATUS IS CLOSED

RULE 12

IF TANK RK2 LEVEL <= 2.8

THEN PIPE Pi17 STATUS IS OPEN

RULE 13

IF TANK T9-R.Bahici LEVEL > 2.9

THEN PUMP Pu3-PSBahici STATUS IS CLOSED

RULE 14

IF TANK T9-R.Bahici LEVEL <= 1

THEN PUMP Pu3-PSBahici STATUS IS OPEN

RULE 15

IF TANK T2-R.DonjiDrafnici LEVEL > 1.9

THEN PIPE P40 STATUS IS CLOSED

RULE 16

IF TANK T2-R.DonjiDrafnici LEVEL <= 1

THEN PIPE P40 STATUS IS OPEN

RULE 17

IF TANK T10-R.Drafnici LEVEL > 1.9

THEN PIPE 1 STATUS IS CLOSED

RULE 18

IF TANK T10-R.Drafnici LEVEL <= 1

THEN PIPE 1 STATUS IS OPEN

RULE 19

IF TANK T3-R.GornjiDrafnici LEVEL > 1.9

THEN PIPE P188 STATUS IS CLOSED

RULE 20

IF TANK T3-R.GornjiDrafnici LEVEL <= 1.8

THEN PIPE P188 STATUS IS OPEN

RULE 21

IF TANK T4-R.Hurije LEVEL > 1.9

THEN PIPE P35 STATUS IS CLOSED

RULE 22

IF TANK T4-R.Hurije LEVEL <= 1

THEN PIPE P35 STATUS IS OPEN

RULE 23

IF TANK T1-R.Gaj LEVEL > 7.9

THEN PIPE P30 STATUS IS CLOSED

RULE 24

IF TANK T1-R.Gaj LEVEL <= 4

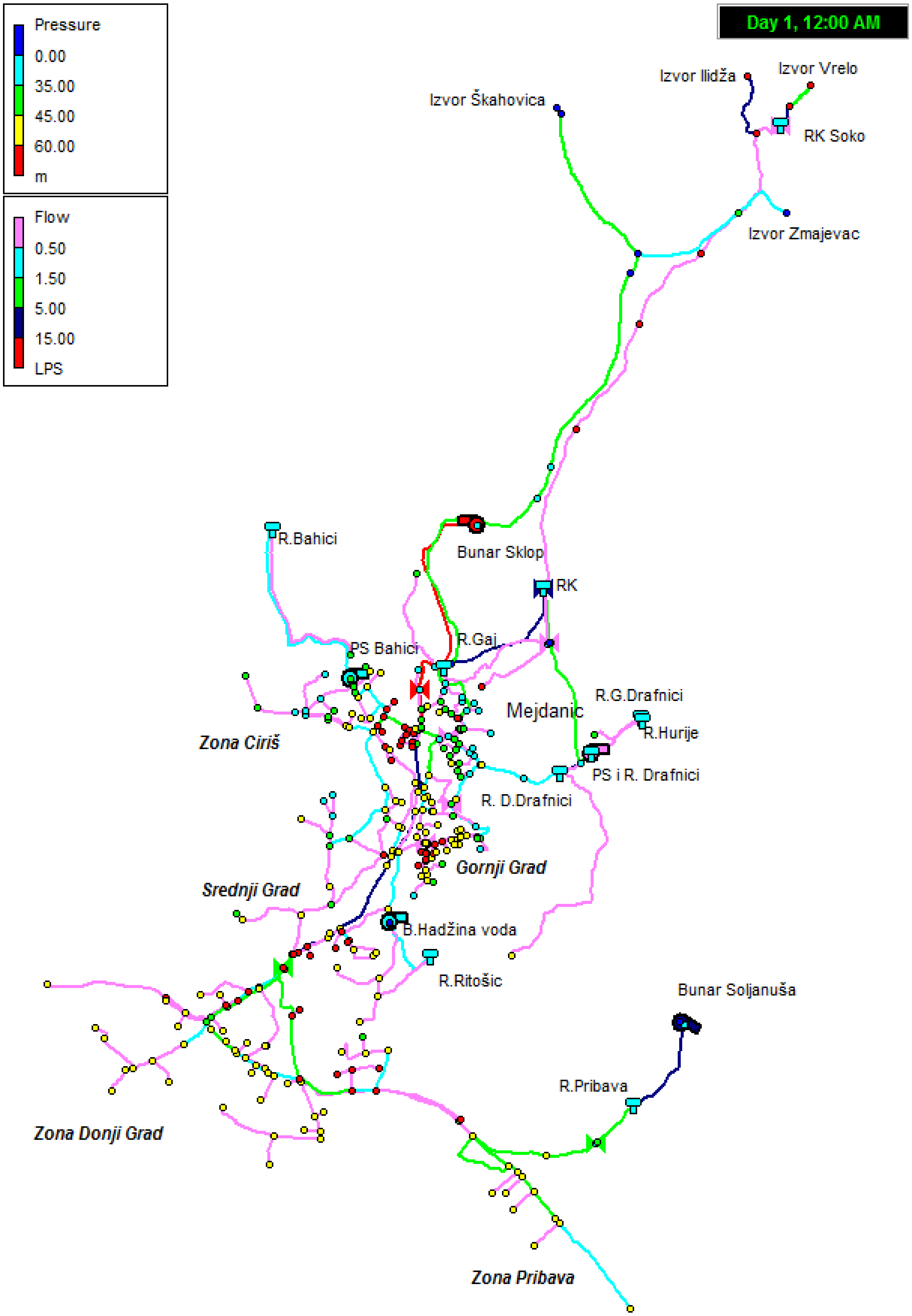
THEN PIPE P30 STATUS IS OPEN

The model has total of:

- Number of nodes - 339
- Number of sources - 7
- Number of reservoirs - 10
- Number of pipelines - 347
- Number of pumps - 5
- Number of caps - 10
- Flow unit - LPS
- Formula for losses - D-W

The consumption allocation by th enodes in the zone Gornji Grad, Srednji Grad ans Donji Grad is not given based on the measurements, but based on the consumers allocation. For this part of the system, there is a summary measurement, but not the measurements in every town part. For Ćiriš and Mejdanić the consumption allocation is given based on the measurements. However, the part of non-revenue water is allocated proportionally to the consumption, because it is not known where th elosses in the system are. It is necessary to make the calibrated hydraulic model which would indicate the points of real losses in the system.

The hydraulic model was developped without the newly designed pipelines in the zone Pribava.
The following chart shows the model of WSS Gračanica with pipelines diameters.



Scheme 3: WSS Gračanica - hydraulic model

2.9.7.2 RESULTS OF HYDRAULIC CALCULATIONS – CONDITION IN 2010 WITH Q=46,86 L/S

After the hydraulic model preparation, the simulation of water supply system operation was made. Operation simulation can be done for different time period intervals. The minimum time period interval can be 24 hours.

The calculation results in hydraulic model can practically be seen in every moment. The most interesting condition for us is, certainlly, the condition in the moment of the maximum consumption, because we can see the system fucntionality.

The calculation results during th emaximum consumption can be seen in the ***Table 91: Calculation result during the maximum hourly consumption in 2010 – calculation results in the pipelines and Table 92: Water needs in the parts of WSS Gračanica***

The ***Scheme 4: Scheme of WSS Gračanica – flow and pressures in the period of maximumhourly consumption - 2010 and Scheme 5: Scheme of WSS Gračanica - velocities and pressures in the period of maximum hourly consumption - 2010*** show the calculation results for the maximum hourly consumption of the existing water supply system. The calculation results details are given in enclosures.

The ***Scheme 6: Scheme of WSS Gračanica - flow and pressures in the period of minimum hourly consumption - 2010 and Scheme 7: Scheme of WSS Gračanica - speed and pressures in the period of minimum hourly consumption - 2010*** show the pressure values, water speed and flow during the minimum hourly consumption in the system.

Considering the calculations partially shown in the tables, charts and schemes, the following can be concluded:

Pressures in the system are very high. In the ***Scheme 8: Nodes in WSS with the pressure less than 1,5 bar in the period of maximum hourly consumption*** it is obvious that in distribution network all of the nodes during the maximum hourly consumption have the pressures higher than 1,5 bar. At the same time, during the maximum hourly consumption, the pressures in most of the nodes are higher than 4,5 bar, what can be seen in the ***Scheme 9: Nodes in WSS with the pressure over 4,5 bar in the period of maximum hourly consumption***. Althought there is a high percent of the pipelines with diameter smaller than Ø 75 mm in the system, and due to the highly positioned reservoir „Gaj“ and proper diameters of the main distribution pipelines, the pressures in the system are even higher than allowed ones. Talking about the pressures reduction, three interventions were conducted in water supply system – installation of 3 reducir valves. However, even besides tha pressure lowering, they are still too high. Only in the zone Mejdanića and side parts in Ćiriš, Drafnići and Hurija, the pressures are lower, and in some nodes even unsatisfying in the period of maximum hourly consumption.

Hydraulic model showed that the velocities in all pipelines are in the allowed scope. That means that none of the pipelines has velocity more than v=1,2 m/s. It means that all of the pipelines are big enough and that they are not the bottlenecks in the system.

We allready mentioned that the significant percent of the pipelines, around **37,64 %** or around **L=27,7 km**, do not satisfy the basic technical conditions with the diameters. Pipelines with diameters smaller than Ø 80 mm, are shown in the ***Scheme 12: Scheme of WSS Gračanica – pipelines with diameter less than Ø 75 mm***.

Table 90: Calculation result during the maximum hourly consumption in 2010 – results in nodes with the operation of hydrant for cisterns charging

Calculation results for 2010				
Node no.	Node elevation	Base consumption in node	Consumption in node at the moment of calculation	Pressure in node at the moment of calculation
	m	l/s	l/s	m
Junc 2	256,00	0,00	0,00	3,93
Junc 3	209,00	0,23	0,29	50,79
Junc 4	201,00	0,11	0,13	58,26
Junc 5	196,00	0,11	0,13	62,90
Junc 6	200,00	0,11	0,13	58,83
Junc 7	213,00	0,11	0,13	45,76
Junc 8	206,00	0,11	0,13	52,74
Junc 9	216,00	0,11	0,13	42,49
Junc 10	218,00	0,11	0,13	40,41
Junc 11	208,00	0,11	0,13	50,37
Junc 12	203,00	0,11	0,13	55,27
Junc 13	193,00	0,11	0,13	65,26
Junc 14	213,00	0,11	0,13	44,91
Junc 15	222,00	0,11	0,13	35,90
Junc 16	220,00	0,04	0,05	39,65
Junc 17	220,00	0,04	0,05	39,61
Junc 18	216,00	0,04	0,05	43,58
Junc 19	231,00	0,04	0,05	28,52
Junc 20	205,00	0,04	0,05	53,98
Junc 21	218,00	0,04	0,05	40,61
Junc 22	191,00	0,04	0,05	67,33
Junc 23	209,00	0,23	0,29	49,32
Junc 24	205,00	0,22	0,28	37,41
Junc 25	201,00	0,23	0,29	40,81
Junc 26	290,00	0,23	0,29	0,00
Junc 27	188,00	0,23	0,29	52,17
Junc 28	185,00	0,23	0,29	54,32
Junc 29	186,00	0,23	0,29	52,92
Junc 30	184,00	0,23	0,29	54,45
Junc 31	181,00	0,63	0,81	52,06
Junc 32	176,00	0,24	0,31	54,98
Junc 33	175,00	0,24	0,31	55,42
Junc 34	174,00	0,24	0,31	40,00
Junc 35	166,00	0,09	0,12	44,26
Junc 36	168,00	0,24	0,31	42,26
Junc 37	170,00	0,09	0,12	40,47
Junc 38	158,00	0,09	0,12	52,41
Junc 39	157,00	0,09	0,12	53,35
Junc 40-BunarSklop	242,00	-21,12	-21,12	0,00
Junc 41	262,00	0,00	0,00	0,00
Junc 43	190,00	0,20	0,26	55,45
Junc 44	243,00	0,00	0,00	2,16
Junc 45	238,00	0,00	0,00	93,88
Junc 46	307,00	0,00	0,00	21,02

Junc 48	329,00	0,50	0,66	39,77
Junc 49	362,00	0,00	0,00	8,00
Junc 51	329,00	0,00	0,00	5,37
Junc 52	341,00	0,00	0,00	0,00
Junc 54	341,00	0,00	0,00	25,66
Junc 55	341,00	0,00	0,00	25,66
Junc 56-IzvorIlidža	390,00	-8,00	-8,00	0,00
Junc 57	308,00	0,00	0,00	15,12
Junc 59-VreloŠkahovica	363,00	-2,00	-2,00	0,00
Junc 60	349,00	0,00	0,00	0,00
Junc 61-IzvorVrelo	397,00	-8,00	-8,00	0,00
Junc 62	375,00	0,00	0,00	0,00
Junc 63-IzvorZmajevac	355,00	-0,62	-0,62	0,00
Junc 64	271,00	0,00	0,00	0,00
Junc 65	318,00	0,71	0,94	37,52
Junc 66	320,00	0,00	0,00	0,14
Junc 67	195,00	0,11	0,13	64,11
Junc 68	170,00	0,09	0,12	40,47
Junc 69	167,00	0,09	0,12	43,43
Junc 70	176,00	0,24	0,31	54,98
Junc 71	177,00	0,24	0,31	53,35
Junc 72	175,00	0,24	0,31	55,29
Junc 73	180,00	0,24	0,31	50,20
Junc 74	181,00	0,24	0,31	52,06
Junc 75	179,00	0,24	0,31	54,06
Junc 76	178,00	0,24	0,31	55,05
Junc 77	179,00	0,24	0,31	54,04
Junc 78	182,00	0,24	0,31	51,03
Junc 79	187,00	0,24	0,31	45,94
Junc 80	187,00	0,24	0,31	46,02
Junc 81	190,00	0,23	0,29	48,55
Junc 82	188,00	0,23	0,29	50,61
Junc 83	180,00	0,23	0,29	58,39
Junc 84	185,00	0,23	0,29	54,30
Junc 85	185,00	0,23	0,29	54,32
Junc 86	190,00	0,23	0,29	48,92
Junc 87	190,00	0,23	0,29	50,66
Junc 88	195,00	0,23	0,29	45,80
Junc 89	211,00	0,23	0,29	30,41
Junc 90	225,00	0,04	0,05	33,98
Junc 91	188,00	0,23	0,29	52,21
Junc 92	189,00	0,23	0,29	51,19
Junc 93	194,00	0,23	0,29	46,16
Junc 94	188,00	0,23	0,29	52,19
Junc 95	190,00	0,23	0,29	49,30
Junc 96	191,00	0,23	0,29	48,27
Junc 97	191,00	0,04	0,05	67,32
Junc 98	206,00	0,04	0,05	52,27
Junc 99	191,00	0,04	0,05	67,33
Junc 100	219,00	0,04	0,05	39,02
Junc 101	226,00	0,04	0,05	32,02
Junc 102	217,00	0,04	0,05	41,31
Junc 103	161,00	0,09	0,12	49,14

Junc 104	160,00	0,09	0,12	50,14
Junc 105	158,00	0,09	0,12	52,14
Junc 106	161,00	0,09	0,12	49,18
Junc 107	162,00	0,09	0,12	47,67
Junc 108	162,00	0,09	0,12	48,20
Junc 109	163,00	0,09	0,12	47,20
Junc 110	166,00	0,09	0,12	44,26
Junc 111	164,00	0,09	0,12	45,82
Junc 112	166,00	0,24	0,31	61,95
Junc 113	166,00	0,24	0,31	59,70
Junc 114	167,00	0,24	0,31	57,82
Junc 115	170,00	0,24	0,31	54,69
Junc 116	181,00	0,24	0,31	43,71
Junc 117	181,00	0,24	0,31	43,46
Junc 118	189,00	0,24	0,31	35,31
Junc 119	195,00	0,24	0,31	29,35
Junc 120	175,00	0,24	0,31	50,48
Junc 121	175,00	0,24	0,31	50,42
Junc 122	173,00	0,24	0,31	52,38
Junc 123	168,00	0,24	0,31	61,04
Junc 124	175,00	0,24	0,31	54,02
Junc 125	165,00	0,09	0,12	45,28
Junc 126	162,00	0,09	0,12	48,28
Junc 127	164,00	0,09	0,12	46,33
Junc 128	164,00	0,09	0,12	46,08
Junc 129	163,00	0,09	0,12	47,34
Junc 130	163,00	0,09	0,12	47,33
Junc 131	164,00	0,09	0,12	46,36
Junc 132	163,00	0,09	0,12	46,92
Junc 133	164,00	0,09	0,12	46,37
Junc 134	164,00	0,09	0,12	46,36
Junc 135	171,00	0,09	0,12	39,69
Junc 136	166,00	0,09	0,12	44,18
Junc 137	157,00	0,09	0,12	53,23
Junc 138	154,00	0,17	0,21	56,20
Junc 139	158,00	0,09	0,12	52,34
Junc 140	202,00	0,00	0,00	39,87
Junc 141	216,00	0,04	0,05	43,58
Junc 142	220,00	0,04	0,05	39,58
Junc 143	240,00	0,23	0,29	19,57
Junc 144	215,00	0,58	0,74	42,72
Junc 145	218,00	0,04	0,05	41,41
Junc 146	208,00	0,04	0,05	51,41
Junc 147	186,00	0,23	0,29	52,45
Junc 148	175,00	0,24	0,31	55,59
Junc 149	177,00	0,24	0,31	51,74
Junc 150	177,00	0,24	0,31	50,71
Junc 151	176,00	0,24	0,31	51,12
Junc 152	183,00	0,24	0,31	42,60
Junc 153	185,00	0,24	0,31	42,52
Junc 154	163,00	0,09	0,12	47,46
Junc 155	167,00	0,24	0,31	58,21
Junc 156	175,00	0,24	0,31	50,68

Junc 157	175,00	0,09	0,12	36,34
Junc 158	165,00	0,09	0,12	45,46
Junc 159	158,00	0,09	0,12	52,03
Junc 160	191,00	0,00	0,00	49,08
Junc 161	191,00	0,23	0,29	49,07
Junc 162	189,00	0,13	0,17	51,02
Junc 163	189,00	0,23	0,29	51,05
Junc 164	207,00	0,23	0,29	33,00
Junc 165	188,00	0,23	0,29	50,80
Junc 166	190,00	0,23	0,29	48,71
Junc 167	196,00	0,11	0,13	62,83
Junc 168	196,00	0,11	0,13	62,82
Junc 169	221,00	0,11	0,13	37,62
Junc 170	232,00	0,11	0,13	26,58
Junc 171	231,00	0,11	0,13	27,61
Junc 172	219,00	0,11	0,13	39,48
Junc 173	195,00	0,23	0,29	43,38
Junc 174	197,00	0,23	0,29	41,44
Junc 175	223,00	0,11	0,13	35,34
Junc 176	209,00	0,11	0,13	49,32
Junc 177	234,00	0,11	0,13	24,13
Junc 178	236,00	0,11	0,13	22,10
Junc 179	246,00	0,11	0,13	12,02
Junc 180	161,00	0,09	0,12	49,18
Junc 181	165,00	0,09	0,12	45,31
Junc 182	201,00	0,11	0,13	57,61
Junc 183	205,00	0,23	0,29	37,41
Junc 184	202,00	0,23	0,29	40,31
Junc 185	202,00	0,23	0,29	40,27
Junc 186	198,00	0,23	0,29	44,16
Junc 187	189,00	0,23	0,29	51,31
Junc 188	154,00	0,09	0,12	56,19
Junc 189	154,00	0,09	0,12	56,19
Junc 190	163,00	0,09	0,12	49,70
Junc 191	163,00	0,09	0,12	47,34
Junc 192	155,00	0,09	0,12	55,23
Junc 193	319,00	0,00	0,00	63,41
Junc 194	210,00	0,23	0,29	32,41
Junc 195	209,00	0,11	0,13	48,97
Junc 196	214,00	0,11	0,13	43,97
Junc 197	226,00	0,11	0,13	31,30
Junc 198	231,00	0,11	0,13	25,64
Junc 199	242,00	0,11	0,13	14,41
Junc 200	232,00	0,11	0,13	24,59
Junc 201	215,00	0,11	0,13	42,22
Junc 202	221,00	0,11	0,13	37,62
Junc 203	212,00	0,11	0,13	46,52
Junc 204	209,00	0,11	0,13	49,85
Junc 205	219,00	0,11	0,13	39,84
Junc 206	213,00	0,11	0,13	45,82
Junc 207	211,00	0,11	0,13	47,84
Junc 208	225,00	0,11	0,13	33,83
Junc 209	225,00	0,00	0,00	33,83

Junc 210	219,00	0,11	0,13	39,82
Junc 211	212,00	0,04	0,05	46,27
Junc 212	226,00	0,04	0,05	32,18
Junc 213	223,00	0,04	0,05	35,24
Junc 214	204,00	0,04	0,05	54,25
Junc 215	201,00	0,04	0,05	57,27
Junc 216	215,00	0,04	0,05	43,18
Junc 217	195,00	0,04	0,05	63,28
Junc 218	192,00	0,04	0,05	66,25
Junc 219	195,00	0,04	0,05	63,28
Junc 220	199,00	0,04	0,05	59,26
Junc 221	192,00	0,04	0,05	66,30
Junc 222	190,00	0,04	0,05	68,28
Junc 223	193,00	0,04	0,05	65,30
Junc 224	198,00	0,04	0,05	60,27
Junc 225	194,00	0,04	0,05	64,32
Junc 226	199,00	0,04	0,05	59,29
Junc 227	196,00	0,04	0,05	62,32
Junc 228	206,00	0,04	0,05	52,27
Junc 229	202,00	0,04	0,05	56,31
Junc 230	206,00	0,04	0,05	52,28
Junc 231	201,00	0,04	0,05	57,31
Junc 232	203,00	0,04	0,05	55,29
Junc 233	205,00	0,04	0,05	53,04
Junc 234	204,00	0,04	0,05	54,01
Junc 235	210,00	0,04	0,05	48,03
Junc 236	208,00	0,04	0,05	49,98
Junc 237	201,00	0,11	0,13	57,75
Junc 238	196,00	0,11	0,13	63,15
Junc 239	192,00	0,11	0,13	67,15
Junc 240	196,00	0,11	0,13	63,10
Junc 241	195,00	0,11	0,13	64,10
Junc 242	193,00	0,11	0,13	66,09
Junc 243	198,00	0,11	0,13	61,15
Junc 244	194,00	0,11	0,13	65,15
Junc 245	119,00	0,04	0,05	140,32
Junc 246	227,00	0,04	0,05	32,30
Junc 247	230,00	0,04	0,05	29,24
Junc 248	234,00	0,04	0,05	25,29
Junc 249	218,00	0,04	0,05	41,54
Junc 250	229,00	0,04	0,05	30,54
Junc 251	217,00	0,04	0,05	42,37
Junc 252	220,00	0,04	0,05	39,32
Junc 253	212,00	0,04	0,05	47,18
Junc 254	230,00	0,04	0,05	29,41
Junc 255	242,00	0,04	0,06	17,85
Junc 256	231,00	0,04	0,05	28,84
Junc 257	228,00	0,04	0,05	31,53
Junc 258	218,00	0,04	0,05	41,52
Junc 259	212,00	0,04	0,05	47,52
Junc 260	216,00	0,04	0,05	43,49
Junc 261	222,00	0,04	0,05	37,55
Junc 262	220,00	0,04	0,05	39,17

Junc 263	216,00	0,04	0,05	43,12
Junc 264	214,00	0,04	0,05	45,11
Junc 265	222,00	0,04	0,05	37,55
Junc 266	227,00	0,04	0,05	32,53
Junc 267	228,00	0,04	0,05	31,51
Junc 268	220,00	0,04	0,05	39,55
Junc 269	221,00	0,04	0,05	38,62
Junc 270	232,00	0,04	0,05	27,58
Junc 271	213,00	0,11	0,13	45,66
Junc 272	206,00	0,11	0,13	52,59
Junc 273	198,00	0,11	0,13	60,85
Junc 274	197,00	0,11	0,13	60,69
Junc 275	204,00	0,11	0,13	54,60
Junc 276	196,00	0,11	0,13	62,80
Junc 277	196,00	0,11	0,13	62,79
Junc 278	228,00	0,04	0,05	31,41
Junc 279	218,00	0,04	0,05	41,37
Junc 280	205,00	0,04	0,05	53,98
Junc 281	213,00	0,04	0,05	45,95
Junc 282	165,00	0,15	0,19	47,25
Junc 283	164,00	1,15	1,47	47,04
Junc 284	163,00	0,15	0,19	47,49
Junc 285	158,00	0,15	0,19	49,80
Junc 286	162,00	0,31	0,40	48,18
Junc 287	159,00	0,15	0,19	49,40
Junc 288	161,00	0,15	0,19	48,55
Junc 289	162,00	1,15	1,47	46,48
Junc 290	159,00	0,15	0,19	48,36
Junc 291	161,00	0,15	0,19	47,39
Junc 292	158,00	0,15	0,19	47,64
Junc 293	162,00	2,15	2,75	45,11
Junc 314	199,00	0,11	0,13	60,22
Junc 315	251,00	0,00	0,00	82,01
Junc 316	304,00	0,00	0,00	29,89
Junc 317	225,00	0,00	0,00	30,46
Junc 318	218,00	0,11	0,13	40,46
Junc 319	196,00	0,23	0,29	42,70
Junc 320	188,00	0,23	0,29	50,67
Junc 321	233,00	1,00	1,33	40,82
Junc 322	252,00	1,20	1,60	26,69
Junc 323	**185,00**	**10,24**	**0,00**	**52,89**
Junc 324	163,00	0,09	0,12	63,63
Junc 325	174,00	0,24	0,31	56,41
Junc 326	240,00	0,23	0,29	22,50
Junc 327	239,00	0,00	0,00	23,86
Junc 328	219,00	0,41	0,50	35,81
Junc 329	255,00	0,00	0,00	0,46
Junc 330	280,00	0,00	0,00	-14,62
Junc 331	190,00	0,20	0,26	54,65
Junc 332	190,00	0,23	0,29	48,41
Junc 333	185,00	0,23	0,29	53,38
Junc 334	190,00	0,20	0,26	54,63
Junc 335	190,00	0,20	0,26	54,61

Junc 336	165,00	0,15	0,19	54,35
Junc 338	210,00	0,00	0,00	31,76
Junc 343	200,00	0,00	0,00	40,91
Junc 349	209,00	0,23	0,29	34,00
Junc 350	174,00	0,24	0,31	55,00
Junc 351	200,00	0,00	0,00	20,00
Junc J1	186,00	0,11	0,13	72,49
Junc J2	203,00	0,23	0,29	35,43
Junc J3	193,00	0,24	0,31	37,56
Junc J4	167,00	0,09	0,12	43,46
Junc J5	200,00	0,00	0,00	40,93
Junc J6-Well Soljanuša	210,00	-6,31	-6,31	0,00
Junc J6	190,00	0,00	0,00	55,46
Junc J7-Well Hadžinavoda	190,00	-0,80	-0,80	0,00
Junc J7	216,00	0,23	0,29	25,41
Junc J8	205,00	0,23	0,29	35,60
Junc J9	191,00	0,00	0,00	48,30
Junc J10	307,00	0,12	0,15	23,01
Junc J11	270,00	0,05	0,06	59,99
Junc J12	242,00	0,00	0,00	18,35
Junc J13	370,00	0,00	0,00	0,00
Junc J17	307,00	0,00	0,00	0,00
Junc J18	163,00	0,00	0,00	47,34
Junc J19	175,00	0,00	0,00	50,68
Junc J15	330,00	0,00	0,00	0,11
Junc J20	330,00	0,00	0,00	0,11
Junc J14	350,00	0,00	0,00	0,00
Junc J16	350,00	0,00	0,00	16,26
Junc J21	328,00	0,00	0,00	2,11
Junc J22	328,00	0,00	0,00	0,00
Tank T1-R,Gaj	254,00		-8,56	5,92
Tank T2-R,DonjiDrafnici	286,00		3,13	1,20
Tank T3-R,GornjiDrafnici	368,00		2,16	1,57
Tank T4-R,Hurije	363,00		-0,94	1,59
Tank T5-R,Ritosici	243,00		-0,22	2,16
Tank T7-R,Pribava	240,00		-1,51	1,59
Tank T9-R,Bahici	253,00		-0,50	2,46
Tank T10-R,Drafnici	320,00		-5,84	0,10
Tank RK1	365,00		0,00	1,26
Tank RK2	330,00		0,34	0,11

Table 91: Calculation result during the maximum hourly consumption in 2010 – calculation results in the pipelines

Calculation results for 2010							
Pipeline	**Lenght**	**Diameter**	**Roughness**	**Flow**	**Speed**	**Unit loss**	**Status**
	m	mm	mm	LPS	m/s	m/km	
Pipe P1	15,56	277,60	0,10	21,12	0,35	0,44	Open
Pipe P2	318,67	198,20	0,10	8,08	0,26	0,40	Open
Pipe P3	266,51	141,00	0,10	7,78	0,50	2,00	Open
Pipe P4	44,64	141,00	0,10	3,76	0,24	0,52	Open
Pipe P5	380,65	141,00	0,10	2,15	0,14	0,19	Open
Pipe P6	148,76	141,00	0,10	1,88	0,12	0,15	Open

Pipe P7	298,90	97,00	0,10	1,74	0,24	0,81	Open
Pipe P8	139,91	97,00	0,10	1,48	0,20	0,60	Open
Pipe P9	258,81	97,00	0,10	0,67	0,09	0,15	Open
Pipe P10	125,53	65,00	0,40	0,54	0,16	0,81	Open
Pipe P11	205,76	100,00	0,40	0,40	0,05	0,06	Open
Pipe P12	409,87	50,00	0,40	0,27	0,14	0,84	Open
Pipe P13	56,30	50,00	0,40	0,13	0,07	0,20	Open
Pipe P14	75,36	141,00	0,10	3,24	0,21	0,40	Open
Pipe P15	88,59	141,00	0,10	3,07	0,20	0,36	Open
Pipe P16	385,88	97,00	0,10	2,08	0,28	1,12	Open
Pipe P17	408,28	97,00	0,10	1,87	0,25	0,91	Open
Pipe P18	322,63	97,00	0,10	1,81	0,25	0,87	Open
Pipe P19	122,72	198,20	0,10	30,64	0,99	4,82	Open
Pipe P20	353,06	198,20	0,10	24,84	0,81	3,23	Open
Pipe P21	159,53	198,20	0,10	24,31	0,79	3,11	Open
Pipe P22	277,81	198,20	0,10	24,02	0,78	3,03	Open
Pipe P23	44,30	141,00	0,10	18,82	1,21	10,63	Open
Pipe P24	305,75	141,00	0,10	14,88	0,95	6,79	Open
Pipe P25	100,46	97,00	0,10	8,12	1,10	14,19	Open
Pipe P26	1.074,11	141,00	0,10	0,31	0,02	0,00	Open
Pipe P27	210,53	97,00	0,10	1,02	0,14	0,31	Open
Pipe P28	218,76	97,00	0,10	0,90	0,12	0,25	Open
Pipe P29	1.172,15	300,00	0,40	21,12	0,30	0,36	Open
Pipe P30	841,85	141,00	0,10	-12,40	0,79	4,80	Open
Pipe P31	454,36	66,00	0,10	0,54	0,16	0,65	Open
Pipe P32	1.057,59	200,00	0,40	-16,00	0,51	1,67	Open
Pipe P33	336,37	79,00	0,10	-3,04	0,62	6,21	Open
Pipe P34	364,50	55,40	0,10	0,66	0,28	2,19	Open
Pipe P35	8,13	55,40	0,10	0,00	0,00	0,00	Closed
Pipe P36	565,31	198,20	0,10	-16,00	0,52	1,41	Open
Pipe P37	186,87	198,20	0,10	-16,00	0,52	1,41	Open
Pipe P38	190,70	141,00	0,10	8,00	0,51	2,10	Open
Pipe P39	434,65	198,20	0,10	-8,00	0,26	0,39	Open
Pipe P40	232,65	55,40	0,10	6,06	2,51	141,40	Open
Pipe P41	47,03	149,00	0,40	2,00	0,11	0,14	Open
Pipe P42	55,42	141,00	0,10	14,73	0,94	6,65	Open
Pipe P43	187,81	97,00	0,10	4,01	0,54	3,73	Open
Pipe P44	138,86	141,00	0,10	-8,00	0,51	2,10	Open
Pipe P45	188,94	97,00	0,10	-3,99	0,54	3,71	Open
Pipe P48	1.053,20	123,40	0,10	2,00	0,17	0,32	Open
Pipe P49	850,93	97,00	0,10	0,00	0,00	0,00	Open
Pipe P50	2.207,74	55,40	0,10	0,94	0,39	4,11	Open
Pipe P51	789,44	79,00	0,10	3,04	0,62	6,21	Open
Pipe P52	79,97	55,40	0,10	3,04	1,26	37,33	Open
Pipe P54	147,54	141,00	0,10	6,44	0,41	1,41	Open
Pipe P55	56,32	123,40	0,10	3,07	0,26	0,69	Open
Pipe P56	72,05	50,00	0,40	0,92	0,47	8,66	Open
Pipe P57	55,30	50,00	0,40	0,31	0,16	1,08	Open
Pipe P58	141,84	50,00	0,40	0,31	0,16	1,08	Open
Pipe P59	72,11	97,00	0,10	0,31	0,04	0,04	Open
Pipe P60	23,93	141,00	0,10	1,84	0,12	0,14	Open
Pipe P61	74,62	141,00	0,10	1,54	0,10	0,10	Open
Pipe P62	15,13	55,40	0,10	0,31	0,13	0,55	Open

Pipe P63	55,64	97,00	0,10	0,92	0,12	0,26	Open
Pipe P64	169,45	55,40	0,10	0,31	0,13	0,55	Open
Pipe P65	154,85	79,00	0,10	0,31	0,06	0,10	Open
Pipe P66	85,87	80,00	0,40	-0,88	0,18	0,72	Open
Pipe P67	444,00	55,40	0,10	0,29	0,12	0,51	Open
Pipe P68	365,91	80,00	0,40	-1,47	0,29	1,88	Open
Pipe P69	401,41	50,00	0,40	0,29	0,15	1,00	Open
Pipe P70	17,42	97,00	0,10	0,23	0,03	0,02	Open
Pipe P71	82,52	97,00	0,10	-2,59	0,35	1,66	Open
Pipe P72	253,01	97,00	0,10	-3,18	0,43	2,42	Open
Pipe P73	60,30	97,00	0,10	0,29	0,04	0,03	Open
Pipe P74	214,93	55,40	0,10	0,05	0,02	0,02	Open
Pipe P75	103,54	97,00	0,10	0,88	0,12	0,24	Open
Pipe P76	110,01	66,00	0,10	0,29	0,09	0,22	Open
Pipe P77	70,73	97,00	0,10	0,29	0,04	0,03	Open
Pipe P78	69,19	55,40	0,10	0,29	0,12	0,51	Open
Pipe P80	464,90	55,40	0,10	0,33	0,14	0,62	Open
Pipe P81	135,55	50,00	0,40	0,05	0,03	0,04	Open
Pipe P83	404,27	79,00	0,10	0,12	0,02	0,01	Open
Pipe P84	188,65	97,00	0,10	0,12	0,02	0,01	Open
Pipe P85	105,12	26,00	0,40	0,12	0,22	4,86	Open
Pipe P86	53,80	66,00	0,10	0,12	0,03	0,03	Open
Pipe P87	89,43	26,00	0,40	0,12	0,22	4,86	Open
Pipe P88	355,63	79,00	0,10	3,07	0,63	6,34	Open
Pipe P89	145,64	66,00	0,10	1,84	0,54	6,00	Open
Pipe P90	565,82	66,00	0,10	0,31	0,09	0,24	Open
Pipe P91	260,89	97,00	0,10	1,23	0,17	0,43	Open
Pipe P92	147,59	66,00	0,10	0,92	0,27	1,68	Open
Pipe P93	268,79	55,40	0,10	0,31	0,13	0,55	Open
Pipe P94	106,59	50,00	0,40	0,31	0,16	1,08	Open
Pipe P95	131,49	66,00	0,10	0,92	0,27	1,68	Open
Pipe P96	99,63	55,40	0,10	0,31	0,13	0,55	Open
Pipe P97	165,38	55,40	0,10	0,31	0,13	0,55	Open
Pipe P98	70,04	66,00	0,10	0,31	0,09	0,24	Open
Pipe P99	182,63	123,40	0,10	0,12	0,01	0,00	Open
Pipe P100	51,57	26,00	0,40	0,12	0,22	4,86	Open
Pipe P101	136,65	55,40	0,10	0,12	0,05	0,06	Open
Pipe P102	90,12	26,00	0,40	0,12	0,22	4,86	Open
Pipe P103	87,39	55,40	0,10	0,12	0,05	0,06	Open
Pipe P104	105,04	26,00	0,40	0,12	0,22	4,86	Open
Pipe P105	205,31	66,00	0,10	0,21	0,06	0,12	Open
Pipe P106	171,28	55,40	0,10	0,12	0,05	0,06	Open
Pipe P107	138,34	97,00	0,10	3,76	0,51	3,32	Open
Pipe P108	84,84	55,40	0,10	0,05	0,02	0,02	Open
Pipe P109	702,22	55,40	0,10	0,74	0,31	2,63	Open
Pipe P110	90,92	55,40	0,10	0,05	0,02	0,02	Open
Pipe P111	46,92	150,00	0,40	0,69	0,04	0,02	Open
Pipe P112	236,78	66,00	0,10	-0,13	0,04	0,04	Open
Pipe P113	463,94	100,00	0,40	0,29	0,04	0,03	Open
Pipe P114	245,36	80,00	0,40	-0,31	0,06	0,10	Open
Pipe P115	22,70	97,00	0,10	9,04	1,22	17,42	Open
Pipe P116	10,74	97,00	0,10	8,43	1,14	15,23	Open
Pipe P117	196,44	97,00	0,10	2,27	0,31	1,30	Open

Pipe P118	71,88	55,40	0,10	1,84	0,76	14,44	Open
Pipe P119	86,27	55,40	0,10	1,23	0,51	6,76	Open
Pipe P120	166,84	50,00	0,40	0,92	0,47	8,66	Open
Pipe P121	337,39	55,40	0,10	0,31	0,13	0,55	Open
Pipe P122	1.060,72	97,00	0,10	0,12	0,02	0,01	Open
Pipe P123	436,77	50,00	0,40	-0,31	0,16	1,08	Open
Pipe P124	3,69	97,00	0,10	-0,61	0,08	0,13	Open
Pipe P125	88,62	26,00	0,40	0,12	0,22	4,86	Open
Pipe P126	61,56	66,00	0,10	1,05	0,31	2,12	Open
Pipe P127	7,79	66,00	0,10	0,88	0,26	1,55	Open
Pipe P128	59,77	40,00	0,40	0,17	0,13	1,08	Open
Pipe P129	112,21	66,00	0,10	-0,29	0,09	0,22	Open
Pipe P130	138,81	55,40	0,10	0,29	0,12	0,51	Open
Pipe P131	151,50	97,00	0,10	1,67	0,23	0,74	Open
Pipe P132	289,54	80,00	0,40	0,59	0,12	0,34	Open
Pipe P133	97,86	60,00	0,40	0,13	0,05	0,06	Open
Pipe P134	116,76	97,00	0,10	-0,27	0,04	0,03	Open
Pipe P135	416,38	97,00	0,10	1,21	0,16	0,42	Open
Pipe P136	213,39	79,00	0,10	0,40	0,08	0,16	Open
Pipe P137	148,66	55,40	0,10	0,13	0,06	0,10	Open
Pipe P138	239,06	55,40	0,10	0,27	0,11	0,44	Open
Pipe P139	148,48	60,00	0,40	-0,29	0,10	0,40	Open
Pipe P140	249,52	80,00	0,40	-0,10	0,02	0,01	Open
Pipe P141	77,28	66,00	0,10	0,67	0,20	0,94	Open
Pipe P142	212,57	55,40	0,10	0,13	0,06	0,10	Open
Pipe P143	118,25	50,00	0,40	0,40	0,21	1,79	Open
Pipe P144	111,66	50,00	0,40	0,13	0,07	0,20	Open
Pipe P145	139,14	40,00	0,40	0,13	0,11	0,73	Open
Pipe P146	294,58	79,00	0,10	0,35	0,07	0,12	Open
Pipe P147	175,58	141,00	0,10	1,57	0,10	0,11	Open
Pipe P148	39,04	97,00	0,10	1,80	0,24	0,86	Open
Pipe P149	149,09	80,00	0,40	1,21	0,24	1,30	Open
Pipe P150	62,68	66,00	0,10	0,88	0,26	1,55	Open
Pipe P151	56,38	66,00	0,10	0,59	0,17	0,75	Open
Pipe P152	103,91	50,00	0,40	0,29	0,15	1,00	Open
Pipe P153	66,10	80,00	0,40	2,52	0,50	5,29	Open
Pipe P154	79,16	97,00	0,10	2,23	0,30	1,26	Open
Pipe P155	257,89	66,00	0,10	0,23	0,07	0,14	Open
Pipe P156	119,49	79,00	0,10	0,12	0,02	0,01	Open
Pipe P157	1,24	97,00	0,10	5,53	0,75	6,83	Open
Pipe P158	210,73	97,00	0,10	5,24	0,71	6,18	Open
Pipe P159	43,04	97,00	0,10	4,78	0,65	5,20	Open
Pipe P160	62,38	141,00	0,10	2,50	0,16	0,25	Open
Pipe P161	197,73	141,00	0,10	2,96	0,19	0,34	Open
Pipe P162	22,57	141,00	0,10	2,73	0,17	0,29	Open
Pipe P163	9,72	55,40	0,10	0,23	0,10	0,33	Open
Pipe P164	79,05	141,00	0,10	2,15	0,14	0,19	Open
Pipe P165	85,35	141,00	0,10	1,92	0,12	0,16	Open
Pipe P166	6,32	97,00	0,10	0,00	0,00	0,00	Closed
Pipe P167	401,29	97,00	0,10	-3,38	0,46	2,72	Open
Pipe P168	13,58	97,00	0,10	1,15	0,16	0,38	Open
Pipe P169	229,46	97,00	0,10	0,92	0,12	0,26	Open
Pipe P170	104,84	97,00	0,10	0,69	0,09	0,15	Open

Pipe P171	43,86	97,00	0,10	0,46	0,06	0,08	Open
Pipe P172	128,37	66,00	0,10	0,67	0,20	0,95	Open
Pipe P173	51,92	66,00	0,10	0,12	0,03	0,03	Open
Pipe P174	145,60	97,00	0,10	0,35	0,05	0,05	Open
Pipe P175	160,72	97,00	0,10	0,12	0,02	0,01	Open
Pipe P176	229,35	97,00	0,10	5,13	0,69	5,93	Open
Pipe P177	113,38	97,00	0,10	5,01	0,68	5,68	Open
Pipe P178	1,53	141,00	0,10	22,55	1,44	15,05	Open
Pipe P179	29,94	141,00	0,10	20,78	1,33	12,86	Open
Pipe P180	1,40	97,00	0,10	-1,18	0,16	0,40	Open
Pipe P181	17,04	97,00	0,10	0,00	0,00	0,00	Open
Pipe P182	171,95	97,00	0,10	-0,59	0,08	0,12	Open
Pipe P183	10,22	97,00	0,10	-1,37	0,19	0,52	Open
Pipe P184	1,69	97,00	0,10	-1,76	0,24	0,81	Open
Pipe P185	124,20	198,20	0,10	28,90	0,94	4,31	Open
Pipe P186	20,36	198,20	0,10	25,13	0,81	3,31	Open
Pipe P187	383,50	55,40	0,10	2,82	1,17	32,38	Open
Pipe P188	13,11	55,40	0,10	2,82	1,17	32,38	Open
Pipe P189	8,99	141,00	0,10	1,47	0,09	0,10	Open
Pipe P190	248,07	141,00	0,10	0,29	0,02	0,00	Open
Pipe P191	65,68	198,20	0,10	32,26	1,05	5,32	Open
Pipe P192	248,81	198,20	0,10	31,23	1,01	5,00	Open
Pipe P193	154,00	55,40	0,10	0,94	0,39	4,12	Open
Pipe P194	36,01	55,40	0,10	0,13	0,06	0,10	Open
Pipe P195	300,89	55,40	0,10	0,67	0,28	2,23	Open
Pipe P196	118,09	40,00	0,40	0,40	0,32	5,62	Open
Pipe P197	313,40	40,00	0,40	0,13	0,11	0,73	Open
Pipe P198	65,47	40,00	0,40	0,13	0,11	0,73	Open
Pipe P199	117,50	40,00	0,40	0,13	0,11	0,73	Open
Pipe P200	125,91	40,00	0,40	0,13	0,11	0,73	Open
Pipe P201	241,44	97,00	0,10	0,81	0,11	0,20	Open
Pipe P202	136,94	97,00	0,10	0,54	0,07	0,10	Open
Pipe P203	140,58	55,40	0,10	0,13	0,06	0,10	Open
Pipe P204	124,76	55,40	0,10	0,13	0,06	0,10	Open
Pipe P205	42,02	97,00	0,10	0,27	0,04	0,03	Open
Pipe P206	5,96	97,00	0,10	0,00	0,00	0,00	Open
Pipe P207	127,02	55,40	0,10	0,13	0,06	0,10	Open
Pipe P208	33,28	79,00	0,10	0,16	0,03	0,02	Open
Pipe P209	128,83	26,00	0,40	0,05	0,10	0,69	Open
Pipe P210	38,53	26,00	0,40	0,05	0,10	0,69	Open
Pipe P211	35,85	26,00	0,40	0,05	0,10	0,69	Open
Pipe P212	132,20	26,00	0,40	0,05	0,10	0,69	Open
Pipe P213	46,16	26,00	0,40	0,05	0,10	0,69	Open
Pipe P214	40,42	26,00	0,40	0,05	0,10	0,69	Open
Pipe P215	29,46	26,00	0,40	0,05	0,10	0,69	Open
Pipe P216	40,07	26,00	0,40	0,05	0,10	0,69	Open
Pipe P217	45,37	26,00	0,40	0,05	0,10	0,69	Open
Pipe P218	61,35	26,00	0,40	0,05	0,10	0,69	Open
Pipe P219	43,63	26,00	0,40	0,05	0,10	0,69	Open
Pipe P220	34,49	26,00	0,40	0,05	0,10	0,69	Open
Pipe P221	45,96	26,00	0,40	0,05	0,10	0,69	Open
Pipe P222	58,72	26,00	0,40	0,05	0,10	0,69	Open
Pipe P223	126,20	55,40	0,10	0,13	0,06	0,10	Open

Pipe P224	118,12	79,00	0,10	0,13	0,03	0,01	Open
Pipe P225	26,30	55,40	0,10	0,13	0,06	0,10	Open
Pipe P226	75,64	55,40	0,10	0,13	0,06	0,10	Open
Pipe P227	55,44	55,40	0,10	0,13	0,06	0,10	Open
Pipe P228	80,00	50,00	0,40	0,16	0,08	0,35	Open
Pipe P229	78,22	26,00	0,40	0,05	0,10	0,69	Open
Pipe P230	64,22	50,00	0,40	0,05	0,03	0,04	Open
Pipe P231	122,76	55,40	0,10	0,05	0,02	0,02	Open
Pipe P232	53,35	55,40	0,10	0,38	0,16	0,82	Open
Pipe P233	93,02	55,40	0,10	0,05	0,02	0,02	Open
Pipe P234	47,39	20,00	0,40	0,05	0,17	4,06	Open
Pipe P235	73,10	55,40	0,10	0,05	0,02	0,02	Open
Pipe P236	120,95	141,00	0,10	4,06	0,26	0,60	Open
Pipe P237	351,60	141,00	0,10	3,95	0,25	0,57	Open
Pipe P238	148,78	55,40	0,10	0,05	0,02	0,02	Open
Pipe P239	64,46	141,00	0,10	2,25	0,14	0,21	Open
Pipe P240	121,54	66,00	0,10	0,16	0,05	0,06	Open
Pipe P241	50,42	40,00	0,40	0,05	0,04	0,09	Open
Pipe P242	44,89	26,00	0,40	0,05	0,10	0,69	Open
Pipe P243	80,50	141,00	0,10	2,91	0,19	0,33	Open
Pipe P244	119,94	141,00	0,10	2,14	0,14	0,19	Open
Pipe P245	40,09	26,00	0,40	0,16	0,31	9,52	Open
Pipe P246	67,23	26,00	0,40	0,05	0,10	0,69	Open
Pipe P247	87,26	26,00	0,40	0,05	0,10	0,69	Open
Pipe P248	5,30	79,00	0,10	-0,55	0,11	0,28	Open
Pipe P249	28,43	26,00	0,40	0,05	0,10	0,69	Open
Pipe P250	36,62	79,00	0,10	0,05	0,01	0,01	Open
Pipe P251	175,10	32,00	0,40	0,05	0,07	0,23	Open
Pipe P252	86,44	40,00	0,40	0,13	0,11	0,73	Open
Pipe P253	46,08	20,00	0,40	0,13	0,43	25,17	Open
Pipe P254	91,38	55,40	0,10	0,13	0,06	0,10	Open
Pipe P255	66,65	55,40	0,10	0,13	0,06	0,10	Open
Pipe P256	63,76	26,00	0,40	0,05	0,10	0,69	Open
Pipe P257	39,80	26,00	0,40	0,05	0,10	0,69	Open
Pipe P258	120,79	97,00	0,10	0,00	0,00	0,00	Closed
Pipe P259	498,97	97,00	0,10	3,18	0,43	2,43	Open
Pipe P260	289,24	97,00	0,10	4,26	0,58	4,18	Open
Pipe P261	69,59	97,00	0,10	5,96	0,81	7,89	Open
Pipe P262	211,70	26,00	0,40	0,19	0,36	12,73	Open
Pipe P263	43,95	97,00	0,10	5,58	0,76	6,96	Open
Pipe P264	140,49	26,00	0,40	0,19	0,36	12,73	Open
Pipe P265	112,37	97,00	0,10	4,99	0,68	5,64	Open
Pipe P266	219,89	97,00	0,10	4,61	0,62	4,85	Open
Pipe P267	171,80	26,00	0,40	0,19	0,36	12,73	Open
Pipe P268	39,80	97,00	0,10	3,14	0,42	2,37	Open
Pipe P269	216,22	26,00	0,40	0,19	0,36	12,73	Open
Pipe P270	690,20	97,00	0,10	2,75	0,37	1,86	Open
Pipe P292	31,16	55,40	0,10	0,67	0,28	2,23	Open
Pipe P293	58,75	55,40	0,10	0,40	0,17	0,89	Open
Pipe P294	797,45	198,20	0,10	-16,00	0,52	1,41	Open
Pipe P295	620,81	198,20	0,10	-16,00	0,52	1,41	Open
Pipe P296	342,29	198,20	0,10	-16,00	0,52	1,41	Open
Pipe P297	59,04	60,00	0,40	0,66	0,23	1,79	Open

Pipe P298	101,00	60,00	0,40	0,55	0,19	1,27	Open
Pipe P299	36,90	79,00	0,10	-0,33	0,07	0,12	Open
Pipe P300	88,16	79,00	0,10	-0,44	0,09	0,19	Open
Pipe P301	385,52	55,40	0,10	0,29	0,12	0,51	Open
Pipe P302	2,18	55,40	0,10	-0,11	0,04	0,05	Open
Pipe P304	278,60	97,00	0,10	0,29	0,04	0,03	Open
Pipe P305	32,75	97,00	0,10	0,00	0,00	0,00	Closed
Pipe P306	20,33	50,00	0,40	0,79	0,40	6,37	Open
Pipe P307	88,93	50,00	0,40	0,49	0,25	2,61	Open
Pipe P308	276,68	50,00	0,40	-1,33	0,68	17,61	Open
Pipe P309	245,10	55,40	0,10	-2,93	1,21	34,72	Open
Pipe P310	58,11	141,00	0,10	17,84	1,14	9,59	Open
Pipe P311	503,60	141,00	0,10	17,84	1,14	9,59	Open
Pipe P312	140,90	55,40	0,10	0,00	0,00	0,00	Open
Pipe P313	434,56	26,00	0,40	-0,12	0,22	4,86	Open
Pipe P314	369,00	97,00	0,10	-3,99	0,54	3,71	Open
Pipe P315	132,83	97,00	0,10	-4,30	0,58	4,26	Open
Pipe P316	1.625,33	97,00	0,10	2,33	0,31	1,36	Open
Pipe P317	208,76	97,00	0,10	2,62	0,35	1,70	Open
Pipe P318	1.357,10	97,00	0,10	2,62	0,35	1,70	Open
Pipe P319	1.363,17	55,40	0,10	0,00	0,00	0,00	Open
Pipe P320	1.176,53	66,00	0,10	0,50	0,14	0,55	Open
Pipe P321	1.125,52	79,00	0,10	-0,62	0,13	0,34	Open
Pipe P322	419,83	66,00	0,10	0,77	0,22	1,20	Open
Pipe P323	403,35	80,00	0,40	0,59	0,12	0,34	Open
Pipe P324	320,99	80,00	0,40	0,29	0,06	0,10	Open
Pipe P325	112,69	66,00	0,10	0,26	0,07	0,17	Open
Pipe P326	235,05	66,00	0,10	0,26	0,07	0,17	Open
Pipe P327	495,40	100,00	0,40	-7,63	0,97	14,33	Open
Pipe P330	323,23	141,00	0,10	-7,82	0,50	2,02	Open
Pipe P331	328,22	141,00	0,10	-7,82	0,50	2,02	Open
Pipe P332	641,81	198,20	0,10	-6,31	0,20	0,25	Open
Pipe P340	207,91	55,40	0,10	0,13	0,06	0,10	Open
Pipe 1	1,01	55,40	0,10	3,04	1,26	37,32	Open
Pipe Pi2	2,00	66,00	0,10	-0,50	0,14	0,55	Open
Pipe Pi4	0,01	66,00	0,10	-0,22	0,07	0,00	Open
Pipe Pi5	2,00	66,00	0,10	0,00	0,00	0,00	Closed
Pipe Pi6	10,00	100,00	0,40	0,00	0,00	0,00	Closed
Pipe Pi7	2,00	100,00	0,40	0,00	0,00	0,00	Closed
Pipe Pi9	20,59	141,00	0,10	7,65	0,49	1,94	Open
Pipe Pi10	42,77	141,00	0,10	6,84	0,44	1,57	Open
Pipe Pi11	32,57	141,00	0,10	6,58	0,42	1,46	Open
Pipe Pi12	75,11	141,00	0,10	4,03	0,26	0,59	Open
Pipe Pi13	51,45	80,00	0,40	1,48	0,29	1,89	Open
Pipe Pi14	1,67	141,00	0,10	2,96	0,19	0,33	Open
Pipe Pi15	14,50	141,00	0,10	3,13	0,20	0,37	Open
Pipe Pi16	95,94	55,40	0,10	0,27	0,11	0,45	Open
Pipe Pi17	0,01	198,20	0,10	8,00	0,26	0,00	Open
Pipe Pi18	128,93	97,00	0,10	2,62	0,35	1,70	Open
Pipe Pi19	11,02	79,00	0,10	0,67	0,14	0,40	Open
Pipe Pi20	138,46	97,00	0,10	0,94	0,13	0,27	Open
Pipe Pi21	40,33	79,00	0,10	0,82	0,17	0,57	Open
Pipe Pi22	8,35	79,00	0,10	0,71	0,15	0,44	Open

Pipe Pi23	37,70	79,00	0,10	0,60	0,12	0,33	Open
Pipe Pi24	17,25	79,00	0,10	0,49	0,10	0,23	Open
Pipe Pi25	50,06	79,00	0,10	0,38	0,08	0,15	Open
Pipe Pi26	32,70	79,00	0,10	0,27	0,06	0,08	Open
Pipe Pi27	54,04	97,00	0,10	0,49	0,07	0,09	Open
Pipe Pi28	51,41	97,00	0,10	0,38	0,05	0,06	Open
Pipe Pi29	56,21	97,00	0,10	0,27	0,04	0,03	Open
Pipe Pi30	17,98	97,00	0,10	0,16	0,02	0,01	Open
Pipe Pi31	142,48	97,00	0,10	0,05	0,01	0,00	Open
Pipe Pi32	42,41	55,40	0,10	0,22	0,09	0,31	Open
Pipe Pi33	94,26	55,40	0,10	0,11	0,05	0,06	Open
Pipe Pi34	83,23	97,00	0,10	2,19	0,30	1,23	Open
Pipe Pi37	8,24	141,00	0,10	7,82	0,50	2,02	Open
Pipe Pi38	0,99	80,00	0,40	0,00	0,00	0,00	Closed
Pipe Pi40	11,02	66,00	0,10	0,80	0,23	1,30	Open
Pipe Pi3	346,92	55,40	0,10	0,22	0,09	0,30	Open
Pipe Pi35	513,95	55,40	0,10	0,06	0,03	0,03	Open
Pipe Pi41	76,91	50,00	0,40	0,31	0,16	1,08	Open
Pipe Pi42	1,13	97,00	0,10	1,25	0,17	0,44	Open
Pipe Pi1	2,00	141,00	0,10	8,00	0,51	2,10	Open
Pipe Pi8	1,75	200,00	0,10	16,00	0,51	1,34	Open
Pipe Pi36	0,01	200,00	0,40	15,66	0,50	0,00	Open
Pipe Pi39	0,03	200,00	0,40	12,40	0,39	1,24	Open
Pump Pu1-PSDrafnici				2,82	0,00	-62,32	Open
Pump Pu3-PSBahici				0,00	0,00	0,00	Closed
Pump Pu2-PSSoljanuša				6,31	0,00	-35,38	Open
Pump Pu4-HVoda				0,80	0,00	-58,00	Open
Pump Pu5-Sklop				21,12	0,00	-22,57	Open
Valve V1		200,00		30,94	0,98	15,32	Active
Valve V2		100,00		5,55	0,71	15,00	Active
Valve V3		150,00		7,82	0,44	20,91	Active
Valve V5		100,00		0,00	0,00	0,00	Closed
Valve V6		50,00		0,00	0,00	0,00	Closed
Valve V7		100,00		0,00	0,00	0,00	Closed
Valve V10		100,00		0,00	0,00	0,00	Closed
Valve V4		200,00		15,66	0,50	0,00	Open
Valve V8		200,00		16,00	0,51	30,83	Active
Valve V9		100,00		12,40	1,58	65,78	Active
Total:	**65.472,58**						

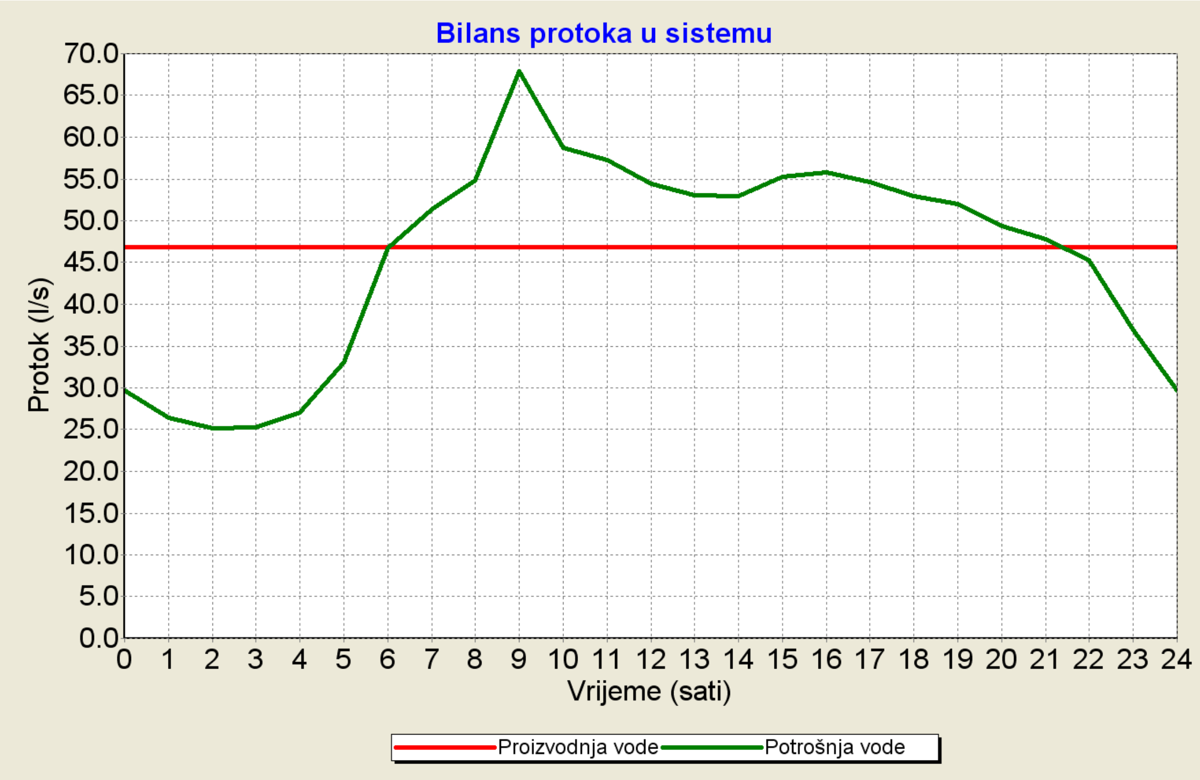
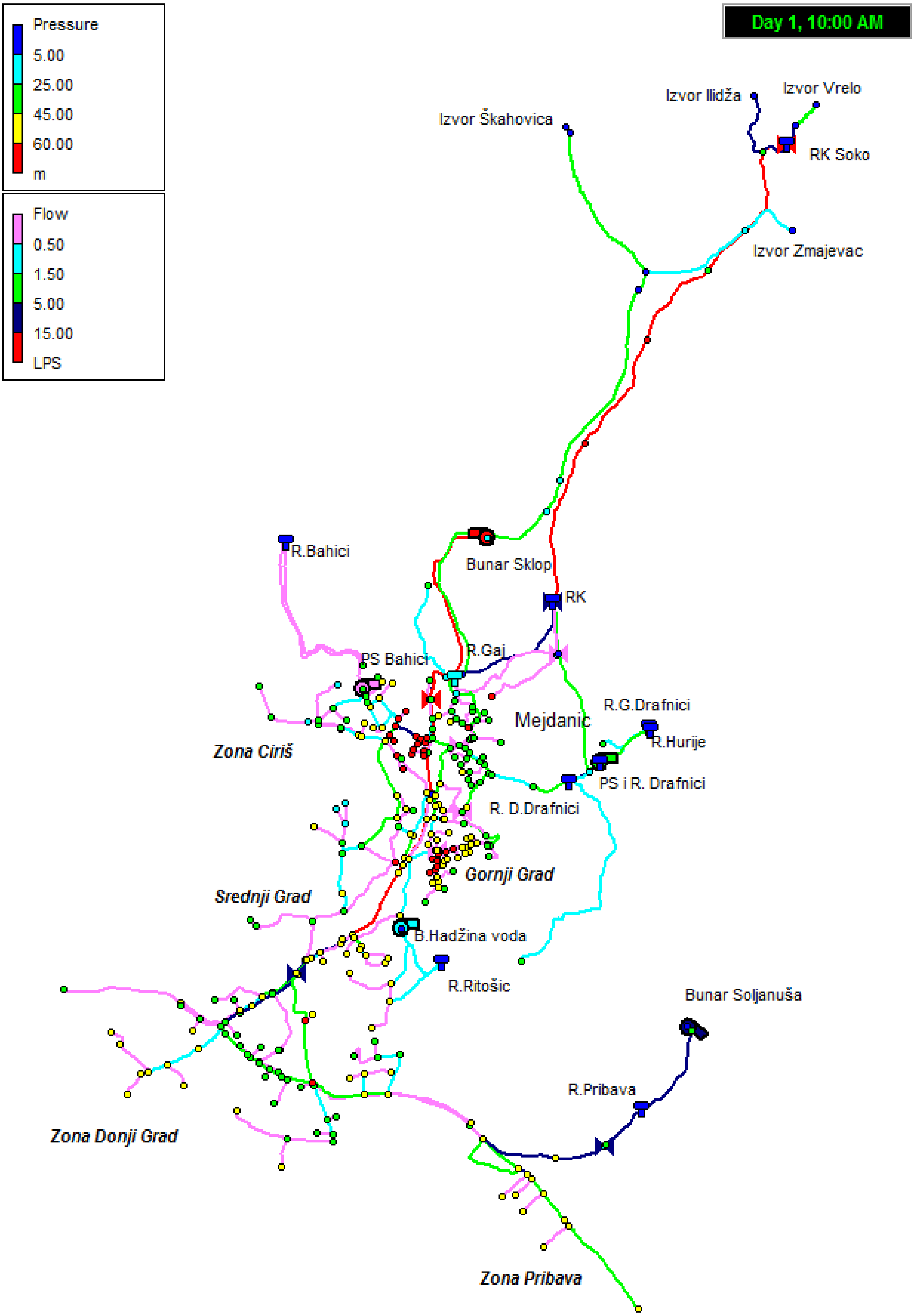
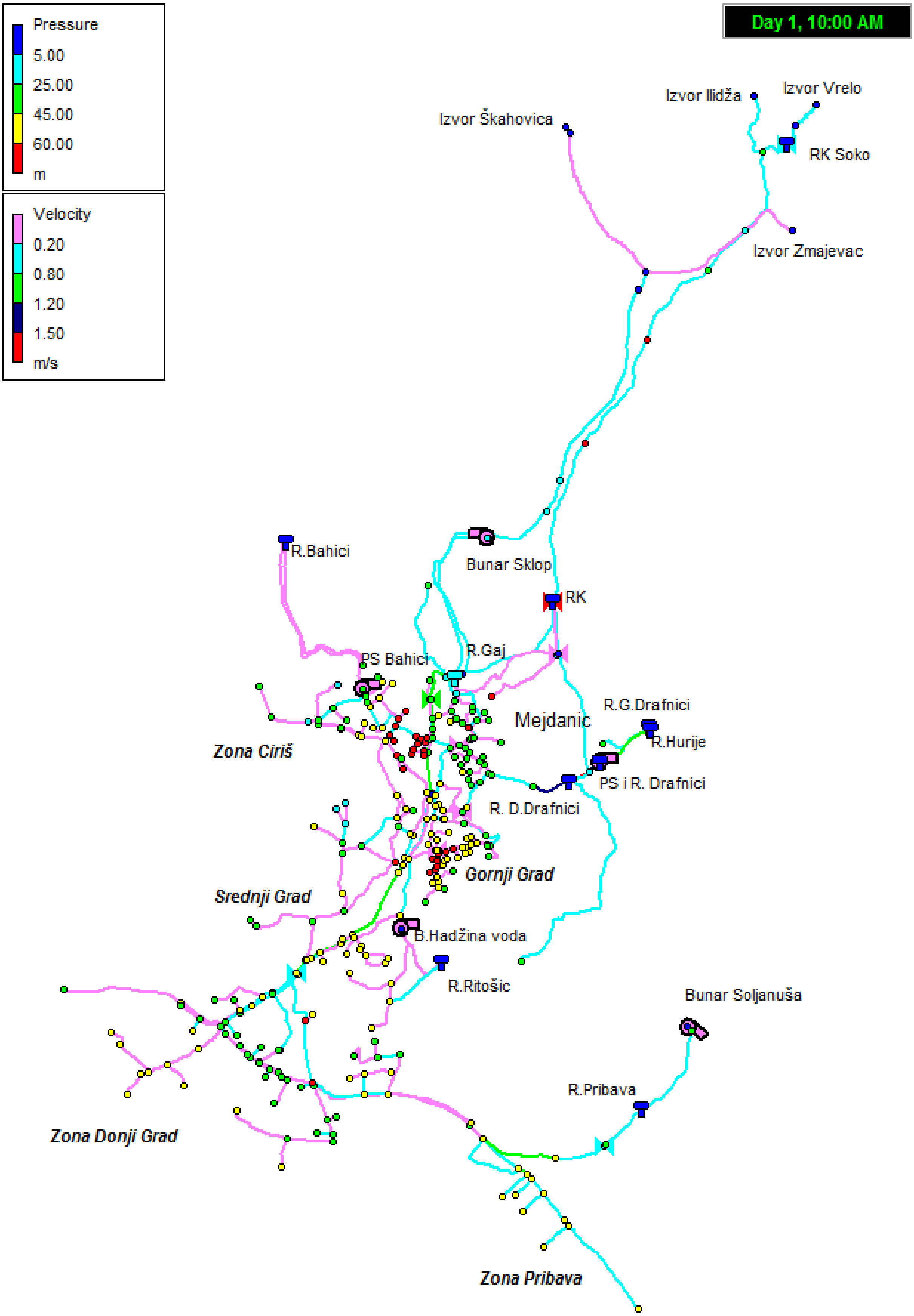


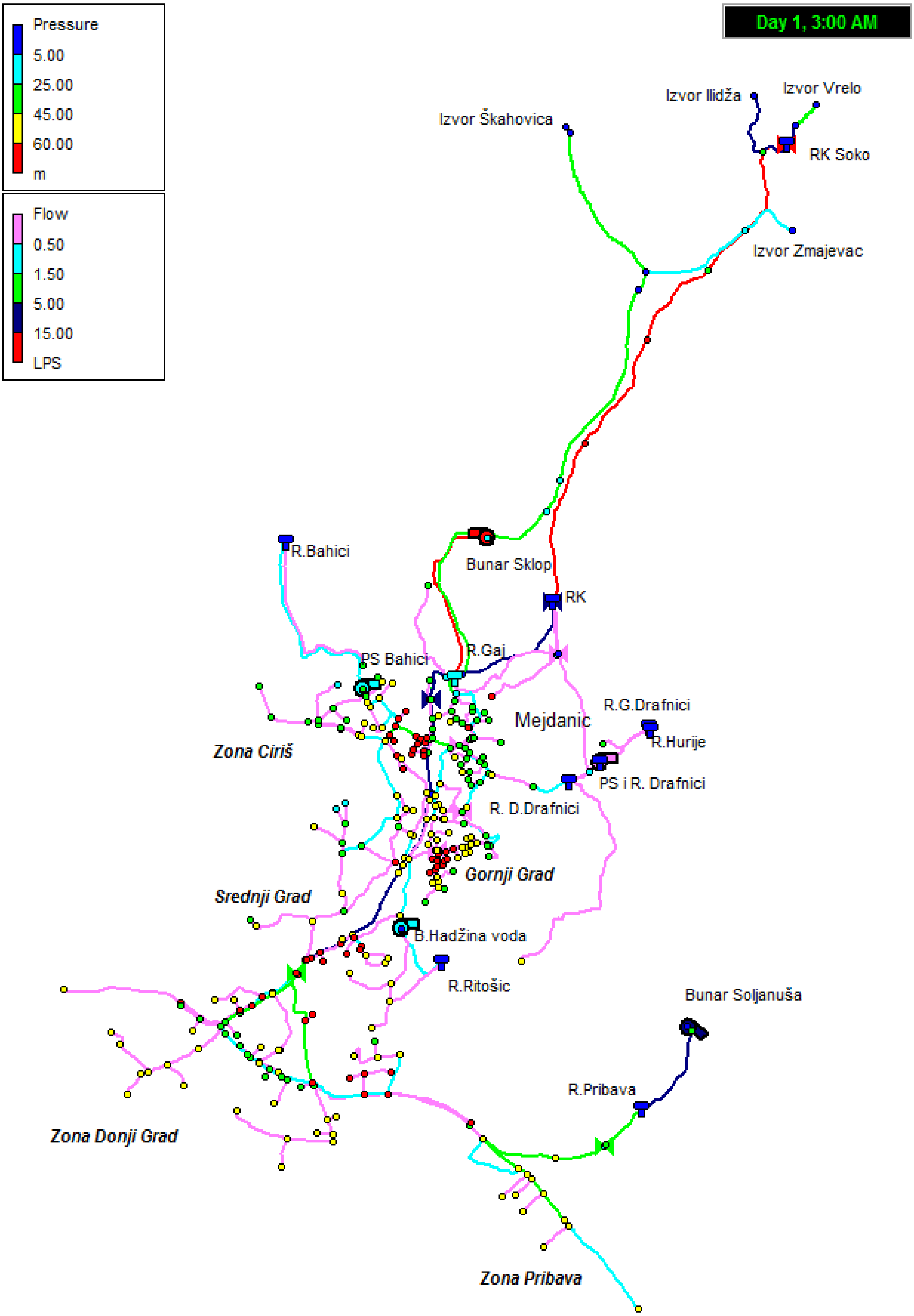
Chart 17: Chart of flow in the system – production - consumption



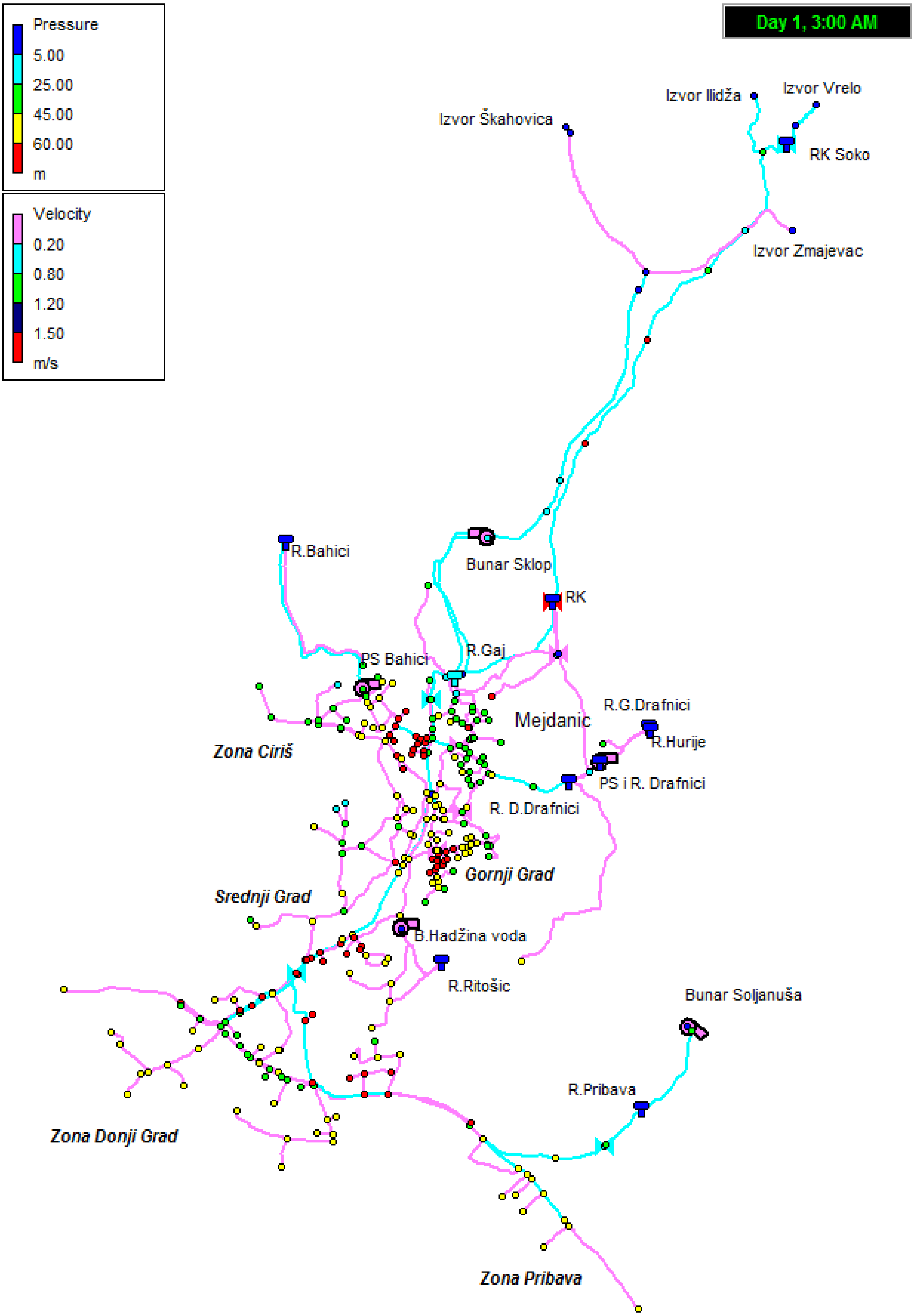
Scheme 4: Scheme of WSS Gračanica – flow and pressures in the period of maximumhourly consumption - 2010



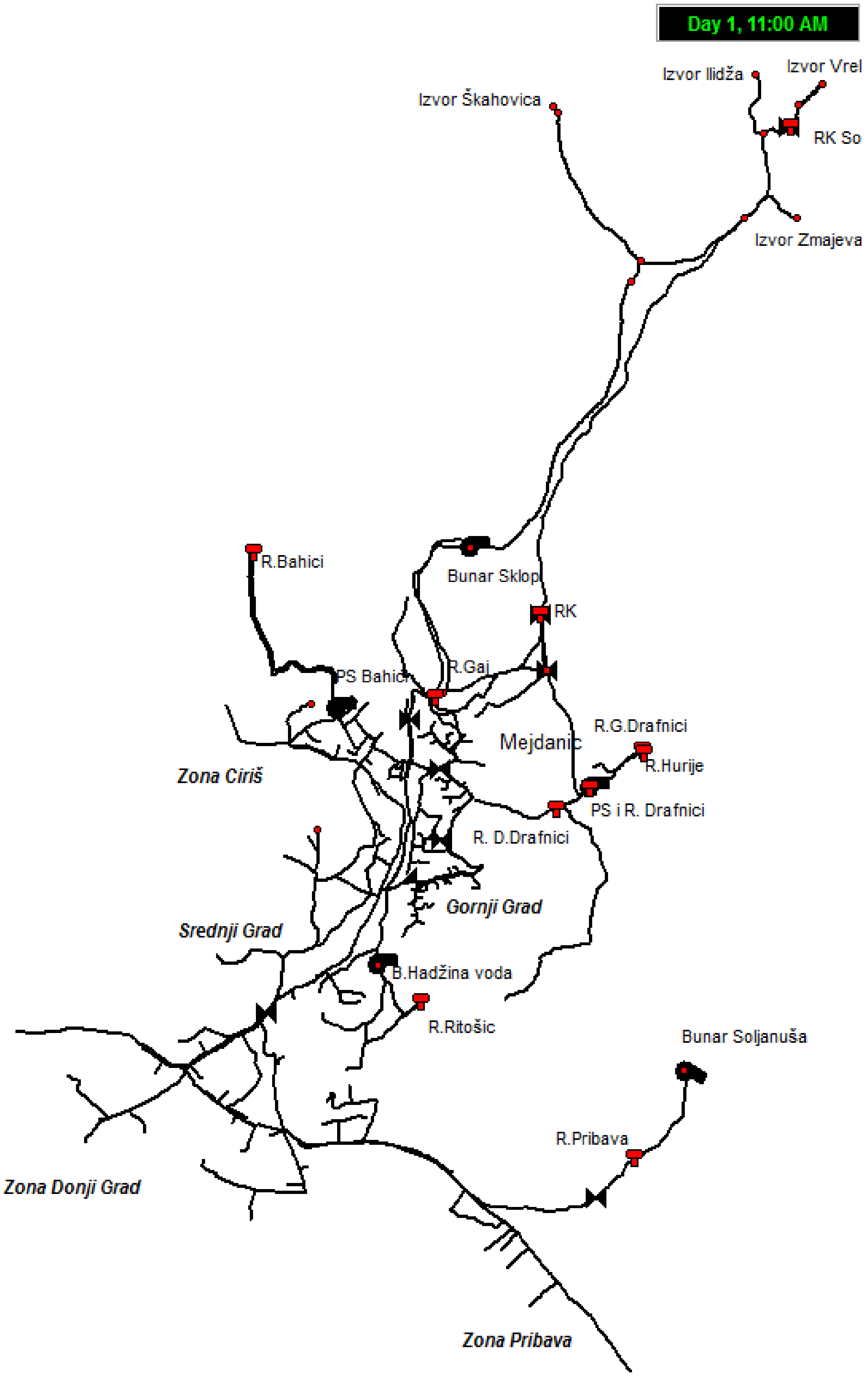
Scheme 5: Scheme of WSS Gračanica - velocities and pressures in the period of maximum hourly consumption - 2010



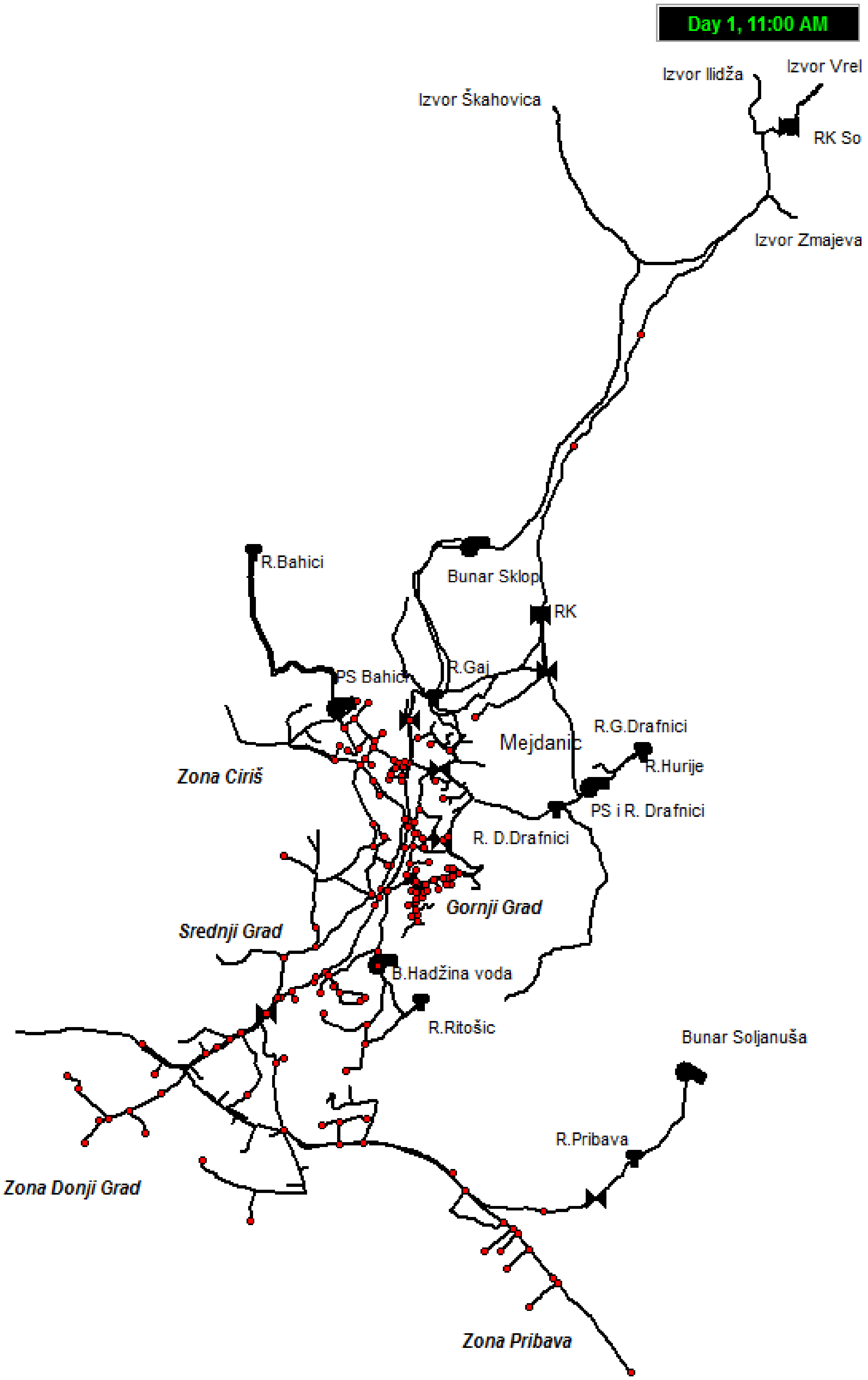
Scheme 6: Scheme of WSS Gračanica - flow and pressures in the period of minimum hourly consumption - 2010



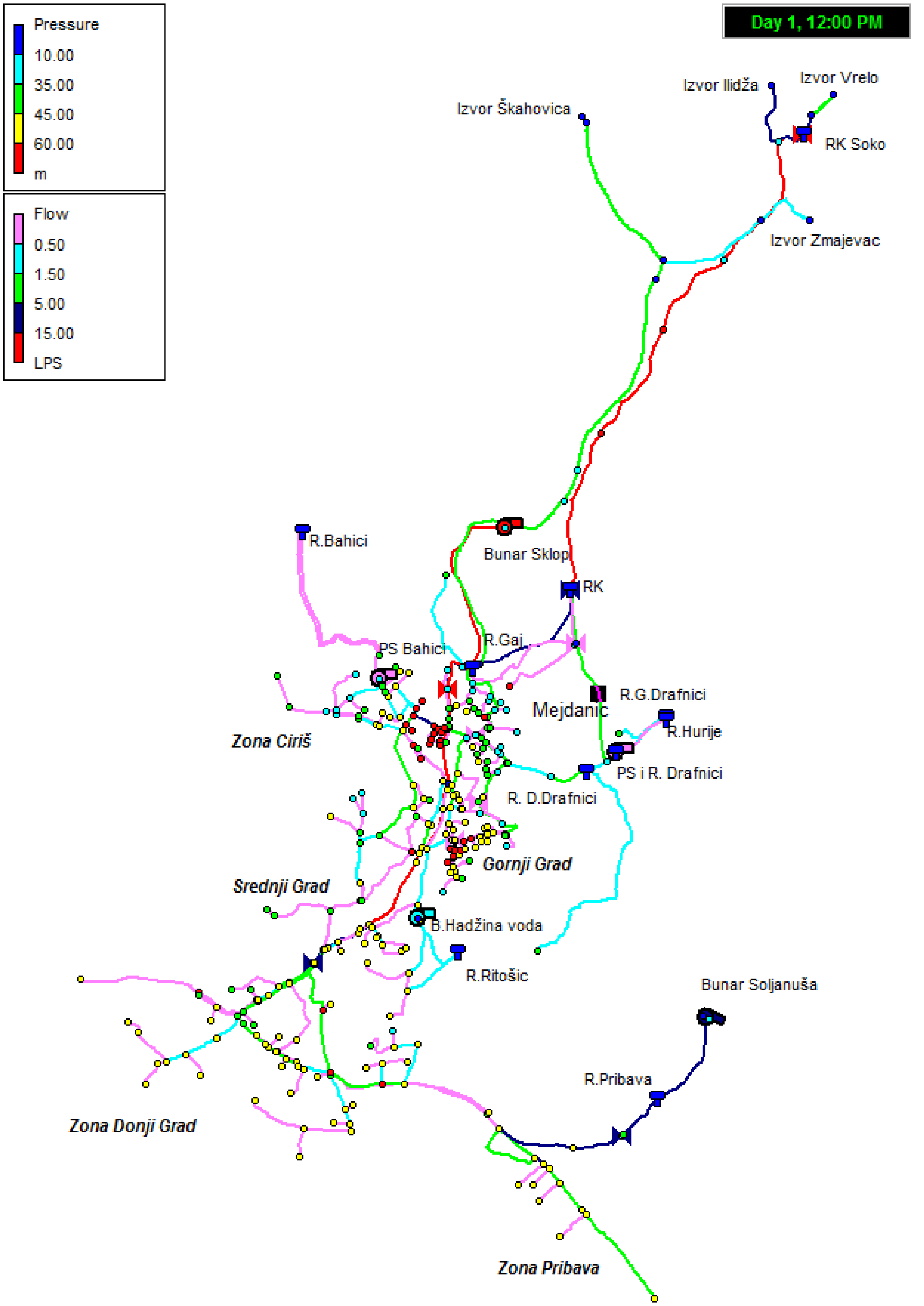
Scheme 7: Scheme of WSS Gračanica - speed and pressures in the period of minimum hourly consumption - 2010



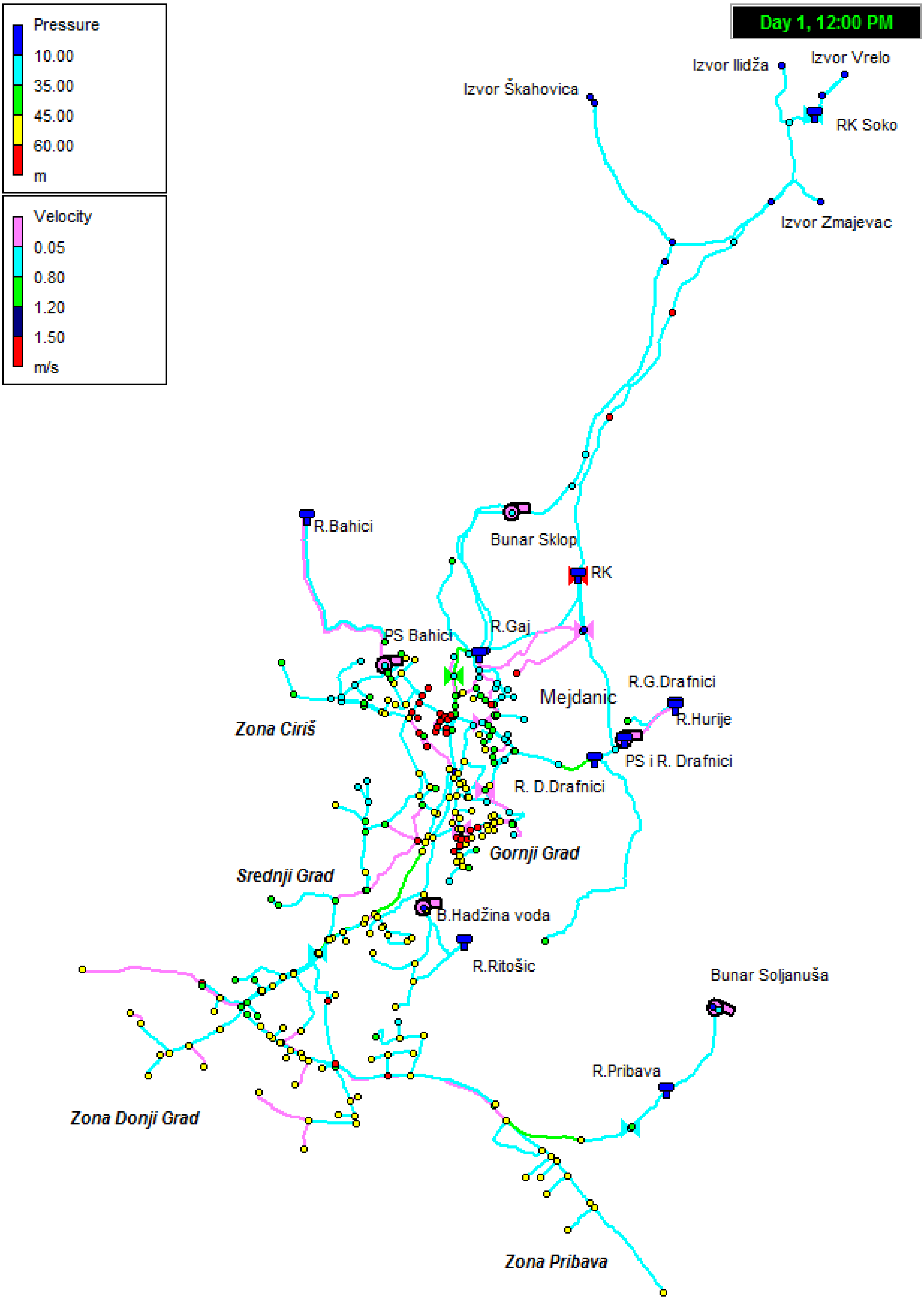
Scheme 8: Nodes in WSS with the pressure less than 1,5 bar in the period of maximum hourly consumption



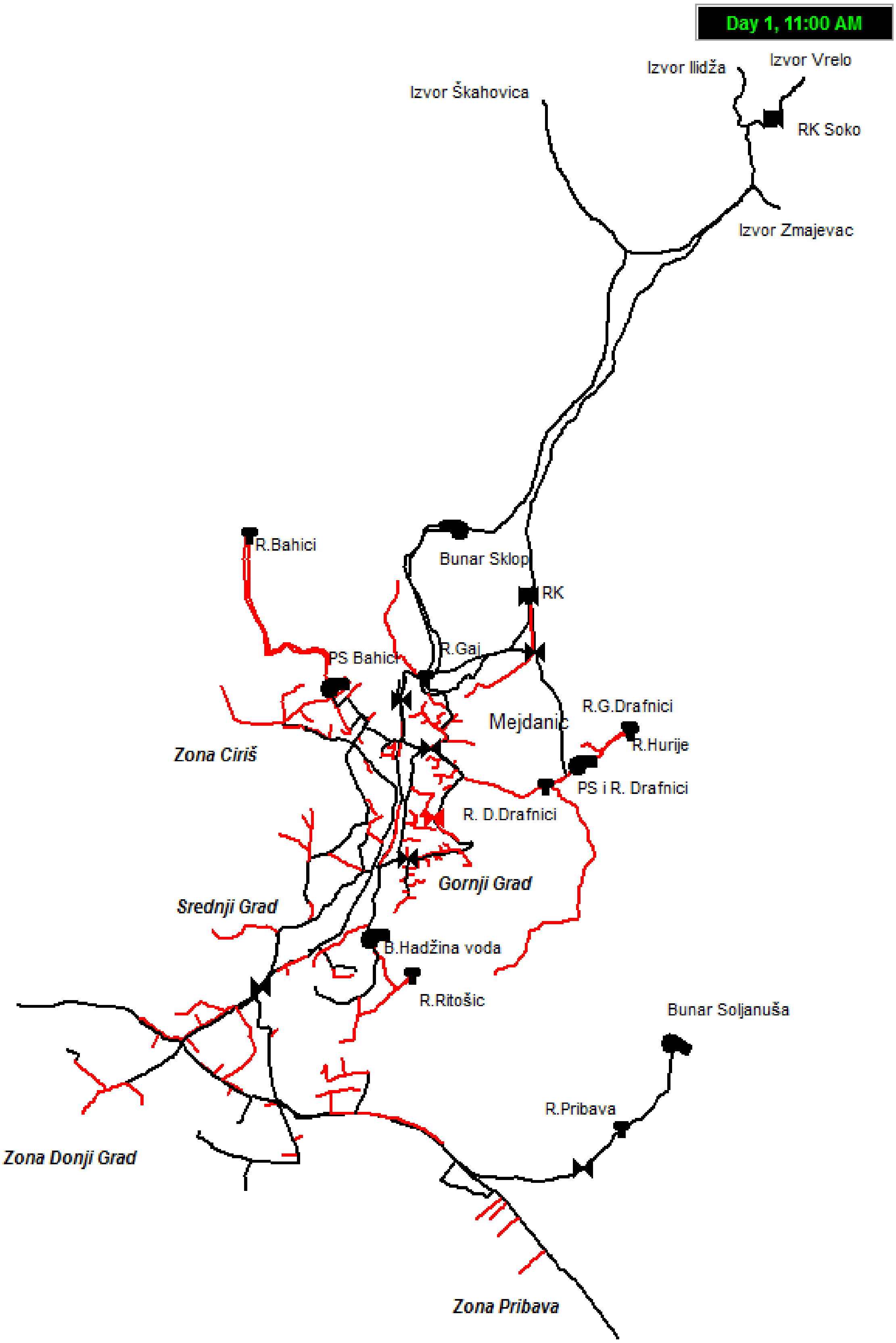
Scheme 9: Nodes in WSS with the pressure over 4,5 bar in the period of maximum hourly consumption



Scheme 10: Scheme of WSS Gračanica - flow and pressures in the period of maximum hourly consumption - 2010 with the operation of 2 hydrants while charging the cisterns in the node 323



Scheme 11: Scheme of WSS Gračanica - flow and pressures in the period of minimum hourly consumption - 2010 with the operation of 2 hydrants while charging the cisterns in the node 323



Scheme 12: Scheme of WSS Gračanica – pipelines with diameter less than Ø 75 mm

The following charts show calculation results in specific nodes and pipelines. The charts of water level in reservoir "Gaj" during 24 hours, water flow in the pipelines P191 and P2. Those are the main distribution pipelines from reservoir "Gaj" towards town. Based on the calculated nonlinearity coefficient (Demand Pattern), it can be seen that night consumption is lower than the maximum hourly consumption. That shows relativelly good system maintanance. However, the night consumption could still be reduced. The night consumption in the period between 2 and 5 o'clock shows the losses in the system, because the biggest consumption during the night is because of losses in the system.

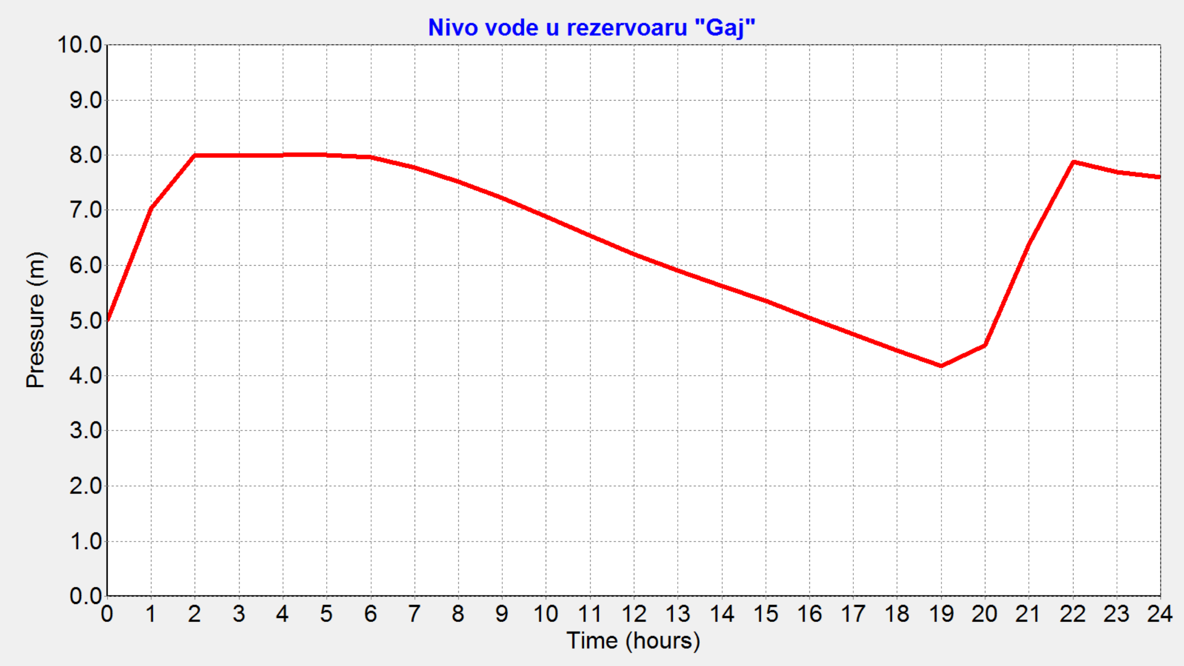


Chart 18: Water level in reservoir "Gaj" - 2010

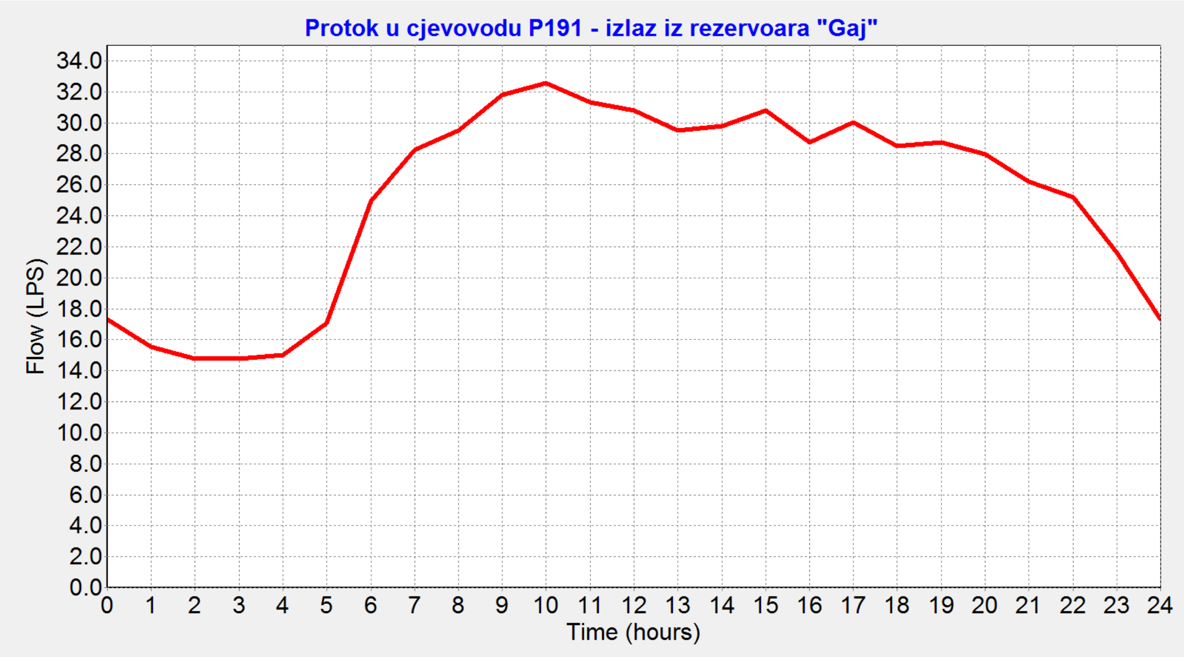


Chart 19: Flow in pipeline P191 – reservoir outlet "Gaj" - 2010

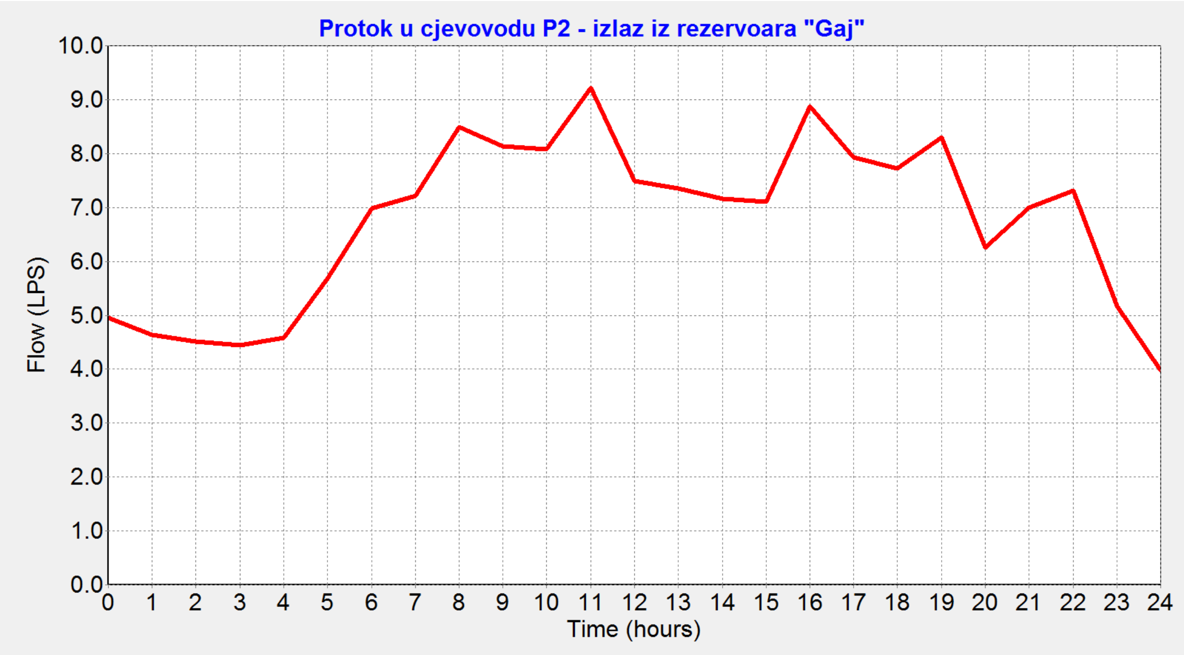


Chart 20: Flow in the pipeline P2 – outlet of reservoir "Gaj" - 2010

The following chart, ***Chart 21: Pressure in the node number 27 - Srednji*** Grad, shows pressure in node number 27 - Srednji Grad. This chart form indicates low linear losses, whaich means that the pipelines in that part are bigger than the current needs. In the ***Chart 22:*** , we can, also, see the example for Donji Grad where we have big percent of small profiles pipelines. Even besides that, the pressures in the town zone are still to high.

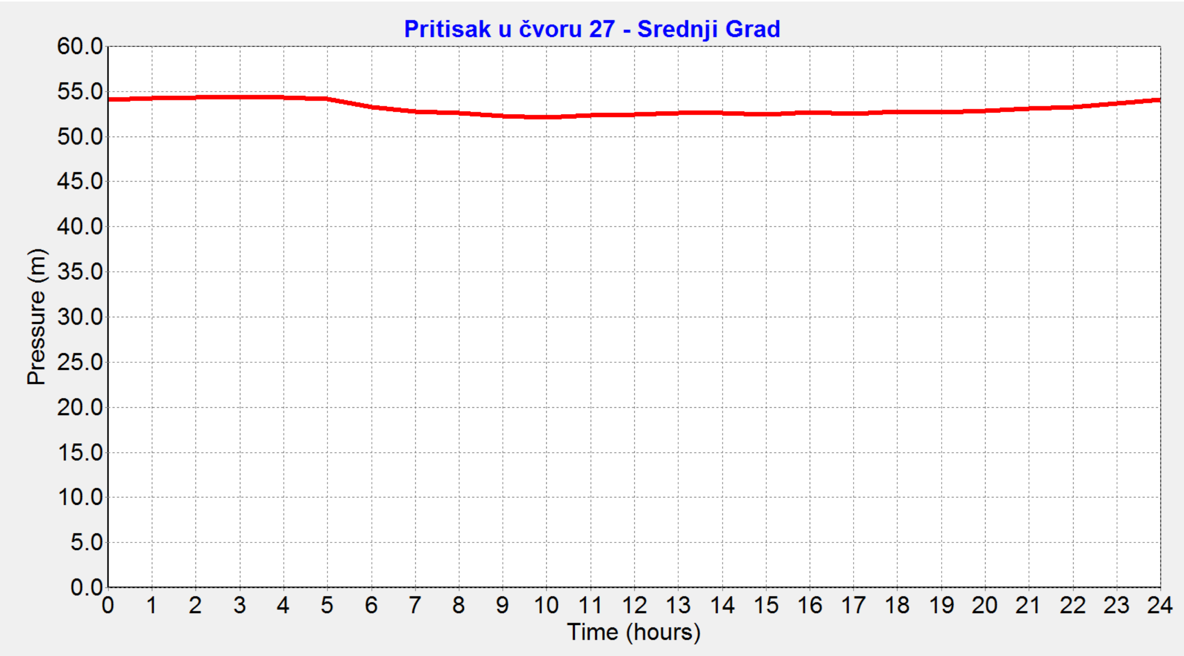


Chart 21: Pressure in the node number 27 - Srednji Grad

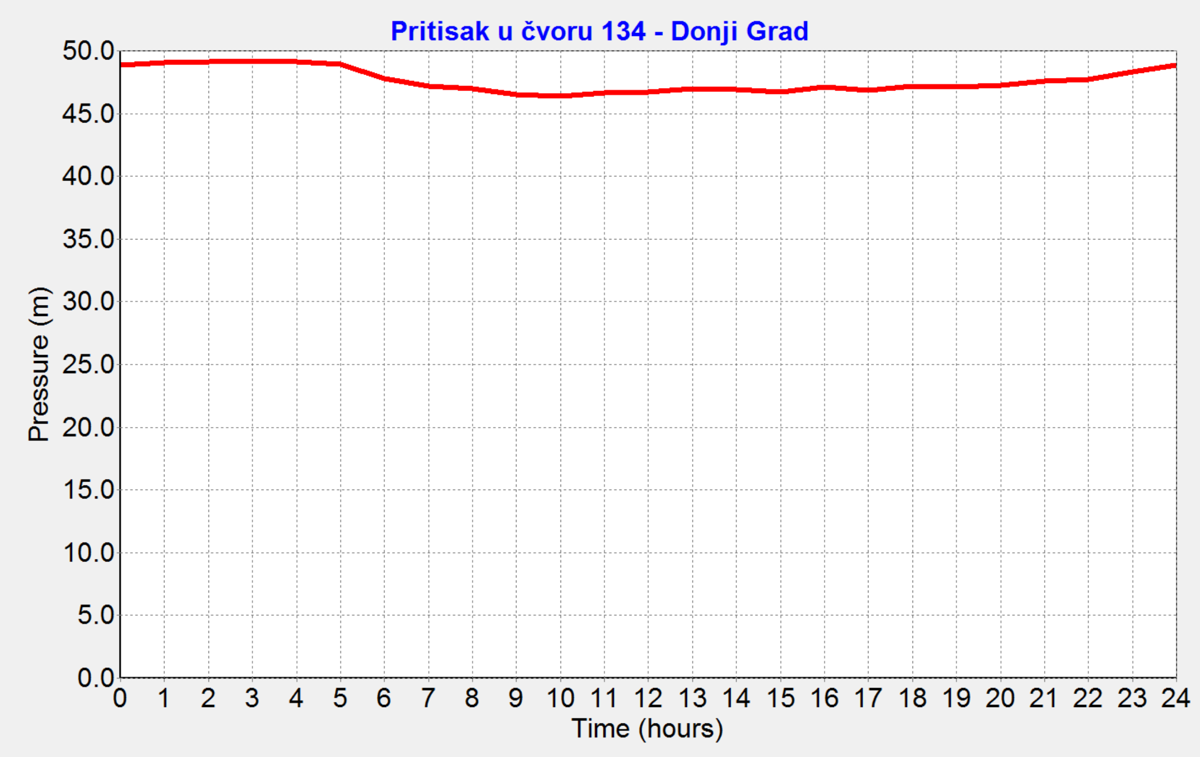


Chart 22: Pressure in node number 134 - Donji Grad

The following chart shows the pressure change before reducir valve which lowers the pressure at the border of Srednji Grad and Donji Grad. In the node number 32 the pressure changes during the day are so big. That means thatthe main distribution pipeline which goes from reservoir "Gaj" to Donji Grad i well dimensioned.

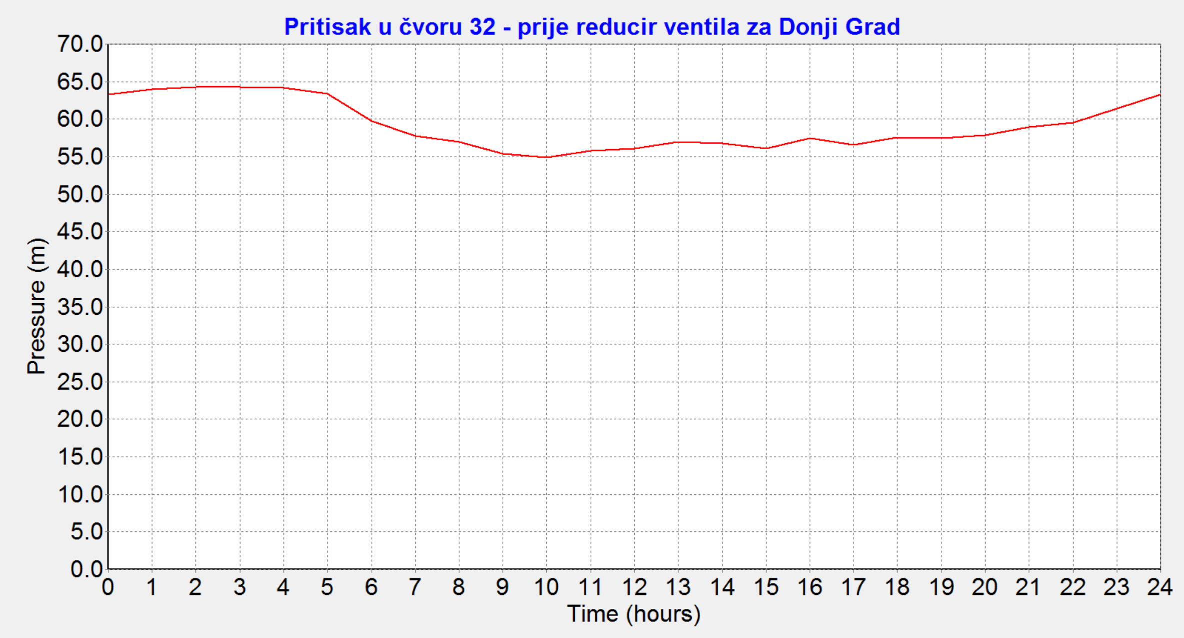


Chart 23: Pressure in node number 32 – before reducer valve Donji Grad

The following chart shows pressures in one of the nodes in the settlement Ćiriš – node number 171. In this chart we can, also, see that the pressure changes are low, which takes us to the conclussion that the network is well dimensioned.

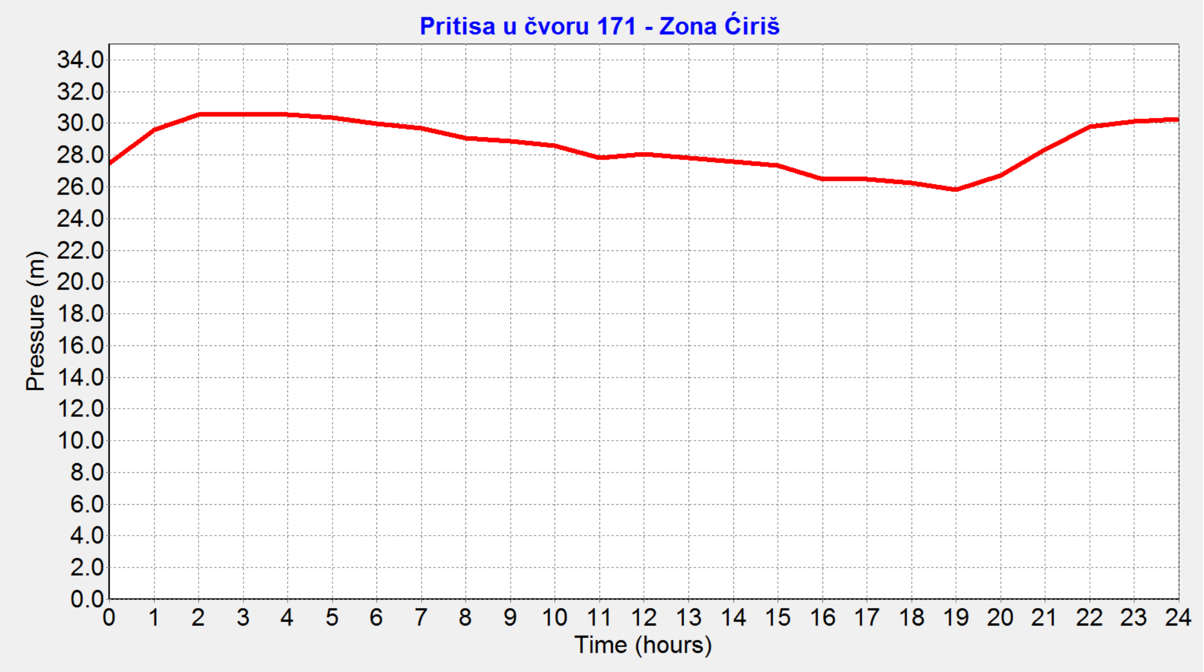


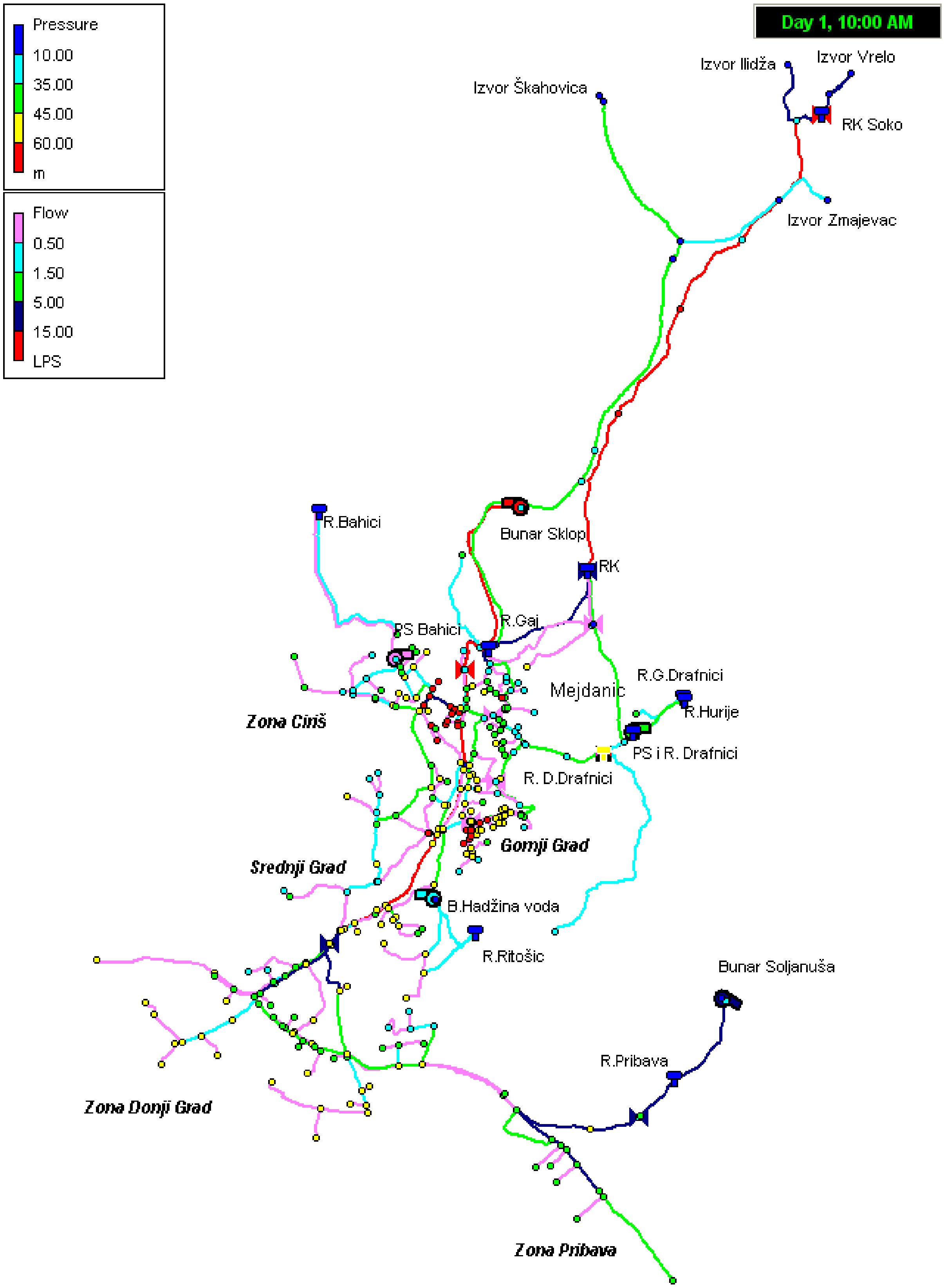
Chart 24: Pressure in node number 171 - Zone Ćiriš

2.9.7.3 RESULTS OF HYDRAULIC CALCULATIONS – CONDITION IN 2010 WITH Q=53,28 L/S

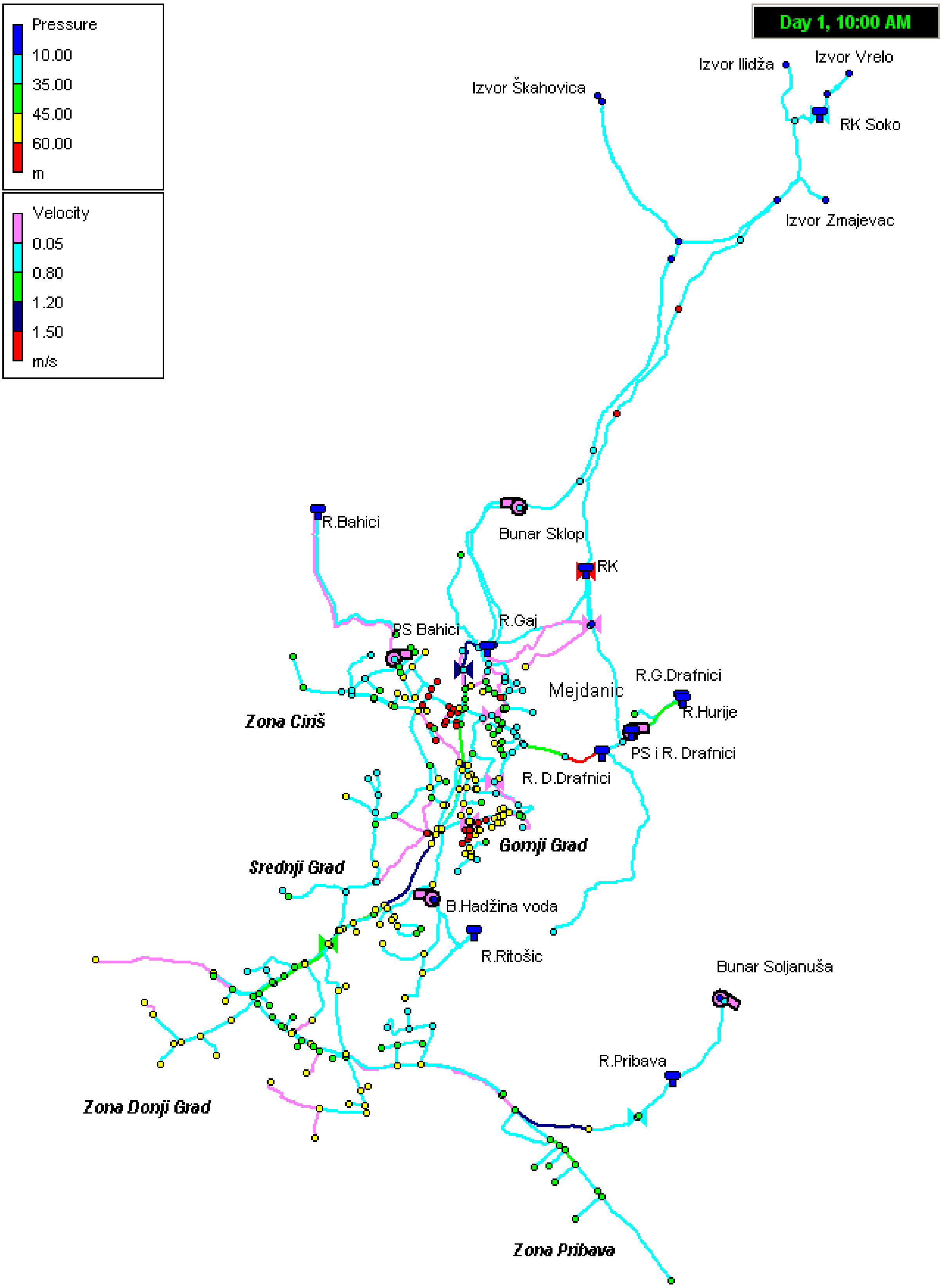
The hydraulic calculation of the current WSS Gračanica was, also, made with water quantity of $Q_{max\ dn.}$ =53,28 l/s. It is usual that the calculation is made for maximum daily consumption, but due to the lack of measurements, it was first made for Q=46,86 l/s for which we had the measurements data.

By adding the water quantity of **Q=53,28-46,86=6,42 l//s** in allready precessed model, we obtained the maximum hourly consumption model. The results for this model were given in ***Scheme 13: Scheme of WSS Gračanica - flow and pressures in the period of maximum hourly consumption - 2010 with operation of hydrant while charging the cistern in the node 323 and Scheme 14: Scheme of WSS Gračanica - speed and pressures in the period of maximum hourly consumption - 2010 with operation of hydrant while charging the cistern in the node 323***.

While increasing water quantities in the system, the pressures were not disturbed. Also, the velocities in the pipelines remained within the allowed limits, with the exception of the pipeline form reservoir Donji Drafnići.



Scheme 13: Scheme of WSS Gračanica - flow and pressures in the period of maximum hourly consumption - 2010 with operation of hydrant while charging the cistern in the node 323



Scheme 14: Scheme of WSS Gračanica - speed and pressures in the period of maximum hourly consumption - 2010 with operation of hydrant while charging the cistern in the node 323

2.9.7.4 RECOMMENDATIONS FOR WATER SUPPLY SYSTEM OPERATION IMPROVEMENT – 2010

In WSS Gračanica, the biggest problems at the moment are:

- Lack of water at the sources,
- Protection of the sources.
- High pressure in the system;
- High percent of losses in water supply system;
- High percent of th epipelines with diameter smaller than Ø 80 mm;
- Old house connections.

2.9.7.4.1 THE LACK OF WATER AT THE SOURCES

Talking about water supply sources, Gračanica Municipality area is one of the most jeopardized in BiH. The biggest source in Gračanica Municipality used for water supplying are the wells Sklop, with minimum yield Q_{min}=17,0 l/s. This source is used for water supplying of the population and industry of Gračanica town. In WSS Gračanica the situation concerning the water quantities, i.e. water balances improved in the last few years, especially because of the action of losses reduction in the system. However, the water balance is pretty unstable and in the case of the same minimum at the sources this balance would be completelly disturbed and it would come to water reductions. During the system operation under the reduction, huge water quantities would be lost for the system establishment in parts with the reduction.

This problem can be solved only by investigation works. Investigations should help finding the locations of potable water. In Gračanica Municipality there are only few natural sources. Two biggest natural sources are captured and used for water supplyng the seetlement Soko and in WSS Gračanica. However, capacity of these sources is such that t can satisfy only the needs of Soko settlement and some smaller part of WSS Gračanica.

In the area of Gračanica Municipality investigations were conducted, but never completed. These investigations should solve the issue, not only in WSS Gračanica area, but in entire Gračanica Municipality area.

According to the information, the posible locations of new sources could be in Stjepan Polje area and the area between Donja Lohinja and Donja Orahovica.

The other location could be north from the well Sklop.

2.9.7.4.2 SOURCES PROTECTION

It is necessary to implement measures brought in the Reports on sources protection measures.

2.9.7.4.3 HIGH PRESSURES IN WSS GRAČANICA

Hydraulic model indicates to the high pressures in the parts: Gornji Grad, Srednji Grad, Donji Grad and the part of the zone Ćiriš. Even besides the reducir valve which lowers the pressures in the zone Gornji Grad and at the borders of the zones Srednji Grad and Donji Grad for almost 2,0 bar (at both locations), there is still high pressure in biggest part of the town. The high pressures problem is expressed in the zone Pribava, as well. Reservoir Pribava is set too high, so reducir valve is installed under the reservoir, which lowers the pressure in settlement. Even besides that, the pressures in that part of water supply system are still too high.

This high pressures problem must be solved through hydraulic model by installing the reducir valve in certain parts of the system. In this moment, it is not recommended to give solutions through hydraulic model which is not calibrated.

2.9.7.4.4 HIGH PERCENT OF LOSSES IN WATER SUPPLY SYSTEM

The high losses percent problem exists in all water supply systems in BiH , but in the surrounding countries, as well. Althought in WSS Gračanica we have significant improvements concerning the reduction of non-revenue water quantity and especially physical losses, there are still some posibilities for those losses to be reduced. The aim is to reduce the losses to 20 % of the total produced water quantity. However, for these objectives we need knowledge, time and means. It can not be expected that these objectives can be realized in a short time period, but we have to plan with these activities. Losse control activities and losses reduction must be permanent activity.

After the replacement of small profiles pipelines, the certain percent of losses will decrease. It is assumend that the highest percent of losses is at the connection pipelines which should be replaced in the future.

The activities on losses percent reduction are urgent.

2.9.7.4.5 HIGH PERCENT OF THE PIPELINES WITH DIAMETER SMALLER THAN Ø 80 MM

The item ***2.3.6 Pipelines in WSS Gračanica***, describes pipelines in WSS Gračanica. The total lenght of the pipelines smaller than Ø 80 mm is 37.64 % of the total pipeline lenght or L=27.80 km.

The maps do not have all pipelines in water supply system, due to the lack of data. It is assumed that these pipelines are longer.

The ***Scheme 12: Scheme of WSS Gračanica – pipelines with diameter less than Ø 75 mm*** shows the review of all pipelines with diameter smaller than Ø 80 mm.

It is necessary to replace all of these pipelines with pipelines which diameters are minimum Ø 80 mm.

2.9.7.4.6 OLD HOUSE CONNECTIONS

Its is estimated that WSS Gračanica have around L=50.0 km pielines for house connections. High percent of these pipelines is very old and it is assumed that big percent of losses is exactly in these pipelines. Reconstruction of the house connections is necessary.

2.9.7.5 RESULTS OF HYDRAULIC CALCULATIONS – RECOMMENDATIONS FOR SYSTEM DEVELOPMENT TILL 2035

Hydraulic calculations for the future WSS Gračanice were made using the hydraulic model which was developped for the existing condition. According to the ***Table 59:*** the required water quantities for WSS Gračanica were calculated for the planning period untill 2035. Based on these calculations, it is estimated that the maximum dailty water requariments will be Q_{maxdn}=86,01 l/s. So, the estimation is that in the area of the current WSS Gračanica with the settlement Pribava, these water quantities will be required. The sources should have minimum capacity of Q=86,01 l/s. Considering the available water quantities at the sources in WSS Gračanica which can give the minimum of Q_{min}=34,80 l/s the large water deficite in the system is evident. It is, also, planned to leave the natural sources for settlement Soko, Škahovica and other settlements around those sources. ***Table 85:*** shows the estimations of available water quantities, water requirements and water quantity deficite untill the end of the planning period 2035. If natural sources are left for settlements Soko and Škahovica, the water deficite untill the end of the planning period would be **Q=63,3 l/s**.

2.9.7.5.1 WATER SUPPLY SOURCES IN 2035

In this moment we don't have the solution for this deficite. There are some indicators that north from the source Sklop some new wells could be drilled, with the **Q=20,0 do 30,0 l/s** of water.

The rest of **Q=33,3 l/s** of water would have to enabled from Stjepan Polje and Orahovica.

Hydraulic model for the end of the planning period 2035 is set with the following assumptions about the sources:

- Natural sources are left for the settlements Soko and Škahovica, but the recommandation for the higher parts of WSS Gračanica, reservoirs Drafnići and Hurije is that they should still be supplied from these sources, when there is enough water at the sources,
- Using the new source (wells) north from the well Sklop, before the settlement Soko, with the water quantity of **Q_{min}=30,0 l/s**,
- By using the new sources in the zone Stjepan Polje and Orahovica, as follows:
    - **Wells in Stjepan Polje** with **Q_{min}=50,0 l/s** i
    - **Wells in Orahovica with Q_{min}=40,0 l/s**.

The priority in all options are investigation works for finding the new water quantities for water supplying the population and industry. This doesn't relate only to the town, but, also, to the entire municipality. So, to these sources, besides the municipality part which is connected to the WSS Gračanica, would, also, be connected the settlements Stjepan Polje, Lendići, Donja Orahova and eventually some other local communities depending on the water quantities which could be found in this area.

Any kind of connecting the surrounding settlements to the existing water supply system of Gračanica represent the huge risks that the existing available water quantities in this system are not enough. It can lead to the fall of the system and water reductions which lead to the big problems, talking about the system water quantity, as well as the network water quality. The settlement Lendići and some other settlements located around Gračanica with the existing sources in WSS Gračanica, do not have the technically reasonable explanation to be connected to this system.

The following table, ***Table 92: Water needs in the parts of WSS Gračanica*** shows the water requirements at the parts of the WSS Gračanica for 2010, as well as the plan for 2035. The water requirements for 2035 are given proportionally to the requirements for 2010. The assumption is that the percent of consumption growth will be bigger in the zones Donji Grad and Pribava, but nydraulacally bad option is the option given in the following table, so the option that will be worked on is this one.

The Table 94: Reservoir volume required at the end of the planning period 2035***Table 93: Water requirements by the parts of WSS Gračanica, available water quantities at the sources*** shows water requirements in the parts of WSS Gračanica, but, also, the available quantities at the existing sources, as well as the requirements at the new sources. Considering the requirements in the settlements Soko and Škahovica, natural sources are excluded from these balances and left for the water supplying of the settlements Soko and Škahovica.

Based on calculation, new required water quantities are Q=63,83 l/s. The part of water deficite would be solved from new wells, north from the well Sklop with the assumed minimum yield of Q_{min}=30,0 l/s, and the part would be solved from the field south from Gračanica with Q=33,38 l/s.

Table 92: Water needs in the parts of WSS Gračanica

Supply zones	Required water quantities in 2010 – data from the model	Required water quantities in 2035
	l/s	l/s
Gornji Grad	11,39	20,90
Srednji Grad	10,23	18,78
Donji Grad	3,95	7,24
Ćiriš	6,90	12,66
Mejdanić	3,47	6,37
Pribava	6,31	11,59
Drafnići-Hurije	3,81	7,00
Ritošići	0,80	1,47
In total:	**46,86**	**86,01**

This kind of sources allocation would lead to the Gračanica water supply system zonning. The table shows that the source Sklop and new source north from the well Sklop would be sufficient for the water supply of the the zones Gornji Grad, Ćiriš, Mejdanić and Drafnići - Hurije. This is the 3rd and the 4th altitude of WSS Gračanica. Water in this area is of a good quality which, exept of disinfection by chlor, doesn't need any kind of treatment.

The existing source Soljanuša would partially solve the Pribava water supply issue. Water deficite in settlement Pribava, and, also, the zone Donji and Srednji Grad and Ritošići would be solved by using the new sources, or if Regional water supply system would be made from that system. The Regional water supply system is questionable, so we are mentioning here the option with eventual new water quantities from the well Stjepan Polje and Donja Orahovica.

If we consider **the well in Stjepan Polje** with the capacity of **Q_{min}=20,0 l/s**, the additional water quantity should be added to the region of **Donja Orahovica and new wells in Stjepan Polje**. Considering the water quality in the well Stjepan Polje which requires the water treatment, more desirable option, if the water is of a better quality, would be to lead some water to the zone Donja Orahovica.

All of the above are assumptions, and the real solution can be given only by knowing the precise data about the sources and their capacity. As it was allready mentioned, the priority are investigationworks in the aim of finding the new water quantities.

Table 93: Water requirements by the parts of WSS Gračanica, available water quantities at the sources

<table>
<tr><th rowspan="2">Sources</th><th>Minimum source yield for 2010</th><th rowspan="2">Supply zones</th><th colspan="2">Required water quantities in 2035</th><th>Available water quantities in 2035</th><th colspan="2">Required new water quantities</th><th>Required water quantities at the end of the planning period 2035</th><th rowspan="2">Supply zones</th></tr>
<tr><th>l/s</th><th colspan="2">l/s</th><th>l/s</th><th colspan="2">l/s</th><th>l/s</th></tr>
<tr><td rowspan="4">Sklop and new source</td><td rowspan="4">17</td><td>Gornji Grad</td><td>20,90</td><td rowspan="4">46,93</td><td rowspan="4">47,00</td><td rowspan="4">30,00</td><td rowspan="4">30,00</td><td rowspan="4">47,00</td><td rowspan="4">3^{rd} and 4^{th} altitude</td></tr>
<tr><td>Ćiriš</td><td>12,66</td></tr>
<tr><td>Mejdanić</td><td>6,37</td></tr>
<tr><td>Drafnići-Hurije</td><td>7,00</td></tr>
<tr><td>Soljanuša + new source</td><td>5,70</td><td rowspan="2">Pribava</td><td rowspan="2">11,59</td><td>5,70</td><td>5,70</td><td rowspan="2">5,89</td><td rowspan="4">33,38</td><td rowspan="2">11,59</td><td rowspan="2">1^{st} altitude</td></tr>
<tr><td rowspan="4">New sources from Stjepan Polje, Orahovica or Regional WSS</td><td rowspan="4">?</td><td rowspan="4">33,38</td><td rowspan="4">33,31</td></tr>
<tr><td>Srednji Grad</td><td>18,78</td><td rowspan="3">27,49</td><td rowspan="2">20,25</td><td>2^{nd} altitude</td></tr>
<tr><td>Ritošići</td><td>1,47</td><td>2^{nd} altitude</td></tr>
<tr><td>Donji Grad</td><td>7,24</td><td>7,24</td><td>1^{st} altitude</td></tr>
<tr><td>**In total:**</td><td>**22,70**</td><td></td><td>**86,01**</td><td>**86,01**</td><td>**86,01**</td><td>**63,38**</td><td>**63,38**</td><td>**86,01**</td><td></td></tr>
</table>

2.9.7.5.2 RESERVOIRS AND WATER SUPPLY ZONES AT THE END OF THE PLANNING PERIOD 2035

The concept of a future solution for the water supply would be the four altitude zones of supply and potential supply zone above the town Drafnići that would be 5 or more supply zones. The third and fourth altitude would be covered by Sklop source and a new source north of the reservoir "Gaj". Reservoir capacity "Gaj" goes beyond the needs of this system for the planning period until 2035.

However, for the needs of zone Drafnići, Hurije and the area above these settlments, it is necessary to construct new reservoir and pumping station at the reservoir "Gaj". From reservoir "Gaj" water would be pumped into the new reservoir which would be constructed at the elevation 330 MASL.

From the new reservoir, water would gravitationally go to the existing reservoir and pumping station Drafnići. From the reservoir Drafnići water would gravitationally go to the existing reservoir Donji Drafnići and then pumped to the new reservoir Hurije. New reservoir Hurije would replace two existing reservoirs Gornji Drafnići and reservoir Hurija which are of a small capacity.

However, reservoir space deficite is sexpressed in the 1st and 2nd supply zone altitude. If Q=33,38 l/s of new water is inserted into the system, reservoir space deficite is in the 1st altitude zone V=1.000,0 m^3. This new reservoir space should, also, satisfy the needs of the 1st altitude zone, as well as to provide the reserves for pumping station of the 2nd altitude zone.

So, from the reservoir of the 1st altitude zone the water would be pumped into the new reservoir of the 2nd altitude zone which required volume is V=300,0 m^3.

The total deficite of reservoir space at the end of the planning period would be V=800,0 m^3. This is hydraulically most favourable option. This scenario would take place if there is Q_{min}=30,0 l/s at the new source north from Sklop. Less water quantity at this new source would increase new water quantity in the area of Stjepan Polje and Donja Orahovica, what would condition the additional reservoir volume in the 1st and 2nd altitude zone.

The following table shows the estimation of required reservoir volume at the end of the planning period, 2035.

Table 94: Reservoir volume required at the end of the planning period 2035

Supply zones	Supply zones	Required reservoir volume at the end of the planning period	Current reservoir volume	Reservoir volume deficit		Adopted volume
		m^3	m^3	m^3		m^3
Gornji Grad	3^{rd} and 4^{th} altitude	1.216,42	1.920,00	-703,58	0,00	0,00
Ćiriš						
Mejdanić						
Drafnići-Hurije						
Pribava	1^{st} altitude	300,41	300,00	0,41	188,12	300,00
Donji Grad		187,70	0,00	187,70		
Srednji Grad	2^{nd} altitude	524,88	100,00	424,88	424,88	500,00
Ritošići						
In total:					613,00	800,00

This reservoir space deficite shows the requirements based on the water quantities. However, the following tables show the existing reservoirs and planned reservoirs needed in the system.

Table 95: Existing and planned reservoirs

Existing reservoirs

Reservoir	Reservoir position coordinates (x)	Reservoir position coordinates (y)	Overflow elevation (MASL)	Reservoir depth (m)	Bottom elevation (MASL)	Volume (m^3)	Number of inhabitants in the reservoir zone
Gornji Drafnići	6.526.380,82	4.951.813,02	370,00	2,00	368,00	20,00	971
Donji Drafnići	6.525.873,83	4.951.467,14	288,00	2,00	286,00	30,00	
PS Drafnići	6.526.066,26	4.951.590,67	322,00	2,00	320,00	30,00	
Hurije	6.526.382,72	4.951.798,37	370,00	2,00	368,00	20,00	
Bahići	6.524.089,01	4.952.978,66	256,00	3,00	253,00	50,00	482
Ritošići	6.525.067,88	4.950.333,17	246,00	3,00	243,00	100,00	678
Gaj	6.525.156,99	4.952.122,32	262,00	8,00	254,00	1.800,00	13.248
Pribava	6.526.326,69	4.949.414,29	243,50	3,50	240,00	300,00	2.128
					In total:	**2.350**	**17.507**

Planned reservoirs

Reservoir	Reservoir position coordinates	Reservoir position coordinates	Overflow elevation	Reservoir depth	Bottom elevation	Needed volume	Adopted volume
	(x)	(y)	(MASL)	(m)	(MASL)	(m^3)	m^3
Reservoir Stjepan Polje	6.519.368,91	4.953.172,08	223,00	3,00	220,00	235,50	250,00
Reservoir Donja Orahovica	6.528.453,66	4.945.649,11	225,00	3,00	222,00	235,50	250,00
Reservoir of the I altitude	6.525.237,48	4.949.587,05	215,00	6,00	209,00	1.059,75	1.000,00
Rezervoar of the II altitude - Ritošić	6.525.067,88	4.950.333,17	244,00	4,00	240,00	314,00	300,00
Reservoir Hurije - new	6.526.382,72	4.951.798,37	372,00	4,00	368,00	113,04	100,00
Reservoir for Drafniće and Hurije	6.525.886,69	4.952.296,17	334,00	4,00	330,00	254,34	250,00
Reservoir Sklop - collector	6.525.366,06	4.953.006,68	246,00	6,00	240,00	406,08	400,00
						In total:	**2.550,00**

Existing reservoir remaining in the system						
Reservoir	**Reservoir position coordinates (x)**	**Reservoir position coordinates (y)**	**Overflow elevation (MASL)**	**Reservoir depth (m)**	**Bottom elevation (MASL)**	**Volume**
						m^3
Gornji Drafnići	6.526.380,82	4.951.813,02				
Donji Drafnići	6.525.873,83	4.951.467,14	288,00	2,00	286,00	30,00
PS Drafnići	6.526.066,26	4.951.590,67	322,00	2,00	320,00	30,00
Hurije	6.526.382,72	4.951.798,37				
Bahići	6.524.089,01	4.952.978,66	256,00	3,00	253,00	50,00
Ritošići	6.525.067,88	4.950.333,17				
Gaj	6.525.156,99	4.952.122,32	262,00	8,00	254,00	1.800,00
Pribava	6.526.326,69	4.949.414,29	243,50	3,50	240,00	300,00
In total:						**2.210,00**

Total:	**4.760,00 m^3**

2.9.7.5.3 SOLUTION CONCEPT FOR WSS GRAČANICA 2035

Future solution concept for WSS Gračanica is following:

- ***SOURCES:***
  - 1st and 2nd altitude
    - Wells Soljanuaš- Q_{min}=5,70 l/s
    - New wells - Q_{min}=33,38 l/s
  - 3rd and 4th altitude
    - Wells Sklop - Q_{min}=17,0 l/s
    - New wells - Q_{min}=30,0 l/s
  - **In total: Q_{min}=86,01 l/s**
- ***RESERVOIRS:***
  - 1st altitude
    - Reservoir Pribava - V=300 m^3
    - **New reservoir - V=1.000 m^3**
  - 2nd altitude
    - **New reservoir Ritošić - V=300 m^3**
    - Reservoir Ritošić - V=100 m^3
  - 3rd altitude
    - Reservoir Gaj - V=1.800 m^3
    - Reservoir Donji Drafnići - V=30 m^3
    - Reservoir PS Drafnići - V=30 m^3
    - New collector reservoir Sklop - V=400 m^3
  - 4th altitude
    - Reservoir Bahići - V=50 m^3
    - Reservoir Gornji Drafnići - V=20 m^3 - ukida se
    - Reservoir Hurije - V=20 m^3 - ukida se
    - New reservoir Hurije - V=150 m^3
  - **In total: V=4.760 m^3**
- ***PUMPING STATIONS:***

  Existing pumping station, exept of PS Hadžijina voda, would be kept. It is necessary to adapt the pumping stations capacities to the future needs, what was done by hydraulic model. New pumping stations would be:

  - Pumps at the new source north from Sklop;
  - Pumping station at the location of the source Sklop;
  - Pumping station Gaj for supplying the settlements Drafnići and Hurije
  - Pumps at the new source in the area of Stjepan Polje or Donja Orahovica and

- Pumping station in the new reservoir of the 1st altitude for pumping the water into the new reservoir of the 2nd altitude.

The following table shows characteristics of the planned pumping stations.

Table 96: Planned pumping stations in WSS Gračanica

Pumping station	Capacity (l/s)	Water rising height (m)	Pumps power (kW)
New source north from Sklop	30,00	30,00	18,46
New PS at the collecting reservoir at the source Sklop	47,00	25,00	24,10
New PS at reservoir "Gaj"	10,00	85,00	17,44
New source for the 1st and 2nd altitude	33,38	80,00	54,78
PS for the 2nd altitude at the reservoir of the 1st altitude	20,25	35,00	14,54
Total:	**140,63**		

- ***PIPELINES:***

Pipelines would be partially changed, the pipelines which do not satisfy the technical regulations.

It is necessary to construct new pipelines, as follows:

- Supply pipeline from the planned source north from Sklop towards new collecting reservoir,
- Supply pipeline from the new source in Stjepan Polje or Donja Orahovica towards reservoir of the 1st altitude,
- suppply – pressure pipeline from the 1st altitude, i.e. planned pumping station towards planned reservoir of the 2ns altitude,
- new pipelines – replacement of pipelines of small diameter and
- new main distribution pipelines in the zone Donji Grad.

The ***Scheme 15: Planned water supply system in 2035 – maximum hourly consumption – values of the flow and pressures and Scheme 16: Planned water supply system in 2035 – maximum hourly consumption – values of the velocities and pressures*** shows the calculation for the end of the planning period with new sources, but, also, the water quantity of Q=35,0 l/s of water for Stjepan Polje and other settlements and Q=16,0 l/s for Donja Lohinja and Donja Orahovica. This calculation with no accuratelly determined sources is only assumed.

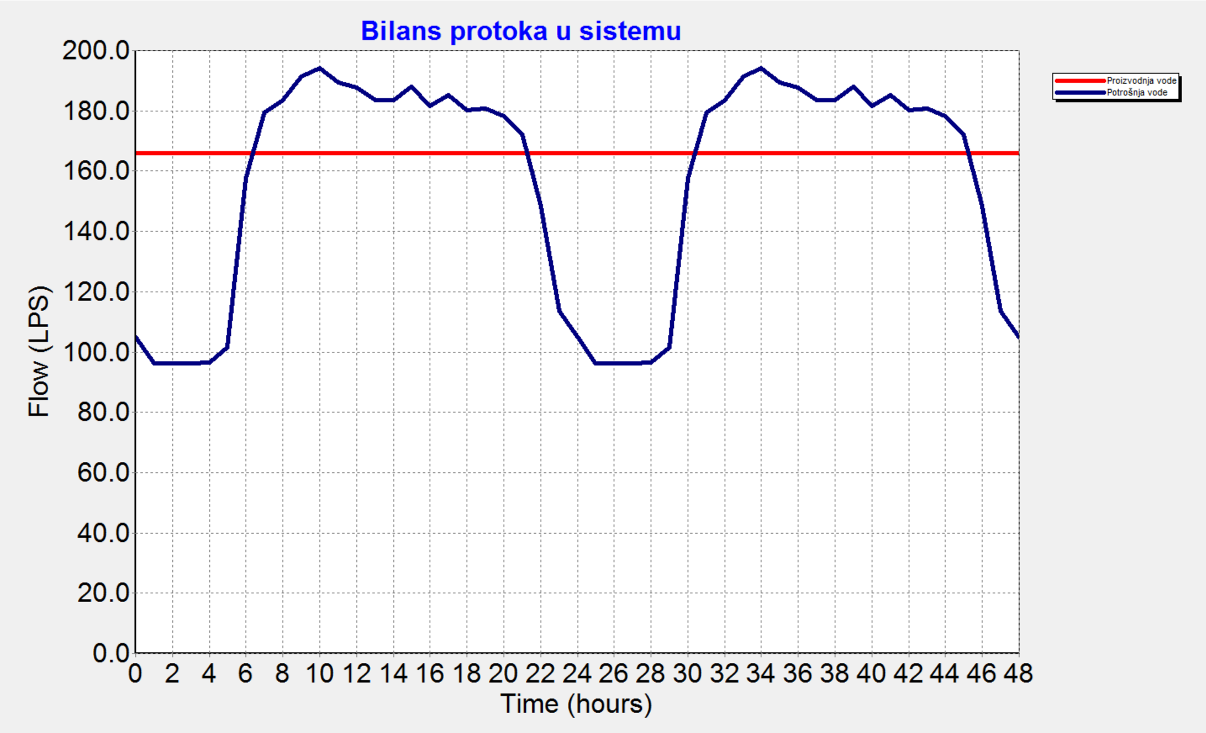
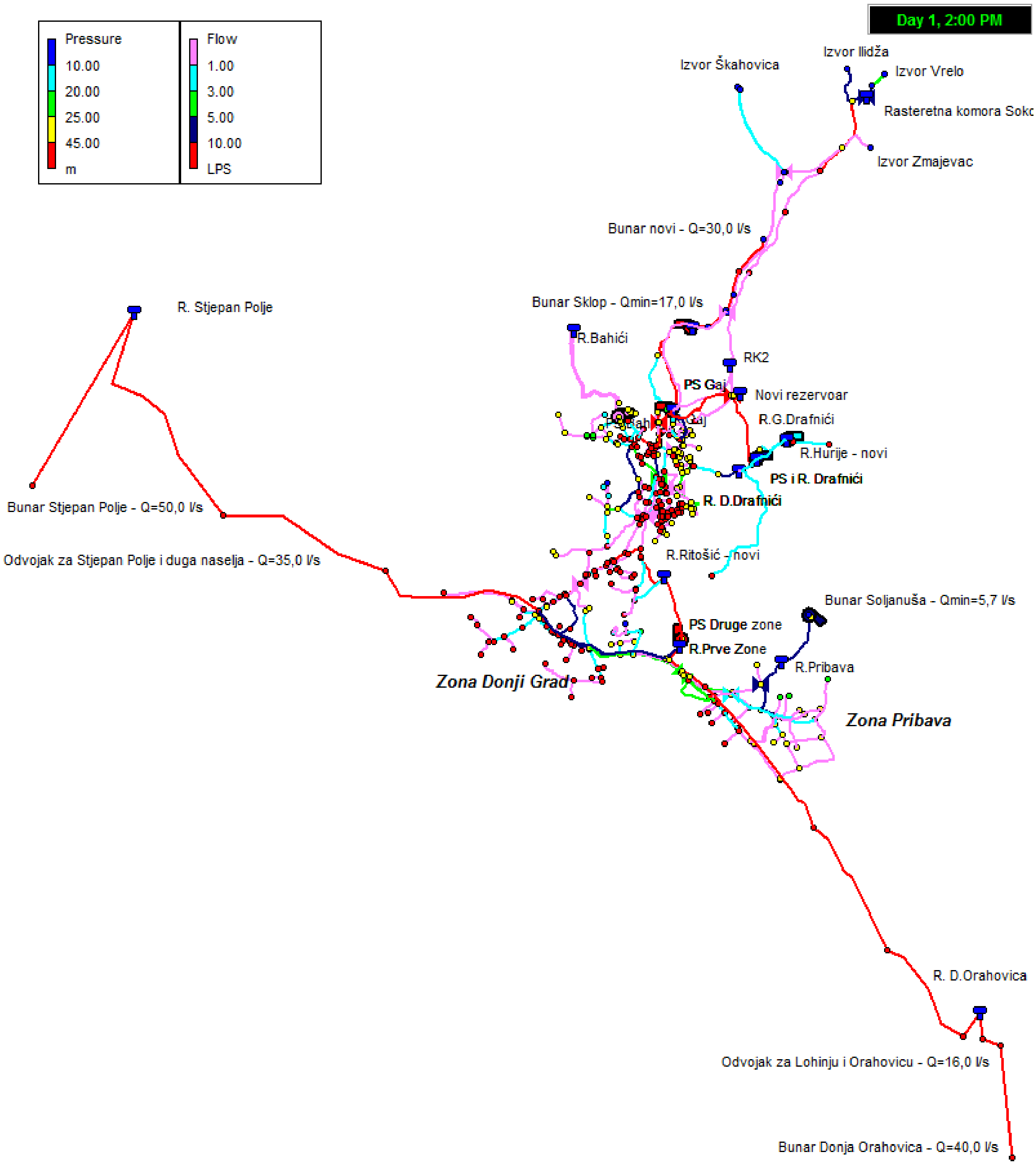
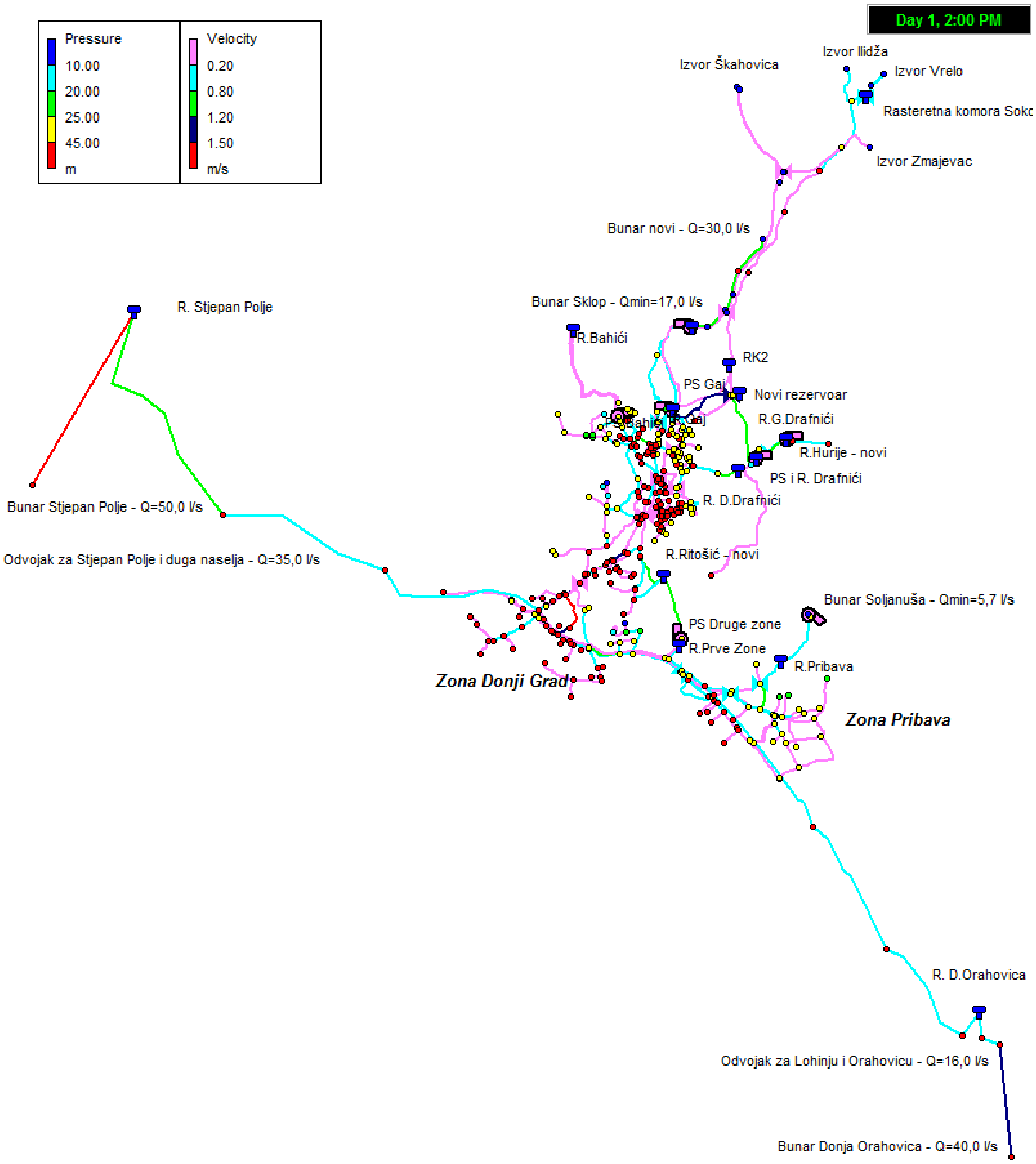


Chart 25: Flow balance in the system – production and consumption of water in the system in 2035 with additional water quantities in Stjepan Polje, Donja Lohinja and Orahovica



Scheme 15: Planned water supply system in 2035 – maximum hourly consumption – values of the flow and pressures



Scheme 16: Planned water supply system in 2035 – maximum hourly consumption – values of the velocities and pressures

2.10 REHABILITATION, RECONSTRUCTION AND DEVELOPMENT OF GRAČANICA WATER SUPPLY SYSTEMS

2.10.1 REHABILITATION AND DEVELOPMENT OF WSS GRAČANICA

2.10.1.1 REHABILITATION OF WSS GRAČANICA

In WSS Gračanica, the biggest problems are as follows:

- Lack of water in the sources;
- Protection of the sources;
- Construction of the plants for drinking water treatment at the sources „Ilidža“ and „Soko“;
- High pressures in the system;
- High percent of losses in the water supply system;
- High percent of the pipelines with diameter smaller than Ø 80 mm;
- Old house connections.

Basic activities which need to be implemented in the aim of water losses reduction can be performed by following:

REDUCTION OF LOSSES IN THE SYSTEM

- Establishing GIS and developing a Hydraulic model of WSS for better control of the system and better insight into the state of water supply system
- Metering and detection of failures in the system,
- Repair the defects on the water distribution network,
- Replace pipeline sections with the occurrence of major or continuous losses,
- Defect removal on the household installations – this must be carried out in coordination with owners of the facilities and Housing companies,
- Obtain equipment for detection of failures (correlator and mobile ultrasonic flowmeter) and train a team for their detection for this must become regular future activity,
- Existing water meters calibrate, defective water meters replace and install water meters on the connections where there are no any,
- Make record of all connections,
- Eliminate bottlenecks in the system by construction of new pipelines,
- Replace pipelines with a diameter of less than DN 80 mm,
- Replace defective valves on the junction and construct inspection chambers on those junctions.

Priorities in solving problems are, as follows:

- Establishing GIS and developing a hydraulic model of water supply system,
- Detection and removal of water losses as a permanent process (costs of emergency interventions are estimated , but this is a continuous process that needs to be done on the regular basis and, therefore, it is necessary, every year, to secure the funds for this purpose),

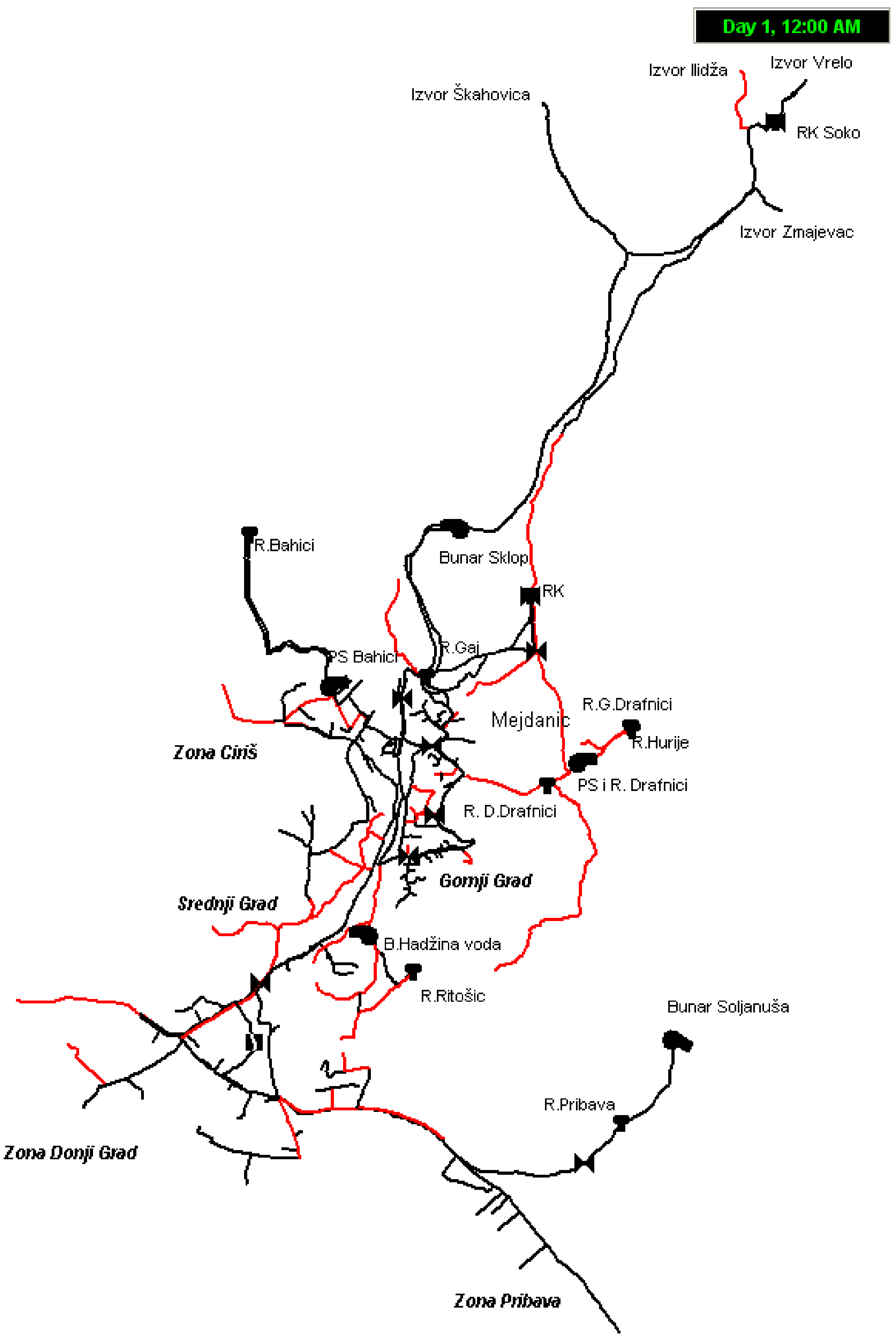
- Establishing metering in the system by installing the flow meters for both, the system facilities determined by distribution network zones, and the end users.
- Replacement of pipeline, to reduce losses in the system.

The following table shows pipelines which need to be rehabilitated in the first 10 years untill the completion of the Study. It is necessary to rehabilitate the pipelines which are of a poor quality and of high losses percent, as well as the pipelines of a smaller profiles. The ***Table 98: Incomes of provided services and expenses of JP „Vodovod i kanalizacija“ dd Gračanica and Scheme 17: WSS Gračanica – Pipelines which need to be replaced in the future 10 years*** shows the review of these pipelines.

Table 97: Pipelines which need to be replaced in the period of 10 years

Pipeline – mark based on the model	Lenght	Diameter - current	Roughness	Diameter - replacement
	m	mm	mm	mm
Pipe P10	125,53	65	0,4	80
Pipe P11	205,76	100	0,4	100
Pipe P12	409,87	50	0,4	80
Pipe P13	56,30	50	0,4	80
Pipe P25	100,46	97	0,1	100
Pipe P32	1.057,59	200	0,4	200
Pipe P33	336,37	79	0,1	100
Pipe P34	364,50	55,4	0,1	80
Pipe P35	8,13	55,4	0,1	80
Pipe P39	434,65	198,2	0,1	200
Pipe P40	232,65	55,4	0,1	80
Pipe P50	2.207,74	55,4	0,1	150
Pipe P51	789,44	79	0,1	150
Pipe P52	79,97	55,4	0,1	100
Pipe P66	85,87	80	0,4	200
Pipe P67	444,00	55,4	0,1	100
Pipe P68	365,91	80	0,4	80
Pipe P78	69,19	55,4	0,1	80
Pipe P81	135,55	50	0,4	80
Pipe P88	355,63	79	0,1	80
Pipe P89	145,64	66	0,1	80
Pipe P90	565,82	66	0,1	80
Pipe P92	147,59	66	0,1	80
Pipe P94	106,59	50	0,4	80
Pipe P95	131,49	66	0,1	80
Pipe P109	702,22	55,4	0,1	80
Pipe P111	46,92	150	0,4	150
Pipe P112	236,78	66	0,1	80
Pipe P113	463,94	100	0,4	100
Pipe P114	245,36	80	0,4	80
Pipe P116	10,74	97	0,1	100

Pipe P122	1.060,72	97	0,1	100
Pipe P126	61,56	66	0,1	80
Pipe P127	7,79	66	0,1	80
Pipe P129	112,21	66	0,1	80
Pipe P136	213,39	79	0,1	80
Pipe P138	239,06	55,4	0,1	80
Pipe P139	148,48	60	0,4	80
Pipe P140	249,52	80	0,4	80
Pipe P149	149,09	80	0,4	80
Pipe P155	257,89	66	0,1	80
Pipe P156	119,49	79	0,1	80
Pipe P158	210,73	97	0,1	100
Pipe P159	43,04	97	0,1	100
Pipe P169	229,46	97	0,1	100
Pipe P170	104,84	97	0,1	100
Pipe P171	43,86	97	0,1	100
Pipe P176	229,35	97	0,1	100
Pipe P177	113,38	97	0,1	100
Pipe P187	383,50	55,4	0,1	100
Pipe P188	13,11	55,4	0,1	
Pipe P193	154,00	55,4	0,1	80
Pipe P195	300,89	55,4	0,1	80
Pipe P196	118,09	40	0,4	80
Pipe P228	80,00	50	0,4	80
Pipe P230	64,22	50	0,4	80
Pipe P240	121,54	66	0,1	80
Pipe P241	50,42	40	0,4	80
Pipe P301	385,52	55,4	0,1	80
Pipe P306	20,33	50	0,4	80
Pipe P307	88,93	50	0,4	80
Pipe P308	276,68	50	0,4	80
Pipe P309	245,10	55,4	0,1	80
Pipe P322	419,83	66	0,1	80
Pipe P323	403,35	80	0,4	80
Pipe P324	320,99	80	0,4	200
Pipe P326	235,05	66	0,1	80
Pipe P340	207,91	55,4	0,1	80
Pipe Pi35	513,95	55,4	0,1	80
Pipe Pi42	1,13	97	0,1	200
Pipe Pi5	2,00	66	0,1	80
Pipe 1	1,01	55,4	0,1	100
Total:	**18.669,56**			



Scheme 17: WSS Gračanica – Pipelines which need to be replaced in the future 10 years

Necessary measures for monitoring of water supply system

In order to establish monitoring of water supply system it is necessary to divide water network into sectors and establish a process of metering of flow, pressure and water quality parameters that are not subject to this project. That refers to:

- **Continuous metering of flow and pressure on the water source,**
- **Continuous metering of flow and water level in reservoirs,**
- **Continuous metering of flow and pressure at characteristic points in the network.**

Beside these measurements, the system must have accurate water meters and perform their regular reading as well as monitoring of consumption trends. Regular monitoring and analysis of these measured quantities will provide control of water production and consumption in water supply system. Monitoring of flow rate and pressure in certain branches, especially flow rates during periods of the night minimum flow, it is possible to detect occurrence of new faults and respond quickly with repairs.

ZONNING OF THE WATER SUPPLY SYSTEM GRAČANICA

Despite the measures taken on zoning of distribution systems and reduce the pressure in the system, this project is not completed. It is necessary to project zoning distribution system. Pressures in the system are still quite high.

CONSTRUCTION OF POTABLE WATER TREATMENT PLANT AT THE SOURCES „ILIDŽA" AND „SOKO"

According to previous analysis of water quality on these two sources and the samples which were tested for this project, the main problem in these two sources is the turbidity. It is necessary to build two plant blocks – "self-washing filters.

2.10.1.2 DEVELOPMENT OF WSS GRAČANICA

The preceding items give detailed descriptions of the WSS Gracanica, data on population and area coverage of water supply system, the demographic projections of population in the area of water supply systems, detailed information about the water supply system, detailed data on production and consumption of water and planning needs for water. Based on these input data in the item***2.9.7 Hydraulic analysis of WSS Gračanica*** we got the calculations for the existing water supply system and the results analysis, as well as Gračanica water supply system development needs for the period untill 2035.

Future Gracanica water supply system solution is given.

One of the main problems in WSS Gracanica are certainly insufficient quantities of water on existing sources. This is, in addition to reducing losses in the existing water supply system, a matter of priority. It is necessary to do investigative work and then on the basis of research work carry out exploration wells and open new sources. The solution is given as three locations where potential sources are assumed to be able to find new water. These solutions are provided in the hydraulic analysis. Opening new sources can be done in several stages. The first and second phase would be connecting the well in Stjepan Polje, which is allready drilled, to the water supply system. After that, if the water is found near the Sklop source and at new location of Stjepan Polje, new water quantities would be enabled for LC Stjepan Polje, depending on the water quantities for some other local communities. Depending on investigation works, the third phase would be inserting water from the wells in Donja Lohinja, i.e. Donja Orahovica. For now, the complete solution is within theoretical frames, due to the fact that we don't know where those new water quantities will be found.

The solution of inserting the new water quantities is shown in Hydraulic calculations.

The works values are given in ***2.13 Priced Bill of Quantities***.

2.10.2 REHABILITATION AND DEVELOPMENT OF LOCAL WATER SUPPLY SYSTEMS

2.10.2.1 REHABILITATION OF THE LOCAL WATER SUPPLY SYSTEMS

Local water supply systems are detaily described in the item ***2.9 Analysis of WSS Gračanica***.

Based on collected data about the local water supply systems, the following can be concluded:

1. In the description of local water supply systems in Gračanica Municipality, it was mentioned that there is not enough data on local systems. However, it is one of the main problems of these water supply systems. In most cases, there is no project documentation of these systems. The location, diameters and the pipelines lenghts are unknown.

   Measures – It is necessary to conduct the additional investigations in the aim of determining the pipelines position, pipelines profiles....

2. The second biggest problem is the water quality at the sources and sources yields. The water quality at the sources is mostly not controlled and there is no data about the yield of these sources. For any kind of system development planning, the main data is the source's yield.

   Measures – It is necessary to install the flow meters at the sources in the aim of water quantities yield measurements. More significant sources should be monitored and the yield should be measured, especially during the droughts. The water quality should be analysed regularly.

3. In the entire Gračanica Municipality area, trhere id potable water deficite.

   Measures – It is necessary to conduct the additional investigations in the aim of determining the new water quantities. After that, solve the issue of water supply for the entire Gracanica Municipality area, and not only partially.

4. Most of the facilities in the system need to be rehabilitated. This relates to the construction part of the pumping stations facilities, reservoirs and sources. It is necessary to protect the facilities, physically as well. It is, also, necessary to rehabilitate or replace electro – mechanical equipment.

5. Most of the pipelines in the system are of a small diameter, and documentation about the pipelines construction does not exist. Pipelines should be rehabilitated because of the high percent of losses and then conduct reconstruction of the pipelines which do not satusfy with the quality and th etechnical conditions.

6. There are no measurements in the system. The produced and consumed water is not measured. It is necessary to install the flow meters at the sources, reservoirs, pumping stations and at the end users. The system can not be controlled without the meausrements.

Smaller settlements supplied from the local sources will at first remain at these sources with the evenyual connections of th enew sources and rehabilitation of the existing facilities in the system and the expansion of those facilities which do not satisfy with its capacity. In the second phase, the development phase, these water supply systems would be controlled by JKP „Vodovod i kanalizacija" Gračanica with posibility of connecting these systems with th etown water supply system.

The values of works are given in ***2.13 Priced Bill of Quantities***.

2.10.2.2 THE DEVELOPMENT OF LOCAL WATER SUPPLY SYSTEMS

In this moment it is very hard to give the guidelines for local water supply systems development. Considering the fact that none of th elocal systems have sufficient water quantities at the sources, new sources sre not defined, we will provide only rough estimation of works quantity relating to the longterm water supply of population and industry.

The item ***2.9 Analysis of WSS Gračanica***, detailly shows the requirement analysis for alll local communities. It, also, shows water requirements in local communities, available sources and current capacity of local water supply systems facilities.

Besides the exisitng water supply systems, it will be necessary to reconstruct the big part of the system. In the most cases, the local water supply systems did not satisfy water supply systems technical requirements.

The works values are given in ***2.13 Priced Bill of Quantities.***

2.11 MACRO-AVAILABLE ESTIMATION AND INVESTMENT CAPABILITY OF POPULATION, LOCAL COMMUNITY, MUNICIPALITY AND AUTHORIZED WATER/UTILITY COMPANY FOR INVESTING INTO THE WATER SUPPLY SYSTEM

Macro-available estimation and socio-economic analysis, investment capability for investing into the water supply system. Consultant needs to asses the macro-available investment amount for implementation of the measures. This indicative value will lead the Consultant while defining the acceptable technical measures scope. The total price must include the price of investments and re-investments, price of the functioning and maintanance the general management.

Assesment of macro-availability has to be based on the estimation of the real users community capacity to pay, which will be based on the socio-economic analysis, including all of the users (households, commercial, industrial and institutional), with the consideration of integrated approach to the water supply systems and drainage and treatment of waste waters.

The estimation of general capacity of users community contribution needs to be calculated for th eperiod used for longterm Master plan, which is based on the current situation and socio – economic result assesment, estimated prognosis of financial situation of the households and prognosis of commercial and industrial development. These scenarios must be studied: 'optimistically', 'normally' and 'pesimistically'. Every scenario has to contain the prognosis of state, entity, canton and municipal product in apsolute value and percent of domestic product, as well as the financial unit per inhabitant of the partner municipality .

Availability analysis needs to end with the assesment of the user's will to pay the water supply services and drainage and treatment of the waste waters. This estimation has to be based on the existing data, including all users categorries. Community users will, as well as the financial capacity need to be taken into consideration, what can lead to situation for necessary investments to be conducted in the time period phases.

2.12 LONGTERM DEVELOPMENT PLAN FOR THE ENTIRE PLANNING PERIOD (20 YEARS) WITH THE LIST OF INVESTMENTS MEASURES

Longterm water supply development plan. Plan will be based on the addopted concept – preliminary design, with the defined water supply facilities, water supplying divided into systems, zones and sub-zones, calculated maximum water requirements, defined water treatment at the capture points, locations and capacities of the reservoirs, pumping and pre-pumping stations, main pipelines, hydraulic calculations, management systems and all other technical elements. The longterm development plan will provide the identification of the projects and estimation of the expences, as well as criteria for priority projects, including the risks assesment and tries to prevent the consequences for realization of the total project efficiency.

2.13 PRICED BILL OF QUANTITIES

2.13.1 PRICED BILL OF QUANTITIES FOR WSS GRAČANICA

2.13.1.1 SOURCES PROTECTION ACCORDING TO THE REPORT

Source Sklop		
I PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Preparation of the Project for Sokoluša river regulation	31.12.2009.	18.000,00
Preparation of the Project for rehabilitation works (terrain levelling, roads water drainage)	Untill 31.7.2009	9.000,00
In total for the I Phase:		**27.000,00**
II PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Sokoluša river regulation in the Sklop source zone	31.12.2012.	93.000,00
Terrain levelling and roads water drainage	31.12.2009.	40.000,00
Rehabilitation of the fence and capture facilities	31.12.2009.	28.000,00
Monitoring establishment in accordance with the Decision on sanitary protection zones in the entire protected area		10.000,00
In total for the II Phase:		**171.000,00**
Recapitulation:		
I Phase		27.000,00
II Phase		171.000,00
In total for Sklop source:		**198.000,00**

Source Ilidža and Vrela (Soko)		
I PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Preparation of the Project for construction the sewerage system of LC Soko, with waste water aquatron	31.12.2009.	24.000,00
Preparation of the Project for construction the sewerage system of LC Škahovica, LC Piskavica and Babići, with waste water aquatron	31.12.2010.	50.000,00
Preparation of the Project for device with drinking water aquatron (based on the data on quality and sources capacity)	till 31.7.2009	9.000,00

Preparation of the Project for spring regulation at Ilidža source	31.12.2009.	13.000,00
Preparation of hydrogeological map of wider area (R 1:1.000) with all of the sources marked and other hydrogeological appereances because of rehabilitation	31.12.2009.	15.000,00
In total for the I Phase:		**111.000,00**
II PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Sewerage system construction based on the Projects	31.12.2012.	1.580.000,00
Rehabilitation of sources according to the hydrogeological map	31.12.2012.	40.000,00
Implementation of agro-pedological investigations in the aim of establishing the optimum conditions of processing and using the land in protected zones	31.12.2010.	8.000,00
Identify the basics of forest management in the protection zones	31.12.2010.	3.000,00
Monitoring establishment in accordance with the Decision on sanitary protection zones in the entire protected area	31.12.2012.	10.000,00
Water factory construction at the source Ilidža and Vrela	31.12.2011.	100.000,00
In total for the II Phase:		**1.741.000,00**
Recapitulation:		
I Phase		111.000,00
II Phase		1.741.000,00
In total for the sources Ilidža and Vrelo:		**1.852.000,00**

Source Soljanuša		
I PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Preparation of hydrogeological map of wider area (R 1:1.000) with all of the sources marked and other hydrogeological appereances because of rehabilitation	31.12.2009.	10.000,00
Preparation of the Project for spring regulation at Soljanuša source	31.12.2009.	7.000,00
Rehabilitation of the protection fence and facilities	31.12.2009.	33.000,00
In total for the I Phase:		**50.000,00**
II PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Implementation of agro-pedological investigations in the aim of establishing the optimum conditions of processing and using the land in protected zones	31.12.2010.	8.000,00

Performance of the Project for spring regulation from the direction of Soljanuša settlement (based on the project)	31.12.2011.	32.000,00
Rehabilitation of sources according to the hydrogeological map	31.12.2012.	40.000,00
Monitoring establishment in accordance with the Decision on sanitary protection zones in the entire protected area		10.000,00
In total for the II Phase:		**90.000,00**
Recapitulation:		
I Phase		50.000,00
II Phase		90.000,00
Total for the source Soljanuša:		**140.000,00**

Source Hadžijina voda		
I PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Preparation of the Project for sewerage system rehabilitation of Ritašići settlement	31.12.2009.	5.000,00
Preparation of the Project for precipitation water drainage of the roads	31.12.2009.	5.000,00
Exisiting facility rehabilitation	31.12.2009.	12.000,00
In total for the I Phase:		**22.000,00**
II PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Sanacija i izmještanje dijela kanalizacionog sistema naselja Ritašići	31.12.2010.	60.000,00
Izgradnja odvođenja oborinskih voda sa putne komunikacije	31.12.2010.	10.000,00
Monitoring establishment in accordance with the Decision on sanitary protection zones in the entire protected area		5.000,00
In total for the II Phase:		**75.000,00**
Recapitulation:		
I Phase		22.000,00
II Phase		75.000,00
Total for Hadžijina voda		**97.000,00**

Summary recapitualation		
Source		**Price (KM)**
Source Sklop		198.000,00
Source Ilidža and Vrela (Soko)		1.852.000,00
Source Soljanuša		140.000,00
Source Hadžijina voda		97.000,00
In total:		**2.287.000,00**

2.13.1.2 DEVELOPMENT OF GIS AND HYDRAULIC MODEL WSS GRAČANICA AND REDUCTION OF LOSSES IN THE SYSTEM

GIS, hydraulic model, defects removal, monitoring the system and procurement of equipment for defects removal and project documentation development	Total price (KM)
Development of GIS data basea	100.000,00
Developing hydraulic model of water supply system	100.000,00
Procurement of equipment and monitoring	200.000,00
Developing project documentation – Preliminary and Main projects	487.321,87
Rehabilitation in the period untill 2015	300.000,00
Rehabilitation in the period 2015 - 2020	1.000.000,00
Rehabilitation in the period 2020 - 2035	1.000.000,00
In total:	**3.187.321,87**

2.13.1.3 CONSTRUCTION OF NEW AND REPLACEMENT OF EXISTING PIPELINES

2.13.1.3.1 PLANNED TRANSPORT PIPELINES FROM THE SOURCE

Planned transport pipelines from the source				
Section	**Pipeline diameter (mm)**	**Pipeline lenght (m)**	**Unit price (KM/m)**	**Total price (KM)**
Planned well Stjepan Polje - R.Stjepan Polje	250	2.100,00	162,60	341.460,00
R.Stjepan Polje – planned reservoir of the I zone	250	8.100,00	162,60	1.317.060,00

Planned well D.Lohinja or Orahovica - R.D.Lohinja	250	1.700,00	162,60	276.420,00
R.D.Lohinja - planned reservoir of the I zon	250	5.700,00	162,60	926.820,00
Planned well in the Sklop system	200	1.200,00	148,40	178.080,00
Total:		**18.800,00**	**Total:**	**3.039.840,00**

2.13.1.3.2 NEW PLANNED PIPELINES

Section	Pipeline diameter (mm)	Pipeline lenght (m)	Unit price (KM/m)	Total price (KM)
Pressure pipelines from R. of the 1st zone to R. of the 2nd zone	200	700,00	148,40	103.880,00
Pipelines in zone Pribava	different			500.000,00
			Total:	**603.880,00**

2.13.1.3.3 REPLACEMENT OF THE SMALL PROFILES PIPELINES

Section	Pipeline diameter (mm)	Pipeline lenght (m)	Unit price (KM/m)	Total price (KM)
Pipelines of a profile smaller than DN 80 mm	80-200	30.000,00	71,76	2.152.800,00
Total:		**30.000,00**	**Total:**	**2.152.800,00**

2.13.1.4 CONSTRUCTION OF POTABLE WATER TREATMENT PLANT

Section	Kapacitet (l/s)	Unit price (KM/m^3)	Total price (KM)
Vrelo Ilidža	15	5.000,00	75.000,00
Vrelo	20	5.000,00	100.000,00
Stjepan Polje	20	7.500,00	150.000,00
Stjepan Polje	30	7.500,00	225.000,00
Donja Orahovica	40	7.500,00	300.000,00
Total:		**Total:**	**850.000,00**

2.13.1.5 RESERVOIRS

2.13.1.5.1 REHABILITATION OF EXISTING RESERVOIRS

Rehabilitation of existing reservoirs

The existing reservoirs need to be rehabilitated. Rough estimation is that we need the means from 5 % to 20 % of investments reservoir value for reservoir rehabilitation. Besides the rehabilitation of construction reservoir part, hydro-machines equipment, gate and reservoir fence need to be rehabilitated.

Reservoir	Reservir volume (m^3)	Reservoir damages percent	Unit price (KM/m^3)	Total price (KM)
Gornji Drafnići	20,00	20,00%	1.000,00	4.000,00
Donji Drafnići	30,00	15,00%	1.000,00	4.500,00
PS Drafnići	30,00	20,00%	1.000,00	6.000,00
Hurije	20,00	20,00%	1.000,00	4.000,00
Bahići	50,00	10,00%	1.000,00	5.000,00
Ritošići	100,00	15,00%	1.000,00	15.000,00
Gaj	1.800,00	10,00%	900,00	162.000,00
Pribava	300,00	5,00%	1.000,00	15.000,00
Total:	**2.350,00**		**Total:**	**215.500,00**

2.13.1.5.2 NEW RESERVOIRS CONSTRUCTION

Reservoir	Reservir volume (m^3)	Unit price (KM/m^3)	Total price (KM)
Reservoir Stjepan Polje	250,00	1.000,00	250.000,00
Reservoir Donja Orahovica	250,00	1.000,00	250.000,00
Reservoir of the I altitude	1.000,00	900,00	900.000,00
Reservoir of the II altitude - Ritošić	300,00	1.000,00	300.000,00
Reservoir Hurije - new	100,00	1.000,00	100.000,00
Reservoir for Drafniće and Hurije	250,00	1.000,00	250.000,00
Reservoir Sklop - Collector	400,00	950,00	380.000,00
	2.550,00	**Total:**	**2.430.000,00**

2.13.1.6 PUMPING STATION

2.13.1.6.1 REHABILITATION OF EXISTING PUMPING STATIONS

Rehabilitation of existing pumping stations

Rehabilitation includes the replacement of defect equipment and pumping station facility. It is estimated that the need for rehabilitation is around 25 % of new equipment value, and around 3.000,00 KM per each pumping station for facilities.

Pumping station	Capacity (l/s)	Water rising height (m)	Pumps power (kW)	Unit price of new PS (KM/W)	Total price (KM)
PS Sklop - wells Sklop	25,00	15,00	7,69	1.750,00	6.365,22
PS Hadžina voda	1,00	55,00	1,13	1.750,00	3.493,57
PS Drafnići	1,00	45,00	0,92	1.751,00	3.404,06
PS Soljanuša - bunari	6,00	30,00	3,69	1.750,00	4.615,31
PS Bahići	1,00	30,00	0,62	1.750,00	3.269,22
Total:	**34,00**			**Total:**	**21.147,37**

2.13.1.7 CONSTRUCTION OF NEW PUMPING STATIONS

Pumping station	Capacity (l/s)	Water rising height (m)	Pumps power (kW)	Unit price of new PS (KM/W)	Total price (KM)
New source north from Sklop	30,00	30,00	18,46	1.750,00	32.306,11
New PS at the collector reservoir at the source Sklop	47,00	25,00	24,10	1.750,00	42.177,43
New PS at the reservoir "Gaj"	10,00	85,00	17,44	1.751,00	30.528,76
New source for the 1st and 2nd altitude	33,38	80,00	54,78	1.750,00	95.861,05
PS for 2nd altitude at the reservoir of the 1st altitude	20,25	35,00	14,54	1.750,00	25.441,24
Total:	**140,63**			**Total:**	**226.314,60**

2.13.1.8 USING NEW SOURCES

Name of the source	Minimum source capacity (l/s)	Unit price (KM/l)	Price of introducing sources into the system (KM)
Hydrogeological investigation works and geophysical testings			250.000,00
Drilled wells north from the existing wells „Sklop“	30,0	35.000,00	1.050.000,00

New wells in the area of Stjepan Polje	30,0	35.000,00	1.050.000,00
Coonecting the wells in Stjepan Polje to the system	20,0	5.000,00	100.000,00
New wells in the area of D.Lohinja - D.Orahovica	40,0	35.000,00	1.400.000,00
	120,0		**3.850.000,00**

2.13.1.9 REMOTE CONTROL SYSTEM - SCADA

Description	Total price (KM)
Software and application	50.000,00
New source north from Sklop	45.000,00
New PS at the collector reservoir at the source Sklop	45.000,00
New PS at the reservoir "Gaj "	45.000,00
New wells in the area of Stjepan Polje	45.000,00
New wells in the area of D.Lohinja - D.Orahovica	45.000,00
PS for 2nd altitude at the reservoir of the 1st altitude	45.000,00
PS Sklop - Wells Sklop	45.000,00
PS Drafnići	45.000,00
PS Soljanuša - wells	45.000,00
PS Bahići	45.000,00
Reservoir Stjepan Polje	7.000,00
Reservoir Donja Orahovica	7.000,00
Reservoir of the 1st altitude	7.000,00
Reservoir of the 2nd altitude - Ritošić	7.000,00
Reservoir Hurije - new	7.000,00
Reservoir for Drafniće and Hurije	7.000,00
Reservoir Sklop - Collector	7.000,00
Donji Drafnići	7.000,00
PS Drafnići	7.000,00
Bahići	7.000,00
Gaj	7.000,00
Pribava	7.000,00
Total:	**534.000,00**

2.13.1.10 RECAPITULATION

Description of works		Price (KM)	
Sources protection measures based on the Report of protection zones			2.287.000,00
	Source Sklop	198.000,00	
	Sources Ilidža and Vrela (Soko)	1.852.000,00	
	Source Seljanuša	140.000,00	
	Source Hadžijina voda	97.000,00	
GIS, hydraulic model, defects removal, monitoring the system and procurement of equipment for defects removal and development of project documentation			3.187.321,87
Pipelines – construction of new and replacement of existing pipelines			5.796.520,00
	Planned transport pipelines from the source	3.039.840,00	
	Planned new pipelines in the system	603.880,00	
	Pipelines replacement	2.152.800,00	
Construction of potable water treatment plants			850.000,00
Reservoirs			2.645.500,00
	Rehabilitation of existing reservoirs	215.500,00	
	Construction of new reservoirs	2.430.000,00	
Pumping stations			247.461,97
	Rehabilitation of existing pumping stations	21.147,37	
	Construction of new pumping stations	226.314,60	
Using new sources			3.850.000,00
Remote control system - Scada			534.000,00
		Total:	**19.397.803,83**

Remark: Unit price of the pipelines was calculated with demolition and asphalting the traffic roads for the pipes lining.

2.13.2 PRICED BILL OF QUANTITIES FOR LOCAL WSS GRAČANICE

2.13.2.1 DEVELOPMENT OF GIS AND HYDRAULIC MODEL WSS, PROJECT DOCUMENTATION AND REDUCTION OF LOSSES IN THE SYSTEM

GIS, hydraulic model, defects removal, monitoring the system and procurement of equipment for defects removal and project documentation development	Ukupna cijena (KM)
Development of GIS data basea	150.000,00
Developing hydraulic model of water supply system	200.000,00
Procurement of equipment and monitoring – water meters in the system	872.089,46
Developing project documentation – Preliminary and Main projects	813.318,40
Rehabilitation in the period untill 2015	250.000,00
Rehabilitation in the period 2015 - 2020	500.000,00
Rehabilitation in the period 2020 - 2035	500.000,00
Total:	**3.285.407,86**

2.13.2.2 REHABILITATION OF EXISITNG WSS

Description of activities	Number of connections - estimation	Unit price (KM/connection)	Total price (KM)
Rehabilitation of WSS - sources, reservoirs, pumping stations, pipelines, house connections	7.632,00	150,00	1.144.800,00
Total:	**7.632,00**	**Total:**	**1.144.800,00**

2.13.2.3 CONSTRUCTION OF NEW AND REPLACEMENT OF EXISTING

2.13.2.3.1 REHABILITATION OF EXISTING PIPELINES

Description of activities	Number of connections - estimation	Unit price (KM/connection)	Total price (KM)
Rehabilitation of WSS - sources, reservoirs, pumping stations, pipelines, house connections	7.632,00	150,00	1.144.800,00
Total:	**7.632,00**	**Total:**	**1.144.800,00**

2.13.2.3.2 PLANNED NEW PIPELINES

Section	Pipeline diameter (mm)	Pipeline lenght (m)	Unit price(KM/m)	Total price (KM)
Construction of new pipelines in the system - estimated 15 % of existing pipelines lenght	80-200	62.684,70	100,00	6.268.470,00
			Total:	**6.268.470,00**

2.13.2.3.3 REPLACEMENT OF EXISTING PIPELINES

Section	Pipeline diameter (mm)	Pipeline lenght (m)	Unit price(KM/m)	Total price (KM)
Estimated 30 % of existing pipelines lenght	80-200	125.369,40	71,76	8.996.508,14
			Total:	**8.996.508,14**

2.13.2.4 CONSTRUCTION OF POTABLE WATER TREATMENT PLANT

Section	Capacity (l/s)	Unit price (KM/m^3)	Total price (KM)
Sources - 20 % of water	43	5.000,00	214.868,02
Wells - 80 % of water	172	7.500,00	1.289.208,10
		Total:	**1.504.076,12**

2.13.2.5 RESERVOIRS

2.13.2.5.1 REHABILITATION OF EXISTING RESERVOIRS

Rehabilitation of existing reservoirs
The existing reservoirs need to be rehabilitated. Rough estimation is that we need the means from 20 % of investments reservoir value for reservoir rehabilitation. Besides the rehabilitation of construction reservoir part, hydro-machines equipment, gate and reservoir fence need to be rehabilitated.

Reservoir	Reservir volume (m^3)	Reservoir damages percent	Unit price (KM/m^3)	Total price (KM)
All reservoirs	2.796,00	20,00%	1.000,00	559.200,00
			Total:	**559.200,00**

2.13.2.5.2 CONSTRUCTION OF NEW RESERVOIRS

Reservoir	Reservir volume (m^3)	Unit price (KM/m^3)	Total price (KM)
Deficit for 2035	2.773,38	1.000,00	2.773.378,99
		Total:	**2.773.378,99**

2.13.2.6 PUMPING STATIONS

2.13.2.6.1 REHABILITATION OF EXISTING PUMPING STATIONS

Rehabilitation of existing pumping stations Rehabilitation includes the replacement of defect equipment and pumping station facility. It is estimated that the need for rehabilitation is around 25 % of new equipment value, and around 3.000,00 KM per each pumping station for facilities.					
Pumping station	**Capacity (l/s)**	**Water rising height (m)**	**Pumps power (kW)**	**Unit price of new PS (KM/W)**	**Total price (KM)**
19 pumping stations	30,00	40,00	24,61	1.750,00	67.768,70
Total:	**30,00**			**Total:**	**67.768,70**

2.13.2.6.2 CONSTRUCTION OF NEW PUMPING STATIONS

Pumping station	Capacity (l/s)	Water rising height (m)	Pumps power (kW)	Unit price of new PS (KM/W)	Total price (KM)
It is estimated that 90 % of water will be pumped from new sources	139,60	40,00	114,53	1.750,00	200.435,33
Total:	**139,60**			**Total:**	**200.435,33**

2.13.2.7 USING NEW SOURCES

Name of the source	Minimum source capacity (l/s)	Unit price (KM/l)	Price of introducing sources into the system (KM)
Hydrogeological investigation works and geophysical testings			250.000,00
Drilled wells - 80 %	124,09	35.000,00	1.050.000,00
Natural sources - 20 %	31,02	35.000,00	1.050.000,00
Total:	**155,11**	**Total:**	**2.350.000,00**

2.13.2.8 REMOTE CONTROL SYSTEM - SCADA

Description	Total price (KM)
Software and application	50.000,00
Estimation	500.000,00
Total:	**550.000,00**

2.13.2.9 RECAPITULATION AOF LOCAL WATER SUPPLY SYSTEMS

Description of works		Price (KM)	
Sources protection measures - estimation			2.000.000,00
Investigation wors in water supply systems, collecting documentation about existing systems, water supply systems mapping, rehabilitation of losses and development of project planning documentation			3.285.407,86
Pipelines – Construction of new and replacement of existing pipelines			16.409.778,14
	Rehabilitation of existing systems	1.144.800,00	
	Planned new pipelines in the system	6.268.470,00	
	Replacement of the pipelines	8.996.508,14	
Construction of potable water treatment plant			1.504.076,12
Reservoirs			3.332.578,99
	Rehabilitation of existing reservoirs	559.200,00	
	Construction of new reservoirs	2.773.378,99	
Pumping stations			268.204,04
	Rehabilitation of existing pumping stations	67.768,70	
	Construction of new pumping stations	200.435,33	
Using the new sources			2.350.000,00
System remote control Scada			550.000,00
		Total:	**29.700.045,14**

2.13.3 SUMMARY PRICED BILL OF QUANTITIES FOR GRAČANICA MUNICIPALITY

Opis radova		Cijena (KM)	
Sources protection measures based on the Report of protection zones			4.287.000,00
	Izvorište Sklop	198.000,00	
	Izvorište Ilidža i Vrela (Soko)	1.852.000,00	
	Izvorište Seljanuša	140.000,00	
	Izvorište Hadžijina voda	97.000,00	
	Sources protection measures – local systems	2.000.000,00	
GIS, hydraulic model, defects removal, monitoring the system and procurement of equipment for defects removal and development of project documentation			6.472.729,73
Pipelines – construction of new and replacement of existing pipelines			22.206.298,14
	Rehabilitation of the local WSS	1.144.800,00	
	Planned transport pipelines from the source	3.039.840,00	
	Planned new pipelines in the system	6.872.350,00	
	Pipelines replacement	11.149.308,14	
Construction of potable water treatment plants			2.354.076,12
Reservoirs			5.978.078,99
	Rehabilitation of existing reservoirs	774.700,00	
	Construction of new reservoirs	5.203.378,99	
Pumping stations			515.666,00
	Rehabilitation of existing pumping stations	88.916,07	
	Construction of new pumping stations	426.749,93	
Using new sources			6.200.000,00
Remote control system - Scada			1.084.000,00
		Total:	**49.097.848,98**

3 PRIORITIZED PLAN OF INVESTMENT MEASURES FOR A 10 YEAR PERIOD

3.1 WSS GRAČANICA

3.1.1 SOURCES PROTECTION BASED ON THE REPORT

Source Sklop		
I PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Preparation of the Project for Sokoluša river regulation	31.12.2009.	18.000,00
Preparation of the Project for rehabilitation works (terrain levelling, roads water drainage)	till 31.7.2009	9.000,00
In total for the I Phase:		**27.000,00**
II PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Sokoluša river regulation in the Sklop source zone	31.12.2012.	93.000,00
Terrain levelling and roads water drainage	31.12.2009.	40.000,00
Rehabilitation of the fence and capture facilities	31.12.2009.	28.000,00
Monitoring establishment in accordance with the Decision on sanitary protection zones in the entire protected area		10.000,00
In total for the II Phase:		**171.000,00**
Recapitulation:		
I Phase		27.000,00
II Phase		171.000,00
In total for Sklop source:		**198.000,00**

Source Ilidža and Vrela (Soko)		
I PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Preparation of the Project for construction the sewerage system of LC Soko, with waste water aquatron	31.12.2009.	24.000,00
Preparation of the Project for construction the sewerage system of LC Škahovica, LC Piskavica and Babići, with waste water aquatron	31.12.2010.	50.000,00
Preparation of the Project for device with drinking water aquatron (based on the data on quality and sources capacity)	do 31.7.2009	9.000,00
Preparation of the Project for spring regulation at Ilidža source	31.12.2009.	13.000,00

Preparation of hydrogeological map of wider area (R 1:1.000) with all of the sources marked and other hydrogeological appereances because of rehabilitation	31.12.2009.	15.000,00
In total for the I Phase:		**111.000,00**
II PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Sewerage system construction based on the Projects	31.12.2012.	1.580.000,00
Rehabilitation of sources according to the hydrogeological map	31.12.2012.	40.000,00
Implementation of agro-pedological investigations in the aim of establishing the optimum conditions of processing and using the land in protected zones	31.12.2010.	8.000,00
Identify the basics of forest management in the protection zones	31.12.2010.	3.000,00
Monitoring establishment in accordance with the Decision on sanitary protection zones in the entire protected area	31.12.2012.	10.000,00
Water factory construction at the source Ilidža and Vrela	31.12.2011.	100.000,00
In total for the II Phase:		**1.741.000,00**
Recapitulation:		
I Phase		111.000,00
II Phase		1.741.000,00
In total for the sources Ilidža and Vrelo:		**1.852.000,00**

Source Soljanuša		
I PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Preparation of hydrogeological map of wider area (R 1:1.000) with all of the sources marked and other hydrogeological appereances because of rehabilitation	31.12.2009.	10.000,00
Preparation of the Project for spring regulation at Soljanuša source	31.12.2009.	7.000,00
Rehabilitation of the protection fence and facilities	31.12.2009.	33.000,00
In total for the I Phase:		**50.000,00**
II PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Implementation of agro-pedological investigations in the aim of establishing the optimum conditions of processing and using the land in protected zones	31.12.2010.	8.000,00
Performance of the Project for spring regulation from the direction of Soljanuša settlement (based on the project)	31.12.2011.	32.000,00

Rehabilitation of sources according to the hydrogeological map	31.12.2012.	40.000,00
Monitoring establishment in accordance with the Decision on sanitary protection zones in the entire protected area		10.000,00
In total for the II Phase:		**90.000,00**
Recapitulation:		
I Phase		50.000,00
II Phase		90.000,00
Total for the source Soljanuša:		**140.000,00**

Source Hadžijina voda		
I PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Preparation of the Project for sewerage system rehabilitation of Ritašići settlement	31.12.2009.	5.000,00
Preparation of the Project for precipitation water drainage of the roads	31.12.2009.	5.000,00
Exisiting facility rehabilitation	31.12.2009.	12.000,00
In total for the I Phase:		**22.000,00**
II PHASE		
Type of works	**Deadline (year)**	**Price (KM)**
Rehabilitation and relocation of the sewerage system part in settlement Ritašići	31.12.2010.	60.000,00
Precipitation drainage of the road	31.12.2010.	10.000,00
Monitoring establishment in accordance with the Decision on sanitary protection zones in the entire protected area		5.000,00
In total for the II Phase:		**75.000,00**
Recapitulation:		
I Phase		22.000,00
II Phase		75.000,00
In total for Hadžijina voda		**97.000,00**

Summary recapitulation		
Source		**Cijena (KM)**
Source Sklop		198.000,00
Source Ilidža and Vrela (Soko)		1.852.000,00
Source Soljanuša		140.000,00
Source Hadžijina voda		97.000,00
In total:		**2.287.000,00**

3.1.2 Development of GIS and hydraulic model WSS Gračanica and reduction of losses in the system

GIS, hydraulic model, defects removal, monitoring the system and procurement of equipment for defects removal and project documentation development	Ukupna cijena (KM)
Development of GIS data basea	100.000,00
Developing hydraulic model of water supply system	100.000,00
Procurement of equipment and monitoring – water meters in the system	200.000,00
Developing project documentation – Preliminary and Main projects	487.321,87
Rehabilitation in the period untill 2015	300.000,00
Rehabilitation in the period 2015 - 2020	1.000.000,00
In total:	**2.187.321,87**

3.1.3 CONSTRUCTION OF NEW AND REPLACEMENT OF EXISTING PIPELINES

3.1.3.1 PLANNED TRANSPORT PIPELINES FROM THE SOURCE

Planned transport pipelines from the source				
Section	**Pipeline diameter (mm)**	**Pipeline lenght (m)**	**Unti price (KM/m)**	**Total price (KM)**
Planned well Stjepan Polje - R.Stjepan Polje	250	2.100,00	162,60	341.460,00
R.Stjepan Polje – planned reservoir of the I zone	250	8.100,00	162,60	1.317.060,00
Planned well in the system Sklop	200	1.200,00	148,40	178.080,00
Total:		**11.400,00**	**Total:**	**1.836.600,00**

3.1.3.1.1 NEW PLANNED PIPELINES

Section	Pipeline diameter (mm)	Pipeline lenght (m)	Unti price (KM/m)	Total price (KM)
Pressure pipeline from the R. 1. zone to the R. 2. Zone	200	700,00	148,40	103.880,00
Pipelines in the zone Pribava	razni			500.000,00
			Total:	603.880,00

3.1.3.1.2 REPLACEMENT OF THE SMALL PROFILES DIAMETER

Section	Current pipeline diameter (mm)	Pipeline lenght (m)	Planned pipeline diameter (mm)	Unti price (KM/m)	Total price (KM)
Pipe P10	65	125,53	80,00	65,88	8.270,05
Pipe P11	100	205,76	100,00	71,76	14.765,19
Pipe P12	50	409,87	80,00	65,88	27.001,91
Pipe P13	50	56,30	80,00	65,88	3.709,14
Pipe P25	97	100,46	100,00	71,76	7.208,65
Pipe P32	200	1.057,59	200,00	148,40	156.946,36
Pipe P33	79	336,37	100,00	71,76	24.137,91
Pipe P34	55	364,50	80,00	65,88	24.013,26
Pipe P35	55	8,13	80,00	65,88	535,60
Pipe P39	198	434,65	200,00	148,40	64.502,06
Pipe P40	55	232,65	80,00	65,88	15.326,98
Pipe P50	55	2.207,74	150,00	113,08	249.651,24
Pipe P51	79	789,44	150,00	113,08	89.269,88
Pipe P52	55	79,97	100,00	71,76	5.738,65
Pipe P66	80	85,87	200,00	148,40	12.743,11
Pipe P67	55	444,00	100,00	71,76	31.861,37
Pipe P68	80	365,91	80,00	65,88	24.106,28
Pipe P78	55	69,19	80,00	65,88	4.558,55
Pipe P81	50	135,55	80,00	65,88	8.929,77
Pipe P88	79	355,63	80,00	65,88	23.428,97
Pipe P89	66	145,64	80,00	65,88	9.594,50
Pipe P90	66	565,82	80,00	65,88	37.276,09
Pipe P92	66	147,59	80,00	65,88	9.723,10
Pipe P94	50	106,59	80,00	65,88	7.022,41
Pipe P95	66	131,49	80,00	65,88	8.662,63
Pipe P109	55	702,22	80,00	65,88	46.261,99
Pipe P111	150	46,92	150,00	113,08	5.305,58
Pipe P112	66	236,78	80,00	65,88	15.598,93
Pipe P113	100	463,94	100,00	71,76	33.292,26
Pipe P114	80	245,36	80,00	65,88	16.164,19
Pipe P116	97	10,74	100,00	71,76	770,52
Pipe P122	97	1.060,72	100,00	71,76	76.117,27
Pipe P126	66	61,56	80,00	65,88	4.055,30
Pipe P127	66	7,79	80,00	65,88	513,08
Pipe P129	66	112,21	80,00	65,88	7.392,20
Pipe P136	79	213,39	80,00	65,88	14.058,13

Pipe P138	55	239,06	80,00	65,88	15.749,27
Pipe P139	60	148,48	80,00	65,88	9.781,73
Pipe P140	80	249,52	80,00	65,88	16.438,18
Pipe P149	80	149,09	80,00	65,88	9.822,05
Pipe P155	66	257,89	80,00	65,88	16.989,53
Pipe P156	79	119,49	80,00	65,88	7.871,80
Pipe P158	97	210,73	100,00	71,76	15.121,63
Pipe P159	97	43,04	100,00	71,76	3.088,55
Pipe P169	97	229,46	100,00	71,76	16.465,91
Pipe P170	97	104,84	100,00	71,76	7.523,46
Pipe P171	97	43,86	100,00	71,76	3.147,21
Pipe P176	97	229,35	100,00	71,76	16.458,30
Pipe P177	97	113,38	100,00	71,76	8.135,86
Pipe P187	55	383,50	100,00	71,76	27.519,96
Pipe P188	55	13,11	100,00	71,76	940,77
Pipe P193	55	154,00	80,00	65,88	10.145,78
Pipe P195	55	300,89	80,00	65,88	19.822,50
Pipe P196	40	118,09	80,00	65,88	7.779,64
Pipe P228	50	80,00	80,00	65,88	5.270,19
Pipe P230	50	64,22	80,00	65,88	4.230,81
Pipe P240	66	121,54	80,00	65,88	8.006,92
Pipe P241	40	50,42	80,00	65,88	3.321,90
Pipe P301	55	385,52	80,00	65,88	25.398,06
Pipe P306	50	20,33	80,00	65,88	1.339,58
Pipe P307	50	88,93	80,00	65,88	5.858,78
Pipe P308	50	276,68	80,00	65,88	18.227,68
Pipe P309	55	245,10	80,00	65,88	16.147,19
Pipe P322	66	419,83	80,00	65,88	27.658,27
Pipe P323	80	403,35	80,00	65,88	26.572,70
Pipe P324	80	320,99	200,00	148,40	47.635,06
Pipe P326	66	235,05	80,00	65,88	15.484,96
Pipe P340	55	207,91	80,00	65,88	13.697,31
Pipe Pi35	55	513,95	80,00	65,88	33.859,03
Pipe Pi42	97	1,13	200,00	148,40	167,69
Pipe Pi5	66	2,00	80,00	65,88	131,76
Pipe 1	55	1,01	100,00	71,76	72,48
otal:		**18.669,56**		**Total:**	**1.554.395,59**

3.1.3.2 CONSTRUCTION OF POTABLE WATER TTERATMENT PLANT

Section	**Capacity (l/s)**	**Unit price (KM/m^3)**	**Total price (KM)**
Vrelo Ilidža	15	5.000,00	75.000,00
Vrelo	20	5.000,00	100.000,00
Stjepan Polje	20	7.500,00	150.000,00
Stjepan Polje	30	7.500,00	225.000,00
Total:		**Total:**	**550.000,00**

3.1.3.3 RESERVOIRS

3.1.3.3.1 REHABILITATION OF EXISTING RESERVOIRS

Rehabilitation of existing reservoirs

The existing reservoirs need to be rehabilitated. Rough estimation is that we need the means from 5 % to 20 % of investments reservoir value for reservoir rehabilitation. Besides the rehabilitation of construction reservoir part, hydro-machines equipment, gate and reservoir fence need to be rehabilitated.

Reservoir	Reservoir volume (m^3)	Reservoir damage percent	Unit price (KM/m^3)	Total price (KM)
Gornji Drafnići	20,00	20,00%	1.000,00	4.000,00
Donji Drafnići	30,00	15,00%	1.000,00	4.500,00
PS Drafnići	30,00	20,00%	1.000,00	6.000,00
Hurije	20,00	20,00%	1.000,00	4.000,00
Bahići	50,00	10,00%	1.000,00	5.000,00
Ritošići	100,00	15,00%	1.000,00	15.000,00
Gaj	1.800,00	10,00%	900,00	162.000,00
Pribava	300,00	5,00%	1.000,00	15.000,00
Total:	**2.350,00**		**Total:**	**215.500,00**

3.1.3.3.2 CONSTRUCTION OF NEW RESERVOIRS

Reservoir	Reservoir volume (m^3)	Unit price (KM/m^3)	Total price (KM)
Reservoir Stjepan Polje	250,00	1.000,00	250.000,00
Reservoir of the 1st altitude	500,00	900,00	450.000,00
Reservoir of the 2nd altitude - Ritošić	300,00	1.000,00	300.000,00
Reservoir Hurije - new	100,00	1.000,00	100.000,00
Reservoir for Drafnići and Hurije	250,00	1.000,00	250.000,00
Reservoir Sklop - Collector	400,00	950,00	380.000,00
	1.800,00	**Total:**	**1.730.000,00**

3.1.3.4 PUMPING STATIONS

3.1.3.4.1 REHABILITATION OF EXISTING PUMPING STATIONS

Rehabilitation of existing pumping stations

Rehabilitation includes the replacement of defect equipment and pumping station facility. It is estimated that the need for rehabilitation is around 25 % of new equipment value, and around 3.000,00 KM per each pumping station for facilities.

Pumping station	Capacity (l/s)	Water rising level (m)	Pumps power (kW)	Unit price of new PS (KM/W)	Total price (KM)
PS Sklop - wells Sklop	25,00	15,00	7,69	1.750,00	6.365,22
PS Hadžina voda	1,00	55,00	1,13	1.750,00	3.493,57
PS Drafnići	1,00	45,00	0,92	1.751,00	3.404,06
PS Soljanuša - wells	6,00	30,00	3,69	1.750,00	4.615,31
PS Bahići	1,00	30,00	0,62	1.750,00	3.269,22
Total:	**34,00**			**Total:**	**21.147,37**

3.1.3.4.2 CONSTRUCTION OF NEW PUMPING STATIONS

Pumping station	Capacity (l/s)	Water rising level (m)	Pumps power (kW)	Unit price of new PS (KM/W)	Total price (KM)
New source north from Sklop	30,00	30,00	18,46	1.750,00	32.306,11
New PS at the collector reservoir at the source Sklop	47,00	25,00	24,10	1.750,00	42.177,43
New PS at the reservoir "Gaj"	10,00	85,00	17,44	1.751,00	30.528,76
New source for the 1st and 2nd altitude	33,38	80,00	54,78	1.750,00	95.861,05
PS for 2nd altitude at the reservoir of the 1st altitude	20,25	35,00	14,54	1.750,00	25.441,24
Total:	**140,63**			**Total:**	**226.314,60**

3.1.3.5 USING NEW SOURCES

Name of the source	Minimum source capacity (l/s)	Unit price (KM/l)	Price of source introduction into the system (KM)
Hydrogeological investigation works and geophysical testings			250.000,00
Drilled wells north from the existing wells „Sklop“	30,0	35.000,00	1.050.000,00
New wells in the area of Stjepan Polja	30,0	35.000,00	1.050.000,00

Wells introduction into the system in Stjepan Polje	20,0	5.000,00	100.000,00
	120,0		**2.450.000,00**

3.1.3.6 REMOTE CONTROL SYSTEM - SCADA

Description	**Total price (KM)**
Software and application	50.000,00
New source north from Sklop	45.000,00
New PS at the Sklop source collectiong reservoir	45.000,00
New PS at reservoir "Gaj"	45.000,00
New wells in the area of Stjepan Polje	45.000,00
PS for the 2nd altitude at the reservoir of the 1st altitude	45.000,00
PS Sklop - wells Sklop	45.000,00
PS Drafnići	45.000,00
PS Soljanuša - wells	45.000,00
PS Bahići	45.000,00
Reservoir Stjepan Polje	7.000,00
Reservoir of the 1st altitude	7.000,00
Reservoir of the 2nd altitude - Ritošić	7.000,00
Reservoir Hurije - new	7.000,00
Reservoir for Drafniće and Hurije	7.000,00
Reservoir Sklop - Collector	7.000,00
Donji Drafnići	7.000,00
PS Drafnići	7.000,00
Bahići	7.000,00
Gaj	7.000,00
Pribava	7.000,00
Total:	**482.000,00**

3.1.3.7 RECAPITULATION

Description of works		Price (KM)	
Protection measures according to the Report on sources protection zones			2.287.000,00
	Source Sklop	198.000,00	
	Source Ilidža and Vrela (Soko)	1.852.000,00	
	Source Seljanuša	140.000,00	
	Source Hadžijina voda	97.000,00	
GIS, hydraulic model, defects removal, monitoring the system and procurement equipment for defects removal and project documentation development			2.187.321,87
Pipelines – construction of new and replacement of existing pipelines			3.994.875,59
	Planned transport pipeline from the source	1.836.600,00	
	Planned new pipelines in the system	603.880,00	
	Replacement of the pipelines	1.554.395,59	
Construction of potable water treatment plant			550.000,00
Reservoirs			1.945.500,00
	Rehabilitation of existing reservoirs	215.500,00	
	Construction of new reservoirs	1.730.000,00	
Pumping stations			247.461,97
	Rehabilitation of existing pumping stations	21.147,37	
	Izgradnja novih pumpnih stanica	226.314,60	
Construction of new pumping stations			2.450.000,00
Remote control system Scada			482.000,00
		Total:	**14.144.159,43**

3.2 LOCAL WATER SUPPLY SYSTEMS OF GRAČANICA MUNICIPALITY

3.2.1 DEVELOPMENT OF GIS, PROJECT DOCUMENTATION, MEASUREMENTS AND AND REDUCTION OF LOSSES IN THE SYSTEM

Investigation wors in water supply systems, collecting documentation about existing systems, water supply systems mapping, rehabilitation of losses and development of project planning documentation	**Total price (KM)**
Development of GIS data basea	150.000,00
Developing hydraulic model of water supply system	200.000,00
Procurement of equipment and monitoring – water meters in the system	872.089,46
Developing project documentation – Preliminary and Main projects	583.793,85
Rehabilitation in the period untill 2015	250.000,00
Rehabilitation in the period 2015 - 2020	500.000,00
Total:	**2.555.883,31**

3.2.2 REHABILITATION OF EXISTING WATER SUPPLY SYSTEMS

Description of activities	Number of connections - estimation	Unit price (KM/connection)	Total price (KM)
Rehabilitation of water supply system - sources, reservoirs, pumping stations, pipelines, house connections	7.632,00	150,00	1.144.800,00
Total:	**7.632,00**	**Total:**	**1.144.800,00**

3.2.3 CONSTRUCTION OF NEW AND REPLACEMENT OF OLD PIPELINES

3.2.3.1 REHABILITATION OF EXISTING PIPELINES

Description of activities	Number of connections - estimation	Unit price (KM/connection)	Total price (KM)
Rehabilitation of water supply system - sources, reservoirs, pumping stations, pipelines, house connections	7.632,00	150,00	1.144.800,00
Total:	**7.632,00**	**Total:**	**1.144.800,00**

3.2.3.2 NEW PLANNED PIPELINES

Section	Pipeline diameter (mm)	Pipeline lenght (m)	Unit price (KM/m)	Total price (KM)

Construction of new pipelines in the system - Estimated 5 % of current pipelines lenght	80-200	18.805,41	100,00	1.880.541,00
			Total:	**1.880.541,00**

3.2.3.3 REPLACEMENT OF EXISTING PIPELINES

Section	Pipeline diameter (mm)	Pipeline lenght (m)	Unit price (KM/m)	Total price (KM)
Estimation is that 30 % of existing pipelines will have to be replaced	80-200	125.369,40	71,76	8.996.508,14
			Ukupno:	**8.996.508,14**

3.2.4 CONSTRUCTION OF POTABLE WATER TREATMENT PLANT

Section	Capacity (l/s)	Unit price (KM/m^3)	Total price (KM)
Sources - 20 % of water	30	5.000,00	151.442,91
Wells - 80 % of water	121	7.500,00	908.657,46
		Total:	**1.060.100,37**

3.2.5 RESERVOIRS

3.2.5.1 REHABILITATION OF EXISTING RESERVOIRS

Rehabilitation of existing reservoirs

The existing reservoirs need to be rehabilitated. Rough estimation is that we need the means 20 % of investments reservoir value for reservoir rehabilitation. Besides the rehabilitation of construction reservoir part, hydro-machines equipment, gate and reservoir fence need to be rehabilitated.

Reservoir	Reservoir volume (m^3)	Reservoir damage percent	Unit price (KM/m^3)	Total price (KM)
All reservoirs	2.796,00	20,00%	1.000,00	559.200,00
			Total:	**559.200,00**

3.2.5.2 CONSTRUCTION OF NEW RESERVOIRS

Reservoir	Reservoir volume (m^3)	Unit price (KM/m^3)	Total price (KM)
Deficit for 2020	1.129,40	1.000,00	1.129.400,23
	1.129,40	**Total:**	**1.129.400,23**

3.2.6 PUMPING STATIONS

3.2.6.1 REHABILITATION OF EXISTING PUMPING STATIONS

Rehabilitation of existing pumping stations

Rehabilitation includes the replacement of defect equipment and pumping station facility. It is estimated that the need for rehabilitation is around 25 % of new equipment value, and around 3.000,00 KM per each pumping station for facilities.

Pumping station	Capacity (l/s)	Water rising level (m)	Pumps power (kW)	Unit price of new PS (KM/W)	Total price (KM)
19 pumping stations	30,00	40,00	24,61	1.750,00	67.768,70
Total:	**30,00**			**Total:**	**67.768,70**

3.2.6.2 CONSTRUCTION OF NEW PUMPING STATIONS

Pumping station	Capacity (l/s)	Water rising level (m)	Pumps power (kW)	Unit price of new PS (KM/W)	Total price (KM)
It is estimated that 90 % of water will be pumped from the new sources	82,51	40,00	67,70	1.750,00	118.474,59
Total:	**82,51**			**Total:**	**118.474,59**

3.2.7 USING NEW SOURCES

Name of the source	Minimum source capacity (l/s)	Unit price (KM/l)	Price of source introduction into the system (KM)
Hydrogeological investigation works and geophysical testings			250.000,00
Drilled wells - 80 %	73,34	35.000,00	1.050.000,00
Natural sources - 20 %	18,34	35.000,00	1.050.000,00
Total:	**91,68**	**Total:**	**2.350.000,00**

3.2.8 RECAPITULATION FOR LOCAL WATER SUPPLY SYSTEMS

Description of works		Price (KM)	
Sources protection measures - estimation			2.000.000,00
Investigation wors in water supply systems, collecting documentation about existing systems, water supply systems mapping, rehabilitation of losses and development of project planning documentation			2.555.883,31
Pipelines – construction of new and replacement of existing pipelines			12.021.849,14
	Rehabilitation of existing water supply systems	1.144.800,00	
	Planned new pipelines in the system	1.880.541,00	
	Replacement of the pipelines	8.996.508,14	
Construction of potable water treatment plant			1.060.100,37
Reservoirs			1.688.600,23
	Rehabilitation of existing reservoirs	559.200,00	
	Construction of new reservoirs	1.129.400,23	
Pumping stations			186.243,29
	Rehabilitation of existing pumping stations	67.768,70	
	Construction of new pumping stations	118.474,59	
Using the new sources			2.350.000,00
		Total:	**21.862.676,34**

3.3 FINANCIAL AND ECONOMIC ANALYSIS

3.3.1 INTRODUCTION

Financing the priority projects

Financial capacity for financing the „priority projects“ will be searched in the basic three potential financial sources:

- Incomes of providing services
    - Increasing the services cost
    - Increasing the number of users
    - Savings in operation – increasing the efficiency
- Investments by the Municipality (and wider community)
- investments by the international and local financial institutions

The estimation of financial capacity will be done by the methodology which consists of four basic steps.

STEP 1 – Estimation of macroeconomic availability

Estimation of macroeconomic availability will be based on the estimation of Municipality economic development, average salaries in Gracanica Municipality and projections of economic development which will be defined by the social product GDP growth (BDP).

For all analysis the data were taken from the follwing:

- Federal Bureau for Statistics FBiH (http://www.fzs.ba):
    - TUZLA CANTON IN FIGURES / UDK 311.314 (497,6)/ Sarajevo 2010
- Agency for Statistics BiH (http://www.bhas.ba):
    - Consumer Price Index in BiH – (2007-2009), ISSN 1840-104X, Sarajevo 2009
    - APD 2007 poverty and life conditions, Sarajevo 2008
    - APD 2007 final results, Sarajevo 2008
- Gračanica Municipality data

STEP 2 – Estimation of financial capacity

Estimation of financial capacity will be included into the estimation of utility company financial capacity, to provide the additional finances through:

- Increasing the number of users
- Increasing the charging level
- Increasing the service cost
- Savings in operation and managing

For the estimation of financial capacity, we will use modificated version of „FEASIBLE“ program developped by the OECD „EAP Task Force“; more about the methodology itself, you can find at OECD web page:

http://www.oecd.org/document/56/0,3746,en_2649_34335_33719928_1_1_1_1,00.html

The methodology is made specifically for planners and decision makers in order to facilitate the planning of investment programs based on an assessment of available financial capacity. The general methodology is quite simple and consists of defining and comparing the cash flows of income and expenditure targets for each year of the analyzed period.

The result of the analysis is plan of incomes increasing and estimation of the incomes which can be used for financing of defined priority measures investment program.

Municipality is, also, one of the posible and available financing sources, and as as estimation of municipal financial capacity we will use the estimation of mun icipal average investments into the water supply projects drafted during the recent yaers.

We will, also, estimate the posibility of municipality to finance the suggested priority investment measures through the loans from international or local financial institutions.

As the last financial source, we have grants from the higher level government budget, i.e. from Canton and Federation BiH budget.

STEP 3 – Defining the financial capacity

In this step few potential scenarios will be developed, if posible, and asses their sustainabilities as the posible financial sources.

STEP 4

This final step will asses the realistic definition of the suggested Priority measures program and recomend it's eventual redefining.

These recommandations will be the initial step for the draft of the Feasibility Study for priority investment measures.

3.3.2 MACROECONOMIC AVAILABILITY AND SOCIO-ECONOMIC ANALYSIS

The analysis of macroeconomic availability of funds will be based on an analysis of three primary sources of funding, as follows:

- Potential savings in utility company operation
- Price policy analysis and increasing the services incomes
- Analysis of wider community posibilities, but before all Municipality

3.3.2.1 ANALYSIS OF UTILITY COMPANY POSIBILITIES

The following table shows the data on the structure of utility company incomes and expenses.

The basic indicators of utility company JP „Vodovod i kanalizacija“ dd Gračanica operation are shown in the following tables.

Service prices

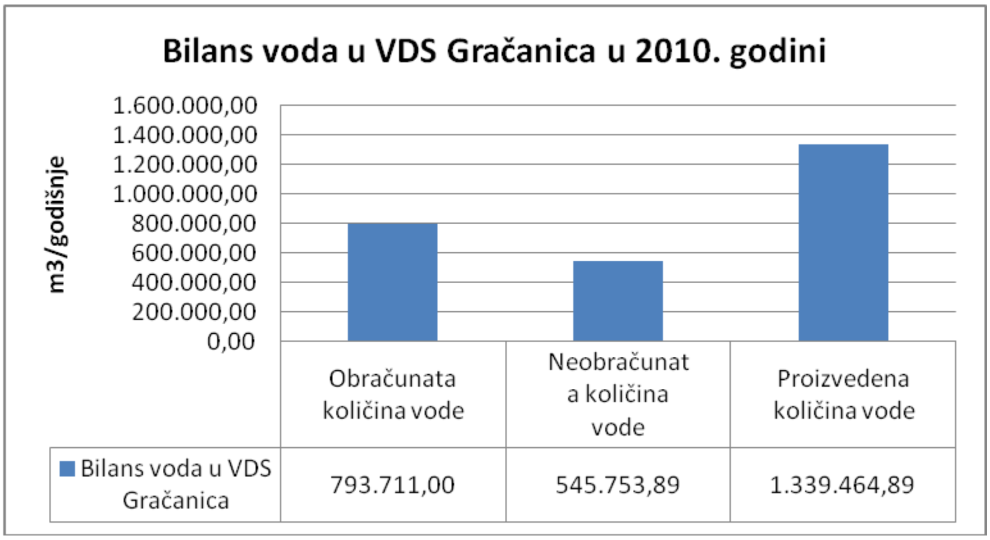
	Households	Public institutions	Industry
Water component	0,60	1,20	2,20
Sewerage component	0,20	0,20	0,20
Water capture tax	0,01	0,01	0,01
Waste water tax	0,04	0,04	0,20; 0,1; 0,04
Development component (planned for investments)	0,09	0,10	0,10
VAT	17%	17%	17%
TOTAL COMBINED PRICE (KM)	0,94+VAT	1,55+VAT	2,61+VAT

Specific water consumption

Inhabitants connected to the system	Total water produced in 2009 (m^3/year)	Specific water production (l/capita/day)
17.507	1.437.288,50	224,92

Inhabitants connected to the system	Total revenue water in 2009 (m^3/year)	Specific water consumption (l/capita/day)	Total revenue water for population in 2009 (m^3/year)	Specific water consumption without industry (l/capita/day)
17.507	838.422,00	131,21	663.676,00	103,86

Non-revenue water



Incomes of services provided by the company JP „Vodovod i kanalizacija“ dd Gračanica are shown in the following table.

Incomes of provided services

Table 98: Incomes of provided services and expenses of JP „Vodovod i kanalizacija“ dd Gračanica

Type of income	Value (KM)
Water providing incomes	710.140
Waste water disposal services incomes	128.886
Water meter taxes incomes	15.316
Additional services incomes	79.001
Other incomes	90.134
INCOMES IN TOTAL	**1.023.477**

Utility company expenses

Type of expenses	Vrijednost (KM)
Water and sewerage maintanance expenses	114.837
Electricity	105.544
Employees salaries	423.029
Amortization	121.623
Other expenses	257.092
EXPENSES IN TOTAL	**1.022.125**

To d the estimation of the actual financial capacity of utility company, we will not start from estimation of necessary, but available means.

International practices, as well as EU recommandations emphasize that socially acceptable expenses level for water supply service is 2-2,5% of the household income, i.e. 4-5 % of the total water supply services, sewerage and waste water treatment costs.

It is, aslo, of our interest to estimate the household incomes growth projections, since the future incomes of utility company will be directly depending of the mentioned.

3.4.2 MACROECONOMIC AVAILABILITY ANALYSIS

Gračanica Municipality is moderatelly developed municipality; the research of UNDP BiH „Regional disparity in BiH“ was based on multicriteria estimation of the municipalities development in BiH and according to this research Gračanica is at the 66th place of totally 142 municipalities in BiH regarding the development.

In recent years, the number of employed persons did not exceed the number of 10000.

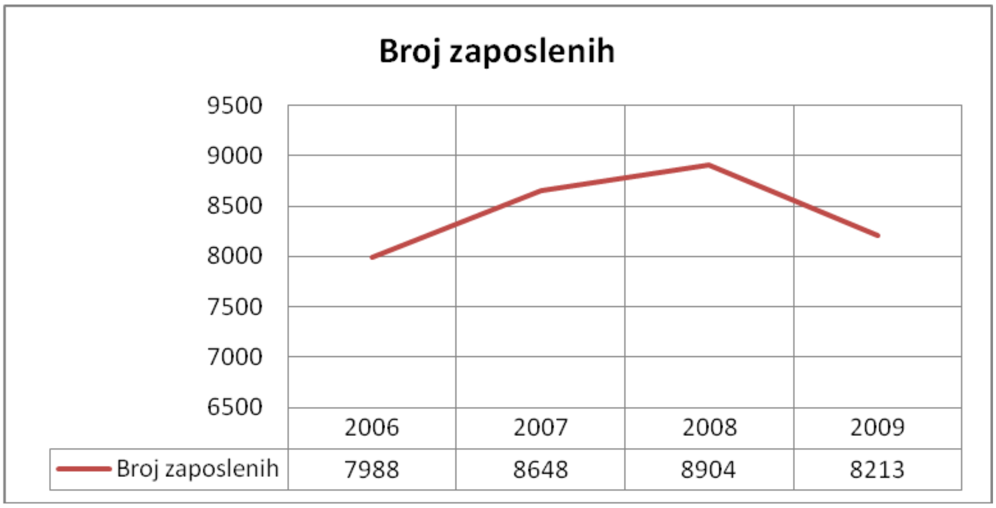


Chart 26: Number of employees in Gračanica Municipality

On the oter hand, the net average salaries are constantly increasing, but still not like the average of Federation BiH. Unfortunatelly, this data indicates the economy development, as well as the smaller percent of people employed in public administrations and services.

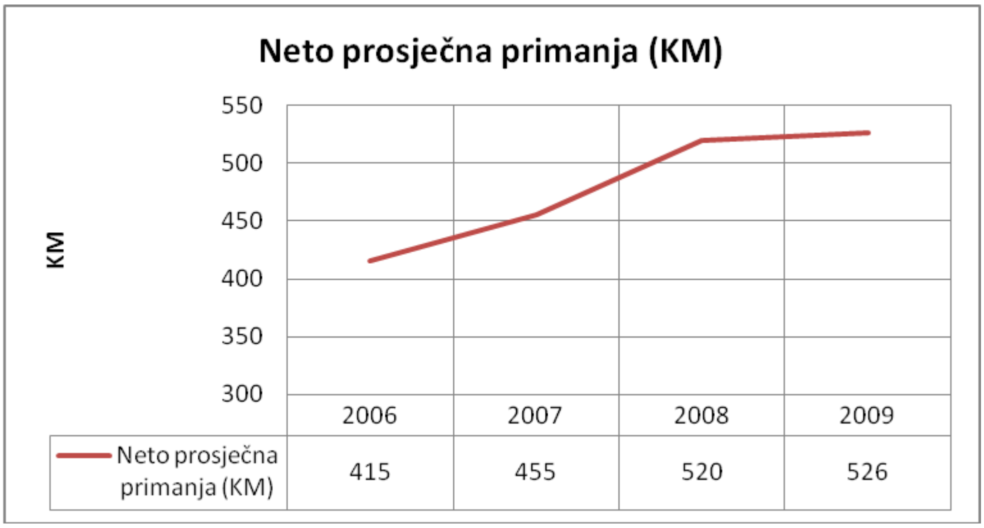


Chart 27: Average net salaries in Gračanica Municipality

It is of our interest to compare the actual expenses with the theoretically posible water supply service expenses, expressed as percent of household income.

Average actual water supply services price as income percent

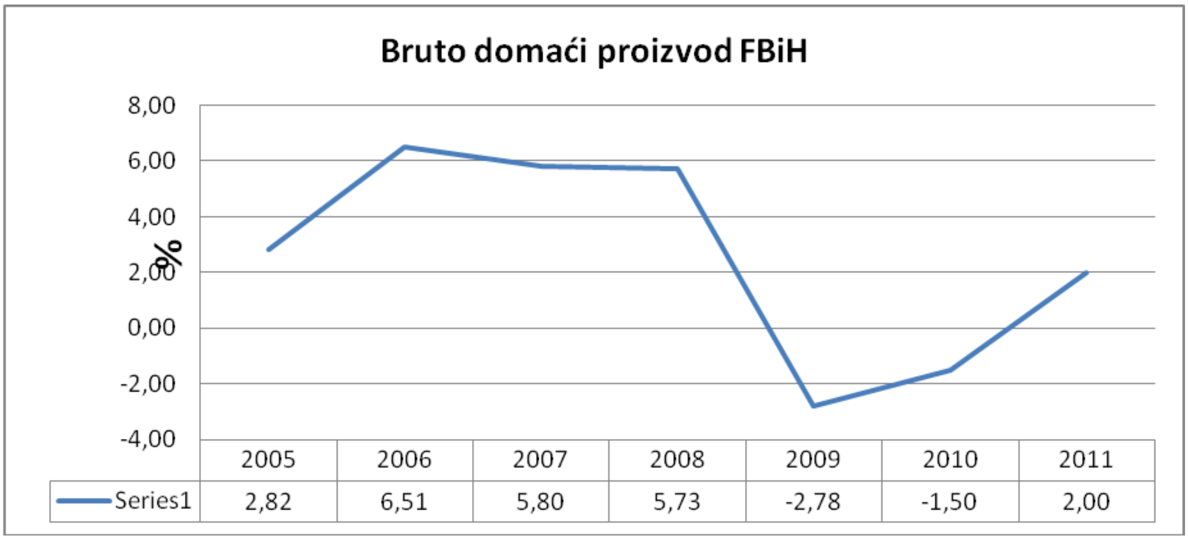
Specific consumption	l/capita/day	103
Specific consumption	m3/month	3,09
Service cost	KM/m3	0,6
Water supply expenses	KM	1,854
As a percent of current incomes	(%)	0,86%

Posible water supply service price of 2,0% of the household income

Specific consumption	l/capita/day	103
Specific consumption	m3/month	3,09
Service cost	KM/m3	1,39
Water supply expenses	KM	4,29
As a percent of current incomes	(%)	2,00%

The above tables show that, even without the planned growth projections, we already have the huge space for water supply services price increasing.

Since we are talking about financial projections for some longer planned period, it is of our interest to estimate the future development projections. We assume that the household incomes will grow inside of the same GSP product of FBiH.



Since the GSP growth in FBiH and BiH was very turbulent and expossed to the different mechanism actions (VAT implementation, world economic crisis, decreasing donations and aids for BiH, etc.) it is very difficult to find relevant estimations of GSP growth for some longer time period. That is the reason for projecting the future incomes growth analysis in three options:

OPTION 1 – Moderate projection, which assumes the minimum GDP growth of 1% annual rate

OPTION 2 - Optimistic projection, which assumes the GDP growth of 4% annual rate

OPTION 3 - Optimistic projection, which assumes the negative GDP growth of -3% annual rate

Starting from assumption that there are three persons in the average household with 1, 2 persons working, it was posible to calculate average household incomes and water supply services cost. In this way, we came up with the price which comply with the financial capability of the consumers.

Analysis results are shown in the following tables

<u>Average monthly household incomes</u>

3 persons in a household

1,2 persons working

Table 99: Average monthly household income - Gračanica

Moderate projection						
Year	2010	2015	2020	2025	2030	2035
Household monthly income KM	637	670	704	740	778	817
GDP growth		1%	1%	1%	1%	1%
Inflation		0%	0%	0%	0%	0%
Total		1%	1%	1%	1%	1%

Pesimistic projection						
Year	2010	2015	2020	2025	2030	2035
Household monthly income KM	612	526	451	388	333	286
GDP growth		-3%	-3%	-3%	-3%	-3%
Inflation		0%	0%	0%	0%	0%
Total		-3%	-3%	-3%	-3%	-3%

Optimistic projection						
Year	2010	2015	2020	2025	2030	2035
Household monthly income KM	656	799	972	1.182	1.438	1.750
GDP growth		4%	4%	4%	4%	4%
Inflation		0%	0%	0%	0%	0%
Total		4%	4%	4%	4%	4%

Table 100: Water supply service price as a percent of household income

Service price depending on the income						
Pesimistic projection	**2% of the income**					
Year	2010	2015	2020	2025	2030	2035
Service price KM/m3	1,32	1,13	0,97	0,84	0,72	0,62
GDP growth		-3%	-3%	-3%	-3%	-3%
Inflation		0%	0%	0%	0%	0%
Total		-3%	-3%	-3%	-3%	-3%
Moderate prijection						
Service price KM/m3	1,38	1,45	1,52	1,60	1,68	1,76
GDP growth		1%	1%	1%	1%	1%
Inflation		0%	0%	0%	0%	0%
Total		1%	1%	1%	1%	1%
Optimistic projection						
Service price KM/m3	1,42	1,72	2,10	2,55	3,10	3,78
GDP growth		4%	4%	4%	4%	4%
Inflation		0%	0%	0%	0%	0%
Total		4%	4%	4%	4%	4%

Service price depending on the income						
Pesimistic projection	**1,3% of the income**					
Year	2010	2015	2020	2025	2030	2035
Service price KM/m3	0,86	0,74	0,63	0,54	0,47	0,40
GDP growth		-3%	-3%	-3%	-3%	-3%
Inflation		0%	0%	0%	0%	0%
Total		-3%	-3%	-3%	-3%	-3%
Moderate projection						
Service price KM/m3	0,89	0,94	0,99	1,04	1,09	1,15
GDP growth		1%	1%	1%	1%	1%
Inflation		0%	0%	0%	0%	0%
Total		1%	1%	1%	1%	1%
Optimistic projection						
Service price KM/m3	0,92	1,12	1,36	1,66	2,02	2,45
GDP growth		4%	4%	4%	4%	4%
Inflation		0%	0%	0%	0%	0%
Total		4%	4%	4%	4%	4%

Increase of the income of Gracanica MUnicipality employees depending on GDP growth

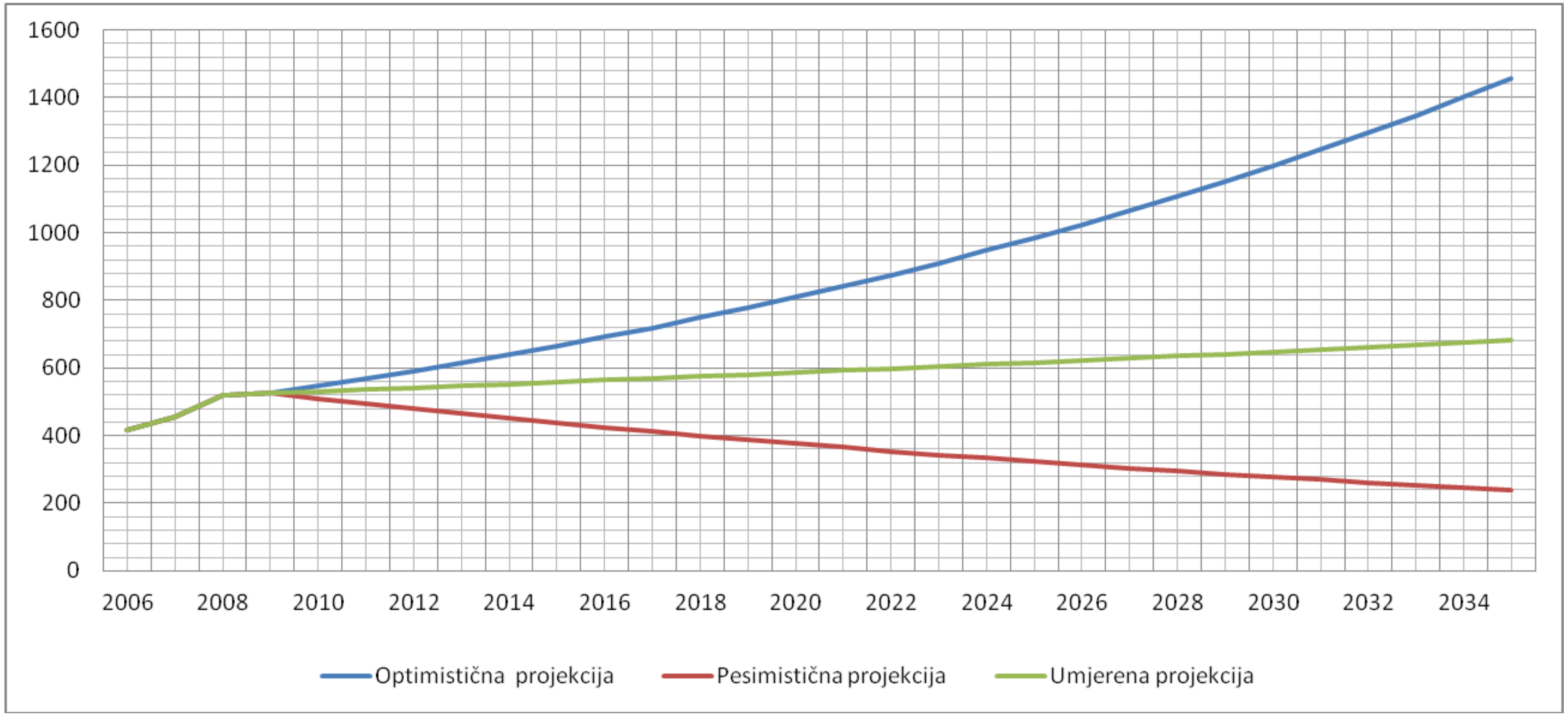


Chart 28: Average net salaries depending on the GDP growth in Gračanica Municipality

For the needs of financial capacity estimation we took that the water supply services price growth will be 1,3% of the household income in the first 8 years period.

Reasons for this assumptiton are as follows:

- considering the relativelly low household incomes, which are just a bit higher than the poverty limit, we thhink that the projections based on the higherprice growth would be too optimistic
- no matter how low are the prices, it will be necessary to plan their gradual increase
- Gračanica Municipality started the activities for finding the loans and donations for construction of sewerage network and purifiers in Gračanica town. Realization of this activities will, also, demand the significant increase of sewerage services price.

Of our interest is to compare the current households expenses for water supply services with the estimated household consumption in accordance with the „Survey on household consumption in BiH - 2007“

Share of water and sewerage expenses in the household incomes and consumption	
Water supply as a income percent	0,86%
Water supply as a consumption percent	0,54%
Water and sewerage as a percent of income in total	1,32%
Water and sewerage as a percent of consumption in total	0,70%

It is obvious that the current share of the cost of water supply, sewage and waste water is almost negligible and much lower than the recommended value.

The conclusion is that there is sufficient room to increase prices for services, not to undermine the social status of families and individuals who are at risk of poverty.

3.3.2.2 ELASTICITY OF DEMAND FOR SERVICES AND WILLINGNESS TO PAY

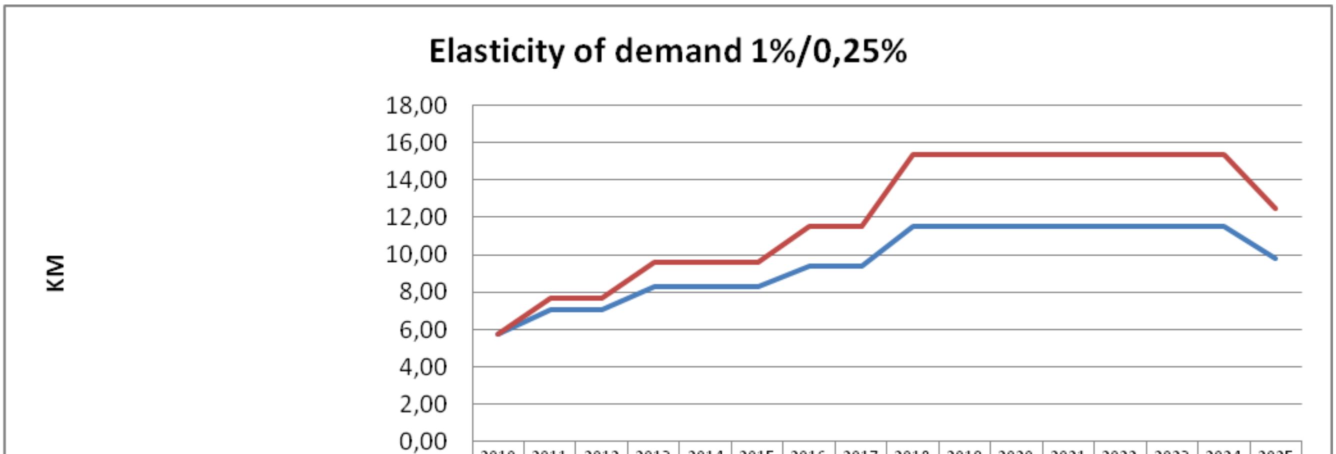
Price elasticity of demand for water is the change in demand divided by the change in the price of water at any point in the curve of demand. Usually the demand for water is considered "inelastic" because the elasticity is less than + / - 1, indicating that one percent increase in void rates to lower (or higher) than one percent change in demand. Usually the elasticity calculations go in natural logarithms as the coefficient of elasticity of return as a percentage change, and because they are easier to interpret. Elasticity is calculated for the average cost and consumption variable.

Price elasticity of demand for water is increasing the amount consumed per unit, increase in income or consumption. Although the demand may decline in response to price increases, the demand will increase as a result of increase in real household income.

Such analysis is not done in Bosnia and the only attempt to estimate the demand elasticity is given in the project of the European Commission's water quality management at the level of river basins in Bosnia and Herzegovina Europe Aid/119168/C/SV/BA

This attempt is based on data of ISMS Study on household consumption in 2002. The document estimated that the elasticity of water prices increase by one percent will lead to 0.5 percent volume decline in water consumption, and one percent increase in real household income will lead to 0.8 percentage volume increase of water consumption.

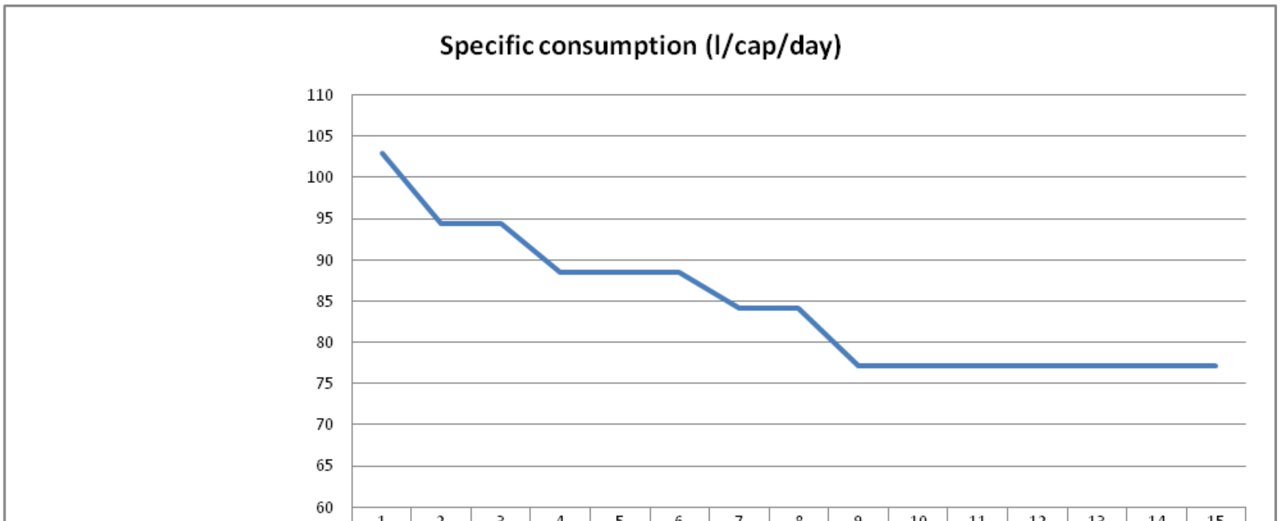
Potentially increased consumption due to the increase of household income is not taken into account because it is considered that the real growth of income will be sufficient to amortize the expected increase in price. Only with a significant absolute increase in income and reduction of water supply cost below 1.2% for the economic cost of water, one can expect growth in demand as a result of revenue growth.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Prihod od vodosnabdijevanja po domaćinstvu mjesečno uključen elasticitet potražnje	5,77	7,05	7,05	8,26	8,26	8,26	9,41	9,41	11,51	11,51	11,51	11,51	11,51	11,51	11,51	9,79
Prihod od vodosnabdijevanja po domaćinstvu mjesečno bez elasticiteta potražnje	5,77	7,69	7,69	9,61	9,61	9,61	11,53	11,53	15,38	15,38	15,38	15,38	15,38	15,38	15,38	12,49

Chart 29: Elasticity of demand

Reducing the water consumption



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Specifična potrošnja (l/st/dan)	103	94,42	94,42	88,52	88,52	88,52	84,09	84,09	77,08	77,08	77,08	77,08	77,08	77,08	77,08

Willingness to pay for services and consumers surplus

Assessment of willingness to pay for services is one of the most controversial issues when it comes to preparing financial and economic plans for utility companies development.

Analysis to assess the readiness of users to pay for a particular service are designed and used primarily for the economic evaluation of investments that can not be evaluated in money market and, therefore, this analysis became very popular when it comes to environmental projects that will have consequences for the environment and improving conditions of life.

The application of such analysis in cases where a monopoly on services under the customs of state regulation has proved to be less flourishing because they do not take into account other financial mechanisms that do not affect the willingness to pay for certain services.

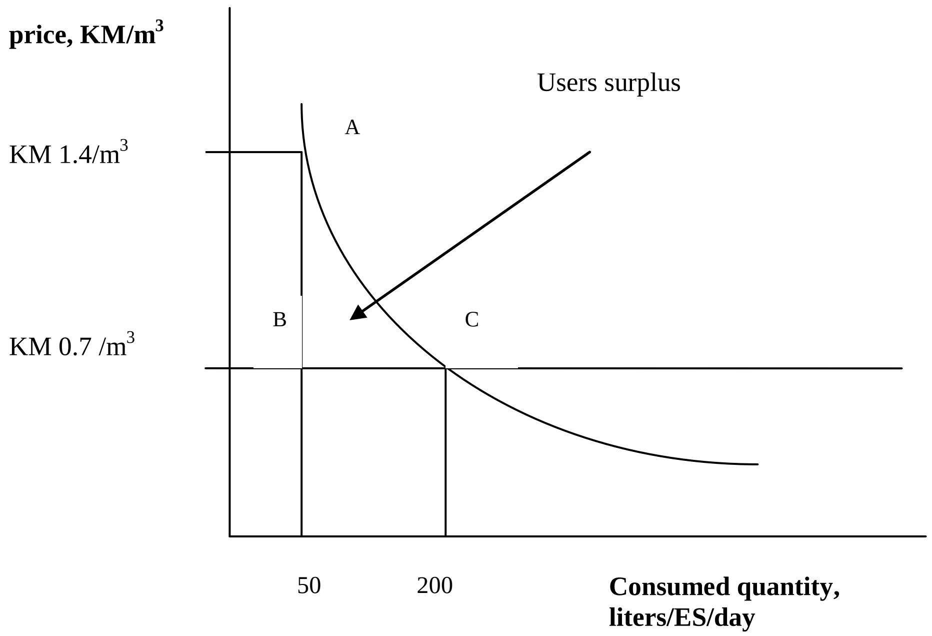
Experience in all transition countries shows that, when it comes to water supply services a lot bigger problem is "unwillingness to service charge" comparing to the "Consumer willingness to pay“.

Regarding the utility company, the low charging level of app. 67%, and according to the estimation of utility company itself, without the few 'bigger' consumers the charging percent falls under 60%. The mentioned is a consequence of:

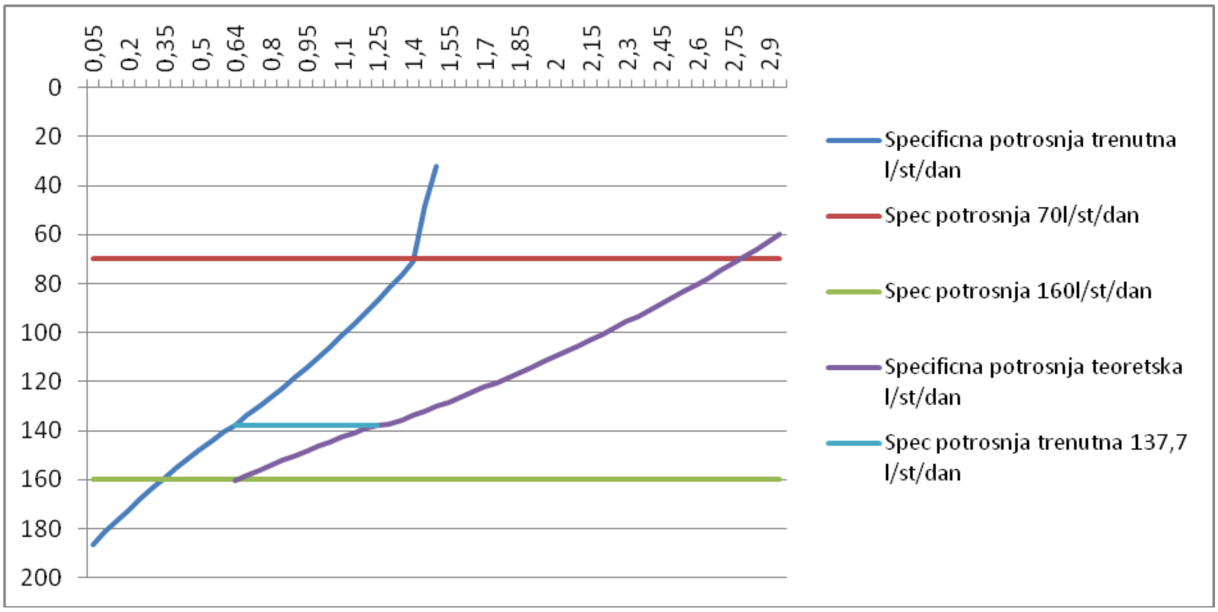
- migration of population during and after the war, ans unsolved property-legal issues
- social policy of services charging through significantly low service prices and amnesting the consumers of paying for the services

The method which is much more common when it comes to assessing willingness to pay for services is the consumer surplus estimates.

Consumers surplus concept is briefly presented by the following chart:



Analysis of „consumers surplus“ were made for the needs of this Study, and they show that the estimated readyness for paying for the services is app. 1.4 KM/m^3, as follows in the chart:



REMARK

THIS KIND OF ANALYSIS ARE USUALLY MADE AT STATE/ENTITY LEVEL, SO THE PRESENTED RESULTS IN THIS STUDY NEED TO BE TAKEN WITH A SLIGHT RESERVE, MOST PROBABLY THAT THE PRECISELLY MADE ANALYSIS WOULD SHOW THAT THE CONSUMERS SURPLUS IS HIGHER THAN THE ESTIMATED 1,4 KM/m^3, I.E. THAT OUR ESTIMATIONS ARE PRETTY CONSERCATIVE AND OPTIMISTIC.

3.3.3 ANALYSIS OF GRACANICA MUNICIPALITY INVESTMENT CAPABILITY

The following table shows that Gracanica Municipality allocates the finances for water supply projects from capital investments bdget annually of app. 350.000,00 to 450.000,00 KM .

Creditworthiness of the municipality is estimated at 4,800,000.00 KM, but in line with its strategic commitments Gracanica municipality has applied for a loan from the European Investment Bank through the project "Water and Sanitation in FBiH" in the prescribed amount with the aim of building a sewage network and filters and reconstruction water system, so that we can consider that there is a possibility of financial credit of the Municipality to support the implementation of priority measures.

Additional possible sources of funding as applications to the municipality of Gracanica and the Canton of the Federation, however, possible to estimate the amount of funds available at this time are not known.

Table 101: Gračanica Municipality budget 2009

Data taken from the reoprt on Gracanica Municipality budget for 2009	
1. TOTAL INCOMES	9.388.355 KM
1.1. Tax revenue	6.520.847 KM
1.2. Non-tax revenue	1.805.334 KM
1.3. Current supports - grants	1.322.489 KM
2. TOTAL INCOMES	2.464.432 KM
TOTAL BUDGET (1+2)	11.852.787 KM
3. TOTAL EXPENDITURES	10.494.032 KM
3.1. Current expenditures	6.022.345 KM
3.2. Capital expenditures	4.471.687 KM
4. DIFFERENCE BETWEEN INCOMES, REVENUES AND EXPENDITURES ((1+2)-3)	
(Budget suficite)	1.358.755 KM
4.1. repayments of loan	1.051.352 KM
4.2. Net budget suficite	307.403 KM

3.3.4 SOCIALY JEOPARDIZED GROUPS AND POPULATION

Research on the households consumption in BiH was related to the issue of poverty line in BiH. Based on the research, the poverty line is defined as follows:

Relative poverty		
Relative poverty line per adjusted member per month	350,22	(KM)
Poverty percent per adjusted member	15,64	(%)
water supply expenses involvement in the total expenditures		
Relative poverty line per addapted person monthly	350,22	
Water supplying	7,30	2,09%
Water and sewerage in total	9,62	2,75%

In thhis table we can see that even for the persons at the poverty limit, the water supply services price does not exceed 2,0 % in the total expenditures.

In the following period after completion of the planned increase in the prices of water supply services is necessary to monitor changes in specific water consumption, when the specific water consumption reaches a value of app. 80 l / capita / day, is necessary to analyze the possibility of the introduction of block tariffs to protect poor users from the negative social impact of price increases.

Considering the socially jeopardized population in Gracanica Municipality area and the issue of their connection to the system, these issues are detailly precessed and the recommandations are given in the Study.

„Action Plan for social inclusion in the social / child protection to the area of water supply in the municipality of Gracanica for 2011-2012, done in the implementation of the project "Democratic governance in the field of economy - Providing access to water supply through institutional development and infrastructure ", which implements the initiative for a better and more humane inclusion (IBHI), within the MDG-F in water supply.

3.4 FINANCIAL CAPACITY ANALYSIS

Analysis was made for more Scenarios based on the following assumptions:

All prices are calculated based on the current prices without the inflation, VAT and other taxes.

SCENARIO 1

Posible incomes sources are defined as follows:

- Incomes of providing water supply services with the increase of price up to 1,6% of the estimated household income
- Household incomes will increase in accordance with the „moderate growth projection“, i.e. with the 1% GDP growth
- Increase of utility company services charging level to 95%
- Price of services for the industry and small companies will remain the same and its' increase is not planned

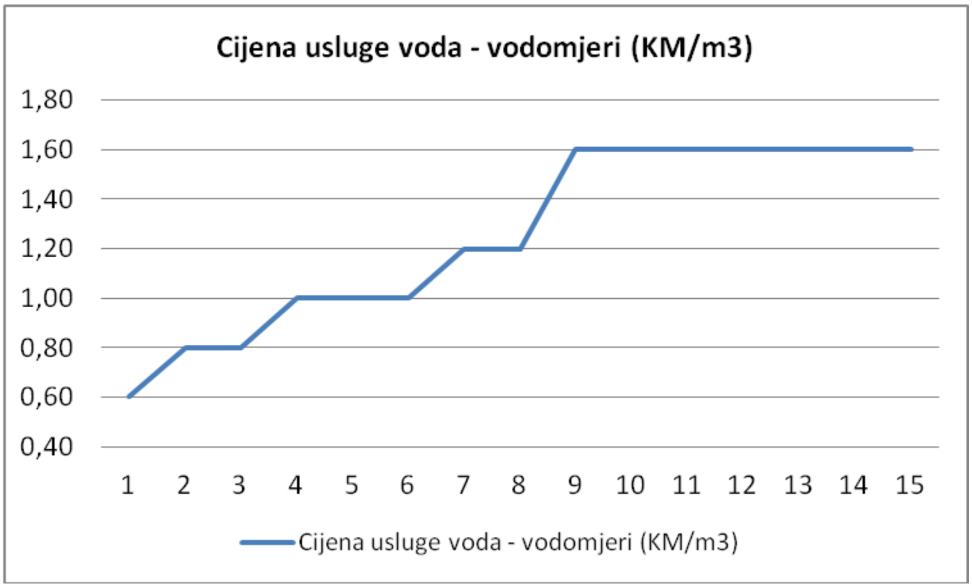


Chart 30: Plan of increasing the water supply services prices

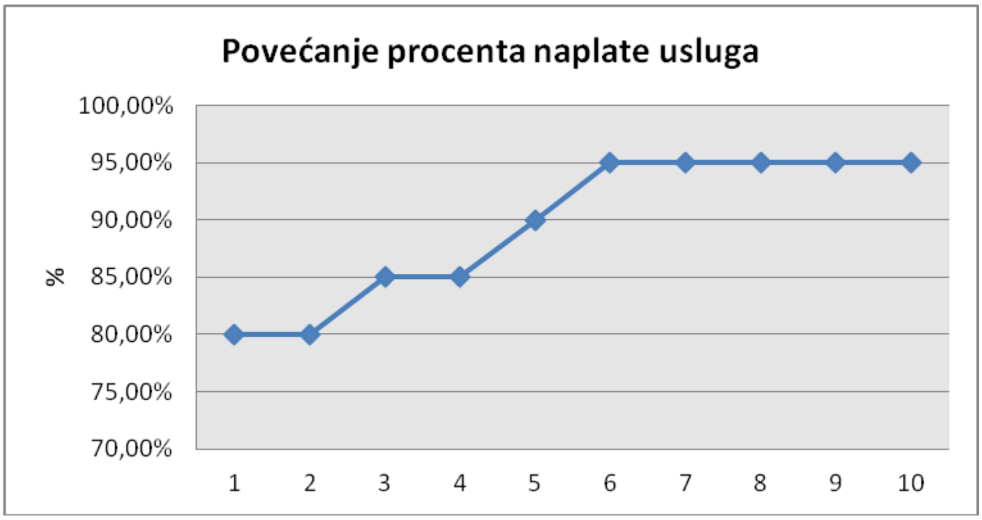


Chart 31: Plan of increasing the water supply services prices

Operation expenses of utility company JP „Vodovod i kanalizacija“ dd Gračanica operation are estimated in accordance with the following table.

Table 102: Estimation of utility company operation expenses

Type of expenses	KM/ year		
Expenses of water supply system maintanance	97.611	**163.170**	Održavanje
Electricity	105.544		
Employees salaries	359.575		
Amortization			
Other expenses	218.528	**618.088**	Operativni
EXPENSES IN TOTAL	884.638	**781.258**	Ukupno

Program of priority measures for the following ten years in WSS Gračanica

Description of works		Cost (KM)	
Sources protection measures based on the Report on sources protection zones			2.287.000,00
	Source Sklop	198.000,00	
	Sources Ilidža and Vrela (Soko)	1.852.000,00	
	Source Seljanuša	140.000,00	
	Source Hadžijina voda	97.000,00	
GIS, hydraulic model, defects removal, system monitoring and procurement of equipment for defects removal and development of project documentation			2.187.321,87
Pipelines – construction of new and replacement of existing pipelines			3.994.875,59
	Planned transport pipelines from the source	1.836.600,00	
	Planned new pipelines in the system	603.880,00	
	Pipelines replacement	1.554.395,59	
Construction of drinking water treatment plants			550.000,00
Reservoirs			1.945.500,00
	Rehabilitation of existing reservoirs	215.500,00	
	Construction of new reservoirs	1.730.000,00	
Pumping stations			247.461,97
	Rehabilitation of existing pumping stations	21.147,37	

	Construction of new pumping stations	226.314,60	
Using the new sources			2.450.000,00
Remota control system - Scada			482.000,00
		Total:	**14.144.159,43**

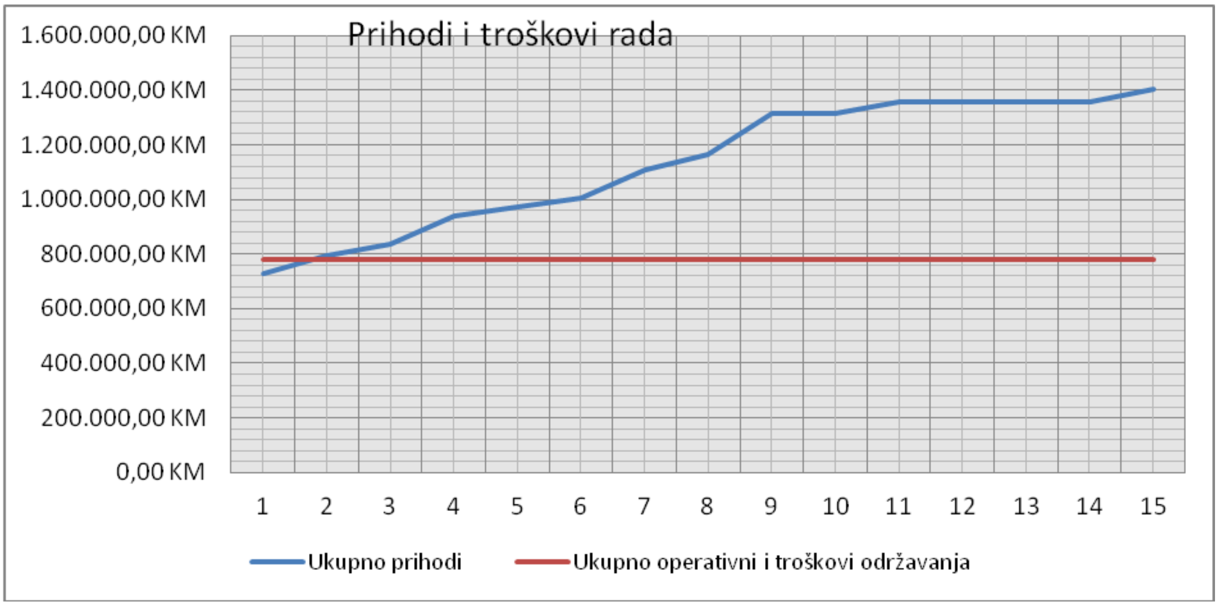
In other words, when we exclude VAT from this estimation and divide it to the planned implementation period, we get that the average investment expenditure is app. 1.2 miliona KM annually.

Total:	**14.144.159**	**KM**
VAT	2.055.134	**KM**
Without VAT	12.089.025	**KM**
Period (year)	10	**KM**
Average annual investment	1.208.903	**KM**

After the calculations we obtain the following result for Scenario 1:

Planned growth of prices and charging percent will have a good impact to the utility company financial situation, but only after the first 4 years of implementation of this plan we can expect the rest of the income of app. 400.000,00 KM which could be used for financing the Measures priority plan.

The incomes and expenses flow for water supply component



The following chart shows coverage of utility company operation expenses, and we have two types of expenses coverage.

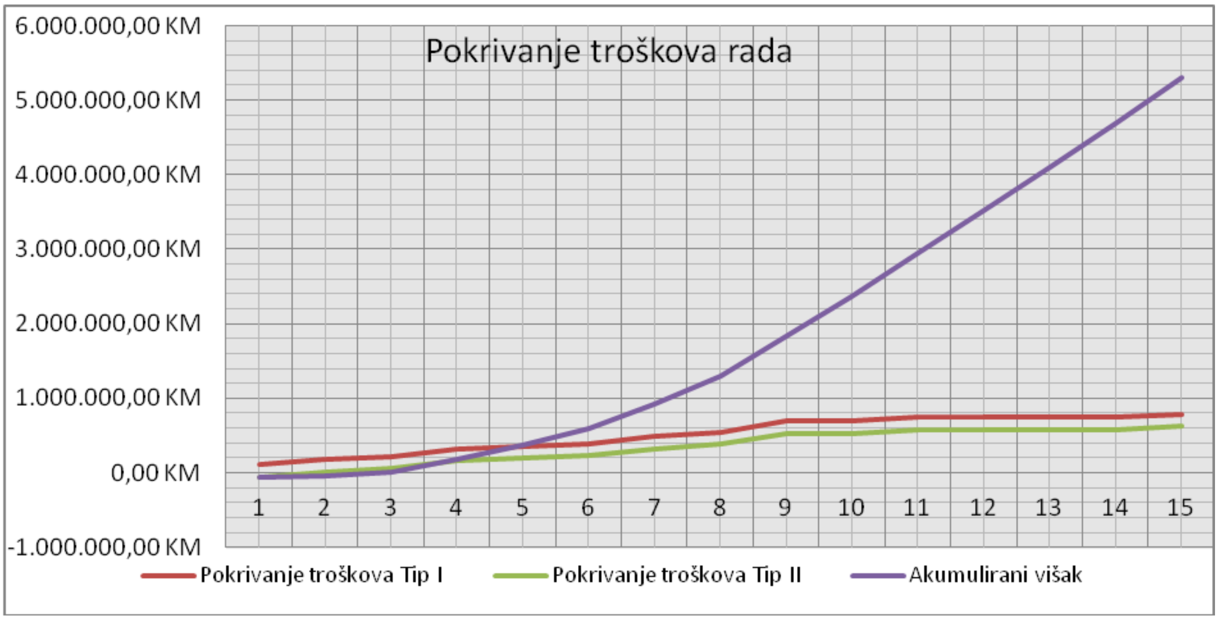


Chart 32: Coverage of operation expenses –Scenario 1 witthout investments

Expenses recovery Type I	Difference between operational expenses and total incomes after investing
Expenses recovery Type II	Difference between operational and maintenance expenses and total incomes after investing

Obviously, the first four years the utility company has to wait for the effect of price increases and cost recovery, and in five years we can expect a surplus income for investment and the ability to start the investment cycle for defined plan of priority measures.

The total value of accumulated financial capacity would amount to app. 3 million KM in 10 years, and in 15 years app. 5 million.

This indicates that the start of implementation of priority measures should be postponed until eventually reaching a certain level of income or utility company to find additional funds to finance the plan priorities in the first three years, as recommended by the consultant.

Obviously, given the assumptions of the cost of services the utility company is not able to finance defined plan of priority investments in full. A particular drawback of this scenario is the lack of funds for investment in the first three years.

Due to the all above mentione, we had to make the Scenario 2 which assumes the following:

SCENARIO 2

- Water supply services incomes with the price increase up to 2% of the estimated household income with faster price growth comparing to 1
- Household incomes will be increasing in accordance with the „moderate increase projection“, i.e. with the 1% GDP increase
- Increasing the charging percent of utility company operation services to 95%
- Price of services for industry i small companies will remain the same and the increase is not planned

- In the 6th year of implementation, the utility company will take 2 millions KM loan
- Co-financing of the Priority measures plan is planned by Gračanica Municipality of 1,8 million KM
- The increase of utility company operational and maintanance expenses of 5% annual rate

Loan repayment conditions

Loan value	KM2.000.000,00
Annual interest rate	6,00%
Annual repayment	10
Inception date of repayment	2018
Monthly repayment	KM14.328,62
Number of repayments	240
Interests in total	KM1.438.869,08
Loan expenses in total	KM3.438.869,08

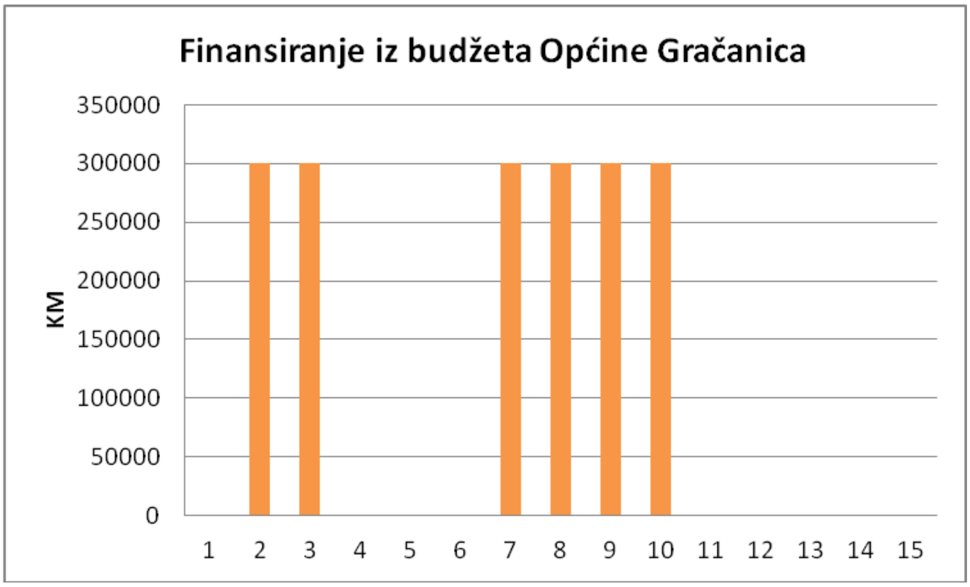


Chart 33: Capital grants dynamic of Gračanica Municipality

The following chart shows the Investment plan

Chart 34: Investment plan - Scenario 2

Results of Scenario 2 are following:

Incomes and expenditures flow

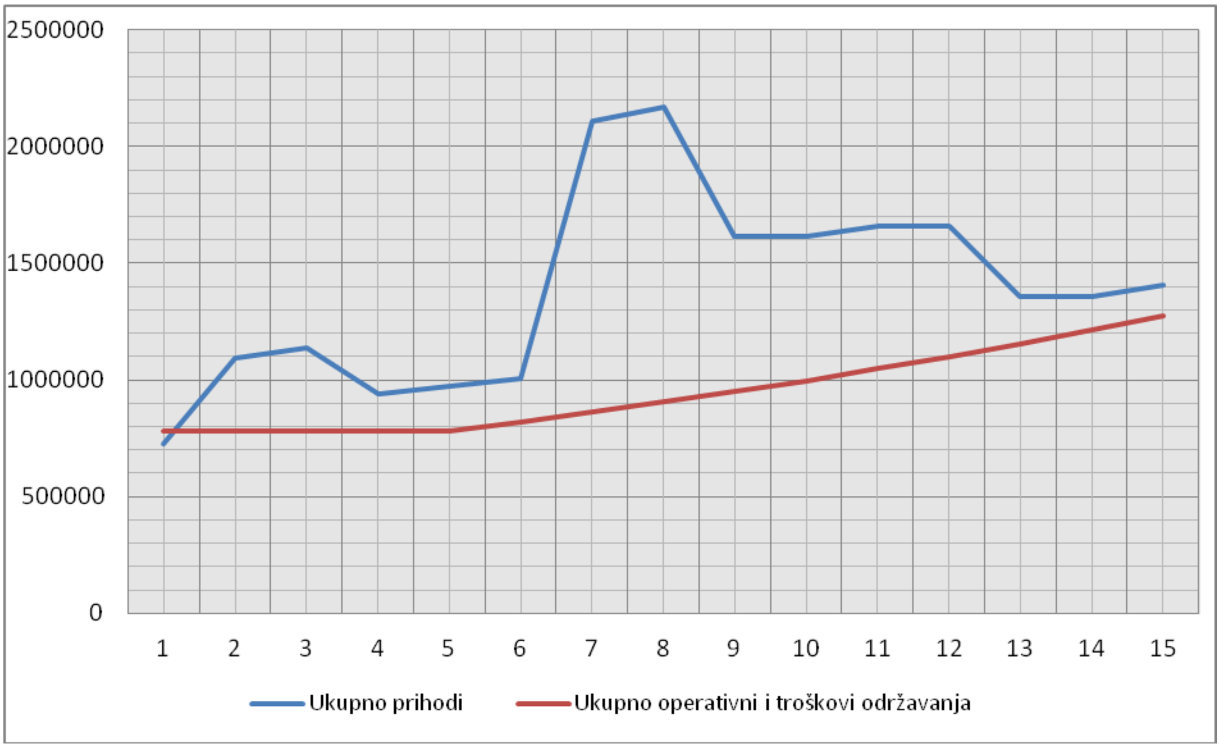


Chart 35: Incomes and expenditures flow - Scenario 2

Expenses recovery chart

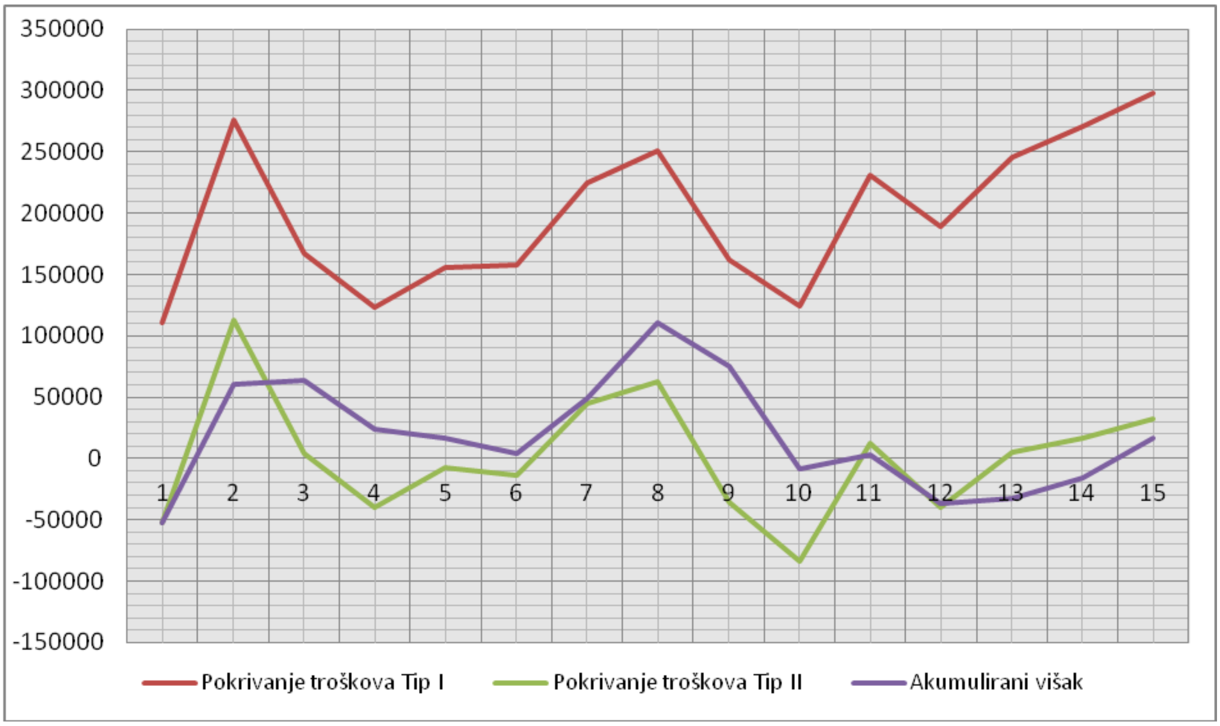


Chart 36: Expenses recovery - Scenario 2

Expenses recovery Type I	Difference between operational expenses and total incomes after investing
Expenses recovery Type II	Difference between operational and maintenance expenses and total incomes after investing

It is obvious that Scenario 2, in terms of financial means, is much more advantageous.

The investment by the municipality would allow the implementation plan of priority measures go in the third year, and more rapid price increases and borrowing would allow the utility to continue its implementation of the plan assets.

The total financial capacity to Scenario 2 is estimated to 7.7 million inclusive of VAT. Investments in the first 5-6 years would be focused on rehabilitation of the existing water supply system components and perform exploration work on the new sources as well as design.

Investment in new supplies of water are provided for only 7 years of implementation, it is considered that, by then, a clear strategy and plan for provision of additional quantities of water will be developed.

Conclussion

Through the analysis of financial capacity and defining Scenarios, Scenarios 1 and 2 are determined by the minimum and maximum financial scenario when it comes to the municipality of Gracanica and a plan of priority measures for the water supply system.

Scenario 1 is the minimum required investment to the utility system, and in a sustainable situation, the implementation will be in accordance with the scenario of a guarantee implementation of app. only 55% of the proposed plan.

Scenario 2, on the other hand, is the maximum possible investment plan at the moment and guarantees implementationof priority investment plan in almost the entire amount. Despite the rapid increase in prices of services, the share of costs in household income will not exceed the recommended percentages of 2 to 2.5% and profit from such an investment project would be substantial and guaranteed long-term sustainability of municipal enterprises, as well as development of water supply to Gracanica Municipality.

It should be noted that the implementation of financial scenarios largely depends on general economic development, all calculations were done assuming extreme "moderate" growth and GDP growth of 1% per year, which means that any future growth will have more than a favorable impact on implementation of defined scenarios.

The fllowing tables show calculations for Scenario 2:

SCENARIO 2 – RESULTS

Table 103: Scenario 2 Results

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Incomes	All values are in KM														
Incomes of services to the households															
Collected incomes	368.431	434.222	461.361	558.851	591.725	624.598	701.254	739.159	886.043	886.043	931.482	931.482	931.482	931.482	976.920
Incomes of services to the industry															
Collected incomes	360.000	360.000	373.500	382.500	382.500	382.500	405.000	427.500	427.500	427.500	427.500	427.500	427.500	427.500	427.500
Incomes from budget institutions															
Collected incomes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total incomes	728.431	794.222	834.861	941.351	974.225	1.007.098	1.106.254	1.166.659	1.313.543	1.313.543	1.358.982	1.358.982	1.358.982	1.358.982	1.404.420
Other incomes	0	0	0	0	0	0	1.000.000	1.000.000	0	0	0	0	0	0	0
Additional financing from the budget	0	300.000	300.000	0	0	0	0	0	300.000	300.000	300.000	300.000	0	0	0
Incomes in total	728.431	1.094.222	1.134.861	941.351	974.225	1.007.098	2.106.254	2.166.659	1.613.543	1.613.543	1.658.982	1.658.982	1.358.982	1.358.982	1.404.420
Expenses															
Operational expenses	618.088	618.088	618.088	618.088	618.088	648.993	681.442	715.515	751.290	788.855	828.298	869.712	913.198	958.858	1.006.801
Operational and reinvestment expenses	163.170	163.170	163.170	163.170	163.170	171.328	179.895	188.890	198.334	208.251	218.663	229.596	241.076	253.130	265.787
Operational and maintanance expenses before savings	781.258	781.258	781.258	781.258	781.258	820.321	861.337	904.404	949.624	997.106	1.046.961	1.099.309	1.154.274	1.211.988	1.272.587
Expenses savings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operational and maintanance expenses in total	781.258	781.258	781.258	781.258	781.258	820.321	861.337	904.404	949.624	997.106	1.046.961	1.099.309	1.154.274	1.211.988	1.272.587
Loan repayment	0	0	0	0	0	0		180.000	180.000	180.000	180.000	180.000	180.000	180.000	180.000
Investment expenses	0	200.000	350.000	200.000	200.000	200.000	1.200.000	1.200.000	700.000	700.000	600.000	600.000	200.000	130.000	100.000
Total expenses	781.258	981.258	1.131.258	981.258	981.258	1.020.321	2.061.337	2.284.404	1.829.624	1.877.106	1.826.961	1.879.309	1.534.274	1.521.988	1.552.587
Lack of money for investing	728.431	894.222	784.861	741.351	774.225	807.098	906.254	966.659	913.543	913.543	1.058.982	1.058.982	1.158.982	1.228.982	1.304.420
Expenses recovery type I	110.343	276.134	166.773	123.263	156.136	158.106	224.811	251.145	162.253	124.689	230.684	189.269	245.783	270.124	297.619
Expenses recovery type II	-52.827	112.964	3.603	-39.907	-7.034	-13.223	44.916	62.255	-36.081	-83.562	12.021	-40.327	4.707	16.993	31.832
Accumulated surplus	-52.827	60.137	63.739	23.832	16.799	3.576	48.492	110.747	74.666	-8.896	3.125	-37.203	-32.495	-15.502	16.330

4 FEASIBILITY STUDY FOR PRIORITY INVESTMENTS

4.1 INTRODUCTION

Initiation and implementation of this phase will be followed as a result of the findings of the Master Plan. For priority investment component / components indentificiranu as investment measures / measures, the Consultant shall ensure that adequate consideration be given alternative solutions. The Consultant should pay special attention to the design assumptions (input data) and ensure that the design of buildings and networks is consistent with the current situation and realistic forecasts. The Consultant is required to prepare a feasibility study of proposed priorities for the Investment measure / measures to demonstrate that the proposed best possible solutions that are feasible in the planning period. The feasibility study should take into account all technical, socio-economic, financial and environmental aspects of the measure.

The consultant should ensure that the partner municipalities, charge water / utility company, the body responsible for licensing / permitting, and all other parties are informed of the progress of development of the Feasibility Study.

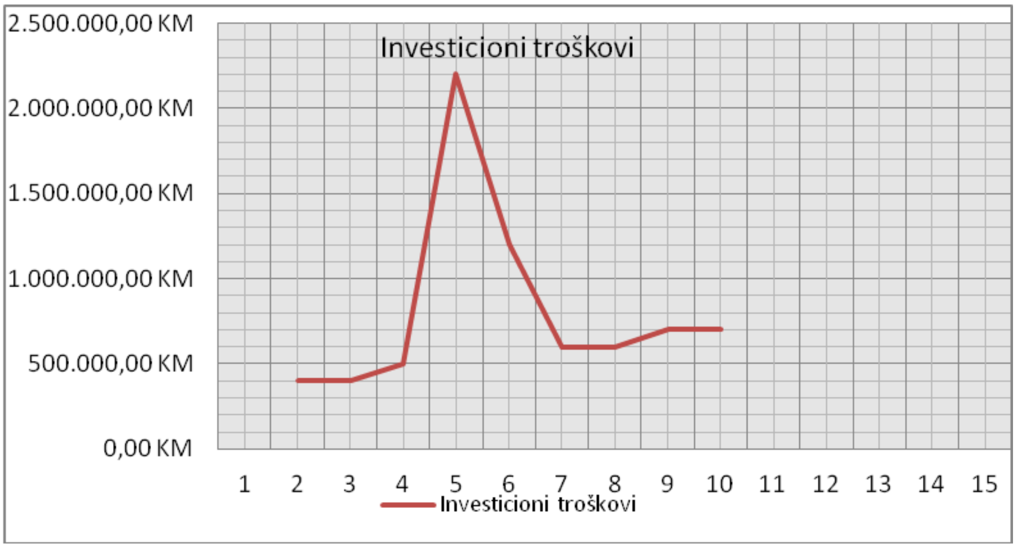
4.2 IDENTIFYING THE TECHNICAL CONDITIONS FOR INVESTMENT MEASURES AND PRICED BILL OF QUANTITY

Recapitulation of priority investments plan

Description of works		Cost (KM)	
Sources protection measures according to the Report on sources protection zones			**633.000,00**
	Source Sklop	198.000,00	
	Sources Ilidža and Vrela (Soko)	198.000,00	
	Source Seljanuša	140.000,00	
	Source Hadžijina voda	97.000,00	
GIS, hydraulic model, deffects removal, system monitoring and procurement of equipment for deffects removal and development of project documentation			**1.387.321,87**
Pipelines – construction of new and replacement of old pipelines			**3.528.559,26**
	Planned transport pipelines from the source	1.836.600,00	
	Planned new pipelines in the system	603.880,00	
	Pipelines replacement	1.088.079,26	
Construction of drinking water treatment plant			**550.000,00**
Reservoirs			**900.500,00**
	Rehabilitation of existing reservoirs	215.500,00	
	Construction of new rerservoirs	685.000,00	
Pumping stations			**247.461,97**
	Rehabilitation of existing pumping stations	21.147,37	
	Construction of new pumping stations	226.314,60	
Using the new sources			**875.000,00**
Remote control system - Scada			**482.000,00**
		Total:	**7.806.381,13**

4.3 FINANCIAL AND ECONOMIC ANALYSIS

Realization plan of Priority investments plan



Expenditures of utility company JP „Vodovod i kanalizacija“ dd Gračanica operation are estimated in accordance with the following table:

Expenditure type	KM/ year		
WSS maintanance cost	97.611	**203.150**	Maintanance
Electricity	105.544		
Employees salaries	450.000		
Amortization			
Other expenses	218.528	**668.528**	Operational
TOTAL EXPENDITURES	871.683	**871.683**	Total

<u>Incomes analysis</u>

- Water supply services incomes with the price increase up to 2% of the estimated household income with faster price growth comparing to 1
- Household incomes will be increasing in accordance with the „moderate increase projection“, i.e. with the 1% GDP increase
- Increasing the charging percent of utility company operation services to 95%

- Price of services for industry i small companies will remain the same and the increase is not planned
- In the 6th year of implementation, the utility company will take 2 millions KM loan
- Co-financing of the Priority measures plan is planned by Gračanica Municipality of 1,8 million KM
- The increase of utility company operational and maintanance expenses of 5% annual rate

Loan repazment conditions

Loan value	KM3.000.000,00
Annual interest rate	6,00%
Repayment in years	10
Inception repayment date	2018
Monthly repayment	33.306,15
Number of repayment	120

Financial analysis results are shown in the folllowing tables:

Table 104: Flow and result of the financial analysis

Operational maintanance costs

In KM

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Expenses in total	*681.258*	*681.258*	*681.258*	*681.258*	*681.258*	*809.959*	*839.785*	*870.781*	*902.998*	*936.485*	*1.160.297*	*1.205.940*	*1.253.493*	*1.303.042*	*1.354.674*
Operational and maintanace costs	*681.258*	*681.258*	*681.258*	*681.258*	*681.258*	*809.959*	*839.785*	*870.781*	*902.998*	*936.485*	*1.160.297*	*1.205.940*	*1.253.493*	*1.303.042*	*1.354.674*
Maintanance	163.170	163.170	163.170	163.170	163.170	276.328	290.145	304.652	319.885	335.879	541.673	568.756	597.194	627.054	658.407
Operational costs	518.088	518.088	518.088	518.088	518.088	533.631	549.640	566.129	583.113	600.606	618.625	637.183	656.299	675.988	696.267

In KM

Projection of incomes

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of households connected to the system		4861	4861	4861	5139	5139	5139	5139	5417	5417	5417	5694	5694	5694	5694	5972
No. of consumers connected to the system		17500	17500	17500	18500	18500	18500	18500	19500	19500	19500	20500	20500	20500	20500	21500
Water consumption (liter/capita/day)		103	94,42	94,42	88,52	88,52	88,52	84,09	84,09	77,08	77,08	77,08	77,08	77,08	77,08	77,08
Water consumption per household (m3/day)		0,37	0,34	0,34	0,32	0,32	0,32	0,30	0,30	0,28	0,28	0,28	0,28	0,28	0,28	0,28
No. of households wth water meter		4.861	4.861	4.861	5.139	5.139	5.139	5.139	5.417	5.417	5.417	5.694	5.694	5.694	5.694	5.972
No. of households wthout water meter		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water service price – water meters	(KM/m3)	0,60	0,80	0,80	1,00	1,00	1,00	1,20	1,20	1,60	1,60	1,60	1,60	1,60	1,60	1,60
Water service price – lump sum	(KM/connection/month)	6,00	6,00	6,00	6,00	6,00	8,00	12,00	14,00	14,00	14,00	14,00	14,00	14,00	14,00	14,00

Charged services incomes

Households																
- Invoiced consumption	KM	460.539	542.778	542.778	657.472	657.472	657.472	738.162	778.062	932.677	932.677	980.507	980.507	980.507	980.507	1.028.336
- Charging rate	%	80,00%	80,00%	85,00%	85,00%	90,00%	95,00%	95,00%	95,00%	95,00%	95,00%	95,00%	95,00%	95,00%	95,00%	95,00%
Households – IN TOTAL																
- Invoiced consumption	KM	460.539	542.778	542.778	657.472	657.472	657.472	738.162	778.062	932.677	932.677	980.507	980.507	980.507	980.507	1.028.336
- Charged value	KM	368.431	434.222	461.361	558.851	591.725	624.598	701.254	739.159	886.043	886.043	931.482	931.482	931.482	931.482	976.920
Annual household income per person	KM	2550	2575	2601	2627	2653	2680	2707	2734	2761	2789	2817	2845	2873	2902	2931
Invoiced service as % of the income	%	1,03%	1,20%	1,19%	1,35%	1,34%	1,33%	1,47%	1,46%	1,73%	1,72%	1,70%	1,68%	1,66%	1,65%	1,63%
Charged service as % of the income	%	0,83%	0,96%	1,01%	1,15%	1,21%	1,26%	1,40%	1,39%	1,65%	1,63%	1,61%	1,60%	1,58%	1,57%	1,55%
Indistry and other bussines consumers																
- Invoiced consumption	KM	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	650.000
- Charging rate	%	80,00%	80,00%	83,00%	85,00%	85,00%	85,00%	90,00%	95,00%	95,00%	95,00%	95,00%	95,00%	95,00%	95,00%	95,00%
TOTAL - Indistry and other bussines consumers																
- Invoiced consumption	KM	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	450.000	650.000
- Charged value	KM	360.000	360.000	373.500	382.500	382.500	382.500	405.000	427.500	427.500	427.500	427.500	427.500	427.500	427.500	617.500
Financing from the budget and aother sources																
1.Municipal budget			300.000	300.000				300.000	300.000	300.000	300.000					
2. Grant I																
3. Grant II																
Total		0	300.000	300.000	0	0	0	300.000	300.000	300.000	300.000	0	0	0	0	0

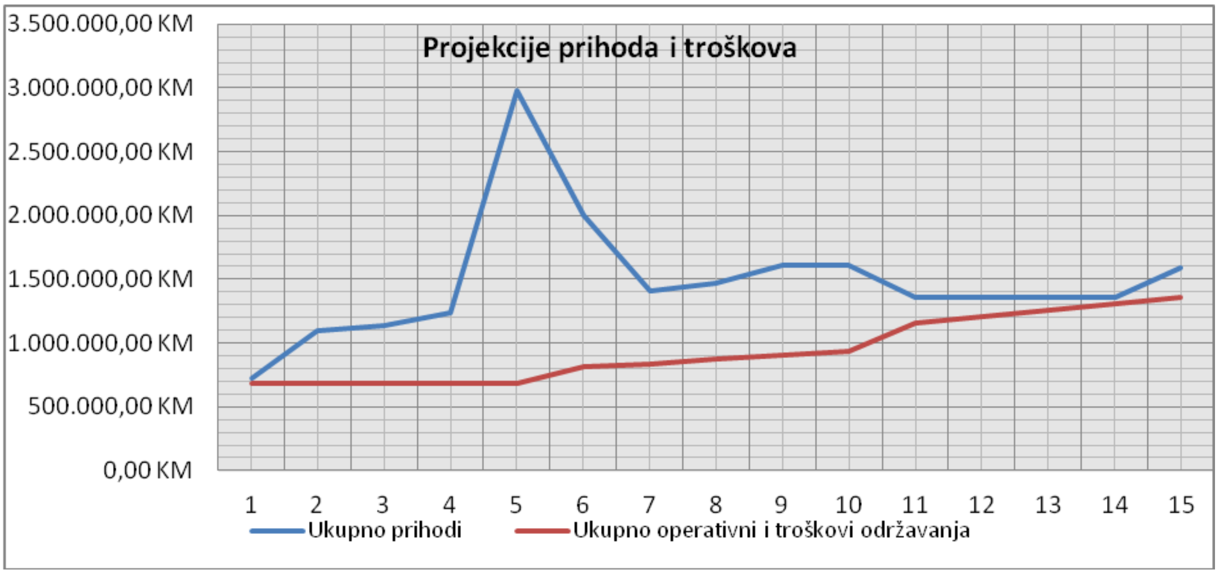
Other income sources

1. Other sources	KM							1.000.000	1.000.000							
2.																
3.																
Total		0	0	0	0	0	0	1.000.000	1.000.000	0	0	0	0	0	0	0

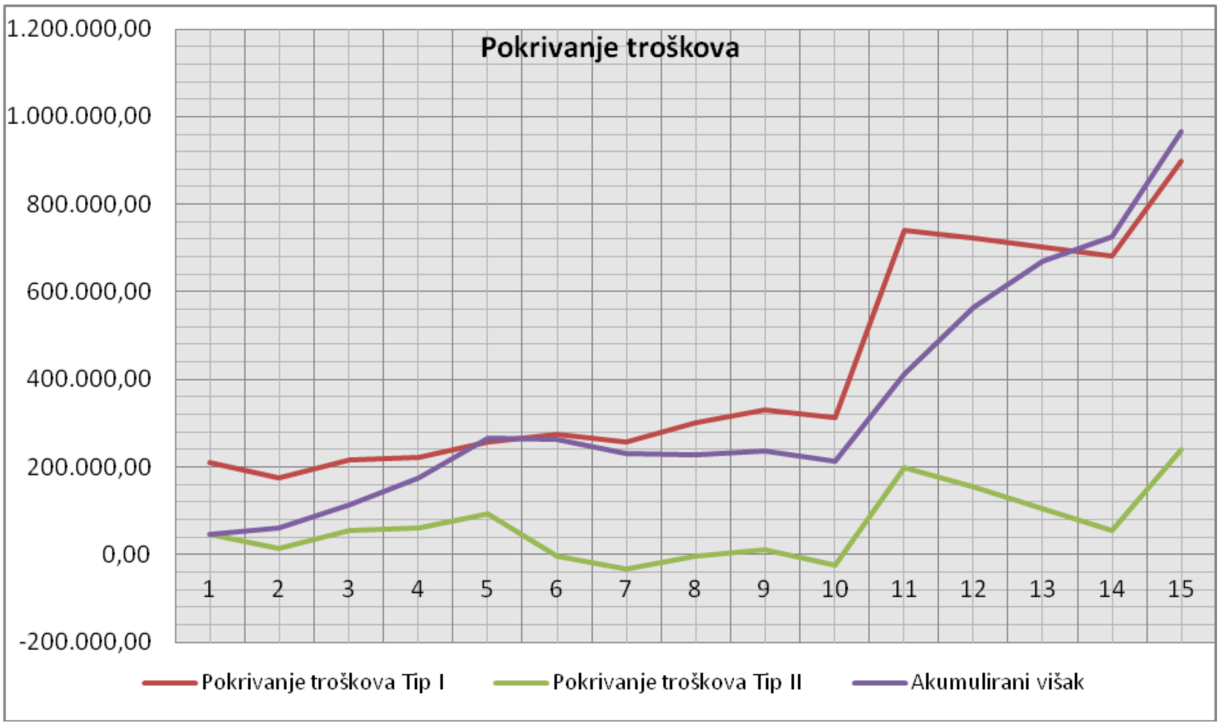
Scenario results

Year	1	2	3	4	5	6	7	8	9	15
Incomes	All values in 1000 KM									
Incomes of services to the households										
Collected incomes	368,43	434,22	461,36	558,85	591,72	624,60	701,25	739,16	886,04	886,04
Incomes of services to the industry	0	0	0	0	0	0	0	0	0	0
Collected incomes	360,00	360,00	373,50	382,50	382,50	382,50	405,00	427,50	427,50	427,50
Incomes from budget institutions	0	0	0	0	0	0	0	0	0	0
Collected incomes	0	0	0	0	0	0	0	0	0	0
Incomes in total	728,43	794,22	834,86	941,35	974,22	1.007,10	1.106,25	1.166,66	1.313,54	1.313,54
Other incomes	0,00	0,00	0,00	0,00	2.000,00	1.000,00	0,00	0,00	0,00	0,00
Additional financing from the budget	0,00	300,00	300,00	300,00	0,00	0,00	300,00	300,00	300,00	300,00
	0	0	0	0	0	0	0	0	0	0
Incomes in total	728,43	1.094,22	1.134,86	1.241,35	2.974,22	2.007,10	1.406,25	1.466,66	1.613,54	1.613,54
Expenses	0	0	0	0	0	0	0	0	0	0
Operational costs	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Maintanance and reinvestments costs	163	518,09	518,09	518,09	518,09	518,09	533,63	549,64	566,13	583,11
Operational and maintannace costs before the savings	681	163,17	163,17	163,17	163,17	163,17	276,33	290,14	304,65	319,88
Costs savings	681,26	681,26	681,26	681,26	681,26	809,96	839,78	870,78	903,00	936,49
Operational and maintannace costs in total	681	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Investments costs	0	681,26	681,26	681,26	681,26	681,26	809,96	839,78	870,78	903,00
Costs in total	0,00	0,00	0,00	0,00	0,00	399,67	399,67	399,67	399,67	399,67
	0	0	0	0	0	0	0	0	0	0
The lack of money for investments	728,43	694,22	734,86	741,35	774,22	807,10	806,25	866,66	913,54	913,54
Costs recovery Type I	210,34	176,13	216,77	223,26	256,14	273,47	256,61	300,53	330,43	312,94
Costs recovery Type II	12,96	53,60	60,09	92,97	-2,86	-33,53	-4,12	10,55	-22,94	240
Accumulated surplus	47,17	60,14	113,74	173,83	266,80	263,94	230,41	226,28	236,83	213,89

Projections of the incomes and expenses



Expenses coverage



Expenses recovery Type I	Difference between operational expenses and total incomes after investing
Expenses recovery Type II	Difference between operational and maintenance expenses and total incomes after investing

Conclussion

In accordance with the defined scenario and assumptions, the suggested Priority measures plan for Gracanica Municipality is:

- feasible, there are enough financial means for its realization
- sustainable, with the price of services ans increasing the incomes it will be posible to ensure repayment of the loan of 3 millions KM and cover the reinvestment costs of 3% of the investment amount annually

Internal rate of means return

	20 YEARS	
	NPV	IRR
	(KM)	(%)
OPTION 2	311.507	8%

YEAR	PROJECT CASH FLOW 1000 KM
1	-305,78
2	-265,14
3	-258,65
4	-1.925,78
5	-892,90
6	-193,75
7	-133,34
8	-86,46
9	-86,46
10	658,98
11	658,98
12	658,98
13	658,98
14	894,42
15	1.180,85
16	1.180,85
17	1.180,85
18	1.180,85
19	1.180,85
20	186,20

Quantification:

- Losses reduction to 20 % of the total production
- Increasing the consumers number to 4500 inhabitants
- Providing the necessary water quantities in accordance with the projections of development and water balance
- Reaching the financial sustainability of utility company „Vodovod i kanalizacija“
- Improving the water supply services quality

4.4 PRELIMINARY ASSESMENT OF IMPACT TO THE ENVIRONMENT

The previous assesment is in accordance with the „Book of Rules on the plants obliged to have the assesment of impact to the environment and plants which can be constructed and start operating only if there is environment certificate for it“; for all other projects which are subject to this study, it is not necessary.

4.5 IMPLEMENTATION PLAN AND STRATEGY

The implementation of priority investments plan in Gracanica Municipality is responsibility of the Supervisory Board, which was coordinating and managed the development of the Water supply Study.

The Supervisory Board will regularly revide the Priority projects plan in accordance with the investments measures implementation, as well as comply it with the available means.

<table>
<tr><td rowspan="7">Supervisory Board</td><td rowspan="4">Gračanica Municipality</td><td>Nusret Helić</td><td>Chief of Staff, Supervisory Board President</td></tr>
<tr><td>Zijad Dedić</td><td>Municipality Representative</td></tr>
<tr><td>Junuzović Razija</td><td>Financial Expert</td></tr>
<tr><td>Aida Hodžić</td><td>Technical Expert</td></tr>
<tr><td rowspan="3">“Vodovod i Kanalizacija” Gračanica</td><td>Fuad Alić</td><td>Managing Director</td></tr>
<tr><td>Jasmin Mulabdić</td><td>Technical Director</td></tr>
<tr><td>Zejneba Hadžihasanović</td><td>Financial Director</td></tr>
</table>

4.6 DYNAMIC PLAN OF PRIORITY INVESTMENT PLAN IMPLEMENTATION

GRAČANICA

Year	1	2	3	4	5	6	7	8	9	10
Activity										
GIS, hydraulic model, deffects removal, system monitoring and development of project documentation										
Replacement of the small profiles pipelines										
Planned new pipeline										
Construction of new distribution transport pipelines – new sources										
Construction of drinking water treatment plants										
Rehabilitation of existing reservoirs										
Construction of new reservoirs										
Rehabilitation of existing pumping stations										
Construction of new pumping stations										
Using the new sources										
SCADA (telemetric system)										

Number of connected inhabitants	17.500	17.500	17.500	18.500	18.500	18.500	18.500	19.500	19.500	19.500
Average annual investment expense (KM)	400.000	400.000	500.000	2.000.000	1.000.000	2.000.000	1.000.000	600.000	600.000	600.000

5 ENCLOSURES

ENCLOSURE NO. 1: GENERAL MAP OF GRAČANICA WATER SUPPLY SYSTEM – EXISTING WATER SUPPLY PLAN - 1:25.000

ENCLOSURE NO. 2: GENERAL MAP OF GRAČANICA WATER SUPPLY SYSTEM – EXISTING WATER SUPPLY PLAN - 1:25.000

ENCLOSURE NO. 3: TABLE OVRVIEW OF THE LOCAL WATER SUPPLY SYSTEMS IN GRAČANICA MUNICIPALITY

PRILOG BR. 4: RESULTS OF WATER QUALITY ANALYSIS AT THE SOURCES