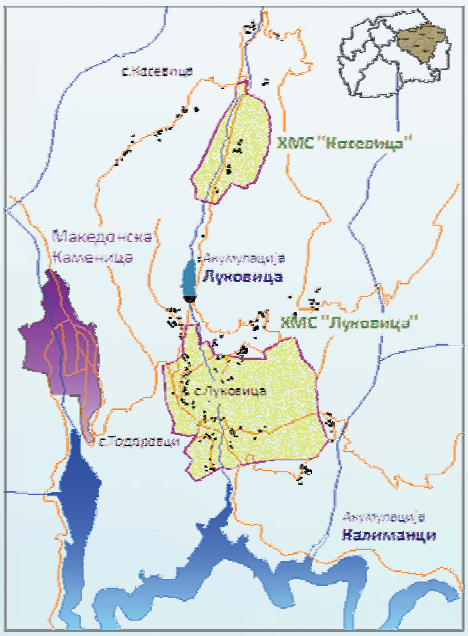
EAST REGION

FEASIBILITY STUDY

FOR CONSTRUCTION OF SMALL ACCUMULATION AT THE RIVER KOSEVICHKA, MAKEDONSKA KAMENICA



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ABBREVIATION

CEE- Central and Eastern Europe

CVM - Contingent Valuation Method

€ - Euro

EIA - Environmental impact assessment

EU - European Union

GDP - Gross Domestic Product

ha - Hectare

HDPE - High-density polyethylene

IRR - Internal rate of return

IPPC - Integrated Pollution Prevention and Control

PE - Public Enterprise

km - Kilometer

kWh - kilowatt hour

m - meter

MKD – Macedonian Denar

MLSG – Ministry of Local-Self Government

MOEPP – Ministry of Environment and Physical Plannin

National Environmental Investment Strategy (2009 – 2013))

NGO - (Non-governmental organization)

NPV- Net Present Value

ЛЕР – План за Локален Економски Развој

ЛЕАП – Локален Еколошки Акционен План

O&M - Operation and Maintenance -costs)

PIU - Project Implementation Unit

PSP - Private (waste management) service provider

PVC - Polyvinyl chloride

SEE - South East Europe

VAT - Value Added Tax

WACC - Weighted average cost of capital

WB - The World Bank

WM- Water management

1. EXECUTIVE SUMMARY

The goal of this Study is to prepare Draft proposal for implementation of an integrated management system for the water resource of the river Kosevicka.

Apart from the primary goal of the Study which is directed to creation of conditions for improvement of the living standard of the regional population, it takes into consideration the possibilities for: evidencing the justifiability for dam construction of the river Kosevicka, the selection of optional solution for location, height and type of the dam, economic and technical sustainability of the planned accumulation, environmental protection and improvement with positive influences by the accumulation, protection and improvement of the water environment through rational and sustainable water exploitation, possibilities and opportunities offered by the accumulation for tourism development as well as possibilities and potentials offered by the accumulation for energetic exploitation.

The Study covers the basin of the river Kosevicka/Lukovicka (the settlements Kosevica, Lukovica and Todorovci are located along the river's area) and the settlements Makedonska Kamenica and Kostin Dol. The drainage basin covers area of 21,6 км2 and it extends entirely on the area of the Municipality Makedonska Kamenica. The river springs out under the Mountain Osogovo from the locality Shumska Cuka nearby the state border with Republic of Bulgaria at the elevation of 1500 above sea level. The length of the river from the springs to the flow-in is around 11km.

During the analysis of recent management with the water resources in the project area the following problems were identified: not sufficient and inadequate supplying of drinking water, disconnection and insecurity in the operability of the village systems for water supplying, small and divided fields for irrigation, extensive agricultural production because of non-existence of the irrigation system and few other problems which directly influence on the quality of life.

From the analysis of the current situations and the strategic development plans for the region the following have been identified as future beneficiaries of the water potential of the river Kosevicka/Lukovicka and in compliance with the priority for their satisfaction:

- Ecologically guaranteed flowing;
- Water supplying to Makedonska Kamenica in the dry season period and complete water supplying to the settlement in the project area;
- Water supplying of the future industrial zone and the thermal power station;
- Irrigation of farmland in the vicinity of the village Kosevica and Lukovica;
- Energetic exploitation of the spillway waters.

On the basis of the previously stated beneficiaries, their identified problems and needs several technical concepts were prepared which during the study were elaborated in details and their implementation should be executed step by step:

- Technical concept 1 - Meeting of the needs of water for different beneficiaries with water pumping from the existing accumulation Kalimanci. This solution foresees construction of water wells in the close proximity of the accumulation and pumping station which shall distribute the water to different beneficiaries.
- Technical concept 2 - Meeting of the needs of water for different beneficiaries with construction of two small accumulation along the river flow of the river Kosevicka/Lukovicka.

- **Technical concept 3- foresees construction of one accumulation on the river Lukovicka with height sufficient enough to suit the needs of all future beneficiaries. This Alternative foresees construction of a small weir above the village Kosevica which shall allow water to pool in sufficient quantities for water supplying of the population from the village Kosevica.**

All technical solutions are elaborated to the level of drafts and are analysed with complex financial simulation models. On the basis of detailed technical economic analysis and complex matrix for deciding Alternative 3 was defined as the most favourable alternative. The selection is based on the following:

- Alternative 3 has the lowest negative net current value i.e. the most favourable financial performances;
- Lower operational and maintenance costs and replacement costs which have direct influence on the service fees i.e. they result in significantly smaller prices for м^3 supplied water for irrigation and water supplying
- The possibility for electricity generation with usage of renewable resource (hydro energy) provides additional - besides higher fiscal incomes - "ecological" benefits from the projects through reduction of emission of greenhouse gases.
- The key infrastructural structure – accumulation – has significantly longer period of exploitation compared to the pumping station.
- The Alternative provides protection of the accumulation Kalimanci from the alluvium which is generated in the drainage basin of the river Lukovicka and extension of the period of exploitation.
- Also as another significant advantage of Alternative 3 is the opportunity for tourism and fishery development.
- Alternative 3 is completely complied with the tender of the Government of Republic of Macedonia for construction of small hydro power station.

As a summary, the technical proposal comprises of construction of rock-filled embankment dam with height of 28 m by which an accumulation is created with capacity of ~620x10^{3}m^3 water. By balance analysis it is proved that this accumulation can cover the needs of water for:

- Ecologically guaranteed flowing
- Water supplying to settlements in the region;
- Contribution to the water supplying of Makedonska Kamenica in the dry months;
- Coverage of the needs of technical water for the thermal power station and the future industrial area;
- It shall provide water for the biggest beneficiary i.e. irrigation. Namely, the accumulation provides water for irrigation of around ~310 ha farmland in the vicinity of the village Lukovica and Kosevica.

In order to meet the needs of water for different beneficiaries the Study gives technical solutions for all necessary structures: dam with appurtenance, supplying pipelines, pumping stations, reservoirs, irrigation systems and equipment for the irrigation. All structures are dimensioned with help of optimization methods. The total investment value of the selected Alternative amounts around ~3.8x10^6 Euros out of which the biggest part refers to the construction of the dam with the appurtenance.

Following the economical logic for self-sustainability of the project we adopted fees for the supplied water which are considered to be affordable and acceptable for the end-users and thus high level of collection of the fees is expected and this shall provide financial sustainability of the system. The fees comprises of expenses for the supplied water (expenses against the system operator) and expenses of the water communities (beneficiaries of the system).

Although the project has negative net current value and it proves itself as financial non-feasible, the accumulative results from the assessment of the economic performances of the project looking from the aspect of the entire local community and on the basis of the comparison between the expenses and the benefits with applied corrections because of price adjustments and externalities are extremely positive and amount to ENCV (@5%)=€7,349,667, EIRR=16.58%. It is stated that the project has relatively higher probability of 75% to achieve EIRR of 15.6%.

The risk in reference to the success and sustainability of the project is deemed moderate. The highest risk lies in the provision of sufficient financial means for project realization. All other risks although with different potential for occurrence and influence are considered to be controllable. In order to minimise the risks it is recommended that the project is conducted phase by phase pursuant the steps described in the Study.

General assessment of the positive and negative influences by the project on the environment had been conducted from any perspectives. Regarding the influences on the environment general conclusion is that there are no serious issues which have been identified at the pooling of water from the river basin of the river Lukovica pursuant Alternative 3. The changes are insignificant, and on the other side the reduction of the water would not have any influence on the biological minimum of the flow in the river Lukovica which is guaranteed.

2. INTRODUCTION

2.1 BASIC DATA FOR THE PROJECT

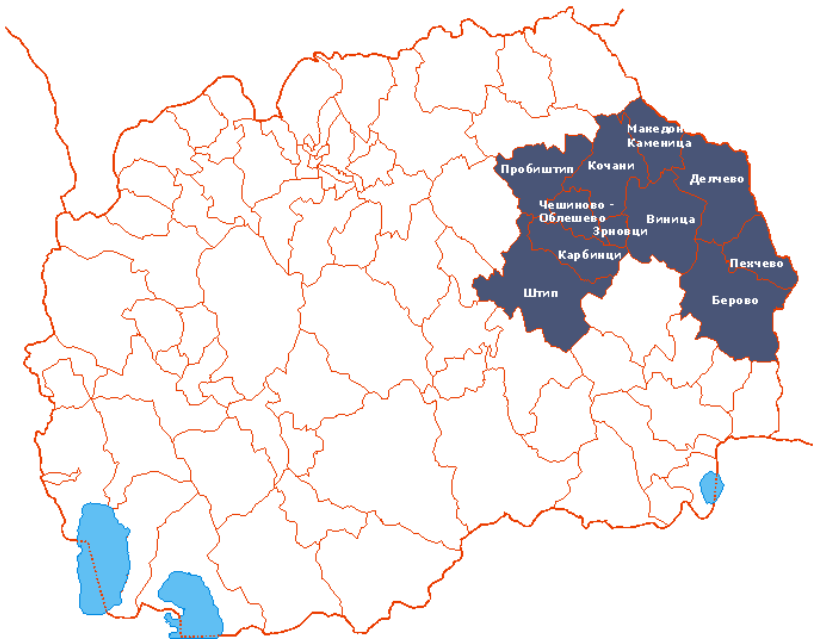
The Center for development of the Eastern planning region as an operational body which is in charge of the development of this region pursuant the Law on balanced regional development, promotes and implements the regional idea in order to achieve more rapid economic development of the region and to assist in compliance of the development with the European standards. The Center for development of the Eastern planning region has identified within its program activities the areas which require researches and which may assist in acceleration of the economic development of the Region. Special emphasizes is given to the exploitation of the existing water potential as one of the essential factors which influence on the agricultural production which on its behalf has special importance for this region especially regarding the part of production of ecological healthy food.



Picture 2.1: Planning regions in Macedonia

The river Bregalnica is the most important in the water resources in the region where there are two high dams at the accumulations Kalimanci and Berovo lake. The lack of water is a consequence from non-exploitation of the existing water potentials of this river as the most important river in the region as well as one of the largest tributary which flows in the river Vardar.

The accumulation Kalimanci is located on the territory of Municipality Makedonska Kamenica and it is the largest artificial lake in Eastern Macedonia where the rivers Kamenicka, Kosevicka and Ribnica flow into with their basins on the territory of the above mentioned municipality.



Picture 2.2: Municipalities in the East region

The municipality Makedonska Kamenica is an area the same as the entire region which faces with lack of water during the dry season for water supplying and irrigation of the agricultural areas especially in the parts of the villages Kosevica, Lukovica and Todorovci. For this purpose, the municipality Makedonska Kamenica in accordance with the planned project activities for the Eastern planning region, prepared project task for preparation of the "Feasibility study for construction of mini-accumulation at the river Kosevicka" by which and on basis of technical and economic analysis we shall bring optional solution for location, height and type of the accumulation at the river Kosevicka.

2.2 AIMS OF THE STUDY

General aims of the Study:

- Improvement of the living conditions for the population in the Municipality Makedonska Kamenica, i.e. sustainable development of the municipality
- Sustainable management of the water resources of the river Kosevicka and exploitation of the disposable water potential of the river.

Specific aims of the Study:

- Reviewed possibilities and evidencing of the justifiability for dam construction on the river Kosevicka
- Adopted optional solution for location, height and type of the accumulation on the river Kosevicka
- Recommendations regarding the economic and technical sustainability of the planned accumulation
- Protection and development of the environment with positive influences offered by the accumulation
- Protection and development of the water environment through rational and sustainable water exploitation
- Researched possibilities and potentials offered by the accumulation for tourism

development

- Researched possibilities and potentials offered by the accumulation for energetic exploitation

2.3 METHODOLOGY

The assessment study of the feasibility of the project for construction of mini-accumulation on the river Kosevicka and irrigation system for the agricultural areas in the municipality Makedonska Kamenica is prepared by the company Hydro-Energo Engineering DOO Skopje in cooperation with PointPro Consulting DOO, Skopje. The Study is primarily intended for the Assembly and for the other authorized officials in the municipality Makedonska Kamenica to serve them as elementary tool for adopting decisions in reference to the project implementation.

The tasks which were executed for assessment of the feasibility and profitability of the project covered the following:

- Mobilization of a team for project realization
- Collection and analysis of data and preparation of a concept for the irrigation system;
- Identification, processing, and assessment of alternative technical solutions for establishing and development of irrigation system and other appurtenance;
- Preparation of additional technical and financial analysis and assessment of net financial and economic effect of the project as well as its influence on the environment;
- Preparation of the final report.

The representatives of the municipal management and the public enterprises from the Municipality provided the consultancy team with relevant basic information necessary for study preparation. Meetings were held with the municipal representatives on few occasions on which the aims of the study and the identified project alternatives were discussed. Few site-visits were also realized on different locations in the Municipality in order to analyze the site conditions.

The economic analysis conducted in the study refers to the stated period/ term of the project of 25 years i.e. from 2011 to 2035. The remaining analysis refer to the period of 45 years i.e. for the foreseen period from 2005 to 2050.

2.4 FORM OF THE REPORT

The whole study for Possibilities for small accumulation construction of Kosevichka river, is "word" document, on Macedonian and English. Other sections of the study are presented in various formats and software, but the presentation is executed in "word" or "PDF". All analysis use the metric system, while the economic and investment analysis are calculated in DEN or Euros - €.

The report is divided on 13 sections:

Table 2.3: Structure of the sections

Section	Contents
Section 1	**Executive summary**

Section 2	**Introduction** of basic data for the project, purposes of the study and the applyed methodology
Section 3	**General information** about Macedonia, especially for the East region and the municipality of Makedonska Kamenica
Section 4	**Project area**, with detailed topography description, available water resources, hydrological and climate elements, the impact from climatic changes
Section 5	**Water demands**, for the population, industry, irrigation, biological minimum and other users
Section 6	**Technical concept of the project**, alternative solutions, description of the structures, investment cost of the alternatives
Section 7	**Water management analysis** or balance analysis to determine the physical parameter of the system
Section 8	**Cost Benefit Analisis**, financial and economic analysis, with costs and benefit analysis, factors of conversion and tariffs for different beneficiaries
Section 9	**Organization and management**
Section 10	**Estimation for the impact of enviorement**, with analysis and short overview of the potencial positive and also negative impact of the project to the enviorement
Section 11	**Project risks and sustainability**
Section 12	**Implementation Plan**
Section 13	**Conclusions from all the analysis and recommendations**

The document contains 48 annexes, where 22 are chart presentations and others are text annexes.

Document also contains a number of charts and summary tables which represent the results of conducted analysis, numbered according to the number of the Section they refer.

Most of the charts and tables are prepared by the project team for the aims of the Study . As references is used additional material from the archives of project team. In case of using external material there is information for the source.

3. GENERAL INFORMATION

3.1 MACEDONIA, EASTERN REGION

The Republic of Macedonia (further "Macedonia") is a country located in the central Balkan Peninsula in Southeastern Europe. It is one of the successor states of the former Yugoslavia, which declared independence in 1991. It became a member of the United Nations in 1993, but as a result of the dispute with Greece about the name, it was admitted under the provisional reference of the Former Yugoslav Republic of Macedonia, sometimes abbreviated as FYROM. The problems with their Greek neighbors are one of the reasons for the low development of the country.

Macedonia is a landlocked country and has borders to Kosovo to the northwest, Serbia to the north, Bulgaria to the east, Greece to the south and Albania to the west. The country's capital is Skopje, with 506,926 inhabitants according to the 2002 census. Other bigger towns are: Bitola, Kumanovo, Prilep, Tetovo, Ohrid, Veles, Stip, Kocani, Gostivar and Strumuca. Official language is Macedonian and the official currency is Macedonian Denar.



Picture 3.1: Planning regions and municipalities in Republic of Macedonia

Eastern Region covers the basin of the river Bregalnica and occupies 14% of the territory in Republic of Macedonia with an area of 3537 km2. The region is divided into 11 municipalities (Berovo, Vinica, Delcevo, Zrnovci, Karbinci, Kocani, Makedonska Kamenica, Pehcevo, Probistip, Cheshinovo- Oblesevo and Stip), divided into 217 settlements where 209 of them are characterized as rural settlements.

Total number of inhabitants in the region is 202,154. The density of population is 57 person/km2. However, due to the permanent process of population decreasment, there is a large number of displaced villages, villages with 100 residents and villages with high index of aging. This condition leads to 66% concentration of the population in urban areas.

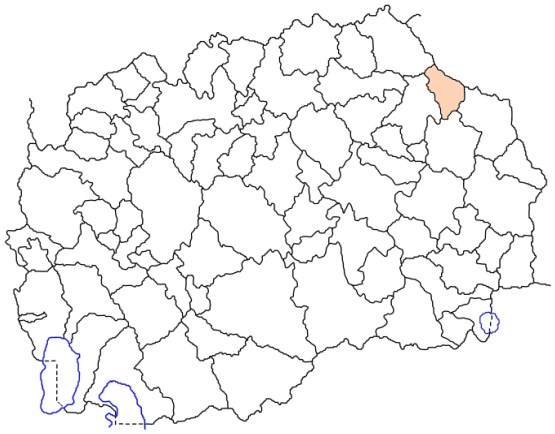
Table 3.1. Demographic data at regional level in Macedonia

	Population on 31.12.2005	Population growth	Natural growth	Net migration	above 65 years (%)	above 15 years (%)
Republic of Macedonia	2.038.514	5.97	4.076	1.894	11,0	19,2
Pelagonia region	236.316	-840	-557	-283	15,2	16,6
Vardar region	133.214	83	-12	-71	11,9	17,5
North-western region	173.89	438	410	28	10,5	21,1
South- western region	222.623	209	309	-100	10,3	20,8
Skopje region	588.93	5.039	2.576	2.463	10,6	18,5
North- eastern region	171.88	99	221	-320	11,3	18,3
Poloski region	309.507	2.257	1.366	891	8,2	23,3
Eastern region	202.154	-951	-237	-714	11,9	16,7

Source – Republic of Macedonia: Nacional Development Plan for 2007-2009, february 2007

3.2 MAKEDONSKA KAMENICA

Municipality of Makedonska Kamenica is located in the Eastern part of Macedonia, under Osogovo mountain. On East it borders with Municipality Delcevo, on South with Municipality Vinica, on West with Municipality Kocani and on North with Municipality Kriva Palanka and the state border with Bulgaria. It covers total area of 189 km^2.



Picture 3.2: Municipalities in Macedonia

Municipality Makedonska Kamenica consists of nine settlements where eight are rural: Todorovci, Lukovica, Kostin Dol, Kosevica, Moshtica, Dulica, Sasa and Cera. Makedonska Kamenica is community center and the ninth settlement. Rural settlements are broken by type. The municipality has altitude from 445 m (the inflow of Kamenicka river in lake Kalimanci) to 2252 m (Ruen, the peak of Osogovo Mountains).

3.2.1 Demograhy

According to the census in 2002, the Municipality of Makedonska Kamenica has 8110 residents. In terms of ethnic structure, 98% of the population are Macedonians, and the remaining 2% are other national minorities. The population is almost equal by the gender structure.

Tablea 3.2. Number of population by settlements

Settlement	Population
Dulica	305
Kosevica	240
Kostin dol	116
Lukovica	269
Makedonska Kamenica	5.147
Moshica	543
Sasa	876
Todorovci	235
Cera	379

3.2.2 Economy

The development of the Strategy for Local Economic Development of Municipality Makedonska Kamenica is realized within the project Development of strategic documents for the Municipality of Makedonska Kamenica - Strategy for Local Economic Development and Local Environmental Action Plan. Regional Center for entry from Delchevo was responsible for the implementation of these documents by establishing contractual obligations with the Municipality of Makedonska Kamenica and Foundation Open Society Institute - Macedonia.

The objectives of the project are to confirm the potentials, opportunities and conditions that should determine the economic and social development with emphasis on outbound solutions to overcome unemployment, building economic capacity and human resources to overcome the current problems in the Municipality of Makedonska Kamenica.

3.2.3 Hydrography

Makedonska Kamenica is characterized with hilly and mountainous area that allows formation of many mountain watercourses with small catchment area, short lengths and large slopes. Kamenicka/ Lukovichka River has the highest water management significance. Kamenicka River is a mountain river with spring beneath the highest peak of Mount Osogovo and inflows in river Bregalnica. Catchment area is 115.2 km^2 and the length of the basin is 22.5 km. Kamenicka River has 6 watercourses from the left side (Crvena, Svinja, Koza, Petrova, Ponishte and Moshtichka) and 2 from the right side (Goreshtica and Susica). These watercourses and Kamenicka River are forming hydrographic network with a total length of 62.1 km. Lukovichka River is the second largest watercourse whose spring is located on the Macedonian-Bulgarian border. The total length of river is 11.5 km and catchment area of 21.6 km^2. Other watercourses have small catchment areas and are short in length so during the summer period they are often dry. On the territory of the municipality, with a volume of 127 million m^3 Kalimanci lake is the biggest hydrological structure and in the same time the largest hydrological structure in Eastern Macedonia which collects the water from Kamenicka, Lukovichka and Ribnichka River.

3.2.4 Climate

The geographical position, orographycal characteristics, hydrographyc network and other natural conditions and peculiarities have impact to the movement of air masses and climate characteristics. The air masses usually come from the north and frontal northeast and have a strong influence on the temperature. In winter, they bring overcasts and through summer refreshment. Except in the mountain areas, the climate in Makedonska Kamenica is moderately warm continental with some Mediterranean influences of air that penetrates along south side across the river Bregalnica. Accumulation Kalimanci also has influence of the climate with relatively fresh and not very cold winters and pleasant temperatures in summer.

3.2.5 Resources

East Region in Republic of Macedonia is mainly mountainous area with very fertile soil that could be used for development of tourism, agriculture and forest industry, but only if there would be no problems with road infrastructure. This area abounds with colored metals and nonmetals. Thus, the area of Makedonska Kamenica has greater quantity of lead-zinc ore (galena and zink svalerit) which are mainly concentrated in the mine "Sasa". Reserves with average metal-rich ore are estimated on 100 million tonnes which is about 70% of total reserves of lead and zinc in the country. In the vicinity of Kostin Dol there are reserves of coal and quartz, building and decorative stone, sand and other building materials that have local and wider economic significance.

Municipality Makedonska Kamenica is relatively reach with water potencial. Kamenicka and Lukovichka river have the highest water management significance. The biggest hydrological structure on the territory of the municipality is Kalimanci lake, which has a volume of 127 million m3 and at the same time is the largest hydrological structure in Eastern Macedonia which collects the water from Kamenicka, Lukovichka and Ribnichka River.

Suitable areas for agricultural development are along Kamenica river valleys with its tributaries and Bregalnica that gives total agricultural area of 8725.1 ha. The general climatic and soil conditions make Makedonska Kamenica suitable for fruit development, especially for growing walnut, chestnut, pear, apple, plum and hazelnut.

4. PROJECT AREA

4.1 DESCRIPTION OF THE PROJECT AREA

The Study covers the basin of the river Kosevicka (the settlements Kosevica, Lukovica and Todorovci are located along the river's area) and the settlements Makedonska Kamenica and Kostin Dol. The drainage basin covers area of 21,6 км^2 and it extends entirely on the area of the Municipality Makedonska Kamenica. The river springs out under the Mountain Osogovo from the locality Shumska Cuka nearby the state border with Republic of Bulgaria at the elevation of 1500 above sea level. The length of the river from the springs to the flow-in is around 11km. In its upper part of the river flow it flows through the village Kosevica and in this part the river is called Kosevicka River, while in the down part when it passes through the village Lukovica it is called Lukovicka River and therefore this river shall be named as Kosevicka/Lukovicka hereinafter. The river basin flows into north-eastern- south-western direction with average width of the basin of 1.88 km and average altitude of 926 above the sea level.

The river is formed from 3 tributaries which spring out at almost the same altitude. It flows from the north towards south with different inclination of the riverbed. The borders of the drainage basin of the river Lukovicka/Kosevicka are represented through the borderlines of the Mountain Osogovo along the length of the Macedonian- Bulgarian border - Shamska cuka 1674m, Grapceto, Atanasica 1603 above the sea level, Siva kobila to Ramno on north and north-east, the watershed on the west is the same with the watershed on the east on Kamenicka River, from Shamska cuka it flows towards south through Kantranlija 1550m, Luti Rid 1287m, Karadzovska maala, Goranska maala, Grncarsko maalo and through Paunkovsko maalo to the flow-in on the eastern watershed from Ramno through Ramnishte, Bel Kamen and downstream along the ridges towards the flow-in. The eastern watershed divides the basin of the river Ribnicka. The total length of the watersheds amounts to 24 km.

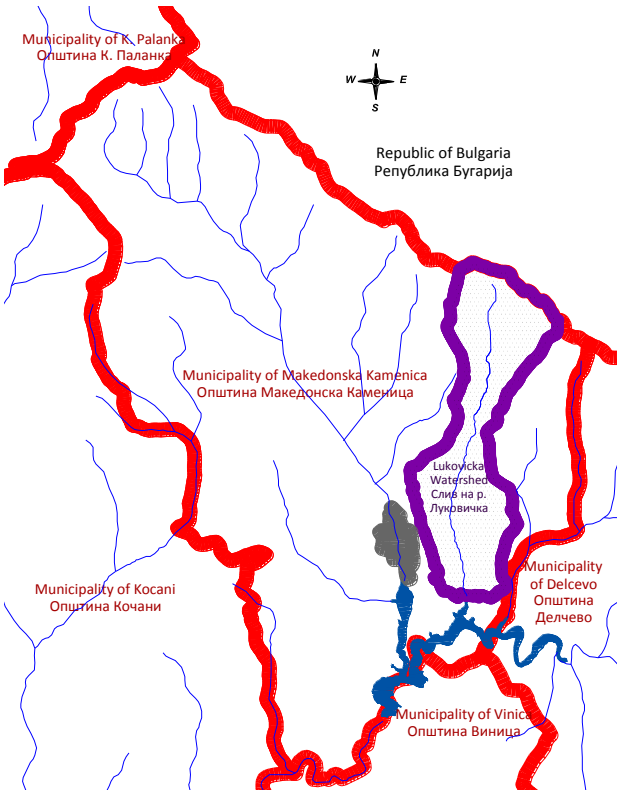


Chart 4.1:

Project area – Watershed on Kosevicka river

More details of the project area are illustrated in the annexes: Annex 1- Overview map, Annex- 2 watershed of Lukovicka river.

4.2 TOPOGRAHY

In sense of topography this area features with steep downhill especially in the part of the spring, divided with typical mountainous watercourses deeply engraved in the terrain. Approximately around the middle of the river basin the inclinations of the terrain become softer and on the other side the downhill become larger and gradually are modified into farmland from mountainous type on relatively small spaces. In its entirety it is an area with topography of typical mountainous features.

4.3 LAND USE

According to the orographic features, the Municipality Makedonska Kamenica is mainly highlands. Suitable areas for development of agriculture can be found along the river valleys of Kamenica with tributaries and Bregalnica.

In the area of Makedonska Kamenica the total farmland is estimates on 4705 ha out of which 3529 is usufruct land i.e. 75% (census of the agriculture from 2007). Most common crops on the farmland are grains, but significant part is taken by the vegetables and fruit crops.

The forests in the municipality Makedonska Kamenica cover around 9000 ha (47,3%) from its territory, with woodland of over 12% compared to the average in the Republic. The municipality has high percentage of wooded land (80% or 7200 ha) which is extremely favourable. According to the structure of the forests, the high forests (woodland) with the most wooden mass participate with 60% while the shrubs cover area of 1700 ha (24%) and the forest crops participate with 1200 ha (16%). The forests which consist of one type of tree (leafy and coniferous) are the most common (94%), and the combined forests participate with 400 ha (6%).

The control of the land use in the project area i.e. in the basin of the Kosevicka/Lukovicka river is executed pursuant the analysis of the statistical data from the census of the agriculture, terrain data, satellite images as well as prepared map on the level of Macedonia for land use pursuant the nomenclature of the Corrine land use classification.

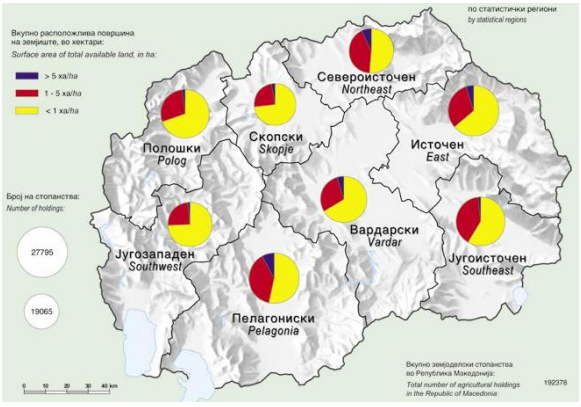
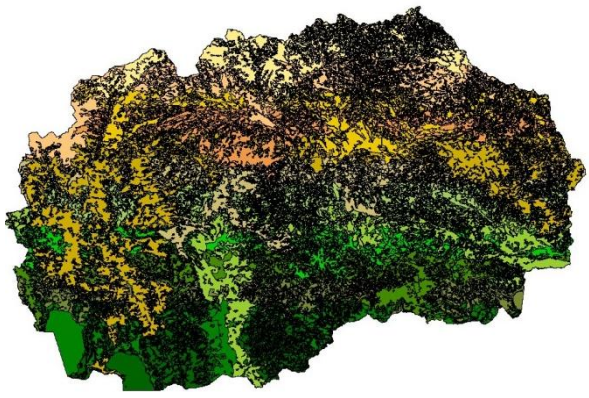


Chart 4.2 Number of holdings divided by land area



Corinne land use classification

Bigger part of the lots in the discussed area are relatively small, divided and irregularly arranged in connection with the conditions of flowing from the drainage basin. Pursuant the census, the representation of the lots with dimensions up to 1 hectare is over 65% while the lots with dimensions from 1 to 2 hectare are around 30%. The average size of the lots amounts to 0.3 – 0.4 ha.

It is estimated that the agricultural land covers ~35% from the total area of the drainage basin.

The division and the unfavourable arrangement of the lots is more evident on the right side of the river Lukovicka, compared to the left side and the upper part, where the lots are larger and more regularly arranged certainly in hydrological sense which is definitely due to the larger number of bigger business agricultural companies.

The representation of the urban zones in the basin is very small. The percentage of individual family houses with yards is estimated at ~19% compared to the total area.

The remaining areas from the basin are treated as natural and agricultural areas and areas under degraded forests, fallow land, forests and etc.

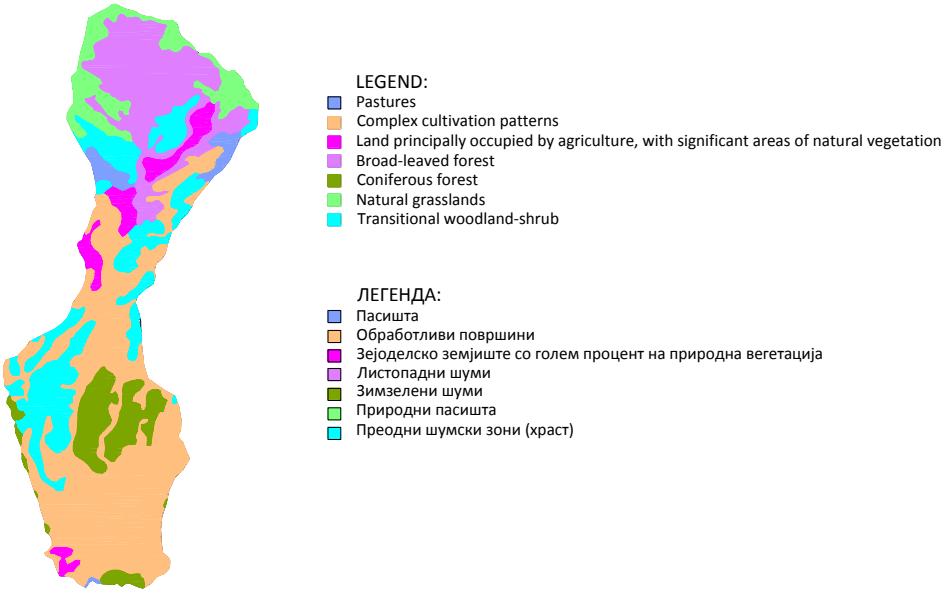


Chart 4.3. Land use of project area

For the porposes of hydrological analysis, percenatge representation of the areas according to the classification of Corrine is transformed in classification of SCS (soil conservative system) to determin the curve number CN.

CN or curve number is a parameter which reflects the conditions watershed runoff. It depends on the soil type, the method of cultivation etc. To determine the effective precipitation (precipitation that form surface runoff) CN parameter is directly correlated with the moisture deficit.

The value of the single CN ratios and division of areas are taken from Stefan Prohaska hydrological land plant complexes, and hydrologic conditions for weak and "C" hydrological soil group, which actually suits the conditions in river Lukovica watershed.

Table 4.1. Values of the curve number CN for river Lukovica watershed

Lukovicka/ Kosevicka river	**F (%)**	**Single CN**	**Composite CN**
Low degraded forests	11.92%	77	9.2
Lowland forests	3.61%	73	2.6
High forests	32.56%	70	22.8
Pastures	4.18%	79	3.3
Bare and eroded areas	5.86%	90	5.3
Agricultural areas, crops in rows	22.72%	85	19.3
Family houses with yards	19.16%	80	15.3
Total	**100**		**78**

4.4 HIDROGRAPHY OF THE CONSIDERED AREA

Hydrographic network in the watershed of Kosevichka/ Lukovichka river is poorly developed. It is a small watershed and has no possibility of forming numerous river flows with large lenghts. Hydrographic network of Lukovichka river cosists of Lukovicka river itself with the three spring branches and tributaries with short torrents and generally impermanent flow.

Table 4.2. Base hydrographic features of the river Kosevicka/ Lukovicka

Watershed area	21.4	km^2
Spring elevation	1490	m
River mouth elevation	479	m
Length of river	11.0	km
Watershed parting length	24	km
Watershed average width	1.88	km
Average altitude	926	km
Basain average slope	88.7	‰
Watershed parting development	1.46	
River basain curvature	1.09	

The watershed of Lukovicka river is low forested where the forest cover is mainly with poor quality forest (exception are small areas of beech forests in the source area). It covers 15-20% of the total watershed area. The source area around the border with Bulgaria is covered with grass, areas below have lesser grass quality, in the middle area is arable land with

shallow soils and beneath village Lukovica there are soils with better quality where used to grow rice.

4.5 HYDROGEOLOGICAL CONDITIONS

Past researches for rivers Kamenicka and Kosevichka, tributaries of river Bregalnica, were made by Incom engineering in 1990 and are presented in "Study of available surface and underground waters on Kamenicka and Kosevichka river and possibilities for their usage". As part of that study it was also prepared hydrogeological study of Kosevichka/Lukovichka watershed which represent the hydrogeological characteristics of the considered territory. This Study uses these data as parameters for hydrogeological conditions. According to them the terrain is mainly built of crystal shales from I order, i.e. gneiss, a series of quartz-graphite shales, numerous discontinuitets of quartz- latites, dacites, indesite as well as quarternary sediments represented by alluvial river terraces on Kamenicka and Lukovichka river basine and pliocene sediments in the vicinity of river Lukovica.

According to the rock porosity on the considered terrain, following types of aquifers can be distinguished: compresive, cracked, karst- cracked, anhydrous terrain.

The compresive type is spread on the quarternary sediments in alluvial river sediments of Lukovicka river and on pliocen lake sediments. Alluvial sediments that can be found in Lukovichka river are built from rough sorted sandy- ballasted sediments with large pieces of parent rocks that build the surrounding terrain are characterized by good filtratione features. Ground waters that can be found in pliocene lake sediments in Lukovichko field have no particular significance because they are poor with water. They are with minimal capacity and cannot be considered for water supply.

Cracked type of aquifers can be found in the upper part of Kosevichka/ Lukovicka watershed, where were indentified several springs with capacity of 3-5l/s. The temperature of aquifer waters in Lukovichka watershed are in the range of 6-13°C that classifies them in cold waters.

4.6 METEOROGICAL (CLIMATE AND GEOGRAPHY) DESCRIPTION

Over Macedonia two main climates are mixed: Continental, typical for northeast and higher regions of Macedonia and Mediterranean by Thessaloniki basin, mainly along Vardar valley. This is because of common merit and process which climate does (atmospheric circulation, quantity of solar energy, precipitations and wind appearance) geographical environment through this process transited (geographical latitude, ground and plant cover and e.c.t.) Although the object of this study is small region the influences of this two main climate are present. In this region, before the dam Kalimanci was build, Mediterranean climate had more influence, which is confirmed with more serious rice plant in the downstream of two river basins. After the dam construction (heighth-92m), the transport of hot currents along Bregalnica valley was interrupted and were made condition for more intensive continental climate influence.

In this paper are used analysis of data from Kriva Palanka, Kochani, Delchevo, Berovo and precipitation stations Sasa, Istibanja, Grad, Blatec, Kostin Dol, Dramche for the period of 1990-2002.

Table 4.3. Measure station

Name of the station	Altitude (m)	Geografical latitude	Geografical longitude	Basin
Kocani	345	41° 55'	22° 25'	Bregalnica
Istibanja	380	41° 56'	22° 30'	
Berovo	824	41° 43'	22° 51'	"
Grad	700	41°56'	22° 51'	"
Delcevo	630	41°58'	22° 46'	"
Blatec	700	41°50'	22° 35'	"
Sasa	920	42° 05'	22° 23'	
Kostin Dol	685	42° 02'	22° 38'	"
Dramce	710	42° 01'	22°43'	"
Kriva Palanka	691	42° 12'	22°20'	"

4.6.1 Precipitation

Osogovo region, which is the subject of this Study, is mountainous region that extends into northeastern Macedonia and its eastern lateral exposure extends to the borders of northwestern Bulgaria. Characteristical for this range are the two high peaks Ruen and Carev Vrv 2085, Sasa mine, rural residences and poorly organized river and mountain fund. In the southwestern of this massive is located the mining settlement Makedonska Kamenica. For the past few years this region is focused on organization and utilization of natural resources and environment protection.

River Bregalnica is flowing in the base of Osogovo mountains and in its middle basin Kamenicka and Lukovichka river inflow as its right tributaries. It is important to note that in this area Osogovo has a high developed hydrographic network, so besides the two mentioned rivers, there are also ground waters. Precipitation in this area are measured at about 10 stations where two of them are climatological and two main meteorological stations.

Data from the main stations are used as reference. Method of correlation, reduction and reference data help to fill the incomplete series of data. Because of various reasons it is common to use this approches.

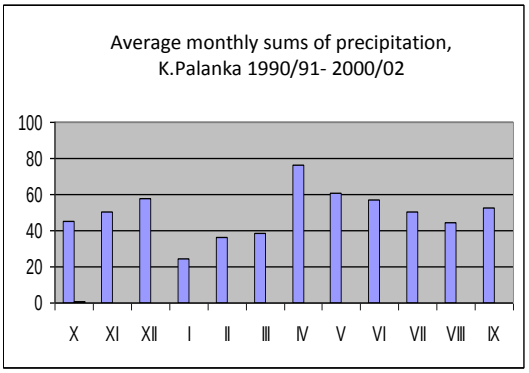
Average annual rainfall in the middle basin of river Bregalnica for the period 1990-2002 (13 years) varie from the lowest 480mm in Grad to the highest 675mm in Blatec. Minimal average annual precipitations for the same period also varie from 213mm in Grad to 457mm in Blatec and maximal from 555mm in Kocani to 894mm in Sasa.

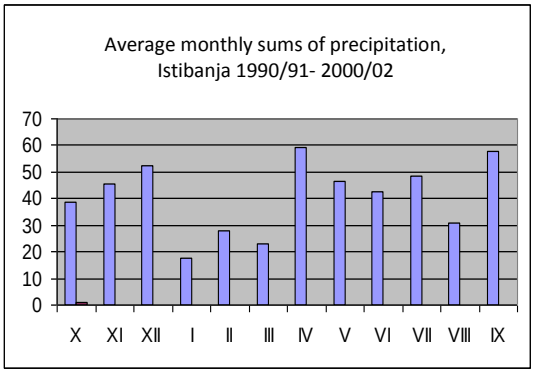
The monthly amount of precipitations in the considered period is highest in December in Blatec 92mm, while the minimal monthly amount of rainfall is 18mm in Istibanja in January.

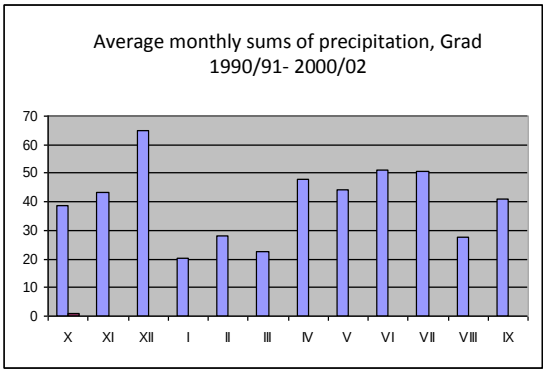
According to the measured precipitations of previously mentioned meteorological stations, southeastern parts of Osogovo dispose of more water than southwestern parts.

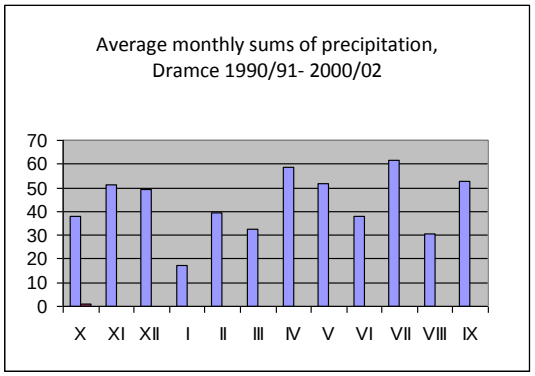
The tables below represent the monthly amounts of precipitation while the charts show the same values.

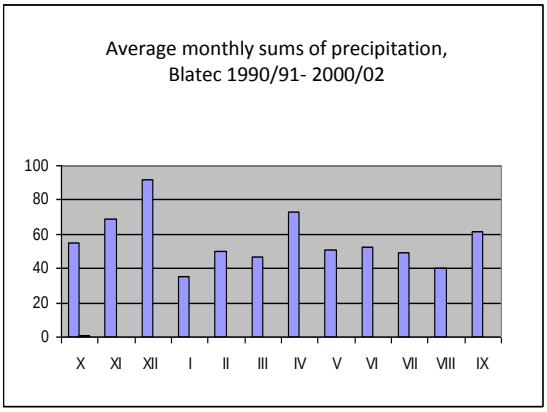
Chart 4.4: Average monthly sums of precipitations in mm

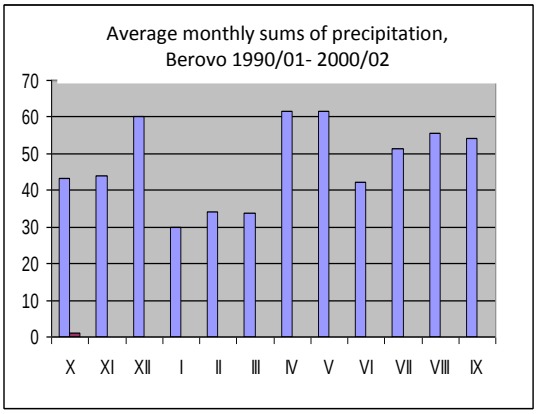


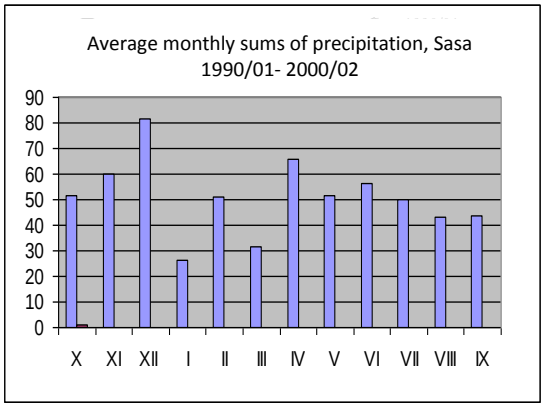


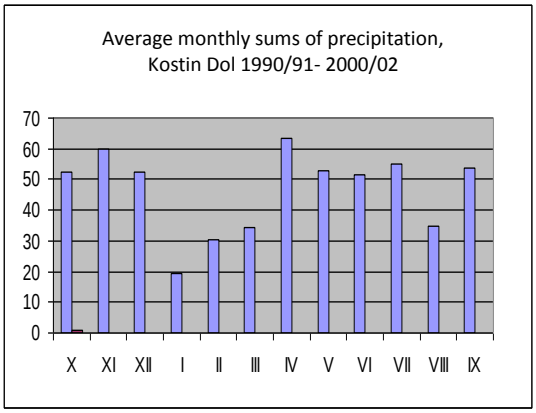


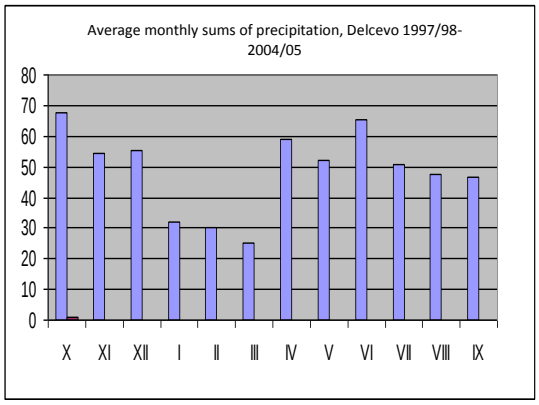


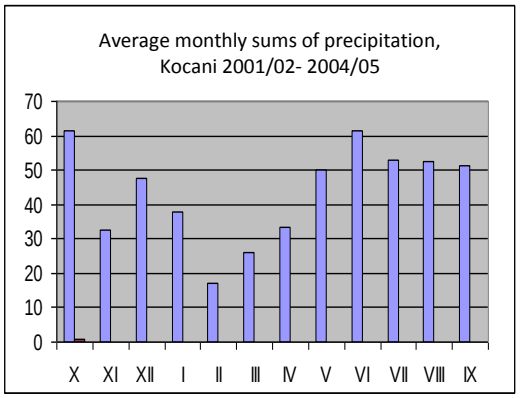












The measured precipitations in Sasa are characteristical for Kamenicka watershed, because Sasa is located on the basin of the river and is about 1332 lower than the highest peak of Osogovo-Ruen, and 1165m lower than the peak Carev Vrv (2085). This indicates that higher amounts of rainfall per year can be expected on the higher parts of the watershed. The regime of precipitation throughout the year is relatively smooth and follows certain laws. Based on the precipitations data from the archives of National Institute for Hydrometeorology for the considered stations, it is obvious that rainy periods are in spring, summer and late autumn, but in winter is less rainy. During the spring highest precipitations are in April, during the summer in July, during autumn in November, and on winter December is the month with highest precipitations (1990/91-2001/02).

The lowest precipitations are occurring in winter months from January to March. In this region (1990/91-2001/02) the first three months of the year are almost without rain or very little amount of rain. The sum of precipitation in the warmer periods of the year is greater than the cold periods and according to the relative variation of precipitation it can be said that in the period 1990-2002 the impact of continent is even greater than previously discussed period 1949-1969.

According to the considered period maximal monthly precipitations in the region are measured in Blatec (228mm) in December 1990.

Interannual and intermonthly variation are quite big so the interval of this chronological disharmony should be defined.

It is characteristical that the greatest interannual variation is recorded in Grad and the least in Blatec, Kocani and Delcevo.

Analysis of precipitations are made by using the values of precipitations which show the critical points on map with relative weather condition,. The lowest isohyet is on 700m and is almost 200mm, the highest isohyet is on almost 900m and is more than 1000mm.

Data are shown in Table 1,2,3 Annex 23.

4.6.2 Air temperature

Annual regime of air temperature is closely related to atmospheric circulation conditions, the relief and the altitude. In this area these parameters and other components have influence to the temperature regime causing relatively cold winters and hot summers where spring and autumn are transitional temperature regimes. Such seasonal temperature expressiveness is determined by its continental character. Lowest monthly average temperatures occur in January and highest in August, i.e. July. Deviations of average

temperatures that occur in the coldest and warmest month are larger by absolute value for January, February, March and December than in July and August. High interannual and intermonthly variations are characteristical for January, March and December.
During winter period the transfer of relative cold air mass is from north to east and rarely from northeast and west. The average January temperature for Kochani 2000-2005 is 1.7^{o}C and is for 0.3^{o}C higher then temperature in 1949-69, for Delchevo -1.4^{o}C and is for 1.3^{o}C lower then temperature in 1949/69.

In the mountainous parts with the increasing of elevation temperatures are going down but this decreases are slowler during anticyclone winter.

Average January temperatures are between 3-4.5^{o}C below the zero at elevation of 1000m, 6-7^{o}C below the zero on elevation of 1800-2000m. The absolute minimal temperature is in December in Delchevo (-25.5 ^{o}C).

Spring temperatures are changing differently, where there are often high temperature variations with the increasing of elevation. During April average temperature for Delchevo is 9.4^{o}C and is for 0.8^{o}C lower than temperature in 1949-69, for Berovo 7.9^{o}C and is for 0.4 ^{o}C lower than temperature in 1949-69. The temperatures are decreasing with the increasing of elevation.

During summer period, temperatures have more stable character than others seasons. It is because the fast transfer of cold Atlantic mass in the hot continental zones under the influence of solar heat. Average July temperatures vary from 19.1oS in Berovo (0.9 oS higher than in 1949/86) to 21.1^{o}C in Delchevo (1.0^{o}C higher than in 1949/86). The absolute maximal temperatures 36.2^{o}C and 40.5 ^{o}C are noticed in Berovo and Delchevo.

During autumn period, decreasing of temperatures are caused by the often transfer of cold air mass from northwest and north and decreased solar radiation.

Average temperature for October for Berovo is 9.7 ^{o}C (1.0^{o}C higher than 1949-86) and for Delchevo 10.9 ^{o}C (1.0 ^{o}C higher than 1949-86). The high mountain areas have less average temperature in October because then can be appeared first frosts of the year.

Compared with the minimal temperatures during the period 1949-86, higher minimal temperatures are characteristical for the considered period.

These data are represented in Table 4, annex 23.

4.6.3 Snow cover

In the upper watershed of Bregalnica- near basins of Kamenichka and Lukovichka River, in the lower parts of Osogovo mounatain, the snow is inconstant and have relatively small thickness. More days with snow cover have the higher parts of the watershed where the thickness of snow is greater, for example on Ruen 2252m, Carev Vrv 2085m, Vlaina etc. The available data for the period (2000- 2005) show that the first snow on Osogovo falls in November, but with low intensity and usually do not stays through the entire winter and beginning of spring (until April). As the altitude increase, the thickness of the snow also increases as same as the increase of precipitation, depending on elevation. The period of snow melting begins in spring months on temperatures higher than 0 oS.

Temperature increase in March causes intense snow melting because of high temperatures and longer days. Average number of days with snow in Kocani and Delcevo is 14. Maximum measured snow cover in Delcevo in December is 44cm. The snowfall period is from January to April and November to December. The lowest number of snowy days was recorded in March. For comparison, in Berovo highest snow thickness for the considered period is 52cm.

These data are represented in Table 4 of Annex 23.

4.6.4 Ice appearance

In this part of Bregalnica watershed the ice appearance was registered (evidenced) from 1954 in Delchevo and from 1949 in Berovo. The earliest date of ice appearance was registered in Berovo on 09.09.1953 and in Delchevo on 16.09.1958. The latest date for both is on 08.06.1962. These are extremely dates.

Ragarding to the fact that ice is formed at temperatures below zero, ice appearance for the period 2000- 2005 was earliest registered in September and latest in May. In Kriva Palanka earliest frost appearance was on 19th October 2005, while the latest was on 25th May 2004. In Berovo earliest frost appearance was on 05 September 2003 and the latest was on 26 May 2004.

These data are represented in Table 3 and 4 of Annex 23.

4.6.5 Relative humidity

As a result of evaporation from water surfaces and Earth's crust there is permanent presence of water vapour in the atmosphere. Humidity is registered as absolute, relative humidity and moisture deficiency. In the analyzed period (1949-86) in Delcevo average relative humidity ranges from 82% (September) to 67% (July) and in Berovo from 83% (January) to 68% (July). The regime of relative humidity for the period of 2001-2005 in Berovo ranges from 90% (December) to 30% (July) and in Kriva Palanka from 85% (December) to 58% (July and August).

These data are represented in Table 4 of Annex 23.

4.6.6 Winds

Analyzed climatological region is windy. From the total number of measured data 397‰ in Berovo (1997-2002) and 679‰ in Delcevo (1997-2000) are winds from different directions, and 603‰ and 321‰ without wind, with silences.

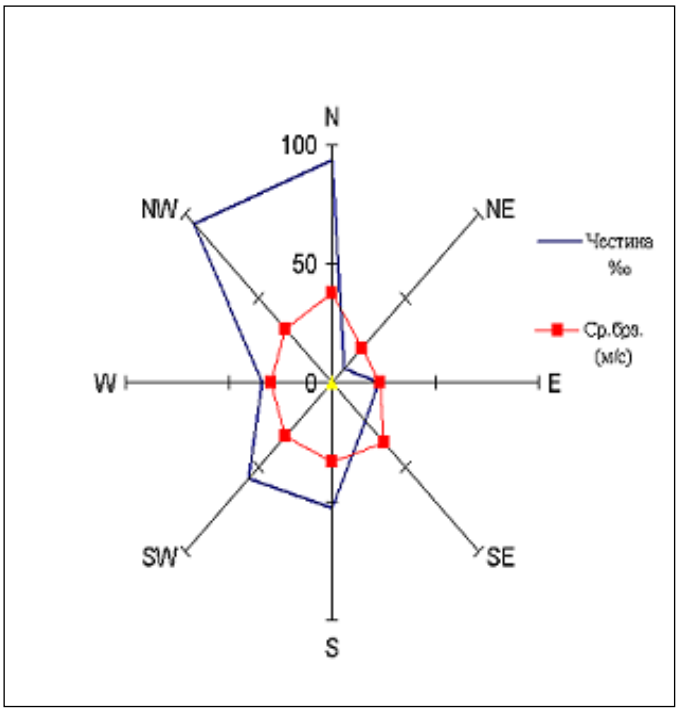
Average annual appearance of the North wind is 94‰ and 175‰ with average annual speed of 3.7 m/sec and 3.0 m/sec. Average annual appearance of the South wind is 53‰ and 57‰ with average annual speed of 3.4m/sec and 3.2m/sec.

Average annual appearance of the West wind is 34‰ and 49‰ with an average annual speed of 2.9 m/sec and 3.0 m/sec.

Average annual appearance of the Southeast wind is 23‰ and 67‰, with average monthly speed of 3.5m/sec and 3.0m/sec. Average annual appearance of the Soutjwest wind is 57‰ and 20‰ with average monthly speed of 3.2 m/sec or 3.3m/sec.

Increased wind appearance and relatively high air temperatures provide favorable conditions for evaporation of free water surface. Average annual evaporation is about 880l/m2 water surface and about 54% higher than average annual amount of precipitation for the period 1950- 1975.

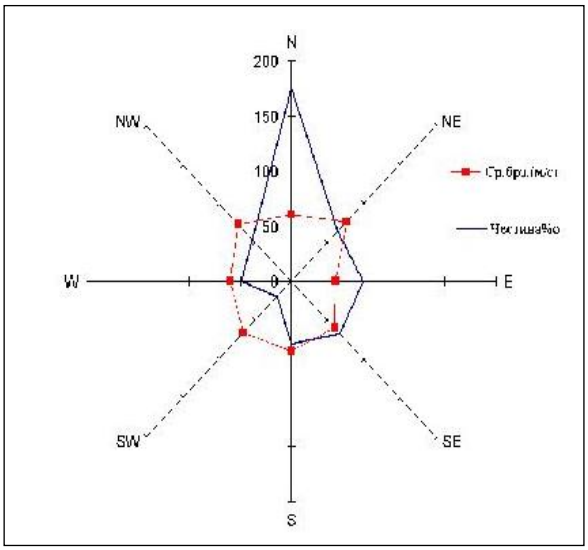
Chart 4.5 Average annual roze of wind for Berovo (1997-2002) GMS:BEROVO



Silences (C=603‰)

Direction	C	N	NE	E	SE	S	SW	W	NW
Appearance (‰)	603	94	9	23	23	53	57	34	94
Speed (m/s)		3.7	2.0	2.3	3.5	3.4	3.2	2.9	3.2

Chart 4.6 Average annual roze of wind for Delchevo (1997-2002)



Silences (C=321‰)

Direction	C	N	NE	E	SE	S	SW	W	NW
Appearance (‰)	321	175	64	70	67	57	20	49	53
Speed (m/s)		3.0	3.8	2.2	3.0	3.2	3.3	3.0	3.6

Table 4.4 Appearance and wind speed

1997-2000

Direction	Appearance (‰)	Speed (m/s)
SW	20	3,3
W	49	3,0
NW	53	3,6
S	57	3,2
NE	64	3,8
SE	67	3,0
E	70	2,2
N	175	3,0
C	321	

1954-1968

Direction	Appearance (‰)	Speed (m/s)
SW	51	27
W	51	2,8
NW	63	3,3
S	64	1,5
NE	68	2,6
SE	70	2,4
E	114	2,4
N	165	2,7
C	344	

4.7 HYDROLOGICAL CHARACTERISTICS OF KOSEVICKA/ LUKOVICKA RIVER

For the porposes of this Study are used hydrological data which were provided by RHMZ's Hydrological basis for watersheds in region 2- Osogovo from 1997. The hydrology analysis give a review of two measured points of the considered area: Meausure point of river Kosevicka with 1000m elevation and measure point of river Lukovicka with 590m elevation.

The measured average daily flows cover the period from 1975- 1990. Since there are no continous measurements from the measuring points, they were obtained by regression dependency with Zletovica for the period 1975- 1990 based on hydrological data base. Missing average monthly flows from the measured points of Lukovicka watershed for the period 1961-1974 and 1991-2005 were obtained by average monthly flows of river Zletovica for the period 1961 - 2005 years. Regression dependencies have shown extremely high degree of correlativity.

The measure point of river Kosevicka (elevation 1000m) is 8.1 km from the estuary in Kalimanci accumulation or 2.9 km from its own spring (elevation 1490m) and covers catchment area of 4.86 km^2. The average annual flow distribution cycle by months of Kosevica river is variable. The most flow distribution is in April and May and least in September and January.

Table 4.5: Characteristic flows of river Kosevicka for the period 1961- 2005

month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Q_{year}
Qmin	0.013	0.009	0.024	0.059	0.063	0.029	0.018	0.015	0.010	0.011	0.009	0.015	0.009
Qsr	0.043	0.042	0.078	0.160	0.146	0.103	0.061	0.046	0.038	0.045	0.047	0.053	0.072
Qmax	0.158	0.155	0.221	0.379	0.363	0.234	0.179	0.139	0.103	0.234	0.210	0.203	0.379

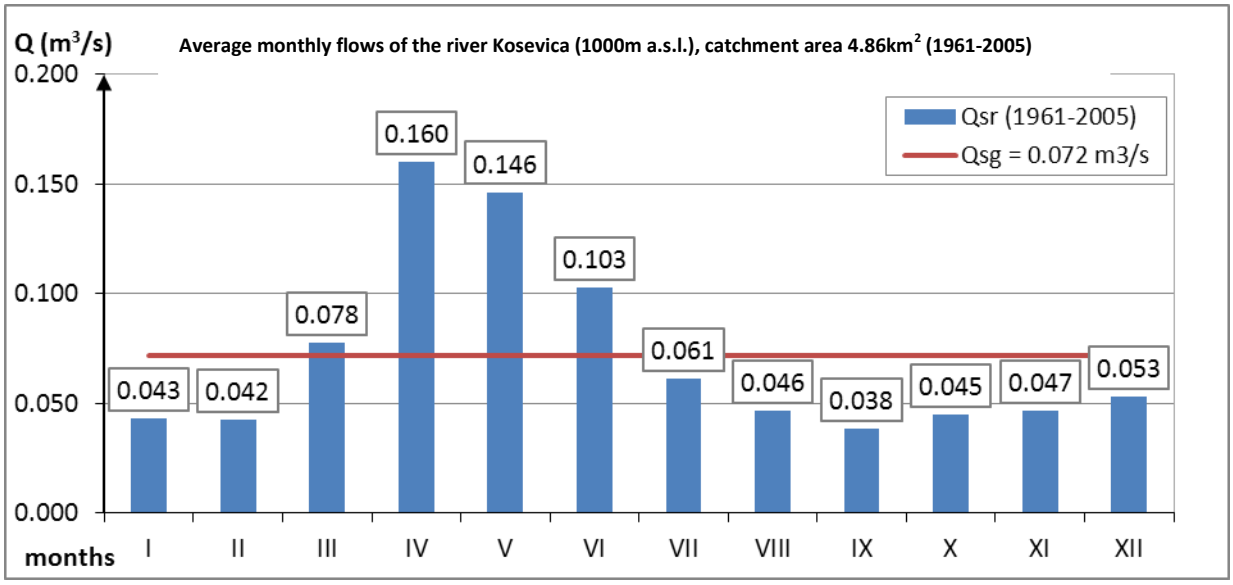


Chart 4.7 Average monthly flows of the river Kosevica

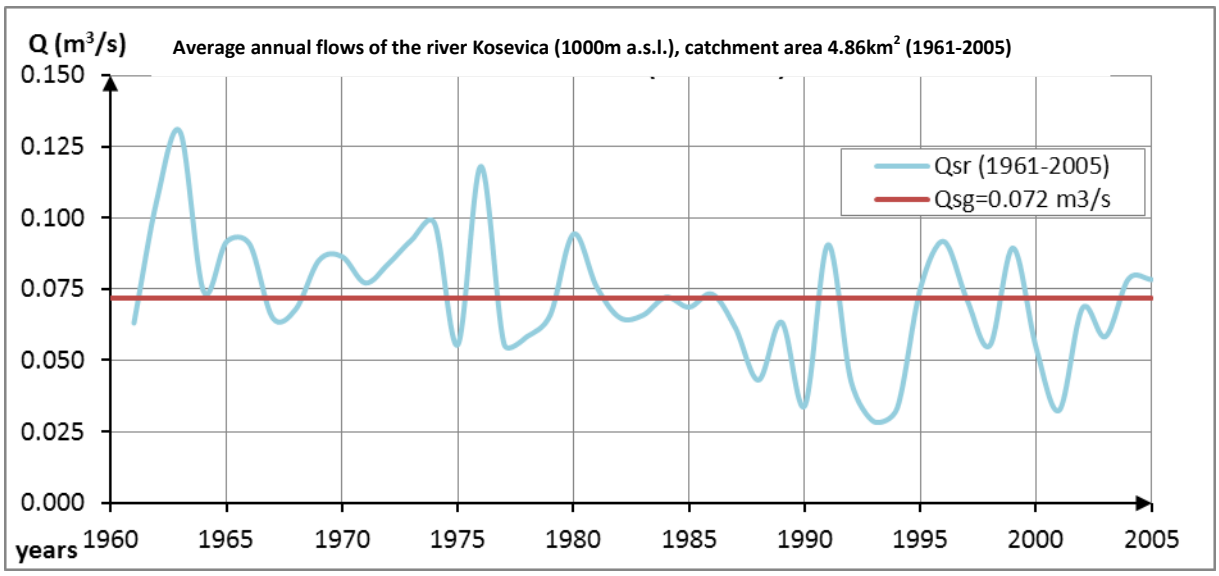


Chart 4.8 Average annually flows of the river Kosevicka

The measure point of the river Lukovica (elevation- 590m) is 2.4km from the estuary in Kalimanci accumulation or 8.6km from its own spring (elevation- 1490m) and covers catchment area of 12.80km^2. Average annual flow distribution cycle by months of Lukovica river is variable. The most flow distribution is in April and May and least in September.

Total hydrological data are presented in Annex 24.

Tabel 4.6: Characteristic flows of river Lukovica for the period 1961- 2005

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Q_{year}
Qmin	0.034	0.030	0.061	0.100	0.096	0.037	0.020	0.017	0.012	0.014	0.014	0.033	**0.012**
Qsr	0.114	0.138	0.189	0.277	0.220	0.133	0.068	0.052	0.045	0.058	0.076	0.117	**0.124**
Qmax	0.421	0.503	0.539	0.662	0.542	0.305	0.198	0.154	0.120	0.301	0.336	0.439	**0.662**

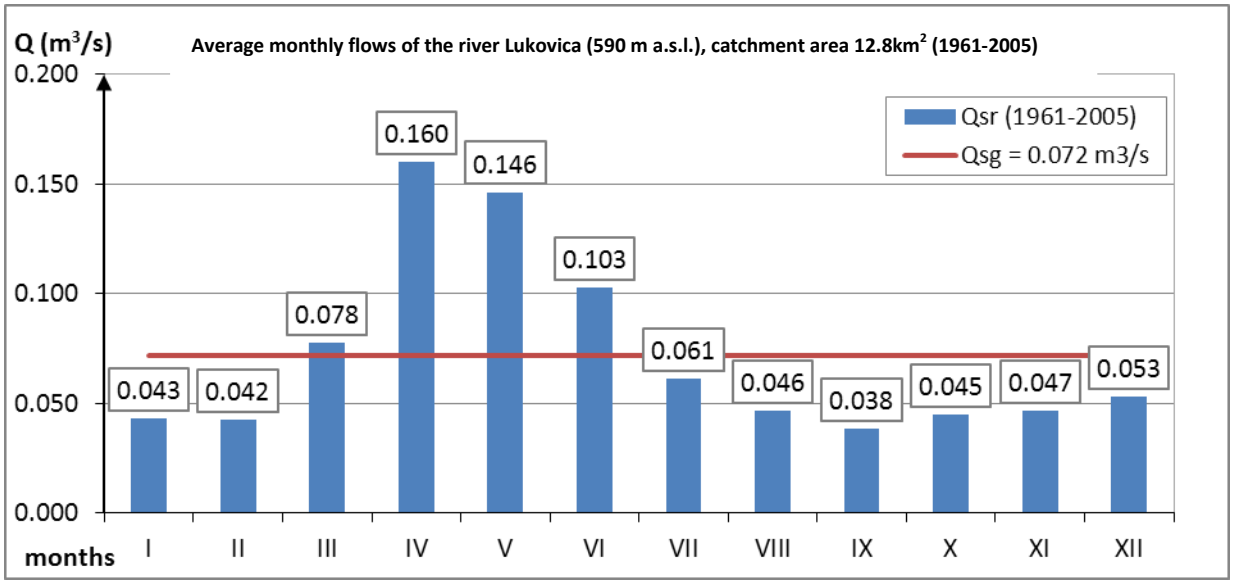


Chart 4.9 Average monthly flows of the river Lukovica

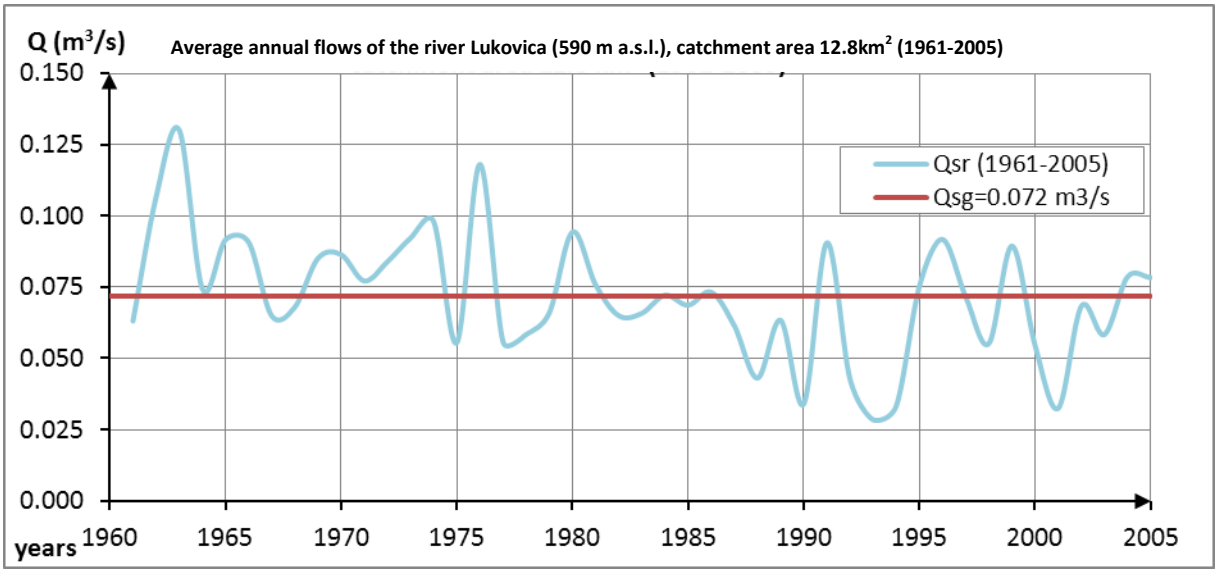


Chart 4.10 Average annually flows of river Lukovicka

4.8 SCENARIOS FOR THE IMPACT OF CLIMATE CHANGES IN REPUBLIC OF MACEDONIA

4.8.1 Input data

In order to estimate the impact of possible climate change in the future period for the water demands for plants and irrigation, is carried out an analysis of data with climatic elements and their changes under Climate change scenarios for Republic of Macedonia, developed by University of Nova Gorica, Centre for Atmospheric Research (Bergant K. 2006).

The prognosis of possible climate changes are performed by the method of proportional reduction (downscaling) of Global models at regional level. There are multiple methods of direct results transmission of Global models to smaller local regions where the publication of climate change scenarios for the Republic of Macedonia has applied empirical (statistical) method that use simple mathematical/ statistical models to describe the dependence of the dynamic output of the general global climate models to local variables.

It is generally expected changes of lesser intensity in winter and more intense changes in summer and autumn months. Significant increase in air temperature is possible during the summer months with special emphasis on temperature difference between summer and winter periods. There is an evident change and extreme temperatures, where the maximum gradient is greater than the minimum, which reflects in average daily temperature increase.

In this Study are included 15 meteorological stations grouped into six climatic regions, according to the division of Filipovski. The stations in Berovo and Kriva Palanka are representatives of continental climate in the eastern region, while stations in Bitola, Prilep, Ohrid and Resen are representatives of the south or south- western region.

The annual pattern of expected temperature changes in this region is similar to the model for the continental region in the southern part of Macedonia, but the intensity of the change is slightly lower.

Compared to Bitola and Prilep, it is also expected a slight precipitation increase in winter, but decreaset in all other seasons, with the greatest intensity in relative terms, for the summer. In summer and autumn, is expected daily temperature increase range.

Detail examination is given in tables for two time section (2025 and 2050) and for all seasons and the annual average. From the considered five scenarios (minimum, low, average, high and maximum) only expected possible are presented (Bergant K. 2006).

Table 4.7. Projected changes of the average, minimal and maximal air temperatures (^{o}C) (Bergant K. 2006)

$T_{average}$ (^{o}C)	Dec/Jan/Feb		Mar/Apr/May		Jun/Jul/Aug		Sep/Oct/Nov		Annual	
Scenario	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
Low	1.0	2.1	1.0	1.8	1.1	2.2	0.9	1.7	1.0	2.0
Average	1.1	2.4	1.1	2.1	1.3	2.5	1.0	1.9	1.1	2.2
High	1.3	2.8	1.3	2.5	1.7	2.8	1.2	2.2	1.3	2.6

T max (°C)	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
Low	1.0	2.2	1.0	1.9	1.4	2.9	1.2	2.2	1.1	2.3
Average	1.2	2.6	1.1	2.2	1.8	3.3	1.4	2.5	1.4	2.7
High	1.4	3.2	1.3	2.6	2.4	3.7	1.7	2.8	1.7	3.1

T min (°C)	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
Low	1.1	2.5	0.7	1.3	0.8	1.5	0.7	1.4	0.9	1.7
Average	1.2	2.8	0.8	1.5	0.9	1.8	0.8	1.6	0.9	1.9
High	1.4	3.3	0.9	1.7	1.1	2.1	0.9	1.9	1.1	2.1

Table 4.8. Projected changes of average precipitation (%) (Bergant K. 2006).

P (%)	Dec/Jan/Feb		Mar/Apr/May		Jun/Jul/Aug		Sep/Oct/Nov		Annual	
Scenario / Year	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
Low	5	9	-3	-2	0	-8	-2	-6	-1	-2
Average	2	4	-4	-5	-4	-10	-2	-7	-2	-5
High	0	1	-6	-8	-13	-11	-3	-9	-6	-7

4.9 GENERATING SYNTHETIC SEQUENCES OF CLIMATE SERIES

The values of average scenario are entered in the historical climate data series, new sequences are generated and then again is carried out the calculation of irrigation water demands.

Time allocation within one year of the projected seasonal climatic values of the characteristic elements is performed by means of fourth degree polynomial equations. In fact, polynomials have been developed for transferring the seasonal in monthly values for all climate elements, for the two time section 2025 and 2050. Adaptability of the anticipated dependence is significant, with extremely high values of correlation coefficients.

The second step is complete series filling with monthly values of climate elements between the two characteristic time sections. Filling is performed with direct interpolation between the reference values from 2025 and 2050. Zero value is 2000.

These distributed time series of climate elements, define only differences in terms of change of the characteristic temperatures expressed in °C or decrease of precipitation expressed in %. Finally, time distributed changes of climate elements are added to the historical climate data measured characteristics and then is performed calculation for future irrigation water demands with the influence of climate change.

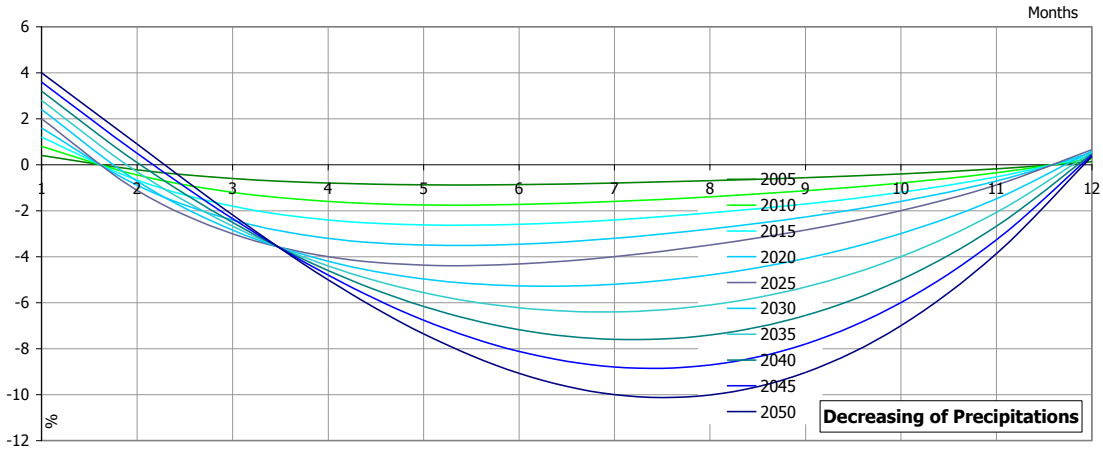


Chart 4.11. Time series distribution of monthly precipitation for specific year (%)

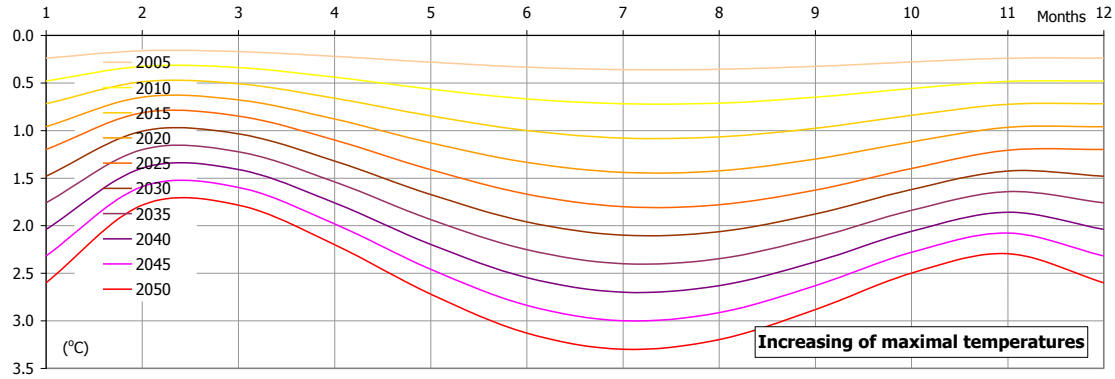


Chart 4.12. Time series distribution of maximal air temperatures for specific year (°C)

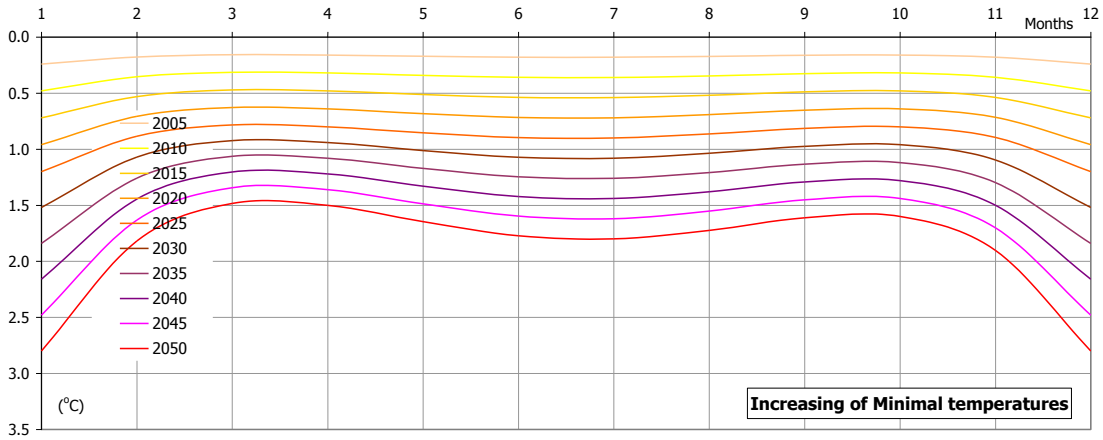


Chart 4.13. Time series distribution of minimal air temperatures for specific year (°C)

Assessment of other climatic elements (solar radiation and wind speed) is generally performed at national level. For both elements, the relative expected change is small and do not exceed 5%. Minor increase in solar radiation are expected throughout the year, with

extreme in summer months. There is almost no change in speed of the dominant winds over Macedonia.

Table 4.9. Projected changes of average solar radiation (%).

SolarRadia. (%)	Dec/Jan/Feb		Mar/Apr/May		Jun/Jul/Aug		Sep/Oct/Nov		Annual	
Scenario / Year	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
Low	0	0	1	2	2	3	1	1	1	2
Average	1	1	2	3	3	4	2	3	2	3
High	2	2	3	4	4	6	3	5	3	4

Table 4.10. Projected changes of average wind speed (%)

WindSpeed (%)	Dec/Jan/Feb		Mar/Apr/May		Jun/Jul/Aug		Sep/Oct/Nov		Annual	
Scenario / Year	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
Low	2	1	0	3	-2	0	-1	-6	0	0
Average	3	2	2	4	0	1	-1	-4	1	1
High	3	3	5	5	3	2	0	0	3	2

All analysis are conducted on a monthly basis for a period of 45 years. To represent the large amount of data more visably, the presentation of the characteristic values is through appropriate assistance of empirical probability of average monthly values for the feature. The presentation of the results was performed with three characteristic empirical probablilties (25%, 50% and 75%), with minimum and maximum value and in some cases by average value of the feature.

Table 4.11. Projected values of monthly precipitation (MS Delcevo, 2006 - 2050)

P(%)	Jan	Fev	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Noe	Dec	Av
Av.	32.9	33.8	34.5	44.8	59.1	49.6	44.8	40.7	39.1	45.5	57.8	47.4	530
Min	0.3	2.8	0.1	4.4	18.0	10.5	3.5	0.2	6.6	0.2	7.4	1.0	304
25%	16.2	19.1	16.5	24.9	38.8	25.8	23.9	19.9	20.1	17.2	27.4	26.5	453
50%	31.1	33.3	30.1	42.8	56.4	45.3	40.0	36.9	30.5	40.2	48.1	44.5	544
75%	42.1	48.1	48.1	54.4	71.6	68.8	57.1	53.1	52.0	61.3	75.7	58.3	597
max	75.2	75.0	116.3	137.3	140.2	146.4	217.4	115.5	133.2	122.0	190.8	147.6	878

Table 4.12. Projected values of maximal air temperatures (MS Delcevo, 2006 - 2050)

T_{max}(°C)	Jan	Fev	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Noe	Dec	Av
Av.	5.8	7.8	11.8	17.4	22.8	26.5	29.1	29.3	25.4	19.8	13.0	8.1	18.1
Min	1.5	1.8	7.3	13.9	18.6	23.6	25.4	23.6	20.7	13.4	6.4	3.3	16.2
25%	4.9	6.0	9.6	15.6	21.4	24.9	27.8	27.8	24.6	18.0	12.1	6.2	16.9
50%	6.3	7.2	11.4	17.1	23.0	26.6	28.7	29.2	25.0	19.4	13.1	7.4	18.1
75%	6.8	9.6	14.0	18.3	24.3	27.8	30.8	30.4	26.6	20.8	14.3	9.8	18.9
max	9.9	14.5	17.8	22.4	27.0	30.1	33.1	33.5	32.3	25.9	18.9	13.9	20.7

Table 4.13. Projected values of minimal air temperatures (MS Delcevo, 2006 - 2050)

T_{min}(°C)	Jan	Fev	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Noe	Dec	Av
Av.	-4.7	-2.9	0.2	3.9	8.3	11.4	12.5	12.1	8.5	4.3	1.2	-2.6	4.4
Min	-10	-11.9	-3.9	1.4	4.7	7.7	8.3	8.5	6.0	-0.1	-4.3	-8.4	2.3
25%	-6.5	-4.3	-0.5	3.4	7.5	10.4	11.8	11.6	7.6	2.8	-0.2	-3.9	3.9
50%	-4.2	-2.6	0.4	3.9	8.4	11.5	12.6	12.2	8.6	4.8	2.0	-2.5	4.5
75%	-3.1	-0.8	1.0	4.8	8.9	12.2	13.5	12.7	9.4	5.7	3.0	-1.6	4.7
max	1.5	1.0	2.7	5.9	11.6	13.5	14.7	17.3	11.4	7.6	7.5	2.0	5.6

Table 4.14. Projected values of wind speed (MS Delcevo, 2006 - 2050)

WS (km/d)	Jan	Fev	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Noe	Dec	Av
Av.	137	150	164	174	149	146	144	137	134	122	129	128	143
Min	46	83	82	81	81	99	76	72	54	54	65	46	96
25%	110	131	144	153	126	135	125	116	109	99	108	108	127
50%	135	147	165	171	153	140	144	135	134	121	127	133	145
75%	154	165	180	191	171	162	161	161	152	148	153	155	153
max	269	240	294	310	209	198	216	196	240	214	208	195	216

Table 4.15. Projected values of solar radiation (MS Delcevo, 2006 - 2050)

SR (h)	Jan	Fev	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Noe	Dec	Av
Av.	3.1	4.1	5.1	6.5	7.8	9.2	10.6	10.0	8.2	6.2	4.0	2.8	6.5
Min	1.2	1.6	2.5	3.8	5.7	7.0	8.1	7.7	5.7	3.9	2.3	1.3	5.7
25%	2.4	3.3	3.9	5.7	7.2	8.4	9.6	9.3	7.5	5.6	3.4	2.4	6.3
50%	3.0	4.1	5.4	6.3	7.6	9.3	10.4	10.1	8.4	6.3	4.1	2.7	6.4
75%	3.9	4.9	6.1	7.3	8.7	9.9	11.5	10.7	8.9	6.9	4.5	3.3	6.6
max	4.8	6.6	7.8	8.9	9.8	10.9	12.5	11.8	10.3	8.5	5.9	4.1	7.2

5. WATER DEMAND

This part of the study identifies the following potential beneficiaries of water potentional of river Lukovica/ Kosevica each presented in order of priority:

- Water supply of Makedonska Kamenica in low water periods and complete water supply of settlements in the project area
- Water supply of the future industrial zone and power thermal station
- Irrigation of arable area to the village Lukovica and Kosevica

5.1 WATER DEMANS FOR THE POPULATION

The purpose of this Study is to determine water demans for the settlements in the project area. The system, according to the project task and consultations with the client of this Study, should satisfy the necessary quantities of water of Makedonska Kamenica in low water periods with predefined dynamic and fully coverage of water demands of settlements: Lukovica, Todorovci and Kosevica.

Water supply demands are connected with the following factors: number of inhabitants, climate, the standard of population etc.

For the settlements Makedonska Kamenica, Kosevica, Lukovica and Todorvci the anticipated irrigation norm is 200 l/person/day.

Calculations presume water demands to the period to 2050, or for next 40 years. The number of residents by inventoried years is given in Table 5.1.

Table 5.1. Number of residents and growth for the period 1981 – 2002

Settlement		1981	1991	1994	2002	$Psr_{1981-2002}$
Makedonska Kamenica	population	3382	4778	4334	5147	
	growth p[%]	5.38	3.52	-3.20	2.17	2.02
Kosevica	population	349	290	321	240	
	growth p[%]	-1.33	-1.83	3.44	-3.57	-1.77
Lukovica	population	324	286	304	269	
	growth p[%]	-0.77	-1.24	2.06	-1.52	-0.88
Todorovci	population	228	217	240	235	
	growth p[%]	-0.47	-0.49	3.42	-0.26	0.14

The number of residents in the villages has steady declination, so for the future period the minimal growth is estimated on p=0.5%. Analyses for resident number in the final period were made for p= 1% resident growth (for Makedonska Kamenica).

Calculations for resident number of future period are represented in the table below.

Table 5.2. Number of residents for every fifth year for the period of 2010 – 2050

Settelment	M.Kamenica	Todorovci	Lukovica	Kosevica	Total
Anticipated resident growth	1%	0.5%	0.5%	0.5%	
2010	5573	245	280	250	**6098**
2015	5858	251	287	256	**6396**
2020	6157	257	294	263	**6708**
2025	6471	264	302	269	**7036**
2030	6801	270	309	276	**7380**
2035	7148	277	317	283	**7742**
2040	7512	284	325	290	**8121**
2045	7895	291	333	297	**8520**
2050	8298	299	342	305	**8938**

In the table below are represented average daily water demans for the period of 2010 – 2050.

Table 5.3: Water demands for the period of 2010- 2050

Settelment	M.Kamenica	Todorovci	Lukovica	Kosevica	Total
Irrigation norm (l/resident/day)					
2010-2050	200	200	200	200	
Average daylly water consumption Qsr/day (l/day)					
2010	1,114,693	48,913	55,990	49,954	**1,269,550**
2015	1,171,553	50,148	57,404	51,215	**1,330,321**
2020	1,231,314	51,415	58,853	52,509	**1,394,091**
2025	1,294,124	52,713	60,339	53,834	**1,461,011**
2030	1,360,137	54,044	61,863	55,194	**1,531,238**
2035	1,429,518	55,409	63,425	56,588	**1,604,939**
2040	1,502,437	56,808	65,027	58,017	**1,682,289**
2045	1,579,077	58,242	66,669	59,481	**1,763,469**
2050	1,659,626	59,713	68,352	60,983	**1,848,674**
Average daylly water consumption qsr/day (l/s)					
2010	12.90	0.57	0.65	0.58	**14.69**
2015	13.56	0.58	0.66	0.59	**15.40**
2020	14.25	0.60	0.68	0.61	**16.14**
2025	14.98	0.61	0.70	0.62	**16.91**
2030	15.74	0.63	0.72	0.64	**17.72**
2035	16.55	0.64	0.73	0.65	**18.58**
2040	17.39	0.66	0.75	0.67	**19.47**
2045	18.28	0.67	0.77	0.69	**20.41**
2050	19.21	0.69	0.79	0.71	**21.40**

Following chart represents projected mounthly variations of total water consumption and the ammount of water that will replenish water supply system of Makedonska Kamenica.

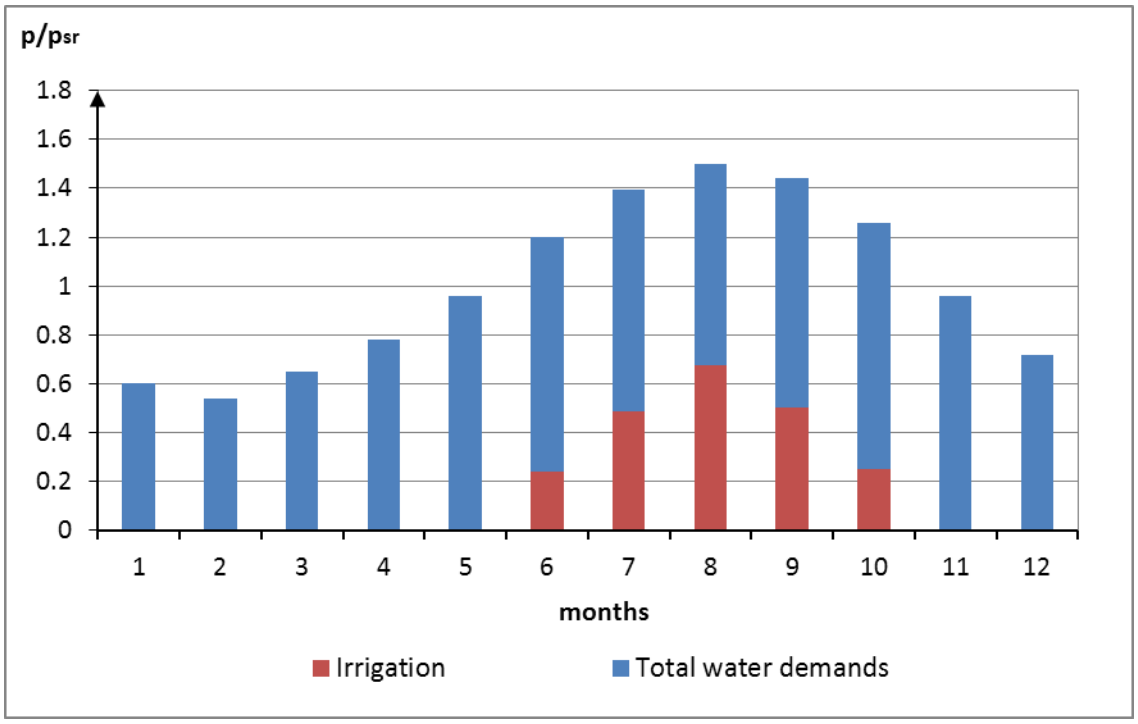


Chart 5.1. Chart of mounthly variations of water consumtion for M. Kamenica

5.2 DEMANS FOR WATER TECHNICAL

The project determines the necessary demans for technical water for the thermal power station in Kamenica and for the new industrial zone (3- 4ha area) that sould be constructed, according to the Construction plans of the municipality.

For the balance analysis and station requirements it is foreseen to allocate 50-100m3 per month but only during their work. Since there is no comprehensive plan for utilization of the industrial zone and representation of different types of industries, the analysis has been conducted with the quantities of 2.5 l/m^2/day.

5.3 COMPOSITION OF THE CROPS

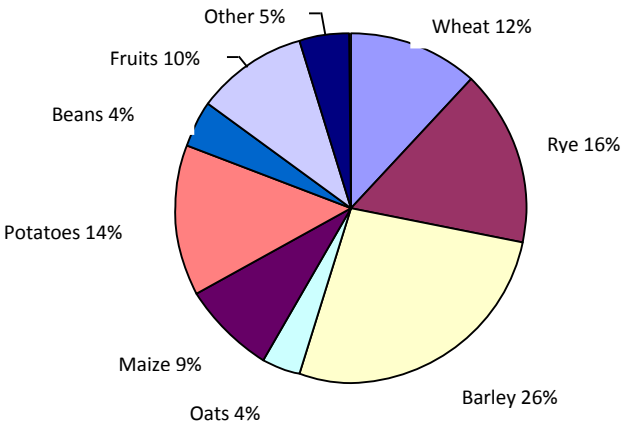
5.3.1 Current land use

Agricultural production in the region is very extensive which is conditioned by the dry conditions. There are mainly cereals that cover 65% of the area. Dominant crops are also potatoes and fruits represented by the plums.

The representation of different crops for the region according census for agriculture in 2007 is given below:

Table 5.4 Crop representation (by the census in 2007)

Crops	Makedonska Kamenica
Wheat	12%
Rye	16%
Barley	26%
Oats	4%
Maize	9%
Potatoe	14%
Beans	4%
Fruits	10%
Other	5%



The table with current utilization of the area (according census for agriculture in 2007) is given in the annexes.

5.3.2 Other bases

Existing documents which process this matter do not give a detail description of the composition of crops for the sub region of Makedonska Kamenica.

Composition of the crops for different climatic regions was proposed by the JBIC team from Japan, presented in the study SAPROF.

The proposed composition of crops is similar to the agricultural basis compared to the percentage in representation of different corps as well in terms of estimated needs for irrigation water. In addition, various compositions are presented for hydro ameliorative system Breglnica, systems in Stip region, and compositions for Kriva Palanka and Berovo region.

Table 5.5 Composition of crops (SAPROF)

	Stip		Bregalnica		Berovo-K.Palanka	
	I Crops	II Crops	I Crops	II Crops	I Crops	II Crops
Wheat1	32%		31%		10%	
Maiza		24%		9%		4%
Rise				22%		
Tobacco		5%		4%		
Sunflower		13%		10%		
Cabbage						
Tomatoes		4%		3%		2%
Pepper		5%		4%		
Other vegetable		8%		11%		4%
Apples						
Plums					65%	65%
Wild cherries	3%	3%	6%	5%	26%	26%
Other fruits	10%	10%	23%	20%		
Wine yard	28%	28%	14%	12%		
Alfalfa	32%		31%		10%	

5.3.3 Anticipated composition of crops

When compiling crop rotation and composition of crop in terms for irrigation, despite the principle of irrigation effect maximization, are taken other factors that impact positively on the structure, quality of soil, disease etc. To define the composition of crops, completely are followed recommendations of agricultural bases and studies as well as recommendations from the client of this technical documentation. Mainly few basic principles are kept:

- The presence of cereals compared with annual crops to allow rotation of crops (4-5 year crop rotation).
- Introduction of crops typical for irrigation conditions with high yields and profitablity, in order to get profitable irrigation investment. According to the conditions in Makedonska Kamenica it is recommended cultivation of perennial fruit species, especially the plum tree.
- Introduction of second crops cultivation that will result in increased production per unit area, particularly for low profitable crops (wheat and barley) after which it can be grown secondary crops (hybrid corn for seed with a short vegetation, tomatoes and cabbage).
- Introduction of crops that allow cash overcome so farmers could provide income over a longer period, thereby their economic power will increase. Such crops are gardening with more harvests over the vegetation and have high market potential.
- Forage crops that have a positive impact on soil quality improvement and locally provide with fodder.

The recommended composition of crops is given in the following table. Identical composition of crops is presumed for both subsystem (Lukovica and Kosevica):

Table 5.6 Composition of the crops covered by the project area

	Lukovica	Kosevica	
Crop	Area (ha)	Area (ha)	Percentage (%)
Maiza	37.5	9	15.0%
Barley	31.3	7.5	12.5%
Wheat1	18.8	4.5	7.5%
Tobacco	6.3	1.5	2.5%
Potatoes	25.0	6.0	10.0%
Other vegetable	6.3	1.5	2.5%
Tomatoes	12.5	3.0	5.0%
Peppers	12.5	3.0	5.0%
Alfalfa	12.5	3.0	5.0%
Wild cherries	6.3	1.5	2.5%
Apples	6.3	1.5	2.5%
Pears	6.3	1.5	2.5%
Plums	62.5	15.0	25.0%
Walnuts	6.3	1.5	2.5%
	250 ha	60 ha	100%

The presumed crop composition provides cereals partition of 22.5%, which is enough to meet the agricultural requirements and 12.5% barley contributes in fodder provision. Besides barley, 5% of alfalfa also contributes in fodder provision. Land utilization with forage crops (for grain and hay) would be about 40%, which is a solid base for the livestock requirements which becomes important branch in the region of Makedonska Kamenica and around.

The proposed crop composition contains high portion of fruit crops, which would cover 35% of irrigated areas. The most dominant fruit is plum tree which is represented with 25%.

Beside these crops it is recommended vegetable production of 22.5% areas..

5.4 IRRICATION WATER DEMANDS

Hydro ameliorative system Lukovica/Kosevica is a complex water management and hydropower system that allows fully utilization of available water potentials in the river basin.

According to the Project task, beside meeting water supply demands for the population and industry, there is also anticipated irrigation for the areas in municipality of Makedonska Kamenica and irrigation of ~ 310ha on areas around villages Kosevica and Lukovica.

5.4.1 Aims and methods applied in the Study

The purpose of this documentation is to determine the demands for irrigation water for both individual hydro ameliorative subsystems Lukovica with area of 250 ha and Kosevica with area of 60 ha.

The composition of the crops are determined by previously described principles according to the existing agricultural censuses, surveys and current agricultural practices in the region.

Also, by climatic parameters changing in terms of expected climate changes, recalculation of water demands has been made and it is estimated the possible increase as result of possible climate changes.

To increase the reliability of irrigation, all generated data series for irrigation water demands are for period from 1961 to 2005, where demands are represented with fixed discreat intervals depending of requirements as follow: daily, decimal, monthly and yearly.

To complet the omitted values of historical climate and meteorological sequences some corelative and greater degree regression dependencies (with one or more independent variable values) are used. Correlations are set at monthly levels.

Durring the preparation of this Study are used modern computer programs and tools for data bases processing (Access, Excel), statistical processing (Excel, Statistica), determining the demans for water (CropWat, CropSys, ClimGen, Aqua Crop) etc.

5.4.2 Survey of the existing documentation

Durring the preparation of this section of the Study this existing documentation was used:

- Study for irrigation in Republic of Macedonia, 1975
- Study for integral development of river Vardar, 1975
- Study SAPROF
- Scenarios of climate changes in Republic of Macedonia
- Agriculture Census, 2007
- Statistical Bulletin for farming, orchards and livestock, 2008 and 2009
- FAO Irrigation and Drainage Papers 24, 25 and 56

5.5 CROP WATER DEMAND

5.5.1 General

The determination of irrigation water demands for specific systems is made for a period of 45 years which are presented as discrete values for one day.

Water demands are determined by reference evaporation, calculated by the method of Penman-Monteith.

For HIS Lukovica despite the historical data that are used to determine irrigation water demands, there are also calculated synthetic data series which include the possible climate change until 2050 according the average scenario.

5.5.2 Applied methods

This section treats total water demand for crops, irrigation water demands and water duties for irrigations. After active usage the soil reaches greater irrigation water demands. Because of this, water demands will be analized for optimal irrigation conditions. In order to get more accurate quantity of water for irrigation it is necessary to determine the composition of the crops which will be grown on that region.

Crop water demands are determined by FAO Irrigation and Drainage paper 24.25 and 56. FAO software CROPWAT 4.3 is also used. First is determined the reference evaporation according modified method of Penman-Monteith. Than the reference evaporation is used to

determine the irrigation water demands with appliance of crops coefficients given in the FAO and adapted for our condition. These calculations include effective precipitations. After the calculation of irrigation water demands, water duties are calculated, which by recommendation of the FAO are presented as average monthly, continual flows, namely as continual irrigation of 24 hours, every day. This valuation can be transferred as valuation for short irrigation (20 hours, 18 hours etc).

5.5.3 Reference evaporation (ETo)

Reference evaporation according FAO is climate characteristic and it represents the evaporation of well irrigated and optimally maintained grass with height of 10 cm. These calculations are made by FAO 24 and 56 methodology using software CROPWAT 4.3. This methodology is considered as one of the most accurate and gives results approximately same as the real situation. This calculations also include meteorological data for the station in Delcevo.

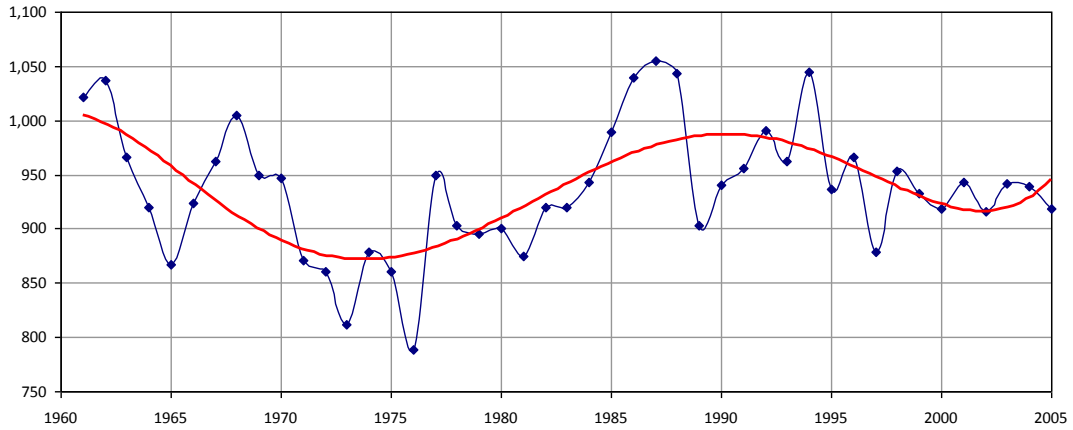
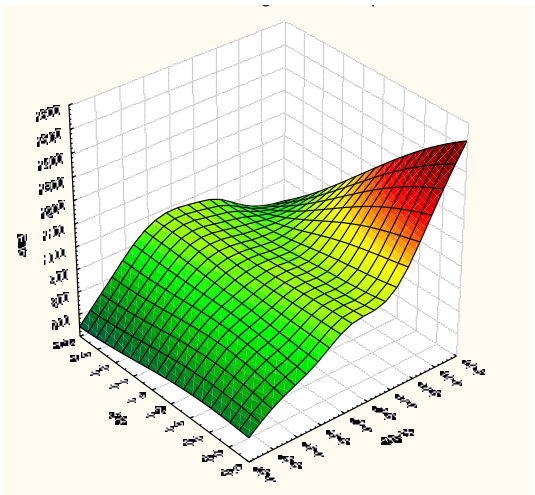


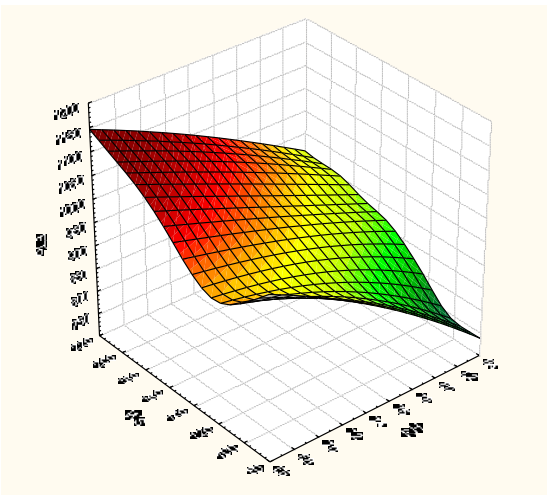
Chart 5.2. Annual values of referent evaporation for Delcevo measure station

The reference evaporation is obtained by the measured data from Delcevo measure station. Diagrams represent the dependence of reference evaporation from the other climate elements (MS Stip).

1. ETo=f(Tmax, SolarRadiation)



2. ETo=f(RelativeHumidity, WindSpeed)



5.5.4 Crop Water Demands

The total crop water demand is defined as the quantity of water needed to meet the water consumption for evaporation of some crop which grow in compact plantation on larger area not infected with diseases and without any restrictive factors in order to achieve maximum yield potential for specified conditions (FAO irrigation and drainage paper No 24, Crop Water Requirement). It actually represents the water demands for each crop and depends on climatic conditions, the crop by itself and consider the transpiration and evaporation of the soil.

The effect of crop for overall crop water demands is determined by so-called crop coefficient (kc) which shows the relationship between evaporation reference (ETo) and evaporation culture (ETc). Coefficient values of the crops differ for each crop, but also differ for same crop depending on the stage of growth, the period of vegetation and weather conditions of that period. Evaporation of the crop is defined in mm/day as an average value. The calculation is performed by the formula:

$$ETc = ETo \cdot kc$$

ETc (ET crop) – evaporation of the crop or crop water demands of any period in mm

ETo – reference evaporation for the same period in mm

Kc – crop coefficient for the same period

According to the crop, stage of development and growth, the crop evaporation may be higher, equal or less than the reference evaporation. In principle the values of initial and final development phase are lower than the reference evaporation, in complete development phase depending of the crop and its water demands, values are usually less lower, and only for the crops with very high water demands are equal or greater than the reference evaporation.

The total water consumption is determined by FAO method with appliance of crop coefficients by phases of development, provided by FAO and corrected and adapted for our conditions.

Based on data of reference evaporation and crop coefficient values at each phases of development total crop water demand could be determined. The results are given in Annexes.

It may be noticed that crops grown on such conditions have relatively high water demands. Water demands depend on many factors, but primarily by the type of crops and climate factors. Considering the composition of crops and climate characteristics of the region, water demands are expected to be slightly higher for same crop which grows on others regions.

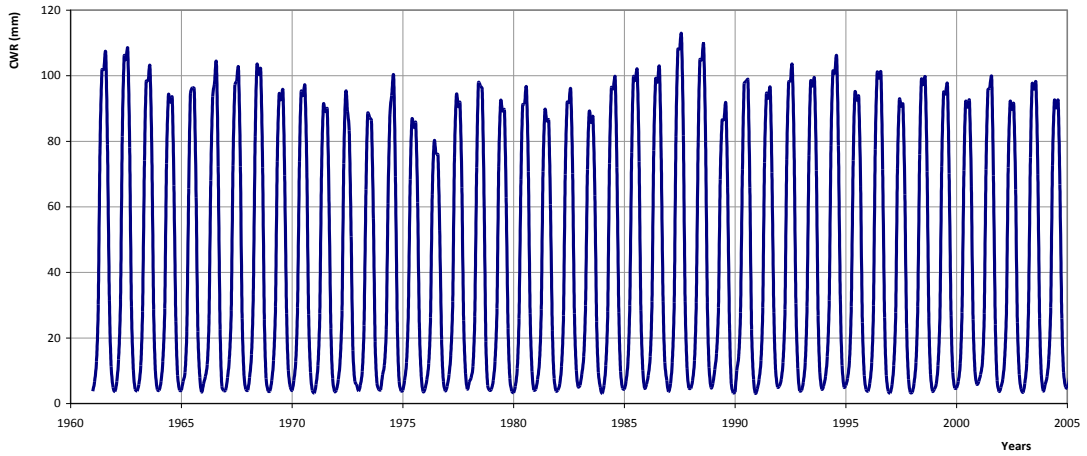


Chart 5.3. Diagram of historical water demands of crop for HIS Lukovica for the period 1961 to 2005

In addition, total annual and monthly crop water demands (in mm) with various empirical probabilities are represented in the table and diagram below.

Table 5.7 Total crop water demand in mm (HIS Lukovica) for the period of 1961 – 2005

CWR	Jan	Fev	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
min	3.1	5.2	9.4	22.1	61.1	79.9	76.0	76.0	50.9	16.2	5.1	3.1	429
25%	3.8	6.2	11.9	27.6	71.0	92.0	90.0	91.8	65.3	23.0	7.6	3.8	495
50%	4.1	7.1	12.7	28.8	72.5	94.7	93.9	96.3	69.6	25.7	8.7	4.3	519
75%	4.9	7.9	13.2	29.5	75.2	98.3	98.0	101.8	72.1	27.5	9.9	4.8	535
max	6.7	10.3	15.2	33.1	81.6	108.1	107.7	112.5	81.7	31.6	12.5	7.1	592

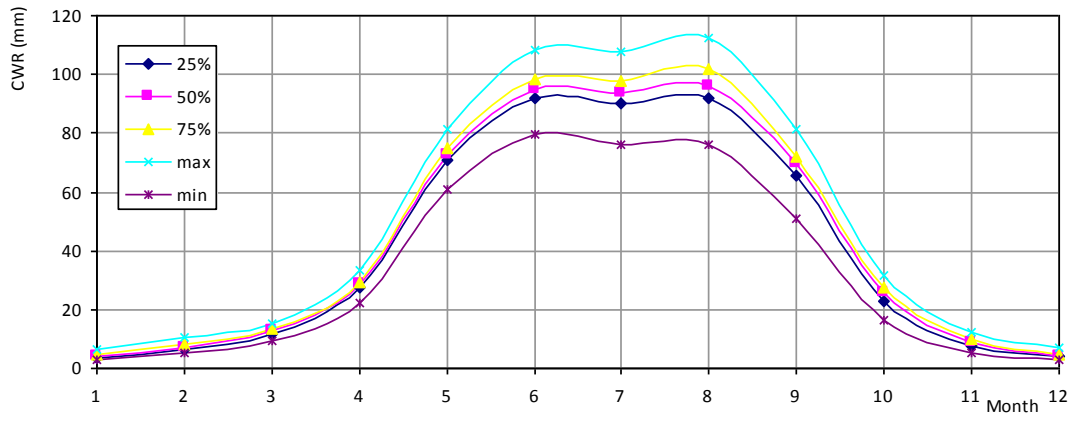


Chart 5.4. Diagram of crop water requirements (CWR) with various empirical probabilities for Lukovica and Kosevica

5.5.5 Crop Irrigation water requirements (IWR)

Irrigation Water Requirement according FAO methods is the required water quantity for irrigation (irrigation norm) determined as subtraction between total crop water requirement and effective precipitation:

IWR = ETc - Peff

IWR - required water quantity for irrigation (irrigation norm) in mm

ETc - crop evaporation (total crop water requirement) in mm

Peff - effective precipitation in mm

Effective precipitation are determined according FAO recommendations (FAO irrigation and drainage paper No 25, Effective rainfalls in irrigated agriculture).

Summary data series of precipitation per year of considered period are decreased by the level of efficiency of their soil moisture transformation and crops accessibility. Among all other methods, FAO is recommending method of fixed efficiency, especially for those areas which have not been explored enough for the influence of soil and crops of effective precipitation usage.

Effective precipitation depend on climate, topography, soil structure, initial soil moisture, irrigation method, crop rooting depth, crop cover… There are almost no explorations for effective precipitation in Macedonia. FAO recommendation is to apply method of fixed efficiency (USBR - United States Bureau of Reclamation) with fix percent of average monthly precipitation in scope of 75% - 85%.

Our calculation anticipates the value of 60% for fixed efficiency which corresponds to monthly precipitation of 50-75mm according to USBR.

It could be noticed that effective precipitation for semi dry year (75%) in the period of vegetation are almost negligible and crop cultivation without irrigation is debatable and there is not certainly that it would be profitably.

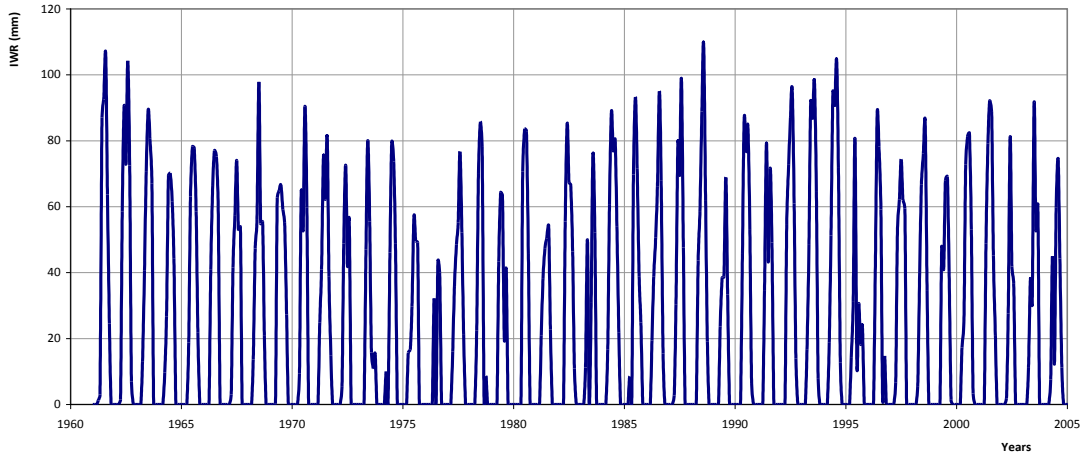


Chart 5.5. Diagram of historical irrigation water requirements (Irrigation norms) for HIS Lukovica for the period of 1961- 2005

In addition, total annual and monthly irrigation water demands with various empirical probabilities are represented in the table and diagram below.

Table 5.8 Irrigation water requirements in HIS Lukovica (in mm) for the period of 1961 – 2005

IWR	Jan	Fev	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.8	0.0	0.0	0.0	0.0	116
25%	0.0	0.0	0.0	0.0	26.6	56.0	55.6	57.7	38.9	0.0	0.0	0.0	259
50%	0.0	0.0	0.0	3.0	40.7	69.3	73.0	74.4	49.1	3.3	0.0	0.0	306
75%	0.0	0.0	0.0	13.7	48.4	79.2	83.7	84.3	59.5	15.3	0.0	0.0	346
max	0.0	0.0	0.0	24.8	62.7	94.8	97.9	109.2	72.5	27.2	0.0	0.0	444

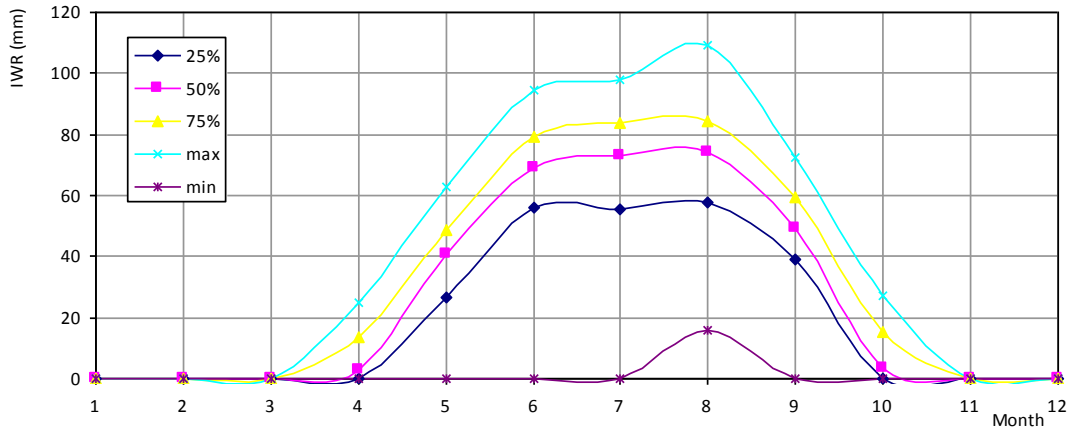


Chart 5.6. Diagram of monthly crop irrigation water requirements with different probabilities (IWR) for Lukovica and Kosevica

5.5.6 Water duty for irrigation (FWR)

Based on previous data, total water irrigation demands can be determine by the considered land utilization. This calculation is performed by multiplying irrigation water demands per unit surface with the represented area.

Water duty for irrigation is calculated using the formula:

$$q = \frac{\alpha * IWR}{0.36 * n * t}$$

α - The relative contribution of crop in the seedtime structure

IWR - required quantity of water for irrigation (irrigation norm) in mm

n - Number of hours for watering during 24 hours (the calculations are for 24 hours)

t - Number of days for watering (recommended daily watering during vegetation)

For the purposes of this study, the efficiency of water usage for irrigation is 100% and represented water duty are for 100% efficiency of water for irrigation. Depending on the applied technique of irrigation it can be applied efficiency of water usage for irrigation. The

efficiency of individual irrigation techniques in agricultural area (distribution of water in the field) are taken as 85-90% for micro irrigation , 70-80% for techniques of sprinklers and 50-70% for gravitation irrigation techniques.

In addition are represented monthly water duty and maximal annual in (l/sec/ha) with different empirical probabilities.

Table 5.9 Irrigation water duty (in l/sec/ha) HIS Lukovica for the period of 1961 – 2005

FWR	Jan	Fev	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Sum
min	0	0	0	0.000	0.000	0.000	0.000	0.145	0.000	0	0	0	0.14
25%	0	0	0	0.000	0.189	0.411	0.437	0.530	0.399	0	0	0	0.53
50%	0	0	0	0.025	0.290	0.509	0.575	0.683	0.504	0	0	0	0.68
75%	0	0	0	0.114	0.344	0.582	0.659	0.774	0.610	0	0	0	0.77
max	0	0	0	0.206	0.446	0.696	0.770	1.003	0.743	0	0	0	1.00

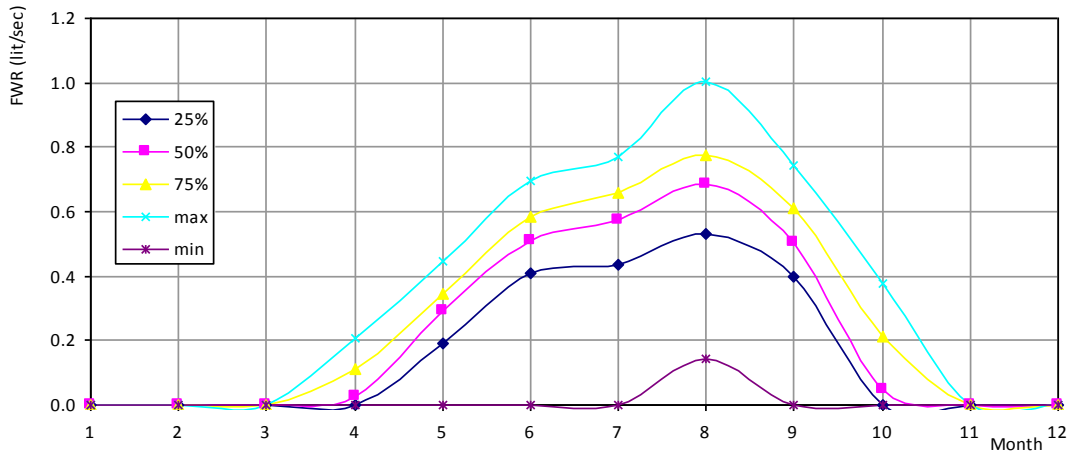


Chart 5.7. Diagram of monthly irrigation water duty with different probabilities for Lukovica and Kosevica

5.6 IRRIGATION METHODS

Recommended irrigation methods are based on achieving the best results and reducing the needed of labour. The appliances of techniques for irrigation by gravity despite the involved labour, also require investments in earth works. Surface techniques beside the requirement of levelled and flat surfaces also have a high loss of water and create conditions for secondary salinity which is very inconvenient.

Micro irrigation methods (micro sprinklers, drop irrigation) should be applied in combination of irrigation with fertilization, i.e. by applying fertilization to achieve significantly better results. Wherever possible is necessary to apply this techniques due to excellent results in terms of yield, water saving, environmental protection and cheaper production.

A micro sprinkler with fertilization is recommended at fruit orchards, while drip irrigation with fertilization can be applied to: wine yards, garden crops, tomatoes, peppers, cabbage, etc.

Although water losses can be significant, sprinklers are the only solution for irrigation for more crops. In general it is not recommend purchase of large and expensive machines for irrigation, but mobile and self-standing wings. To achieve best results the sprinklers must be carefully selected and to comply with soil water permeability.

Irrigation with sprinklers (mobile, self-standing wings and typhon) is recommended for: barley, alfalfa, wheat1, maize and others.

5.7 THE IMPACT OF EVENTUAL CLIMATE CHANGES TO IRRIGATION WATER DEMANDS

The main agents of the reference evaporation are average maximum and minimum air temperature, relative humidity, solar radiation and wind speed. In this section there is a calculation of ETo but as a function of climate elements that contain the potential changes.

Average annual value of potential evaporation for considered period is 1146mm.

More significant air temperature increase during the summer months with special emphasis of the temperature difference between summer and winter periods and the obvious extreme temperatures change, where the maximum is greater than the minimum gradient, directly reflects the potential evaporation.

Comparing the entire sequences, predicted water demands for plants according to climate change is extremely higher in the summer months. In general, the increase of potential evaporation almost linearly reflects on irrigation water demands to the plants.

In wetter periods, the difference in water demands for plants between two periods is present only in the summer months, while in the dryer periods the difference is more emphasized at the beginning of vegetation period until the first irrigation, immediately after spring sowing.

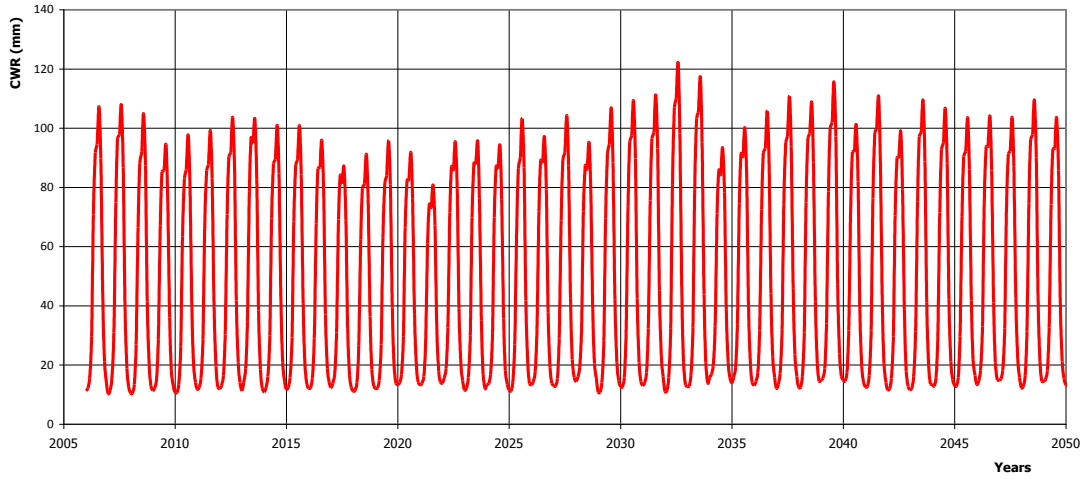


Chart 5.8. Diagram of predicted crop water demands for HIS Lukovica for the period of 2006-2050

Average value of plants water demands for considered period is 558 mm and is 12% greater than the reference- historical period.

The introduction of effective precipitation does not emphasize the difference in irrigation water demands, but only changes the monthly distribution of differences for different

periods in terms of humidity. During the summer period, from the analysis of effective precipitation can be noticed that effective precipitation in the vegetation period for average dry year (75%) are almost negligible with apparent positive impact of the small precipitation increase in other periods of the year.

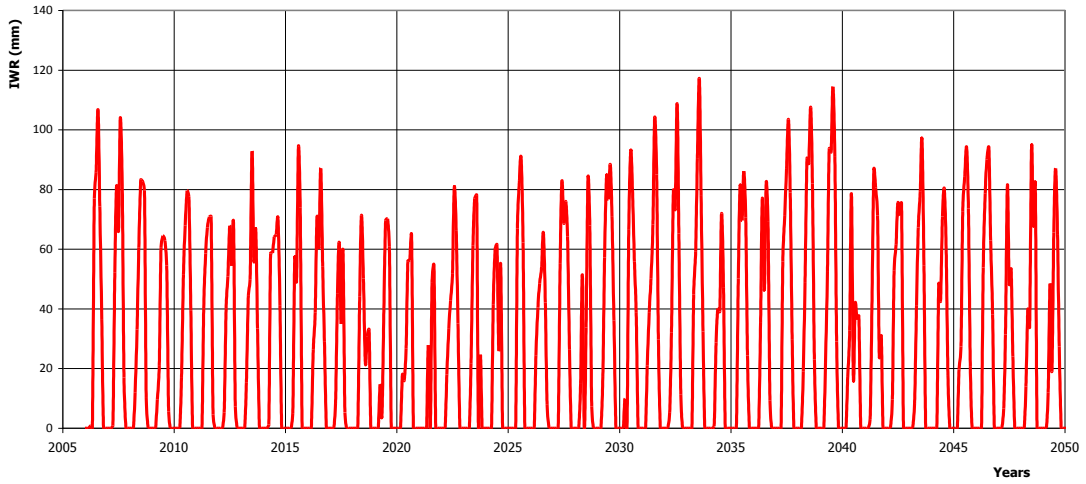


Chart 5.9. Diagram of predicted irrigation water demands (Irrigation norm) for HIS Lukovica for the period of 2006- 2050

Average annual value of required water for irrigation in considered period is 330 mm and is 9% greater than the reference- historical period.

The dependence of irrigation demands of potential evaporation rounded for annual amounts for the considered period are represented on the chart below.

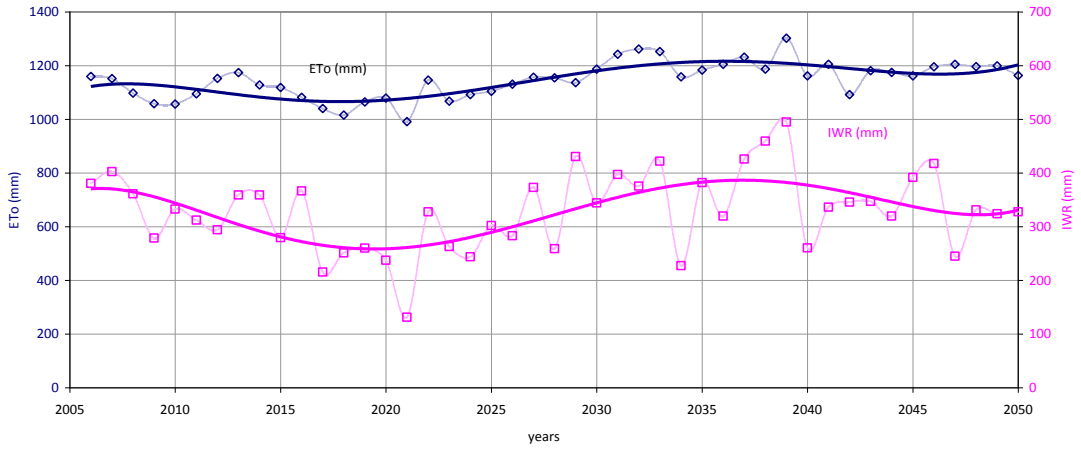


Chart 5.10. Comparative diagram of predicted irrigation water demands and potential evaporation for HIS Lukovica for the period of 2006- 2050

Additional balance analysis of the considered alternative are conducted on the calculated values of irrigation water demands for the period of 2006-2050, in order to evaluate the impact of possible future climate change on the probability of irrigation area or possible reduction at constant probability appearance.

5.8 QUALITY IRRIGATION

The maximum yield of crops is a function of climatic conditions and their genetic potential. Approaches to the maximal yields are only possible by adjusting of irrigation, reviewed by engineering perspective of plants biological water requirement. Therefore, efficient use of water in agricultural production denotes the achievement of purposefulness in the planning, designing and water resources managing by meeting the requirements in quantity and time.

When water demands for plants are not fully covered, the water deficit will directly affect the crop development and its yield. The way that water deficit affects то the development of crop and its yield, mostly depends on the type of crop and its development stage. Assessment of the effect of water stress on crop yield reduction is possible by quantifying the ratio of relative evaporation (ETa/ETm) from one side and maximum crop yield (Ya/Ym) on other side. Also to determine the impact of water deficit to the yield, it is necessary to develop a relationship between relative yield reduction and relative deficit evaporation through empirically derived factor of the crop yield Ky.

$$\left(1-\frac{Y_a}{Y_m}\right)=\left(1-\frac{ET_a}{ET_m}\right)\times K_y$$

Ya – current crop yield (tons/ha)

Ym – maximal crop yield (tons/ha)

ETa – current crop evaporation (mm)

ETm – maximal crop evaporation (mm)

Ky – crop factor

Previous dependence proposed by FAO (J. Doorenbos, AH Kassam), belongs to a group of linear productive functions and can be used to calculate the current yield for a single period of crop development.

To understand the effect of irrigation on crop development and yields in the hydro ameliorative system Lukovica, proposed FAO dependence is replicated to the dominant crops in the system (maize, wheat, alfalfa, fruits, etc.).

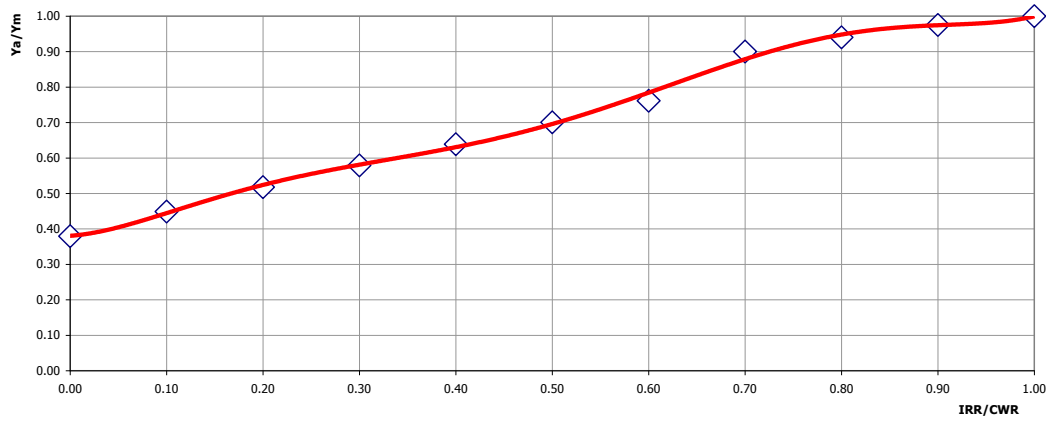


Chart 5.11. Total yield increase as a function of irrigation for the whole Hydro system

Based on an analysis of relative yields of individual crops, with their sublimation for the whole hydro system and their adequate area representation, that expresses them as total relative yields compared to the maximum possible yields, can be noticed that the most

significant benefits of irrigation compare with yield increasing can be expected in the area where irrigation takes for approximately 70-80% of the total water demands for plants. Till this limit the increase of yields is steep and almost proportional with irrigation increase and it can be expected yield increase of ~50% compared to the yield without irrigation, i.e. it can be achieve a total yield of 90% compared to the maximum. Further irrigation increasing is giving less increase of irrigation.

All these facts emphasize the role of irrigation in increasing the yields and define the limit of irrigation probability (80%) which was later used in the balance analysis.

5.9 CONCLUSIONS

- Irrigation is expected to give a strong effect on the yield of crops. The values of yields, compared as weight ratio, indicates that it can be expected double increase of overall yield.

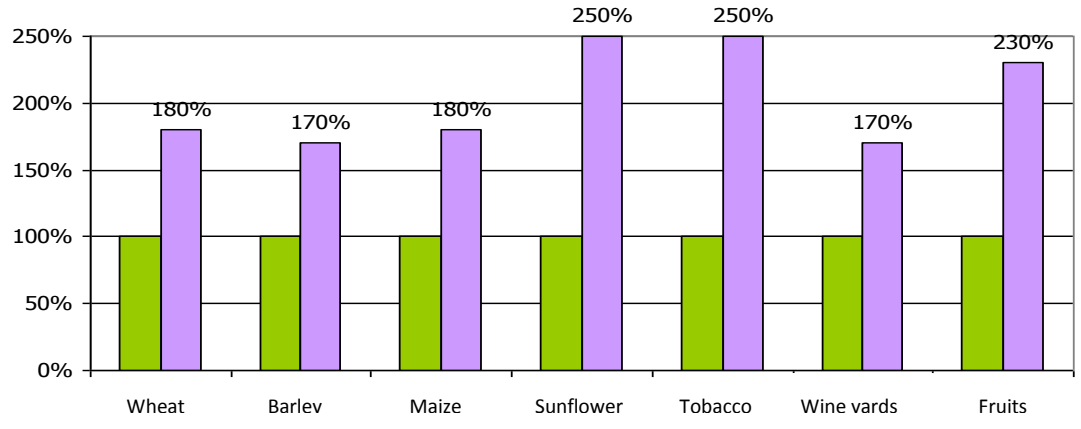


Chart 5.12. Expected yields of irrigation

- Used data for climate and meteorological elements are from measure station Delcevo for the period of 1961- 2005.

- Incomplete climatic historical and meteorological data series are correlative and more degrees recessional dependencies (with one or more independent variable values). Correlation coefficients that define adaptation of the model is very high.

- Irrigation water demands are calculated by methodology of FAO Irrigation and Drainage Paper 24, 25 and 56th using the programming package CROPWAT 4.3., based on previously defined input file with climatic elements and percentage of crop area (cropping pattern).

- Calculated results are presented in sublimation form within tables and only for specific probability of appearance in terms of considered series. Complete tables are presented in the section with Annexs.

- Daily values of the crops irrigation water demands were obtained by linear discretization of subsequent additional decade values.

- Analyses are implemented by introduction of 100% efficiency of water usage for irrigation. In practice the efficiency of irrigation depends on the applied technology for irrigation (for micro irrigation ~ 85-90%, ~ 70-80% for irrigation with sprinklers) and by reducing the efficiency the value of irrigation water demand is increasing, i.e. water duty.

- Composition of crops on agricultural based can enter the system with 75-85% efficiency. It was obtained as a result of the presence of crop and the most suitable irrigation technique.
- Water demands for plants with established climate change, which include decreased precipitations and variable time distribution, may increase in future and it can be expect 9% increasing of irrigation water demands for the whole considered period.

6. TECHNICAL CONCEPT OF THE PROJECT

6.1 GENERAL

According to the Project task, this study elaborates several alternatives to cover the requirements of the system beneficiaries as a function of water potential of river Kosevichka. The study also identifies the future beneficiaries of water potential of the river which are presented in order of priority to meet the requirements:

- Guaranteed ecological flow
- Water supply of Makedonska Kamenica in periods with low water quantity
- Complete water supply of settlements in the project area
- Water supply of the future industrial zone and thermal power station
- Irrigation of arable land in the area of village Kosevica (60ha) and Lukovica (250ha).

Beside the water supply, the aim of the proposed alternatives is to achieve other benefits: protection from sediment, flood protection, creating conditions for developing tourism and other benefits that are reviewed later in this stud.

All analyzed alternatives treat customers equally.

6.2 SURVEY OF THE EXISTING DOCUMENTATION

При изработката на оваа Студија, во целост е анализирана и респектирана следнава техничка документација:

- Main project for water supply of M. Kamenica, designed by “Melioproekt”.
- Main project for water supply of M. Kamenica, designed by Rudarski Institut Skopje 1988.
- Main building project for regulation of river Kamenicka, designed by Rudarski Institut Skopje 1989.
- Hydrological base of the middle zone of Kriva reka watershed, designed by RHM Zavod Skopje 1985.
- Hydrological study of river Bregalnica, designed by Hidroelektroproekt and Zavod za vodostopanstvo Skopje 1959.
- Study for the available surface and underground water for the watershed of river Kosevica and Lukovica and the possibilies of exploitation, designed by INKOM Inzenering during 1990.
- Hydro technical characteristics of Calamanco accumulation, EVN Macedonia
- Hydrological base of watercourses for the Region 2 OSOGOVO, RHMZ Skopje 1997
- Local Ecological Actional Design for municipality of Makedonska Kamenica
- Local Economic Development Design of municipality Makedonska Kamenica

6.3 ALTERNATIVE TECHNICAL SOLUTIONS FOR WATER POTENCIAL UTILIZATION

For the purposes of this study following alternatives for water potential utilization of Lukovichka / Kosevichka River are thoroughly developed to "Cost-benefit" analysis.

6.3.1 Alternative 1

This alternative provides water pumping from existing Kalimanci accumulation to meet the requirements of water to different beneficiaries. This solution is based on constructing an area of borenholes nearby accumulation and pump station that will distribute the water to different beneficiaries.

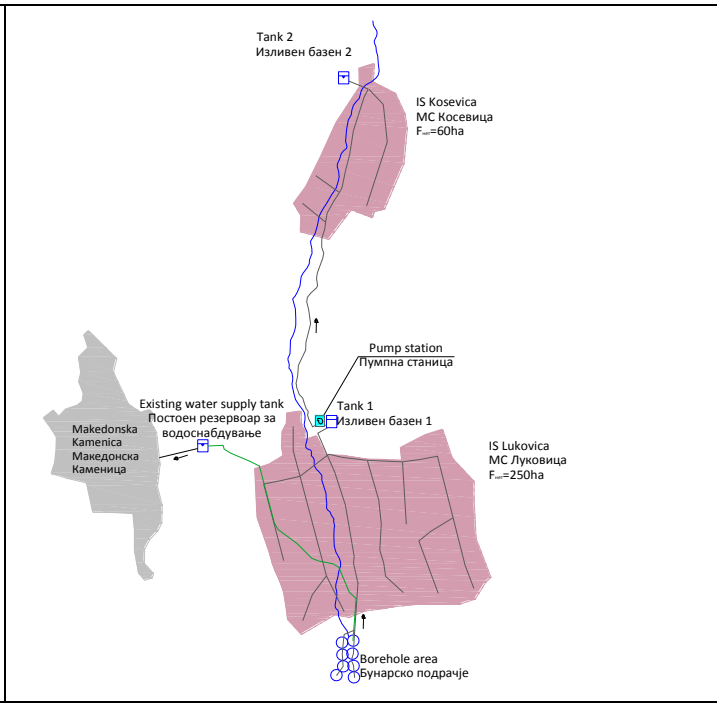
Water from the borenholes would be transported to the irrigation system (through break chamber) while water for Kosevichko Pole would be pumped from the break chamber.

To complete the quantities of water for M. Kamenica and other settlements one borenhole and separate supply lines connected with the tanks would be used.

This alternative actually simulates the scenario "do nothing". Utilization of water potential of the river is balanced through the accumulation Kalimanci.

The alternative itself has no high investment costs, but operating costs are expected to be significantly high.

Chart 6.1. Schematic representation of Alternative 1



6.3.2 Alternative 2

Alternative 2 is based on the principles of the current Study for available surface and underground waters of river Kamenicka/ Lukovichka watershed and utilization possibilities made by ICOM engineering in 1990.

Only the physical parameters for hydraulic structures were undertaken from this study, while all other elements are updated with new data.

The requirements for water would be meet by building two small accumulations along the Kosevichka/ Lukovichka river.

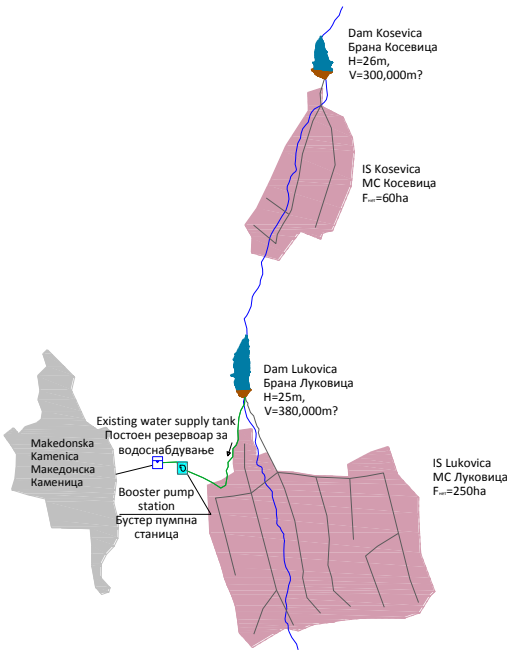
The considered dam height of Kosevichka River is 26m (elevation of the crest 784 m) with 0.3x106m3 total volume of water. The dam is quite large with extremely unfavourable ratio of built-in material and accumulated water.

The considered dam height of Lukovicka River is 25m (elevation of the crest 620 m) with 0.42x106m3 total volume of water. Compared with the previous, this dam provides better ratio of built-in material and accumulated water.

The accumulation in upper flow of river Kosevicha has less volume and is porpose to meet the requirements of water supply to Kosevica and irrigation of ~60 ha to the area of the village Kosevica. The other accumulation (Lukovica) is porpose to meet water supply requirements of other settlements (Makedonska Kamenica, Lukovica and Todorovci) and industry. It should provide water for irrigation of ~ 250 ha of arable land to Lukovichko field. Due to the relatively small volume of this accumulation, it is necessary to develop a system for detailed management of water resources and accumulation.

This alternative also provides electricity production from the overflow water by two small hydroelectric power plants located in the toes of the embankment of future dams.

Chart 6.2. Schematic representation of Alternative 2

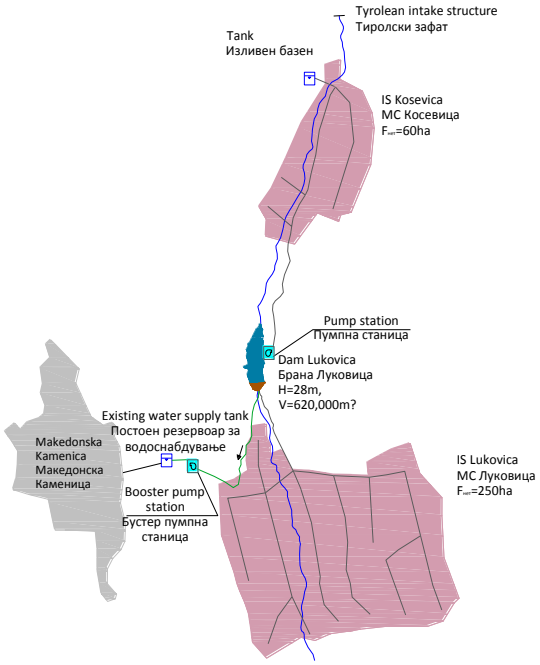


6.3.3 Alternative 3

Alternative 3 provides construction of only one accumulation on Lukovichka River, with greater height in order to respond to the needs of future users. This alternative also provides construction of a small intake above village Kosevica, which will capture the required amount of water supply for the population of village Kosevica. Furthermore it can be used as energy intake for the small hydro power plant included in the tender of the Ministry of Economy.

According to balance analysis explained below in this study (Chapter 7), completely satisfying water requirements are achieved by dam with height of 28m (elevation 623m) with accumulation capacity of 0.62x106m^3.

Chart 6.3. Schematic representation of Alternative 3



As previously, this dam is projected as a rock- filled with central clay core. For the needs of this alternative and the needs of optimization analysis, which task is to identify the optimum height of the dam, investment analysis are calculated for different heights of the dam (25, 30 and 35 m).

To meet the requirements of water for irrigation of Kosevichko field (60 acres), is planned small pumping station with break chamber.

Also small booster station is planed to the supply line till the tank of Makedonska Kamenica. The need of this station should be confirmed by further analysis.

Water supply of other users (settlements and industry) and the irrigation of Lukovichko field (250 hectares) is planned to be gravitational.

Similar to alternative 2, it is also planned utilization of water energy potential of overflown water from the accumulation that is more significant during the winter and spring months.

6.4 TECHNICAL CHARACTERISTICS OF HYDRAULIC STRUCTURES

The alternative solutions, beside the concept in terms of meeting water requirements for different beneficiaries, have differences and by the type of anticipated hydraulic structures. In this section there is a brief description of the technical features of more important objects for all alternatives. Technical characteristics of the structures that are common to all alternatives or they are repeating with different physical characteristics are unified. The dimensions of some of the smaller objects are passed by a preliminary analysis or by experience and should be confirmed by detailed technical projects

6.4.1 Dam technical solution

6.4.1.1 Dams

This technical documentation presumes construction of rock fill dams with central clay core, two-layered filter protection and rock fill shell. The type of dam is chosen according the topographic conditions, geological characteristics of dam site and available local materials near dam site and recommendations of the existing technical documentation.

The construction of rock fill shell is by filling in layers from local sites or future accumulation area and compacting till necessary compression is achieved. The anticipated slopes of the faces are 1:1.9 on the downstream slope and upstream slope.

The protection of the upstream slope of the shell is with rocks with larger diameter and better characteristics from the base one to protect its zone from the minimal level to the dam crest.

Shell and dam funding is performed on previously cleaned layer.

The dam has central core, one meter below the level of the crest. The width of the core in the crest is 4.0m. Downstream and upstream slope of the core is constant 1:0.25 according by maximal longitudinal section of the dam.

Along all length the core is relying on the parent rock where all sedimentation material has previously been removed. After this the core is dreading in for additional 0.5-1.0m in the base rock with inclination 1:1.

The core is from clay in layers of 0.20m with compacting till necessary compression is achieved.

Also is planned single filter protection with downstream thickness of 3.0m and double filter protection to the upstream filter with thickness of 4.0m, horizontally measured. Along all length in downstream direction filters are relying on the parent rock and follow the line between the core and the rock. The inclination of the filter is same as the core inclination and it will be constructed as the clay core, layer by layer.

Table 6.1 represents some unified characteristical values for dams and other significant parameters.

Table 6.1 Characteristic values for dams

Crest width	5.00 m
Crest width of the clay core	4.00 m
Shell inclination	1:1.9
Clay core inclination	1:0.25
Filter inclination	1:0.25
Bottom river elevation	595/758 m

At the time of the construction, water evacuation is planned to be with diversion pipe under the dam body which later would be fitted in the solution for permanent structure (bottom outlet) and upstream cofferdam.

6.4.1.2 Upstream cofferdam

Upstream cofferdam is planned to be constructed with the same material as the dam body with upstream slope 1:3 (1:2) and downstream slope 1:2. Crest width of the cofferdam is 3.0 (4.5)m and the height is 5.0m.

Water- impermeability is provided by upstream clay facing with variable thickness: 1.5m on the top and the thickness on the bottom is variable and follows the upstream slope of the facing which is 1:3.0.

Facing foundation is performed by a small cutoff trench which penetrates to the base rock.

6.4.1.3 Structures for flood flow evacuation

During the exploitation of dams, Q1000 is taken as authoritative flood flow for evacuation. Due to the relatively small volume of the accumulation they are not participating in the wave floodway.

Side spillway for flood flow evacuation is design with a specific length that fits well with specific features on the field. Spillway is located on the right side of Lukovichkata dam, while due to the better topographic characteristics spillway of Kosevichka dam is located on the left side. In transverse direction the collecting duct has trapeze form. Spillway rim elevation has normal top water level. The designed spillway elevation is 1:50 (2.0)m.

On the front the side spillway is closed with reinforced concrete wall.

Massive overflow sill and collecting channel along of the entire length are foundated in the rock. The outline of the rock is taken from engineering geological profile.

The slope along the channel was design to be less than critical.

From the collecting channel, water turns into a transitional section. This channel has the same geometry as the collecting channel.

On the place where transitional section and the dam meet is foreseen a massive concrete retaining wall, designed to stand the dike and water pressure. Retaining wall is almost normally positioned with the axle of the dam which shortens the length of the connection and provides better sagging of the dike.

The chute begins after a transitional section and is getting into a zone with enhanced slopes and variable geometry of the cross section.

Situational the chute is designed in turn that allows geometry change.

To allay the energy from overflow water in the river basin is foreseen construction of massive concrete rebound sill (at Lukovichka dam). To allay the energy from overflow water at Kosevichkata dam is foreseen construction of downstream apron.

6.4.1.4 Normal top water level determination

When determining the normal top water level in the accumulations, which is conducted in the part for "Water analysis", there are 2 conditions that should be completely meet:

- The volume of the useful area should be greater than the required volume of useful area in the accumulation to meet the water requirements of different beneficiaries.

- Dam’s crest elevation should not exceed the maximum dam’s crest elevation according to the topographic conditions of the dam site that enable rational dam building

6.4.1.5 Flood water analysis

Flow hydrograph and its shape. All over the world and here there are number of methods to calculate the maximal overflow of small watersheds. It means that there is no uniquely defined procedure for calculation. All existing methods and their parameters with great precision are derived for certain areas in the world and can be used in those areas. Calculations include several most applied empirical methods and a software package. Empirical methods are based on the Rational theory and the theory of “Synthetic Single hydrograph”. Analysis and flood flow control is made with the software package Smada 6.0.

Software package SMADA 6.0

The input data in software are the topographic features of the watershed. The transformation of intense into effective precipitation is by SCS (Soil Conservative Service) method, where the temporal distribution of rain is taken by SCS method Type II.

Concentration time is calculated as average of all concentration times according to different authors, (Izzard's equation, Bransby Wiliams's equation, Kerby's equation, Kirpich's equation, FAA's equation, Kinematic equation).

The anticipated concentration time for river Lukovica watershed is 120 minutes, while for river Kosevicka watershed is 80 minutes.

Hydrographs for different return periods are obtained using the SCS 486 2 method and compared with the method of Santa Barbara.

In addition are presented characteristic flood waves with different return periods for Lukovichka River.

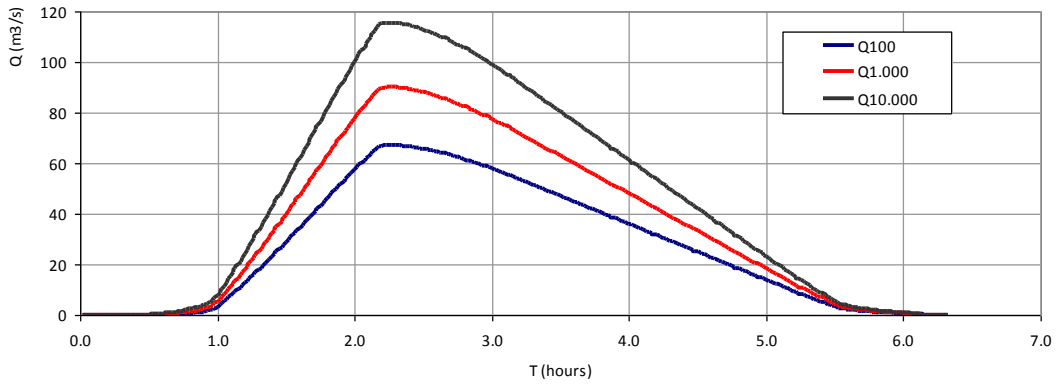


Chart 6.4. Flood flow hydrograph for Lukovica dam

Flood flows for Kosevica dam profile are obtained upon the principles of analogy of the two watersheds as function of the watersheds area.

6.4.1.6 Amount of produced and brought sediment in the accumulation

To maintain the “dead” area, the quantity of erosive sediment that would be sedimented in accumulation Lukovica will be analytically calculated because there are no available measurement data.

Erosive sediment that is expected in future accumulation will be calculated by the method of prof. Gavrilovic, which gives good results and have been applied on more accumulations by comparing the analytical calculated numbers and ecosoned measurements. The accuracy of these tests was 10 to 15%.

According to average annual production of erosive sediments in the watershed of the accumulation Lukovica will be:

$$W_{god.} = TH_{god.}\pi\sqrt{Z^3}F[m^3/god]$$

T- Temperature coefficient - 0.8

Hyear.- annual sum of rainfalls – (mm)

π - constant

Z - Coefficient of watershed erosion - 0.70 (0.1 – lowest, 1.5 – highest erosion)

F – Catchment area - 12.85 км^2

$$W_{god.} = 0.8x600x3.14x\sqrt{0.70^3}x12.85 = 11.343m^3 / god.$$

The total amount of erosive sediment that is produced in the watershed cannot access to the accumulation because part of that sediment is retained in the watershed in different holes, obstacles, etc.

The amount of sediment retained in the watershed is calculated by the retension coefficient:

$$Ru = \frac{(OD)^{0.5}}{0.25x(Lx10)}$$

Where:

O – Watershed parting length -5.2km

D – Average heigh difference t - 0.192km

L – Watershed lenght-2.2km

$$Ru = \frac{(20x1.0)^{0.5}}{0.25x(8+10)} = 0.224$$

According to this, the erosive sediment that will be sedimented in the accumulation will be:

$$G_{god.} = W_{god.}xRu = 11.343x0.224 = 2538m^3 / god.$$

For a period of 40 years there would be ~0.1x106m3 sediment in the accumulation, which specifies the dead area of the accumulation.

Quantities of sediment for Kosevica dam profile are obtained upon the principles of analogy of the two watersheds as function of the watershed area.

6.4.2 Pump station

Alternative solution 1 presumes water capturing for Lukovica and Kosevica and additional quantities of water for M.Kamenica with borenhole pumps located along the accumulation Kalimanci near the estuary with river Lukovichka. The water from borenholes would be transported to Lukovica and breaki chamber 1 with 620 meters elevation. For purposes of Kosevichko field the water would be pumped to break chamber 2 with 760 meters elevation. One borenhole directly connected to the tank would be used for additional quantities of water for M.Kamenica.

There are 8 borenholes at distance of 100 meters, each with capacity of 35-40 l/s or total capacity of 280-320 l/s. The depth of the borenhole is 50 m and diameter of the borenhole pipe is PE HDPI NP 20bars, Ø = 280 mm. Maximum lowering to the minimum level of the accumulation is at elevation 480 meters.

Submersible pumps are with these characteristics: Q = 40 l/s, Nman = 152m, N = 100KW.

Table 6.2. Hydraulic calculation for pressure pipe Borenholes- Break chamber (620m)

	L	D	Qpum	V	n	C	J	dh	Hpum	HIB	Hst	Hman
	m	mm	l/s	m/s		$m^{1/2}/s$	m/m	m	mnv	mnv	m	m
Borenholes –BC (620м)	2650	500	280	1.43	0.012	58.93	0.004	12.4	480	620	140	152.4

To provide M. Kamenica with necessary quantities of water for Alternative 2 and 3, Booster Station on the water supply pipe will overcome height differences of Lukovica accumulation level and tank level (if necessary).

Breaking chambers are designed as reinforced concrete pools with a volume of 100m3, which allow synchronous operation of the pumps.

6.4.3 Technical solution of intake structure

To meet water demands for village Kosevica, according to Alternative 3, in the basin of river Kosevichka is anticipated construction of concrete intake structure with spillway and outlet. The choice for intake type is in terms of its usage for energy purposes. Intake structure is located about 2 km north of the dam site of Kosevichka.

This provides daily flow equalization for water supply requirements.

Intake structure is combination of two parts: Massive spillway overflow sill and wing walls. The spillway is designed by the curve of Kruger Ofecerov to ensure better hydraulic conditions, while downstream area is designed with a round curvature coupled with a short transitional section.

The wing walls are also massive and exceed over the spillway rim. Foundation is scalable and follows the field line. In transverse direction, upstream side is vertical while the downstream has a slope that follows the connection between the dam's crest and the necessary height of the slope walls.

Whole intake structure is anticipated to be constructed with concrete MB30, V-6, M-100 and cement with low hydration (hydration heat).

It must be emphasised the need of regularly sediment flushing to keep the object functional.

The water from the intake is distributed by the supply pipe. The pipe for the intake is steal. Input section is specifically shaped with console expense and bar only by the side of the river.

The equipment (valve and aerated pipe) is placed in reinforced manhole downstream from wing wall.

6.4.4 Technical solution for Irrigation network

6.4.4.1 Introduction

On this phase irrigation network was set on topographic maps with different scales (from 25.000 to 2.500) depending of the details and the clarity.

For the purposes of study, for tracing the network, determining unfavourable topographic zones in terms of steep slopes, settlements and infrastructure and also for height perceiving for dimensioning, three-dimensional terrain model in GIS environment was made.

6.4.4.2 Irrigation Network

Irrigation area is divided into two zones (two subsystem), as follows:

- Subsystem **Lukovica** with area of 250ha
- Subsystem **Kosevica** with area of 60ha

Although subsystems are designed as independent system, they are based on the same principles and for same crops.

When setting up the network it is consider to achive best adaptation to the existing topographic conditions on the field in terms of reducing the structures along the pipelines. The existing road infrastructure is used wherever possible that would reduce the investment costs required for construction of access roads and land expropriation.

In the part of the Study with attachments there is a graphical representation of the network development, pipe layout and the zone they cover.

The network consists of main and distribution pipelines. Supplying the irrigation areas with water is provided by secondary network. Secondary network has no everywhere regular shape. It is also set to meet the defined distances between the pipelines and thus to achieve best adaptation to the specific topographical and infrastructural conditions.

The distance between the pipelines of the secondary network is 300 m which is defined as optimal in terms of conditions on the field.

Determined material of these pipelines is polyethylene for all diameters and zones with pressure to 16 bar. One of the reasons for the use of these pipelines is the large range of coverage of different diameters and their availability in the domestic market.

6.4.4.3 Main pipeline

The collected water from the intake structure through two main pipes is distributed to irrigation areas.

The length of the main pipelines varies for different alternatives.

For example, for Alternative 3, the length of GV1 which distributes water to Kosevichko field is 1230 meter while the length of GV2 which distributes water to Lukovichko field is 870 m.

Main pipelines are from polyethylene pipes with diameters of 280mm or 560mm.

In terms of total length of the network, the main pipelines take 9% of it.

In the section of the Study with annexes there are charts about both pipelines depending of the variant that is considered.

6.4.4.4 Distribution pipelines

Water from the main pipelines transits in the distribution pipelines.

Although distribution pipelines are just transit pipelines, in many cases they can be used for irrigation (installing hydrants) to ensure the most adequate and economical area coverage. This phenomenon is more prevalent in Kosevichko field.

For the two subsystems are anticipated 4 distribution pipelines with different label depending of its importance.

The total length of distribution pipelines is 5300 meters where 2720m cover Kosevichko field and 2580m cover Lukovichko field. Although Kosevichko field is far smaller, there is large percentage of distribution pipelines because they have large percentage of their own areas that directly distribute water although they are transit.

Distribution pipelines are projected to be from PE with diameters from 180 mm to 400 mm. These data are from the conducted hydraulic analysis.

In the section of the Study with annexes there is a chart for each alternative.

In terms of total length of the network, distribution pipelines represent 38%.

6.4.4.5 Tercial pipelines

Direct distribution to the irrigation area is provided by tercial pipelines. Total length of tercial pipelines is 7.350m.

Along all tercial networks there are different diameters that vary from 250mm to 180mm. Larger diameters are usuall for longer pipelines. On every 100m on the tercial pipelines are located hydrants with exception of the first one located at 50m from pipeline beginning. While designing the irrigation area, the main intention was to ensure efficiency of irrigation system.

Most of the tercial pipelines are with larger length, especially pipelines that are directly connected with the main pipeline, so it was necessary to devide pipeline to several zones with different flow, depending of size of matched area.

As already mentioned, distance between pipelines is 300m, with exception of those suited over hilly terrain when the distance is less then 300m.

Tercial pipelines take 53% of the total length of irrigation network.

Because there is also anticipated installation of hydrants on the tercial pipelines, it can be noticed high percent (71%) of pipelines with direct contribution to irrigation. Low percent of transit pipelines gives high grade of efficiency of irrigation network.

Structures of the irrigation network

Hydrants

Hydrants are located on such distances to enclose larger area as possible i.e. to enable irrigation with irrigation equipment and by furrow.

Hydrants are with portable band and all necessary fittings and corresponding flow capacity of 25 l/s and 15 l/s.

Along the network there are totally 150 hydrants.

Other typical and special structures:

Beside the hydrants, along the length of the pipelines there are other typical and special structures, such as:

- Control valves (at every joint)
- Air valves and outlets structures (on locations with horizontal and vertical refraction above up and down)
- Concrete blocks (On location where pipeline is changing its horizontal direction)
- Passage under ravine and river
- Road crossing structure (At some places where route of main pipelines as well as secondary or tercial pipelines is crossing different class of roads)

Unlike the hydrants, these structures are not analysed in detail and investment value is estimated as part of installation works.

6.4.4.6 Irrigation equipment

For the process of equipment selection are taken in consideration the pedologic soil characteristics, especially the wetting coefficient, the crops structure, land ownership, the existing infrastructure as roads, electricity transmittals, rivers, ravines, terrain slope etc.

The concepts of previously defined alternatives are designed to provide enough pressure for irrigation with sprinkle and drip irrigation.

Appliance of watering technique beside the presence of labour also requires investments in earth works.

The advantages of irrigation techniques with sprinklers and drip irrigation are:

- Water saving,
- There is no possibility of soil erosion,
- There is no over moistening of the soil because of the precise dozing of the water quantity for irrigation of the soil,
- There is possibility to fertilize soil trough sprinkler system etc.

Application of micro irrigation technique (such as micro sprinklers and “drop by drop” irrigation) has to combine with fertilization in order to achieve better results. It is recommended to apply this irrigation method wherever has certain available condition because of the exceptional results of crops yields, water saving, environment protection etc. According to the crop composition, micro irrigation is anticipated for 35% of arable areas where 10% are drip irrigation combined with fertilization and 25% micro sprinklers also with fertilization. Although irrigation with sprinkler has lost of water due to evaporation or effluence of water on slope terrain, it has to be selected for certain crops. It is anticipated for 65% of the arable areas.

In general it is not recommended purchase of large and expensive machines for irrigation, but mobile and self- floodplain wings. For larger size area it is recommended selection of typhon as suitable equipment type. When selecting sprinkling it must consider their compatibility with water permeability of the soil, to achieve best results.

The irrigation area is divided on small parcels, which has an impact to the process of the equipment selection. Crop types are also one of the criteria for equipment selection.

The slope of the irrigation parcels varies. The most common are areas with inclination of 0-10% (40% of the total area), while areas with inclination of 10-15% participate with 25% of the total area.

Land ownership, the terrain steep slope, the existing low range roads, rivers and ravines, lead to the proposal of a wide spectre of equipment like hydromatic, electrometric, corner system, typhoon, single wings, drip irrigation, hand move sprinkler sets etc.

The definition of the equipment for any particular part of the planned irrigation area has to be done in the further steps of the designs preparation and it has to be done after collection all information for the land ownership, analyse of the possibility for parcels grouping and crops uniform, estimation of the parcels slopes, soil quality investigation and calculated available pressure in the network at the any particular hydrant.

Table 6.3: Recommended irrigation techniques and their participation in project area

Crop	Type of irrigation
Wheat	Sprinkles, mobile floodplain wings, self- floodplain wings or typhon
Barley	Sprinkles, mobile floodplain wings, self- floodplain wings or typhon

Rye	Sprinkles, mobile floodplain wings, self- floodplain wings or typhon
Oats	Sprinkles, mobile floodplain wings, self floodplain wings or typhon
Maize	Sprinkles with raised sprays, typhons, drip irrigation or eventually furrow in exceptional cases
Potatoes	Sprinkles with raised sprays, typhons, drip irrigation or eventually furrow in exceptional cases
Tobacco	Sprinkles with raised sprays, typhons, drip irrigation or eventually furrow in exceptional cases
Tomatoes	Drip irrigation with fertilization
Peppers	Drip irrigation with fertilization
Fruits	Micro sprinklers with fertilization
Alfalfa	Sprinkles, mobile floodplain wings, self- floodplain wings or typhon

Generally, the irrigation equipment selection for this stage of the project is based on the criteria of the terrain slope and the planned crops, which includes a proposal for a most adequate way of irrigation, which comply with the crop needs and the crop coverage.

Typhons

Typhons are often applied mostly because of their good efficiency and reliability, low labour cost caused by fewer manoeuvres for changing a machine position than other irrigation technologies. Their automatic irrigation system has been manufactured to operate in the most difficult operational conditions.

Beside irrigation, they can be used for fertilization.

Typhon is the largest machine recommended in this Study. Two types of anticipated typhons are: typhon of medium type and mini type.

Typhons are applied in the zones with terrain slope less than 10%.

Zones with such slopes are usually zones with highest pressure (over 5bars) which is condition for proper function of rain guns.

Solid set systems

These systems are able to function with low pressure (3 bars), they can be easily adapted to terrain conditions because of its flexibility which makes them very suitable for hilly terrain, do not require any special stuff training and have low investment costs.

Spray lines

Spray lines are presented on a small portion of the total area. This type of equipment has certain advantages such as shorter period for its interchange, large daily irrigation efficiency, less damages due to crop override, and required less manpower for manipulation.

Disadvantages of this type of equipment are that it is not adjustable to different shape of terrain as hilly one; it requires higher working pressure, which limits its application on plain irrigation area with high pressure.

Drip irrigation

Irrigation type “drop by drop” (drip irrigation) and micro raining considering proposed composition of crops, has larger potential for applied percentage of total area. But because of the relatively high investment cost it is proposed to cover average 35 % of dry feed crops irrigation area.

This irrigation type is proposed for zones with low working pressure (due to ability of irrigation system to achieve maximal efficiency even if pressure is very low from 0.5 bars to one bar) and for zones with unfavourable terrain topography.

This irrigation type has uniform water discharge under different pressures up to 3%,

There is table with anticipated type of irrigation equipment according to the necessary type of irrigation for specific crop composition.

Table 6.4: Anticipated irrigation equipment

General data	**Kosevicko and Lukovicko field**
Total area (ha)	310
Percentage of sprinklers	65%
Percent of micro sprinklers and drip irrigation	35%
Percentual representation of the equipment on the total area	
TYPHONS large and medium (75, 80, 90)	33%
Solid Set Systems	5%
Spray Lines (ВК10)	42%
Micro sprinklers and drip irrigation (ha)	35%
Total	100%
Anticipated equipment (com & ha)	
TYPHONS mini (75мм)	3
Solid Set Systems	4
Spray Lines (БК10)	1
Micro sprinklers and drip irrigation (ha)	110

6.5 ASSESSMENT FOR THE INVESTMENT COSTS

The bill of quantities and calculations include all hydro-technical structures, such as: dams, pumping stations, distribution pipelines, intake structures, irrigation networks, irrigation equipment and other smaller hydro-technical structures.

The level of processing of individual hydro-technical structure is different and it depends on the importance and investment value. Calculated value for different version is prepared for later stages of this study, more exactly in ***financial and economic part and the phase of deciding the most favourable choice of solution variant***.

Based on previous experience of designing similar projects and technical documentation, there have been made analysis with different degree of development, some of the positions are discussed in more detail and some are taken orientation or as a percentage of the detailed ones(i.e. positions that make up the principal of the accounting value of object).

Prices are according to the current market conditions and compared by several bidders, while quantities are designated and linked by computer which prevents random error by typing of entry and data processing.

The determination of the accounted values of all previously described variant solutions was carried out with equal conditions and unit prices.

In the section with annexes are given tables with full bill of quantities for all three variant solutions with detailed descriptions of positions, quantities and prices, organized by type of work and tables with recapitulation.

6.5.1 Investment costs for Lukovica Dam

Lukovichka dam is analyzed on detailed digitized maps. Analogous to the alternative three, which should define the optimal height of the dam, investment analysis are made for several different heights of the dam.

The bill of quantities for earth masses, are derived from longitudinal sections at a distance of 5 (10)m.

In addition is the graph for the investment value of Lukovichka Dam with heightening step of 5m with expected range of optimum height of the dam according to the useful volume.

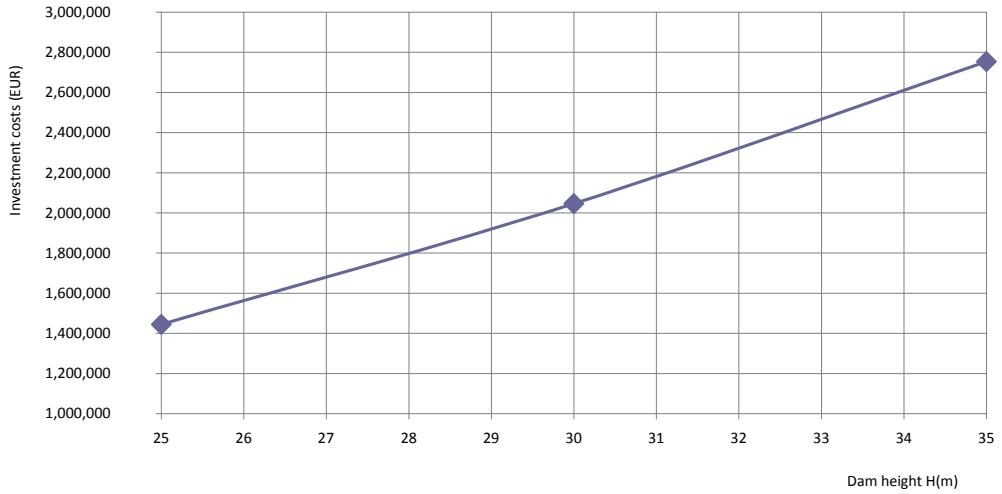


Chart 6.5. Investment costs for Lukovica Dam

For the anticipated dam height (by the balance analysis), below is the cost overview of earth works and components of hydraulic scheme:

Table 6.5: Overview table for Lukovicka Dam with 28m height

	Description	Investment (EUR)
1	Dam	1,288,968
2	Spillway, chute and flip bucket	298,762
3	Diversion tunnel (bottom outlet)	204,841
4	Contingencies (15%)	268,886
	Total	**2,061,456**

6.5.2 Investment cost for Kosevica Dam

Kosevica dam is only analyzed in Alternative 2 where physical characteristic are predefined by the Study for water potential exploitation of rivers in Makedonska Kamenica, 1990.

Longitudinal section on distance of 5 (10) m are given for dam height of 26 m with predefined characteristic section and bill of quantities of earth works.

Table 6.6: Overview table for Kosevichka dam with height of 26m

	Description	Investment (EUR)
1	Dam	1,424,728
2	Spillway, chute and flip bucket	326,344
3	Diversion tunnel (bottom outlet)	206,992
4	Contingencies (15%)	293,710
	Total	**2,251,773**

6.5.3 Investment costs for Pump station

As previously described in the technical part, Alternative 1 is based on construction of borenhole area and pump station near accumulation Kalimanci.

Investment cost for the pump station is determined by detailed bills and it costs 359,050 EUR.

Table 6.7: Overview table for pump station

	Description	Investment (EUR)
1	Investigation works	5,353
2	Construction of 8 borenholes	86,205
3	Constriction of manholes with pumps	165,877
4	Control post	1,619
5	Electrical part, monitoring and management equipment, SCADA	100,000
	Total	**359,054**

6.5.4 Investment costs for irrigation system and equipment

Irrigation system is divided into several characteristically parts: Irrigation network (primary, secondary and tercial), network structures (typical and special) and irrigation network.

Complete bill of quantities are in the section with annexes.

Table 6.8: Overview table for irrigation system and equipment

Description- Irrigation system	**Investment (EUR)**
Expropriation	15,986 €
Geodetic works	4,567 €
Earth works	245,456 €
Montage works	519,454 €
Hydrants	127,044 €
Typical and special structures	42,927 €
Total	955,435 €
Planning, designing, engineering	114,652 €
Contingencies (10%)	95,544 €
Total	**1,165,631 €**
By ha	**3,760 €**
By m'	**83 €**

Description- Irrigation equipment	**Investment (EUR)**
Irrigation equipment with sprinklers	45,002 €
Irrigation equipment with micro sprinklers	59,699 €
Irrigation equipment for drip irrigation	123,200 €
Total	**227,901 €**
By ha	**12 €**

Other structures (booster pumps, break chambers, intake structures, etc.) are part of bills of quantities of larger facilities and are in the section with annexes.

Below is a chart of review for alternatives that contain the basic initial and specific investment per hectare irrigated area and per capita of the project area.

Table 6.9: Overview table of Investment cost for the Alternatives

Alternative	**Investment (EUR)**	**Investment per hectare**	**Investment per capita**
Alternatives 1	1.864.261	6,014	1.02
Alternatives 2	5.722.695	18,460	3.13
Alternatives 3	3.784.162	12,207	2.07

The general conclusion is that obtained investments in general correspond to the previous practise for similar type of objects here and abroad.

7. BALANCE ANALYSE

7.1 GENERAL

Modified hydrological series and modified water demands for water supply of population, industry and irrigation in the project area, impose the need of detailed analysis for construction of small accumulation to satisfy water demands.

To meet the water requirements of different beneficiaries in the project area, several variants are considered:

- Meeting water demands of different beneficiaries with water pumping from existing accumulation Kalimanci. This solution provides construction of borenhole area near the accumulation and pump station that would distribute water to different beneficiaries.

- Meeting the water demands of different beneficiaries by building two small accumulations along Kosevichka/Lukovichka river. In the upper flow the accumulation of the river Kosevicha has less volume and is anticipated to meet water supply demands of Kosevica and irrigation for ~ 60ha in the area of village Kosevica. Accumulation Lukovica should meet the rest water supply demands of settlements Makedonska Kamenica, Lukovica, Todorovci and the industry. It should provide water for irrigation of ~ 250 ha arable land in Lukovichko field. Due to the relatively small volume of this accumulation, it is necessary to develop a system of detailed management of water resources and accumulation area. This decision has been taken from the current study for water potential exploitation of rivers in the municipality of Kamenica, which defines physical characteristics of the system.

- The third alternative anticipates construction of only one accumulation on Lukovichka River, with some greater height, in order to respond to the needs of future beneficiaries. This alternative anticipates construction of a small intake over village Kosevica, which would collect the required quantity of water for the population of village Kosevica.

In addition, detailed balance analysis is conducted only for the third alternative, in order to define the parameters (height of the dam and accumulation volume) that will fully meet the requirements of future beneficiaries with required probability.

Because physical parameters of the systems for the other two alternatives are predefined, they will be examined in balance analysis represented with special models.

As previously mentioned, basic purpose of the small accumulation of Lukovica should satisfy water demands to the beneficiaries where the priority is water supply to the population, industry and irrigation of arable land.

There are completely new analyses for construction of small accumulation Lukovica to satisfy water demands of different beneficiaries, but with effect of meteorological and hydrological values and sequences for users water demands which contain the expected impact of climate change.

In the balance analysis are created two models which simulate the behaviour of the accumulation Lukovica. The first model refers to the historical data that are used to determine basic parameters of the reservoir, while with the second model is performed checking of the behaviour of accumulation Lukovica in terms of climate changes. Based on the output of the models, there have been made conclusions about the behaviour of the accumulation in terms of different scenarios and future recommendations for accumulation management following the positive practices of different scenarios.

Balance analysis for specific time period is obtained by the following order and principles:

- Input data definition (metrological, hydrological, topographic, water demand for different beneficiaries etc.)
- Balance models definition
- Definition of boundary conditions of probability for requested appearance (water supply, irrigation) and mathematical definition
- Control of the water supply probability for different beneficiaries of the system
- Control the sensitivity of the required appearance probability as function of climate change
- Presentation of typical results of the analysis with their own reference and summarization of conclusions.

7.2 INPUT DATA

Input data into balance models of Lukovica accumulation (or the two accumulations according to the second alternative) are topographic features of accumulations, hydrological data for inflows in the accumulation, water supply requirements for the industry and population, metrological data necessary for determining the evaporation of accumulation, biological minimum (as an exit of accumulation for both periods) and others.

7.2.1 Hydrological data

According to the input hydrological data which are comprised with the future accumulations, primary is respected the principle of satisfying the requirements of biological minimum and then water demands for water supply of population which has not been taken by the system. The remaining leads are brought into the accumulation.

Hydrological values for river Lukovica/Kosevica are processed in two distinctive profiles for the area of future possible accumulations.

Average annual flow profile for dam Kosevica is 95 lit/sec, while annual flow profile for dam Lukovica is estimated at 125 lit / sec.

The influence of climate change can be expected to reduce the flow for almost 10%, and for the Dam Lukovica can be expected to reduce average annual flow on 115lit/sec.

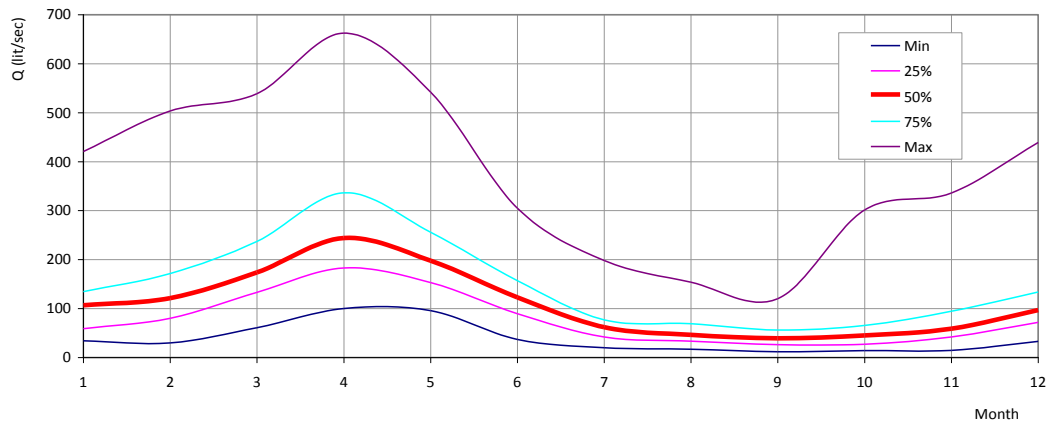


Chart 7.1. Inflow in accumulation Lukovica for the period of 1961 – 2005

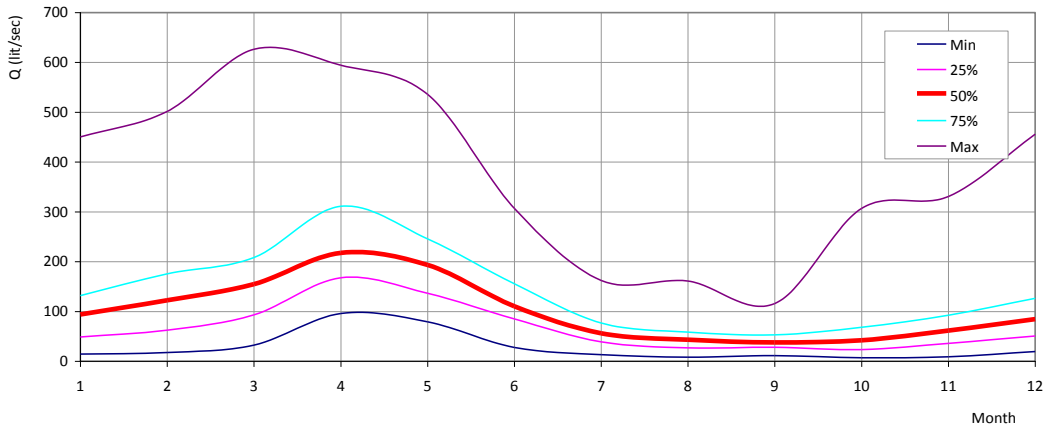


Chart 7.2. Anticipated inflows in accumulation Lukovica for the period of 2006- 2050

7.2.2 Irrigation water demands

The determination of irrigation water demands for hydro ameliorative system Lukovica is conducted for a period of 45 years, with discrete representation of one day.

Water demands determined by reference evapotranspiration are calculated with the modified method of Penman - Monteith.

About HIS Lukovica besides determining the irrigation water demands with historical data, they are also calculated with synthetic data series which include the possible climate changes till 2050 according to the average scenario.

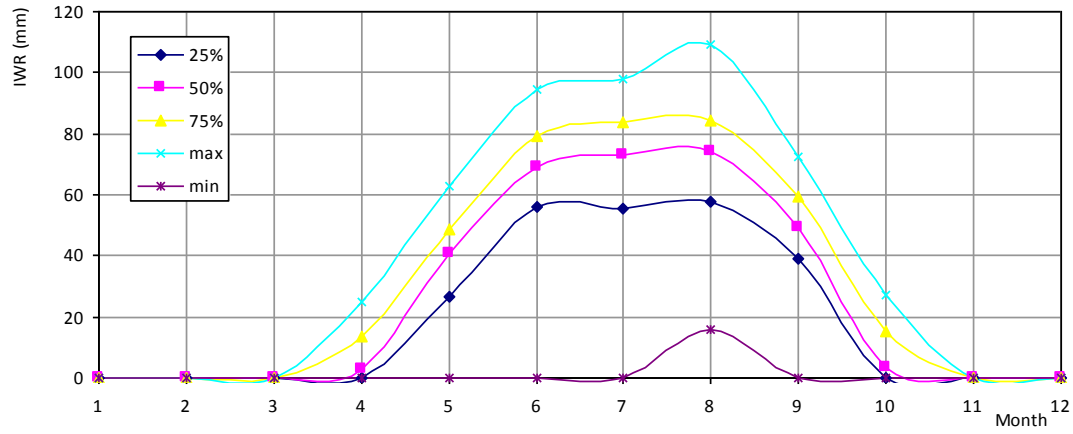


Chart 7.3. Irrigation water demands for the period of 1961 – 2005

7.2.3 Water supply demands for population and industry

The detailed analysis of water supply demands for population and industry is conducted and presented on the beginning of the Study.

End users that would use the benefits of the accumulation are:

- Water supply for the population in Makedonska Kamenica only in summer period to replenish the existing system. Water supply is going to accomplish with predefined pattern which is also approved by this documentation user

- Complete water supply on some settlements along the river Lukovichka/ Kosevichka
- Water supply for the power thermal station and future industrial zone near by Makedonska Kamenica.

Table 7.1. Water Supply coefficients of monthly distribution for the two specific periods

Month	Water supply for M. Kamenica	Water supply for the population and industry
January	0%	100%
February	0%	100%
March	0%	100%
April	0%	100%
May	0%	100%
June	20%	100%
July	35%	100%
August	45%	100%
September	35%	100%
October	20%	100%
November	0%	100%
December	0%	100

Table 7.2. Annual water supply demands for the population and industry

User	M. Kamenica (10^3 m^3)	Settlements (10^3 m^3)	Industry ($10^3 m^3$)
Population	92.0	84.0	30

7.2.4 Evaporation from the accumulation

Additional loss from the accumulations is evaporation from free water surface. The evaporation was calculated upon Mayer recommendation which use the method of mass transfer (Applied Hydrology) and as function from the size of water surface during time.

To calculate the evaporation, input parameters in the model are the data from the meteorological stations in Delcevo.

Table 7.3. Historical monthly values for evaporation for MS Delcevo

1961-2005	
Month	C (m^3/m^2/month)
January	0.0174
February	0.0211
March	0.0320
April	0.0590
May	0.0746
June	0.0950
July	0.1272
August	0.1158
September	0.0793
October	0.0445
November	0.0257
December	0.0182

7.2.5 Biological minimum

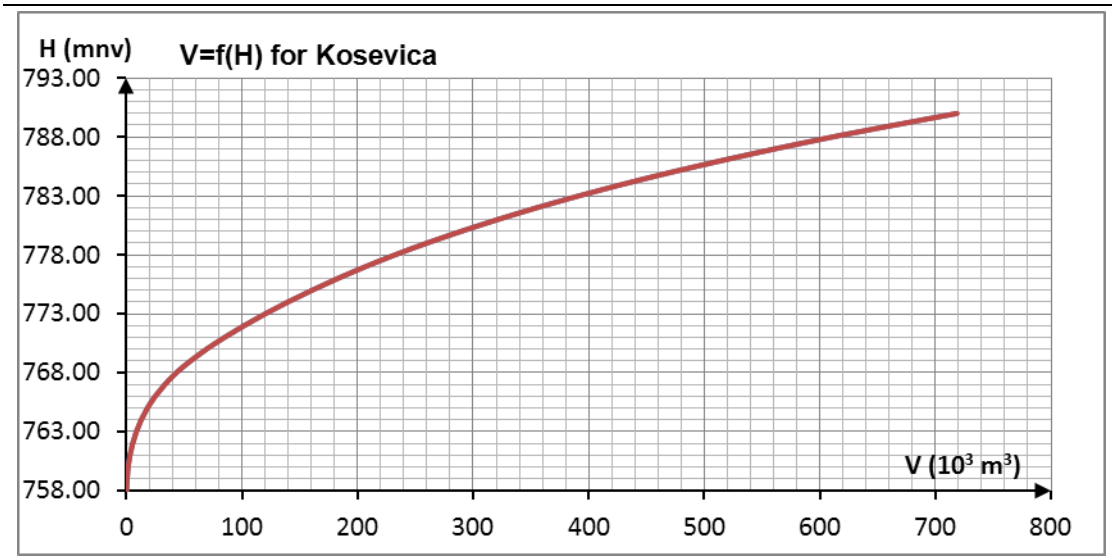
The ecologically guaranteed flow (biological minimum) in the balance model has been taken as 10% from the multi annual average flow of the considered rivers.

Table 7.4. Biological minimum of river Lukovica for the profiles of the dams

Profile	Q bio.min (lit/sec)
Kosevica	9.5
Lukovica	12.5

7.2.6 Topograhical features

Topographic features of the accumulations expressed through the curve of volumes and the curve of free water surface, are obtained by existing topographic maps (scale 1:2500) and existing documentation. For the purposes of balance analysis, the curves are mathematically described by several multilevel polynomials.



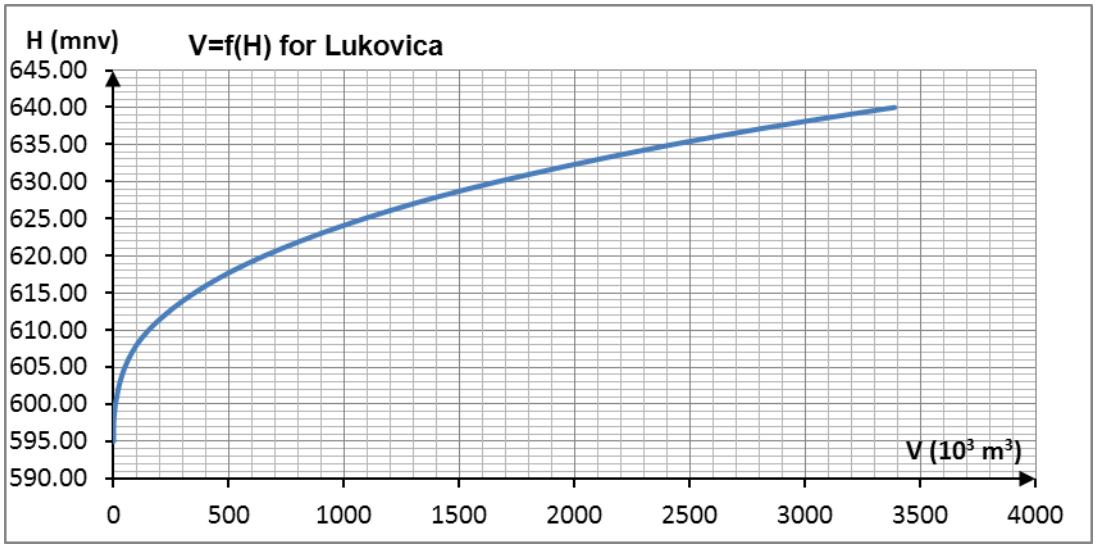


Chart 7.4. Curve of volumes and water surface of Kosevica and Lukovica accumulations

Table 7.5. Basic characteristics of the accumulations according to Alternative 2 (Study for water potential exploitation of the rivers in municipality of Kamenica)

	KOSEVICA		LUKOVICA		
Index	Altitude	Volume	Altitude	Volume	characteristics
	masl	$10^6 m^3$	masl	$10^6 m^3$	/
Zrk	758	0.00	595	0. 00	River basin
Zmin	770	0.100	608	0.100	Dead / Minimal
Znor	780	0.300	616	0.420	Usefull / Normal
Zmax	782		618		Maximal
Zcrest	784		620		Crest

7.3 ALGORITHM FOR THE SIMULATION BALANCE MODEL FOR MANAGEMENT AND DIMENSIONING OF THE FUTURE ACCUMULATIONS

The balance model is developed with time step of one month, according to the same purpose and type of input values.

According to the hydrological input values, it was earlier mentioned about the method and the intake of water from the river into accumulations. First, are the requirements of biological minimum, then water supply demands of local settlements and then remaining water is brought into the accumulation.

For the predefined demands that should be meet by the accumulation is determined a criteria and the order of their satisfaction.

The first step is to meet the demands of the biological minimum, second to meet water supply demands of the population and industry and eventually to meet the irrigation demands of the arable land.

Beside these criteria, because of the importance of water supply, there is also introduced a criterion which after the conducted balance, if in the current month there is not enough water in accumulation to meet water supply demands for next three months, irrigation is stopped for the reviewed month. The same criterion is performed at each month subsequently.

This significantly increases the reliability and probability in terms of water supply of town Makedonska Kamenica and several towns with potable water.

As criteria for completely fulfilment of water supply for future customers, to meet water demand with previously defined priorities, following limited (minimum allowed) probabilities are anticipated:

- 100 % обезбеденост на биолошкиот минимум
- 98% monthly and 95% annual probability of water supply for the population and industry
- 95% monthly and 80% annual probability of irrigation.



Xrs – Inflow in the accumulation from river Lukovica

Yev – Evaporation from water surface of the accumulation

Ye – Ecologically quarantined flow

Yi – Discharge from the accumulation for irrigation

Yw – Discharge from the accumulation for water supply and industry

Yhpp – Energy utilization of overflow water from the accumulation

Chart 7.5. Input and output data representation of accumulation Lukovica

The algorithm for balance models consist of several modules, including:

- Module for available resources (useful area of the accumulation)
- Module which simulates the discharge from the accumulation depending on the available water and the anticipated management policy
- Module that is perceived response of the accumulation
- Module for allocation of discharged water from the accumulation
- Module for calculation of generated hydroelectricity, but only by overflow water

7.4 RESULTS FROM THE CONDUCTED ANALYSIS

Balance analysis of Alternative 1 are not conducted, because it is anticipated as a source to use the borenhole area near accumulation Kalimanci which characteristics are determined based on optimal analysis with included hydro geological conditions of the area.

As pointed out earlier, balance models are conducted to examine the physical parameters of future accumulations (Kosevica and Lukovica) according ALTERNATIVE 2.

Special balance model is developed for Alternative 3, which has to define the necessary parameters and characteristics of accumulation Lukovica, to meet the requirements of all water beneficiaries. This Balance model is supplemented with a module that simulates the influence of climate changes to water supply probability.

7.4.1 Alternative 2

Analyses show that almost entire period, accumulation Kosevica is completely full with substantial overflown water. Unlike Kosevica, accumulation Lukovica, which serves the majority of users is often at minimal level and has relatively low potable water supply probability and irrigation probability.

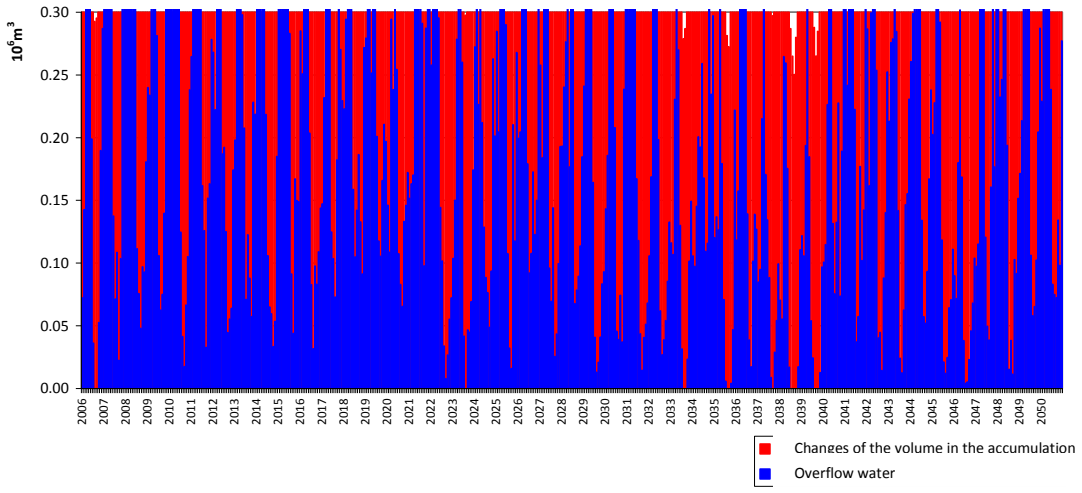


Chart 7.6. Changes of the volume and overflows of accumulation Kosevica

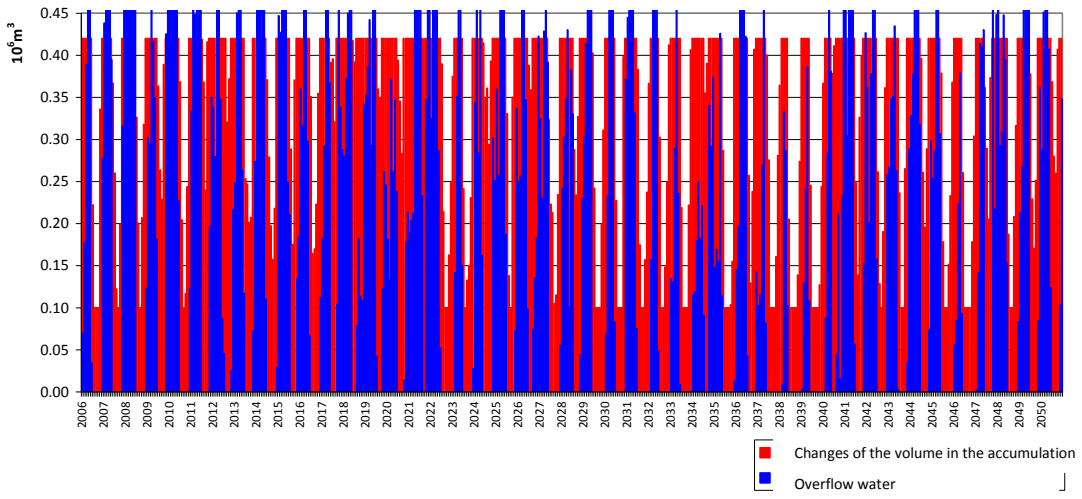


Chart 7.7. Changes of the volume and overflows of accumulation Lukovica

However, we consider that this phenomenon in real terms will not be so expressed. These analyses were conducted with a time step of a month. If management policies are examined with a smaller time step (e.g. one day), it will express the coupling action of the two cascade accumulations (their work as one system), variations of the volumes would be more equal and water supply and irrigation probability would be higher.

7.4.2 Alternative 3

The ultimate purpose of the balance analysis for this alternative is to define the height of the future dam (Lukovica) and to determine useful volume which will enable meeting the water demands for different beneficiaries with predefined minimal levels of probability.

With optimal analysis is determined that the accumulation (dam) that meets the required condition, should have the following physical characteristics:

Table 7.6. Basic characteristics of the dam and accumulation Lukovica

Index	Altitude	Height	Volume	Characteristics
	masl	м	106m3	/
Z_{rk}	595.0	0.0	0.000	River basin
Z_{min}	608.0	13.0	0.100	Dead / Minimal
Z_{nor}	619.5	24.5	0.620	Useful / Normal
Z_{max}	621.0	26.0	0.720	Maximal
Z_{crest}	623.0	28.0		Crest

The elevation of minimal level is based on the analysis of the total amount of sediment that is expected to be generated over the accumulation exploitation.

The elevation of maximal level is determined on the basis of predefined flooding water with a different return period and anticipated length of the spillway.

After processing the results of calculations that were carried out with balance model of Alternative 3, these conclusions can be noted:

Results that were obtain by statistical processing of the output of balance models in terms of change in volume during the considered period and by the end water supply demands and water demands for irrigation, are used to construct diagrams of overall probability and characteristic monthly probability appearance of volumes in the accumulation.

It can be noticed relatively common probability of the accumulation. In more than 50% of cases, the accumulation probability is up to normal levels.

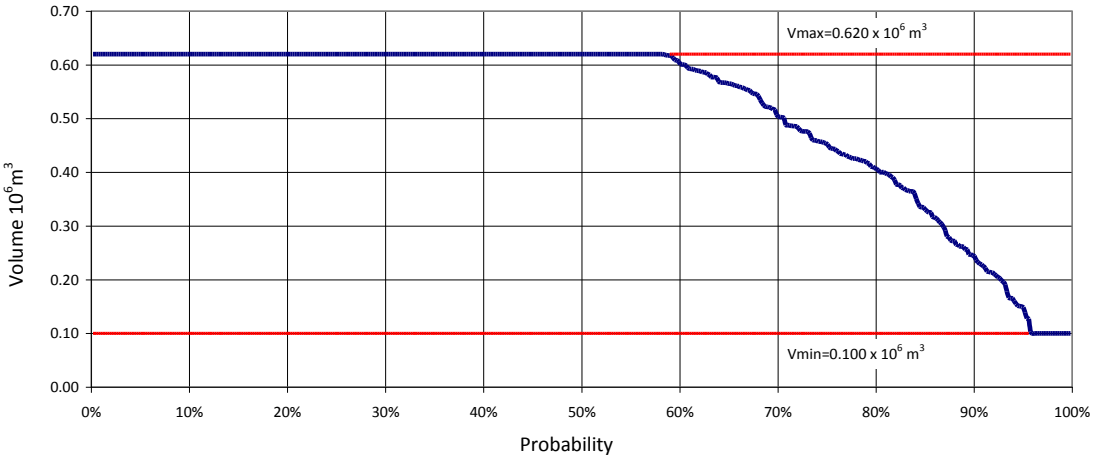


Chart 7.8. Total probability appearance of volumes in the accumulation Lukovica (Alternative 3)

Although strict, selected criteria for probability is on favour of safetly supplyment with anticipated quantities of water for the users (water supply and irrigation)

As before, it can be noticed from the diagram that relatively frequent fulfilment of the reservoir can be expected in summer months even at least considered probability.

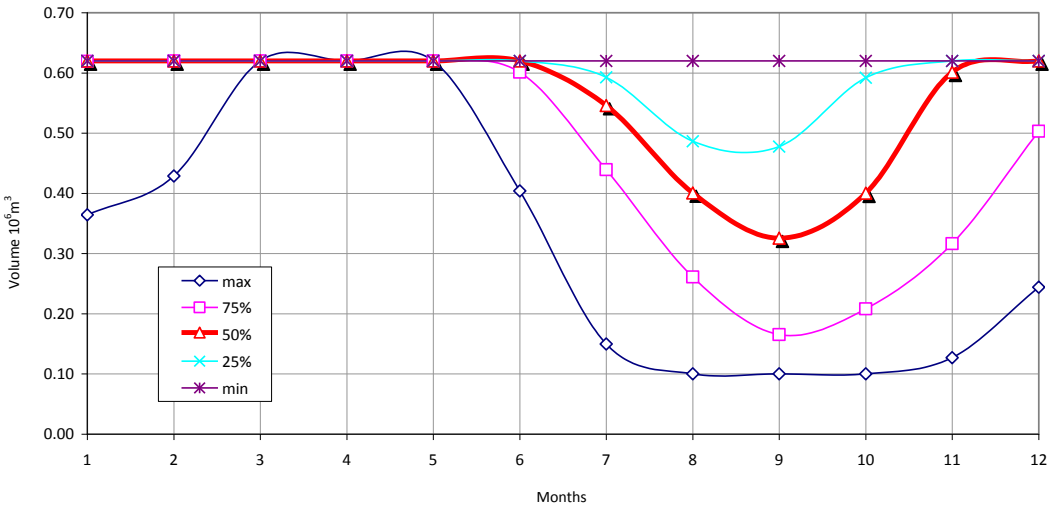


Chart 7.9. Characteristic monthly probability appearance of volumes in the accumulation Lukovica (Alternative 3)

It is a result of the completely different monthly flow distribution and water demands of one side and the volume of accumulation on other side.

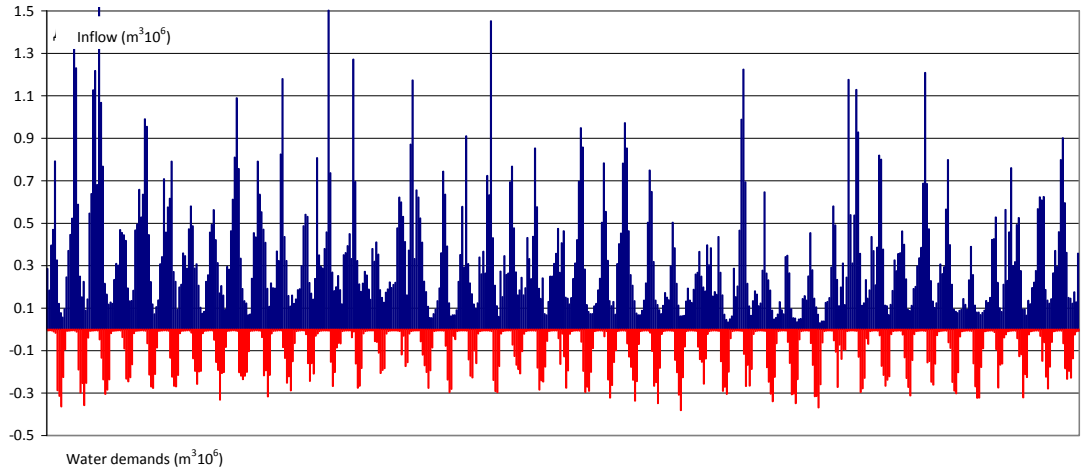


Chart 7.10. Inflows in the accumulation and water demands of the users (Alternative 3)

The obtained probabilities, which are relatively close and high, are result of strict criteria set in terms of meeting the water demands, but also because of the relatively small volume of the accumulation in terms of the hydrological capacity of river. Because of this when designing irrigation system it should be left a certain reserve, which on the other hand is expected to occur due to topographic conditions in the region.

There are also analyses for overflown water. Overflows are common, as a result of the small volume of the accumulation. The average monthly overflown quantities for the considered period of 45 years is about 0.1 m^3/sec. Overflows are most common in the spring months, which completely stop after watering intensification.

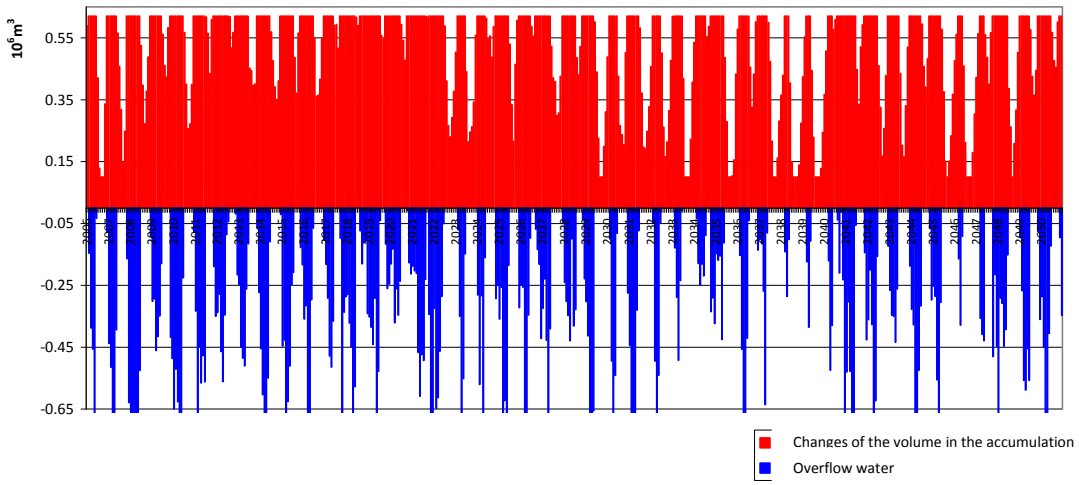


Chart 7.11. Changes of the volume and overflows of accumulation Lukovica (Alternative 3)

7.5 IMPACT OF EVENTUAL CLIMATE CHANGES

The basic parameters of future accumulation Lukovica are determined based on ever emerging weather, climate and hydrological values, with general assumption for their recurrence in future.

Complete uncertainty is how in future climate will change and how hydro ameliorative systems will act on these changes. This Study provides answers of these questions by implementing and analyzing the various scenarios that involve alternative climate scenarios.

Slightly different impression is obtained when in the analysis are entered input data that contain possible climate change. As mentioned earlier, all input data needed for Balance analysis are defined for two distinctive time periods: historical and presumed with incorporated climate change.

Comparing the two specific periods, analysis indicate to possible reduction potential in presumed hydrological period for ~ 10%.

In the next period because of the impact of climate changes is expected significantly incensement of water demands for different beneficiaries. It can be expected increasing of irrigation water demands for ~ 9%.

To simulate the impact of possible climate change, which would allow comparative analysis, are conducted same calculations for historical period and for assumed period (2006-2050).

It can be noticed reduction of irrigation probability for maximum surface coverage (F = 310ha). The probability in terms of historical period is reduced to ~ 80%.

Although there is some probability reduction, it is actually within the set criteria for minimum probability appearance.

This emphasise the conclusion that the impact of possible climate change will be insignificant, that will not require additional structural or unstructured measures as response of hydro ameliorative system in future.

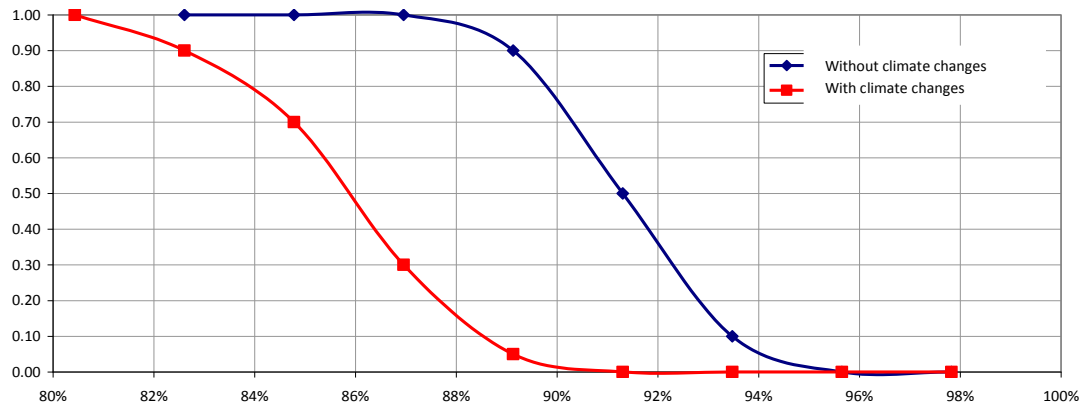


Chart 7.12. The impact of climate changes to irrigation probability (Alternative 3)

8. COST-BENEFIT ANALYSIS

8.1 FINANCIAL COST-BENEFIT ANALYSIS

8.1.1 Aims and methodology

The financial analysis generally has two aims:

- To assess the feasibility of the project from financial aspect (financial costs against the incomes), but looking from the point of view of the project providers;
- To assess the solvency of the local community (end-users) in the project region for financing of the investment and acceptance of the anticipated market prices (fees) of the final products i.e. to assess the financial sustainability of the project.

These aspects are especially important if we take into consideration that the project for construction of mini-accumulation on Kosevicka River and irrigation system for irrigation of agricultural areas shall provide provision of new public utility service for the community in the municipality Makedonska Kamenica.

8.1.2 Assumptions and approach

The period which is subject to analysis covers 25 years where the investment (construction of the system: dam/accumulation with all appurtenance, irrigation system and hydro electrical facility) is in the first and the second year of the discussed period, while the incomes realized on the basis of the benefits from the project shall occur upon the third year onward. All incomes and costs are estimated according to the current prices in year 2010. All calculations in this heading are expressed in Euros. Also, the estimation is VAT exclusive.

The feasibility from financial aspect of the analyzed project is estimated on basis of two criteria for bringing decisions which are as follows:

- Financial net current value (NCV), and
- Financial internal rate of return (IRR).

The used discount rate in the analysis amounts to 5%. All expenses connected to the project which were incurred in the past shall be deemed non-refundable costs and thus they are not taken into consideration in this analysis. However, the residual values of the assets (fixed assets) with useful life longer than the analysed period have been taken into account.

8.1.3 Analyzed alternatives

In order to meet the needs of water for different beneficiaries in the project area the following Alternatives have been discussed and analyzed:

- Meeting of the needs of water for different beneficiaries with water pumping from the existing accumulation Kalimanci. This solution foresees construction of water wells in the close proximity of the accumulation and pumping station which shall distribute the water to different beneficiaries.
- Meeting of the needs of water for different beneficiaries with construction of two small accumulations along the river flow of the river Kosevicka/Lukovicka. This solution is taken over from the existing study for exploitation of the water potential of the rivers in the municipality Kamenica where the physical features of the system are defined.
- The third alternative foresees construction of one accumulation on the river Lukovicka with height of 28 m (volume of $620x10^3m^3$), so it would suit the needs of all future beneficiaries. Alternative solution foresees construction of a small weir above the

village Kosevica which shall allow water to pool in sufficient quantities for water supplying of the population from the village Kosevica.

8.1.4 Project costs

The analysis takes into consideration the following categories of costs for each discusses Alternative separately: (1) investment costs; (2) operational and maintenance costs; (3) replacement costs and (4) other costs. Hereinafter there is specific review of each of these categories, as follows:

Investment costs:

The investment (capital) costs are classified in few more significant components which as a whole contain all of the essential expenses for construction of mini-accumulation (Alternative 2 and 3) or pumping station (Alternative 1) and the irrigation system. The components of the investment are the following: (1) expropriation of the land; (2) construction of a dam (civil engineering works and equipment); (3) construction of a pumping station (Alternative 1); (4) construction of an irrigation system; (5) construction of appurtenance and assembly of the equipment for mini hydro electrical power station; and (6) turnover capital.

Overview of the investment costs per components and per total needs of investments for each Alternative separately is presented in the Table 8.1. and 8.2; detailed information for the investment are provided in the Annexes 28-30.1.

Table 8.1: Summary of investment costs per components and alternatives

Position		Alternative 1	Alternative 2	Alternative 3
Land Expropriation	€	100,000	225,000	187,500
Dam Construction	€			
Civil works	€		3,794,768	1,999,612
Equipment	€		117.364	61,844
Small Hydro Power Plant (150kW)	€		180.000	90,000
Small Pump Station (Intake Structure)	€			40,000
Pump Station	€			
Civil works	€	113,082		
El.Equipment	€	100,000		
Objects & Equipment	€	145,972		
Irrigational System	€			
Civil works	€	324,532	324,532	324,532
Piping	€	633,734	633,734	633,734
Objects & Pipe Structures	€	207,365	207,365	207,365
Irrigation Equipment	€	227,901	227,901	227,901
Working Capital Requirements	€	11,675	12,032	11,675
TOTAL	**€**	**1,864,261**	**5,722,695**	**3,784,162**

Table 8.2: Investment costs per components and alternatives

Position		Alternative 1	%	Alternative 2	%	Alternative 3	%
Land Expropriation	€	100,000	5.4	225,000	3.9	187,500	5.0
Dam Construction	€	0	0.0	4,092,131	71.5	2,191,456	57.9
Pump Station	€	359,054	19.3	0,0	0.0	0,0	0.0
Irrigational System	€	1,393,532	74.7	1,393,532	24.4	1,393,532	36.8
Working Capital Requirements	€	11,675	0.6	12,032	0.2	11,675	0.3
TOTAL	**€**	**1,864,261**	**100.0**	**5,722,695**	**100.0**	**3,784,162**	**100.0**

Investment costs:

The investment (capital) costs are classified in few more significant components which as a whole contain all of the essential expenses for construction of mini-accumulation (Alternative 2 and 3) or pumping station (Alternative 1) and the irrigation system. The components of the investment are the following: (1) expropriation of the land; (2) construction of a dam (civil engineering works and equipment); (3) construction of a pumping station (Alternative 1); (4) construction of an irrigation system; (5) construction of appurtenance and assembly of the equipment for mini hydro electrical power station; and (6) turnover capital.

Overview of the investment costs per components and per total needs of investments for each Alternative separately is presented in the Table 8.1. and 8.2; detailed information for the investment are provided in the Annexes 28-30.1.

Table 8.3: Average annual operational and maintenance costs

Position		Alternative 1	%	Alternative 2	%	Alternative 3	%
Labour	€	75,276	40.9	80,442	59.1	75,276	62.2
Maintance costs	€	36,102	19.6	46,691	34.3	36,738	30.4
Dam (0.5% of invest.)	€	0		20,461		10,957	
Small hydro power plant (0.5% of inv.)	€	0		900		450	
Irrigational System (1% of inv.)	€	11,656		11,656		11,656	
Equipment (6% of inv.)	€	13,674		13,674		13,674	
Pump Station (3% of	€	10,772		0		0	
Running costs	€	72,755	39.5	8,947	6.6	8,947	7.4
Energy consumption for pumping	€	72,755		8,947		8,947	
TOTAL	**€**	**184,133**	**100.0**	**136,080**	**100.0**	**120,961**	**100.0**

Table 8.4 Hereinafter contains information for the needed number of staff for securing continuous operation and maintenance of the entire system.

Table 8.4: Required number of stuff

Position	Number
General Manager	1
Technical Director and Supplies	1
Administration	1
Mechanical/Civil Engineer	2
Operative workers	6

Replacement costs:

The replacement costs refer to needed reinvestments in equipment and construction works which are to be realized during the life cycle of the analyzed project. As a result of the different periods of depreciation, different items of the equipment and construction objects shall be replaced in different time periods and with different frequency.

Table 8.5 shows the planned costs for replacement for the project per the discussed Alternatives and in dependence on the technical solution and the foreseen equipment. Generally, during the discussed 25 –year period of exploitation it is anticipated that there is one-time replacement of the entire equipment of the dam, Hydro electrical facility, buildings and the irrigation equipment, as well as replacement of the equipment for the pumping station (Alternative 1) twice.

Table 8.5: Replacement costs

Replacement costs		Alt. 1	Alt. 2	Alt. 3
Dam equipment	€	0	117,364	61,844
SHHP equipment	€	0	72,000	36,000
Pump station equipment	€	145,972	0	0
Irr. Equipment and structures	€	207,365	207,365	207,365
Irr. equipment	€	227,901	227,901	227,901
TOTAL	**€**	**581,237**	**624,629**	**533,109**

Electricity:

The biggest part of the costs in Alternative 1 fall on the electricity for pumping of the requested water quantity to the future beneficiaries.

In the analysis the price of the electricity is calculated pursuant the pricelist of the supplier for industrial consumers (two-tariff system), but with projected increase of the price of the electricity up to the European average until 2019. After this period, the price of the electricity is almost fixed i.e. it follows the European rise which is relatively low and amounts to 0.025%.

Other costs:

The remaining types of project costs which are taken into consideration in the analysis include: costs for institution establishing (foundation of new organizations necessary for systems operation and maintenance), campaign for raising of public awareness of the population for the importance of the project/investment and the imperative of payment of the fees for usage of water for irrigation from the system as well as water securing.

Overview of these costs for the analyzed Alternative 3 (as an example) is presented in Table 8.6.

Table 8.6: Other costs (Alternative 3)

Other costs/Year		1	2	3
Institutional setup and mngt.	€	30,000	20,000	10,000
Awareness raising campaign	€	30,000	20,000	10,000
Insurance	€		2,746	2,746

Considering the importance and the dynamics of exploitation, the costs for institutional organization and campaign for raising of the public awareness are projected to have maximum value in the fist year from the discussed period and subsequently they are to decrease and from the third year onward the costs for the institutional organization are with fixed value (10,000 €/year), while the costs for public campaign are anticipated to last till the sixth year of the life cycle of the project.

8.1.5 Incomes

There are few types of incomes related to the analyzed project, i.e. construction of mini-accumulation on the river Kosevicka and the irrigation system such as: (1) incomes from the service (payment of fees for the supplied water for irrigation and water supplying) and (2) incomes from the production of electricity (mini hydroelectric power station for Alternative 2 and 3).

Generally, when planning public infrastructural development projects the incomes should be balanced in order to provide to the services provider (system operator) entire coverage of the capital (investment) costs and operational and maintenance costs during the entire useful age of the project. Still, the experience had shown that in developing countries the incomes generated from public utility services such as irrigation water supply (agricultural production) and population water supplying are often not sufficiently large so that they can provide independently the entire profitability and sustainability of the systems so there is a need of certain type of endowment and/or co-financing by general public (budget) incomes.

Incomes from services – irrigation and water supplying:

The projected incomes from supplying of irrigation water for the agricultural areas and population water supplying are estimated on the basis of the assumed annual quantity of supplied water to the end-users and the adopted values of fees for provision of this type of service. The assumption for the annual supplied quantities of water for irrigation are represented in heading 5.4 in this study, while the annual supplied quantities of water for water supplying are represented under heading 5.1 and 5.2. The adopted initial fee for the service amounts to 5.1 MKD/м3 (0.0813 €/м3) VAT exclusive, and it provides coverage of the total: (1) current operational and maintenance costs for the planned infrastructural systems/ constructions, (2) replacement costs and (3) remaining (other) costs but not return on investment for construction of the systems; detailed description of the defined fee policy and the anticipated implications is presented under heading 8.1.7 hereinafter. Continuous uniformed rise of the initial fee of 2% annually in length of 17 years (2011-2027) is also taken into account and after this period the fees for this type of service in the analysis are fixed. Summary overview of the incomes from the service of irrigation water supply and water supplying per discussed Alternatives is presented in Table 8.7. hereinafter.

Incomes from electricity generation:

The incomes from the sale of the electricity generated from the small hydroelectric power station integrated in the accumulation (Alternative 2 and 3) are accounted on the basis of the projected annual quantities of generated energy and adopted value of 0.12 €/kWh (7.4 MKD/kWh), as market price of the electricity. The market price is adopted on the basis of the Decision by the Regulatory committee on energy of Republic of Macedonia for regulation of the purchase price (fees) of electricity generated by hydroelectric power station which have secured status of preferential producers and it is taken as an invariant in duration of the entire analyzed period. Summary overview of the incomes from the sale of electricity is presented in Table 8.7 hereinafter.

Table 8.7: Summary overview of the incomes per alternatives

Alternative 1	**Incomes (€)**					
	2011	**2015**	**2020**	**2025**	**2030**	**2035**
Irrigation	0	71,148	76,574	66,466	90,004	97,580
Water supply	0	14,270	16,467	19,003	20,667	21,607
El.power	0	0	0	0	0	0
TOTAL	**0**	**85,419**	**93,041**	**85,469**	**110,671**	**119,187**
Alternative 2	**Incomes (€)**					
	2011	**2015**	**2020**	**2025**	**2030**	**2035**
Irrigation	0	71,148	76,574	66,466	90,004	97,580
Water supply	0	14,270	16,467	19,003	20,667	21,607
El.power	0	48,502	43,857	26,752	46,723	33,832
TOTAL	**0**	**133,921**	**136,898**	**112,221**	**157,393**	**153,019**
Alternative 3	**Incomes (€)**					
	2011	**2015**	**2020**	**2025**	**2030**	**2035**
Irrigation	0	71,148	76,574	66,466	90,004	97,580
Water supply	0	14,270	16,467	19,003	20,667	21,607
El.power	0	27,969	26,032	15,320	24,702	17,137
TOTAL	**0**	**113,387**	**119,073**	**100,789**	**135,373**	**136,324**

Remaining (residual) values:

The remaining values of the assets (infrastructural buildings) with life/ useful age longer than the analyzed 25 year period are taken into account as specific incomes in the analysis through assessment of their remaining value at the end of the discussed period. The following residual values are used in the analysis: 95% for the dam, 5% for the equipment of the dam and the irrigation equipment, 25% for the irrigation system and other structures, 0% for the pumps and other electro-mechanical equipment. Overview of the remaining values is given in Table 8.8.

Table 8.8: Residual values

Structures and equipment		Alternative 1	Alternative 2	Alternative 3
Dams	€	0	3,716,525	1,958,383
Pumps and equipment	€	28,271	0	0
Irrigation system	€	291,408	291,408	291,408

8.1.6 Project net financial gain and selection of alternative solution

The estimation of the financial net gain of the project is based on the analysis of the net cash flows (analysis of the costs and incomes). It contains analysis of the financial net current value (NCV) for each discussed Alternative at adopted discount rate of 5%. The collective results from the analysis are presented in Table 8.9; and the details are given in the Annexes 42, 43 and 44.

Table 8.9: Financial net current value (NCV) for each alternative

Alternative	Financial net current value (@5%) (EUR)
Alternative 1	**-3,464,772**
Alternative 2	**-4,836,753**
Alternative 3	**-3,542,388**

On the basis of the analysis, it is obvious that the smaller investment costs for Alternative 1 and 3 automatically result in more favourable results. Still, all Alternative s have negative NCV and do not prove themselves as financially feasible which means that the incomes generated on the basis of the assumed fees for the services and from the electricity generation cannot cover the investments and the total costs i.e. do not provide sustainable operability of the system. This aspect as addition to the fact that the project shall result in significant direct positive social effects for the community (details provided in the heading 8.2 hereinafter), justifies assistance for project realization with Grant for coverage of the entire investment value.

On the basis of the analysis also final selection of the alternative project solution has been done where it was decided that Alternative 3 is the most favourable alternative which foresees the following: **Construction of rock-filled embankment dam of the river Lukovica with height of 28 m (which creates accumulation W=620x103m3), to suit the needs of all future beneficiaries. The Alternative foresees construction of irrigation system for irrigation of both fields (Kosevica with area of 60 hectares and Lukovica with area of 250 ha). The transfer of the water to the field in Kosevica shall be executed through small pumping station and reservoir. Also construction of small weir above the village Kosevica is projected and it shall cover the necessary quantity for water supplying of the population from the village Kosevica. This Alternative offers water supplying also to other settlements from the project area (Kamenica, Todorovci, Lukovica...) to which the water shall be distributed through separate pipelines. For utilization of the spillway waters, construction of mini hydroelectric power station is projected within the area of the dam.**

The selection of ALTERNATIVE 3 as the most favourable project technical solution is based on the following:

1. **Alternative 3 has insignificantly larger negative NCV from Alternative 1 (discrepancy of 77,600 € on annual level), which actually means that the two analyzed Alternative 1 and 3 have almost identical financial performances. The essential difference between these two Alternatives is that the Alternative 1 has lower investment value compared to Alternative 3 (difference of almost 2 million Euros) but at the same time Alternative 3 has significantly lower costs for operation and maintenance (discrepancy of 63,100 Euros on annual level), lower replacement costs (discrepancy of 48,130 € during the analyzed period) as well as higher annual incomes at identical service fees (as a result of electricity generation) compared to Alternative 1, so that within the discussed time period of 25 years both Alternatives result in almost identical financial performances and feasibility.**
2. **Lower operational and maintenance costs and replacement costs at Alternative no.3 have direct influence on the service fees i.e. they result in significantly smaller prices for м^3 supplied water for irrigation and water supplying (see heading 8.1.7, table 8.11). This data is especially important considering the adopted strategy for financing of the project with Grant for coverage of the total initial investment, thus the incomes from the service fees (irrigation and water supplying) and other incomes would be sufficient for coverage of all ongoing costs (operation, maintenance, replacement and etc) for regular system operability. Therefore, if the initial investment costs are covered with the means from the Grant (which actually is a condition/request for any Alternative), lower fees for the supplied water which cover all ongoing costs shall result in their wider acceptance by the end-users and thus providing higher level of financial sustainability of the project.**
3. **Even if the capital costs are to be covered by Grant and besides the larger total incomes in Alternative 2 as a result of larger electricity generation compared to the Alternative 3, which shall result in the lowest water fees for coverage of the ongoing costs (operation, maintenance, replacement and other) still Alternative 2 is rejected because of relatively huge initial investment (discrepancy of 1.94 million Euros compared to Alternative 3 and 3.85 million Euros compared to Alternative 1 (table 8.1);**
4. **The possibility for electricity generation with usage of renewable resource (hydro energy) at Alternative 3 compared to Alternative 1 provides additional - besides higher fiscal incomes - "ecological" benefits from the projects through reduction of emission of greenhouse gases.**
5. **Finally, one of the most important factor for selection of Alternative no.3 is that the key infrastructural structure – accumulation – subject to the appropriate technical solution has significantly longer period of exploitation compared to the pumping station in Alternative 1.**
6. **As additional advantage of Alternative 3 compared to Alternative 1 is the protection of the accumulation Kalimanci from the alluvium which is generated in the drainage basin of the river Lukovicka. Namely, in the future accumulation**

there is to be retention/ dead space which shall hold the entire quantity of accumulated alluvium for the period of exploitation of the accumulation.

7. **Also as another significant advantage to** Alternative **3 compared to** Alternative **1, is the opportunity for tourism and fishery development.**

8. As last but not the least of importance advantage of Alternative **3 compared to Alternative 2 is the possibility for compliance of the third** Alternative **with the tender of the Government of Republic of Macedonia for construction of small hydroelectric power stations. This tender projects construction of two small power stations (with number 337 and 338) along the river flow of the river Lukovica/Kosevica in the proximity of the location of the future dams. Alternative 3 is not contradictory to the tender documentation and it is easily integrated in one common solution since it foresees exploitation of the water potential of the river in the downstream section of the river's flow.**

8.1.7 Fee structure, affordability and acceptance of the projected fees

In order to provide long-term utilization of the investments when planning infrastructural facilities in the public sector, the principles of the economic efficiency and the fiscal sustainability impose the need of coverage of all project costs - capital (investment) costs, operational and maintenance costs and other costs - by the incomes from the end-users. But generally, in worldwide practice frameworks few examples of built public irrigation systems have been noticed where the incomes directly had covered something more than the operational and maintenance costs [1].

The planning of the fee policy for the analyzed project includes:

1. Analysis of the requisite fees (price of water per m3) for irrigation and water supplying which should provide coverage of the total project costs.
2. Analysis of the acceptance (affordability) of these fees through:
    - Comparison with the current fees for the same service at the existing irrigation systems in R. Macedonia
    - Possibility/ readiness for payment of the fees by the end-users (farmers) assessed as irrigation costs in % from the average annual income from agricultural production.
3. Defining of final proposal to the fee policy.

Requisite fees for coverage of the project costs:

The fees per $м^3$ water for irrigation and water supplying which shall provide incomes sufficient to cover the total costs for construction, operation and maintenance of the irrigation system as well as all facilities for the analyzed three alternative solutions are presented in the Table 8.10. These fees are calculated on the basis of assumed annual quantities of supplied water to the end-users and net cash flow (incomes - expenses) during the analyzed period of 25 years which are secured by the fees upon a condition that the abovementioned result in NCV=0 at discount rate of 5%.

[1] Source: "Guidelines for Planning Irrigation and Drainage Investment Projects, Technical Paper 11"; FAO Investment Centre, 1996.

Table 8.10: Sufficient incomes to cover the total costs for the project

Alternative	Tariffs to cover O&M costs (MKD/m^3)					
	2011	2015	2020	2025	2030	2035
Alternative 1	20.0	21.7	23.9	26.4	27.5	27.5
Alternative 2	26.0	28.1	31.0	34.2	35.6	35.6
Alternative 3	20.3	22.0	24.3	26.8	27.9	27.9

The fees per $м^3$ water for irrigation and water supplying which shall provide incomes sufficient to cover the total costs for operation and maintenance of the irrigation system as well as all facilities, replacement cost and other costs (without direct return on investment) for the analyzed three alternative solutions are presented in the Table 8.11. These fees are calculated on the basis of the same assumptions as the analysis for coverage of the total project costs.

Table 8.11: Sufficient incomes to cover the total costs for operation and maintenance, replacement cost and other costs

Alternative	Tariffs to cover O&M costs (MKD/m^3)					
	2011	2015	2020	2025	2030	2035
Alternative 1	12.5	13.5	14.9	16.5	17.2	17.2
Alternative 2	2.9	3.2	3.5	3.9	4.0	4.0
Alternative 3	5.1	5.5	6.1	6.8	7.0	7.0

Analysis of the affordability and acceptance of the fees:

The analysis of the affordability and the acceptance of the fees for supply of water for irrigation contains comparison with the current fees used at the existing irrigation systems in R. Macedonia and assessment of the payment abilities of “additional” costs (compared to the ongoing) from the increased production as a result of the irrigation, as % from the total average net incomes per unit agricultural land.

Overview of the water fees which are charged to the end-users of few hydro melioration systems in R. Macedonia are presented in Table 8.12.

Table 8.12: Overview of the water fees for irrigation in Macedonia

Southern Vardar		
Mixed system (by gravity and with pumping)	den/m^3	7.0
System with pumping	den/m^3	10.0
Old system	den/ha	21,000
HIS Strezevo		
Fee	den/ha	450
Water priece	den/m^3	1,014

HIS Tikves				
Without pumping	den/ha	6.796	den/m^3	1.03
System with pumping	den/ha	10,974	den/m^3	3.32
HIS Bregalnica				
Water communities	den/m^3	0.644		
Individual	den/m^3	0.834		
Technical water	den/m^3	2.14		
HIS Mantovo- Radovis				
Peper	den/ha	13,500	den/m^3	2.25
Tobacco	den/ha	10,000	den/m^3	3.13
Maize	den/ha	10,000	den/m^3	2.50
Fruits	den/ha	9,500	den/m^3	2.71
Technical water			den/m^3	4.20

Obviously the differences in the fees between the separate melioration systems are large where the lowest (minimal fees) can be found for HMS Bregalnica while the maximum fees for HMS Juzen Vardar. However, the average value of $м^3$ water for irrigation from all systems amounts to around 3.5 mkd/ $м^3$.

The table 8.13 hereinafter contains summary data for the expected average increased gross incomes per unit area (ha) as a result of the increased production due to irrigation and indicative fees (prices) per $м^3$ which shall result in direct costs of 5% i.e. 7% from the total gross incomes.

Table 8.13: Indicative values of fees for irrigation and water supply

Benefits	**Fees[2]**	
Gross income from the increased agricultural production (€/ha/year)	for 5% from the gross incomes (€/m3)	for 7% from the gross incomes (€/m3)
4,136	0.07	0.10
Gross income from the increased agricultural production (MKD/ha/year)	for 5% from the gross incomes (mkd/m3)	for 7% from the gross incomes (mkd/m3)
253,939	4.23	5.93

The values laid down in Table 8.13 represent average sizes for the entire analyzed 25 year period. The comparison values (benchmarks) of 5% and 7% direct costs for irrigation from the total gross incomes from the activity are adopted on the basis of data collected from the best practice of projects for development of irrigation systems in the public sector in developing countries[3].

According to these analysis and the obtained values (Table 8.12 and 8.13), the amount of the water fees which might be considered affordable and acceptable for the end-users and which will provide relatively high level of fiscal sustainability of the system is between the

[2] At average size of 3,000 $м^3$ water for 1 hectare cultivated land annually.

[3] Source: "Guidelines for Planning Irrigation and Drainage Investment Projects, Technical Paper 11"; FAO Investment Centre, 1996.

limits of 4.5 and 6.5 mkd/m3. Obviously, these fees are significantly lower than the ones that might provide coverage of the total project costs (Table 8.10).Still, on the other side these values of the fees are quite sufficient to provide coverage of the total costs for operation and maintenance, replacement of the equipment as a result of depreciation during the exploitation period and other ongoing system costs (Table 8.11).

Draft fee policy and expected implications:

On the basis of the previously described analysis the following fee policy for the project is proposed:

Table 8.14: Proposed fees for irrigation and water supply

Start Tariff	€/m^3	0.08	MKD/m^3	5.0	€/ha	243.9	MKD/ha	15,000
Average Tariff	€/m^3	0.10	MKD/m^3	6.2	€/ha	304.8	MKD/ha	18,700
Max Tariff	€/m^3	0.11	MKD/m^3	6.9	€/ha	334.8	MKD/ha	20,600

	2011	2015	2020	2025	2030	2035
€/m^3	0.08	0.09	0.10	0.11	0.11	0.11
MKD/m^3	5.0	5.4	6.0	6.6	6.9	6.9

As it was mentioned before, the proposed fees provide coverage of the total costs for operation and maintenance, replacement of the equipment as a result of depreciation during the exploitation period and the other ongoing expenses; but these fees do not provide return on investment for construction of the system. These fees are considered affordable and acceptable for the end-users, and thus high level of fees collection is expected and by that provision of financial sustainability of the system.

8.2 ECONOMIC COST-BENEFIT ANALYSIS

8.2.1 Aim of the analysis and methodology

Generally, the aim of the economic (or socio-economic) analysis is to assess the entire influence of one project over the improvement of the economic welfare of the citizens of certain state/society. The economic analysis of the project is similar to the financial analysis in the aspect that both analyses assess the profit from the investment. But, financial profit is not the same as the economical profit. The financial analysis of one project assesses the profit (fiscal) which goes to the subject that executes the project, while the economic analysis measures the effect by the project over the national economy. However, in order one project to sustain economically it must be financially sustainable as well (as it is described in detail in the heading 8.1), because if the project is not financially sustainable the economic benefits would not be realized.

The process of implementation of economic analysis of the costs and the benefits understands calculation of the in-flows and out-flows in the financial analysis of the cash flow with assistance of factors of conversion in order to reflect the factual economic costs where the benefits and the social costs are included herein and which were not considered

in the financial analysis. This understands conversion from market price into accounting price in order to take into consideration the distortion of the market and to include the externalities which shall lead to costs and benefits which are not included in the financial analysis because they do not generate monetary costs or profit.

There are three basic steps in the analysis of the economic sustainability and profitability of one project:

- Corrections of externalities: identification, quantification and evaluation in monetary assets (if possible) of the economic (external) costs and benefits;
- Fiscal correction: conversion from market into accounting price;
- Benefits-costs comparison.

The results and the conclusions from the economic analysis of the project for construction of mini- accumulation on the river Kosevicka and the irrigation system according to the adopted Alternative 3 are presented further on in the text.

8.2.2 External project benefits and costs

Increased agricultural production:

One of the most significant aim of the project is supplying of water for irrigation to total of 310 ha farmland in Municipality Makedonska Kamenica. The irrigation of the farmland certainly shall result in larger crops (productivity).

For assessment of the effects from irrigation a scenario (model) is used which shall simulate the changes in the production. Detailed description of the analysis as well as the obtained final values – incremental changes [4] in the crops for the adopted structure of agricultural crops on the project agricultural area during the entire analyzed period – are stated under the heading 5.3 and 5.4.

The value of the increased production is assessed on the basis of the background data for movement of the market price of the agricultural crops and projection of the future changes of the prices. For each of the represented agricultural crops separately data from FAOSTAT are used for movement of the market prices (MKD/kg) generally in the EU countries and Russia in the period from 1991 to 2009, but the trend of the future changes (increase and decrease) of the market prices of the crops is projected as average value on the basis of the background data for the neighbouring countries of R. Macedonia[5], and this is only for the period from 1998 to 2009. Details from the analysis of the background data for the market prices of the agricultural crops as well as projected trend of the future changes of the prices are presented in Annex 45.

On the basis of the projections for incremental changes in the production of the most represented agricultural crops and the projected trend of the changes of the market prices

[4] Following the principle for execution of cost-benefit analysis, we discussed the incremental changes/benefits from the project i.e. we took into consideration the difference between the current (pre-project) incomes and the incomes which would be result of the irrigation. Meanwhile, for the needs of the analysis, an assumption is adopted that the current (pre-project) condition would retain in the entire foregoing analyzed period.

[5] Example: Albania, Bulgaria, Bosnia-Herzegovina, Greece, Kosovo, Romania, Serbia, Slovenia, Croatia, Montenegro, Hungary.

of the crops, an economic (monetary) value of the increased agricultural production for the analyzed 25 year period is obtained. The abovementioned cumulative for all represented crops is between the limits from around 400,000 Euros annually to around 1,4 million Euros annually. Details from the analysis are presented in Annex 46 and 47.

Reduced emission of the greenhouse gases:

Additional socio-economic benefits from the project, besides the direct fiscal effects occurs as a result of electricity production from the mini hydroelectric power station with usage of spillway waters from the accumulation as renewable resource. Such generated energy provides replacement (avoidance) of the same quantity of energy obtained with usage of fossil fuels that results in effective reduction (avoidance) of emission of greenhouse gases.

The effect i.e. the volume of the runaway emission of greenhouse gasses is estimated on the basis of projections for annual production of electricity from the power station during the analyzed 25 year period and the adopted value of reduction of 480 tones of CO_2 with production of 1 GWh electricity from mini HEPS.

The value (monetary) of the runaway emissions of greenhouse gasses is estimated on the basis of the volume of the runaway emissions (tons/year) and adopted price for reduction of emissions of CO_2 according to the recommendations/projections of EIB of €25/ton in 2010 year and rise up to €45/ton in 2030 year[6]. For the analyzed 25 year period this value moves within the limits from €1,500/year to €6,000/year.

Increased costs of the agricultural production:

One of the external costs (adverse effect) which occurs as a result of the project is increased costs which shall be borne by the farmers for the increased agricultural production. The analysis of these costs is made on the basis of background data for the average: (1) tangible costs (fertilizers, pesticides, tractor hours, maintenance of fixed assets and other smaller tangible costs); (2) labour (work hours); and (3) indirect costs (sale, marketing, management, insurance, loans, depreciation) which shall be borne by farmers taking into consideration all agricultural crops and their quantity/representation. Again, we take into consideration only the incremental values of the change (increase or decrease) of the production. The costs are estimated to around 130,000 €/year in the year 1 to 220,000 € in the last year from the analyzed period.

Costs for supplied water (opportunity costs of agricultural production):

Besides the supplying of water for irrigation of the agricultural land, the project shall also provide water for water supplying for the population and technical water. Besides the positive effects the utilization of these water resources for other (non-agricultural) purposes from the farmer's aspect represents specific (opportunity) costs because of the missed opportunity for usage of the water quantities for agricultural needs. The value of these costs

[6] Source: Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste, COWI 2000.

is estimated on the basis of projections for the annual quantities of water supplied for water supplying and adopted fee (price) for water per m^3. These move between the limits from €13,500/year up to €21,500/year.

8.2.3 Fiscal correction and conversion in the accounting prices

Fiscal corrections of prices include the subtraction of certain value from the market prices used in the financial analysis which generally refer to the taxes, subventions and unilateral payments such as: (1) value added tax – VAT; (2) subventions and (3) other indirect taxes.

The following step in the economic analysis is the conversion from the market into the accounting prices with application of the conversion factors. This is done because the current prices of the raw materials and the products do not reflect their factual social value because of market malformations. These malformations can include aspects such as: monopoly regime, commercial barriers and low labour productivity.

In case of the analyzed project, the construction (investment) and the operation and maintenance costs are connected with the local workforce, local/domestic materials and equipment and small part of imported materials and equipment. The percentage of each of these positions in the total cost – construction, operation and maintenance - is given in the Table hereinafter (Table 8.15); and there is a description of the applied factors of conversion for each position.

Local workforce (salaries): for all categories of local workforce, the factor of conversion is calculated as follows:

$$CF = (100 – UR)/100 = 0.75$$

where:

UR – factual estimated unemployment rate = 25%. The unemployment rate of 25% is assumed and it is used in this study as deemed that it would result with more factual estimation of the economic price of the labour.

Foreign workforce: No reconciliation of the costs had been performed because the financial prices are expressed in marginal prices. The percentage of costs doe foreign workforce during the construction is estimated at 0% from the total investment.

Local products: The biggest part of the products (materials and equipment) for construction and for operation and maintenance will originate from domestic manufacturers. No reconciliation (conversion factor 1) had been performed because the financial costs are VAT excluded.

Imported products: the main products and imported materials and equipment that shall be used for construction and maintenance of the dam, the remaining structures and the irrigation system include: steel products, fuel and certain part of the equipment/machinery. The average percentages from these positions in the total costs are estimated on the basis of the review of the investment costs. Applied conversion factors for all imported products (without diesel oil) regarding the fact that these products are to be imported from EU - member state, amounts to 1.

Diesel oil: The applied factor of conversion amounts to 0.76 calculated as maximum allowable production/marginal prices of the diesel in Macedonia for the period 2008/2009 and the current market price.

Land (as specific non-commercial asset): It is assumed that the local market of real estate is not sufficiently representative for alternative values of land utilization, so thus the current market price is not corrected in the analysis (conversion factor 1.2). Further on, the residual value of the end of the analyzed life cycle of the project is integrated in the analysis and this covers the value of the land.

Table 8.15: Conversion factors

Position	% of the total value	FK
OPERATION& MAINTANCE COSTS	**100%**	**0.82**
Salaries and allowances of O&M costs	58.9%	0.75
Dams Annual Maintance costs	10.5	0.88
SHPP Annual Maintance Costs	0.4	0.95
Irr. Sysrem Annual Maintance costs	11.2	0.94
Equipment Annual Maintance costs	13.2	0.93
Pump Station Annual Maintance costs	0.0	0.93
Energy Consumption for Pumping	5.8	0.96
DAM INVESTMENT COSTS	**100.0**	**0.88**
Land	3.3	1.20
Civil works- local labour	26.6	0.75
Civil works- “imported” labour	0.0	1.00
Local materials	62.2	0.90
Imported materials	0.0	1.00
Equipment	2.7	1.00
SHHP	4.0	1.00
Pump station (Intake)	1.1	1.00
IRRIGATION SYSTEM INVESTMENT	**100**	**0.94**
Land	0.0	1.00
Cicil works- local labour	7.0	0.75
Local materials	16.3	1.00
Pipelines- local materials and equipment	31.9	1.00
Pipelines- local labour	13.7	0.75
Structures- local materials and	10.4	1.00
Structures- local labour	4.5	0.75
Irrigation equipment- local/imported	16.4	1.00

8.2.4 Results from the economic analysis

The assessment of the project achievements in economic sense, i.e. from the local community aspect is based on comparison of the costs and the monetary values of the

profits with the applied correction to malformation of the costs and addition to the values of the externalities (as above described) and calculation of the net profit. The accumulative information from the economic analysis of the proportion cost-profit is given herein; details are presented in the Annex 47.

ENCV (@5% Discount rate)	**€7,349,667**
EIRR	**16.58%**

Discount rate of 5% is used in the analysis which is considered to be representative social discount rate for R. Macedonia.

On the basis of the calculated project achievement indexes (ENCV and EIRR[7]), it can be concluded that the project- if it is accomplished and pursuant the presented assumptions - it is economically remunerative and it shall result in significant benefits and increase of the social welfare of the local community. This means that the total net project benefits (at provided return on investments and coverage of all ongoing project costs) in the analyzed period off 25 years of exploitation have current positive value of €7.35 million and internal (annual) rate of return on investment of 16.6%.

The study does not cover detailed analysis of the profit allocation but considering the type of the project it is evident that minimum 80% of the stated ENCV belongs to the local community – above all the farmers – in the municipality Makedonska Kamenica.

8.2.5 Sensitivity and risk analysis

The aim of the sensitivity analysis is to conduct quality assessment of the effects from the changes on the separate variables which are projected as input parameters in the financial and economic analysis. The sensitivity analysis also assesses the influence from the change (deviation from the projected values) of one input parameter on the achievement indexes (economic performances –ENCV and/or EIRR) of the project where any other parameters are constant.

For this aim we looked separately at the affect of the changes of the following elements: (1) incomes from the increased agricultural production; (2) investment costs and replacement costs and (3) operational and maintenance costs and other costs. The sensitivity analysis covers assessment of the changes of EIRR as criteria for project financial achievement measurement.

The graph given herein shows the sensitivity analysis of EIRR. Evidently, the changes of the incomes from the increased agricultural production have the largest affect on the possible changes of EIRR, although this is not critically big affect. The possible changes/deviations of the other two elements (investment costs and the operational and maintenance costs) would have lower affect on the values of EIRR

[7] ENCV- Economic net current value ; EIRR- Economic internal rate of return.

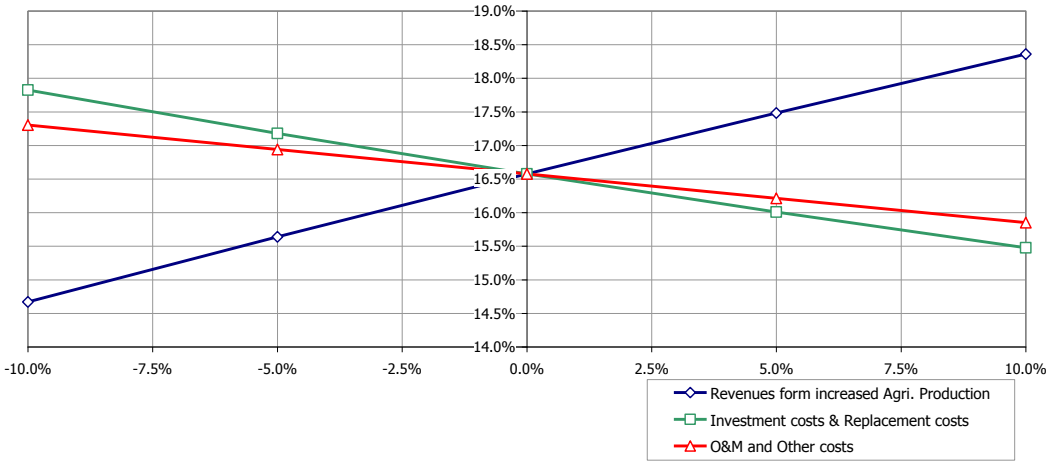


Chart 8.1: Sensitivity diagram

The risk analysis and the relativity of the achievement of the expected/projected project performances have an aim to analyze the accumulative affect caused by the possible changes of all (three) discusses elements simultaneously. Having in mind the complexity of the calculation method as well as relatively large factors/variables and combinations that affect, the risk analysis and the allocation of the relativity of EIRR were analyzed with application of the Monte Carlo -simulation method. The developed calculation model for simulation is based on:

- Input domain includes all abovementioned input variables within the stated limits/interludes;
- On the basis of the nominal values and the corresponding defined interludes of variation for each stated variable, one can define the determinative and stochastic (assumed) values of EIRR;
- For sample of 5,000 arbitrary generated input value for the variables, corresponding value of EIRR is computed for each arbitrary selected set of input values, and it is followed by computation of the accumulative statistical indicators and relativity indicators for the entire domain of the arbitrary selected values. These indicators include: average value, standard deviation, average deviation error, allocation of relativity and accumulative relativity for the frequency of EIRR for each of the 5000 arbitrary input values. The curves of the EIRR relativity allocation and the allocation of the accumulative relativity are represented in the graph herein.

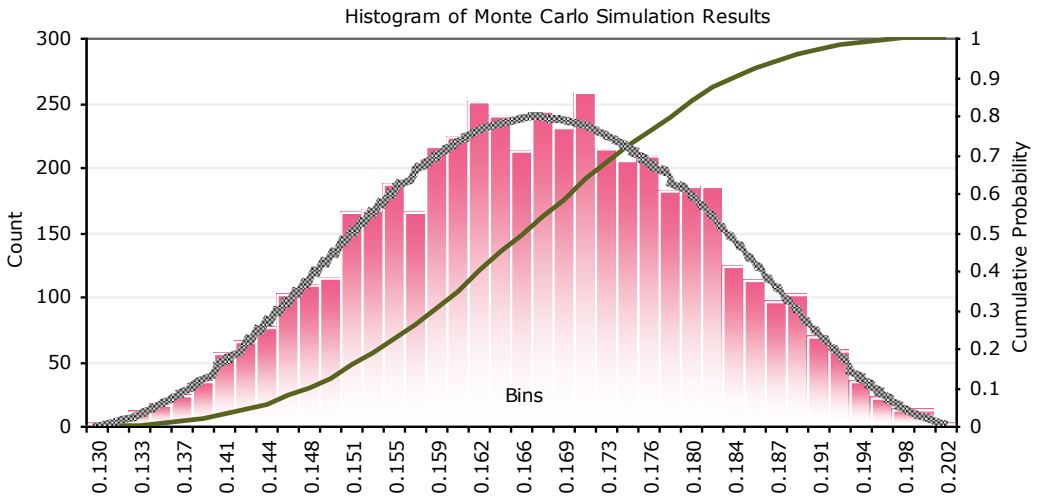


Chart 8.2: Diagram of Monte Carlo Simulation- method

On the basis of the results from the simulation, it can be concluded that there is less than 50% relativity that EIRR shall be lower than the projected initial value of 16.6%. Further on, it can also be concluded that the project has relatively large relativity of 75% to achieve EIRR of 15.6% which is considered to be acceptable index of economic achievement for one public project.

9. ORGANIZATION AND MANAGEMENT

9.1 Overview of the existing legislation

In Republic of Macedonia there is complete existing legislation which refers to the sector-waters and which is in compliance with the European directives. In bigger part of the Study, we quote actual legislation and regulative that refers to the subject issues and herein we provide the summary of the most important effective legal regulations and acts:

Table: Overview of the part of the existing legal legislation and regulative in RM

Environmental Law	Official gazette of RM 53/05 dated of 05.07.2005 year.
Laws on amendments and supplementation of the Law on environment	Official gazette of RM 81/05 of 27.09.2005, 24/07 of 01.03.2007, 159/08 dated of 22.12.2008, 83/09 dated of 03.07.2009
Regulation and rulebooks for strategic assessment of the affect on the environment, assessment of the affect on the environment	
Law on waters	Official gazette of RM 87/08 dated of 15.07.2008
Law on amendment and supplementation of the Law on waters	Official gazette of RM 06/09 dated of 15.01.2009 y, 161/09 of 30.12.2009
Regulation and rulebooks for classification and categorization of waters, river basins, water monitoring, water supplying	
Law on water economy	Official Gazette of RM 85/2003
Law on amendments and supplementation of the Law on water economy	07.11.2005 and 19.08.2008
Law on water communities	Official Gazette of RM 51/2003
Laws on amendment and supplementation on the Law on water communities	07.11.2005 and 20.09.2007

9.2 Potential organizational alternatives for water resources management

As it was mentioned few times before, the main purpose of the mini accumulation Lukovica is to meet the needs of water by the beneficiaries where two priorities are highlighted: water supplying to the population and industry and irrigation of the farmland. Also, the project realization understands construction of entirely new and independent hydro technical system, which imposes the question of organizational background that shall provide its efficient, effective and long-term sustainable management and maintenance. At the moment there is one public utility service company (PUSC “Kamena Reka”) in the municipality Makedonska Kamenica whose competence includes management and maintenance of the water supplying system of the city of Makedonska Kamenica, i.e. in the future it would appear solely as "leaseholder" (beneficiary) of water that is to be used for water supplying of the population and the industry.

Description of the suggested institutional and organizational aspects for organization of the analyzed system for water supplying and irrigation of the agricultural farmland is presented hereinafter in this chapter.

On the basis of the existing legislation[8] and the size (complexity) and importance of the analyzed hydro technical system, alternative (possible) solutions for system organization are the following:

(1) Foundation of water community (WC) and new water economy public enterprise. Water community, as association of owners or beneficiaries of the agricultural land within the limits of the range of the irrigated areas with the new system, shall manage with the irrigation system i.e. sectional and distribution network of the hydro-melioration system. The newly founded water economy enterprise will provide management, utilization, maintenance and control of the hydro-technical system as a whole, i.e. the dam with the accumulation and the appurtenance to the points of water supply to the specific beneficiaries – WC (irrigation), PSUC "Kamena reka" (water supplying to the population and industry), and possible other individual beneficiaries – would produce and sell electricity from the small HEPS within the system.

(2) Foundation of water community (WC) and affiliation of the new system to the existing PWEE "Bregalnica" Kocani. The water community would have the same rights and responsibilities as in the above described alternative (1). The existing PWEE "Bregalnica" would manage with the entire hydro technical system, analogously to the possible newly formed water economy and the description above (1).

9.3 Recommendable organizational background

The abovementioned alternatives were analyzed from aspect of their: (1) efficiency; (2) practicality in relation to the suggested technical concept of the system; (3) assumed political will for changes and (4) risks around the implementation.

On the basis of the estimation we recommend alternative 2 - Foundation of water community and affiliation of the new system to the existing PWEE "Bregalnica" Kocani to be used as a model for organizational background for system management.

Basic criteria and principles on the basis of which this solution had been proposed are the following:

- Preservation of the principle one public entity to manage with the water resource within one water basin.
- Higher economy (lower costs) in the management because of range economy and by these lower prices for the services (supplied water).
- Assumed higher degree of secured sustainability of the system because of existence of multi -annual experience in the management with the hydro technical systems at the existing water economy enterprise.
- Simpler and shorter procedure for commencement of the system management.

All necessary details connected with factual competences, the manner and the procedure of foundation and registration (WC), organization (bodies and organs in the structure of the entities and their separate rights and competences), the operation, financing, control and supervision of the operation of the two entities are stated in the above defined existing legislation:

[8] "Law on water economy" (Official gazette 85/2003) and "Law on water communities" (Official gazette 51/2003).

- Law on water economies (Official Gazette of RM 85/2003 and amendments and supplements dated of 07.11.2005 and 19.08.2008)
- Law on water communities (Official Gazette of RM 51/2003 and amendments and supplements dated of 07.11.2005 and 20.09.2007)

Besides the abovementioned recommendations for organizational background for securing efficient and long-term management and maintenance of the hydro-technical system upon its realization (construction) in order to provide effective conditions for future planning, preparation and commencement of the project implementation it is suggested that the municipality Makedonska Kamenica in cooperation with the other municipalities from the Eastern planning region and the competent public enterprises (PUSC "Kamena reka" and PWEE "Bregalnica") forms Project Implementation Unit. The Project Implementation Unit should work on coordination of the further project preparation including the preparation of the project documentation, assessment of the affect on the environment, provision of funds for realization, commencement of the process for license issuance, etc. The activities of the Project Implementation Unit should be funded by the budget of the Municipality Makedonska Kamenica.

10. ENVIRONMENTAL IMPACT

10.1 INTRODUCTION

The subject of this chapter is the characterisation of the present conditions with regard to the relevant environmental aspects and the assessment of the effects, which result from the planned project with regard to the environmental impact. At first the main problems in connection with the planned project concerning the environmental impact have to be cleared. In principle, two sides have to be considered:

- the effects on the irrigation area including the discharge area downstream and
- the effects on the area from which the water is extracted.

In the case to be judged the subject of the assessment are the changed conditions, which result from the project. Possible environmental impacts in connection with the planned project are:

- Construction of the reservoir on a river Lukovica
- Transport of the water from the reservoir to Makedonska Kamenica, Kosevica, Lukovica and Todorovci and the industry
- Transport of the water from the reservoir to the irrigation area

A general characteristic of the present conditions is given introductory.

10.2 GENERAL CHARACTERISTIC OF THE PRESENT SITUATION

10.2.1 General Description of the Region

The project intends the construction of a dam and reservoir in the Lukovica catchment area for alluvium protection, watersupply of Makedonska Kamenica, Kosevica, Lukovica and Todorovci and the industry and irrigation of agricultural area of the municipality Makedonska Kamenica. The area of interest for this part of the study is situated in the northeastern part of the Republic of Macedonia at the foot of the massif Osogovo. The broader region is known as the East Planning Region.

Since the area of interest is quite large, the relief is very diverse and complex. The elevation is about 445 m a.s.l. (estuary of the river Lukovica in the Lake Kalimanci) to 2252 m (top Ruen of Osogovo Mountains).

10.2.2 Geology

The origin of Pijanec region is tectonic. According to the geomorphologic investigations of B.Z Miloevik, Cviik and other scientists since Paleogen the valley Pijanec constitute a separate valley separated from Kocani and Maleshevian. Destroyed, rotated and crimp paleogen sediments indicate that before Pliocen there were strong tectonic movements, ie, lowering of ground between the valleys and as a result it was created upper flow of the Bregalnica Valley. In the Pliocene, Pijanechka valley was a lake connected to Lake Maleshevsko, with two tributaries, one east of Bejas Tepe hill upon which now runs the River Zhelevica, second west of that hill which later deepened and now is the river Bregalnica.

Pijanechko lake was connected with Kocani Lake, Kustendil and Blagoevgrad Lake. Connections with the last two lakes are cut-off by the rise of the hill on the east side, while the mouth at Lake Kocani deepened and the water expired, which is the lower flow of the river Bregalnica. After the expiry of the lake with fluvial erosion, modern forms of relief Pijanec were formed.

The geological composition of Pijanechka valley is heterogeneous. Lower parts of the valley are Paleogen and Pliocene deposits. These are mostly sands, clays, limestone and conglomerates lying through old eruptive rocks and crystalline schists. Reefs around the valley are mainly composed of crystalline schists and eruptive rocks, especially granite.

The lowest part, the alluvial plain, orignate from sediments occurred by Bregalnica River and its tributaries. It is most fertile land. These different types of soils allow different vegetation type and are very important to the wealth of biodiversity.

In the section with annexes there is Geological overview map (Annex 48) and Excavation conditions (Annex 48.1). Other overview maps (Annex 49 and Annex50) were undertaken from the Study for available surface and underground waters of river Kamenicka/ Lukovichka watershed and utilization possibilities made by ICOM engineering in 1990.

10.2.3 Meterorology

General

The meteorological parameters in this region are measured in the meteorological station Delcevo, which is not fully equipped. However, the climate parameters in Delcevo are representative and can reflect the climate in the municipality Makedonska Kamenica.

Except in the mountain areas, the climate in Makedonska Kamenica is moderately warm continental with some Mediterranean influences that penetrates, on the south side with the river Bregalnica. Rainfall is unevenly distributed throughout the year and higher up the mountain sides.

The structure of the land area is dominated by agricultural land, pastures and forests with more than 90% of the total area, of which forests and forest land in the municipality occupy an area of about 9,000 ha or 47.3% of the total area of the municipality.

Temperature

According to meteorological data from meteorological station in Delcevo, the average annual air temperature is 10,4 ° C with an absolute minimum of -26,7 ° C and an absolute maximum of 37 ° C, while the hills average annual temperature falls to 3,5 ° C. The warmest month is August with an average temperature of 20,1 ° C, while the coldest month is January with an average temperature - 0,1 ° C.

The average monthly and annual air temperature for the period 1961 to 2005 for the meteorological station in Delcevo are shown in the following table.

Table 10.1 Average monthly and annual air temperatures for Delcevo meteorological station, 1961 - 2005

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Ann.
T_{av}	- 0.1	1.6	5.2	10.2	15.0	18.5	20.6	20.1	16.0	10.5	5.3	1.3	10.4

Characteristic points for zoning of the climate and agri-climate as the first, middle and last day of ice from the ice period, the average data at the beginning, end and duration of the period with a temperature higher than 5 and 10oC that affecting the development and productivity in agriculture are not measured in Makedonska Kamenica.

In this part of the Bregalnica watershed, appearance of ice is recorded in Delcevo from 1954th. In Delcevo this phenomenon was measured earliest on 16.09.1958 and latest on 08.06.1962. It was an extreme while regularly appeared in October as the earliest, and in the month of April as latest.

Vegetation period with temperatures above 10 ° C lasts 191 days a year.

According to the Hopkins Bioclimatic Law (Brown and Gibson 1983, Beniston and Fox 1995) the decrease of the temperature of 3oC corresponds to the change of the altitude of 500 m..

Precipitation

Most of the precipitation are in the warm period of the year. Average annual amount of precipitation is 542 mm. The main maximum is in May (61.2 mm average), while the minimum is in January (32.4 mm) (Table 10.2)

The average number of rainy days during the year is 71, with the average annual amount of rainfall of 542 mm. Precipitation although relatively low, their distribution in the vegetation period (April-September) is favorable and is over 50% of the total annual precipitation.
Most of the precipitation is rain.

Table 10.2 Average monthly and annual sums of rainfalls for the period of 1961 – 2005

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Ann.
Delcevo	32.4	34.0	35.1	46.2	61.2	51.6	46.6	42.3	40.5	46.7	58.4	47.2	542.2

The rainfall quantity increases with increase of altitude, but exact figures are difficult to be shown..

Other meteorological Parameter

This region is characterized by relatively long sunny period. Average annual amount the duration of solar radiation is 2347 or 6,4 hours a day, with maximum in July or 10.3 hours per day and a minimum in December of 2.8 hours per day.

Cloudiness and fog is not great, so that during the year dominated by sunny and bright days.

Relative humidity is reduced from January to August and then to the December increase, the average humidity is 75%.

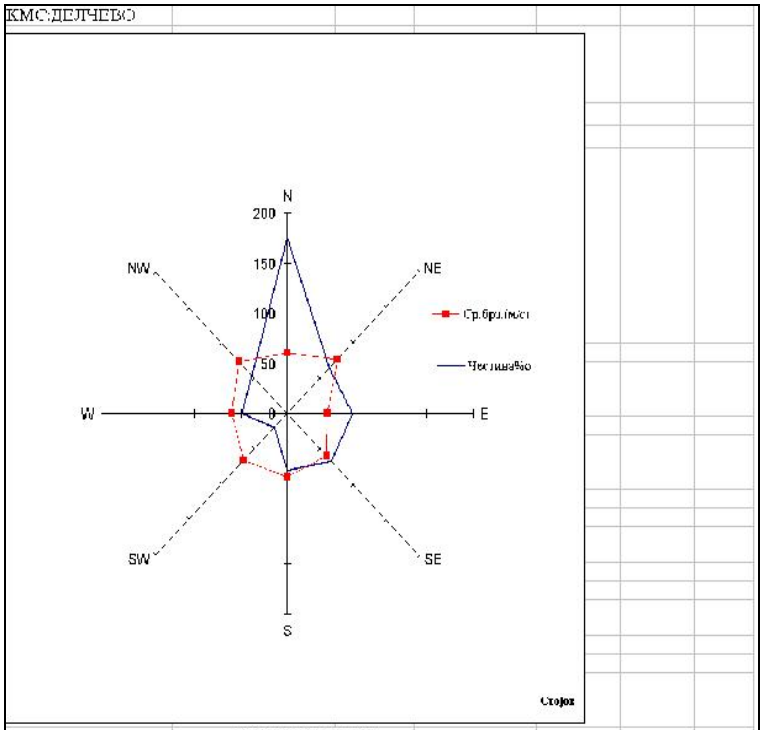
The geographical position, orographyc features, hydrographic network and other natural conditions and peculiarities influence the movement of air masses and climate characteristics. The air masses usually come frontal from the north and northeast and have a strong influence on temperature.

Analyzed area is windy climate. Of the total number of measured phenomena in Delcevo (1997-2000) 679%o are with a frequency of wind from different directions, 321%$_O$ without wind, with silences.

North wind is with the highest average annual frequency 175%o, the average annual speed is 3.0m/sek.

Increased frequency of winds and relatively high air temperatures provide favorable conditions for evaporation of free water surface. That is average about 880 l/m2 year water surface.

Diagram 10.3 Average annual wind rose for Delcevo (1997-2000)



ТИШИНИ(C=321‰)

Правец	C	N	NE	E	SE	S	SW	W	NW
Честина во‰	321	175	64	70	67	57	20	49	53
Брзина(м/с)		3,0	3,8	2,2	3,0	3,2	3,3	3,0	3,6

10.2.4 Hydrology – Water Quality

Hilly and mountainous environment enable the formation of many mountain waterways, with small watersheds, short lengths and large slopes. With the main water management priority are Kamenicka and Lukovichka River. Kamenicka River is a mountain river that flows beneath the highest peak of Mount Osogovo and flows into Bregalnica. Watershed is 115.2 km2, and the length of the riverbed is 22.5 km. Kamenicka River has 6 torrents from the left (red, pig, goat, Petrova, Ponishte and Moshtichka) and 2 on the right side (Goreshtica and Susica). These torrents with Kamenicka River formed hydrographic network with a total length of 62.1 km2. Lukovichka River is the second largest water flow whose spring is located on the Macedonian-Bulgarian border. The total length of river is 11.5 km with watershed of 21.6 km2. Other waterways are with small watersheds and short in length so dry during the summer. Biggest hydrological facility on the territory of the municipality is Kalimanci lake which has a volume of 127 million m3 and is the largest hydrological facility in Eastern Macedonia. In it Kamenicka flow - which runs through the town of Makedonska Kamenica - and Lukovichka and Ribnichka River.

Bregalnica River is the main water artery in the territory of the municipality. She enters the Pijanechka valley from the south through Razlovechka canyon, runs north to Delcevo, where

then go west through the canyon, which starts from Ochipala, enters the territory of Makedonska Kamenica.

Hydrographic network, relief and geological and hydrological conditions are very favorable in terms of rational use of productive water.

Consumers of water are located mainly in the middle or lower courses of rivers, to which water can be distributed by gravitational, or by pumping on small heights.

The total average annual flow of the river Bregalnica into Kalimanci is 264 million m3. With the water of the river Bregalnica most of thePijanechka valley is irigated and downstream, from the accumulation Kalimanci, large agricultural areas near Kocani and Ovce Pole. Irrigation is only localy from Kosevichka river and partly by river Moshtichka.

Within the irrigation system "Bregalnica" especially to protect the reservoir Kalimanci from filling with alluvium, there are a number of Tech. facilities in the riverbed of Lukovichka and Kamenicka river and on some of their tributaries which have been ease-riverbeds of those rivers that have a typical mountain-torrent nature. Also there have been abundant biological things - afforestation of eroded surfaces with acacia and pine forest, which results of reduction of erosion of both watersheds.

The daily water consumption in the city Makedonska Kamenica, for the population, industry and comunal requirements is 40 l / s, and the maximum consumption is 5.8 l / s. The population of the municipality uses potable water from water supply network, which basically meets the needs of residents in the city. The requirements of water in other settlements are met through local rural water supply systems and wells.

The existing water supply infrastructure does not meet the needs of the population of quality potable water. In the municipality there is still present problem of ensuring continuous supply of the population with quality potable water. Regarding the environment, the most critical is water supply from groundwater, from wells, because of the possibility of contamination of ground water whose quality is not controlled.

The quality of potable water in urban water supply system is controlled by the competent institution for health care from Kocani and according to their reports Makedonska Kamenica citizens are supplyed with quality potable water.

The quality of potable water in other settlements in the municipality is not monitored systematically and continuously, but when necessary or incidental. Therefore there are no reliable indicators of the quality of potable water and cannot be given a qualified assessment of water quality used by the population, which is a very serious problem connected with the way of providing drinking water.

Wastewater origin, is mostly from households and industrial facilities.

Industrial wastewater without proper treatment directly poured through the channel network in Kamenicka river. Similar is the situation with wastewater from rural settlements that do not have sewage systems.

Temperature of water in the Kamenicka and Lukovichka river measured on the registered springs that would come into consideration for water supply, ranges from 6-13 oC and are included in the type of cold water. All tested waters are transparent, no color, smell and taste. The value of pH is within the limits of 6.4 to 7.1 and belong to the weak acidic waters. Dissolved minerals are in the minimum limits and based on that belong to the group of poorly mineralized waters. Qualitative characteristics of waters satisfy the quality of potable

water. The hardness is also small and all these amenities include the waters in the class of waters with high quality in terms of water use, and technical supply of industry.

The quality of surface water are monitored only for Kamenicka river, downstream from the discharge of mine. The analyzed data indicate that the water is mostly class II (and occasionally III). Degraded quality is due to the presence of chemical agents, organic and microbiological contamination. Occasionally demonstrated the presence of heavy metals and iron with high concentrations. (Data from NEAP).

However, further investigations are needed to get more information about the water quality of the streams and rivers in dependency of the flow rate and other relevant boundary conditions.

10.2.5 Land Use

According orography, Makedonska Kamenica municipality is predominantly mountainous area. Suitable areas for agricultural development has in the river valleys of Kamenica with the tributaries and Bregalnica that gives arable land estimated at 4,705 ha of which 3529 are useful land, or 75% (Census of Agriculture 2007). The general climatic and soil conditions make Makedonska Kamenica suitable for development of fruit, especially for growing walnut, chestnut, pear, apple and hazelnut (in Moshtica, Sasa, Cera, Kosevica, Lukovica and Kostin Dol).

The general pattern of the land use in the area impacted by the project under consideration corresponds to the geological structure and of course to the corresponding soil formation. Thus, in the lowland (alluvial deposits) the land is used mostly for agricultural purposes.

According to its geographical and topographical location, favorable climate, soil conditions, available pastures and meadows, the municipality has the preconditions for the development of fruit growing and animal husbandry.

Structure of land use:

1. Field crops: cereals, industrial crops, vegetables, forage crops.
2. Fruit: plums, apples, pears, quinces, peaches, walnuts.

Intensification of the processes of industrialization and urbanization, which have elementary character covered a substantial stock of arable land. This tendency in future will be ever present, even intensify, as a result of the need for people to open small and medium industrial complexes on the territory of the municipality of Makedonska Kamenica.

10.2.6 Biodiversity

The value of biological diversity increases with the altitude, corresponding to the land use pattern.

Forests in the municipality of Makedonska Kamenica covers about 9,000 ha (47.3%) of its territory, with percentage higher than 12% of the republic average. The municipality has a high percentage of overgrown forest land (80% or 7,200 ha) which is very favorable. The structure of forests, high forests with most wood are represented app. 60%, ie twice the National average, while lowland forests occupy an area of 1700 ha (24%) and forest crops participate with 1200 ha (16%).

Pure forests (coniferous and deciduous trees) are most common (94%), and mixed forests participate with 400 ha (6%). The forests are characterized by rich biodiversity in terms of flora and fauna, especially with different herbs and teas. 47% of forests are in individual and

53% state ownership. Fund of the timber is about 1.5 million m3 with annual cut of 10,000 m3. The structure prevailing high beech and oak forests which are mainly used to supply the population with firewood, and to a lesser extent and in the forest industry. According to the constructed forest road network, local forests are into the category of secondary open forest. The state forests are managed by PE Macedonian Forests - Forestry economy subsidiary Golak – Delchevo, unit dispatched in Makedonska Kamenica. On the territory of the municipality all forests are regulated by specific plans for forest management: forest management unit Kamenica and forest management unit DULICA-SIVA KOBILA.

In the forests can be found: wild boar, deer, wild rabbit, black eagle, partridge and owl. According to the present situation these species are not endangered by the project activities.
Without taking into account rare species, the area is very important in terms of biodiversity, because of the abundance of species. Beech forests are well preserved. Their economic value is also high. Grass surfaces are very different in terms of composition. They are quite rich in species but they are not sufficiently studied. Further research is needed to better assess their value.

Rivers (in the upper course) are clean, more or less well preserved aquatic ecosystems are, also very important to the overall biodiversity of the region (among other values of these rivers). Since the project activities include direct river basin, the quantity and quality of water, the possibility of damaging or destroying the animal community is present.

10.3 INFLUENCE OF THE PLANNED PROJECT ON THE ENVIRONMENTAL

10.3.1 Socio – Economic Aspects

From the environmental point of view, the socio-economic aspect, especially direct negative impact on humans and human goods, is not an important issue. The benefit is much greater.

There are no human settlements close to the area of construction works, nor are important agricultural lands (properties). Thus, no negative effect of noise, vibration and air pollution to humans is expected during the construction works. The impact during operational phase is only positive.

10.3.2 Environmental Impact arising by the Construction Work

The most of the threats posed by the construction works of the dam and reservoir in the watershed of the river Lukovica concern the destruction and damaging of natural habitats (especially valuable forests), as well as causing migration processes.

Additional impact will be posed by producing the noise and vibrations, as well as air pollution (dust, SO2, NOx, Pb, organic pollutants - hydrocarbons etc.). Some of the biotopes will be irreversibly damaged. It is not possible define all particular impacts on the flora and fauna in the scope of this study. Therefore, it is not possible to envisage all mitigation measures to be undertaken during the construction works. However, some general measures can be mentioned:

- Avoiding well-preserved forests for building of access roads, work camps etc.
- Recultivation of the damaged area after finishing the construction works.
- Solid waste (plastic material, tube caps, human waste etc.) collection and management according to domestic regulations.

- Waste material from the construction works should be properly stored.
- Toxic and hazardous waste management according to the domestic regulations.
- Permanent expert monitoring during the construction phase (beside an engineer, biology or ecology expert is needed).
- Special care should be undertaken while working close to the streams and rivers (concerning pollution from mechanisation, corking the streams with rocks, stones and earth etc.).

A relevant environmental influence can be excluded by the implementation of the mentioned measures.

10.4 INFLUENCE ARISING BY WATER ABSTRACTION FROM THE LUKOVICA RIVER

Зафаќањето вода од реката Луковица е главна човечка интервенција во природата. Ова не е битно само за влијанието на организмите кои живеат во реката, но и за целокупната екологија на соседните еко-системи низводно. За да се избегне негативното влијание врз животната средина, количеството вода во реката Луковица не смее да падне под биолошкиот минимум. Со цел да се процени еколошкиот минимум треба да се земат предвид (I) измерениот минимум на реката Луковица и (II) живите организми во реката.

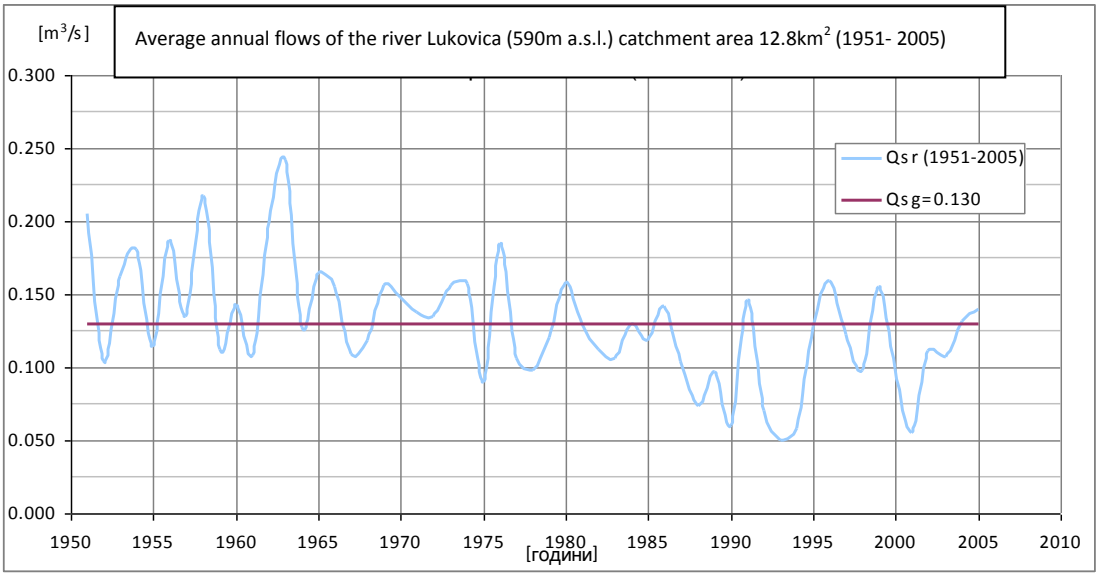


Figure 10.1 Avearge annual discharge of river Lukovica, 590 m a.s.l., 1951 – 2005

On the bases of the showed frequency distribution of the annual average discharge and under consideration of need for the living organisms in the river the ecological minimum for the Lukovica river flow rate will estimated on 10 % of average annual discharge with 0,13 m^3/s. By keeping of this ecological minimum will be minimized the environmental impact arisen by the water abstraction.

Beside, further investigations are recommended concerning the ecological minimum in order to safeguard the ecological system of the Lukovica River also for the long term.

<u>Influence arising by create water reservoir by construction of the dam on river Lukovica</u>

Positive effects will be result by create a water reservoir for the whole ecosystems due to the increasing of relative air humidity and modification of temperature extremes, because the change of the environmental conditions causes an increase of the biodiversity in the area.

10.4.1 Influence arising by Water transfer from Reservoir on river Lukovica to the Irrigation Area

For the transfer of the water from the reservoir on river Lukovica a pipeline will be constructed.

The construction of the pipeline will destroy a definite part, some of it irreversible, of the well preserved forest developing on the dale. However, the project intends to minimise the damage of the preserved nature.

When constructing the network it is best to follow the existing topographic conditions on the ground in terms of reduction of the facilities along the pipelines. Also in all cases is used the existing road infrastructure to reduce the investment required for construction of access roads and land expropriation.

10.4.2 Water or Soil Pollution arising by Agriculture

A significant soil and water pollution in principle can result from fertilisation and use of pesticides in the agriculture. The main causes for a soil and water pollution are the total area of agricultural land and the quality and quantity of used fertiliser and pesticides. The irrigation area will be increased by the planned measure. Therefore, a negative influence can in principle not be excluded. For a quantity assessment of the environmental impact there are not enough data. This deficit of data concerning the present soil pollution, the use of fertiliser and pesticides and a quantity description of all relevant sources for the pollution of the soil as well as the ground and surface water. Nevertheless it can be estimated that the consequences which result from the increased irrigation area will not be significant, because the additional irrigation area is relative small compared with the total agriculture are in this region.

Nevertheless the soil and water pollution generally is an serious problem. In the present not enough data exists about the soil and water pollution arising from agriculture. Therefore further investigations are necessary to get an overview about the situation and to generate suitable measures to limit the environmental impact on a reachable standard.

10.5 SUMMARY

The advantages of this project are obvious - more agricultural production, more potable water for the settlements in the municipality, improved living conditions and economic welfare. In comparison with these advantages the considered environmental aspects play only a subordinate role.

The environmental impacts of the construction and operation of the system are numerous and very complex, especially because of the dimensions of the area under consideration.

Environmental impacts by the construction works of the dam, as well as the construction of the pipelines for transferring of water from the reservoir on river Lukpvica are expected. That concerns especially the destruction and damaging of natural habitats especially

valuable forests. Nevertheless a relevant environmental influence can be excluded by implementation of mitigating measures as described in chapter 10.3.2.

The water abstraction from the Lukovica River is a major human intervention in the nature. This has possibly not only a influencing of the organisms which are living in the river but also the on the overall ecology of the neighbouring ecosystems downstream. To avoid an relevant negative environmental impact it must be saved that the amount of water flow rate in the Lukovica river never will be fall below the ecological minimum arisen by the water abstraction (see chapter 10.3.3).

Beside, further investigations are recommended concerning the ecological minimum in order to safeguard the ecological system of the Lukovica River also for the long term. The new water reservoir may positively affect the ecosystems close to it due to the increasing of relative air humidity and modification of temperature extremes.

With respect to the water or soil pollution arising by agriculture it should be mentioned, that further investigation is needed in order to get more information about the exact quantities of fertilisers and pesticides used in agriculture and the solid transport.

The purpose of these investigations should be to determine suitable measures to limit the environmental impact on a reachable standard.

11. PROJECT RISKS AND SUSTAINABILITY

The project for construction of mini-accumulation on the river Kosevicka and the irrigation system for the agricultural lands in the municipality Makedonska Kamenica is accompanied by certain risks upon its realization which are identified and classified in the table herein, analyzed through the following:

- Description of the project risk
- Probability for risk occurrence defined as low, middle or high
- Risk influence (i.e. affect of certain risk of achievability of the project) defined as low, middle or high;
- Strategy/actions for risks alleviation as well as overcoming and minimizing of the factual risk.

Risk description	Probability	Influence	Strategy/actions for alleviation
Non –provision of land for construction of the accumulation	Low	High	• The suggested location for the accumulation is not being used for agricultural production nor for any other purpose at the moment.
Access to finance	**High**	**High**	• Planning and verification of the Project development strategy including the strategy for provision of funds. • Identification of the potential resources of funding with non-refundable assets (national budget, MFI, development organizations/funds and etc) and organization of meetings for discussion of aims, terms, gains and perspectives of the project.
Delays in the construction of the dam, irrigation system and other appurtenance	Low to middle	Middle	• All planned structures are relatively simple and request mainly "standard" civil engineering works for their performance. • The constructor of the civil engineering works should be selected with monitoring of the stated/requested standards for operation effectiveness, selection criteria, former experience, and through procedure for competitive public procurement call. • There is a need of independent construction supervision. • The biggest part of the system equipment for irrigation is from domestic production. • The final selection of the entire equipment (especially the parts from the equipment that is to be imported) in reference to the capacity, the manufacturer and etc., should be based on detailed planning and to be conducted through procedure of competitive public procurement.
Contractual risk (in case of Public private partnership engagement for	Low to middle	Low to high	• Preparation of detailed and complete agreement. • Execution of transparent procedure for selection of private partner (system operator). • Creation and maintenance of partnership relations and

systems operation and maintenance)			confidence between the public and private partner.
Market risk (non-acceptance of the water fee by the end-users)	Low to middle	Low to middle	• Execution of continuous activities for promotion of the project and rising of the public awareness on local level (end-users) in connection with the project benefits. • Verification of the acceptance of the suggested fee policy by the end-users.
Risk with the expenses	Low	Low	• Granting of authorization and liability of the general and operative manager of the capacity for procurement and activities in reference to the capacity.
Political risk	Low	Low	• Not within the control of the Municipality, but the domain of operation is considered outside of possible political tensions.
Ecological risk	Low	Low	• Duly preparation of the entire relevant documentation for assessment of the influence on environment connected with the construction of the structures/systems. • Duly preparation of a plan for decreasing of possible influences and management plan for influences on the environment.
Lack of acceptance of the project by the public	Low to middle	Middle	• Continuous promotion of the project at the local population. • Obtaining of support by the local public institutions (PE, schools, etc) for the project.

Generally speaking, it is considered that the project has moderate risk for its success and sustainability. Actually, the highest risk considering the capacity and the possibilities of the Municipality to finance the investment by own budget means, is the aspect of the access to finance i.e. provision of sufficient financial means for project realization. All other risks, although with different potential possibility for occurrence and influence are considered to be relatively easy for management.

12. IMPLEMENTATION PLAN

On the basis of the findings from this assessment and the discussions during the various meetings it is recommended that the realization (development) of the project continues phase by phase and cover the following steps:

- Step 1: Adoption of Project Development strategy, including the strategy for provision of funds for realization.

- Step 2: Identification of sources for project funding with non-refundable means (Governmental funds or to development organizations/funds) and organization of meetings for discussion of the aims, terms, gains and the perspectives of the project.

- Step 3: Preparation of planning documents for the project: detailed technical project, Envoirmental Impact Assesment Study (including Social Imact Assesment Study), tender documents for construction.

- Step 4: Obtaining of building and ecological licenses.

- Step 5: Construction of the planned structures: dam, accumulation, irrigation system and mini hydroelectric power station.

- Step 6: Foundation of organizations for system management (PE Water Economy and Water Community), according to the recommendations.

- Step 7: Continuous promotion of the project.

The suggested phase access for implementation is expected to reduce to minimum the risks connected with the further project development including the identification of the financial means for realization as critical risk for the success of the project.

13. CONCLUSIONS AND RECOMMENDATIONS

The general aims of the Study are in essence directed towards the improvement of the living conditions for the population in the municipality Makedonska Kamenica i.e. sustainable development of the municipality and integrated management with the water resources of the river Kosevicka and the exploitation of its water potential.

On the other side the following have been highlighted as specific aims of the Study :

- Reviewed possibilities and evidencing of the justifiability for dam construction on the river Kosevicka
- Adopted optional solution for location, height and type of the accumulation on the river Kosevicka
- Recommendations regarding the economic and technical sustainability of the planned accumulation
- Protection and development of the environment with positive influences offered by the accumulation
- Protection and development of the water environment through rational and sustainable water exploitation
- Researched possibilities and potentials offered by the accumulation for tourism development
- Researched possibilities and potentials offered by the accumulation for energetic exploitation

The Study unites few different methodologies in dependence on the type of the executed analysis.

As future beneficiaries of the water potential of the river Kosevicka/Lukovicka pursuant the priority of their satisfaction, the following had been identified:

- Ecologically guaranteed flowing
- Water supplying to Makedonska Kamenica in the dry season period and complete water supplying to the settlement in the project area
- Water supplying of the future industrial zone and the thermal power station
- Irrigation of farmland in the vicinity of the village Kosevica and Lukovica
- Energetic exploitation of the spillway waters

For all of these beneficiaries we have computed multiannual needs of water (for the historical and projected period) where the largest beneficiary appears to be the irrigation with the participation of ~80% in reference to the total needs.

When we discuss the projected (foreseen) period (2006-2050) and the needs of irrigation water one can expect an increase of 9% of these needs under the influence of the climate changes and in comparison to the reference -historical period.

The proceeds is placed in function of the climate changes and the genetic potential of the above mentioned in order to assess the influence of the irrigation on the growth of the planned crops in the project area. The functional dependence indicates to the fact that the effect from the irrigation is huge and growth of around ~60% may be expected for the proceeds compared to the proceeds without irrigation.

Three Alternatives were analyzed for meeting of the beneficiaries' needs of water:

- Alternative 1 - Meeting of the needs of water for different beneficiaries with water pumping from the existing accumulation Kalimanci. This solution foresees construction of water wells in the close proximity of the accumulation and pumping station which shall distribute the water to different beneficiaries.
- Alternative 2 - Meeting of the needs of water for different beneficiaries with construction of two small accumulations along the river flow of the river Kosevicka/Lukovicka.
- The third alternative foresees construction of one accumulation on the river Lukovicka with height sufficient enough to suit the needs of all future beneficiaries. This Alternative foresees construction of a small weir above the village Kosevica which shall allow water to pool in sufficient quantities for water supplying of the population from the village Kosevica.

The suggested alternative solutions differ one from another besides the concept of meeting the needs of water for different beneficiaries also according to the type of the projected hydro technical structures. All significant structures are discussed and analyzed in detail from any aspects –technical as well as investment aspect.

The dams are projected to be built as rock-filled embankment with central clay core (with usage of the local resources). The irrigation network is projected to be developed in the two sub-zones (two sub-systems) as follows:

- Sub-system Lukovica with capacity of 250 ha
- Sub-system Kosevica with capacity of 60 ha.

At the setting of the network all the best endeavours had been put to adapt the network to the existing topographical conditions on the site in sense of attenuation of the structures along the length of the pipelines.

Contemporary irrigation equipment such as equipment for rainmaking and micro-irrigation (micro - drippers, drip irrigation system) in combination with fattening, i.e. with application of fertirgation.

The water economy (balance) analysis is conducted for all the suggested Alternatives but the most detailed description is provided for the third Alternative whereof the parameters (height of the dam and the volume of the accumulation) resulted, which shall entirely meet the needs of the potential beneficiaries with the requested provision. By optimized analysis it is stated that the accumulation (dam) should have the following physical features:

Label	Elevation	point	Volume	Feature
	masl	м	$10^6 m^3$	/
Zrk	595.0	0.0	0.000	River basin
Zmin	608.0	13.0	0.100	Dead/Minimum
Znor	619.5	24.5	0.620	Used/Normal
Zmax	621.0	26.0	0.720	Maximum
Zcrest	623.0	28.0		Crest

The analysis indicates to significant spillway waters during the spring months (out of which we calculated directly the electricity generation).

High values of provision of obtained volumes (frequent pooling of the accumulation). This occurrence is a result most of all to selected criteria of provision of the occurrence but also because of relatively small volume of accumulation in reference to the hydrological capacity of the river.

If in the water economy (balance) models we input the needs of water for different beneficiaries, climate, hydrological and elements which are part of the possible climate changes one can notice reduction of irrigation provision at the requested maximum coverage of the areas (F=310 ha) for 5% which is insignificant. Namely, the accumulation can respond to the possible climate changes without additional structural measures or adjusting.

Detailed financial analysis of the project is conducted which covers all three possible alternative solutions. The accumulative results and conclusions from the analysis are the following:

Fees: Planning of the fee policy for the analyzed project includes: (1) analysis of the requested fees (price per water per m³ for irrigation and water supplying which shall provide the coverage of the total project expenses; (2) analysis of the affordability (acceptability) of these fees and (3) definition of the final proposal of the fee policy. On the basis of the previously described analysis, the following fee policy for the project is suggested:

Start Tariff	€/m^3	0.08	MKD/m^3	5.0	€/ha	243.9	MKD/ha	15,000
Average Tariff	€/m^3	0.10	MKD/m^3	6.2	€/ha	304.8	MKD/ha	18,700
Max Tariff	€/m^3	0.11	MKD/m^3	6.9	€/ha	334.8	MKD/ha	20,600

Such fees are considered to be affordable and acceptable for the end-users and thus a high level of fee collection is expected and by this provision of financial sustainability of the system.

Project net financial gain: The accumulative results from the analysis are given hereunder:

Alternative	**Financial net current value (@5%) (EUR)**
Alternative 1	**-3,464,772**
Alternative 2	**-4,836,753**
Alternative 3	**-3,542,388**

All alternatives have negative net current value and they do not prove themselves as financially feasible which means that the incomes generated on the basis of the assumed fees for services and from the electricity generation cannot cover the investment and the total costs i.e. they do not provide sustainable operability of the system.

Selection of alternative solution: as the most favourable solution is Alternative number 3. The selection is based on the following:

- Alternative 3 together with Alternative 1 have the lowest net current value i.e. the two analyzed Alternatives 1 and 3 have almost identical financial performances.

- Lower operational and maintenance costs and replacement costs at Alternative no.3 have direct influence on the service fees i.e. they result in significantly smaller prices for м^3 supplied water for irrigation and water supplying.
- Even if the capital costs are to be covered by Grant and besides the larger total incomes in Alternative 2 as a result of larger electricity generation compared to the Alternative 3, which shall result in the lowest water fees for coverage of the ongoing costs, still Alternative 2 is rejected because of relatively huge initial investment.
- The possibility for electricity generation with usage of renewable resource (hydro energy) at Alternative 3 compared to Alternative 1 provides additional - besides higher fiscal incomes - "ecological" benefits from the projects through reduction of emission of greenhouse gases.
- Finally, one of the most important factor for selection of Alternative no.3 is that the key infrastructural structure – accumulation – subject to the appropriate technical solution has significantly longer period of exploitation compared to the pumping station in Alternative 1.
- As additional advantage of Alternative 3 compared to Alternative 1 is the protection of the accumulation Kalimanci from the alluvium which is generated in the drainage basin of the river Lukovicka.
- Also as another significant advantage to Alternative 3 compared to Alternative 1, is the opportunity for tourism and fishery development.
- As last but not the least of importance advantage of Alternative 3 compared to Alternative 2 is the possibility for compliance of the third Alternative with the tender of the Government of Republic of Macedonia for construction of small hydroelectric power stations. This tender projects construction of two small power stations (with number 337 and 338) along the river flow of the river Lukovica/Kosevica in the proximity of the location of the future dams

Detailed economic analysis of the project is conducted for the selected Alternative 3. The accumulative results from the assessment of the economic performances of the project looking from the aspect of the entire local community and on the basis of the comparison between the expenses and the benefits with applied corrections because of price adjustments and externalities are the following:

ENCV (@5% discount rate)	**€7,349,667**
EIRR	**16.58%**

On the basis of the calculated project achievement indexes (ENCV and EIRR[9]), it can be concluded that the project is economically remunerative and it shall result in significant benefits and increase of the social welfare of the local community. This means that the total net project benefits (at provided return on investments and coverage of all ongoing project

[9] ENCV- Economic net current value ; EIRR- Economic internal rate of return.

costs) in the analyzed period of 25 years of exploitation have current positive value of €7.35 million and internal (annual) rate of return on investment of 16.6%.

On the basis of detailed analysis of the sensitivity and risks upon the achievement of the projected economic performances of the project it had been concluded that the possible changes/deviations of the incomes from the increased agricultural production have largest influence on the possible changes of the EIRR, although it does not constitute critically large influence. Also, it is concluded that there is not more than 50% probability that EIRR shall be less than the projected initial value of 16.6%. Further on, it is summarized that the project has relatively high probability of 75% in order to achieve EIRR of 15.6% which is considered to be acceptable index of economic achievement for one public project.

The risk in reference to the success and sustainability of the project is deemed moderate. The highest risk lies in the provision of sufficient financial means for project realization. All other risks although with different potential for occurrence and influence are considered to be controllable. In order to minimise the risks it is recommended that the project is conducted phase by phase pursuant the steps described in the Study.

General assessment of the positive and negative influences by the project on the environment had been conducted from any perspectives. Regarding the influences on the environment general conclusion is that there are no serious issues which have been identified at the pooling of water from the river basin of the river Lukovica pursuant Alternative 3. The changes are insignificant, and on the other side the reduction of the water would not have any influence on the biological minimum of the flow in the river Lukovica which is guaranteed.

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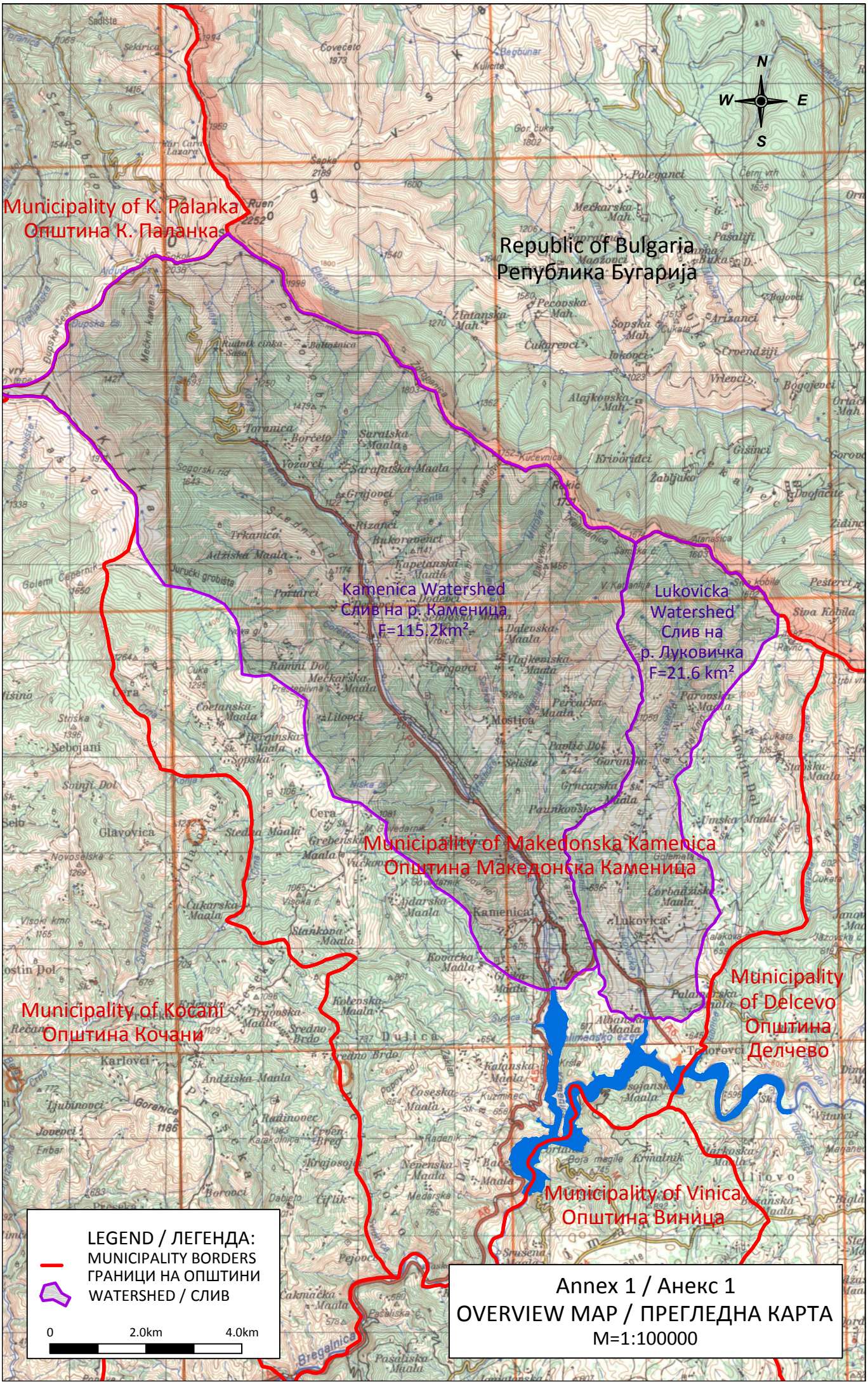
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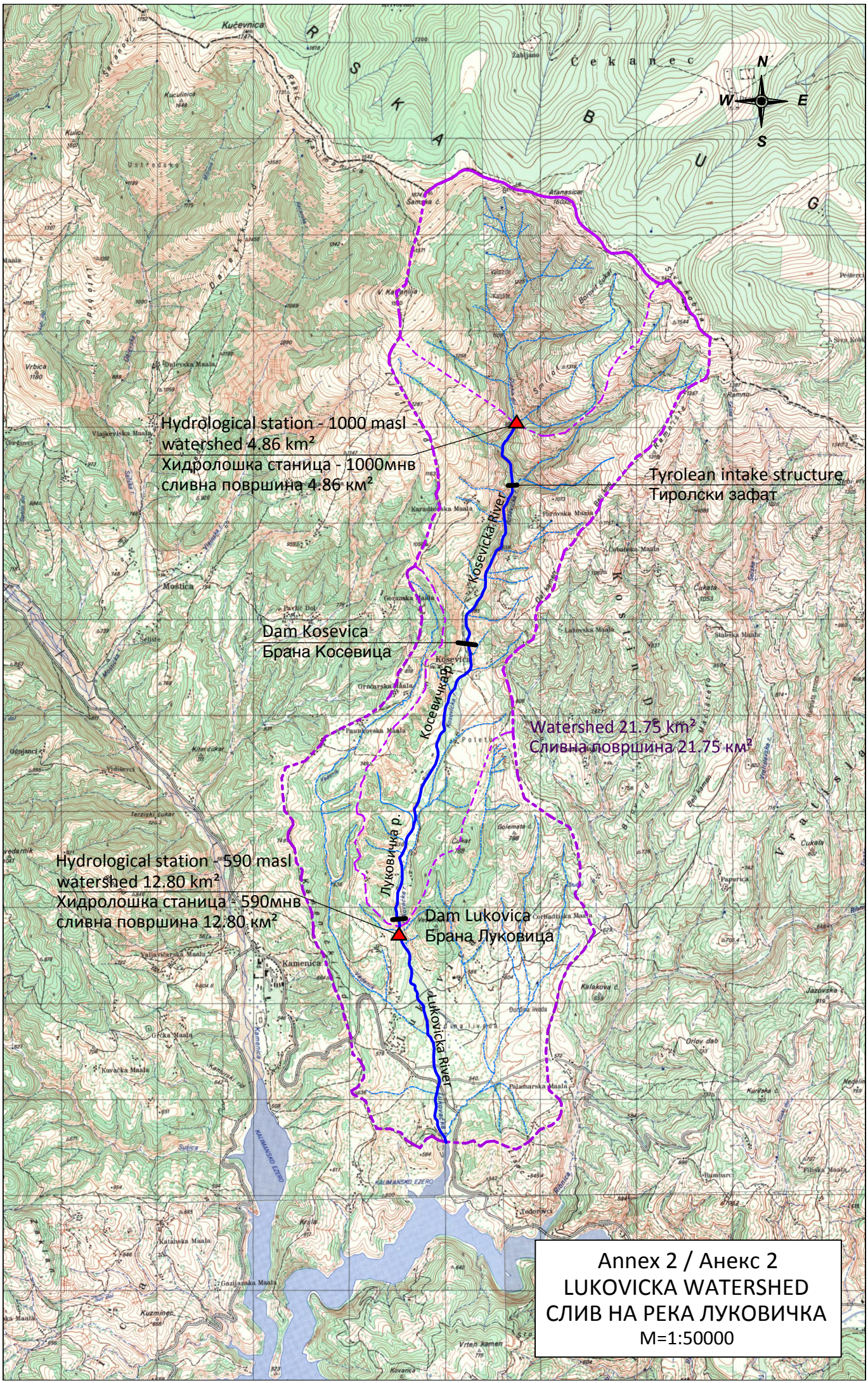
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План за Локален Економски Развој на Општина Македонска Каменица


N
W
E
S
Municipality of K. Palanka
Општина К. Паланка
Republic of Bulgaria
Република Бугарија
Kamenica Watershed
Слив на р. Каменица
F=115.2km²
Lukovicka
Watershed
Слив на
р. Луковичка
F=21.6 km²
Municipality of Makedonska Kamenica
Општина Македонска Каменица
Municipality of Kocani
Општина Кочани
Municipality
of Delcevo
Општина
Делчево
Municipality of Vinica
Општина Виница
LEGEND / ЛЕГЕНДА:
MUNICIPALITY BORDERS
ГРАНИЦИ НА ОПШТИНИ
WATERSHED / СЛИВ
0
2.0km
4.0km
Annex 1 / Анекс 1
OVERVIEW MAP / ПРЕГЛЕДНА КАРТА
M=1:100000



Annex 2 / Анекс 2
LUKOVICKA WATERSHED
СЛИВ НА РЕКА ЛУКОВИЧКА
M=1:50000

LEGEND / ЛЕГЕНДА:
SETTLEMENT
НАСЕЛЕНО МЕСТО
RIVERS / РЕКИ
ROADS / ПАТИШТА
IRRIGATION AREA
ВКУПНА ПОВРШИНА КОЈА СЕ НАВОДНУВА

0 1km

N
W E
S

Tank 2
Изливен базен 2
Kt=760mnv

Kosevica
Косевица

IS Kosevica
MC Косевица
$F_{нет}$=60ha,
Q=60l/s

Косевичка река

Kosevicka River

пат М. Каменица - Рудник Саса
road M. Kamenica - Mine Sasa

Каменичка река

Pump station
Пумпна станица

Existing water supply tank
Постоен резервоар за водоснабдување

Tank 1
Изливен базен 1
Kt=620 mnv

Makedonska Kamenica
Македонска Каменица

IS Lukovica
MC Луковица
$F_{нет}$=250ha,
Q=210l/s

Lukovica
Луковица

Луковичка река

Ribnicka River

Магистрален пат Кочани - Берово
Road Kocani - Berovo

Lukovicka River

Рибничка река

Accumulation Kalimanci

Borehole area
Бунарско подрачје

Todorovci
Тодоровци

Акумулација Калиманци

Annex 3 / Анекс 3
ALTERNATIVE 1 / АЛТЕРНАТИВА 1
OVERVIEW MAP / ПРЕГЛЕДНА КАРТА
M=1:20000

LEGEND / ЛЕГЕНДА:
SETTLEMENT
НАСЕЛЕНО МЕСТО
RIVERS / РЕКИ
ROADS / ПАТИШТА
IRRIGATION AREA
ВКУПНА ПОВРШИНА КОЈА СЕ НАВОДНУВА

0 1km

N
W E
S

Dam Kosevica
Брана Косевица
H=26m,
V=300,000m³

Kosevica
Косевица

Косевичка река

IS Kosevica
МС Косевица
$F_{нет}$=60ha,
Q=60l/s

Kosevicka River

пат М. Каменица - Рудник Саса
road M. Kamenica - Mine Sasa

Каменичка река

Dam Lukovica
Брана Луковица
H=25m,
V=380,000m³

Existing water supply tank
Постоен резервоар за водоснабдување

Makedonska Kamenica
Македонска Каменица

Booster station
Бустер станица

Луковичка река

IS Lukovica
МС Луковица
$F_{нет}$=250ha,
Q=210l/s

Ribnicka River

Lukovica
Луковица

Lukovicka River

Магистрален пат Кочани - Берово
Road Kocani - Berovo

Рибничка река

Accumulation Kalimanci

Todorovci
Тодоровци

Акумулација Калиманци

Annex 4 / Анекс 4
ALTERNATIVE 2 / АЛТЕРНАТИВА 2
OVERVIEW MAP / ПРЕГЛЕДНА КАРТА
M=1:20000

LEGEND / ЛЕГЕНДА:
SETTLEMENT
НАСЕЛЕНО МЕСТО
RIVERS / РЕКИ
ROADS / ПАТИШТА
IRRIGATION AREA
ВКУПНА ПОВРШИНА КОЈА СЕ НАВОДНУВА

0 1km

N
W E
S

Tyrolean intake structure for water suppling of Kosevica
Тиролски зафат за водоснабдување на Косевица

Tank
Изливен базен
Kt=760mnv

Kosevica
Косевица

Косевичка река

IS Kosevica
МС Косевица
$F_{нет}$=60ha,
Q=60l/s

Kosevicka River

Pump station
Пумпна станица

Dam Lukovica
Брана Луковица
H=28m,
V=620,000m³

Existing water supply tank
Постоен резервоар за водоснабдување

Makedonska Kamenica
Македонска Каменица

Booster station
Бустер станица

Lukovica
Луковица

Луковичка река

Lukovicka River

IS Lukovica
МС Луковица
$F_{нет}$=250ha,
Q=210l/s

Ribnicka River

Рибничка река

Пат М. Каменица - Рудник Саса
road M. Kamenica - Mine Sasa

Каменичка река

Магистрален пат Кочани - Берово
Road Kocani - Berovo

Accumulation Kalimanci

Todorovci
Тодоровци

Annex 5 / Анекс 5
ALTERNATIVE 3 / АЛТЕРНАТИВА 3
OVERVIEW MAP / ПРЕГЛЕДНА КАРТА
M=1:20000

N
W E
S

634000
658000

634500
658000

800.00
790.00
780.00
770.00
760.00
750.00

1
2

634000
657500

634500
657500

LEGEND/ЛЕГЕНДА:
① DIVERSON TUNNEL (BOTTOM OUTLET)
ОПТОЧЕН ТУНЕЛ (ТЕМЕЛЕН ИСПУСТ)
② SPILLWAY/ПРЕЛИВЕН ОРГАН

Annex 6 / Анекс 6
LAYOUT OF DAM KOSEVICA (Alt. 2, H=26m)
СИТУАЦИЈА НА БРАНА КОСЕВИЦА (Алт. 2, H=26m)
M=1:2500

N
W
E
S
633500
655500
633500
655000
640.00
630.00
620.00
610.00
600.00
610.00
620.00
630.00
640.00
1
2

LEGEND / ЛЕГЕНДА:
① DIVERSON TUNNEL (BOTTOM OUTLET)
ОПТОЧЕН ТУНЕЛ (ТЕМЕЛЕН ИСПУСТ)
② SPILLWAY / ПРЕЛИВЕН ОРГАН

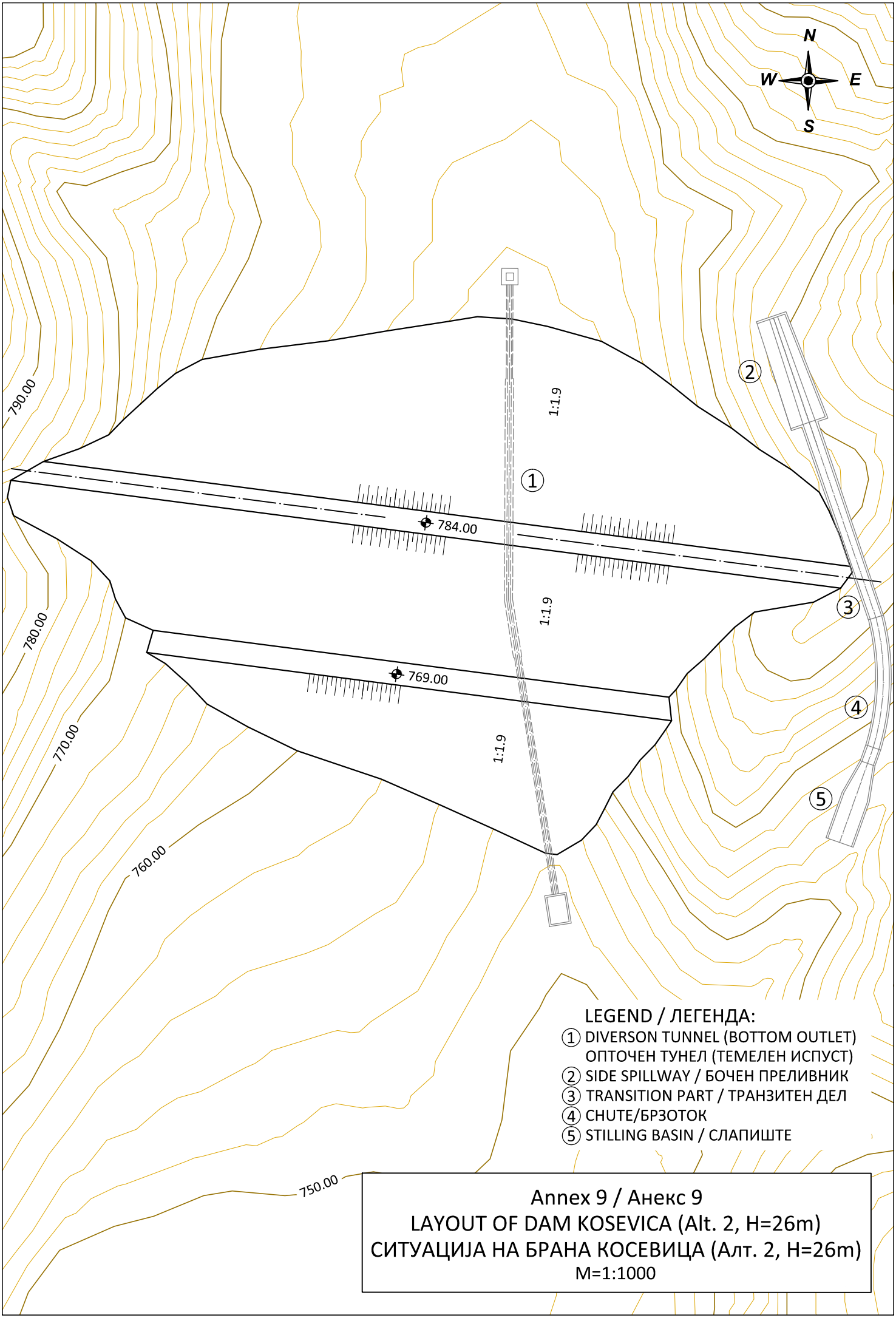
Annex 7 / Анекс 7
LAYOUT OF DAM LUKOVICA (Alt. 2, H=25m)
СИТУАЦИЈА НА БРАНА ЛУКОВИЦА (Алт. 2, H=25m)
M=1:2500

N
W
E
S

633500
655500
633500
655000
640.00
630.00
620.00
610.00
600.00
610.00
620.00
630.00
640.00
2
1

LEGEND / ЛЕГЕНДА:
① DIVERSON TUNNEL (BOTTOM OUTLET)
ОПТОЧЕН ТУНЕЛ (ТЕМЕЛЕН ИСПУСТ)
② SPILLWAY / ПРЕЛИВЕН ОРГАН

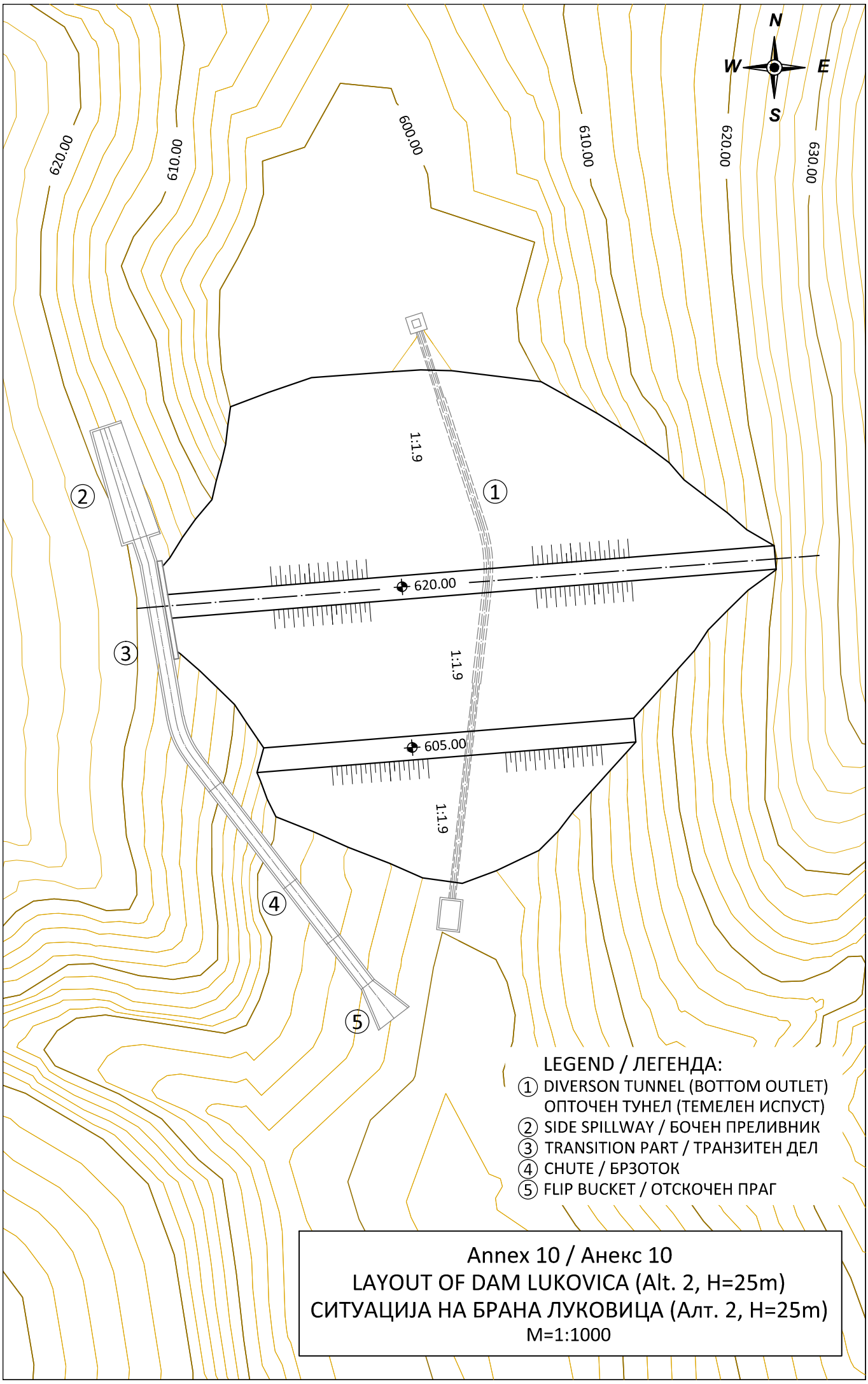
Annex 8 / Анекс 8
LAYOUT OF DAM LUKOVICA (Alt. 3, H=28m)
СИТУАЦИЈА НА БРАНА ЛУКОВИЦА (Алт. 3, H=28m)
M=1:2500



LEGEND / ЛЕГЕНДА:

① DIVERSON TUNNEL (BOTTOM OUTLET)
ОПТОЧЕН ТУНЕЛ (ТЕМЕЛЕН ИСПУСТ)
② SIDE SPILLWAY / БОЧЕН ПРЕЛИВНИК
③ TRANSITION PART / ТРАНЗИТЕН ДЕЛ
④ CHUTE/БРЗОТОК
⑤ STILLING BASIN / СЛАПИШТЕ

Annex 9 / Анекс 9
LAYOUT OF DAM KOSEVICA (Alt. 2, H=26m)
СИТУАЦИЈА НА БРАНА КОСЕВИЦА (Алт. 2, H=26m)
M=1:1000

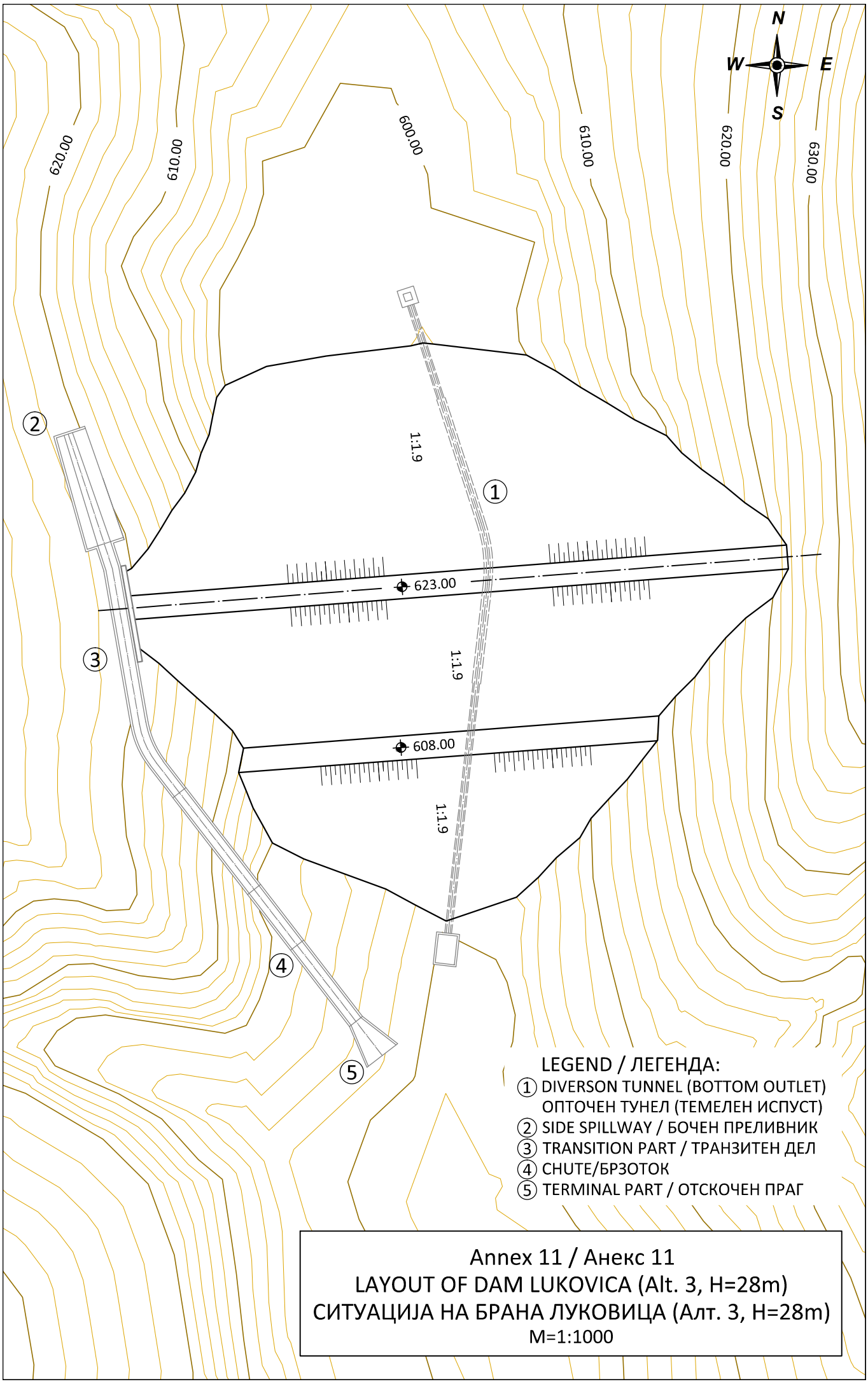


Annex 10 / Анекс 10

LAYOUT OF DAM LUKOVICA (Alt. 2, H=25m)

СИТУАЦИЈА НА БРАНА ЛУКОВИЦА (Алт. 2, H=25m)

M=1:1000

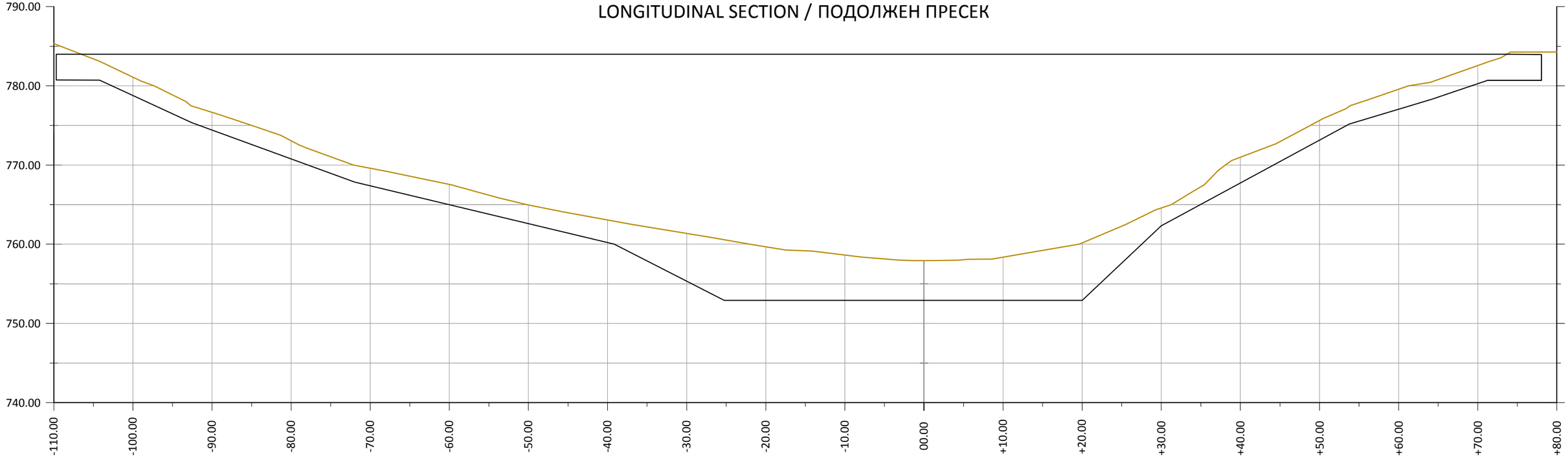


LEGEND / ЛЕГЕНДА:

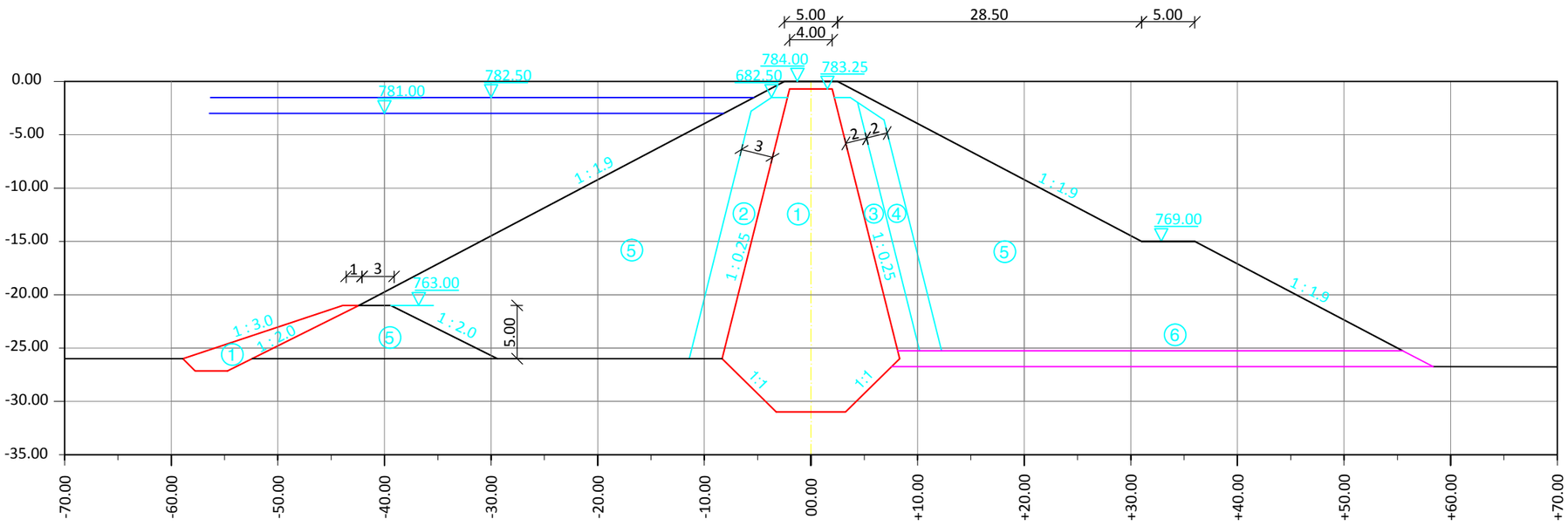
① DIVERSON TUNNEL (BOTTOM OUTLET)
ОПТОЧЕН ТУНЕЛ (ТЕМЕЛЕН ИСПУСТ)
② SIDE SPILLWAY / БОЧЕН ПРЕЛИВНИК
③ TRANSITION PART / ТРАНЗИТЕН ДЕЛ
④ CHUTE/БРЗОТОК
⑤ TERMINAL PART / ОТСКОЧЕН ПРАГ

Annex 11 / Анекс 11
LAYOUT OF DAM LUKOVICA (Alt. 3, H=28m)
СИТУАЦИЈА НА БРАНА ЛУКОВИЦА (Алт. 3, H=28m)
M=1:1000

LONGITUDINAL SECTION / ПОДОЛЖЕН ПРЕСЕК



TYPICAL CROSS SECTION / КАРАКТЕРИСТИЧЕН ПОПРЕЧЕН ПРЕСЕК



LEGEND / ЛЕГЕНДА:

① LOAM CORE / ГЛИНЕНО ЈАДРО
② UPSTREAM FILTER LAYER / СПРОТИВОДЕН ФИЛТЕР
③ DOWNSTREAM FILTER LAYER / НИЗВОДЕН ФИЛТЕР
④ DOWNSTREAM FILTER LAYER / НИЗВОДЕН ФИЛТЕР
⑤ ROCKFILL / КАМЕН
⑥ DRAINAGE / ДРЕНАЖА

Alternative 2 / Алтернатива 2

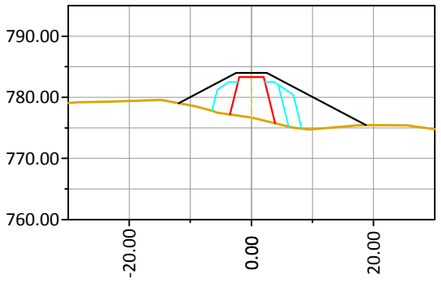
Annex 12 / Анекс 12
LONGITUDINAL AND TYPICAL CROSS SECTION OF DAM KOSEVICA (Alt. 2, H=26m)
ПОДОЛЖЕН И КАРАКТ. ПОПРЕЧЕН ПРЕСЕК НА БРАНА КОСЕВИЦА (Alt. 2, H=26m)
M=1:500

Annex 13 / Анекс 13

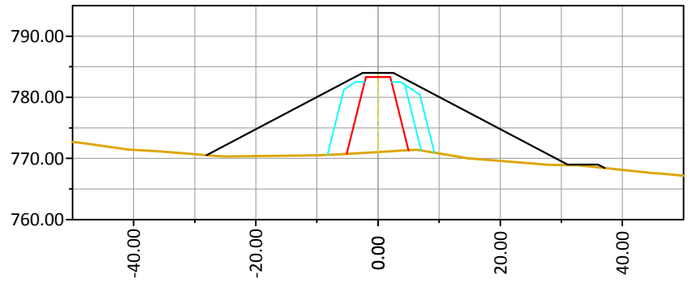
CROSS SECTIONS OF DAM KOSEVICA (H=26m) / ПОПРЕЧНИ ПРЕСЕЦИ НА БРАНА КОСЕВИЦА (H=26m)

M=1:1000

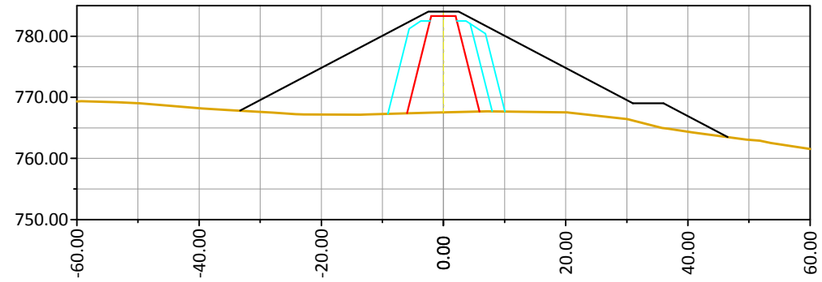
ст. - 90.00



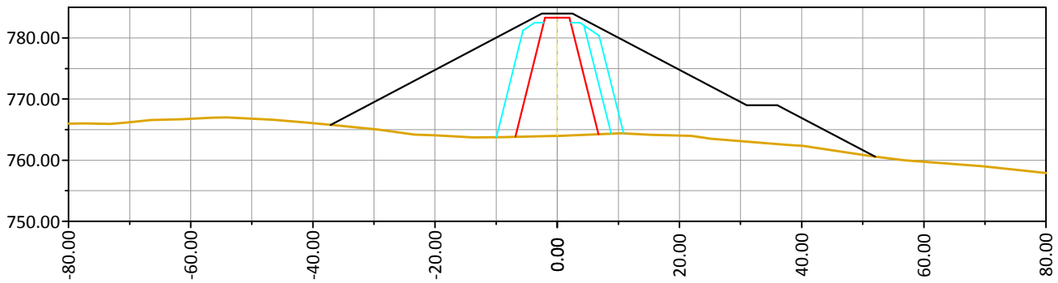
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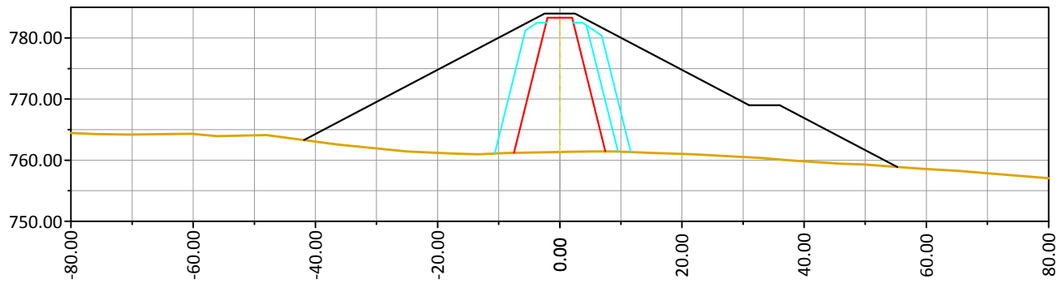
ст. - 60.00



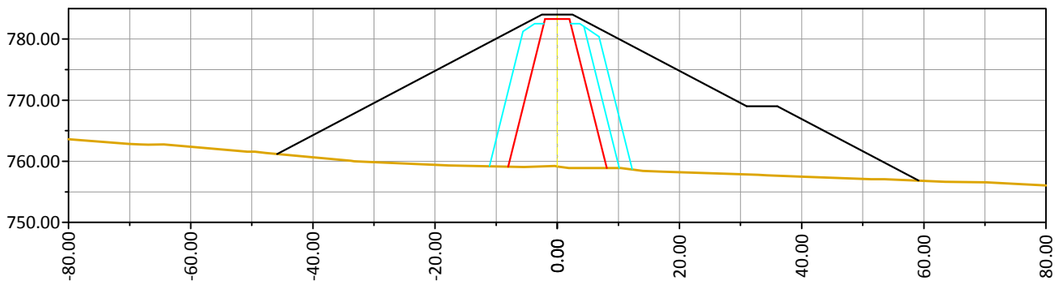
ст. - 45.00



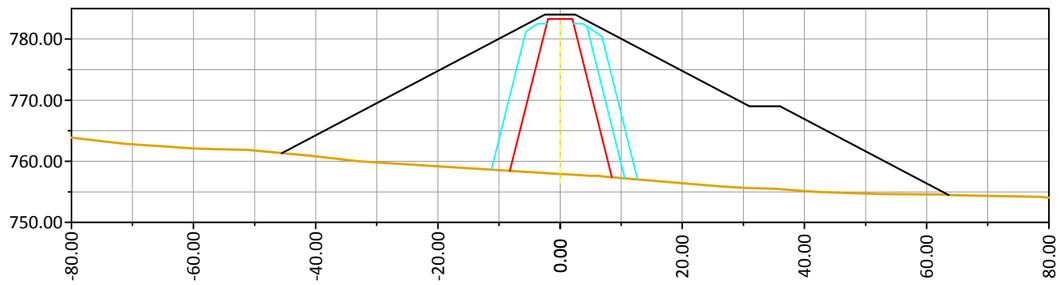
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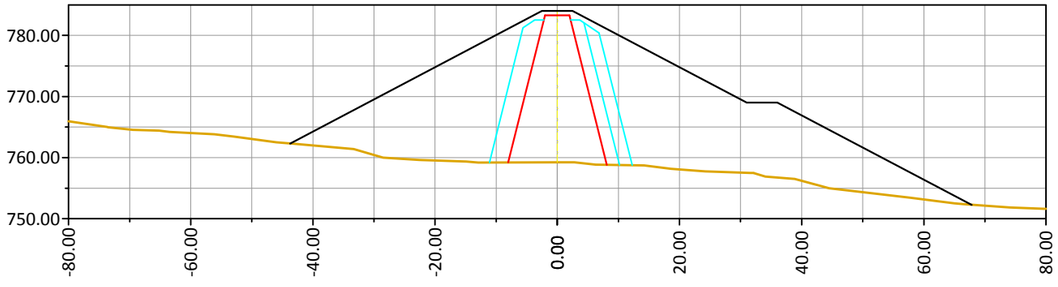
ст. - 15.00



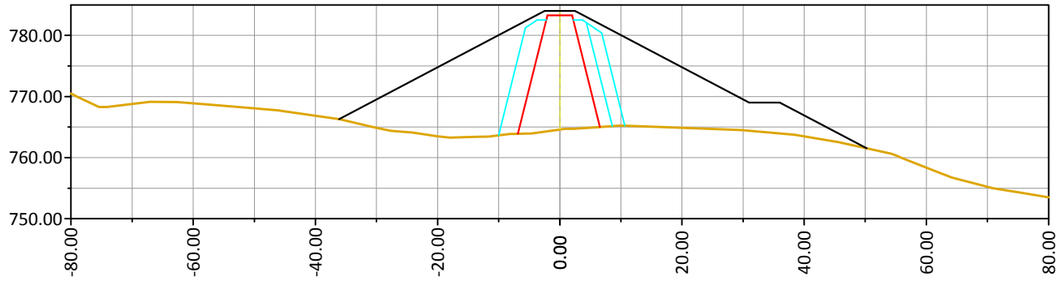
ст. 00.00



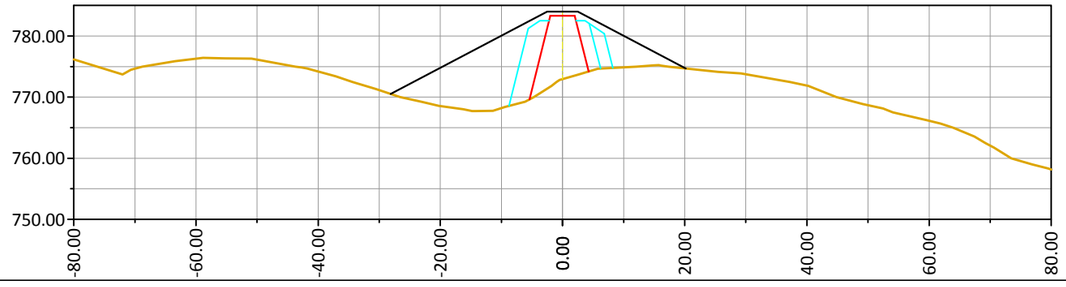
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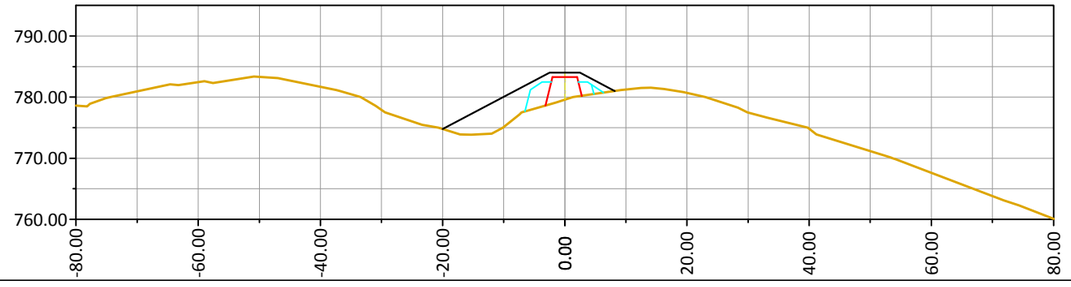
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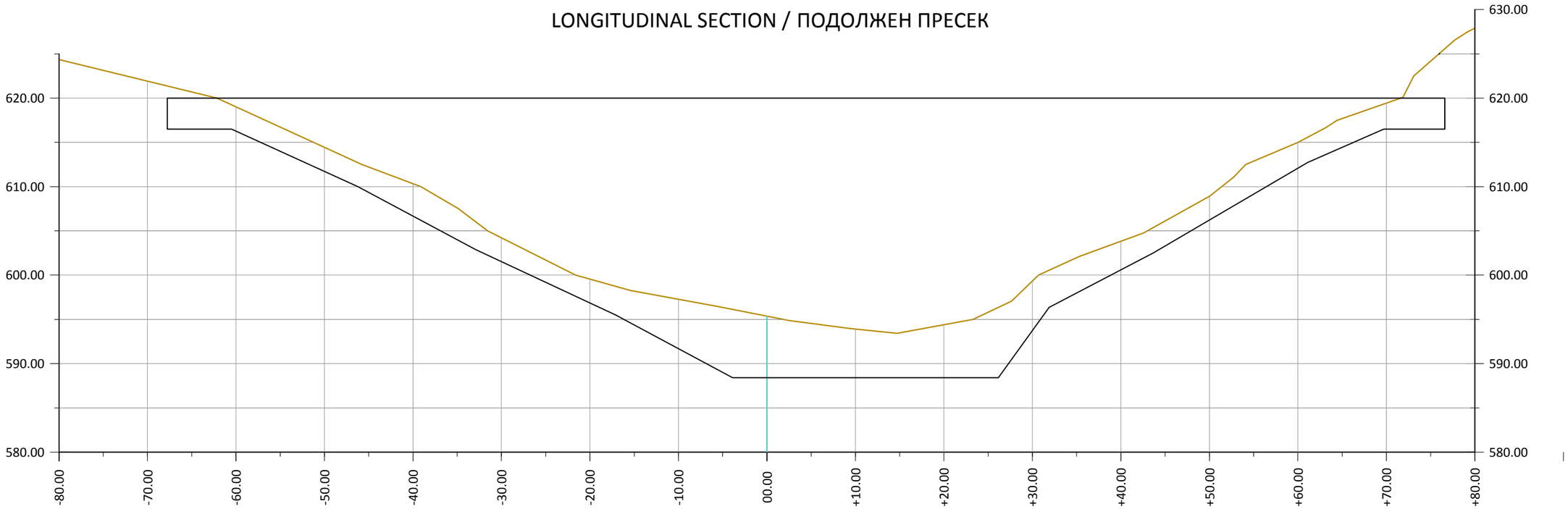
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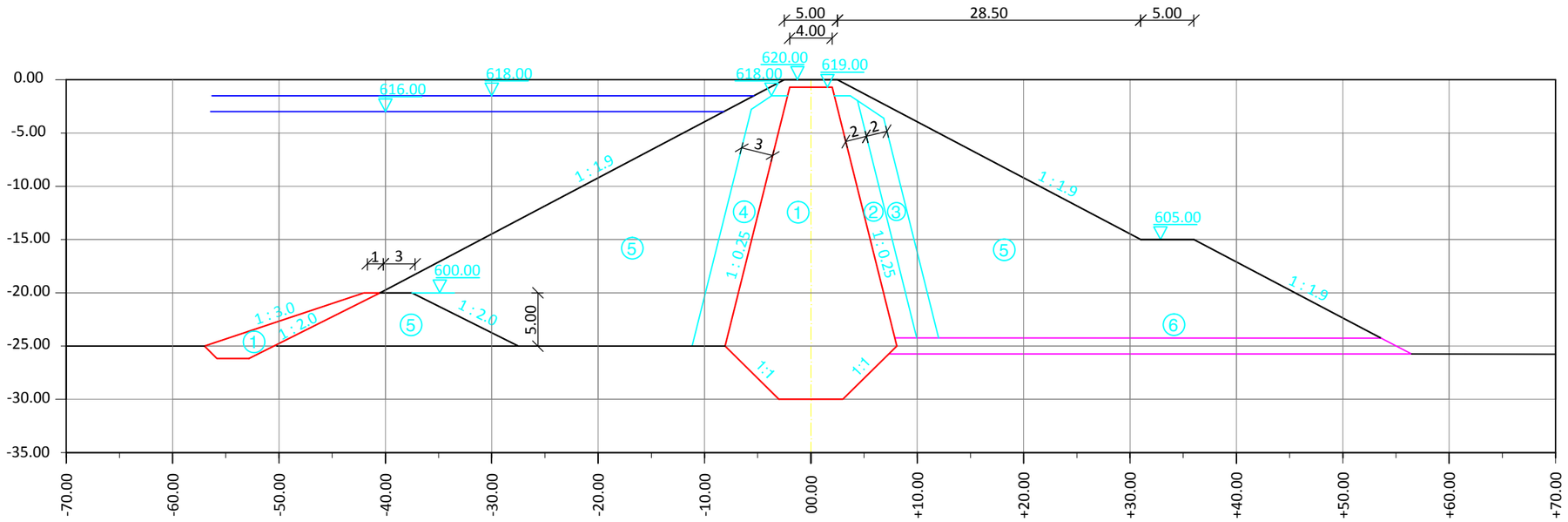
ст. +60.00



LONGITUDINAL SECTION / ПОДОЛЖЕН ПРЕСЕК



TYPICAL CROSS SECTION / КАРАКТЕРИСТИЧЕН ПОПРЕЧЕН ПРЕСЕК



LEGEND / ЛЕГЕНДА:

① LOAM CORE / ГЛИНЕНО ЈАДРО
② UPSTREAM FILTER LAYER / СПРОТИВОДЕН ФИЛТЕР
③ DOWNSTREAM FILTER LAYER / НИЗВОДЕН ФИЛТЕР
④ DOWNSTREAM FILTER LAYER / НИЗВОДЕН ФИЛТЕР
⑤ ROCKFILL / КАМЕН
⑥ DRAINAGE / ДРЕНАЖА

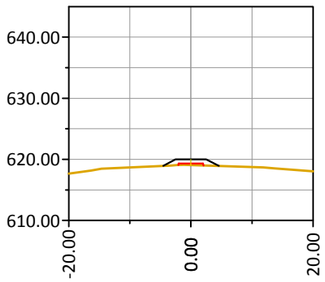
Annex 14 / Анекс 14
LONGITUDINAL AND TYPICAL CROSS SECTION OF DAM LUKOVICA (Alt. 2, H=25m)
ПОДОЛЖЕН И КАРАКТ. ПОПРЕЧЕН ПРЕСЕК НА БРАНА ЛУКОВИЦА (Алт. 2, H=25m)
M=1:500

Annex 15 / Анекс 15

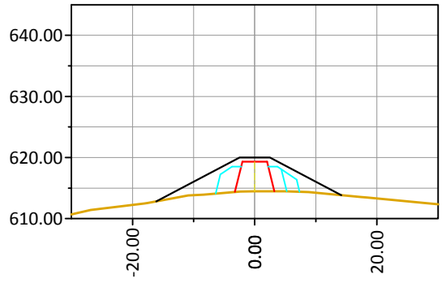
CROSS SECTIONS OF DAM LUKOVICA (H=26m) / ПОПРЕЧНИ ПРЕСЕЦИ НА БРАНА ЛУКОВИЦА (H=25m)

M=1:1000

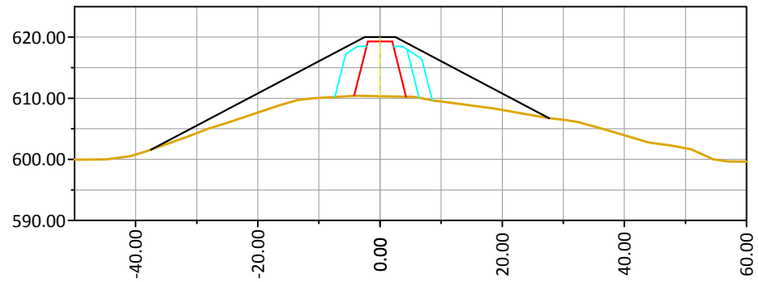
ст. - 60.00



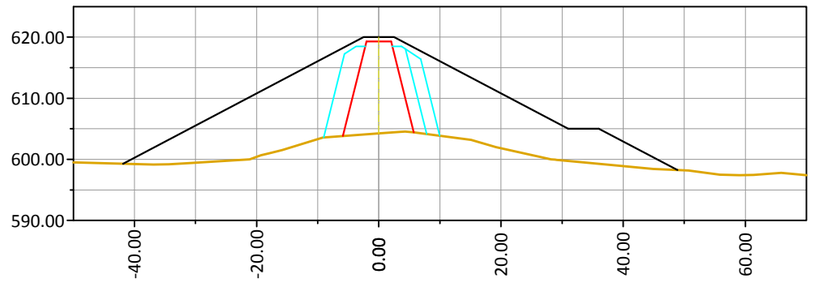
ст. - 50.00



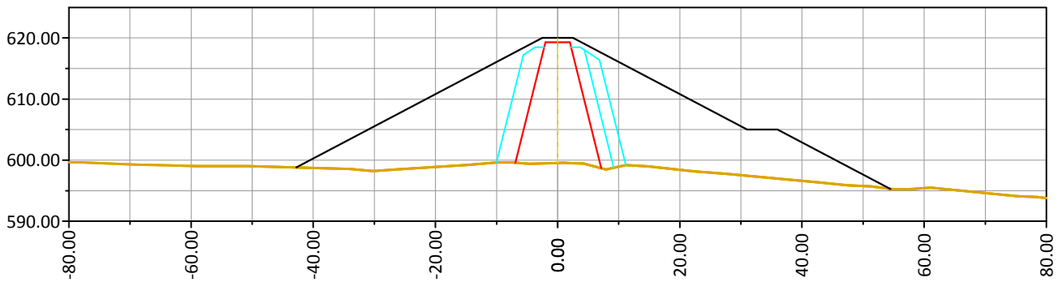
ст. - 40.00



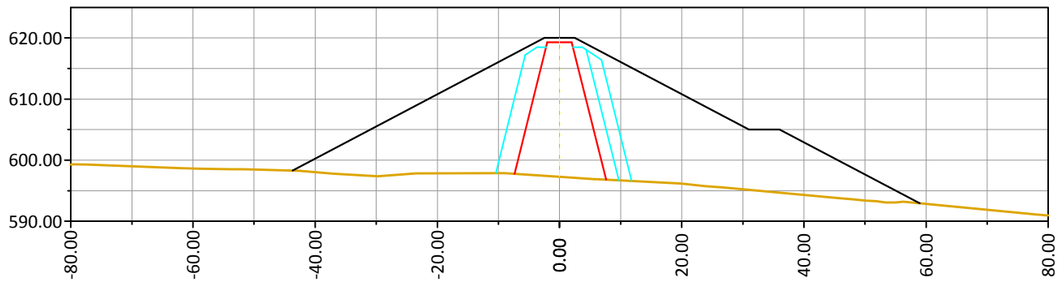
ст. - 30.00



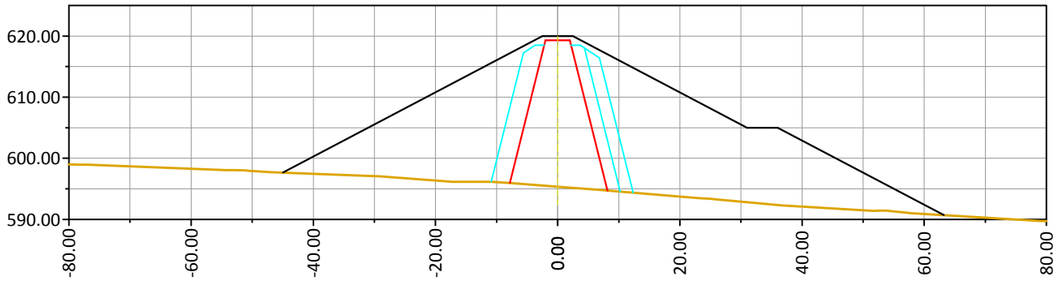
ст. - 20.00



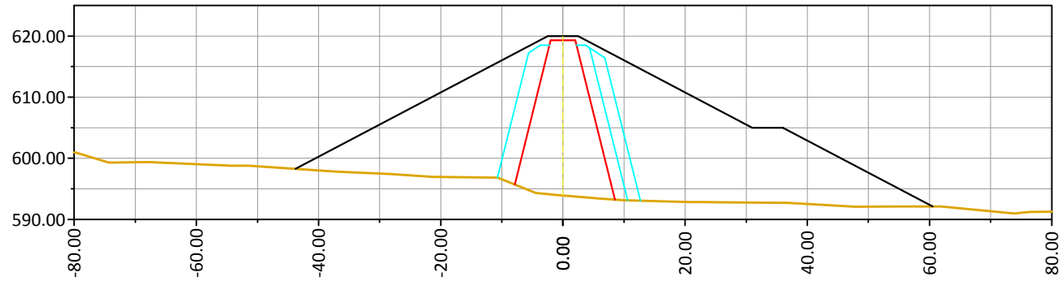
ст. - 10.00



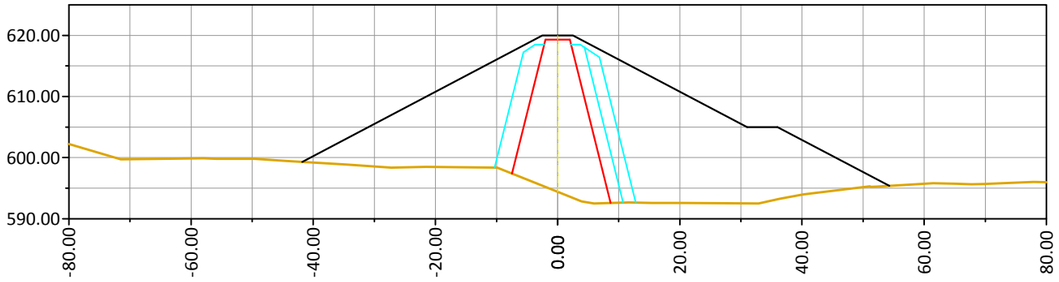
ст. 00.00



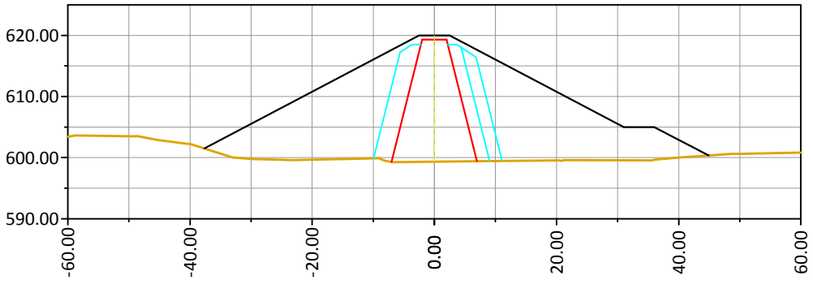
ст. + 10.00



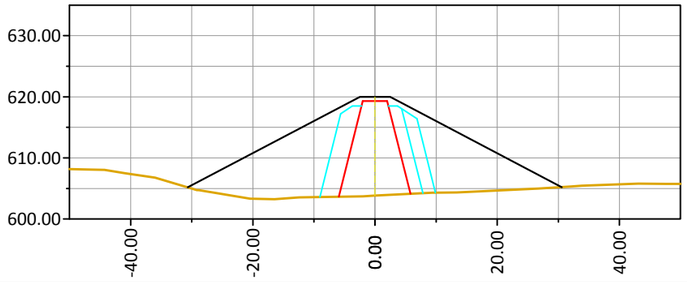
ст. + 20.00



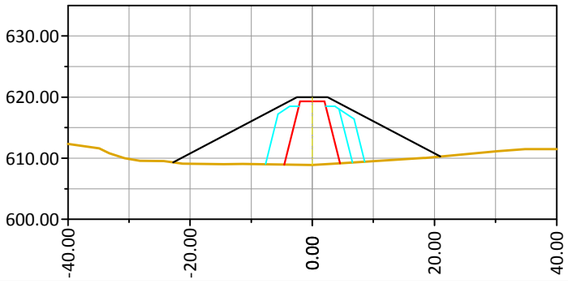
ст. + 30.00



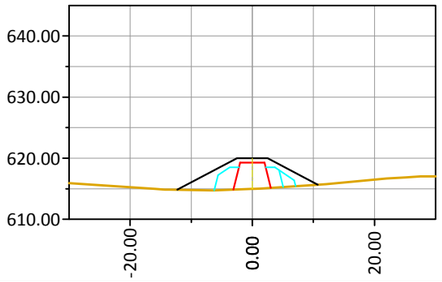
ст. + 40.00



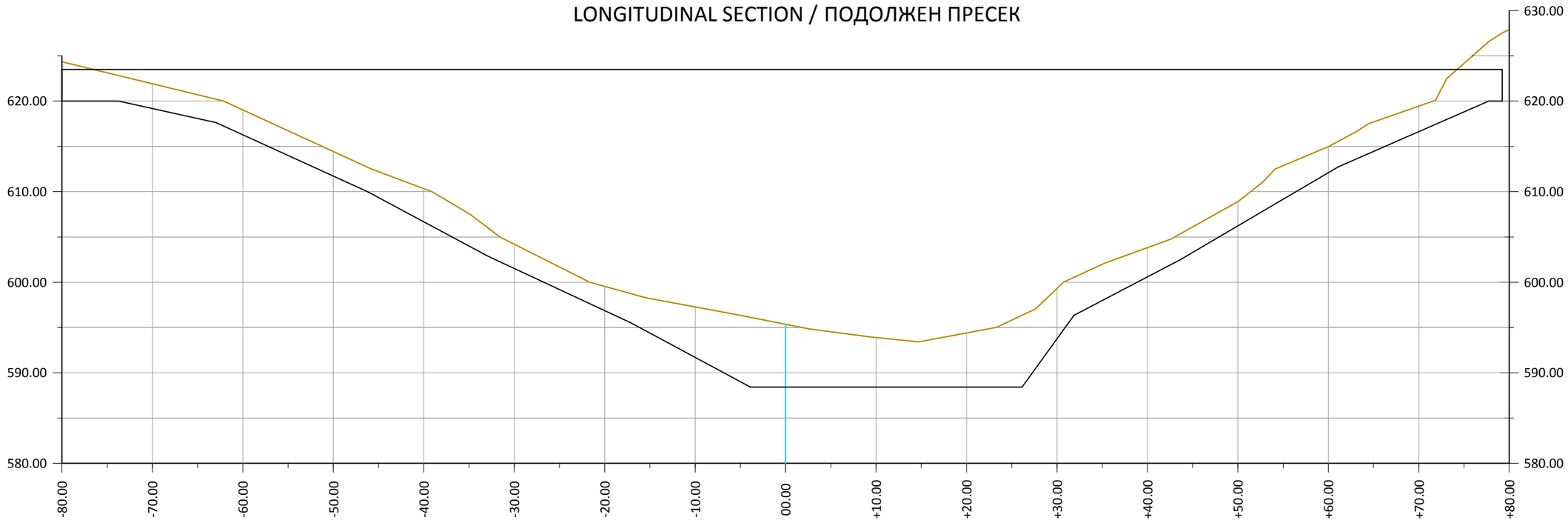
ст. + 50.00



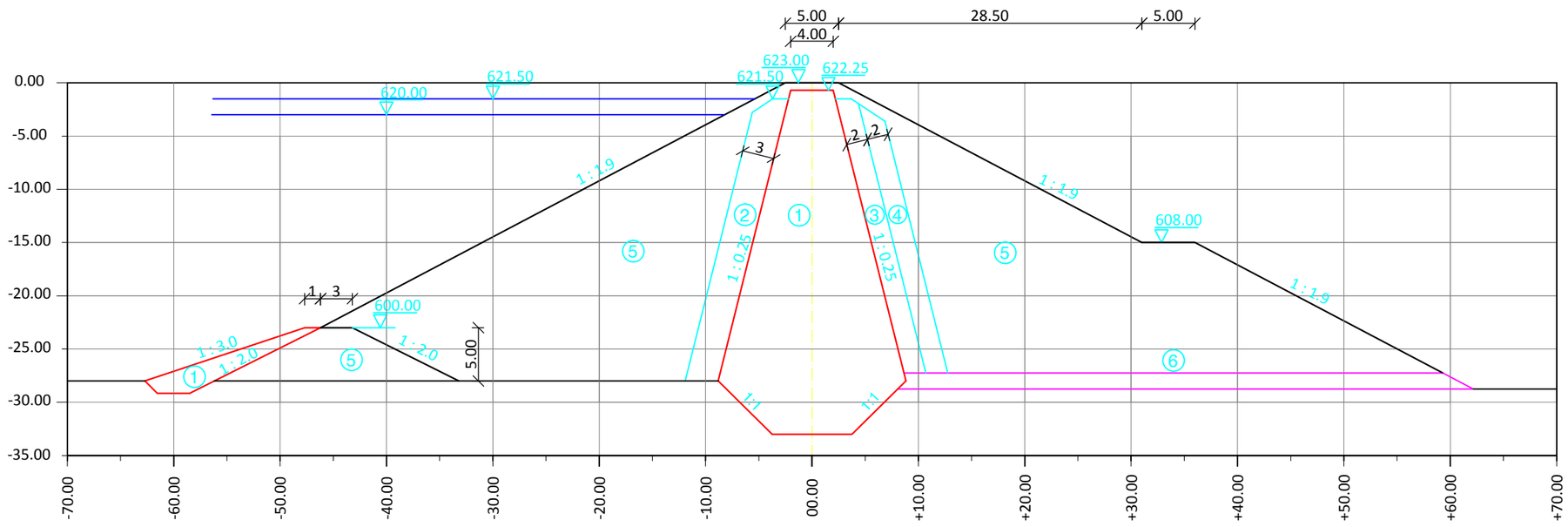
ст. + 60.00



LONGITUDINAL SECTION / ПОДОЛЖЕН ПРЕСЕК



TYPICAL CROSS SECTION / КАРАКТЕРИСТИЧЕН ПОПРЕЧЕН ПРЕСЕК



LEGEND / ЛЕГЕНДА:

① LOAM CORE / ГЛИНЕНО ЈАДРО
② UPSTREAM FILTER LAYER / СПРОТИВОДЕН ФИЛТЕР
③ DOWNSTREAM FILTER LAYER / НИЗВОДЕН ФИЛТЕР
④ DOWNSTREAM FILTER LAYER / НИЗВОДЕН ФИЛТЕР
⑤ ROCKFILL / КАМЕН
⑥ DRAINAGE / ДРЕНАЖА

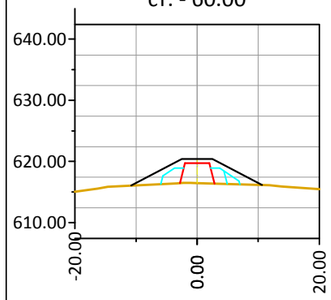
Annex 16 / Анекс 16
LONGITUDINAL AND TYPICAL CROSS SECTION OF DAM LUKOVICA (Alt.3, H=28m)
ПОДОЛЖЕН И КАРАКТ. ПОПРЕЧЕН ПРЕСЕК НА БРАНА ЛУКОВИЦА (Алт.3, H=28m)
M=1:500

Annex 17 / Анекс 17

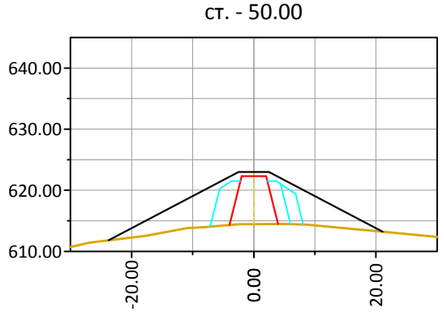
CROSS SECTIONS OF DAM LUKOVICA (H=28m) / ПОПРЕЧНИ ПРЕСЕЦИ НА БРАНА ЛУКОВИЦА (H=28m)

M=1:1000

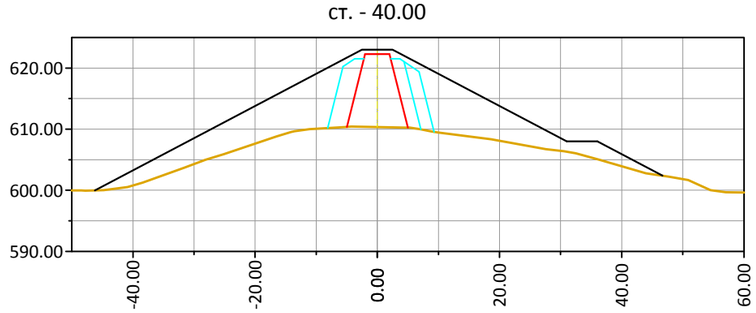
ст. - 60.00



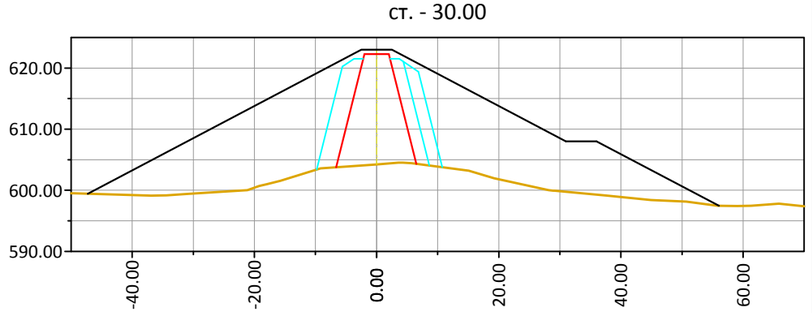
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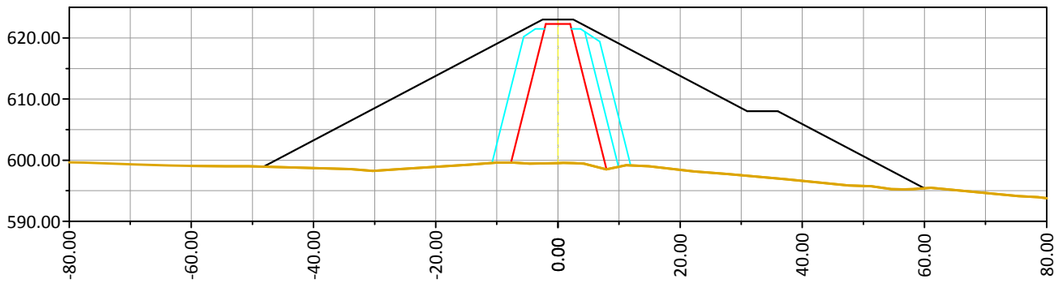
ст. - 40.00



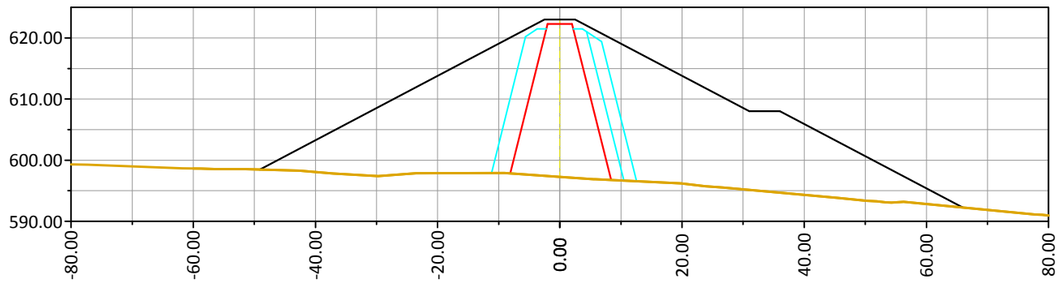
ст. - 30.00



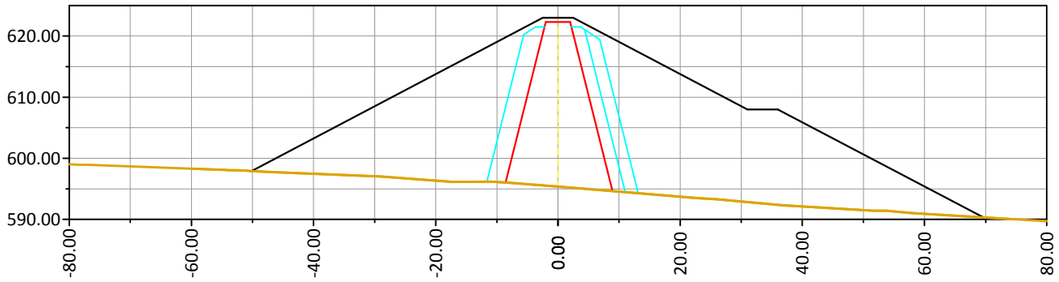
ст. - 20.00



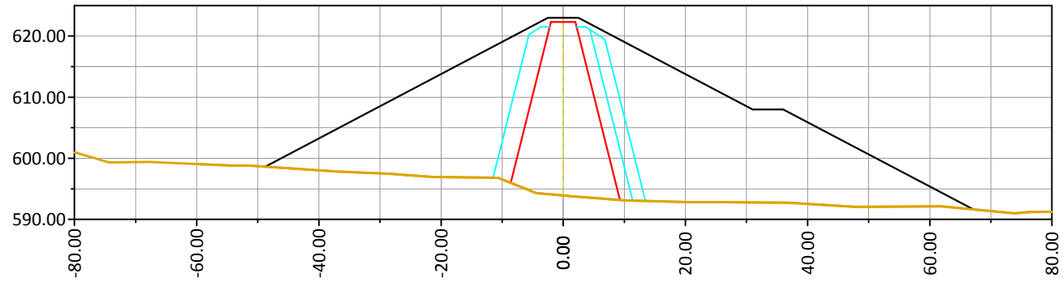
ст. - 10.00



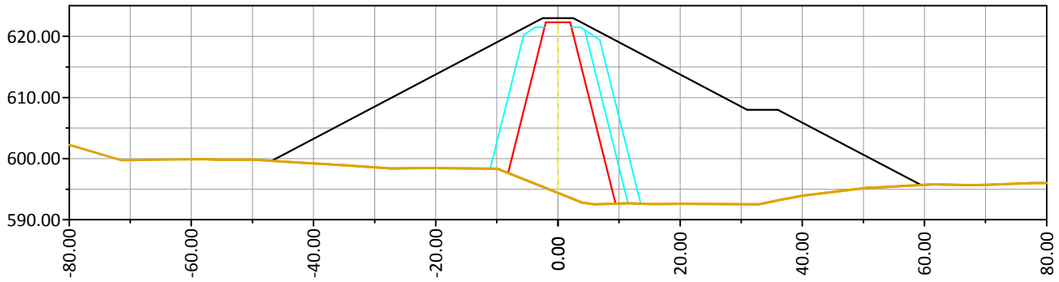
ст. 00.00



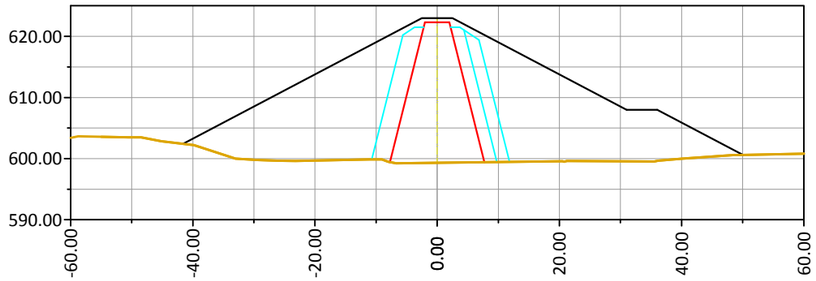
ст. + 10.00



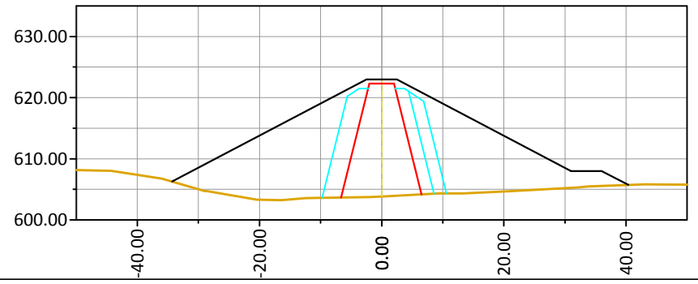
ст. + 20.00



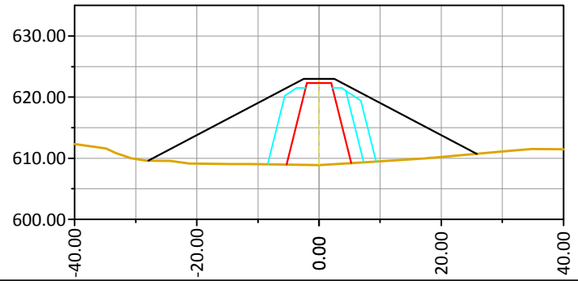
ст. + 30.00



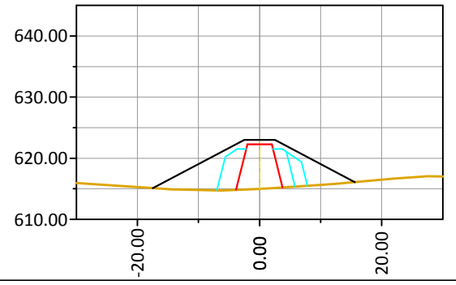
ст. + 40.00



ст. + 50.00



ст. + 60.00

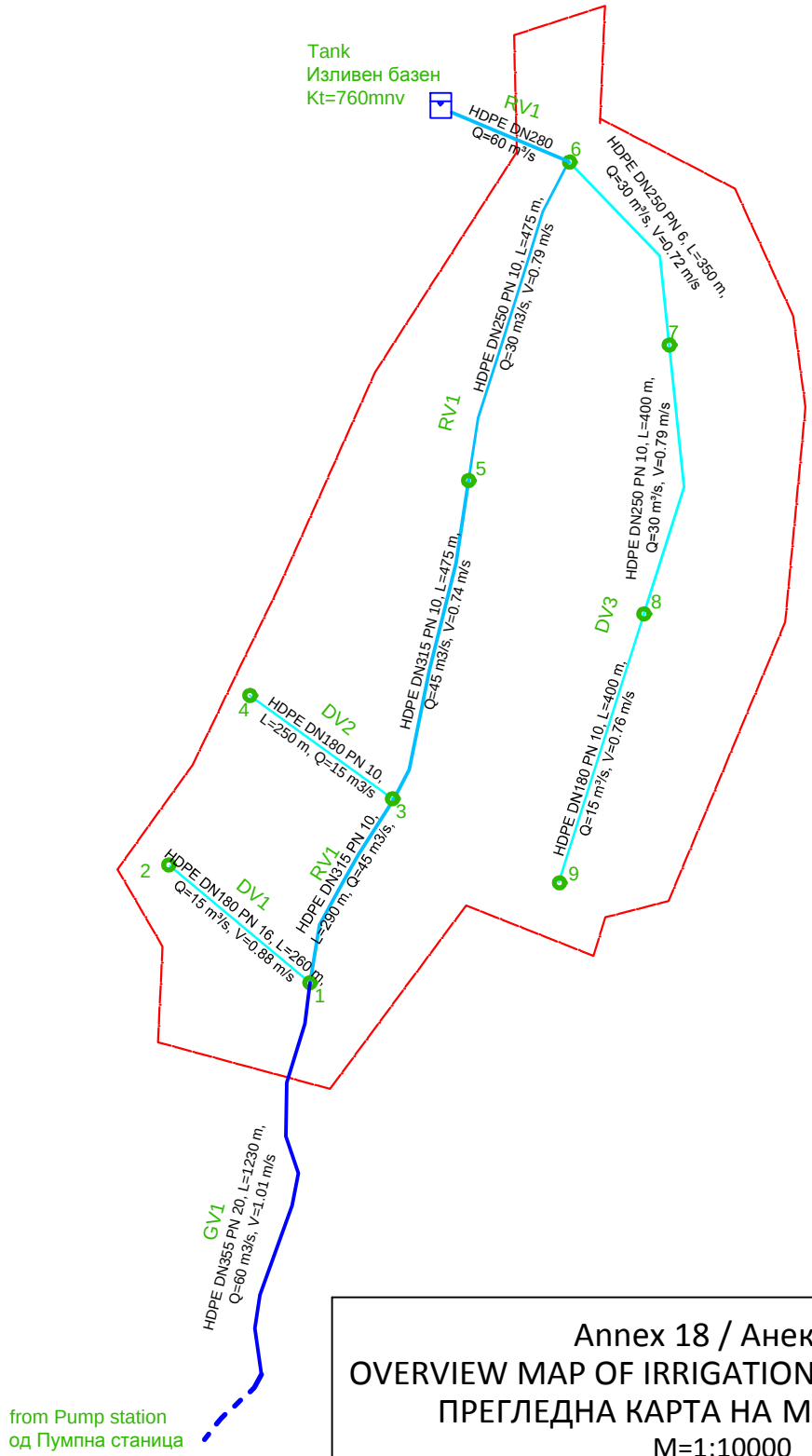


LEGEND / ЛЕГЕНДА:

MAJOR PIPELINES / ГЛАВНИ ЦЕВКОВОДИ

MINOR PIPELINES / РАЗВОДНИ ЦЕВКОВОДИ

FIELD PIPELINES / ДЕЛНИЧНИ ЦЕВКОВОДИ



Annex 18 / Анекс 18

OVERVIEW MAP OF IRRIGATION SYSTEM KOSEVICA

ПРЕГЛЕДНА КАРТА НА МС КОСЕВИЦА

M=1:10000



LEGEND / ЛЕГЕНДА:

MAJOR PIPELINES / ГЛАВНИ ЦЕВКОВОДИ

MINOR PIPELINES / РАЗВОДНИ ЦЕВКОВОДИ

FIELD PIPELINES / ДЕЛНИЧНИ ЦЕВКОВОДИ

Annex 19 / Анекс 19

OVERVIEW MAP OF IRRIGATION SYSTEM LUKOVICA

ПРЕГЛЕДНА КАРТА НА МС ЛУКОВИЦА

M=1:10000

LEGEND / ЛЕГЕНДА:

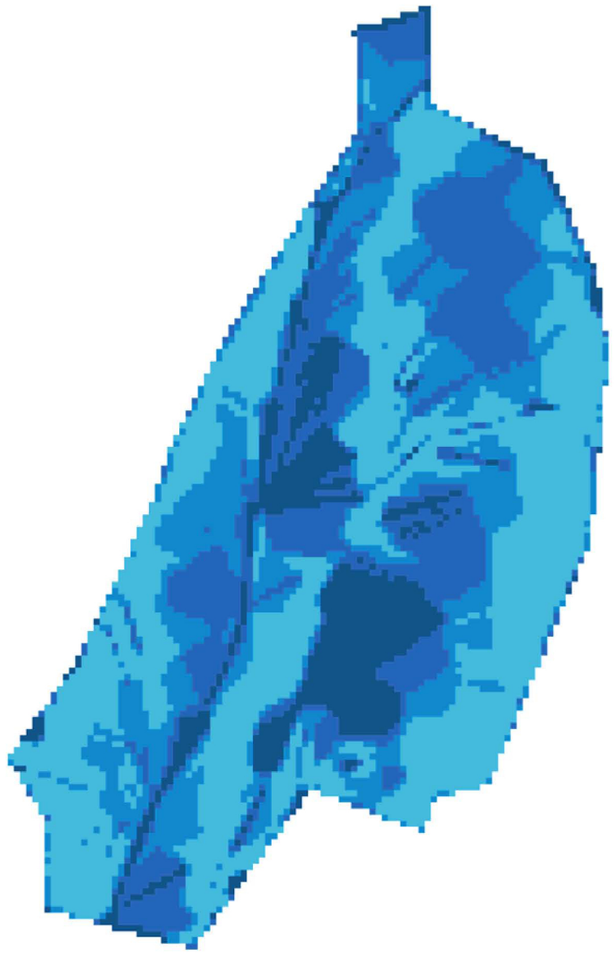
- 0-7%
- 7-10%
- 10-14%
- >14%

N
W E
S

LUKOVICA IRRIGATION AREA
ЛУКОВИЧКО ПОЛЕ

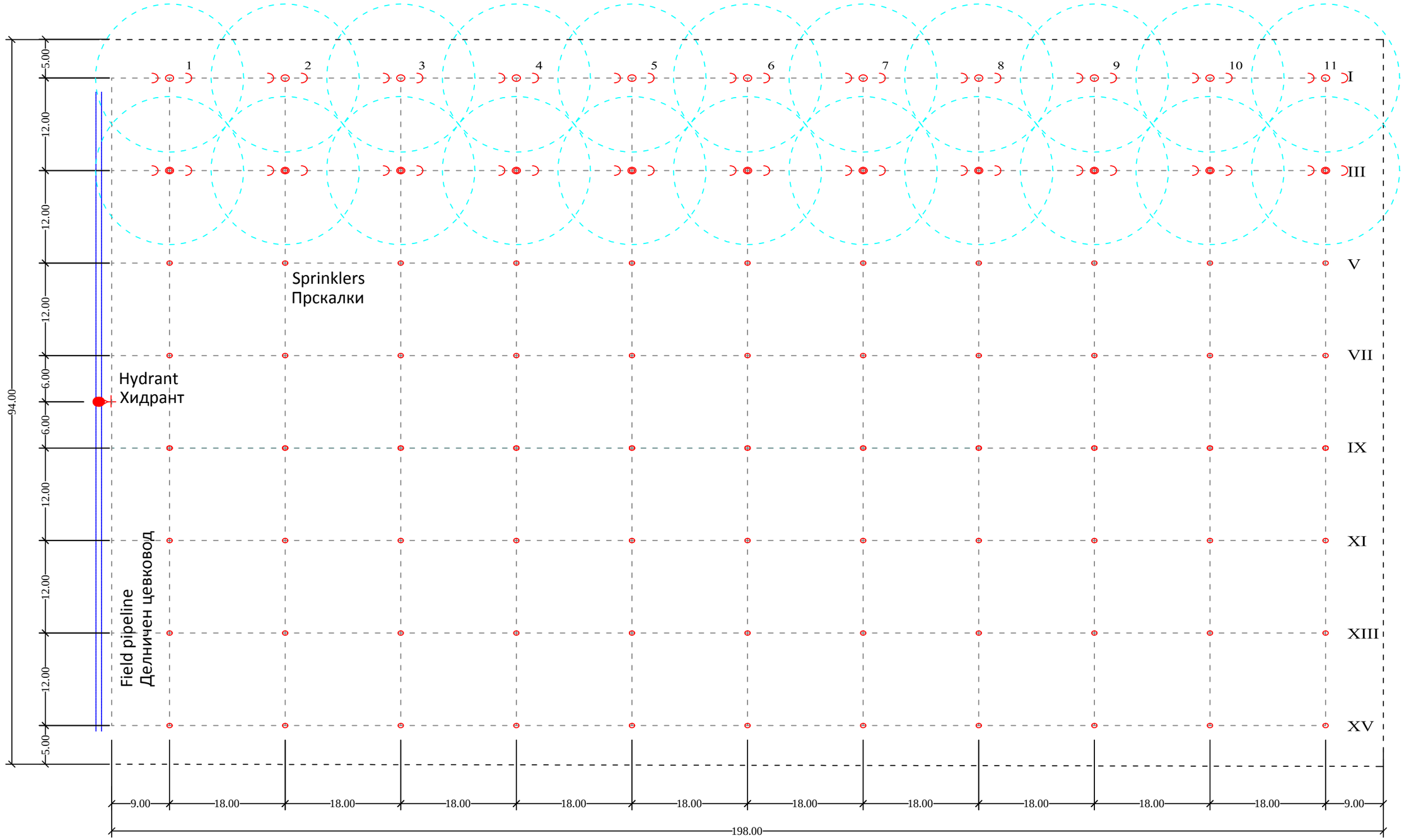


KOSEVICA IRRIGATION AREA
КОСЕВИЧКО ПОЛЕ



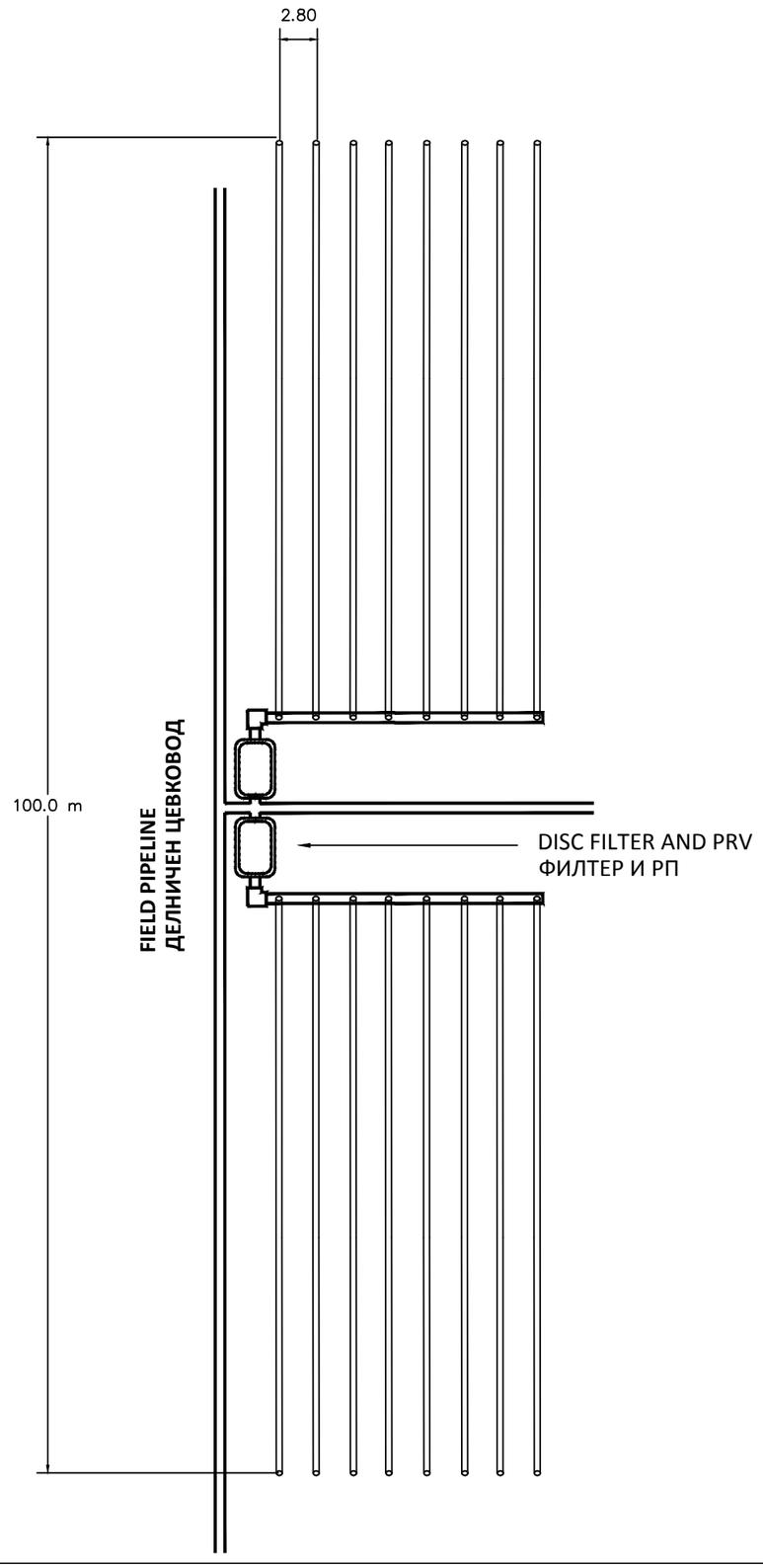
0 200 400 600 800
Meters

Annex 20 / Анекс 20
MAP OF SLOPES
ПРИКАЗ НА НАКЛОНИ
M=1:10000

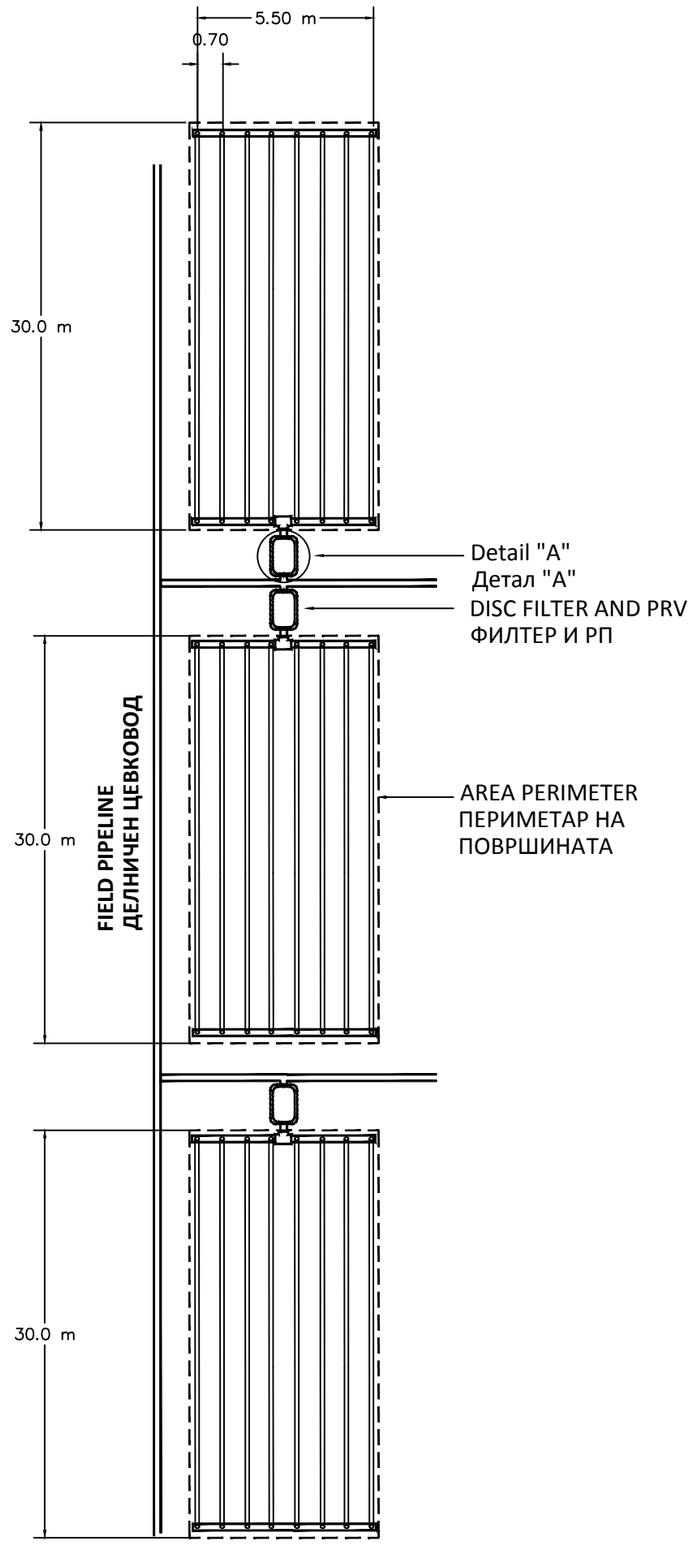


Annex 21 / Анекс 21
SCHEME OF SPRINCLER IRRIGATION
ШЕМА НА НАВОДНУВАЊЕ СО ДОЖДЕЊЕ
M=1:500

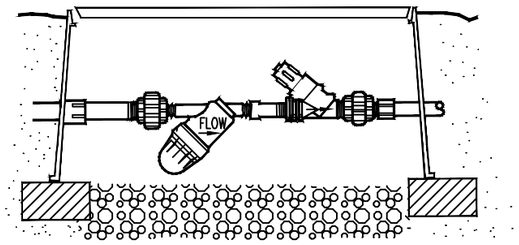
SCHEME OF DRIP IRRIGATION
ШЕМА НА КАПКОВО НАВОДНУВАЊЕ



SCHEME OF DRIP IRRIGATION
ШЕМА НА КАПКОВО НАВОДНУВАЊЕ ЗА ПЛАСТЕНИЦИ



Detail "A"
Детал "A"



DISC FILTER AND PRV
ФИЛТЕР И РП

Annex 22 / Анекс 22
SCHEMES OF DRIP IRRIGATION
ШЕМИ НА КАПКОВО НАВОДНУВАЊЕ

Annex 23
Characteristic climate data

Table 1. Sum of average monthly rainfalls, highest and lowest sum of average montly rainfalls, k - coefficient - period 1990/01-2001/02

STATION K.Palanka

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1990/91-01/02	average (mm)	594	45	51	58	24	36	38	76	61	57	50	45	53
Rainfalls	minimum (mm)	322	3	11	18	3	11	10	33	23	13	8	7	10
	maximum (mm)	777	146	81	118	70	72	74	175	106	147	95	158	148
	k	2	59	7	6	28	7	8	5	5	11	13	22	15

STATION Berovo

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1990/91-01/02	average (mm)	571	43	44	60	30	34	34	62	62	42	51	56	54
Rainfalls	minimum (mm)	375	3	9	12	4	7	10	18	37	8	14	2	10
	maximum (mm)	803	90	88	138	65	81	56	106	100	96	138	150	153
	k	2	33	10	12	19	12	6	6	3	12	10	75	15

STATION Istibanja

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1990/91-01/02	average (mm)	491	39	46	53	18	28	23	59	46	43	49	31	58
Rainfalls	minimum (mm)	308	0	1	5	0	0	0	28	10	9	0	0	0
	maximum (mm)	818	81	89	143	34	59	51	116	100	132	134	67	232

STATION Gradce

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1990/91-01/02	average (mm)	480	38	43	65	20	28	23	48	44	51	51	27	41
Rainfalls	minimum (mm)	213	1	2	3	0	5	0	10	13	14	7	0	7
	maximum (mm)	713	86	98	157	49	69	47	84	125	92	166	54	97

STATION Dramce

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1990/91-01/02	average (mm)	521	38	51	49	17	39	33	59	52	38	62	31	53
Rainfalls	minimum (mm)	294	0	14	4	3	9	10	15	25	9	9	0	12
	maximum (mm)	688	108	103	97	41	76	68	94	82	92	161	75	170
		2	14	12	7	6	3	10	18	748	15	1079	516	25

STATION Kostin Dol

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1990/91-01/02	average (mm)	560	52	60	52	19	30	34	64	53	51	55	35	54
Rainfalls	minimum (mm)	387	3	15	13	3	2	8	25	20	0	5	0	10
	maximum (mm)	742	121	86	107	58	79	74	99	95	111	138	120	125

STATION Blatec

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1990/91-01/02	average (mm)	675	55	69	92	36	50	47	73	51	53	49	40	62
Rainfalls	minimum (mm)	457	3	12	24	6	6	17	33	31	10	7	1	0
	maximum (mm)	854	132	106	228	69	121	78	118	94	86	144	78	195

STATION Sasa

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1990/91-01/02	average (mm)	613	52	60	82	26	51	32	66	51	56	50	43	44
Rainfalls	minimum (mm)	397	3	17	9	5	3	8	16	25	0	14	0	8
	maximum (mm)	894	137	103	196	72	130	68	118	95	116	129	121	107
	k	2	48	41	10	7	4	1162	17	605	13	44	26	21

Table 2. Sum of average monthly rainfalls, highest and lowest sum of average montly rainfalls, average, highest and lowest monthly temperatures - period 2000/01-2004/05

STATION Kocani

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
2001/02-2004/05														
	average (mm)	524	62	33	48	38	17	26	33	50	62	53	53	51
Rainfalls	minimum (mm)	459	6	13	40	15	5	0	27	32	19	40	21	17
	maximum (mm)	555	126	67	56	66	34	44	41	71	96	61	73	104
2000/01-2004/05	average (°C)	14.7	15.0	8.8	3.0	2.2	4.3	9.9	12.9	18.5	22.6	25.1	24.1	19.3
Average daily temperatures	minimum (°C)	13.3	12.9	6.8	-3.3	-1.9	0.4	7.3	11.4	15.7	21.0	24.1	22.9	17.4
	maximum (°C)	16.0	18.2	12.6	5.2	5.4	7.8	14.2	13.8	20.4	24.4	27.1	27.8	21.5
Number of days with snow -(2001/02-04/05)	average	15	0	1	5	6	2	1	1	0	0	0	0	0
	minimum	7	0	0	0	3	0	0	0	0	0	0	0	0
	maximum	29	0	2	16	11	3	5	2	0	0	0	0	0
maximum snow cover (cm) 2001-2005	maximum	33	0	6	33	14	3	9	3	0	0	0	0	0
2000/01-2004/05	maximum (°C)	38.8	31.0	27.0	18.5	16.4	20.0	27.8	28.0	33.2	37.0	37.5	38.8	33.5
absolute temperatures	minimum (°C)	-21.0	-7.0	-8.5	-21.0	-20.5	-19.0	-13.5	-14.0	-5.0	2.5	2.0	5.5	-0.5

STATION DELCEVO

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
2000/02-2004/05														
	average (mm)	632	69.3	51.53	59.85	40.68	25.24	27	68.74	50.4	65.7	47.8	72.6	53.7
Rainfalls	minimum (mm)	391	5.8	35.4	31.9	21.9	6.2	0.2	39	16.8	29.2	15.2	46.7	34.2
	maximum (mm)	801	176.3	64.8	73.3	66.2	47.2	52.9	101.4	88.6	121	75.7	103	114
2000/01-2004/05	average (°C)	10.5	10.9	5.3	0.2	-0.5	0.4	5.4	8.9	15.3	18.7	20.9	20.5	15.6
Average daily temperatures	minimum (°C)	9.6	9.0	2.7	-5.6	-3.4	-3.0	3.2	7.1	13.1	17.8	19.8	19.3	14.0
	maximum (°C)	11.5	12.7	8.7	3.2	2.1	3.6	8.5	10.1	17.2	19.9	22.0	22.7	17.0
Number of days with snow -(2000/02-04/05)	average	13	0	0	5	4	2	1	0	0	0	0	0	0
	minimum	5	0	0	1	1	0	0	0	0	0	0	0	0
	maximum	24	0	2	19	8	4	4	1	0	0	0	0	0
maximum snow cover (cm) 2000-2005	maximum	44	0	8	44	24	22	8	5	0	0	0	0	0
2000/01-2004/05	maximum (°C)	-20.5	-6.5	-10.5	-25.5	-19.5	-20.5	-11.5	-15.0	-1.5	2.4	4.0	6.5	-1.5
absolute temperatures	minimum (°C)	39.0	29.5	27.5	19.0	15.5	19.5	27.5	28.5	32.5	35.5	37.0	39.0	32.5

STATION Sasa

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
2000/01-04/05	average (mm)	520	54	22	42	33	29	27	49	56	74	47	44	43
Rainfalls	minimum (mm)	410	4	4	20	11	3	1	8	41	0	16	0	22
	maximum (mm)	703	140	34	73	73	52	52	96	71	136	70	78	69

STATION Kostin Dol

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
2000/01-04/05	average (mm)	595	73	40	42	39	30	34	62	62	71	52	36	55
Rainfalls	minimum (mm)	395	3	25	13	8	10	0	19	20	0	5	0	17
	maximum (mm)	748	170	61	80	80	40	74	99	109	116	77	54	115

STATION Dramce

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
2000/01-04/05	average (mm)	562	56	26	50	33	35	34	52	45	51	81	56	44
Rainfalls	minimum (mm)	294	0	0	4	7	9	7	36	25	27	9	35	17
	maximum (mm)	697	137	43	80	67	78	68	73	68	119	152	101	107

STATION Gradce

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
2000/01-04/05	average (mm)	395	30	37	47	26	23	15	32	39	34	37	36	38
Rainfalls	minimum (mm)	213	1	14	6	12	5	0	10	13	14	7	19	11
	maximum (mm)	484	76	53	71	58	66	28	54	72	57	64	79	96

Table 3. Characteristic climate data - period 1990/91-2001/02 and 2000/01-04/05

STATION Kriva Palanka

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1990/91-2001/02	average (mm)	594	45	51	58	24	36	38	76	61	57	50	45	53
Rainfalls	minimum (mm)	322	3	11	18	3	11	10	33	23	13	8	7	10
sum	maximum (mm)	777	146	81	118	70	72	74	175	106	147	95	158	148
1990/91-2004/05	average (°C)	10.4	11.4	5.9	1.1	0.5	1.5	5.0	9.6	15.0	18.7	20.7	20.4	15.6
Average daily temperatures	minimum (°C)	9.7	8.1	2.2	-4.0	-3.7	-2.8	1.1	4.9	10.9	17.2	18.9	17.8	13.3
	maximum (°C)	11.7	13.8	9.0	3.6	2.5	5.0	9.6	12.2	17.8	20.7	21.6	22.2	19.6
with snow -(2001-05)	average	35	0	4	9	8	8	5	2	0	0	0	0	0
cover (cm)2001-2005	maximum	40	1	24	40	26	18	25	9	0	0	0	0	0
relative humidity 2001-05	average	71	75	77	81	78	73	68	67	68	67	65	69	72

	first frost date		last frost date	
K.Palanka 2001-05	27/10/2001	170 days	16/04/2001	105
2002	29/10/2002		08/04/2002	97
2003	26/10/2003		10/04/2003	99
2004	06/11/2004		25/05/2004	144
2005	19/10/2005		24/04/2005	113

STATION Kriva Palanka

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
2000/01-04/05	average (mm)	648	59	44	47	42	34	41	74	59	72	49	77	50
Rainfalls	minimum (mm)	498.8	8	14	18	12	11	0	31	38	36	34	21	18
	maximum (mm)	746.9	143	108	74	93	74	74	175	96	146	73	158	99
2000/01-04/05	average (°C)	10.8	11.6	6.6	0.8	0.6	1.7	6.1	9.5	15.4	18.7	21.0	20.2	15.2
Average daily temperatures	minimum (°C)	10.2	10.2	4.4	-4.0	-1.1	-2.8	3.8	8.3	12.9	17.4	20.2	18.8	13.9
	maximum (°C)	11.7	12.9	9.0	2.6	2.5	5.0	9.6	11.1	17.8	20.7	21.4	21.8	16.1

STATION Berovo

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1990/91-2001/02	average (mm)	571	43	44	60	30	34	34	62	62	42	51	56	54
Rainfalls	minimum (mm)	375	3	9	12	4	7	10	18	37	8	14	2	10
	maximum (mm)	803	90	88	138	65	81	56	106	100	96	138	150	153
1990/91-2004/05	average (°C)	8.9	9.7	4.6	0.2	-0.8	-0.1	3.4	7.9	13.2	17.2	19.0	18.5	14.0
Average daily temperatures	minimum (°C)	7.8	6.5	0.5	-5.8	-5.4	-4.4	0.0	3.4	9.7	15.5	17.3	16.1	12.0
	maximum (°C)	10.2	12.1	6.9	2.6	2.2	3.4	8.1	9.9	16.1	18.7	20.2	20.4	18.1
Number of days with snow -(2001-05)	average	47		4	15	16	11	3	3					
maximum snow cover (cm)2001-2005	maximum	52	0	14	52	34	18	11	15	18	0	0	0	0
relative humidity 2001-05	average	62	54	57	75	66	55	62	65	62	56	59	66	65

	first frost date		last frost date	
Berovo2001/05	15/10/2001	-0.3	19/04/2001	-0.9
	21/10/2002	-2.5	08/04/2002	-8.2
	05/09/2003	-0.5	21/04/2003	-0.4
	10/09/2004	-0.3	26/05/2004	-0.9
	16/10/2005	-0.5	08/05/2005	-1

Table 4. Characteristic climate data - period 1949/50-1985/86 and 1949/50-68/69

STATION Kriva Palanka

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1949/50-1985/86	average (mm)	648	51	68	49	47	43	43	50	80	73	53	46	43
Rainfalls	minimum (mm)	0	0	13	0	1	6	3	8	30	24	11	0	4
	maximum (mm)	186	123	156	118	92	105	138	127	177	171	186	143	157
1949/50-68/69	average (°C)	10.6	-0.6	1.5	4.6	10.1	14.7	18.2	20.7	20.8	16.8	11.2	6.4	2.7
Average daily temperatures	minimum (°C)	5.5	-4.3	-2.6	0.2	4.8	9.0	12.1	13.9	14.0	10.9	6.5	3.0	-1.1
	maximum (°C)	11.5	3.4	6.2	9.7	15.6	20.5	24.1	27.2	28.0	23.8	17.1	10.9	6.4
maximum snow cover (cm)2001-2005	maximum	40	1	24	40	26	18	25	9	0	0	0	0	0
1951-05	maximum	37.3	31	26,6	19.7	16.9	20.4	9,6/51-9	29.7	1,8/0	36	37.3	36.6	34.4
absolute temperatures	minimum	-20.6	-5.3	-11.6	19/200	-21	-20.6	4,4/51-9	1,1/200	-0.7	1.3	5	4.2	-0.8
relative humidity 1950-1969	average	66	69	76	75	74	71	66	62	65	64	59	55	60

STATION Berovo

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
1949/50-85/86	average (mm)	642	55	70	53	47	45	45	52	76	70	52	40	41
Rainfalls	minimum (mm)	450	0	3	10	7	3	10	4	23	12	6	4	5
Average daily temperatures	minimum (°C)	7.8	3.8	0.6	-2.5	-5.1	-5.3	-0.4	5.4	10.7	14.7	16.6	13.8	11.1
	maximum (°C)	12.3	11.0	8.1	5.1	2.8	5.0	6.3	11.0	16.1	18.5	21.5	21.6	17.7
relative humidity 1949/50-1985/86	average	76	78	79	81	83	81	77	72	73	72	68	68	73

STATION DELCEVO - 1949/50-1985/86

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
	average (mm)	551	51	67	43	38	38	37	45	61	58	44	42	32
Rainfalls	minimum (mm)	390	0	8	8	8	3	4	4	10	11	2	0	4
	maximum (mm)	781	124	192	114	78	85	116	99	146	208	223	118	136
	average (°C)	10.5	9.0			-0.1			10.2					
Average daily temperatures	minimum (°C)	9.1	7.8	1.9	-1.3	-4.4	-4.7	2.1	7.5	13.0	10.2	18.6	18.1	13.4
	maximum (°C)	11.5	13.2	9.6	5.7	3.9	6.5	7.5	13.2	18.3	20.6	22.7	21.8	18.8
Number of days with snow (1949-69)	average	97.0	6.0	9.4	21.0	24.4	19.0	15.0	5.0	-	-	-	-	0.8

STATION KOCANI - 1949-69

		ann. sum	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
	average (mm)	534	42	65	42	38	38	37	38	65	53	44	38	34
Rainfalls	minimum (mm)	372	1	6	10	4	7	4	6	21	14	1	0	3
	maximum (mm)	777	130	145	88	100	83	126	98	131	122	110	114	115
	average (°C)	12.8	13.7	8.1	3.5	1.4	3.8	8.0	12.7	17.7	21.2	23.1	22.9	10.0
Average daily temperatures	minimum (°C)	11.4	9.3	2.4	0.1	-4.7	-2.4	3.5	10.7	15.5	18.9	21.5	18.8	16.0
	maximum (°C)	14.0	17.6	11.1	7.7	5.7	8.1	11.4	19.3	20.6	23.5	24.6	25.5	22.4

Annex 24. Hydrological data

Average monthly flows (m^3/s) of River Kosevicka for the period 1961- 2005 yr.
hyd. st. - elevation 1000 masl, catchment area 4.86 $км^2$

yr/m	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Q_{srg}
1961	0.040	0.023	0.061	0.105	0.197	0.097	0.041	0.026	0.018	0.028	0.058	0.063	**0.063**
1962	0.062	0.066	0.221	0.272	0.146	0.074	0.051	0.075	0.029	0.041	0.131	0.109	**0.107**
1963	0.158	0.155	0.104	0.379	0.266	0.227	0.073	0.055	0.039	0.037	0.029	0.039	**0.130**
1964	0.043	0.038	0.072	0.102	0.110	0.124	0.065	0.044	0.044	0.053	0.112	0.085	**0.074**
1965	0.092	0.067	0.097	0.220	0.238	0.132	0.076	0.040	0.023	0.030	0.032	0.052	**0.092**
1966	0.048	0.090	0.070	0.128	0.153	0.234	0.091	0.075	0.030	0.057	0.050	0.061	**0.091**
1967	0.048	0.036	0.073	0.129	0.121	0.085	0.104	0.069	0.034	0.021	0.020	0.038	**0.065**
1968	0.036	0.058	0.076	0.126	0.105	0.093	0.057	0.069	0.053	0.027	0.070	0.048	**0.068**
1969	0.065	0.078	0.124	0.242	0.188	0.099	0.064	0.045	0.040	0.019	0.016	0.040	**0.085**
1970	0.064	0.055	0.121	0.142	0.137	0.139	0.138	0.064	0.035	0.063	0.046	0.032	**0.086**
1971	0.051	0.041	0.126	0.261	0.108	0.096	0.053	0.036	0.053	0.035	0.034	0.031	**0.077**
1972	0.027	0.038	0.075	0.121	0.132	0.065	0.057	0.047	0.079	0.234	0.083	0.050	**0.084**
1973	0.040	0.048	0.070	0.332	0.183	0.080	0.061	0.067	0.083	0.054	0.028	0.060	**0.092**
1974	0.050	0.050	0.069	0.075	0.317	0.206	0.109	0.071	0.059	0.063	0.065	0.043	**0.098**
1975	0.026	0.018	0.058	0.072	0.102	0.105	0.063	0.050	0.042	0.051	0.044	0.036	**0.056**
1976	0.027	0.027	0.034	0.107	0.155	0.176	0.179	0.139	0.053	0.107	0.210	0.203	**0.118**
1977	0.046	0.083	0.093	0.117	0.101	0.067	0.060	0.036	0.018	0.016	0.017	0.015	**0.056**
1978	0.019	0.024	0.056	0.167	0.157	0.116	0.041	0.021	0.022	0.019	0.022	0.037	**0.058**
1979	0.048	0.074	0.045	0.198	0.076	0.065	0.056	0.039	0.032	0.036	0.079	0.044	**0.066**
1980	0.052	0.034	0.119	0.137	0.363	0.126	0.069	0.037	0.019	0.080	0.037	0.059	**0.094**
1981	0.036	0.033	0.108	0.172	0.119	0.080	0.054	0.062	0.081	0.046	0.047	0.072	**0.076**
1982	0.047	0.030	0.066	0.192	0.142	0.057	0.049	0.081	0.024	0.020	0.031	0.041	**0.065**
1983	0.035	0.039	0.054	0.106	0.067	0.124	0.157	0.050	0.048	0.034	0.036	0.040	**0.066**
1984	0.043	0.054	0.104	0.212	0.212	0.084	0.039	0.028	0.023	0.021	0.026	0.020	**0.072**
1985	0.026	0.030	0.077	0.175	0.138	0.095	0.045	0.037	0.043	0.020	0.069	0.069	**0.069**
1986	0.064	0.099	0.146	0.188	0.115	0.076	0.070	0.045	0.025	0.019	0.017	0.015	**0.073**
1987	0.019	0.027	0.078	0.167	0.161	0.094	0.046	0.039	0.030	0.021	0.026	0.029	**0.061**
1988	0.021	0.017	0.046	0.113	0.095	0.064	0.038	0.021	0.020	0.018	0.031	0.033	**0.043**
1989	0.019	0.016	0.028	0.059	0.067	0.111	0.084	0.066	0.058	0.115	0.073	0.065	**0.063**
1990	0.022	0.022	0.024	0.101	0.066	0.048	0.023	0.015	0.011	0.014	0.014	0.048	**0.034**
1991	0.021	0.026	0.072	0.219	0.305	0.205	0.073	0.037	0.021	0.039	0.043	0.027	**0.091**
1992	0.015	0.015	0.043	0.144	0.065	0.069	0.062	0.030	0.015	0.016	0.017	0.021	**0.043**
1993	0.013	0.009	0.052	0.078	0.065	0.029	0.018	0.017	0.011	0.014	0.011	0.024	**0.028**
1994	0.022	0.017	0.038	0.102	0.069	0.044	0.035	0.023	0.010	0.011	0.009	0.021	**0.033**
1995	0.018	0.019	0.045	0.129	0.122	0.070	0.037	0.067	0.103	0.034	0.058	0.203	**0.075**
1996	0.076	0.039	0.082	0.250	0.231	0.106	0.038	0.042	0.077	0.042	0.044	0.074	**0.092**
1997	0.052	0.026	0.059	0.182	0.199	0.112	0.038	0.037	0.022	0.034	0.043	0.055	**0.072**
1998	0.038	0.045	0.055	0.103	0.099	0.070	0.031	0.029	0.037	0.055	0.048	0.050	**0.055**
1999	0.047	0.049	0.105	0.268	0.170	0.140	0.077	0.044	0.033	0.036	0.051	0.052	**0.089**
2000	0.037	0.037	0.087	0.177	0.098	0.063	0.031	0.028	0.025	0.025	0.022	0.024	**0.055**
2001	0.016	0.012	0.036	0.087	0.063	0.034	0.027	0.027	0.022	0.023	0.021	0.022	**0.032**
2002	0.018	0.019	0.065	0.095	0.131	0.066	0.033	0.028	0.070	0.163	0.054	0.078	**0.068**
2003	0.107	0.038	0.049	0.110	0.130	0.082	0.031	0.032	0.021	0.039	0.028	0.033	**0.058**
2004	0.031	0.035	0.087	0.139	0.151	0.185	0.063	0.046	0.040	0.041	0.063	0.063	**0.079**
2005	0.041	0.053	0.122	0.194	0.148	0.104	0.050	0.049	0.039	0.051	0.029	0.061	**0.078**
Q_{srm}	**0.043**	**0.042**	**0.078**	**0.160**	**0.146**	**0.103**	**0.061**	**0.046**	**0.038**	**0.045**	**0.047**	**0.053**	**0.072**

Average monthly flows (m^3/s) of River Lukovicka for the period 1961- 2005 yr.

hyd. st. - elevation 590 masl, catchment area 12.80 km^2

yr/m	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Q_{srg}
1961	0.107	0.076	0.148	0.181	0.296	0.126	0.045	0.029	0.022	0.036	0.095	0.138	**0.108**
1962	0.166	0.216	0.539	0.475	0.219	0.096	0.057	0.084	0.034	0.053	0.211	0.238	**0.199**
1963	0.421	0.503	0.254	0.662	0.399	0.296	0.081	0.061	0.045	0.048	0.047	0.087	**0.242**
1964	0.115	0.125	0.175	0.176	0.166	0.161	0.072	0.049	0.052	0.068	0.180	0.185	**0.127**
1965	0.246	0.218	0.237	0.382	0.356	0.172	0.084	0.044	0.028	0.039	0.053	0.115	**0.164**
1966	0.127	0.293	0.170	0.222	0.230	0.305	0.101	0.084	0.036	0.074	0.082	0.134	**0.155**
1967	0.129	0.118	0.176	0.224	0.182	0.111	0.115	0.077	0.040	0.028	0.032	0.084	**0.110**
1968	0.095	0.189	0.184	0.217	0.157	0.121	0.064	0.076	0.062	0.034	0.114	0.105	**0.118**
1969	0.173	0.253	0.302	0.420	0.283	0.129	0.071	0.050	0.047	0.025	0.027	0.089	**0.156**
1970	0.170	0.179	0.295	0.245	0.206	0.182	0.152	0.072	0.041	0.081	0.075	0.072	**0.148**
1971	0.137	0.134	0.308	0.455	0.163	0.124	0.059	0.040	0.062	0.045	0.055	0.069	**0.138**
1972	0.071	0.123	0.182	0.209	0.198	0.084	0.063	0.053	0.092	0.301	0.135	0.111	**0.135**
1973	0.107	0.157	0.171	0.579	0.275	0.104	0.068	0.074	0.097	0.069	0.046	0.131	**0.156**
1974	0.134	0.162	0.168	0.128	0.475	0.268	0.121	0.079	0.068	0.081	0.105	0.095	**0.157**
1975	0.070	0.058	0.142	0.123	0.153	0.136	0.069	0.056	0.049	0.065	0.073	0.083	**0.090**
1976	0.073	0.087	0.082	0.184	0.232	0.231	0.198	0.154	0.062	0.139	0.336	0.438	**0.185**
1977	0.124	0.271	0.232	0.202	0.153	0.087	0.066	0.040	0.021	0.020	0.028	0.035	**0.107**
1978	0.050	0.080	0.134	0.287	0.237	0.151	0.046	0.023	0.026	0.025	0.035	0.084	**0.098**
1979	0.131	0.239	0.109	0.351	0.115	0.084	0.062	0.044	0.038	0.046	0.131	0.097	**0.121**
1980	0.137	0.109	0.270	0.244	0.542	0.166	0.077	0.041	0.023	0.102	0.059	0.129	**0.158**
1981	0.096	0.109	0.259	0.296	0.178	0.104	0.060	0.069	0.094	0.060	0.075	0.161	**0.130**
1982	0.124	0.098	0.163	0.329	0.215	0.074	0.054	0.090	0.028	0.025	0.050	0.093	**0.112**
1983	0.093	0.128	0.133	0.183	0.100	0.157	0.173	0.056	0.056	0.044	0.057	0.089	**0.106**
1984	0.116	0.174	0.260	0.366	0.320	0.109	0.043	0.031	0.028	0.027	0.042	0.045	**0.130**
1985	0.069	0.099	0.188	0.302	0.207	0.125	0.050	0.041	0.050	0.026	0.119	0.150	**0.119**
1986	0.169	0.323	0.363	0.329	0.173	0.099	0.077	0.050	0.029	0.025	0.026	0.033	**0.141**
1987	0.051	0.090	0.188	0.289	0.242	0.123	0.051	0.043	0.035	0.027	0.043	0.064	**0.104**
1988	0.056	0.057	0.111	0.194	0.143	0.083	0.042	0.023	0.024	0.024	0.051	0.072	**0.073**
1989	0.051	0.052	0.070	0.100	0.100	0.141	0.093	0.074	0.069	0.148	0.117	0.143	**0.097**
1990	0.058	0.073	0.061	0.168	0.100	0.062	0.026	0.017	0.013	0.018	0.024	0.107	**0.061**
1991	0.057	0.084	0.174	0.381	0.457	0.268	0.081	0.041	0.025	0.050	0.069	0.061	**0.146**
1992	0.041	0.051	0.104	0.249	0.098	0.089	0.069	0.033	0.018	0.020	0.027	0.048	**0.071**
1993	0.034	0.030	0.127	0.134	0.099	0.037	0.020	0.019	0.013	0.017	0.019	0.053	**0.050**
1994	0.059	0.056	0.093	0.175	0.104	0.056	0.039	0.026	0.012	0.014	0.014	0.047	**0.058**
1995	0.049	0.061	0.109	0.224	0.183	0.090	0.041	0.074	0.120	0.043	0.094	0.439	**0.127**
1996	0.201	0.129	0.201	0.435	0.347	0.138	0.042	0.046	0.090	0.054	0.071	0.163	**0.160**
1997	0.138	0.086	0.144	0.316	0.299	0.145	0.042	0.041	0.026	0.043	0.070	0.122	**0.123**
1998	0.103	0.147	0.134	0.178	0.149	0.091	0.035	0.032	0.043	0.071	0.078	0.111	**0.098**
1999	0.125	0.159	0.256	0.466	0.256	0.182	0.085	0.049	0.039	0.046	0.083	0.115	**0.155**
2000	0.097	0.121	0.211	0.308	0.148	0.081	0.035	0.031	0.030	0.033	0.036	0.054	**0.099**
2001	0.043	0.038	0.087	0.150	0.096	0.044	0.030	0.030	0.026	0.029	0.034	0.050	**0.055**
2002	0.047	0.061	0.158	0.164	0.197	0.085	0.037	0.031	0.081	0.210	0.088	0.171	**0.111**
2003	0.284	0.124	0.119	0.190	0.196	0.106	0.035	0.035	0.025	0.050	0.046	0.073	**0.107**
2004	0.083	0.114	0.212	0.240	0.227	0.241	0.069	0.051	0.047	0.053	0.102	0.138	**0.131**
2005	0.110	0.171	0.298	0.336	0.222	0.135	0.056	0.054	0.045	0.065	0.048	0.133	**0.140**
Q_{srm}	**0.114**	**0.138**	**0.189**	**0.277**	**0.220**	**0.133**	**0.068**	**0.052**	**0.045**	**0.058**	**0.076**	**0.117**	**0.124**

Annex 25. Monthly water demands for water supply (2010-2050 yr.)

month	year	Participation in water supply	M. Kamenica	Monthly water demands	Todorovci + Lukovica	Kosevica	Industrial zone	Heating plant, usage	Heating plant	Total
			V (m^3)		V (m^3)	V (m^3)	V (m^3)		V (m^3)	V ($10^6 m^3$)
1	2010	0%	0	5.0%	2916	898	2500	100%	60	0.00637
2	2010	0%	0	4.5%	2626	809	2500	100%	60	0.00599
3	2010	0%	0	5.4%	3152	971	2500	50%	30	0.00665
4	2010	0%	0	6.5%	3796	1169	2500	0%	0	0.00747
5	2010	0%	0	8.0%	4674	1440	2500	0%	0	0.00861
6	2010	20%	8510	10.0%	5845	1801	2500	0%	0	0.01866
7	2010	35%	17289	11.6%	6783	2090	2500	0%	0	0.02866
8	2010	45%	23974	12.5%	7312	2253	2500	0%	0	0.03604
9	2010	35%	17915	12.0%	7023	2164	2500	0%	0	0.02960
10	2010	20%	8965	10.5%	6147	1894	2500	50%	30	0.01954
11	2010	0%	0	8.0%	4686	1444	2500	100%	60	0.00869
12	2010	0%	0	6.0%	3516	1083	2500	100%	60	0.00716
1	2011	0%	0	5.0%	2931	903	2500	100%	60	0.00639
2	2011	0%	0	4.5%	2639	813	2500	100%	60	0.00601
3	2011	0%	0	5.4%	3168	976	2500	50%	30	0.00667
4	2011	0%	0	6.5%	3815	1175	2500	0%	0	0.00749
5	2011	0%	0	8.0%	4697	1447	2500	0%	0	0.00864
6	2011	20%	8595	10.0%	5874	1810	2500	0%	0	0.01878
7	2011	35%	17462	11.6%	6817	2100	2500	0%	0	0.02888
8	2011	45%	24214	12.5%	7349	2264	2500	0%	0	0.03633
9	2011	35%	18094	12.0%	7058	2174	2500	0%	0	0.02983
10	2011	20%	9055	10.5%	6178	1903	2500	50%	30	0.01967
11	2011	0%	0	8.0%	4709	1451	2500	100%	60	0.00872
12	2011	0%	0	6.0%	3533	1089	2500	100%	60	0.00718
1	2012	0%	0	5.0%	2946	908	2500	100%	60	0.00641
2	2012	0%	0	4.5%	2652	817	2500	100%	60	0.00603
3	2012	0%	0	5.4%	3184	981	2500	50%	30	0.00669
4	2012	0%	0	6.5%	3834	1181	2500	0%	0	0.00752
5	2012	0%	0	8.0%	4721	1454	2500	0%	0	0.00868
6	2012	20%	8681	10.0%	5903	1819	2500	0%	0	0.01890
7	2012	35%	17637	11.6%	6851	2111	2500	0%	0	0.02910
8	2012	45%	24456	12.5%	7385	2275	2500	0%	0	0.03662
9	2012	35%	18275	12.0%	7093	2185	2500	0%	0	0.03005
10	2012	20%	9145	10.5%	6209	1913	2500	50%	30	0.01980
11	2012	0%	0	8.0%	4733	1458	2500	100%	60	0.00875
12	2012	0%	0	6.0%	3551	1094	2500	100%	60	0.00720
1	2013	0%	0	5.0%	2960	912	2500	100%	60	0.00643
2	2013	0%	0	4.5%	2665	821	2500	100%	60	0.00605
3	2013	0%	0	5.4%	3200	986	2500	50%	30	0.00672
4	2013	0%	0	6.5%	3853	1187	2500	0%	0	0.00754
5	2013	0%	0	8.0%	4744	1462	2500	0%	0	0.00871
6	2013	20%	8768	10.0%	5933	1828	2500	0%	0	0.01903
7	2013	35%	17813	11.6%	6885	2121	2500	0%	0	0.02932
8	2013	45%	24700	12.5%	7422	2287	2500	0%	0	0.03691
9	2013	35%	18458	12.0%	7128	2196	2500	0%	0	0.03028
10	2013	20%	9237	10.5%	6240	1922	2500	50%	30	0.01993
11	2013	0%	0	8.0%	4756	1465	2500	100%	60	0.00878
12	2013	0%	0	6.0%	3569	1099	2500	100%	60	0.00723
1	2014	0%	0	5.0%	2975	917	2500	100%	60	0.00645
2	2014	0%	0	4.5%	2679	825	2500	100%	60	0.00606
3	2014	0%	0	5.4%	3216	991	2500	50%	30	0.00674
4	2014	0%	0	6.5%	3872	1193	2500	0%	0	0.00757

month	year	Participation in water supply	M. Kamenica	Monthly water demands	Todorovci + Lukovica	Kosevica	Industrial zone	Heating plant, usage	Heating plant	Total
			V (m^3)		V (m^3)	V (m^3)	V (m^3)		V (m^3)	V ($10^6 m^3$)
5	2014	0%	0	8.0%	4768	1469	2500	0%	0	0.00874
6	2014	20%	8855	10.0%	5963	1837	2500	0%	0	0.01916
7	2014	35%	17991	11.6%	6920	2132	2500	0%	0	0.02954
8	2014	45%	24947	12.5%	7459	2298	2500	0%	0	0.03720
9	2014	35%	18643	12.0%	7164	2207	2500	0%	0	0.03051
10	2014	20%	9329	10.5%	6271	1932	2500	50%	30	0.02006
11	2014	0%	0	8.0%	4780	1473	2500	100%	60	0.00881
12	2014	0%	0	6.0%	3587	1105	2500	100%	60	0.00725
1	2015	0%	0	5.0%	2990	921	2500	100%	60	0.00647
2	2015	0%	0	4.5%	2692	829	2500	100%	60	0.00608
3	2015	0%	0	5.4%	3232	996	2500	50%	30	0.00676
4	2015	0%	0	6.5%	3892	1199	2500	0%	0	0.00759
5	2015	0%	0	8.0%	4792	1476	2500	0%	0	0.00877
6	2015	20%	8944	10.0%	5992	1846	2500	0%	0	0.01928
7	2015	35%	18171	11.6%	6954	2142	2500	0%	0	0.02977
8	2015	45%	25197	12.5%	7497	2310	2500	0%	0	0.03750
9	2015	35%	18829	12.0%	7200	2218	2500	0%	0	0.03075
10	2015	20%	9422	10.5%	6303	1942	2500	50%	30	0.02020
11	2015	0%	0	8.0%	4804	1480	2500	100%	60	0.00884
12	2015	0%	0	6.0%	3604	1110	2500	100%	60	0.00727
1	2016	0%	0	5.0%	3005	926	2500	100%	60	0.00649
2	2016	0%	0	4.5%	2706	834	2500	100%	60	0.00610
3	2016	0%	0	5.4%	3248	1001	2500	50%	30	0.00678
4	2016	0%	0	6.5%	3911	1205	2500	0%	0	0.00762
5	2016	0%	0	8.0%	4816	1484	2500	0%	0	0.00880
6	2016	20%	9033	10.0%	6022	1855	2500	0%	0	0.01941
7	2016	35%	18353	11.6%	6989	2153	2500	0%	0	0.03000
8	2016	45%	25449	12.5%	7534	2321	2500	0%	0	0.03780
9	2016	35%	19017	12.0%	7236	2229	2500	0%	0	0.03098
10	2016	20%	9517	10.5%	6334	1951	2500	50%	30	0.02033
11	2016	0%	0	8.0%	4828	1487	2500	100%	60	0.00888
12	2016	0%	0	6.0%	3622	1116	2500	100%	60	0.00730
1	2017	0%	0	5.0%	3020	930	2500	100%	60	0.00651
2	2017	0%	0	4.5%	2719	838	2500	100%	60	0.00612
3	2017	0%	0	5.4%	3264	1006	2500	50%	30	0.00680
4	2017	0%	0	6.5%	3931	1211	2500	0%	0	0.00764
5	2017	0%	0	8.0%	4840	1491	2500	0%	0	0.00883
6	2017	20%	9124	10.0%	6053	1865	2500	0%	0	0.01954
7	2017	35%	18537	11.6%	7024	2164	2500	0%	0	0.03022
8	2017	45%	25703	12.5%	7572	2333	2500	0%	0	0.03811
9	2017	35%	19208	12.0%	7272	2240	2500	0%	0	0.03122
10	2017	20%	9612	10.5%	6366	1961	2500	50%	30	0.02047
11	2017	0%	0	8.0%	4852	1495	2500	100%	60	0.00891
12	2017	0%	0	6.0%	3641	1122	2500	100%	60	0.00732
1	2018	0%	0	5.0%	3035	935	2500	100%	60	0.00653
2	2018	0%	0	4.5%	2733	842	2500	100%	60	0.00613
3	2018	0%	0	5.4%	3281	1011	2500	50%	30	0.00682
4	2018	0%	0	6.5%	3951	1217	2500	0%	0	0.00767
5	2018	0%	0	8.0%	4864	1499	2500	0%	0	0.00886
6	2018	20%	9215	10.0%	6083	1874	2500	0%	0	0.01967
7	2018	35%	18722	11.6%	7059	2175	2500	0%	0	0.03046
8	2018	45%	25960	12.5%	7610	2344	2500	0%	0	0.03841
9	2018	35%	19400	12.0%	7308	2252	2500	0%	0	0.03146
10	2018	20%	9708	10.5%	6398	1971	2500	50%	30	0.02061
11	2018	0%	0	8.0%	4876	1502	2500	100%	60	0.00894

month	year	Participation in water supply	M. Kamenica	Monthly water demands	Todorovci + Lukovica	Kosevica	Industrial zone	Heating plant, usage	Heating plant	Total
			V (m^3)		V (m^3)	V (m^3)	V (m^3)		V (m^3)	V ($10^6 m^3$)
12	2018	0%	0	6.0%	3659	1127	2500	100%	60	0.00735
1	2019	0%	0	5.0%	3050	940	2500	100%	60	0.00655
2	2019	0%	0	4.5%	2746	846	2500	100%	60	0.00615
3	2019	0%	0	5.4%	3297	1016	2500	50%	30	0.00684
4	2019	0%	0	6.5%	3970	1223	2500	0%	0	0.00769
5	2019	0%	0	8.0%	4889	1506	2500	0%	0	0.00889
6	2019	20%	9307	10.0%	6113	1883	2500	0%	0	0.01980
7	2019	35%	18909	11.6%	7094	2186	2500	0%	0	0.03069
8	2019	45%	26220	12.5%	7648	2356	2500	0%	0	0.03872
9	2019	35%	19594	12.0%	7345	2263	2500	0%	0	0.03170
10	2019	20%	9805	10.5%	6430	1981	2500	50%	30	0.02075
11	2019	0%	0	8.0%	4901	1510	2500	100%	60	0.00897
12	2019	0%	0	6.0%	3677	1133	2500	100%	60	0.00737
1	2020	0%	0	5.0%	3066	944	2500	100%	60	0.00657
2	2020	0%	0	4.5%	2760	850	2500	100%	60	0.00617
3	2020	0%	0	5.4%	3313	1021	2500	50%	30	0.00686
4	2020	0%	0	6.5%	3990	1229	2500	0%	0	0.00772
5	2020	0%	0	8.0%	4913	1514	2500	0%	0	0.00893
6	2020	20%	9400	10.0%	6144	1893	2500	0%	0	0.01994
7	2020	35%	19098	11.6%	7130	2197	2500	0%	0	0.03092
8	2020	45%	26482	12.5%	7686	2368	2500	0%	0	0.03904
9	2020	35%	19790	12.0%	7382	2274	2500	0%	0	0.03195
10	2020	20%	9903	10.5%	6462	1991	2500	50%	30	0.02089
11	2020	0%	0	8.0%	4925	1517	2500	100%	60	0.00900
12	2020	0%	0	6.0%	3695	1139	2500	100%	60	0.00739
1	2021	0%	0	5.0%	3081	949	2500	100%	60	0.00659
2	2021	0%	0	4.5%	2774	855	2500	100%	60	0.00619
3	2021	0%	0	5.4%	3330	1026	2500	50%	30	0.00689
4	2021	0%	0	6.5%	4010	1235	2500	0%	0	0.00775
5	2021	0%	0	8.0%	4938	1521	2500	0%	0	0.00896
6	2021	20%	9494	10.0%	6174	1902	2500	0%	0	0.02007
7	2021	35%	19289	11.6%	7165	2208	2500	0%	0	0.03116
8	2021	45%	26747	12.5%	7725	2380	2500	0%	0	0.03935
9	2021	35%	19988	12.0%	7419	2286	2500	0%	0	0.03219
10	2021	20%	10002	10.5%	6494	2001	2500	50%	30	0.02103
11	2021	0%	0	8.0%	4950	1525	2500	100%	60	0.00903
12	2021	0%	0	6.0%	3714	1144	2500	100%	60	0.00742
1	2022	0%	0	5.0%	3096	954	2500	100%	60	0.00661
2	2022	0%	0	4.5%	2788	859	2500	100%	60	0.00621
3	2022	0%	0	5.4%	3347	1031	2500	50%	30	0.00691
4	2022	0%	0	6.5%	4030	1242	2500	0%	0	0.00777
5	2022	0%	0	8.0%	4962	1529	2500	0%	0	0.00899
6	2022	20%	9589	10.0%	6205	1912	2500	0%	0	0.02021
7	2022	35%	19482	11.6%	7201	2219	2500	0%	0	0.03140
8	2022	45%	27014	12.5%	7763	2392	2500	0%	0	0.03967
9	2022	35%	20187	12.0%	7456	2297	2500	0%	0	0.03244
10	2022	20%	10102	10.5%	6526	2011	2500	50%	30	0.02117
11	2022	0%	0	8.0%	4975	1533	2500	100%	60	0.00907
12	2022	0%	0	6.0%	3733	1150	2500	100%	60	0.00744
1	2023	0%	0	5.0%	3112	959	2500	100%	60	0.00663
2	2023	0%	0	4.5%	2802	863	2500	100%	60	0.00622
3	2023	0%	0	5.4%	3363	1036	2500	50%	30	0.00693
4	2023	0%	0	6.5%	4050	1248	2500	0%	0	0.00780
5	2023	0%	0	8.0%	4987	1536	2500	0%	0	0.00902
6	2023	20%	9685	10.0%	6236	1921	2500	0%	0	0.02034

month	year	Participation in water supply	M. Kamenica	Monthly water demands	Todorovci + Lukovica	Kosevica	Industrial zone	Heating plant, usage	Heating plant	Total
			V (m^3)		V (m^3)	V (m^3)	V (m^3)		V (m^3)	V ($10^6 m^3$)
7	2023	35%	19677	11.6%	7237	2230	2500	0%	0	0.03164
8	2023	45%	27284	12.5%	7802	2404	2500	0%	0	0.03999
9	2023	35%	20389	12.0%	7493	2308	2500	0%	0	0.03269
10	2023	20%	10203	10.5%	6559	2021	2500	50%	30	0.02131
11	2023	0%	0	8.0%	4999	1540	2500	100%	60	0.00910
12	2023	0%	0	6.0%	3751	1156	2500	100%	60	0.00747
1	2024	0%	0	5.0%	3127	963	2500	100%	60	0.00665
2	2024	0%	0	4.5%	2816	867	2500	100%	60	0.00624
3	2024	0%	0	5.4%	3380	1041	2500	50%	30	0.00695
4	2024	0%	0	6.5%	4071	1254	2500	0%	0	0.00782
5	2024	0%	0	8.0%	5012	1544	2500	0%	0	0.00906
6	2024	20%	9782	10.0%	6268	1931	2500	0%	0	0.02048
7	2024	35%	19874	11.6%	7273	2241	2500	0%	0	0.03189
8	2024	45%	27557	12.5%	7841	2416	2500	0%	0	0.04031
9	2024	35%	20593	12.0%	7530	2320	2500	0%	0	0.03294
10	2024	20%	10305	10.5%	6592	2031	2500	50%	30	0.02146
11	2024	0%	0	8.0%	5024	1548	2500	100%	60	0.00913
12	2024	0%	0	6.0%	3770	1161	2500	100%	60	0.00749
1	2025	0%	0	5.0%	3143	968	2500	100%	60	0.00667
2	2025	0%	0	4.5%	2830	872	2500	100%	60	0.00626
3	2025	0%	0	5.4%	3397	1047	2500	50%	30	0.00697
4	2025	0%	0	6.5%	4091	1260	2500	0%	0	0.00785
5	2025	0%	0	8.0%	5037	1552	2500	0%	0	0.00909
6	2025	20%	9880	10.0%	6299	1941	2500	0%	0	0.02062
7	2025	35%	20072	11.6%	7310	2252	2500	0%	0	0.03213
8	2025	45%	27833	12.5%	7880	2428	2500	0%	0	0.04064
9	2025	35%	20799	12.0%	7568	2332	2500	0%	0	0.03320
10	2025	20%	10408	10.5%	6625	2041	2500	50%	30	0.02160
11	2025	0%	0	8.0%	5050	1556	2500	100%	60	0.00917
12	2025	0%	0	6.0%	3789	1167	2500	100%	60	0.00752
1	2026	0%	0	5.0%	3159	973	2500	100%	60	0.00669
2	2026	0%	0	4.5%	2844	876	2500	100%	60	0.00628
3	2026	0%	0	5.4%	3414	1052	2500	50%	30	0.00700
4	2026	0%	0	6.5%	4111	1267	2500	0%	0	0.00788
5	2026	0%	0	8.0%	5062	1560	2500	0%	0	0.00912
6	2026	20%	9979	10.0%	6330	1950	2500	0%	0	0.02076
7	2026	35%	20273	11.6%	7346	2263	2500	0%	0	0.03238
8	2026	45%	28111	12.5%	7920	2440	2500	0%	0	0.04097
9	2026	35%	21007	12.0%	7606	2343	2500	0%	0	0.03346
10	2026	20%	10512	10.5%	6658	2051	2500	50%	30	0.02175
11	2026	0%	0	8.0%	5075	1563	2500	100%	60	0.00920
12	2026	0%	0	6.0%	3808	1173	2500	100%	60	0.00754
1	2027	0%	0	5.0%	3174	978	2500	100%	60	0.00671
2	2027	0%	0	4.5%	2858	881	2500	100%	60	0.00630
3	2027	0%	0	5.4%	3431	1057	2500	50%	30	0.00702
4	2027	0%	0	6.5%	4132	1273	2500	0%	0	0.00790
5	2027	0%	0	8.0%	5088	1567	2500	0%	0	0.00915
6	2027	20%	10078	10.0%	6362	1960	2500	0%	0	0.02090
7	2027	35%	20476	11.6%	7383	2275	2500	0%	0	0.03263
8	2027	45%	28392	12.5%	7959	2452	2500	0%	0	0.04130
9	2027	35%	21217	12.0%	7644	2355	2500	0%	0	0.03372
10	2027	20%	10617	10.5%	6691	2061	2500	50%	30	0.02190
11	2027	0%	0	8.0%	5100	1571	2500	100%	60	0.00923
12	2027	0%	0	6.0%	3827	1179	2500	100%	60	0.00757
1	2028	0%	0	5.0%	3190	983	2500	100%	60	0.00673

month	year	Participation in water supply	M. Kamenica	Monthly water demands	Todorovci + Lukovica	Kosevica	Industrial zone	Heating plant, usage	Heating plant	Total
			V (m^3)		V (m^3)	V (m^3)	V (m^3)		V (m^3)	V ($10^6 m^3$)
2	2028	0%	0	4.5%	2872	885	2500	100%	60	0.00632
3	2028	0%	0	5.4%	3448	1062	2500	50%	30	0.00704
4	2028	0%	0	6.5%	4153	1279	2500	0%	0	0.00793
5	2028	0%	0	8.0%	5113	1575	2500	0%	0	0.00919
6	2028	20%	10179	10.0%	6394	1970	2500	0%	0	0.02104
7	2028	35%	20681	11.6%	7420	2286	2500	0%	0	0.03289
8	2028	45%	28676	12.5%	7999	2464	2500	0%	0	0.04164
9	2028	35%	21429	12.0%	7682	2367	2500	0%	0	0.03398
10	2028	20%	10724	10.5%	6725	2072	2500	50%	30	0.02205
11	2028	0%	0	8.0%	5126	1579	2500	100%	60	0.00926
12	2028	0%	0	6.0%	3846	1185	2500	100%	60	0.00759
1	2029	0%	0	5.0%	3206	988	2500	100%	60	0.00675
2	2029	0%	0	4.5%	2887	889	2500	100%	60	0.00634
3	2029	0%	0	5.4%	3466	1068	2500	50%	30	0.00706
4	2029	0%	0	6.5%	4173	1286	2500	0%	0	0.00796
5	2029	0%	0	8.0%	5139	1583	2500	0%	0	0.00922
6	2029	20%	10281	10.0%	6426	1980	2500	0%	0	0.02119
7	2029	35%	20887	11.6%	7457	2297	2500	0%	0	0.03314
8	2029	45%	28963	12.5%	8039	2477	2500	0%	0	0.04198
9	2029	35%	21644	12.0%	7721	2379	2500	0%	0	0.03424
10	2029	20%	10831	10.5%	6758	2082	2500	50%	30	0.02220
11	2029	0%	0	8.0%	5151	1587	2500	100%	60	0.00930
12	2029	0%	0	6.0%	3865	1191	2500	100%	60	0.00762
1	2030	0%	0	5.0%	3222	993	2500	100%	60	0.00678
2	2030	0%	0	4.5%	2901	894	2500	100%	60	0.00636
3	2030	0%	0	5.4%	3483	1073	2500	50%	30	0.00709
4	2030	0%	0	6.5%	4194	1292	2500	0%	0	0.00799
5	2030	0%	0	8.0%	5164	1591	2500	0%	0	0.00926
6	2030	20%	10384	10.0%	6458	1990	2500	0%	0	0.02133
7	2030	35%	21096	11.6%	7494	2309	2500	0%	0	0.03340
8	2030	45%	29253	12.5%	8079	2489	2500	0%	0	0.04232
9	2030	35%	21860	12.0%	7759	2391	2500	0%	0	0.03451
10	2030	20%	10939	10.5%	6792	2093	2500	50%	30	0.02235
11	2030	0%	0	8.0%	5177	1595	2500	100%	60	0.00933
12	2030	0%	0	6.0%	3884	1197	2500	100%	60	0.00764
1	2031	0%	0	5.0%	3238	998	2500	100%	60	0.00680
2	2031	0%	0	4.5%	2916	898	2500	100%	60	0.00637
3	2031	0%	0	5.4%	3500	1078	2500	50%	30	0.00711
4	2031	0%	0	6.5%	4215	1299	2500	0%	0	0.00801
5	2031	0%	0	8.0%	5190	1599	2500	0%	0	0.00929
6	2031	20%	10488	10.0%	6490	2000	2500	0%	0	0.02148
7	2031	35%	21307	11.6%	7532	2320	2500	0%	0	0.03366
8	2031	45%	29545	12.5%	8120	2502	2500	0%	0	0.04267
9	2031	35%	22079	12.0%	7798	2402	2500	0%	0	0.03478
10	2031	20%	11048	10.5%	6826	2103	2500	50%	30	0.02251
11	2031	0%	0	8.0%	5203	1603	2500	100%	60	0.00937
12	2031	0%	0	6.0%	3904	1203	2500	100%	60	0.00767
1	2032	0%	0	5.0%	3255	1003	2500	100%	60	0.00682
2	2032	0%	0	4.5%	2930	903	2500	100%	60	0.00639
3	2032	0%	0	5.4%	3518	1084	2500	50%	30	0.00713
4	2032	0%	0	6.5%	4236	1305	2500	0%	0	0.00804
5	2032	0%	0	8.0%	5216	1607	2500	0%	0	0.00932
6	2032	20%	10592	10.0%	6523	2010	2500	0%	0	0.02162
7	2032	35%	21520	11.6%	7569	2332	2500	0%	0	0.03392
8	2032	45%	29841	12.5%	8160	2514	2500	0%	0	0.04301

month	year	Participation in water supply	M. Kamenica	Monthly water demands	Todorovci + Lukovica	Kosevica	Industrial zone	Heating plant, usage	Heating plant	Total
			V (m^3)		V (m^3)	V (m^3)	V (m^3)		V (m^3)	V ($10^6 m^3$)
9	2032	35%	22299	12.0%	7837	2414	2500	0%	0	0.03505
10	2032	20%	11159	10.5%	6860	2114	2500	50%	30	0.02266
11	2032	0%	0	8.0%	5229	1611	2500	100%	60	0.00940
12	2032	0%	0	6.0%	3923	1209	2500	100%	60	0.00769
1	2033	0%	0	5.0%	3271	1008	2500	100%	60	0.00684
2	2033	0%	0	4.5%	2945	907	2500	100%	60	0.00641
3	2033	0%	0	5.4%	3535	1089	2500	50%	30	0.00715
4	2033	0%	0	6.5%	4257	1312	2500	0%	0	0.00807
5	2033	0%	0	8.0%	5242	1615	2500	0%	0	0.00936
6	2033	20%	10698	10.0%	6555	2020	2500	0%	0	0.02177
7	2033	35%	21736	11.6%	7607	2344	2500	0%	0	0.03419
8	2033	45%	30139	12.5%	8201	2527	2500	0%	0	0.04337
9	2033	35%	22522	12.0%	7876	2427	2500	0%	0	0.03533
10	2033	20%	11271	10.5%	6895	2124	2500	50%	30	0.02282
11	2033	0%	0	8.0%	5255	1619	2500	100%	60	0.00943
12	2033	0%	0	6.0%	3943	1215	2500	100%	60	0.00772
1	2034	0%	0	5.0%	3287	1013	2500	100%	60	0.00686
2	2034	0%	0	4.5%	2960	912	2500	100%	60	0.00643
3	2034	0%	0	5.4%	3553	1095	2500	50%	30	0.00718
4	2034	0%	0	6.5%	4279	1318	2500	0%	0	0.00810
5	2034	0%	0	8.0%	5268	1623	2500	0%	0	0.00939
6	2034	20%	10805	10.0%	6588	2030	2500	0%	0	0.02192
7	2034	35%	21953	11.6%	7645	2355	2500	0%	0	0.03445
8	2034	45%	30440	12.5%	8242	2539	2500	0%	0	0.04372
9	2034	35%	22748	12.0%	7916	2439	2500	0%	0	0.03560
10	2034	20%	11383	10.5%	6929	2135	2500	50%	30	0.02298
11	2034	0%	0	8.0%	5281	1627	2500	100%	60	0.00947
12	2034	0%	0	6.0%	3963	1221	2500	100%	60	0.00774
1	2035	0%	0	5.0%	3304	1018	2500	100%	60	0.00688
2	2035	0%	0	4.5%	2975	916	2500	100%	60	0.00645
3	2035	0%	0	5.4%	3571	1100	2500	50%	30	0.00720
4	2035	0%	0	6.5%	4300	1325	2500	0%	0	0.00812
5	2035	0%	0	8.0%	5295	1631	2500	0%	0	0.00943
6	2035	20%	10913	10.0%	6621	2040	2500	0%	0	0.02207
7	2035	35%	22173	11.6%	7684	2367	2500	0%	0	0.03472
8	2035	45%	30745	12.5%	8283	2552	2500	0%	0	0.04408
9	2035	35%	22975	12.0%	7955	2451	2500	0%	0	0.03588
10	2035	20%	11497	10.5%	6964	2145	2500	50%	30	0.02314
11	2035	0%	0	8.0%	5308	1635	2500	100%	60	0.00950
12	2035	0%	0	6.0%	3983	1227	2500	100%	60	0.00777
1	2036	0%	0	5.0%	3320	1023	2500	100%	60	0.00690
2	2036	0%	0	4.5%	2989	921	2500	100%	60	0.00647
3	2036	0%	0	5.4%	3589	1106	2500	50%	30	0.00722
4	2036	0%	0	6.5%	4322	1331	2500	0%	0	0.00815
5	2036	0%	0	8.0%	5321	1639	2500	0%	0	0.00946
6	2036	20%	11022	10.0%	6654	2050	2500	0%	0	0.02223
7	2036	35%	22394	11.6%	7722	2379	2500	0%	0	0.03500
8	2036	45%	31052	12.5%	8325	2565	2500	0%	0	0.04444
9	2036	35%	23205	12.0%	7995	2463	2500	0%	0	0.03616
10	2036	20%	11612	10.5%	6998	2156	2500	50%	30	0.02330
11	2036	0%	0	8.0%	5334	1643	2500	100%	60	0.00954
12	2036	0%	0	6.0%	4002	1233	2500	100%	60	0.00780
1	2037	0%	0	5.0%	3337	1028	2500	100%	60	0.00692
2	2037	0%	0	4.5%	3004	926	2500	100%	60	0.00649
3	2037	0%	0	5.4%	3607	1111	2500	50%	30	0.00725

month	year	Participation in water supply	M. Kamenica	Monthly water demands	Todorovci + Lukovica	Kosevica	Industrial zone	Heating plant, usage	Heating plant	Total
			V (m^3)		V (m^3)	V (m^3)	V (m^3)		V (m^3)	V ($10^6 m^3$)
4	2037	0%	0	6.5%	4343	1338	2500	0%	0	0.00818
5	2037	0%	0	8.0%	5348	1648	2500	0%	0	0.00950
6	2037	20%	11133	10.0%	6687	2060	2500	0%	0	0.02238
7	2037	35%	22618	11.6%	7761	2391	2500	0%	0	0.03527
8	2037	45%	31363	12.5%	8366	2578	2500	0%	0	0.04481
9	2037	35%	23437	12.0%	8035	2475	2500	0%	0	0.03645
10	2037	20%	11728	10.5%	7033	2167	2500	50%	30	0.02346
11	2037	0%	0	8.0%	5361	1652	2500	100%	60	0.00957
12	2037	0%	0	6.0%	4022	1239	2500	100%	60	0.00782
1	2038	0%	0	5.0%	3353	1033	2500	100%	60	0.00695
2	2038	0%	0	4.5%	3019	930	2500	100%	60	0.00651
3	2038	0%	0	5.4%	3625	1117	2500	50%	30	0.00727
4	2038	0%	0	6.5%	4365	1345	2500	0%	0	0.00821
5	2038	0%	0	8.0%	5374	1656	2500	0%	0	0.00953
6	2038	20%	11244	10.0%	6721	2071	2500	0%	0	0.02254
7	2038	35%	22844	11.6%	7799	2403	2500	0%	0	0.03555
8	2038	45%	31676	12.5%	8408	2590	2500	0%	0	0.04517
9	2038	35%	23671	12.0%	8075	2488	2500	0%	0	0.03673
10	2038	20%	11845	10.5%	7069	2178	2500	50%	30	0.02362
11	2038	0%	0	8.0%	5388	1660	2500	100%	60	0.00961
12	2038	0%	0	6.0%	4043	1245	2500	100%	60	0.00785
1	2039	0%	0	5.0%	3370	1038	2500	100%	60	0.00697
2	2039	0%	0	4.5%	3034	935	2500	100%	60	0.00653
3	2039	0%	0	5.4%	3643	1122	2500	50%	30	0.00730
4	2039	0%	0	6.5%	4387	1351	2500	0%	0	0.00824
5	2039	0%	0	8.0%	5401	1664	2500	0%	0	0.00957
6	2039	20%	11356	10.0%	6754	2081	2500	0%	0	0.02269
7	2039	35%	23073	11.6%	7838	2415	2500	0%	0	0.03583
8	2039	45%	31993	12.5%	8450	2603	2500	0%	0	0.04555
9	2039	35%	23908	12.0%	8115	2500	2500	0%	0	0.03702
10	2039	20%	11964	10.5%	7104	2189	2500	50%	30	0.02379
11	2039	0%	0	8.0%	5415	1668	2500	100%	60	0.00964
12	2039	0%	0	6.0%	4063	1252	2500	100%	60	0.00787
1	2040	0%	0	5.0%	3387	1044	2500	100%	60	0.00699
2	2040	0%	0	4.5%	3050	940	2500	100%	60	0.00655
3	2040	0%	0	5.4%	3661	1128	2500	50%	30	0.00732
4	2040	0%	0	6.5%	4409	1358	2500	0%	0	0.00827
5	2040	0%	0	8.0%	5428	1672	2500	0%	0	0.00960
6	2040	20%	11470	10.0%	6788	2091	2500	0%	0	0.02285
7	2040	35%	23304	11.6%	7878	2427	2500	0%	0	0.03611
8	2040	45%	32313	12.5%	8492	2616	2500	0%	0	0.04592
9	2040	35%	24147	12.0%	8156	2513	2500	0%	0	0.03732
10	2040	20%	12084	10.5%	7139	2200	2500	50%	30	0.02395
11	2040	0%	0	8.0%	5442	1677	2500	100%	60	0.00968
12	2040	0%	0	6.0%	4083	1258	2500	100%	60	0.00790
1	2041	0%	0	5.0%	3404	1049	2500	100%	60	0.00701
2	2041	0%	0	4.5%	3065	944	2500	100%	60	0.00657
3	2041	0%	0	5.4%	3679	1134	2500	50%	30	0.00734
4	2041	0%	0	6.5%	4431	1365	2500	0%	0	0.00830
5	2041	0%	0	8.0%	5455	1681	2500	0%	0	0.00964
6	2041	20%	11585	10.0%	6822	2102	2500	0%	0	0.02301
7	2041	35%	23537	11.6%	7917	2439	2500	0%	0	0.03639
8	2041	45%	32636	12.5%	8535	2629	2500	0%	0	0.04630
9	2041	35%	24389	12.0%	8197	2525	2500	0%	0	0.03761
10	2041	20%	12204	10.5%	7175	2211	2500	50%	30	0.02412

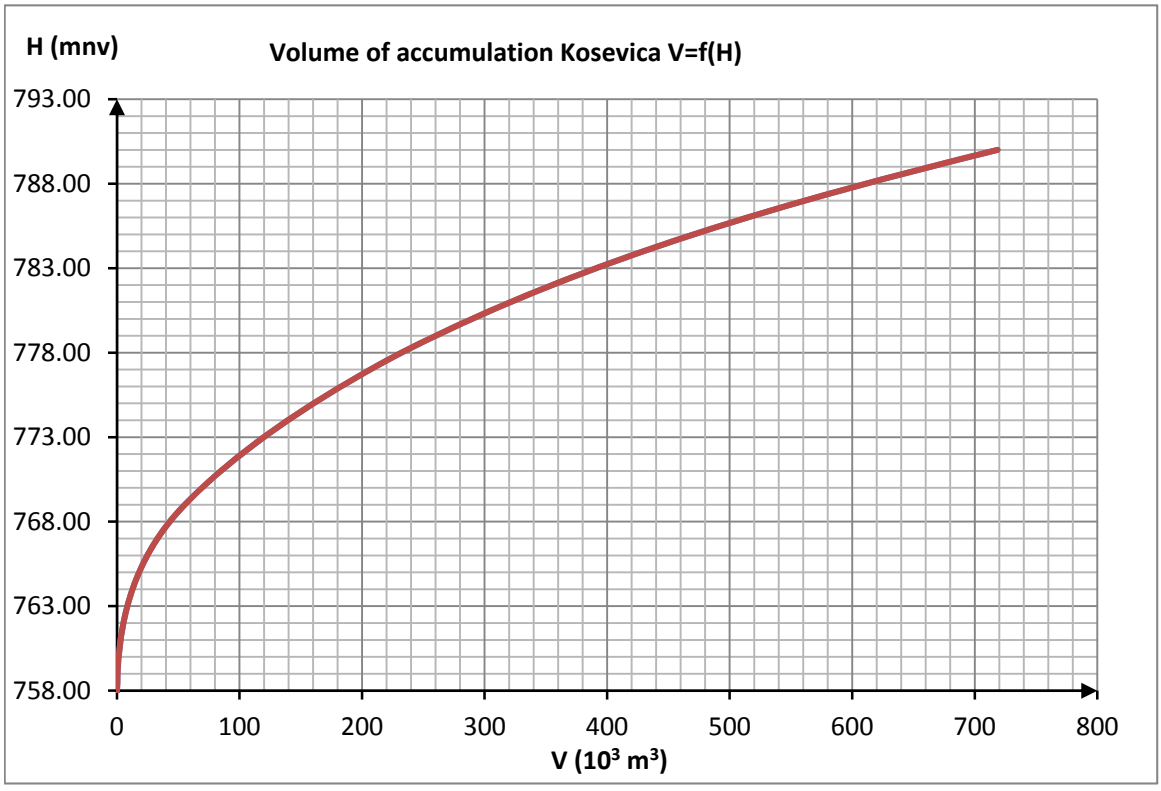
month	year	Participation in water supply	M. Kamenica	Monthly water demands	Todorovci + Lukovica	Kosevica	Industrial zone	Heating plant, usage	Heating plant	Total
			V (m^3)		V (m^3)	V (m^3)	V (m^3)		V (m^3)	V ($10^6 m^3$)
11	2041	0%	0	8.0%	5469	1685	2500	100%	60	0.00971
12	2041	0%	0	6.0%	4104	1264	2500	100%	60	0.00793
1	2042	0%	0	5.0%	3421	1054	2500	100%	60	0.00703
2	2042	0%	0	4.5%	3080	949	2500	100%	60	0.00659
3	2042	0%	0	5.4%	3698	1139	2500	50%	30	0.00737
4	2042	0%	0	6.5%	4453	1372	2500	0%	0	0.00832
5	2042	0%	0	8.0%	5483	1689	2500	0%	0	0.00967
6	2042	20%	11701	10.0%	6856	2112	2500	0%	0	0.02317
7	2042	35%	23772	11.6%	7957	2451	2500	0%	0	0.03668
8	2042	45%	32963	12.5%	8577	2643	2500	0%	0	0.04668
9	2042	35%	24632	12.0%	8238	2538	2500	0%	0	0.03791
10	2042	20%	12326	10.5%	7211	2222	2500	50%	30	0.02429
11	2042	0%	0	8.0%	5496	1693	2500	100%	60	0.00975
12	2042	0%	0	6.0%	4124	1271	2500	100%	60	0.00795
1	2043	0%	0	5.0%	3438	1059	2500	100%	60	0.00706
2	2043	0%	0	4.5%	3096	954	2500	100%	60	0.00661
3	2043	0%	0	5.4%	3716	1145	2500	50%	30	0.00739
4	2043	0%	0	6.5%	4475	1379	2500	0%	0	0.00835
5	2043	0%	0	8.0%	5510	1698	2500	0%	0	0.00971
6	2043	20%	11818	10.0%	6891	2123	2500	0%	0	0.02333
7	2043	35%	24010	11.6%	7996	2464	2500	0%	0	0.03697
8	2043	45%	33292	12.5%	8620	2656	2500	0%	0	0.04707
9	2043	35%	24879	12.0%	8279	2551	2500	0%	0	0.03821
10	2043	20%	12450	10.5%	7247	2233	2500	50%	30	0.02446
11	2043	0%	0	8.0%	5524	1702	2500	100%	60	0.00979
12	2043	0%	0	6.0%	4145	1277	2500	100%	60	0.00798
1	2044	0%	0	5.0%	3455	1065	2500	100%	60	0.00708
2	2044	0%	0	4.5%	3111	958	2500	100%	60	0.00663
3	2044	0%	0	5.4%	3735	1151	2500	50%	30	0.00742
4	2044	0%	0	6.5%	4498	1386	2500	0%	0	0.00838
5	2044	0%	0	8.0%	5538	1706	2500	0%	0	0.00974
6	2044	20%	11936	10.0%	6925	2134	2500	0%	0	0.02349
7	2044	35%	24250	11.6%	8036	2476	2500	0%	0	0.03726
8	2044	45%	33625	12.5%	8663	2669	2500	0%	0	0.04746
9	2044	35%	25128	12.0%	8320	2563	2500	0%	0	0.03851
10	2044	20%	12574	10.5%	7283	2244	2500	50%	30	0.02463
11	2044	0%	0	8.0%	5552	1710	2500	100%	60	0.00982
12	2044	0%	0	6.0%	4165	1283	2500	100%	60	0.00801
1	2045	0%	0	5.0%	3473	1070	2500	100%	60	0.00710
2	2045	0%	0	4.5%	3127	963	2500	100%	60	0.00665
3	2045	0%	0	5.4%	3754	1156	2500	50%	30	0.00744
4	2045	0%	0	6.5%	4520	1393	2500	0%	0	0.00841
5	2045	0%	0	8.0%	5565	1715	2500	0%	0	0.00978
6	2045	20%	12055	10.0%	6960	2144	2500	0%	0	0.02366
7	2045	35%	24492	11.6%	8077	2488	2500	0%	0	0.03756
8	2045	45%	33961	12.5%	8707	2682	2500	0%	0	0.04785
9	2045	35%	25379	12.0%	8362	2576	2500	0%	0	0.03882
10	2045	20%	12700	10.5%	7320	2255	2500	50%	30	0.02480
11	2045	0%	0	8.0%	5579	1719	2500	100%	60	0.00986
12	2045	0%	0	6.0%	4186	1290	2500	100%	60	0.00804
1	2046	0%	0	5.0%	3490	1075	2500	100%	60	0.00713
2	2046	0%	0	4.5%	3142	968	2500	100%	60	0.00667
3	2046	0%	0	5.4%	3772	1162	2500	50%	30	0.00746
4	2046	0%	0	6.5%	4543	1400	2500	0%	0	0.00844
5	2046	0%	0	8.0%	5593	1723	2500	0%	0	0.00982

month	year	Participation in water supply	M. Kamenica	Monthly water demands	Todorovci + Lukovica	Kosevica	Industrial zone	Heating plant, usage	Heating plant	Total
			V (m^3)		V (m^3)	V (m^3)	V (m^3)		V (m^3)	V ($10^6 m^3$)
6	2046	20%	12176	10.0%	6994	2155	2500	0%	0	0.02383
7	2046	35%	24737	11.6%	8117	2501	2500	0%	0	0.03785
8	2046	45%	34301	12.5%	8750	2696	2500	0%	0	0.04825
9	2046	35%	25633	12.0%	8404	2589	2500	0%	0	0.03913
10	2046	20%	12827	10.5%	7356	2266	2500	50%	30	0.02498
11	2046	0%	0	8.0%	5607	1728	2500	100%	60	0.00989
12	2046	0%	0	6.0%	4207	1296	2500	100%	60	0.00806
1	2047	0%	0	5.0%	3507	1081	2500	100%	60	0.00715
2	2047	0%	0	4.5%	3158	973	2500	100%	60	0.00669
3	2047	0%	0	5.4%	3791	1168	2500	50%	30	0.00749
4	2047	0%	0	6.5%	4565	1407	2500	0%	0	0.00847
5	2047	0%	0	8.0%	5621	1732	2500	0%	0	0.00985
6	2047	20%	12297	10.0%	7029	2166	2500	0%	0	0.02399
7	2047	35%	24985	11.6%	8157	2513	2500	0%	0	0.03816
8	2047	45%	34644	12.5%	8794	2709	2500	0%	0	0.04865
9	2047	35%	25889	12.0%	8446	2602	2500	0%	0	0.03944
10	2047	20%	12955	10.5%	7393	2278	2500	50%	30	0.02516
11	2047	0%	0	8.0%	5635	1736	2500	100%	60	0.00993
12	2047	0%	0	6.0%	4228	1303	2500	100%	60	0.00809
1	2048	0%	0	5.0%	3525	1086	2500	100%	60	0.00717
2	2048	0%	0	4.5%	3174	978	2500	100%	60	0.00671
3	2048	0%	0	5.4%	3810	1174	2500	50%	30	0.00751
4	2048	0%	0	6.5%	4588	1414	2500	0%	0	0.00850
5	2048	0%	0	8.0%	5649	1740	2500	0%	0	0.00989
6	2048	20%	12420	10.0%	7065	2176	2500	0%	0	0.02416
7	2048	35%	25234	11.6%	8198	2526	2500	0%	0	0.03846
8	2048	45%	34990	12.5%	8838	2723	2500	0%	0	0.04905
9	2048	35%	26148	12.0%	8488	2615	2500	0%	0	0.03975
10	2048	20%	13085	10.5%	7430	2289	2500	50%	30	0.02533
11	2048	0%	0	8.0%	5663	1745	2500	100%	60	0.00997
12	2048	0%	0	6.0%	4249	1309	2500	100%	60	0.00812
1	2049	0%	0	5.0%	3543	1091	2500	100%	60	0.00719
2	2049	0%	0	4.5%	3190	983	2500	100%	60	0.00673
3	2049	0%	0	5.4%	3829	1180	2500	50%	30	0.00754
4	2049	0%	0	6.5%	4611	1421	2500	0%	0	0.00853
5	2049	0%	0	8.0%	5678	1749	2500	0%	0	0.00993
6	2049	20%	12545	10.0%	7100	2187	2500	0%	0	0.02433
7	2049	35%	25487	11.6%	8239	2538	2500	0%	0	0.03876
8	2049	45%	35340	12.5%	8882	2736	2500	0%	0	0.04946
9	2049	35%	26409	12.0%	8530	2628	2500	0%	0	0.04007
10	2049	20%	13216	10.5%	7467	2301	2500	50%	30	0.02551
11	2049	0%	0	8.0%	5692	1754	2500	100%	60	0.01001
12	2049	0%	0	6.0%	4271	1316	2500	100%	60	0.00815
1	2050	0%	0	5.0%	3560	1097	2500	100%	60	0.00722
2	2050	0%	0	4.5%	3206	988	2500	100%	60	0.00675
3	2050	0%	0	5.4%	3848	1186	2500	50%	30	0.00756
4	2050	0%	0	6.5%	4634	1428	2500	0%	0	0.00856
5	2050	0%	0	8.0%	5706	1758	2500	0%	0	0.00996
6	2050	20%	12670	10.0%	7135	2198	2500	0%	0	0.02450
7	2050	35%	25742	11.6%	8280	2551	2500	0%	0	0.03907
8	2050	45%	35694	12.5%	8927	2750	2500	0%	0	0.04987
9	2050	35%	26673	12.0%	8573	2641	2500	0%	0	0.04039
10	2050	20%	13348	10.5%	7505	2312	2500	50%	30	0.02569
11	2050	0%	0	8.0%	5720	1762	2500	100%	60	0.01004
12	2050	0%	0	6.0%	4292	1322	2500	100%	60	0.00817

Annex 26. Volume of accumulations

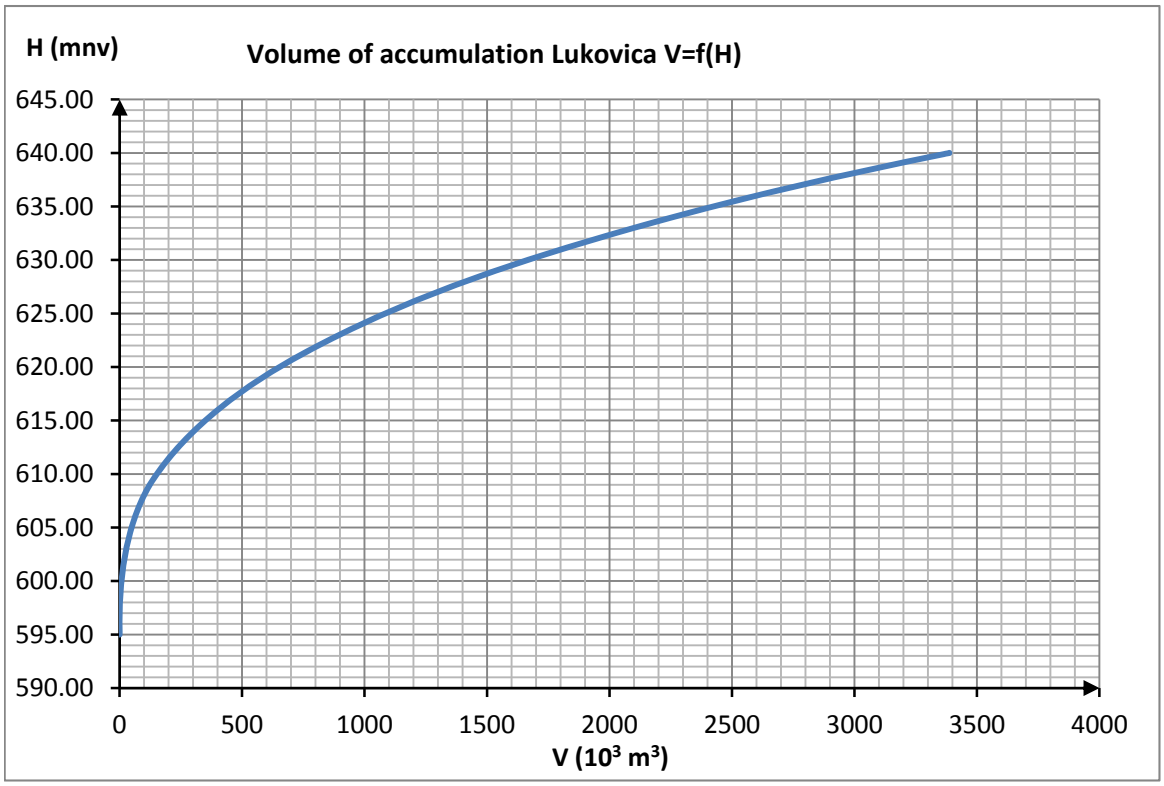
Accumulation Kosevica

level	H	A	A_{avr}	V	ΣV
(mnv)	(m)	(m^2)	(m^2)	(m^3)	10^3 (m^3)
757.92	0.00	0.00			0.00
760.00	2.08	1291.00	645.50	1342.64	1.34
762.00	4.08	2664.00	1977.50	3955.00	5.30
764.00	6.08	4683.30	3673.65	7347.30	12.64
766.00	8.08	7418.50	6050.90	12101.80	24.75
768.00	10.08	10946.83	9182.67	18365.33	43.11
770.00	12.08	15114.40	13030.62	26061.23	69.17
772.00	14.08	17441.30	16277.85	32555.70	101.73
774.00	16.08	20285.85	18863.58	37727.15	139.46
776.00	18.08	23064.20	21675.03	43350.05	182.81
778.00	20.08	26334.90	24699.55	49399.10	232.21
780.00	22.08	31000.30	28667.60	57335.20	289.54
782.00	24.08	34405.20	32702.75	65405.50	354.95
784.00	26.08	40260.56	37332.88	74665.76	429.61
786.00	28.08	45094.54	42677.55	85355.10	514.97
788.00	30.08	50625.84	47860.19	95720.38	610.69
790.00	32.08	57279.33	53952.59	107905.17	718.59



Accumulation Lukovica

level	H	A	A_{avr}	V	ΣV
(mnv)	(m)	(m^2)	(m^2)	(m^3)	10^3 (m^3)
595.00	0.00	0.00			0.00
596.00	1.00	92.73	46.37	46.37	0.05
598.00	3.00	987.81	540.27	1080.54	1.13
600.00	5.00	5317.67	3152.74	6305.48	7.43
602.00	7.00	6983.99	6150.83	12301.66	19.73
604.00	9.00	10635.10	8809.55	17619.09	37.35
606.00	11.00	15247.84	12941.47	25882.94	63.24
608.00	13.00	21082.92	18165.38	36330.76	99.57
610.00	15.00	31138.56	26110.74	52221.48	151.79
612.00	17.00	37517.50	34328.03	68656.06	220.44
614.00	19.00	45063.69	41290.60	82581.19	303.03
616.00	21.00	53253.02	49158.36	98316.71	401.34
618.00	23.00	62233.82	57743.42	115486.84	516.83
620.00	25.00	74180.45	68207.14	136414.27	653.24
622.00	27.00	83355.32	78767.89	157535.77	810.78
624.00	29.00	93877.38	88616.35	177232.70	988.01
626.00	31.00	105656.63	99767.01	199534.01	1187.55
628.00	33.00	118723.07	112189.85	224379.70	1411.93
630.00	35.00	135518.64	127120.86	254241.71	1666.17
632.00	37.00	147575.22	141546.93	283093.86	1949.26
634.00	39.00	161751.32	154663.27	309326.54	2258.59
636.00	41.00	178050.75	169901.04	339802.07	2598.39
638.00	43.00	196473.53	187262.14	374524.28	2972.91
640.00	45.00	218175.63	207324.58	414649.16	3387.56



Annex 27. Hydraulic calculation of irrigation networks

IS LUKOVICA

No	Hours	Pipeline	line		Elevation		L	F	Ftrans	Ftot	q	Qtot	Qadop	PN	DN	V
			from	to	from	to	(m)	(ha)	(ha)	(ha)	(l/sec/ha)	(l/sec)	(l/sec)	(bar)	(mm)	(m/s)
1	18	GV2	zafat	11	620.0	571.0	867	0.0	248.3	248.3	0.80	198.6	210.0	6	560	1.00
2	18	DV7	11	12	571.0	554.0	550	15.0	21.8	36.8	0.80	29.5	30.0	10	250	0.79
3	18	DV7	12	13	554.0	537.8	400	10.9	10.9	21.8	0.80	17.5	30.0	10	250	0.79
4	18	DV7	13	14	537.8	530.6	400	10.9	0.0	10.9	0.80	8.7	15.0	16	180	0.88
5	18	RV3	11	15	571.0	562.6	300	2.8	84.1	86.8	0.80	69.5	75.0	10	355	0.98
6	18	DV3	15	16	562.6	583.0	450	9.7	0.0	9.7	0.80	7.7	15.0	10	180	0.76
7	18	DV4	15	17	562.6	580.7	250	5.8	18.4	24.2	0.80	19.3	30.0	10	250	0.79
8	18	DV4	17	18	580.7	580.6	400	9.2	9.2	18.4	0.80	14.7	15.0	6	160	0.88
9	18	DV4	18	19	580.6	578.3	400	9.2	0.0	9.2	0.80	7.4	15.0	6	160	0.88
10	18	RV3	15	20	562.6	557.0	100	3.1	47.2	50.3	0.80	40.2	45.0	10	315	0.74
11	18	RV3	20	21	557.0	539.0	400	12.5	34.7	47.2	0.80	37.7	45.0	10	315	0.74
12	18	RV3	21	22	539.0	524.4	400	12.5	22.2	34.7	0.80	27.7	30.0	16	280	0.73
13	18	DV5	22	23	524.4	580.9	450	13.2	0.0	13.2	0.80	10.5	15.0	16	180	0.88
14	18	DV6	23	24	580.9	510.0	350	9.0	0.0	9.0	0.80	7.2	15.0	16	180	0.88
15	18	RV4	11	25	571.0	595.2	346	0.0	124.6	124.6	0.80	99.7	105.0	6	400	0.98
16	18	DV8	25	26	595.2	565.2	450	13.3	23.6	36.8	0.80	29.5	30.0	10	250	0.79
17	18	DV8	26	27	565.2	547.0	400	11.8	11.8	23.6	0.80	18.9	30.0	10	250	0.79
18	18	DV8	27	28	547.0	551.0	400	11.8	0.0	11.8	0.80	9.4	15.0	16	180	0.88
19	18	RV4	25	29	595.2	589.0	305	0.0	87.8	87.8	0.80	70.2	75.0	6	315	1.13
20	18	DV9	29	30	589.0	579.1	150	4.1	11.0	15.1	0.80	12.1	15.0	6	160	0.88
21	18	DV9	30	31	579.1	551.5	400	11.0	0.0	11.0	0.80	8.8	15.0	10	160	0.96
22	18	RV4	29	32	589.0	570.8	465	14.4	58.3	72.7	0.80	58.1	60.0	6	315	0.90
23	18	RV4	32	33	570.8	572.8	400	12.4	45.9	58.3	0.80	46.6	60.0	6	315	0.90
24	18	DV10	33	34	572.8	548.9	450	13.8	12.3	26.1	0.80	20.9	30.0	10	250	0.79
25	18	DV10	34	35	548.9	551.2	400	12.3	0.0	12.3	0.80	9.8	15.0	10	180	0.76
26	18	DV11	33	36	572.8	561.2	250	7.6	12.2	19.9	0.80	15.9	30.0	10	250	0.79
27	18	DV11	36	37	561.2	569.3	400	12.2	0.0	12.2	0.80	9.8	15.0	10	180	0.76

IS KOSEVICA

No	Hours	Pipeline	line		Elevation		L	F	Ftrans	Ftot	q	Qtot	Qadop	PN	DN	V
			from	to	from	to	(m)	(ha)	(ha)	(ha)	(l/sec/ha)	(l/sec)	(l/sec)	(bar)	(mm)	(m/s)
1	18	GV1	PS	1	602.5	660.0	1,230	0.0	60.6	60.6	0.80	48.5	60.0	20	355	1.01
2	18	DV1	1	2	660.0	689.0	260	5.0	0.0	5.0	0.80	4.0	15.0	16	180	0.88
3	18	RV1	2	3	689.0	681.4	290	5.0	50.6	55.6	0.80	44.5	45.0	10	315	0.74
4	18	DV2	3	4	681.4	697.6	250	6.0	0.0	6.0	0.80	4.8	15.0	10	180	0.76
5	18	RV1	3	5	681.4	703.0	475	7.5	37.1	44.6	0.80	35.6	45.0	10	315	0.74
6	18	RV1	5	6	703.0	734.5	475	7.5	29.6	37.1	0.80	29.6	30.0	10	250	0.79
8	18	DV3	6	7	734.5	738.6	350	9.0	20.6	29.6	0.80	23.6	30.0	6	250	0.72
9	18	DV3	7	8	738.6	717.7	400	10.3	10.3	20.6	0.80	16.4	30.0	10	250	0.79
10	18	DV3	8	9	717.7	697.2	400	10.3	0.0	10.3	0.80	8.2	15.0	10	180	0.76
11	18	RV1	6	IB	734.5	760.0	180	0.0	60.6	60.6	0.80	48.5	60.0	6	280	1.14

Annex 28. RECAPITULATION
8 BOREHOLES WITH PUMP STATIONS FOR IR LUKOVICA AND KOSEVICA

POS	Description	Quant.	Unit rate (mkd)	Total	Total
			mkd	mkd	euro
I	INVESTIGATION WORKS	1	329,240	329,240	5,353
II	DRILLING OF 8 BOREHOLES	8	662,700	5,301,600	86,205
III	CONSTRUCTION OF 8 MANHOLES WITH PUMPS	8	1,275,183	10,201,462	165,877
IV	CONTROL POST	1	99,545	99,545	1,619
V	EL. EQUIPMENT, EQUIPMENT FOR MONITORING AND MANAGEMENT SCADA	1	6,150,000	6,150,000	100,000
	TOTAL			22,081,848	359,054

Annex 29. BILL OF QUANTITIES FOR DAMS

DAM KOSEVICA H=26m

No	Description of works	Unit	Quant.	Unit rate (mkd)	Amount (mkd)	Amount (euro)
I. DAM						
1. Cleaning of the dam fundation terain						
1	Mechanical tree cuting (Ø 5 do 30 cm)	pcs	679	120	81,474	1,325
2	Mechanical cutting and cleaning the earth of the roots of cut trees and storage it at a proper place	pcs	679	250	169,737	2,760
3	Removing and cleaning the humus and massive loose stone blocks of the dam location terrain, and storage of the material at the depot (of the 12900 m^2 area)					
	Mechanical 70%	m^2	9,030	25	225,750	3,671
	Manual 30%	m^2	3,870	600	2,322,000	37,756
				Total 1:	**2,798,961**	**45,512**
2. Foundation pit for the clay core						
1	Excavation of earth III and IV category (widepit)					
	Mechanical 70%	m^3	3,638	200	727,650	11,832
	Manual 30%	m^3	1,559	700	1,091,475	17,748
2	Leveling and planning of the contact surface for the dam with removing triturated massive stones and blocks (manually with particular use of a pneumatic jack hammer if needed)	m^2	1,890	500	945,000	15,366
3	Cleaning the excavated material and dust from the contact surface until the surface reaches clearance level to start the filling	m^2	1,890	100	189,000	3,073
4	Pumping the drainage water from the foundation pit with portable pump	hour	100	400	40,000	650
				Total 2:	**2,993,125**	**48,669**

No	Description of works	Unit	Quant.	Unit rate (mkd)	Amount (mkd)	Amount (euro)
3. Filling						
3.1 Clay core						
1	Mechanical excavation and loading of material (clay) from borrow pit. Delivery and placing the clayey tampon at the contact surface, (with the higher plasticity of the clay during the placing), and manual compacting and refilling at the places where it is needed	m^3	5,198	800	4,158,000	67,610
2	Mechanical excavation and loading of material (clay) from borrow pit. Delivery and placing the clay in layers thick up to 20-25 cm with mechanical compacting until the necessary compactness is achieved	m^3	24,756	900	22,280,839	362,290
				Total 3.1:	**26,438,839**	**429,900**
3.2. Filter material						
1	Supplying filter material according to granulation structure determined in the technical documentation with delivery and placing in layers thick up to 20 – 30 cm with mechanical compacting					
	Material 2	m^3	8,242	1000	8,241,881	134,014
	Material 3	m^3	5,184	700	3,628,744	59,004
	Material 4	m^3	5,184	1000	5,183,920	84,291
				Total 3.2:	**17,054,544**	**277,310**
3.3. Stone blocks material for the dam body						
1	Mechanical excavation and loading of material from borrow pit (stone pit), with delivery and placing in layers thick up to 1.0 m, and compacting the layer with compactor	m^3	92,237	400	36,894,975	599,918
2	Shaping and aligning the downstream slope with larger stone blocks of the same material like the dam body with particular manual finishing of the surface (layer thickness 2.0m.)	m^2	1,800	800	1,440,320	23,420
				Total 3.3:	**38,335,295**	**623,338**
				Total 3:	**81,828,679**	**1,330,548**
				TOTAL I:	**87,620,764**	**1,424,728**
II. SIDE SPILLWAY, CHUTE and STILLING BASIN						
				TOTAL II:	**20,070,154**	**326,344**
III. DIVERSON TUNNEL						
				TOTAL III:	**12,730,008**	**206,992**

DAM Lukovica H=25m

No	Description of works	Unit	Quant.	Unit rate (mkd)	Amount (mkd)	Amount (euro)
I. DAM						
1. Cleaning of the dam fundation terain						
1	Mechanical tree cuting (Ø 5 do 30 cm)	pcs	479	120	57,474	935
2	Mechanical cutting and cleaning the earth of the roots of cut trees and storage it at a proper place	pcs	479	250	119,737	1,947
3	Removing and cleaning the humus and massive loose stone blocks of the dam location terrain, and storage of the material at the depot (of the 12900 m^2 area)					
	Mechanical 70%	m^2	6,370	25	159,250	2,589
	Manual 30%	m^2	2,730	600	1,638,000	26,634
				Total 1:	**1,974,461**	**32,105**
2. Foundation pit for the clay core						
1	Excavation of earth III and IV category (widepit)					
	Mechanical 70%	m^3	2,811	200	562,100	9,140
	Manual 30%	m^3	1,205	700	843,150	13,710
2	Leveling and planning of the contact surface for the dam with removing triturated massive stones and blocks (manually with particular use of a pneumatic jack hammer if needed)	m^2	1,460	500	730,000	11,870
3	Cleaning the excavated material and dust from the contact surface until the surface reaches clearance level to start the filling	m^2	1,460	100	146,000	2,374
4	Pumping the drainage water from the foundation pit with portable pump	hour	100	400	40,000	650
				Total 2:	**2,321,250**	**37,744**

No	Description of works	Unit	Quant.	Unit rate (mkd)	Amount (mkd)	Amount (euro)
3. Filling						
3.1. Clay core						
1	Mechanical excavation and loading of material (clay) from borrow pit. Delivery and placing the clayey tampon at the contact surface, (with the higher plasticity of the clay during the placing), and manual compacting and refilling at the places where it is needed	m^3	4,015	800	3,212,000	52,228
2	Mechanical excavation and loading of material (clay) from borrow pit. Delivery and placing the clay in layers thick up to 20-25 cm with mechanical compacting until the necessary compactness is achieved	m^3	17,351	900	15,616,121	253,921
				Total 3.1:	**18,828,121**	**306,148**
3.2. Filter material						
1	Supplying filter material according to granulation structure determined in the technical documentation with delivery and placing in layers thick up to 20 – 30 cm with mechanical compacting					
	Material 2	m^3	5,435	1000	5,434,853	88,372
	Material 3	m^3	3,750	700	2,624,912	42,681
	Material 4	m^3	3,750	1000	3,749,874	60,974
				Total 3.2:	**11,809,639**	**192,027**
3.3. Stone blocks material for the dam body						
1	Mechanical excavation and loading of material from borrow pit (stone pit), with delivery and placing in layers thick up to 1.0 m, and compacting the layer with compactor	m^3	63,187	400	25,274,946	410,975
2	Shaping and aligning the downstream slope with larger stone blocks of the same material like the dam body with particular manual finishing of the surface (layer thickness 2.0m.)	m^2	1,339	800	1,070,984	17,414
				Total 3.3:	**26,345,930**	**428,389**
				Total 3:	**56,983,690**	**926,564**
				TOTAL I:	**61,279,400**	**996,413**
II. SIDE SPILLWAY, CHUTE and FLIP BUCKET						
				TOTAL II:	**14,798,844**	**240,632**
III. DIVERSON TUNNEL						
				TOTAL III:	**12,714,818**	**206,745**

DAM Lukovica H=28m

No	Description of works	Unit	Quant.	Unit rate (mkd)	Amount (mkd)	Amount (euro)
I. DAM						
1. Cleaning of the dam fundation terain						
1	Mechanical tree cuting (Ø 5 do 30 cm)	pcs	574	120	68,874	1,120
2	Mechanical cutting and cleaning the earth of the roots of cut trees and storage it at a proper place	pcs	574	250	143,487	2,333
3	Removing and cleaning the humus and massive loose stone blocks of the dam location terrain, and storage of the material at the depot (of the 12900 m^2 area)					
	Mechanical 70%	m^2	7,634	25	190,838	3,103
	Manual 30%	m^2	3,272	600	1,962,900	31,917
				Total 1:	**2,366,098**	**38,473**
2. Foundation pit for the clay core						
1	(widepit)					
	Mechanical 70%	m^3	3,160	200	631,960	10,276
	Manual 30%	m^3	1,354	700	947,940	15,414
2	Leveling and planning of the contact surface for the dam with removing triturated massive stones and blocks (manually with particular use of a pneumatic jack hammer if needed)	m^2	1,621	500	810,500	13,179
3	Cleaning the excavated material and dust from the contact surface until the surface reaches clearance level to start the filling	m^2	1,621	100	162,100	2,636
4	Pumping the drainage water from the foundation pit with portable pump	hour	100	400	40,000	650
				Total 2:	**2,592,500**	**42,154**

No	Description of works	Unit	Quant.	Unit rate (mkd)	Amount (mkd)	Amount (euro)
3. Filling						
3.1 Clay core						
1	Mechanical excavation and loading of material (clay) from borrow pit. Delivery and placing the clayey tampon at the contact surface, (with the higher plasticity of the clay during the placing), and manual compacting and refilling at the places where it is needed	m^3	4,514	800	3,611,200	58,719
2	Mechanical excavation and loading of material (clay) from borrow pit. Delivery and placing the clay in layers thick up to 20-25 cm with mechanical compacting until the necessary compactness is achieved	m^3	22,458	900	20,212,200	328,654
				Total 3.1:	**23,823,400**	**387,372**
3.2. Filter material						
1	Supplying filter material according to granulation structure determined in the technical documentation with delivery and placing in layers thick up to 20 – 30 cm with mechanical compacting					
	Material 2	m^3	6,708	1000	6,708,000	109,073
	Material 3	m^3	4,604	700	3,222,800	52,403
	Material 4	m^3	4,604	1000	4,604,000	74,862
				Total 3.2:	**14,534,800**	**236,338**
3.3. Stone blocks material for the dam body						
1	Mechanical excavation and loading of material from borrow pit (stone pit), with delivery and placing in layers thick up to 1.0 m, and compacting the layer with compactor	m^3	86,849	400	34,739,520	564,870
2	Shaping and aligning the downstream slope with larger stone blocks of the same material like the dam body with particular manual finishing of the surface (layer thickness 2.0m.)	m^2	1,519	800	1,215,200	19,759
				Total 3.3:	**35,954,720**	**584,630**
				Total 3:	**74,312,920**	**1,208,340**
				TOTAL I:	**79,271,518**	**1,288,968**
II. SIDE SPILLWAY, CHUTE and FLIP BUCKET						
				TOTAL II:	**18,373,845**	**298,762**
III. DIVERSON TUNNEL						
				TOTAL III:	**12,597,709**	**204,841**

RECAPITULATION

DAM KOSEVICA H=26m

POS	Description	Total (mkd)	Total (euro)
I	DAM	87,620,764	1,424,728
II	SIDE SPILLWAY, CHUTE and STILLING BASIN	20,070,154	326,344
III	DIVERSON TUNNEL	12,730,008	206,992
IV	CONTINGENCIES 15%	18,063,139	293,710
	TOTAL:	138,484,066	2,251,773

DAM LUKOVICA H=25m

POS	Description	Total (mkd)	Total (euro)
I	DAM	61,279,400	996,413
II	SIDE SPILLWAY, CHUTE and FLIP BUCKET	14,798,844	240,632
III	DIVERSON TUNNEL	12,714,818	206,745
IV	CONTINGENCIES 15%	13,318,959	216,568
	TOTAL:	102,112,021	1,660,358

DAM LUKOVICA H=25m

POS	Description	Total (mkd)	Total (euro)
I	DAM	79,271,518	1,288,968
II	SIDE SPILLWAY, CHUTE and FLIP BUCKET	18,373,845	298,762
III	DIVERSON TUNNEL	12,597,709	204,841
IV	CONTINGENCIES 15%	16,536,461	268,886
	TOTAL:	126,779,533	2,061,456

Annex 30. BILL OF QUANTITIES FOR IRRIGATION NETWORKS

No	Description of works	Unit	Quant.	Unit rate (mkd)	Amount (mkd)	Amount (euro)
I. EXPROPRIATION						
1.1	Temporary expropriation of land where the pipeline is passing trough	m'	14045	70.00	983,150	15,986
				Total I:	**983,150**	**15,986**
II. GEODETIC WORKS						
2.1	Geodetic sticking and marking of pipelines alignment along route of the pipeline	m'	14045	20.00	280,900	4,567
				Total II:	**280,900**	**4,567**
III. EARTH WORKS						
3.1	Mechanical excavation of earth III, IV и V category, depth up to 2.0 m.					
	III cat. 40%	m^3	11236	200.00	2,247,200	36,540
	IVcat. 40%	m^3	11236	400.00	4,494,400	73,080
	V cat. 15%	m^3	4214	600.00	2,528,100	41,107
3.2	Manually earth excavation 5%	m^3	1405	900.00	1,264,050	20,554
3.3	Supply, transport and filling of 10 - 15 cm layer of sand on the bottom of trench and planning	m^3	1405	900.00	1,264,050	20,554
3.4	Manual backfill stockpiled soil and compaction in layers, 30% of the total amount	m^3	13764	150.00	2,064,615	33,571
3.5	Mechanical backfill stockpiled soil and compaction in layers, 70% of the total amount	m^3	5899	90.00	530,901	8,633
3.6	Placing of the rested material nearby the trench	m^3	7023	100.00	702,250	11,419
				Total III:	**15,095,566**	**245,456**
IV. MONTAGE WORKS						
				Total IV:	**31,946,435**	**519,454**
V. HYDRANTS						
				Total V:	**7,813,177**	**127,044**
VI. SPECIAL STRUCTURES						
				Total VI:	**2,640,035**	**42,927**

RECAPITULATION

POS	Description of works	Total (mkd)	Total (euro)
I	*EXPROPRIATION*	*983,150*	*15,986*
II	*GEODETIC WORKS*	*280,900*	*4,567*
III	*EARTH WORKS*	*15,095,566*	*245,456*
IV	*MONTAGE WORKS*	*31,946,435*	*519,454*
V	*HYDRANTS*	*7,813,177*	*127,044*
VI	*SPECIAL STRUCTURES*	*2,640,035*	*42,927*
	PLANING, PREDEVELOPMENT, ENGINEERING (12%)	7,051,112	114,652
	IRR. SYSTEM CONSTRUCTION (I-VI)	58,759,263	955,435
	CONTINGENCIES (10%)	5,875,926	95,544
	TOTAL	71,686,301	1,165,631
	per hectare	*231,246*	*3,760*
	per m'	*5,104*	*83*

Annex 30.1. BILL OF QUANTITIES FOR IRRIGATION EQUIPMENT

IS LUKOVICA , LOWER ZONE (250 ha)

No	Description of works	Unit	Quant.	Unit rate (mkd)	Amount (mkd)	Amount (euro)
I	**SPRINCLER IRRIGATION EQUIPMENT**					
1.1	Supply, delivery and storage of irrigation equipment - **Typhons** small and medium and equipment usage In growth period					
	TYPHONS mini (75mm)	pcs	2	430,500	861,000	14,000
	TYPHONS large and medium (80, 90mm)	pcs	0	615,000	0	0
1.2	Supply, delivery and storage of irrigation equipment - Sprinclers and equipment usage In growth period					
	Solid Set Systems	pcs	4	215,250	861,000	14,000
1.3	Supply, delivery and storage of irrigation equipment - Spray lines and equipment usage In growth period					
	Spray Lines (BK10)	pcs	1	399,750	399,800	6,501
	Total I:				**2,121,800**	**34,501**
II	**MICRO SPRINCLER IRRIGATION EQUIPMENT**					
2.1	Supply, delivery and storage of irrigation equipment - **Micro Srinclers** and equipment usage In growth period					
	Micro Srinclers (ha)	ha	25	95,325	2,383,100	38,750
2.2	Supply, delivery and montage of sand filters for mehanical treatment of water for irrigation					
	Filters with capacity 10 l/s	pcs	4	73,800	295,200	4,800
	Filters with capacity 20 l/s	pcs	2	123,000	246,000	4,000
	Total II:				**2,924,300**	**47,550**
III	**DRIP IRRIGATION EQUIPMENT**					
3.1	Supply, delivery and storage of irrigation equipment - **Drip System** and equipment usage In growth period					
	Drip irrigation (ha)	ha	65	76,875	4,996,900	81,250
3.2	Supply, delivery and montage of sand filters for mehanical treatment of water for irrigation					
	Filters with capacity 10 l/s	pcs	9	73,800	664,200	10,800
	Filters with capacity 20 l/s	pcs	4	123,000	492,000	8,000
	Total III:				**6,153,100**	**100,050**
	TOTAL I+II+III:				**11,199,200**	**182,101**

IS KOSEVICA , LOWER ZONE (60 ha)

No	Description of works	Unit	Quant.	Unit rate (mkd)	Amount (mkd)	Amount (euro)
I	**SPRINCLER IRRIGATION EQUIPMENT**					
1.1	Supply, delivery and storage of irrigation equipment - **Typhons** small and medium and equipment usage In growth period					
	TYPHONS mini (75mm)	pcs	1	430,500	430,500	7,000
	TYPHONS large and medium (80, 90mm)	pcs	0	615,000	0	0
1.2	Supply, delivery and storage of irrigation equipment - **Sprinclers** and equipment usage In growth period					
	Solid Set Systems	pcs	1	215,250	215,300	3,501
1.3	Supply, delivery and storage of irrigation equipment - Spray lines and equipment usage In growth period					
	Spray Lines (BK10)	pcs	0	399,750	0	0
	Total I:				**645,800**	**10,501**
II	**MICRO SPRINCLER IRRIGATION EQUIPMENT**					
2.1	Supply, delivery and storage of irrigation equipment - **Micro Srinclers** and equipment usage In growth period					
	Micro Srinclers (ha)	ha	5	95,325	476,600	7,750
2.2	Supply, delivery and montage of sand filters for mehanical treatment of water for irrigation					
	Filters with capacity 10 l/s	pcs	2	73,800	147,600	2,400
	Filters with capacity 20 l/s	pcs	1	123,000	123,000	2,000
	Total II:				**747,200**	**12,150**
III	**DRIP IRRIGATION EQUIPMENT**					
3.1	Supply, delivery and storage of irrigation equipment - **Drip System** and equipment usage In growth period					
	Drip irrigation (ha)	ha	15	76,875	1,153,100	18,750
3.2	Supply, delivery and montage of sand filters for mehanical treatment of water for irrigation					
	Filters with capacity 10 l/s	pcs	2	73,800	147,600	2,400
	Filters with capacity 20 l/s	pcs	1	123,000	123,000	2,000
	Total III:				**1,423,700**	**23,150**
	TOTAL I+II+III:				**2,816,700**	**45,800**

RECAPITULATION

POS	Description	UPPER ZONE	LOWER ZONE	Total
I	**SPRINCLER IRRIGATION EQUIPMENT**	**645,800**	**2,121,800**	**2,767,600**
	TYPHONS mini (75mm)	430,500	861,000	1,291,500
	TYPHONS large and medium (80, 90mm)	0	0	0
	Solid Set Systems	215,300	861,000	1,076,300
	Spray Lines (BK10)	0	399,800	399,800
II	**MICRO SPRINCLER IRRIGATION EQUIPMENT**	**747,200**	**2,924,300**	**3,671,500**
III	**DRIP IRRIGATION EQUIPMENT**	**1,423,700**	**6,153,100**	**7,576,800**
	TOTAL (mkd)	**2,816,700**	**11,199,200**	**14,015,900**
	TOTAL (euro)	**45,800**	**182,101**	**227,901**
	UN. PRICE PER HECTARE (mkd / ha)	***46,945***	***44,797***	***45,213***
	UN. PRICE PER HECTARE (euro / ha)	***763***	***728***	***735***

Анекс 31. Месечни/Годишни суми на врнежи

Annex 31: Monthly/Yearly Rainfall Sum

МС Делчено / Delcevo ST

(mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Sum
1961	23.2	6.2	37.9	48.2	124.3	24.6	14.8	1.0	25.6	11.2	94.9	35.9	447.8
1962	15.7	53.1	116.4	50.1	38.0	25.8	52.5	6.5	9.3	38.0	152.4	51.7	609.5
1963	75.1	57.3	19.7	25.0	55.7	46.3	14.6	37.0	13.0	52.3	25.8	60.2	482.0
1964	7.6	12.3	34.9	32.1	77.7	41.3	35.5	53.0	37.1	50.8	124.0	40.3	546.6
1965	58.3	48.2	10.4	61.9	78.0	52.6	30.3	30.4	7.2	0.3	21.6	57.2	456.4
1966	51.1	33.0	54.7	55.4	45.3	45.7	34.1	47.6	20.1	59.0	92.1	88.4	626.5
1967	37.3	9.7	23.2	42.1	51.7	66.4	40.4	82.7	30.7	57.7	27.5	56.4	525.8
1968	34.9	49.5	31.8	32.4	57.1	78.8	3.5	78.7	27.5	8.2	98.8	58.2	559.4
1969	57.8	73.5	73.2	48.5	18.3	49.4	42.8	60.7	24.3	0.2	31.6	113.6	593.9
1970	35.3	74.9	49.7	55.2	107.4	52.0	67.5	10.9	17.5	84.5	21.4	26.4	602.7
1971	31.3	36.0	61.7	4.5	49.5	26.8	44.1	14.8	40.2	13.7	28.9	14.1	365.6
1972	30.8	34.7	3.7	38.3	40.5	37.0	78.6	46.3	107.6	112.1	23.0	1.0	553.6
1973	25.8	40.7	43.7	83.9	30.7	14.3	52.7	117.5	76.2	5.8	38.5	45.1	574.9
1974	68.2	50.3	50.5	20.8	100.6	70.4	24.4	43.4	33.7	77.6	60.2	35.0	635.1
1975	11.4	6.3	48.9	19.8	86.2	95.1	45.1	60.3	20.4	110.8	69.1	23.5	596.9
1976	26.3	5.1	7.2	52.1	108.1	79.5	222.7	54.2	21.6	61.1	191.8	62.5	892.2
1977	39.8	33.8	29.0	25.1	65.5	76.0	58.2	25.2	22.7	6.6	59.8	16.5	458.2
1978	37.3	58.4	64.0	58.0	82.6	46.2	18.5	29.7	135.8	17.4	26.7	69.7	644.3
1979	54.5	32.0	28.2	92.3	48.6	46.5	42.7	116.9	36.0	62.2	74.5	18.6	653.0
1980	60.0	2.8	49.6	63.9	115.0	33.9	12.7	22.2	41.8	123.9	50.4	85.0	661.2
1981	30.3	33.6	27.1	12.7	54.4	70.0	59.0	54.1	63.3	50.4	48.4	44.3	547.6
1982	18.3	35.5	45.2	60.6	23.9	11.2	40.0	48.6	39.7	27.7	88.6	70.7	510.0
1983	15.8	29.5	11.4	31.1	35.7	152.2	90.5	19.4	19.1	53.7	76.3	17.1	551.8
1984	24.6	46.5	58.1	19.0	21.2	12.6	31.1	31.8	30.0	9.9	43.0	20.3	348.1
1985	50.0	45.7	61.3	35.8	146.3	49.8	8.1	50.5	58.2	6.0	166.0	8.4	686.1
1986	31.9	75.8	25.6	19.6	64.0	80.9	52.3	12.4	14.0	26.4	7.5	18.5	428.9
1987	59.7	58.5	28.6	47.0	85.6	48.3	63.5	23.1	56.8	56.8	63.9	45.2	637.0
1988	10.9	39.8	28.1	56.5	60.2	77.2	26.0	0.2	29.7	19.6	91.1	27.1	466.4
1989	0.3	25.8	17.0	56.4	74.4	80.1	79.0	37.3	53.9	87.5	31.9	32.3	575.9
1990	4.7	11.1	5.4	88.5	43.0	18.3	36.5	24.3	21.0	26.8	12.9	146.7	439.2
1991	15.3	44.5	24.4	89.5	64.8	25.6	82.4	41.0	35.5	59.8	76.7	12.6	572.1
1992	1.5	2.9	16.8	84.1	32.6	42.1	18.4	12.9	25.7	27.7	52.6	42.8	360.2
1993	25.4	20.5	40.6	21.3	45.5	11.1	16.7	2.1	11.0	31.5	63.6	54.5	343.8
1994	41.0	28.6	11.3	56.1	29.9	30.7	62.7	21.1	16.2	45.9	9.4	50.8	403.7
1995	51.4	9.6	47.4	25.3	71.3	24.0	133.7	105.3	80.1	1.8	42.7	104.7	697.3
1996	36.6	55.2	42.2	50.1	64.1	21.2	34.3	69.9	115.8	19.1	47.1	55.5	611.0
1997	10.4	22.6	47.8	35.0	31.5	50.9	26.4	49.0	7.0	101.7	34.3	59.5	475.9
1998	15.7	66.1	11.4	39.8	60.1	53.4	34.7	22.8	60.3	85.3	87.1	29.2	565.9
1999	24.1	32.7	42.0	53.8	41.3	89.9	43.3	47.3	50.0	42.2	73.1	45.9	585.6
2000	15.2	22.8	30.9	17.6	76.2	32.2	14.4	16.9	22.0	37.0	22.6	10.3	318.2
2001	39.5	9.9	15.7	143.9	37.6	27.3	6.7	18.2	40.6	5.2	19.3	43.1	407.0
2002	25.1	10.8	67.1	44.9	74.0	18.1	79.1	91.1	112.6	99.7	32.5	91.2	746.1
2003	62.7	19.1	0.1	30.1	61.5	111.4	6.6	75.3	15.8	114.4	11.5	55.8	564.4
2004	29.3	22.8	15.8	36.2	45.8	133.4	50.0	29.9	37.5	24.6	82.1	43.3	550.6
2005	34.6	40.6	21.7	16.4	26.6	43.1	67.2	59.3	58.2	87.9	29.0	37.3	521.9
Av	32.4	34.0	35.1	46.2	61.2	51.6	46.6	42.3	40.5	46.7	58.4	47.2	542
Min	0.3	2.8	0.1	4.5	18.3	11.1	3.5	0.2	7.0	0.2	7.5	1.0	318
25%	15.8	19.1	17.0	25.3	40.5	26.8	24.4	21.1	20.4	17.4	27.5	26.4	458
50%	30.8	33.6	30.9	44.9	57.1	46.3	40.4	37.3	30.7	42.2	48.4	44.3	554
75%	41.0	48.2	48.9	56.4	76.2	70.4	59.0	54.2	53.9	62.2	76.7	58.2	610
Max	75.1	75.8	116.4	143.9	146.3	152.2	222.7	117.5	135.8	123.9	191.8	146.7	892

Анекс 32. Просечни температури на воздухот

Annex 32: Average Temperature

МС Делчево / Delcevo ST

(℃)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
1961	-0.6	0.7	6.1	13.2	14.4	18.9	20.6	21.4	16.7	11.2	8.0	0.7	10.9
1962	1.6	-1.9	4.8	10.5	16.3	18.0	21.7	22.5	17.6	12.2	9.6	-0.5	11.0
1963	-3.1	2.5	2.7	10.4	15.2	19.0	21.5	22.4	17.7	11.0	8.0	2.7	10.8
1964	-3.7	0.5	6.2	10.6	13.7	19.7	20.5	19.9	15.3	12.2	7.2	3.0	10.4
1965	1.1	-3.8	5.0	8.9	14.2	18.0	21.6	18.2	16.9	9.2	6.3	2.9	9.9
1966	0.2	6.5	4.6	11.5	15.0	18.2	21.0	21.4	16.7	14.6	7.4	1.5	11.6
1967	-3.8	0.3	6.1	9.9	15.6	17.6	20.4	20.6	16.2	11.9	5.9	1.4	10.2
1968	-2.8	3.7	5.0	12.9	18.3	18.7	21.4	19.4	16.3	10.0	7.6	1.1	11.0
1969	-1.9	3.6	4.8	9.2	18.2	18.1	19.2	19.6	17.4	9.7	7.1	2.5	10.6
1970	2.7	2.8	5.8	11.4	13.0	18.9	20.5	20.4	16.2	9.5	5.4	1.6	10.7
1971	3.9	1.2	3.9	10.9	16.3	19.1	19.4	21.3	14.0	8.5	5.3	1.5	10.4
1972	2.1	3.2	6.9	11.9	15.7	20.5	20.9	19.4	14.1	7.8	5.4	1.6	10.8
1973	0.3	2.2	2.8	9.3	15.8	18.8	20.7	19.3	16.4	10.4	2.6	0.8	10.0
1974	0.9	3.4	6.5	8.1	13.2	17.5	19.8	21.0	16.5	11.4	4.9	0.5	10.3
1975	-1.5	0.3	6.8	10.9	15.5	18.6	20.1	19.5	17.7	10.0	4.3	0.5	10.2
1976	-0.3	1.0	4.0	10.1	14.4	16.9	18.6	15.6	17.7	10.0	4.3	0.5	9.4
1977	0.7	6.1	6.9	10.2	16.1	17.5	20.9	19.9	14.8	9.5	7.7	-1.3	10.8
1978	-0.3	3.8	6.4	9.9	14.3	18.3	20.6	18.9	13.6	9.1	1.0	3.0	9.9
1979	-0.2	2.9	7.2	8.7	14.7	19.8	19.4	18.9	15.9	10.1	7.1	2.5	10.6
1980	-2.9	1.3	5.1	8.6	13.1	17.8	20.1	19.6	15.0	10.0	6.9	1.2	9.7
1981	-2.3	0.3	7.5	9.8	13.9	20.3	19.1	18.6	15.5	11.8	1.9	2.7	9.9
1982	-0.3	-0.9	4.1	8.4	15.4	19.5	19.1	19.5	17.2	11.1	2.9	3.5	10.0
1983	0.7	-0.5	5.7	11.8	15.7	16.6	19.7	18.1	14.1	8.3	2.7	1.7	9.6
1984	1.2	2.2	4.3	8.3	16.1	18.0	19.2	18.4	16.7	12.2	4.5	-0.7	10.0
1985	-0.8	-4.7	5.0	10.8	15.9	16.9	19.8	20.0	14.5	8.0	5.9	2.6	9.5
1986	0.8	0.6	5.9	12.0	15.0	18.0	18.9	20.7	16.0	9.0	2.4	-3.1	9.7
1987	-1.2	3.2	0.4	8.9	13.0	18.3	21.8	19.6	17.9	9.8	5.6	1.8	9.9
1988	1.2	1.8	4.1	9.4	14.8	17.4	22.8	21.2	15.7	8.8	-0.8	-0.6	9.7
1989	-2.9	1.5	7.4	12.6	13.2	15.6	19.5	19.0	14.9	8.9	4.4	-0.6	9.5
1990	-4.3	2.8	7.5	9.7	14.1	17.6	21.0	19.5	14.6	10.8	6.6	1.8	10.1
1991	-1.6	0.5	8.1	9.5	11.7	18.7	20.4	19.6	16.9	11.7	6.9	-2.8	10.0
1992	0.2	0.6	4.9	10.6	13.8	18.3	19.5	22.5	16.2	13.8	6.8	0.1	10.6
1993	-0.9	-1.1	4.5	10.2	15.3	18.7	21.6	22.6	16.6	13.5	3.6	3.0	10.6
1994	3.2	2.5	6.8	11.7	15.8	18.9	21.2	22.2	20.2	12.0	5.1	2.7	11.9
1995	-0.4	4.7	5.2	9.6	14.8	20.1	21.0	18.6	15.2	9.3	1.5	3.5	10.3
1996	0.5	1.0	1.7	9.6	17.1	19.7	21.6	19.7	14.1	10.0	6.5	3.3	10.4
1997	2.3	1.7	3.5	5.6	16.5	20.1	20.1	18.3	15.2	8.2	5.9	0.9	9.9
1998	1.7	3.1	2.3	12.1	14.7	19.7	21.8	22.3	15.7	11.4	4.4	-2.0	10.6
1999	0.7	-0.6	5.3	10.6	15.4	19.2	21.6	21.6	17.1	12.0	5.5	2.9	10.9
2000	-4.4	-0.6	2.3	10.3	13.9	17.5	19.4	20.1	14.5	10.7	7.9	2.9	9.5
2001	3.2	2.8	7.9	9.9	15.4	18.5	22.0	22.1	16.7	12.4	4.9	-0.8	11.3
2002	-0.6	3.6	6.6	10.1	15.5	20.0	21.4	19.2	14.7	9.9	6.1	2.4	10.7
2003	2.7	1.2	4.8	9.2	17.3	20.3	21.7	21.7	15.0	10.3	6.4	1.9	11.0
2004	1.5	2.8	5.7	11.0	13.7	18.4	20.7	19.8	16.1	12.1	5.4	2.5	10.8
2005	2.1	1.8	5.2	10.5	15.8	18.5	21.4	19.5	16.3	10.3	4.8	2.6	10.7

Av	-0.1	1.6	5.2	10.2	15.0	18.5	20.6	20.1	16.0	10.5	5.3	1.3	10.4
Min	-4.4	-4.7	0.4	5.6	11.7	15.6	18.6	15.6	13.6	7.8	-0.8	-3.1	9.4
25%	-1.5	0.5	4.3	9.4	14.1	18.0	19.7	19.3	15.0	9.5	4.4	0.5	9.9
50%	0.2	1.7	5.2	10.2	15.2	18.5	20.6	19.7	16.2	10.3	5.5	1.6	10.4
75%	1.2	2.9	6.5	10.9	15.8	19.2	21.4	21.3	16.7	11.8	6.9	2.7	10.8
Max	3.9	6.5	8.1	13.2	18.3	20.5	22.8	22.6	20.2	14.6	9.6	3.5	11.9

Анекс 33. Максимални Просечни температури на воздухот

Annex 33: Average Maximum Temperature

МС Делчево / Delcevo ST

(℃)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
1961	4.5	5.8	12.0	16.1	22.9	23.8	27.7	30.2	25.5	17.8	13.7	3.3	16.9
1962	6.4	3.7	9.2	16.1	22.9	23.8	27.7	30.2	25.5	17.8	13.7	3.3	16.7
1963	1.4	6.4	8.4	15.4	20.7	24.7	27.8	30.1	25.9	16.5	14.8	7.2	16.6
1964	2.2	4.9	10.8	16.8	18.9	26.0	26.5	26.6	22.1	18.7	11.2	8.2	16.1
1965	5.5	1.7	10.9	13.7	19.8	24.3	28.9	24.2	25.8	18.6	12.9	7.7	16.2
1966	3.1	12.9	9.4	17.2	20.8	23.5	27.4	28.0	24.1	22.0	11.9	5.6	17.2
1967	2.1	5.5	11.5	15.3	21.9	23.2	26.6	28.3	24.2	20.2	12.7	5.6	16.4
1968	1.7	9.3	11.0	19.7	24.9	24.0	27.9	25.4	23.4	17.6	12.1	3.9	16.7
1969	2.2	7.9	8.5	14.7	25.2	24.0	24.8	27.5	24.1	18.4	15.4	5.8	16.5
1970	5.9	7.3	10.4	17.3	18.1	24.9	26.8	27.7	24.1	16.2	12.7	6.4	16.5
1971	8.0	5.4	8.2	16.4	23.0	24.8	25.5	28.8	20.3	15.5	11.4	6.6	16.2
1972	4.4	7.3	13.6	17.6	21.9	27.1	26.9	25.8	20.0	12.8	12.6	7.0	16.4
1973	3.4	6.6	6.9	14.8	22.3	24.7	27.2	25.7	24.0	17.8	9.4	6.0	15.7
1974	4.8	8.8	12.1	13.5	18.3	22.9	27.1	28.1	24.0	17.6	11.2	5.9	16.2
1975	4.8	4.5	13.6	16.9	21.4	24.5	26.2	25.7	25.7	17.2	12.1	5.6	16.5
1976	5.6	5.7	9.6	16.1	20.1	22.9	25.1	22.5	21.5	18.7	11.6	5.8	15.4
1977	6.1	12.3	14.1	16.4	22.3	24.2	28.0	27.5	22.0	19.0	13.5	4.0	17.5
1978	4.1	8.1	12.3	14.7	19.9	24.7	27.1	26.1	20.7	16.7	8.5	7.6	15.9
1979	4.8	7.6	14.0	13.8	21.2	26.3	26.0	25.3	23.5	17.0	11.2	8.9	16.6
1980	1.7	6.3	9.8	13.8	18.7	24.2	27.5	27.4	23.4	18.1	13.4	6.4	15.9
1981	1.9	5.8	14.1	17.2	20.1	27.3	25.2	26.6	23.4	19.6	8.2	7.2	16.4
1982	5.8	6.0	10.1	13.4	21.8	27.0	26.5	27.6	26.9	19.0	12.5	8.8	17.1
1983	7.3	5.8	13.9	20.0	23.2	23.1	27.0	26.2	23.3	18.0	8.9	6.4	16.9
1984	7.5	6.3	8.7	13.6	23.2	25.3	27.0	25.3	25.9	21.2	12.6	6.1	16.9
1985	4.5	3.2	10.5	18.4	23.7	24.8	28.3	28.9	24.8	18.0	12.1	10.6	17.3
1986	6.4	5.9	11.8	20.2	21.9	24.9	26.1	30.2	26.2	18.4	11.3	4.9	17.4
1987	4.2	9.0	6.4	15.5	20.3	26.3	31.2	27.9	28.5	16.5	11.9	6.9	17.1
1988	8.6	8.7	10.5	16.8	22.1	24.9	31.2	30.9	24.4	18.2	5.1	5.8	17.3
1989	6.0	10.2	15.4	21.2	20.2	23.1	27.5	28.0	23.3	17.9	11.7	7.5	17.7
1990	4.4	11.5	16.1	20.3	21.7	26.0	29.9	29.3	23.9	20.8	14.5	6.7	18.8
1991	4.5	5.0	16.7	15.1	18.2	25.3	27.4	27.2	25.3	20.6	15.1	3.3	17.0
1992	4.7	5.2	10.2	16.9	19.7	24.7	26.2	31.2	24.3	24.2	14.9	3.6	17.2
1993	4.6	1.9	9.4	16.3	21.9	25.3	29.0	31.3	24.9	23.7	8.5	10.9	17.3
1994	5.0	9.0	14.1	18.6	22.6	25.6	28.5	30.8	30.3	21.1	11.5	10.2	18.9
1995	4.7	13.3	10.9	15.3	21.1	27.2	28.2	25.8	22.8	16.4	5.2	12.2	16.9
1996	4.7	6.0	6.5	15.3	24.4	26.6	29.0	27.3	21.1	17.6	14.3	11.7	17.1
1997	4.9	7.4	7.4	13.5	23.6	27.2	27.0	25.4	22.8	14.5	13.1	5.6	16.0
1998	4.9	10.1	6.8	19.3	21.0	26.6	29.3	30.9	23.5	20.0	10.1	3.4	17.2
1999	4.8	2.8	11.1	16.9	22.0	26.0	29.0	29.9	25.6	21.1	12.3	10.7	17.7
2000	4.3	2.8	6.7	16.4	19.9	23.7	26.1	27.8	21.7	18.8	17.1	10.7	16.3
2001	5.0	9.5	16.4	15.9	22.1	25.0	29.6	30.6	25.0	21.8	11.0	3.5	17.9
2002	4.6	11.1	13.7	16.1	22.2	27.0	28.7	26.6	22.1	17.6	13.4	9.4	17.7
2003	5.0	6.3	10.0	14.7	24.7	27.5	29.1	30.1	22.5	18.1	14.2	8.0	17.5
2004	4.9	9.4	12.0	17.6	19.6	24.9	27.8	27.4	24.1	21.3	12.0	9.6	17.5
2005	4.9	7.5	10.9	16.8	22.6	25.0	28.7	27.0	24.5	18.1	10.9	9.8	17.2
Av	4.7	7.1	11.0	16.4	21.5	25.1	27.6	27.8	24.0	18.6	12.0	7.0	16.9
Min	1.4	1.7	6.4	13.4	18.1	22.9	24.8	22.5	20.0	12.8	5.1	3.3	15.4
25%	4.3	5.5	9.4	15.1	20.1	24.2	26.6	26.2	22.8	17.6	11.2	5.6	16.4
50%	4.8	6.4	10.9	16.3	21.9	24.9	27.5	27.6	24.1	18.1	12.1	6.6	16.9
75%	5.5	9.0	13.6	17.2	22.6	26.0	28.7	29.9	25.3	20.0	13.4	8.8	17.3
Max	8.6	13.3	16.7	21.2	25.2	27.5	31.2	31.3	30.3	24.2	17.1	12.2	18.9

Анекс 34. Минимални Просечни температури на воздухот

Annex 34: Average Minimum Temperature

МС Делчево / Delcevo ST

(°C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
1961	-5.0	-4.3	-0.3	5.1	7.1	12.1	12.1	11.2	7.0	4.8	2.5	-3.9	4.0
1962	-3.0	-7.3	0.1	3.8	7.5	10.3	12.7	12.9	9.4	6.4	5.2	-3.7	4.5
1963	-7.4	-1.8	-3.2	4.9	8.5	11.7	12.6	12.5	9.1	5.6	2.0	-2.1	4.4
1964	-10.0	-4.4	1.6	2.5	7.1	12.1	12.5	12.1	9.4	5.1	2.7	-2.1	4.1
1965	-4.0	-9.3	-1.0	3.4	7.1	10.2	11.8	10.5	7.1	0.3	-0.2	-1.9	2.8
1966	-4.5	-0.2	-0.2	5.2	6.7	10.0	12.6	13.1	8.5	7.4	2.1	-2.9	4.8
1967	-10.2	-4.5	0.2	3.9	7.6	10.2	12.6	12.3	8.5	4.7	0.1	-3.3	3.5
1968	-7.6	-1.0	-2.0	3.7	10.5	11.7	11.0	12.7	8.9	2.8	3.2	-2.1	4.3
1969	-6.8	-1.1	1.1	2.0	9.5	10.7	11.5	11.4	10.1	1.2	0.1	-0.5	4.1
1970	-0.5	-2.1	0.6	3.8	6.4	10.5	13.1	12.1	8.0	3.9	-0.1	-3.0	4.4
1971	0.3	-2.4	-0.4	4.3	8.4	11.2	11.5	12.5	7.7	2.3	-0.3	-2.9	4.4
1972	-0.3	-0.8	0.0	5.5	7.8	11.8	14.3	12.3	8.4	3.6	0.1	-4.0	4.9
1973	-2.6	-1.8	-0.7	5.1	11.2	12.9	14.3	10.7	9.8	4.2	-2.8	-4.7	4.6
1974	-3.0	-1.9	0.4	1.5	4.2	9.9	10.6	11.3	8.2	4.4	-0.3	-4.2	3.4
1975	-7.3	-5.1	-0.1	3.5	9.0	11.4	12.5	12.1	9.0	3.7	0.2	-4.6	3.7
1976	-7.0	-5.3	-3.0	2.9	7.4	8.4	11.2	8.0	5.9	5.8	1.6	-3.2	2.7
1977	-4.0	0.3	0.4	2.6	8.1	10.0	13.2	11.1	7.3	1.1	1.7	-5.9	3.8
1978	-4.8	-0.7	0.2	3.8	7.4	9.9	11.0	10.0	6.9	2.2	-4.7	-1.5	3.3
1979	-5.8	-1.6	-0.2	3.2	7.8	12.3	11.4	12.4	8.0	4.8	3.0	-2.6	4.4
1980	-8.4	-3.5	0.1	2.4	7.5	10.2	11.9	11.7	7.6	5.6	2.2	-3.1	3.7
1981	-6.5	-4.2	1.3	1.8	7.2	12.7	11.0	11.1	9.4	5.7	-2.7	-1.5	3.8
1982	-5.0	-6.3	-1.2	3.3	8.1	10.4	11.2	12.1	7.9	4.2	-4.8	-1.6	3.2
1983	-5.4	-7.0	-2.7	3.0	5.6	8.6	9.8	8.8	5.4	-0.9	-3.5	-3.7	1.5
1984	-5.0	-2.6	-1.4	1.1	6.0	6.9	7.5	9.3	5.5	3.4	-1.3	-4.9	2.0
1985	-4.7	-12.7	1.0	3.5	9.4	9.8	10.8	11.5	6.0	0.3	1.5	-2.7	2.8
1986	-4.0	-3.2	1.1	2.9	8.4	11.1	11.6	12.2	7.5	2.1	-3.0	-9.3	3.1
1987	-5.8	-1.1	-4.7	2.8	6.4	10.4	12.8	11.1	8.9	5.0	1.0	-2.3	3.7
1988	-3.5	-3.8	-0.8	2.6	7.9	10.5	13.7	11.7	5.9	1.8	-5.6	-6.7	2.8
1989	-9.4	-5.1	0.5	4.2	7.6	9.1	11.7	10.6	7.6	2.1	-1.4	-6.5	2.6
1990	-10.5	-4.1	-0.3	4.5	7.1	9.6	11.2	10.6	6.5	3.0	1.0	-2.9	4.6
1991	-4.4	-2.8	0.1	4.1	6.3	10.6	11.4	11.9	9.4	5.9	3.4	-0.8	4.6
1992	-5.0	0.1	-1.7	2.9	7.5	11.5	10.5	10.3	6.9	3.9	-4.7	-3.6	3.2
1993	-5.3	-3.6	-1.9	4.0	7.8	11.2	11.6	11.7	6.6	5.5	-1.5	-4.9	3.4
1994	0.3	-5.4	-1.8	3.7	6.0	10.1	10.4	11.2	8.8	4.2	-5.2	0.6	3.6
1995	-4.7	-4.5	-0.7	0.6	6.8	11.8	12.3	11.6	7.7	5.4	1.9	-5.8	3.5
1996	-7.2	-6.6	-2.3	3.1	7.2	9.2	12.2	10.5	6.7	0.8	1.7	-6.6	2.4
1997	-2.4	-0.8	-0.3	0.2	7.3	12.2	12.4	11.1	6.1	-0.7	5.6	-6.6	3.7
1998	-9.3	-4.1	-0.3	2.5	9.9	8.1	13.0	11.0	7.9	1.3	0.1	0.6	3.4
1999	-9.2	-4.2	1.4	1.1	7.3	11.0	12.3	16.1	4.7	-0.8	3.1	-3.1	3.3
2000	-4.8	-8.3	-1.1	2.3	7.5	11.7	9.3	10.8	8.2	3.9	0.0	-2.2	3.1
2001	-4.6	-5.2	1.5	0.7	7.2	9.0	12.1	11.4	8.8	2.5	-2.5	-5.3	3.0
2002	-7.4	-1.0	-0.9	4.0	7.7	11.5	10.8	13.7	6.8	5.7	3.6	-5.9	4.0
2003	-4.5	-2.7	1.4	2.3	7.1	10.5	10.9	11.4	10.0	4.0	0.7	-2.5	4.0
2004	-5.6	-1.2	0.0	4.3	6.9	10.1	12.9	9.0	8.1	4.4	1.8	-1.9	4.1
2005	-9.2	-1.7	0.6	3.3	6.9	10.0	12.2	10.5	9.8	3.4	-2.9	-3.3	3.3
Av	-5.4	-3.6	-0.4	3.2	7.6	10.6	11.8	11.4	7.8	3.5	0.1	-3.5	3.6
Min	-10.5	-12.7	-4.7	0.2	4.2	6.9	7.5	8.0	4.7	-0.9	-5.6	-9.3	1.5
25%	-7.3	-5.1	-1.1	2.5	7.1	10.0	11.0	10.7	6.9	2.1	-1.5	-4.7	3.2
50%	-5.0	-3.5	-0.2	3.3	7.4	10.5	11.8	11.4	7.9	3.9	0.1	-3.1	3.7
75%	-4.0	-1.6	0.4	4.0	7.9	11.5	12.6	12.1	8.9	5.0	2.0	-2.1	4.1
Max	0.3	0.3	1.6	5.5	11.2	12.9	14.3	16.1	10.1	7.4	5.6	0.6	4.9

Анекс 35. Релативна влажност на воздухот

Annex 35: Relative Humidity

МС Делчено / Delcevo ST

(%)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
1961	77	77	71	66	69	70	61	58	61	65	71	74	68
1962	76	71	68	60	62	70	63	58	62	73	77	75	68
1963	74	73	76	71	68	69	63	53	63	75	72	74	69
1964	64	80	73	66	70	68	64	63	70	75	84	86	72
1965	84	89	87	84	78	78	60	66	67	68	82	88	78
1966	83	73	73	67	64	69	63	65	66	77	84	83	72
1967	82	85	70	68	66	70	67	67	72	75	82	84	74
1968	84	85	72	61	67	70	54	67	70	70	80	88	72
1969	82	81	81	67	65	68	71	74	79	67	72	87	75
1970	85	79	71	65	68	65	67	63	61	76	82	88	73
1971	83	86	82	76	82	80	74	75	80	82	82	83	80
1972	86	89	71	78	74	65	74	74	83	82	78	79	78
1973	88	82	81	79	76	81	79	79	86	87	77	76	81
1974	80	76	74	71	72	70	68	63	72	77	83	84	74
1975	84	82	79	75	80	77	76	78	80	81	87	83	80
1976	80	82	77	75	78	78	80	82	81	82	87	79	80
1977	78	77	72	67	63	72	69	69	67	71	78	82	72
1978	82	78	70	72	67	65	52	64	77	77	78	82	72
1979	79	76	78	77	73	67	63	71	76	77	79	80	75
1980	78	79	79	80	77	71	64	68	66	83	84	77	76
1981	80	83	86	82	85	70	82	86	88	89	84	84	83
1982	83	83	85	86	77	76	74	73	72	80	80	81	79
1983	84	80	81	72	77	80	79	74	78	79	83	87	80
1984	81	82	78	71	63	61	58	70	67	74	79	82	72
1985	85	78	79	64	74	66	59	68	67	70	82	78	73
1986	79	84	80	63	73	70	68	60	58	72	76	76	72
1987	79	82	79	66	70	66	61	61	65	79	83	86	73
1988	82	79	79	71	72	74	60	58	68	71	83	80	73
1989	82	77	72	67	73	75	69	70	78	78	81	86	76
1990	91	77	65	75	72	63	58	62	67	72	81	88	73
1991	80	80	83	66	70	72	63	76	75	75	85	73	75
1992	77	81	79	57	80	68	68	58	75	78	76	84	73
1993	81	78	77	63	66	76	68	78	71	89	80	77	75
1994	78	77	78	63	75	72	66	72	70	74	80	80	74
1995	82	83	81	67	64	72	69	59	70	70	78	81	73
1996	88	78	75	65	66	77	63	65	73	76	85	86	75
1997	80	77	74	82	75	80	65	75	69	73	81	82	76
1998	83	81	81	70	66	73	70	60	67	76	83	78	74
1999	87	81	82	74	69	74	66	68	71	76	83	77	76
2000	70	80	80	67	70	68	69	71	68	86	83	82	74
2001	75	85	83	75	78	70	67	76	68	70	86	84	76
2002	81	77	88	66	84	72	66	79	81	74	78	79	77
2003	79	80	73	76	73	71	70	61	71	79	81	90	75
2004	82	85	66	74	77	81	66	67	73	79	80	82	76
2005	89	74	79	74	74	71	59	63	67	76	81	87	75
Av	81	80	77	71	72	72	67	68	71	76	81	82	75
Min	64	71	65	57	62	61	52	53	58	65	71	73	68
25%	79	77	73	66	67	68	63	63	67	73	78	79	73
50%	82	80	78	71	72	71	66	68	70	76	81	82	75
75%	84	82	81	75	77	75	69	74	76	79	83	86	76
Max	91	89	88	86	85	81	82	86	88	89	87	90	83

Анекс 36. Брзина на ветер

Annex 36: Wind Speed

МС Делчено / Delcevo ST

(km/day)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
1961	117	135	180	153	171	162	171	171	144	162	144	108	152
1962	99	135	180	180	189	171	216	144	189	144	180	153	165
1963	135	171	162	162	171	135	153	180	135	108	90	135	145
1964	117	153	144	207	171	153	126	135	171	135	108	135	146
1965	72	117	144	153	126	126	144	99	72	72	126	63	110
1966	117	117	135	81	126	108	135	171	117	72	72	99	113
1967	81	144	225	207	171	135	189	171	153	117	135	180	159
1968	153	117	180	198	162	180	180	171	198	162	144	162	167
1969	153	180	162	189	153	198	189	153	153	135	171	153	166
1970	126	189	189	189	153	144	144	153	144	153	117	153	155
1971	153	135	135	135	126	135	153	135	153	144	126	117	137
1972	99	108	153	144	117	126	153	117	90	117	117	108	121
1973	99	126	81	135	108	117	90	99	72	63	81	81	96
1974	63	153	90	153	99	135	108	117	135	153	126	90	119
1975	81	162	126	180	81	117	126	126	108	99	108	135	121
1976	144	135	153	126	99	135	99	72	54	72	81	108	107
1977	99	153	153	171	126	99	117	108	135	99	135	117	126
1978	117	144	189	153	144	135	162	108	108	108	90	72	128
1979	126	126	144	162	135	171	180	108	99	126	135	108	135
1980	108	162	162	153	144	135	171	162	153	162	153	117	149
1981	189	144	162	162	153	162	153	162	126	126	162	153	155
1982	135	153	198	153	180	162	126	135	135	126	153	171	152
1983	135	198	162	144	144	144	144	153	153	153	135	135	150
1984	117	135	171	189	162	153	198	153	135	135	126	117	149
1985	135	162	144	189	135	162	126	126	135	162	153	144	148
1986	252	198	162	270	171	189	144	144	189	171	180	189	188
1987	261	216	252	306	207	180	198	198	243	153	207	144	214
1988	135	234	288	216	180	189	198	162	207	216	126	153	192
1989	126	144	135	144	144	144	126	117	117	99	126	45	122
1990	45	81	126	126	108	135	117	81	99	108	72	45	95
1991	161	130	172	196	158	158	77	112	168	122	138	134	144
1992	176	83	168	222	158	166	147	161	136	151	158	108	153
1993	132	167	163	176	195	139	122	178	109	173	147	105	150
1994	106	183	164	189	169	174	112	186	205	146	65	122	152
1995	147	119	175	161	155	148	147	134	171	107	124	130	143
1996	101	153	153	196	112	105	161	155	138	97	130	103	134
1997	149	136	89	185	82	101	153	136	96	102	157	113	125
1998	113	138	131	169	167	121	174	91	117	123	145	153	137
1999	147	109	184	128	137	125	134	105	134	55	165	155	132
2000	202	99	135	166	143	171	153	121	112	94	154	177	144
2001	138	160	173	125	124	139	93	120	94	111	109	97	123
2002	151	127	106	171	144	162	140	174	132	106	112	95	135
2003	135	148	209	149	169	137	90	160	123	104	120	131	140
2004	220	171	193	210	182	139	140	169	123	94	105	159	159
2005	168	152	163	146	183	131	146	88	123	101	104	171	140
Av	134	147	161	172	147	146	145	138	136	123	129	125	142
Min	45	81	81	81	81	99	77	72	54	55	65	45	95
25%	108	127	144	149	126	135	126	117	112	101	109	108	126
50%	135	144	162	166	153	139	144	136	135	122	126	130	144
75%	151	162	180	189	171	162	162	162	153	151	153	153	152
Max	261	234	288	306	207	198	216	198	243	216	207	189	214

Анекс 37. Сончево сјаење

Annex 37: Daily Sunshine

МС Делчено / Delcevo ST

(Hour)

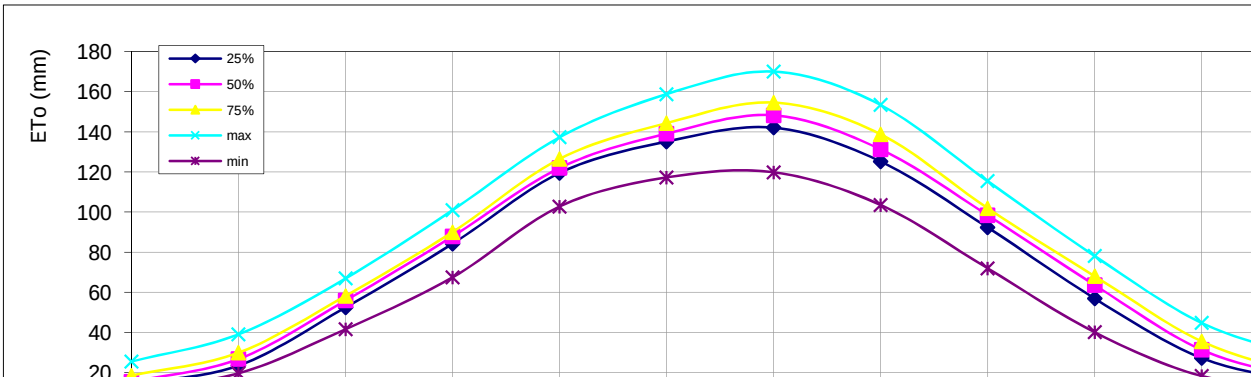
Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
1961	4.0	5.3	5.9	6.1	7.3	9.2	11.2	11.2	10.3	6.1	3.6	2.6	6.9
1962	3.2	4.3	3.7	7.4	9.8	9.0	11.6	11.1	8.8	4.7	2.9	2.3	6.6
1963	2.2	2.3	5.8	5.7	7.3	8.3	10.4	11.1	9.0	5.1	4.5	2.7	6.2
1964	4.6	3.7	3.2	7.9	6.1	9.2	9.8	10.4	6.5	6.3	2.4	2.6	6.1
1965	3.8	3.6	6.0	5.6	7.5	9.8	12.1	9.0	9.7	8.4	4.3	2.6	6.9
1966	2.2	5.9	4.3	5.0	9.2	9.0	10.8	10.3	9.1	6.6	3.4	2.6	6.5
1967	4.6	5.0	5.6	5.1	9.0	9.3	9.3	11.4	8.1	7.1	5.3	3.2	6.9
1968	3.5	4.6	6.5	8.5	8.1	8.5	11.9	8.8	7.8	6.2	3.5	1.5	6.6
1969	3.0	4.0	3.0	6.9	9.7	7.7	8.8	9.9	7.4	8.2	4.9	1.3	6.2
1970	1.6	3.9	5.1	6.0	6.6	9.5	10.2	10.1	9.2	6.4	5.7	3.4	6.5
1971	2.5	3.1	4.2	7.2	8.5	9.9	9.5	10.7	6.1	7.3	4.4	3.2	6.4
1972	1.2	3.0	7.2	5.5	9.0	9.7	8.0	8.4	5.6	3.9	5.7	3.4	5.9
1973	2.0	3.3	3.5	5.9	8.0	9.0	9.4	9.6	8.1	7.0	5.3	3.1	6.2
1974	2.9	4.3	4.6	5.5	6.6	8.8	11.5	10.0	8.4	5.9	4.4	3.5	6.4
1975	4.5	5.2	5.3	7.1	8.0	7.9	9.8	8.4	9.3	5.7	2.3	4.1	6.5
1976	4.4	4.8	5.9	6.3	7.1	8.3	9.0	8.8	7.8	5.4	3.4	2.4	6.1
1977	3.6	4.2	6.3	7.6	8.5	9.4	10.9	10.0	7.1	7.8	4.1	2.9	6.9
1978	3.4	3.3	5.4	5.0	7.1	9.7	11.7	10.3	6.4	6.3	3.8	2.4	6.2
1979	3.2	4.1	6.5	6.4	7.3	9.1	10.2	7.6	8.3	4.5	2.4	3.8	6.1
1980	2.3	5.3	4.0	6.3	5.6	9.3	10.2	10.1	8.4	5.7	4.1	3.2	6.2
1981	2.5	3.7	6.0	8.5	6.9	9.6	9.1	9.3	6.9	6.6	4.1	2.1	6.3
1982	3.3	4.8	5.7	4.8	7.7	10.4	9.7	9.2	8.5	5.2	4.8	2.7	6.4
1983	4.0	5.0	6.4	7.5	8.2	6.8	8.7	8.8	7.7	6.7	3.5	2.2	6.3
1984	3.2	1.6	3.1	3.7	6.9	7.5	11.1	7.5	8.7	6.4	4.5	3.2	5.6
1985	2.4	4.4	3.1	6.5	8.1	9.7	11.2	10.1	9.6	6.2	2.7	4.1	6.5
1986	2.5	1.7	3.6	8.3	7.4	8.0	9.1	10.5	8.7	6.0	5.1	3.5	6.2
1987	2.2	2.9	3.8	5.9	7.3	9.6	10.7	10.4	8.5	4.0	2.9	2.3	5.9
1988	2.3	4.5	4.0	5.8	7.3	7.6	11.8	10.3	7.9	6.1	3.0	3.5	6.2
1989	4.8	5.3	5.9	7.3	6.2	6.9	9.3	9.8	7.1	6.8	4.2	4.1	6.5
1990	4.2	6.5	7.6	5.4	6.6	9.9	10.7	10.0	7.5	5.8	4.3	2.1	6.7
1991	4.2	5.5	2.5	7.1	9.5	9.6	11.3	11.1	9.5	8.1	4.3	1.4	7.0
1992	2.6	3.1	5.6	7.5	8.4	9.9	10.4	9.7	7.1	6.2	5.2	2.7	6.5
1993	2.8	2.2	3.4	8.6	7.6	8.7	11.4	9.1	5.6	5.5	3.9	3.0	6.0
1994	3.9	3.2	6.3	7.2	7.0	9.3	10.1	9.8	7.7	7.1	3.3	2.5	6.5
1995	3.4	3.6	7.3	4.9	6.6	10.5	8.7	8.7	7.2	7.0	2.4	3.2	6.1
1996	2.6	4.6	6.8	5.8	8.6	10.5	11.7	11.2	9.8	6.5	4.0	1.8	7.0
1997	1.6	3.8	5.2	6.0	8.5	10.2	11.4	9.1	7.3	4.5	2.7	3.1	6.1
1998	2.8	3.3	2.4	5.9	8.5	8.1	10.9	11.4	8.3	6.0	3.7	3.3	6.2
1999	3.3	5.2	5.9	5.5	7.1	7.8	12.1	9.0	9.6	4.3	3.5	3.0	6.3
2000	2.4	1.9	6.6	6.4	8.2	9.5	10.7	8.9	8.4	6.6	4.8	2.5	6.4
2001	4.6	4.6	4.8	5.6	8.7	10.2	11.0	9.3	8.0	5.5	4.0	1.9	6.5
2002	1.8	4.8	6.4	6.5	5.5	8.2	9.1	9.9	9.1	7.2	5.2	3.2	6.4
2003	1.6	4.0	4.7	4.9	7.0	9.3	9.8	10.7	8.1	7.6	4.0	3.1	6.2
2004	4.0	3.1	4.4	6.7	8.5	7.7	9.6	9.1	8.6	5.2	3.0	1.3	5.9
2005	1.9	5.7	2.6	6.1	6.9	8.7	9.0	10.4	8.2	4.5	5.8	2.5	6.0
Av	3.1	4.0	5.0	6.3	7.7	9.0	10.3	9.8	8.1	6.1	4.0	2.8	6.4
Min	1.2	1.6	2.4	3.7	5.5	6.8	8.0	7.5	5.6	3.9	2.3	1.3	5.6
25%	2.3	3.3	3.8	5.6	7.0	8.3	9.4	9.1	7.4	5.5	3.4	2.4	6.2
50%	3.0	4.1	5.3	6.1	7.5	9.2	10.4	9.9	8.2	6.2	4.0	2.7	6.3
75%	3.9	4.8	6.0	7.2	8.5	9.7	11.2	10.4	8.8	6.8	4.5	3.2	6.5
Max	4.8	6.5	7.6	8.6	9.8	10.5	12.1	11.4	10.3	8.4	5.8	4.1	7.0

Анекс 38/ Annex 38

Месечни Вредности на Референтната Евапотранспирација (mm) **Делчево**

Monthly values of Reference evaporation (mm) Delcevo

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1961	14.23	25.14	56.79	91.76	130.55	149.45	160.08	145.72	111.80	77.47	40.52	18.64
1962	13.81	25.39	59.13	96.32	136.88	155.69	164.83	147.45	110.32	73.57	36.55	16.96
1963	14.41	21.85	51.13	85.72	124.72	144.28	154.83	140.11	105.85	71.21	35.58	16.21
1964	15.24	25.81	56.16	88.40	123.19	138.10	144.37	127.42	93.90	61.60	30.40	15.52
1965	15.30	25.37	41.68	67.43	110.23	138.97	152.07	130.87	88.95	54.29	28.15	13.42
1966	22.62	30.77	52.49	78.61	114.39	137.54	153.72	141.48	102.09	56.20	18.36	15.17
1967	15.24	29.94	58.62	86.07	121.96	142.74	154.95	139.54	102.17	64.37	29.94	16.51
1968	15.35	29.98	65.95	100.93	137.15	151.55	157.69	139.11	101.68	63.68	27.31	14.82
1969	14.17	26.80	58.01	89.84	123.96	138.58	145.47	130.16	98.44	67.71	36.29	19.39
1970	15.21	26.30	56.78	88.95	124.03	139.78	147.50	132.13	99.41	67.06	33.82	15.36
1971	11.94	21.89	51.37	83.85	118.75	133.93	139.90	122.65	89.09	56.93	27.01	14.04
1972	15.42	27.74	55.90	86.30	123.09	139.05	140.65	113.59	72.00	40.15	23.72	22.63
1973	14.50	21.28	43.05	72.57	109.94	129.94	137.53	117.58	79.96	46.51	22.36	16.39
1974	15.87	32.95	50.78	68.50	102.75	129.63	148.14	135.96	97.74	57.69	24.43	14.80
1975	15.47	26.75	55.46	84.17	114.85	127.22	132.32	116.87	86.76	57.74	28.97	13.95
1976	17.24	27.34	54.07	80.10	107.42	117.20	119.82	103.56	74.84	48.30	24.32	14.81
1977	19.56	33.31	65.17	95.05	126.49	138.04	142.26	125.18	93.04	62.59	32.44	16.82
1978	24.96	29.59	50.11	80.58	121.21	143.69	152.84	130.74	87.28	46.96	19.68	15.35
1979	16.16	26.84	57.02	88.40	121.86	135.35	140.12	122.23	88.71	56.94	27.44	14.50
1980	12.55	19.66	46.73	78.81	115.10	133.69	144.04	131.18	99.95	68.12	34.62	15.72
1981	16.37	27.50	57.18	87.16	118.92	131.20	135.34	117.95	85.79	55.47	27.25	14.73
1982	15.45	22.59	50.12	81.85	117.44	134.89	144.22	130.46	99.16	68.11	36.29	19.65
1983	21.11	33.90	63.73	91.06	120.00	130.47	134.62	119.17	89.81	62.09	34.02	19.23
1984	11.87	21.07	50.95	85.29	123.18	141.50	150.79	135.54	101.89	68.50	34.95	17.81
1985	16.57	26.05	57.09	91.26	128.90	146.26	154.82	138.78	104.34	70.54	36.34	18.30
1986	22.55	32.61	63.28	94.76	129.76	145.43	153.97	139.67	108.02	77.31	44.76	27.15
1987	13.70	22.92	55.69	94.17	137.24	158.70	169.98	153.37	115.44	77.31	38.59	18.35
1988	17.62	26.22	57.72	93.68	134.18	154.04	164.71	149.01	112.87	76.55	38.96	18.37
1989	22.87	39.08	66.91	89.09	114.89	126.96	135.88	124.46	92.97	56.24	21.38	12.45
1990	13.64	38.04	63.79	84.65	120.22	143.27	154.96	134.78	93.01	55.92	26.17	12.06
1991	16.98	28.01	58.25	89.57	123.73	138.78	146.22	131.25	99.55	68.49	36.51	19.08
1992	19.84	28.18	55.36	87.27	124.98	144.03	154.54	140.51	107.98	75.59	37.98	14.83
1993	15.09	24.72	55.68	89.93	127.39	144.36	152.17	135.27	100.46	66.58	33.32	16.93
1994	20.15	31.45	63.16	95.85	132.17	148.89	158.29	144.02	111.19	78.13	41.68	19.19
1995	20.88	28.99	58.40	90.00	124.63	139.31	145.27	127.83	93.78	61.24	30.42	16.35
1996	14.33	23.47	55.04	90.96	130.23	148.16	155.98	137.80	100.85	64.81	30.44	14.11
1997	12.07	21.48	51.19	84.45	120.32	136.14	142.31	124.56	90.04	56.85	26.24	13.12
1998	12.88	23.49	55.03	89.85	127.77	145.05	152.84	135.63	100.17	65.34	31.36	14.44
1999	16.39	22.70	50.97	84.19	121.40	139.41	148.31	132.81	99.21	66.17	33.67	17.95
2000	18.13	25.22	53.33	84.75	119.46	135.08	142.03	126.06	93.78	63.24	34.44	22.78
2001	25.54	33.53	55.95	83.51	119.91	140.32	151.70	135.80	98.25	59.75	25.06	14.29
2002	18.52	28.11	57.30	87.83	121.02	135.01	140.90	124.61	92.35	61.43	31.47	17.20
2003	12.94	23.31	54.36	88.74	126.16	143.08	150.69	133.63	98.60	64.37	31.13	14.91
2004	21.64	30.76	59.68	89.34	121.90	135.53	141.64	125.88	94.40	64.23	34.32	19.71
2005	17.68	26.01	55.10	86.92	121.85	137.22	143.86	127.19	93.77	61.67	30.95	16.89

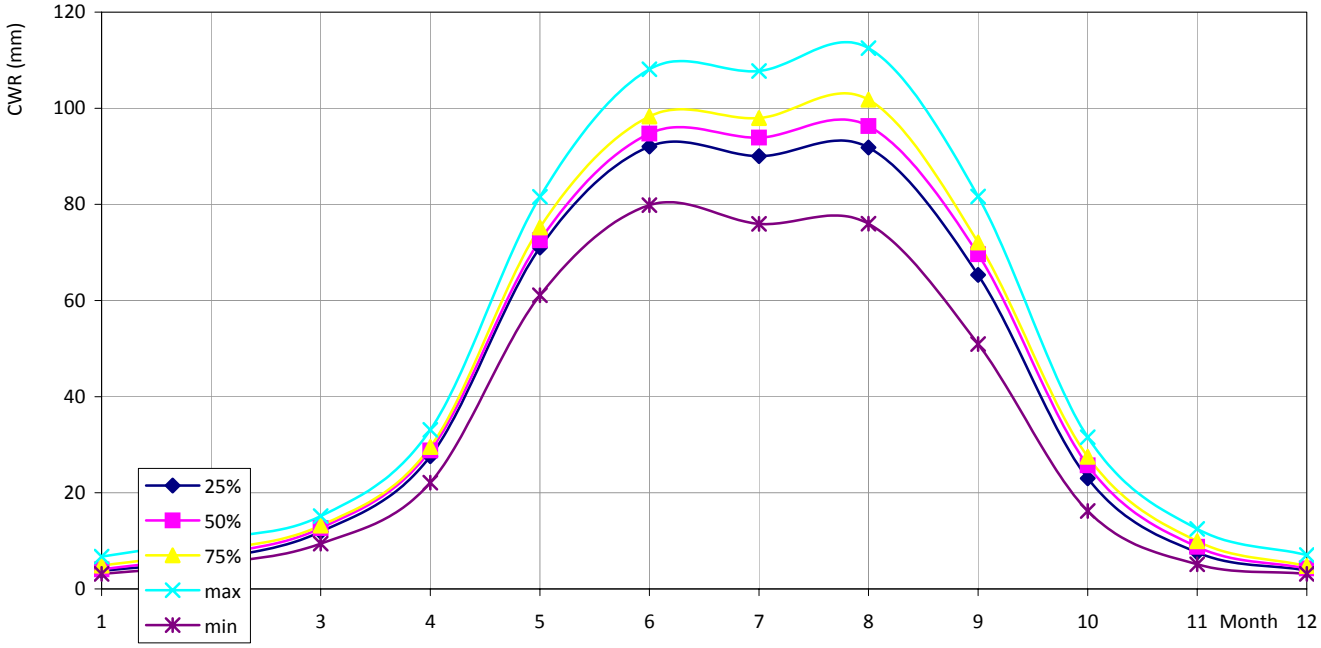


Анекс 39.

Вкупни потреби од вода за културите (mm)

ХМС ЛУКОВИЦА/КОСЕВИЦА

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Sum
1961	3.75	6.64	12.86	30.10	77.61	101.83	101.47	106.89	79.08	31.29	11.31	4.85	**568**
1962	3.64	6.71	13.39	31.59	81.38	106.08	104.48	108.16	78.03	29.71	10.20	4.41	**578**
1963	3.79	5.77	11.58	28.12	74.15	98.30	98.14	102.78	74.87	28.76	9.93	4.21	**540**
1964	4.01	6.82	12.72	29.00	73.24	94.09	91.51	93.47	66.42	24.88	8.48	4.04	**509**
1965	4.03	6.70	9.44	22.12	65.53	94.68	96.39	96.00	62.92	21.93	7.85	3.49	**491**
1966	5.95	8.13	11.89	25.78	68.01	93.71	97.44	103.78	72.21	22.70	5.12	3.94	**519**
1967	4.01	7.91	13.27	28.23	72.51	97.25	98.22	102.36	72.27	26.00	8.35	4.29	**535**
1968	4.04	7.92	14.93	33.11	81.54	103.26	99.96	102.04	71.92	25.72	7.62	3.85	**556**
1969	3.73	7.08	13.14	29.47	73.70	94.42	92.21	95.48	69.63	27.35	10.12	5.04	**521**
1970	4.00	6.95	12.86	29.18	73.74	95.24	93.50	96.92	70.32	27.08	9.44	3.99	**523**
1971	3.14	5.79	11.63	27.50	70.60	91.25	88.68	89.97	63.02	22.99	7.54	3.65	**486**
1972	4.06	7.33	12.66	28.31	73.18	94.74	89.15	83.32	50.93	16.22	6.62	5.88	**472**
1973	3.82	5.62	9.75	23.80	65.36	88.53	87.18	86.25	56.56	18.78	6.24	4.26	**456**
1974	4.18	8.71	11.50	22.47	61.09	88.32	93.90	99.73	69.13	23.30	6.82	3.85	**493**
1975	4.07	7.07	12.56	27.61	68.28	86.68	83.87	85.73	61.37	23.32	8.08	3.63	**472**
1976	4.54	7.23	12.24	26.27	63.86	79.85	75.95	75.97	52.94	19.51	6.79	3.85	**429**
1977	5.15	8.80	14.76	31.18	75.20	94.05	90.17	91.83	65.81	25.28	9.05	4.37	**516**
1978	6.57	7.82	11.35	26.43	72.06	97.90	96.88	95.90	61.74	18.97	5.49	3.99	**505**
1979	4.25	7.09	12.91	29.00	72.45	92.22	88.82	89.66	62.75	23.00	7.66	3.77	**494**
1980	3.30	5.20	10.58	25.85	68.43	91.09	91.30	96.23	70.70	27.51	9.66	4.09	**504**
1981	4.31	7.27	12.95	28.59	70.70	89.39	85.79	86.52	60.68	22.40	7.60	3.83	**480**
1982	4.07	5.97	11.35	26.85	69.82	91.91	91.42	95.70	70.14	27.51	10.12	5.11	**510**
1983	5.56	8.96	14.43	29.87	71.34	88.89	85.33	87.42	63.53	25.08	9.49	5.00	**495**
1984	3.12	5.57	11.54	27.98	73.23	96.41	95.58	99.43	72.07	27.67	9.75	4.63	**527**
1985	4.36	6.88	12.93	29.93	76.63	99.65	98.14	101.80	73.80	28.49	10.14	4.76	**548**
1986	5.94	8.62	14.33	31.08	77.14	99.09	97.60	102.45	76.41	31.22	12.49	7.06	**563**
1987	3.61	6.06	12.61	30.89	81.59	108.13	107.75	112.50	81.65	31.22	10.77	4.77	**592**
1988	4.64	6.93	13.07	30.73	79.77	104.95	104.40	109.31	79.84	30.92	10.87	4.78	**580**
1989	6.02	10.33	15.15	29.22	68.30	86.50	86.13	91.30	65.76	22.71	5.97	3.24	**491**
1990	3.59	10.05	14.45	27.77	71.47	97.61	98.22	98.87	65.79	22.58	7.30	3.14	**521**
1991	4.47	7.40	13.19	29.38	73.56	94.56	92.68	96.28	70.42	27.66	10.19	4.96	**525**
1992	5.22	7.45	12.54	28.62	74.30	98.13	97.96	103.07	76.38	30.53	10.60	3.86	**549**
1993	3.97	6.53	12.61	29.50	75.74	98.36	96.46	99.23	71.06	26.89	9.30	4.40	**534**
1994	5.30	8.31	14.30	31.44	78.58	101.44	100.34	105.65	78.65	31.55	11.63	4.99	**572**
1995	5.50	7.66	13.22	29.52	74.09	94.92	92.08	93.77	66.33	24.73	8.49	4.25	**515**
1996	3.77	6.20	12.46	29.83	77.42	100.95	98.87	101.08	71.33	26.17	8.49	3.67	**540**
1997	3.18	5.68	11.59	27.70	71.53	92.76	90.21	91.37	63.69	22.96	7.32	3.41	**491**
1998	3.39	6.21	12.46	29.47	75.96	98.83	96.88	99.49	70.85	26.39	8.75	3.75	**532**
1999	4.31	6.00	11.54	27.61	72.17	94.98	94.01	97.42	70.17	26.72	9.39	4.67	**519**
2000	4.77	6.67	12.08	27.80	71.02	92.03	90.03	92.47	66.33	25.54	9.61	5.92	**504**
2001	6.72	8.86	12.67	27.39	71.29	95.60	96.16	99.62	69.50	24.13	6.99	3.72	**523**
2002	4.87	7.43	12.98	28.81	71.95	91.99	89.31	91.41	65.32	24.81	8.78	4.47	**502**
2003	3.41	6.16	12.31	29.11	75.00	97.49	95.52	98.02	69.74	26.00	8.69	3.88	**525**
2004	5.70	8.13	13.51	29.30	72.47	92.34	89.78	92.34	66.77	25.94	9.58	5.12	**511**
2005	4.65	6.87	12.48	28.51	72.44	93.49	91.19	93.30	66.33	24.91	8.64	4.39	**507**

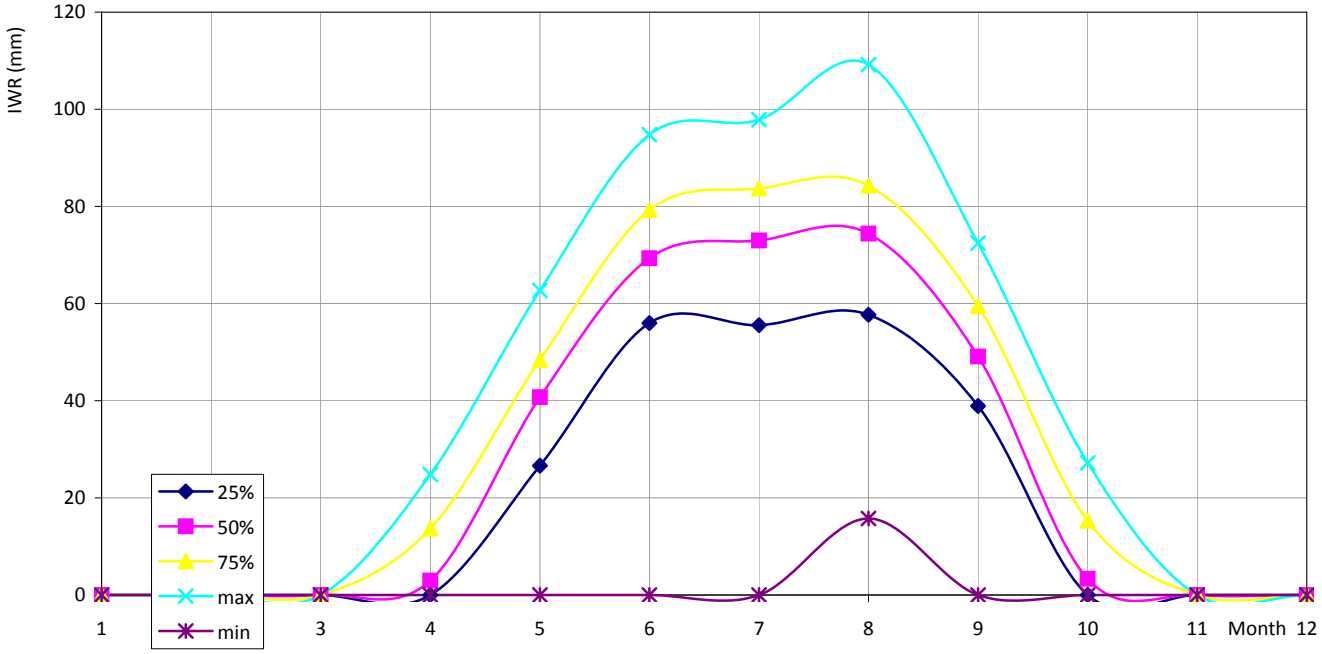


Анекс 40.

Вкупни потреби од вода за наводнување - норма на наводнување (mm)

ХМС ЛУКОВИЦА/КОСЕВИЦА

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Sum
1961	0.00	0.00	0.00	1.18	3.03	87.07	92.59	106.29	63.72	24.57	0.00	0.00	**378**
1962	0.00	0.00	0.00	1.53	58.58	90.60	72.98	104.26	72.45	6.91	0.00	0.00	**407**
1963	0.00	0.00	0.00	13.12	40.73	70.52	89.38	80.58	67.07	0.00	0.00	0.00	**361**
1964	0.00	0.00	0.00	9.74	26.62	69.31	70.21	61.67	44.16	0.00	0.00	0.00	**282**
1965	0.00	0.00	0.00	0.00	18.73	63.12	78.21	77.76	58.60	21.75	0.00	0.00	**318**
1966	0.00	0.00	0.00	0.00	40.83	66.29	76.98	75.22	60.15	0.00	0.00	0.00	**319**
1967	0.00	0.00	0.00	2.97	41.49	57.41	73.98	52.74	53.85	0.00	0.00	0.00	**282**
1968	0.00	0.00	0.00	13.67	47.28	55.98	97.86	54.82	55.42	20.80	0.00	0.00	**346**
1969	0.00	0.00	0.00	0.37	62.72	64.78	66.53	59.06	55.05	27.23	0.00	0.00	**336**
1970	0.00	0.00	0.00	0.00	9.30	64.04	53.00	90.38	59.82	0.00	0.00	0.00	**277**
1971	0.00	0.00	0.00	24.80	40.90	75.17	62.22	81.09	38.90	14.77	0.00	0.00	**338**
1972	0.00	0.00	0.00	5.33	48.88	72.54	41.99	55.54	0.00	0.00	0.00	0.00	**224**
1973	0.00	0.00	0.00	0.00	46.94	79.95	55.56	15.75	10.84	15.30	0.00	0.00	**224**
1974	0.00	0.00	0.00	9.99	0.73	46.08	79.26	73.69	48.91	0.00	0.00	0.00	**259**
1975	0.00	0.00	0.00	15.73	16.56	29.62	56.81	49.55	49.13	0.00	0.00	0.00	**217**
1976	0.00	0.00	0.00	0.00	0.00	32.15	0.00	43.45	39.98	0.00	0.00	0.00	**116**
1977	0.00	0.00	0.00	16.12	35.90	48.45	55.25	76.71	52.19	21.32	0.00	0.00	**306**
1978	0.00	0.00	0.00	0.00	22.50	70.18	85.78	78.08	0.00	8.53	0.00	0.00	**265**
1979	0.00	0.00	0.00	0.00	43.29	64.32	63.20	19.52	41.15	0.00	0.00	0.00	**231**
1980	0.00	0.00	0.00	0.00	0.00	70.75	83.68	82.91	45.62	0.00	0.00	0.00	**283**
1981	0.00	0.00	0.00	20.97	38.06	47.39	50.39	54.06	22.70	0.00	0.00	0.00	**234**
1982	0.00	0.00	0.00	0.00	55.48	85.19	67.42	66.54	46.32	10.89	0.00	0.00	**332**
1983	0.00	0.00	0.00	11.21	49.92	0.00	31.03	75.78	52.07	0.00	0.00	0.00	**220**
1984	0.00	0.00	0.00	16.58	60.51	88.85	76.92	80.35	54.07	21.73	0.00	0.00	**399**
1985	0.00	0.00	0.00	8.45	0.00	69.77	93.28	71.50	38.88	24.89	0.00	0.00	**307**
1986	0.00	0.00	0.00	19.32	38.74	50.55	66.22	95.01	68.01	15.38	0.00	0.00	**353**
1987	0.00	0.00	0.00	2.69	30.23	79.15	69.65	98.64	47.57	0.00	0.00	0.00	**328**
1988	0.00	0.00	0.00	0.00	43.65	58.63	88.80	109.19	62.02	19.16	0.00	0.00	**381**
1989	0.00	0.00	0.00	0.00	23.66	38.44	38.73	68.92	33.42	0.00	0.00	0.00	**203**
1990	0.00	0.00	0.00	0.00	45.67	86.63	76.32	84.29	53.19	6.50	0.00	0.00	**353**
1991	0.00	0.00	0.00	0.00	34.71	79.22	43.24	71.65	49.11	0.00	0.00	0.00	**278**
1992	0.00	0.00	0.00	0.00	54.75	72.86	86.90	95.33	60.94	13.88	0.00	0.00	**385**
1993	0.00	0.00	0.00	16.74	48.42	91.67	86.44	97.99	64.43	7.99	0.00	0.00	**414**
1994	0.00	0.00	0.00	18.68	51.26	94.76	90.32	104.41	72.02	12.65	0.00	0.00	**444**
1995	0.00	0.00	0.00	14.33	31.32	80.54	11.86	30.57	18.25	23.63	0.00	0.00	**211**
1996	0.00	0.00	0.00	0.00	38.95	88.25	78.28	59.14	1.88	14.69	0.00	0.00	**281**
1997	0.00	0.00	0.00	6.72	52.63	62.23	74.36	61.99	59.48	0.00	0.00	0.00	**317**
1998	0.00	0.00	0.00	5.57	39.90	66.77	76.03	85.79	34.69	0.00	0.00	0.00	**309**
1999	0.00	0.00	0.00	0.00	47.40	41.02	68.01	69.06	40.17	1.42	0.00	0.00	**267**
2000	0.00	0.00	0.00	17.24	25.30	72.73	81.37	82.31	53.15	3.31	0.00	0.00	**335**
2001	0.00	0.00	0.00	0.00	48.75	79.23	92.12	88.70	45.13	21.03	0.00	0.00	**375**
2002	0.00	0.00	0.00	1.86	27.57	81.13	41.84	36.78	0.00	0.00	0.00	0.00	**189**
2003	0.00	0.00	0.00	11.05	38.09	30.64	91.56	52.83	60.26	0.00	0.00	0.00	**284**
2004	0.00	0.00	0.00	7.58	44.98	12.31	59.80	74.39	44.28	11.18	0.00	0.00	**255**
2005	0.00	0.00	0.00	18.67	56.46	67.66	50.89	57.70	31.40	0.00	0.00	0.00	**283**

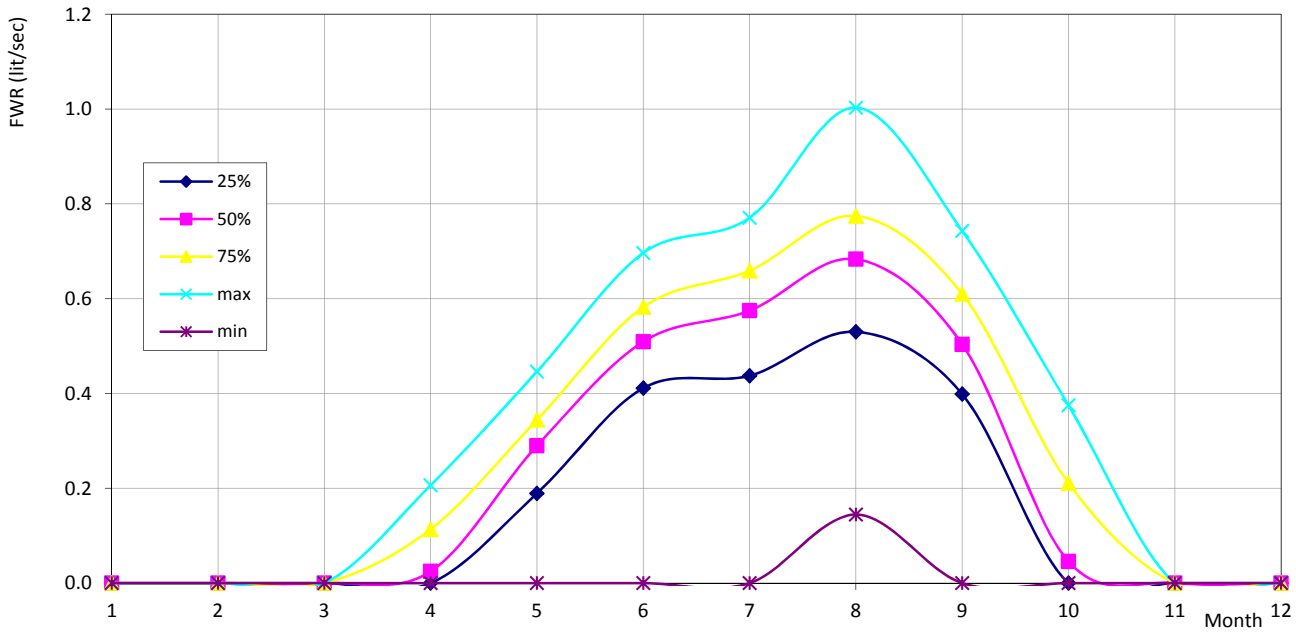


Анекс 41.

Хидромодул за наводнување на културите (lit/sec/ha)

ХМС ЛУКОВИЦА/КОСЕВИЦА

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Max
1961	0.00	0.00	0.00	0.01	0.02	0.45	0.51	0.68	0.46	0.24	0.00	0.00	**0.683**
1962	0.00	0.00	0.00	0.01	0.29	0.47	0.40	0.67	0.52	0.07	0.00	0.00	**0.670**
1963	0.00	0.00	0.00	0.08	0.20	0.36	0.49	0.52	0.48	0.00	0.00	0.00	**0.518**
1964	0.00	0.00	0.00	0.06	0.13	0.36	0.39	0.40	0.32	0.00	0.00	0.00	**0.397**
1965	0.00	0.00	0.00	0.00	0.09	0.32	0.43	0.50	0.42	0.21	0.00	0.00	**0.500**
1966	0.00	0.00	0.00	0.00	0.20	0.34	0.42	0.48	0.43	0.00	0.00	0.00	**0.484**
1967	0.00	0.00	0.00	0.02	0.21	0.30	0.41	0.34	0.39	0.00	0.00	0.00	**0.408**
1968	0.00	0.00	0.00	0.08	0.24	0.29	0.54	0.35	0.40	0.20	0.00	0.00	**0.539**
1969	0.00	0.00	0.00	0.00	0.31	0.33	0.37	0.38	0.40	0.26	0.00	0.00	**0.395**
1970	0.00	0.00	0.00	0.00	0.05	0.33	0.29	0.58	0.43	0.00	0.00	0.00	**0.581**
1971	0.00	0.00	0.00	0.14	0.20	0.39	0.34	0.52	0.28	0.14	0.00	0.00	**0.521**
1972	0.00	0.00	0.00	0.03	0.24	0.37	0.23	0.36	0.00	0.00	0.00	0.00	**0.373**
1973	0.00	0.00	0.00	0.00	0.23	0.41	0.31	0.10	0.08	0.15	0.00	0.00	**0.411**
1974	0.00	0.00	0.00	0.06	0.00	0.24	0.44	0.47	0.35	0.00	0.00	0.00	**0.474**
1975	0.00	0.00	0.00	0.09	0.08	0.15	0.31	0.32	0.35	0.00	0.00	0.00	**0.353**
1976	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.28	0.29	0.00	0.00	0.00	**0.287**
1977	0.00	0.00	0.00	0.09	0.18	0.25	0.30	0.49	0.37	0.21	0.00	0.00	**0.493**
1978	0.00	0.00	0.00	0.00	0.11	0.36	0.47	0.50	0.00	0.08	0.00	0.00	**0.502**
1979	0.00	0.00	0.00	0.00	0.22	0.33	0.35	0.13	0.30	0.00	0.00	0.00	**0.348**
1980	0.00	0.00	0.00	0.00	0.00	0.36	0.46	0.53	0.33	0.00	0.00	0.00	**0.533**
1981	0.00	0.00	0.00	0.12	0.19	0.24	0.28	0.35	0.16	0.00	0.00	0.00	**0.348**
1982	0.00	0.00	0.00	0.00	0.28	0.44	0.37	0.43	0.33	0.11	0.00	0.00	**0.438**
1983	0.00	0.00	0.00	0.07	0.25	0.00	0.17	0.49	0.37	0.00	0.00	0.00	**0.487**
1984	0.00	0.00	0.00	0.10	0.30	0.46	0.42	0.52	0.39	0.21	0.00	0.00	**0.517**
1985	0.00	0.00	0.00	0.05	0.00	0.36	0.51	0.46	0.28	0.24	0.00	0.00	**0.514**
1986	0.00	0.00	0.00	0.11	0.19	0.26	0.36	0.61	0.49	0.15	0.00	0.00	**0.611**
1987	0.00	0.00	0.00	0.02	0.15	0.41	0.38	0.63	0.34	0.00	0.00	0.00	**0.634**
1988	0.00	0.00	0.00	0.00	0.22	0.30	0.49	0.70	0.45	0.18	0.00	0.00	**0.702**
1989	0.00	0.00	0.00	0.00	0.12	0.20	0.21	0.44	0.24	0.00	0.00	0.00	**0.443**
1990	0.00	0.00	0.00	0.00	0.23	0.45	0.42	0.54	0.38	0.06	0.00	0.00	**0.542**
1991	0.00	0.00	0.00	0.00	0.17	0.41	0.24	0.46	0.35	0.00	0.00	0.00	**0.461**
1992	0.00	0.00	0.00	0.00	0.27	0.37	0.48	0.61	0.44	0.13	0.00	0.00	**0.613**
1993	0.00	0.00	0.00	0.10	0.24	0.47	0.48	0.63	0.46	0.08	0.00	0.00	**0.630**
1994	0.00	0.00	0.00	0.11	0.26	0.49	0.50	0.67	0.52	0.12	0.00	0.00	**0.671**
1995	0.00	0.00	0.00	0.08	0.16	0.41	0.07	0.20	0.13	0.23	0.00	0.00	**0.414**
1996	0.00	0.00	0.00	0.00	0.19	0.45	0.43	0.38	0.01	0.14	0.00	0.00	**0.454**
1997	0.00	0.00	0.00	0.04	0.26	0.32	0.41	0.40	0.43	0.00	0.00	0.00	**0.427**
1998	0.00	0.00	0.00	0.03	0.20	0.34	0.42	0.55	0.25	0.00	0.00	0.00	**0.552**
1999	0.00	0.00	0.00	0.00	0.24	0.21	0.37	0.44	0.29	0.01	0.00	0.00	**0.444**
2000	0.00	0.00	0.00	0.10	0.13	0.37	0.45	0.53	0.38	0.03	0.00	0.00	**0.529**
2001	0.00	0.00	0.00	0.00	0.24	0.41	0.51	0.57	0.32	0.20	0.00	0.00	**0.570**
2002	0.00	0.00	0.00	0.01	0.14	0.42	0.23	0.24	0.00	0.00	0.00	0.00	**0.417**
2003	0.00	0.00	0.00	0.06	0.19	0.16	0.50	0.34	0.43	0.00	0.00	0.00	**0.505**
2004	0.00	0.00	0.00	0.04	0.22	0.06	0.33	0.48	0.32	0.11	0.00	0.00	**0.478**
2005	0.00	0.00	0.00	0.11	0.28	0.35	0.28	0.37	0.23	0.00	0.00	0.00	**0.371**



Анекс 42. Финансиски модел за Алтернатива 1
Annex 42. Financial Analysis of Alternative 1

Project Year		1	2	3	4	5	6	7	8	9	10	11
Calendar Year (indicative)		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Demand												
Water Supply Demand	m3/year	164,783	166,240	167,710	169,194	170,692	172,204	173,731	175,271	176,826	178,395	179,979
Irrigation Demands	m3/year	1,135,341	1,221,947	1,084,194	845,115	954,522	958,410	847,313	1,037,455	1,007,180	829,591	1,013,549
Total Water Demand	**m3/year**	**1,300,124**	**1,388,187**	**1,251,904**	**1,014,310**	**1,125,215**	**1,130,614**	**1,021,043**	**1,212,726**	**1,184,006**	**1,007,986**	**1,193,528**
Water/Feed In Energy Tariff												
Feed-In Energy Tariff	euro/kWh	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Water Supply Tariff	euro/m3	0.0813	0.0829	0.0846	0.0863	0.0880	0.0898	0.0916	0.0934	0.0953	0.0972	0.0991
Irrigation Water Tariff	euro/m3	0.0813	0.0829	0.0846	0.0863	0.0880	0.0898	0.0916	0.0934	0.0953	0.0972	0.0991
Tariff collection efficiency WS	**%**	**0%**	**0%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**
Tariff collection efficiency IRI	**%**	**0%**	**0%**	**70%**	**77%**	**85%**	**93%**	**95%**	**95%**	**95%**	**95%**	**95%**
REVENUES												
Revenues from Tariff												
Revenues from Water Supply Tariff	euro	0	0	13,477	13,868	14,270	14,685	15,111	15,550	16,002	16,467	16,945
Revenue from Irrigation Water Tariff	euro	0	0	64,195	56,144	71,148	80,154	73,699	92,043	91,144	76,574	95,426
Total Revenues from Tariffs	**euro**	**0**	**0**	**77,671**	**70,012**	**85,419**	**94,838**	**88,810**	**107,593**	**107,145**	**93,041**	**112,371**
Energy Production	kWh											
Revenues from Energy Production	**euros**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other revenues												
Residual values (Dams)	euro										0	0
Residual values (Pumps)	euro										3,649	0
Residual values (Irr. System)	euro										0	0
Total Other revenues	**euro**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3,649**	**0**
REVENUES		**0**	**0**	**77,671**	**70,012**	**85,419**	**94,838**	**88,810**	**107,593**	**107,145**	**96,690**	**112,371**
PROJECT COSTS												
Investment costs	**euro**											
Land Expropriation	euro	100,000										
Dam Construction	euro											
Civil works	euro											
Equipment	euro											
Small Hydro Power Plant (150kW)	euro											
Small Pump Station (Intake Structure)	euro											
Pump Station	euro											
Civil works	euro	56,541	56,541									
El.Equipment	euro	50,000	50,000									
Objects & Equipment	euro	72,986	72,986									
Irrigational System	euro											
Civil works	euro	162,266	162,266									
Piping	euro	316,867	316,867									
Objects & Pipe Structures	euro	103,682	103,682									
Irrigation Equipment	euro		227,901									
Working Capital Requirements	euro			11,675								
Total Investment Costs		**862,343**	**990,243**	**11,675**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
O&M costs												
Salaries and allowances of O&M costs	euro	61,200	61,200	62,424	63,648	64,872	66,096	67,320	68,544	69,768	70,992	72,216
Maintance Costs												
Dams Annual Maintance costs (0.5%)	euro	0	0	0	0	0	0	0	0	0	0	0
SHPP Annual Maintance Costs (0.5%)	euro	0	0	0	0	0	0	0	0	0	0	0
Irr. Sysrem Annual Maintance costs (1%)	euro	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656
Equipment Annual Maintance costs (6%)	euro	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674
Pump Station Annual Maintance costs (3%)	euro	10,772	10,772	10,772	10,772	10,772	10,772	10,772	10,772	10,772	10,772	10,772
Running Costs												
Energy Consumption for Pumping	euro	45,799	53,630	52,985	46,900	56,032	60,276	58,317	73,231	75,851	68,694	84,990
Total O&M costs		**143,101**	**150,932**	**151,511**	**146,650**	**157,006**	**162,474**	**161,739**	**177,877**	**181,721**	**175,788**	**193,308**
Replacement costs												
Dam Equipment	euro											
SHPP Equipment	euro											
Pump Station Equipment	euro										72,986	
Irr. System Object & Structures	euro											
Irr. Equipment	euro											
Other equipment	euro											
Total replacement costs		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**72,986**	**0**
Other costs												
Institutional setup and mngt.	euro	30,000	20,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Awareness raising campaign	euro	30,000	20,000	10,000	10,000	10,000	10,000		0	0	0	0
Insurance (0.5%)	euro		2,906	2,906	2,906	2,906	2,906	2,906	2,906	2,906	2,906	2,906
Taxes and Other	euro											
Total other costs		**60,000**	**42,906**	**22,906**	**22,906**	**22,906**	**22,906**	**12,906**	**12,906**	**12,906**	**12,906**	**12,906**
Total Project Costs		**1,065,443**	**1,184,082**	**186,092**	**169,556**	**179,912**	**185,380**	**174,645**	**190,783**	**194,627**	**261,681**	**206,214**
Net Benefits		**-1,065,443**	**-1,184,082**	**-108,421**	**-99,545**	**-94,493**	**-90,542**	**-85,834**	**-83,191**	**-87,482**	**-164,990**	**-93,844**
Discount Rate	**5.0%**	**%**										
FNPV	**-3,464,772 €**	**euro**										
FIRR	**#DIV/0!**	**%**										
Start Tariff	**0.0813**	**euro/m3**	**5.0**	**den/m3**	**244**	**euro/ha**	**15,000**	**den/ha**				
Average Tariff	**0.1016**	**euro/m3**	**6.2**	**den/m3**	**305**	**euro/ha**	**18,700**	**den/ha**				
Max Tariff	**0.1116**	**euro/m3**	**6.9**	**den/m3**	**335**	**euro/ha**	**20,600**	**den/ha**				

12	13	14	15	16	17	18	19	20	21	22	23	24	25
2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
181,578	183,192	184,821	186,466	188,126	189,801	191,492	193,199	194,922	196,661	198,417	200,189	201,977	203,783
672,848	673,029	775,996	652,197	346,726	917,810	795,218	694,420	848,865	700,715	995,482	660,012	1,196,995	920,325
854,426	**856,221**	**960,818**	**838,663**	**534,852**	**1,107,611**	**986,710**	**887,619**	**1,043,787**	**897,376**	**1,193,899**	**860,200**	**1,398,972**	**1,124,108**
0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
0.1011	0.1031	0.1052	0.1073	0.1094	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116
0.1011	0.1031	0.1052	0.1073	0.1094	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116
95%	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**
95%	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**
17,438	17,944	18,466	19,003	19,555	20,124	20,304	20,485	20,667	20,852	21,038	21,226	21,415	21,607
64,616	65,926	77,532	66,466	36,042	97,314	84,316	73,628	90,004	74,295	105,549	69,980	126,915	97,580
82,053	**83,870**	**95,998**	**85,469**	**55,597**	**117,438**	**104,619**	**94,113**	**110,671**	**95,147**	**126,587**	**91,205**	**148,330**	**119,187**
0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3,649	0	0	0	0	0	0	28,271
0	0	0	0	0	11,395	0	0	0	5,184	5,184	0	0	291,408
0	**0**	**0**	**0**	**0**	**11,395**	**3,649**	**0**	**0**	**5,184**	**5,184**	**0**	**0**	**319,678**
82,053	**83,870**	**95,998**	**85,469**	**55,597**	**128,833**	**108,268**	**94,113**	**110,671**	**100,331**	**131,771**	**91,205**	**148,330**	**438,865**
0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
73,440	74,664	75,888	77,112	78,336	79,560	80,784	82,008	83,232	84,456	85,680	86,904	88,128	89,352
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656
13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674
10,772	10,772	10,772	10,772	10,772	10,772	10,772	10,772	10,772	10,772	10,772	10,772	10,772	10,772
64,718	68,031	78,324	69,010	45,392	90,664	81,407	73,826	86,491	75,097	99,051	72,629	116,177	94,396
174,260	**178,797**	**190,314**	**182,224**	**159,830**	**206,326**	**198,293**	**191,936**	**205,825**	**195,655**	**220,833**	**195,635**	**240,407**	**219,850**
									0	0			
						72,986							
									103,682	103,682			
					227,901								
0	**0**	**0**	**0**	**0**	**227,901**	**72,986**	**0**	**0**	**103,682**	**103,682**	**0**	**0**	**0**
10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,906	2,906	2,906	2,906	2,906	2,906	2,906	2,906	2,906	2,906	2,906	2,906	2,906	2,906
12,906	**12,906**	**12,906**	**12,906**	**12,906**	**12,906**	**12,906**	**12,906**	**12,906**	**12,906**	**12,906**	**12,906**	**12,906**	**12,906**
187,166	**191,703**	**203,220**	**195,131**	**172,736**	**447,133**	**284,186**	**204,842**	**218,731**	**312,244**	**337,422**	**208,541**	**253,313**	**232,756**
-105,113	**-107,833**	**-107,222**	**-109,662**	**-117,139**	**-318,300**	**-175,917**	**-110,729**	**-108,060**	**-211,913**	**-205,651**	**-117,335**	**-104,983**	**206,109**

Анекс 43. Финансиски модел за Алтернатива 2
Annex 43. Financial Analysis of Alternative 2

Project Year		1	2	3	4	5	6	7	8	9	10	11
Calendar Year (indicative)		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Demand												
Water Supply Demand	m3/year	164,783	166,240	167,710	169,194	170,692	172,204	173,731	175,271	176,826	178,395	179,979
Irrigation Demands	m3/year	1,135,341	1,221,947	1,084,194	845,115	954,522	958,410	847,313	1,037,455	1,007,180	829,591	1,013,549
Total Water Demand	**m3/year**	**1,300,124**	**1,388,187**	**1,251,904**	**1,014,310**	**1,125,215**	**1,130,614**	**1,021,043**	**1,212,726**	**1,184,006**	**1,007,986**	**1,193,528**
Water/Feed In Energy Tariff												
Feed-In Energy Tariff	euro/kWh	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Water Supply Tariff	euro/m3	0.0813	0.0829	0.0846	0.0863	0.0880	0.0898	0.0916	0.0934	0.0953	0.0972	0.0991
Irrigation Water Tariff	euro/m3	0.0813	0.0829	0.0846	0.0863	0.0880	0.0898	0.0916	0.0934	0.0953	0.0972	0.0991
Tariff collection efficiency WS	**%**	**0%**	**0%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**
Tariff collection efficiency IRI	**%**	**0%**	**0%**	**70%**	**77%**	**85%**	**93%**	**95%**	**95%**	**95%**	**95%**	**95%**
REVENUES												
Revenues from Tariff												
Revenues from Water Supply Tariff	euro	0	0	13,477	13,868	14,270	14,685	15,111	15,550	16,002	16,467	16,945
Revenue from Irrigation Water Tariff	euro	0	0	64,195	56,144	71,148	80,154	73,699	92,043	91,144	76,574	95,426
Total Revenues from Tariffs	**euro**	**0**	**0**	**77,671**	**70,012**	**85,419**	**94,838**	**88,810**	**107,593**	**107,145**	**93,041**	**112,371**
Energy Production	kWh	243,530	474,563	572,171	310,551	404,187	375,059	264,592	273,758	374,744	365,475	327,034
Revenues from Energy Production	**euros**	**0**	**0**	**68,661**	**37,266**	**48,502**	**45,007**	**31,751**	**32,851**	**44,969**	**43,857**	**39,244**
Other revenues												
Residual values (Dams)	euro										0	0
Residual values (Pumps)	euro										0	0
Residual values (Irr. System)	euro										0	0
Total Other revenues	**euro**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
REVENUES		**0**	**0**	**146,332**	**107,278**	**133,921**	**139,845**	**120,561**	**140,443**	**152,115**	**136,898**	**151,615**
PROJECT COSTS												
Investment costs	**euro**											
Land Expropriation	euro	225,000										
Dam Construction	euro											
Civil works	euro	1,897,384	1,897,384									
Equipment	euro	58,682	58,682									
Small Hydro Power Plant (150kW)	euro		180,000									
Small Pump Station (Intake Structure)	euro		20,000									
Pump Station	euro											
Civil works	euro											
Piping	euro											
Objects & Equipment	euro		0									
Irrigational System	euro											
Civil works	euro	162,266	162,266									
Piping	euro	316,867	316,867									
Objects & Pipe Structures	euro	103,682	103,682									
Irrigation Equipment	euro		227,901									
Working Capital Requirements	euro			12,032								
Total Investment Costs		**2,763,881**	**2,966,782**	**12,032**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
O&M costs												
Salaries and allowances of O&M costs	euro	65,400	65,400	66,708	68,016	69,324	70,632	71,940	73,248	74,556	75,864	77,172
Maintance Costs												
Dams Annual Maintance costs (0.5%)	euro	20,561	20,561	20,561	20,561	20,561	20,561	20,561	20,561	20,561	20,561	20,561
SHPP Annual Maintance Costs (0.5%)	euro	900	900	900	900	900	900	900	900	900	900	900
Irr. Sysrem Annual Maintance costs (1%)	euro	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656
Equipment Annual Maintance costs (6%)	euro	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674
Pump Station Annual Maintance costs (3%)	euro	0	0	0	0	0	0	0	0	0	0	0
Running Costs												
Energy Consumption for Pumping	euro	6,080	7,186	6,962	5,884	7,187	7,723	7,285	9,487	9,761	8,502	10,914
Total O&M costs		**118,271**	**119,377**	**120,461**	**120,691**	**123,302**	**125,146**	**126,016**	**129,526**	**131,108**	**131,157**	**134,877**
Replacement costs												
Dam Equipment	euro											
SHPP Equipment	euro											
Pump Station Equipment	euro										0	
Irr. System Object & Structures	euro											
Irr. Equipment	euro											
Other equipment	euro											
Total replacement costs		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other costs												
Institutional setup and mngt.	euro	30,000	20,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Awareness raising campaign	euro	30,000	20,000	10,000	10,000	10,000	10,000		0	0	0	0
Insurance (0.5%)	euro		3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163
Taxes and Other	euro											
Total other costs		**60,000**	**43,163**	**23,163**	**23,163**	**23,163**	**23,163**	**13,163**	**13,163**	**13,163**	**13,163**	**13,163**
Total Project Costs		**2,942,153**	**3,129,322**	**155,656**	**143,854**	**146,466**	**148,309**	**139,179**	**142,689**	**144,272**	**144,321**	**148,040**
Net Benefits		**-2,942,153**	**-3,129,322**	**-9,324**	**-36,577**	**-12,544**	**-8,464**	**-18,617**	**-2,246**	**7,843**	**-7,423**	**3,574**

Discount Rate	**5.0%**	**%**							
FNPV	**-4,856,828 €**	**euro**							
FIRR	**#NUM!**	**%**							
Start Tariff	**0.0813**	**euro/m3**	**5.0**	**den/m3**	**244**	**euro/ha**	**15,000**	**den/ha**	
Average Tariff	**0.1016**	**euro/m3**	**6.2**	**den/m3**	**305**	**euro/ha**	**18,700**	**den/ha**	
Max Tariff	**0.1116**	**euro/m3**	**6.9**	**den/m3**	**335**	**euro/ha**	**20,600**	**den/ha**	

12	13	14	15	16	17	18	19	20	21	22	23	24	25
2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
181,578	183,192	184,821	186,466	188,126	189,801	191,492	193,199	194,922	196,661	198,417	200,189	201,977	203,783
672,848	673,029	775,996	652,197	346,726	917,810	795,218	694,420	848,865	700,715	995,482	660,012	1,196,995	920,325
854,426	**856,221**	**960,818**	**838,663**	**534,852**	**1,107,611**	**986,710**	**887,619**	**1,043,787**	**897,376**	**1,193,899**	**860,200**	**1,398,972**	**1,124,108**
0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
0.1011	0.1031	0.1052	0.1073	0.1094	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116
0.1011	0.1031	0.1052	0.1073	0.1094	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116
95%	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**
95%	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**
17,438	17,944	18,466	19,003	19,555	20,124	20,304	20,485	20,667	20,852	21,038	21,226	21,415	21,607
64,616	65,926	77,532	66,466	36,042	97,314	84,316	73,628	90,004	74,295	105,549	69,980	126,915	97,580
82,053	**83,870**	**95,998**	**85,469**	**55,597**	**117,438**	**104,619**	**94,113**	**110,671**	**95,147**	**126,587**	**91,205**	**148,330**	**119,187**
342,641	385,116	392,424	222,937	494,371	259,580	230,137	297,775	389,355	326,641	259,440	262,791	310,790	281,932
41,117	**46,214**	**47,091**	**26,752**	**59,325**	**31,150**	**27,616**	**35,733**	**46,723**	**39,197**	**31,133**	**31,535**	**37,295**	**33,832**
0	0	0	0	0	0	0	0	0	2,934	2,934	0	0	3,716,525
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	11,395	0	0	0	5,184	5,184	0	0	291,408
0	**0**	**0**	**0**	**0**	**11,395**	**0**	**0**	**0**	**8,118**	**8,118**	**0**	**0**	**4,007,933**
123,170	**130,084**	**143,089**	**112,221**	**114,922**	**159,983**	**132,236**	**129,846**	**157,393**	**142,462**	**165,838**	**122,740**	**185,625**	**4,160,952**
0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
78,480	79,788	81,096	82,404	83,712	85,020	86,328	87,636	88,944	90,252	91,560	92,868	94,176	95,484
20,561	20,561	20,561	20,561	20,561	20,561	20,561	20,561	20,561	20,561	20,561	20,561	20,561	20,561
900	900	900	900	900	900	900	900	900	900	900	900	900	900
11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656
13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674
0	0	0	0	0	0	0	0	0	0	0	0	0	0
7,596	7,970	9,490	7,998	4,265	11,322	9,838	8,616	10,565	8,745	12,461	8,286	15,070	11,622
132,867	**134,549**	**137,377**	**137,193**	**134,768**	**143,133**	**142,957**	**143,043**	**146,300**	**145,788**	**150,812**	**147,945**	**156,037**	**153,897**
									58,682	58,682			
						0			72,000				
									103,682	103,682			
					227,901								
0	**0**	**0**	**0**	**0**	**227,901**	**0**	**0**	**0**	**162,364**	**234,364**	**0**	**0**	**0**
10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
0	0	0	0	0	0	0	0	0	0	0	0	0	0
3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163
13,163	**13,163**	**13,163**	**13,163**	**13,163**	**13,163**	**13,163**	**13,163**	**13,163**	**13,163**	**13,163**	**13,163**	**13,163**	**13,163**
146,031	**147,712**	**150,540**	**150,356**	**147,931**	**384,197**	**156,120**	**156,206**	**159,463**	**321,315**	**398,339**	**161,108**	**169,200**	**167,060**
-22,861	**-17,628**	**-7,451**	**-38,135**	**-33,009**	**-224,215**	**-23,885**	**-26,361**	**-2,069**	**-178,853**	**-232,501**	**-38,368**	**16,425**	**3,993,892**

Анекс 44. Финансиски модел за Алтернатива 3
Annex 44. Financial Analysis of Alternative 3

Project Year		1	2	3	4	5	6	7	8	9	10	11
Calendar Year (indicative)		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Demand												
Water Supply Demand	m3/year	164,783	166,240	167,710	169,194	170,692	172,204	173,731	175,271	176,826	178,395	179,979
Irrigation Demands	m3/year	1,135,341	1,221,947	1,084,194	845,115	954,522	958,410	847,313	1,037,455	1,007,180	829,591	1,013,549
Total Water Demand	**m3/year**	**1,300,124**	**1,388,187**	**1,251,904**	**1,014,310**	**1,125,215**	**1,130,614**	**1,021,043**	**1,212,726**	**1,184,006**	**1,007,986**	**1,193,528**
Water/Feed In Energy Tariff												
Feed-In Energy Tariff	euro/kWh	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Water Supply Tariff	euro/m3	0.0813	0.0829	0.0846	0.0863	0.0880	0.0898	0.0916	0.0934	0.0953	0.0972	0.0991
Irrigation Water Tariff	euro/m3	0.0813	0.0829	0.0846	0.0863	0.0880	0.0898	0.0916	0.0934	0.0953	0.0972	0.0991
Tariff collection efficiency WS	**%**	**0%**	**0%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**
Tariff collection efficiency IRI	**%**	**0%**	**0%**	**70%**	**77%**	**85%**	**93%**	**95%**	**95%**	**95%**	**95%**	**95%**
REVENUES												
Revenues from Tariff												
Revenues from Water Supply Tariff	euro	0	0	13,477	13,868	14,270	14,685	15,111	15,550	16,002	16,467	16,945
Revenue from Irrigation Water Tariff	euro	0	0	64,195	56,144	71,148	80,154	73,699	92,043	91,144	76,574	95,426
Total Revenues from Tariffs	**euro**	**0**	**0**	**77,671**	**70,012**	**85,419**	**94,838**	**88,810**	**107,593**	**107,145**	**93,041**	**112,371**
Energy Production	euro/kWh	122,815	237,267	285,671	181,418	233,072	221,098	151,562	154,205	209,293	216,935	177,400
Revenues from Energy Production	**%**	**0**	**0**	**34,280**	**21,770**	**27,969**	**26,532**	**18,187**	**18,505**	**25,115**	**26,032**	**21,288**
Other revenues												
Residual values (Dams)	euro										0	0
Residual values (Pumps)	euro										0	0
Residual values (Irr. System)	euro										0	0
Total Other revenues	**euro**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
REVENUES		**0**	**0**	**111,952**	**91,782**	**113,387**	**121,370**	**106,998**	**126,097**	**132,261**	**119,073**	**133,659**
PROJECT COSTS												
Investment costs	**euro**											
Land Expropriation	euro	187,500										
Dam Construction	euro											
Civil works	euro	999,806	999,806									
Equipment	euro	30,922	30,922									
Small Hydro Power Plant (150kW)	euro		90,000									
Small Pump Station & Intake Structure	euro		40,000									
Pump Station	euro											
Civil works	euro											
Piping	euro											
Objects & Equipment	euro		0									
Irrigational System	euro											
Civil works	euro	162,266	162,266									
Piping	euro	316,867	316,867									
Objects & Pipe Structures	euro	103,682	103,682									
Irrigation Equipment	euro		227,901									
Working Capital Requirements	euro			11,675								
Total Investment Costs		**1,801,043**	**1,971,444**	**11,675**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
O&M costs												
Salaries and allowances of O&M costs	euro	61,200	61,200	62,424	63,648	64,872	66,096	67,320	68,544	69,768	70,992	72,216
Maintance Costs												
Dams Annual Maintance costs (0.5%)	euro	10,957	10,957	10,957	10,957	10,957	10,957	10,957	10,957	10,957	10,957	10,957
SHPP Annual Maintance Costs (0.5%)	euro	450	450	450	450	450	450	450	450	450	450	450
Irr. Sysrem Annual Maintance costs (1%)	euro	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656
Equipment Annual Maintance costs (6%)	euro	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674
Pump Station Annual Maintance costs (3%)	euro	0	0	0	0	0	0	0	0	0	0	0
Running Costs												
Energy Consumption for Pumping	euro	6,080	7,186	6,962	5,884	7,187	7,723	7,285	9,487	9,761	8,502	10,914
Total O&M costs		**104,018**	**105,124**	**106,124**	**106,270**	**108,797**	**110,557**	**111,342**	**114,769**	**116,267**	**116,232**	**119,868**
Replacement costs												
Dam Equipment	euro											
SHPP Equipment	euro											
Pump Station Equipment	euro										0	
Irr. System Object & Structures	euro											
Irr. Equipment	euro											
Other equipment	euro											
Total replacement costs		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other costs												
Institutional setup and mngt.	euro	30,000	20,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Awareness raising campaign	euro	30,000	20,000	10,000	10,000	10,000	10,000		0	0	0	0
Insurance (0.5%)	euro		2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746
Taxes and Other	euro											
Total other costs		**60,000**	**42,746**	**22,746**	**22,746**	**22,746**	**22,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**
Total Project Costs		**1,965,062**	**2,119,314**	**140,544**	**129,015**	**131,543**	**133,302**	**124,088**	**127,514**	**129,013**	**128,978**	**132,613**
Net Benefits		**-1,965,062**	**-2,119,314**	**-28,592**	**-37,234**	**-18,155**	**-11,932**	**-17,090**	**-1,417**	**3,248**	**-9,904**	**1,045**
Discount Rate	**5.0%**	**%**										
FNPV	**-3,531,953 €**	**euro**										
FIRR	**#DIV/0!**	**%**										
Start Tariff	**0.0813**	**euro/m3**	**5.0**	**den/m3**	**244**	**euro/ha**	**15,000**	**den/ha**				
Average Tariff	**0.1016**	**euro/m3**	**6.2**	**den/m3**	**305**	**euro/ha**	**18,700**	**den/ha**				
Max Tariff	**0.1116**	**euro/m3**	**6.9**	**den/m3**	**335**	**euro/ha**	**20,600**	**den/ha**				

12	13	14	15	16	17	18	19	20	21	22	23	24	25
2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
181,578	183,192	184,821	186,466	188,126	189,801	191,492	193,199	194,922	196,661	198,417	200,189	201,977	203,783
672,848	673,029	775,996	652,197	346,726	917,810	795,218	694,420	848,865	700,715	995,482	660,012	1,196,995	920,325
854,426	**856,221**	**960,818**	**838,663**	**534,852**	**1,107,611**	**986,710**	**887,619**	**1,043,787**	**897,376**	**1,193,899**	**860,200**	**1,398,972**	**1,124,108**
0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
0.1011	0.1031	0.1052	0.1073	0.1094	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116
0.1011	0.1031	0.1052	0.1073	0.1094	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116	0.1116
95%	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**
95%	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**	**95%**
17,438	17,944	18,466	19,003	19,555	20,124	20,304	20,485	20,667	20,852	21,038	21,226	21,415	21,607
64,616	65,926	77,532	66,466	36,042	97,314	84,316	73,628	90,004	74,295	105,549	69,980	126,915	97,580
82,053	**83,870**	**95,998**	**85,469**	**55,597**	**117,438**	**104,619**	**94,113**	**110,671**	**95,147**	**126,587**	**91,205**	**148,330**	**119,187**
204,790	207,176	217,940	127,666	294,599	151,984	122,035	170,212	205,850	193,605	145,078	152,928	180,621	142,809
24,575	**24,861**	**26,153**	**15,320**	**35,352**	**18,238**	**14,644**	**20,425**	**24,702**	**23,233**	**17,409**	**18,351**	**21,675**	**17,137**
0	0	0	0	0	0	0	0	0	1,546	1,546	0	0	1,958,383
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	11,395	0	0	0	5,184	5,184	0	0	291,408
0	**0**	**0**	**0**	**0**	**11,395**	**0**	**0**	**0**	**6,730**	**6,730**	**0**	**0**	**2,249,791**
106,628	**108,731**	**122,151**	**100,789**	**90,949**	**147,071**	**119,263**	**114,538**	**135,373**	**125,110**	**150,726**	**109,557**	**170,005**	**2,386,115**
0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
73,440	74,664	75,888	77,112	78,336	79,560	80,784	82,008	83,232	84,456	85,680	86,904	88,128	89,352
10,957	10,957	10,957	10,957	10,957	10,957	10,957	10,957	10,957	10,957	10,957	10,957	10,957	10,957
450	450	450	450	450	450	450	450	450	450	450	450	450	450
11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656	11,656
13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674	13,674
0	0	0	0	0	0	0	0	0	0	0	0	0	0
7,596	7,970	9,490	7,998	4,265	11,322	9,838	8,616	10,565	8,745	12,461	8,286	15,070	11,622
117,774	**119,372**	**122,115**	**121,848**	**119,339**	**127,620**	**127,360**	**127,362**	**130,534**	**129,938**	**134,878**	**131,928**	**139,936**	**137,711**
									30,922	30,922			
						0			36,000				
					227,901				103,682	103,682			
0	**0**	**0**	**0**	**0**	**227,901**	**0**	**0**	**0**	**134,604**	**170,604**	**0**	**0**	**0**
10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746
12,746	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**
130,520	**132,117**	**134,861**	**134,593**	**132,084**	**368,266**	**140,105**	**140,107**	**143,280**	**277,288**	**318,228**	**144,673**	**152,681**	**150,457**
-23,892	**-23,386**	**-12,710**	**-33,804**	**-41,135**	**-221,195**	**-20,842**	**-25,569**	**-7,907**	**-152,178**	**-167,502**	**-35,116**	**17,323**	**2,235,658**

Анекс 45. Историски и Проектирани цени на земјоделските култури

Annex 45. Historical and projected prices of agricultural crops

		Den/kg																Starting	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average 06-08	Zem. Inst	Correl R	m	b	2010	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Пченица	Wheat	11	10	10	10	10	10	11	9	7	11	13	10	8																														
		8	8	8	9	8	9	8	8	8	11	11	10																															
		8	8	9	9	8	9	9	8	8	11	14	11		0.599	0.310	-611	11.30	11.00	11.3	11.6	11.9	12.2	12.5	12.9	13.2	13.5	13.8	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1
Рж	Rye	8	10	10	10	10	10	11	8	8	19	23	17																															
		7	7	8	7	7	7	7	6	7	10	10	9																															
		7	8	9	9	7	9	9	8	9	11	13	11		0.769	0.420	-833	11.77	11.00	11.4	11.8	12.3	12.7	13.1	13.5	13.9	14.4	14.8	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2
Јачмен	Barley	8	8	8	11	10	7	8	7	8	10	11	10	9																														
		7	7	8	8	8	8	8	7	8	11	11	10																															
		9	8	10	10	9	10	10	10	9	13	13	12		0.694	0.358	-708	12.56	10.00	10.4	10.7	11.1	11.4	11.8	12.2	12.5	12.9	13.2	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Овес	Oats	9	7	7	7	12	11	8	12	7	12	8	9																															
		7	7	7	8	7	7	7	7	7	10	10	9																															
		7	7	9	10	8	9	10	10	9	12	14	12		0.836	0.519	-1031	13.26	10.00	10.5	11.0	11.6	12.1	12.6	13.1	13.6	14.2	14.7	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2
Пченка	Maize	9	9	6	11	10	11	8	7	8	12	15	12	8																														
		7	7	8	8	7	8	8	7	8	11	10	10																															
		7	7	9	9	8	9	9	8	8	13	12	11		0.680	0.401	-793	11.79	10.00	10.4	10.8	11.2	11.6	12.0	12.4	12.8	13.2	13.6	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Тутун	Tobacco	9	8	8	8	7	8	12	14	125	116	151	131	80																														
		120	121	128	133	113	105	106	106	110	108	122	113																															
		95	94	93	100	100	96	100	100	98	85	94	92		-0.486	-1.408	2936	105.87	90.00	88.6	87.2	85.8	84.4	83.0	81.6	80.1	78.7	77.3	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9
Компир	Potato	12	13	12	18	17	21	14	11	15	29	14	19																															
		11	11	10	11	10	12	11	10	13	14	12	13																															
		15	13	14	12	12	17	14	12	16	18	16	17		0.550	0.344	-675	16.89	15.00	15.3	15.7	16.0	16.4	16.7	17.1	17.4	17.8	18.1	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4
Кромид	Onion	0	0	0	0	0	0	0	0	0	0	0	0																															
		32	25	25	32	35	37	25	33	37	39	38	38																															
		10	11	11	13	19	19	7	16	17	17	18	18		0.563	0.717	-1422	19.44	25.00	25.7	26.4	27.2	27.9	28.6	29.3	30.0	30.7	31.5	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2
Домат	Tomatoes	4	4	18	30	23	19	22	28	30	34	35	33	12																														
		36	36	39	37	39	43	37	46	47	49	49	48																															
		17	17	16	17	18	20	19	23	21	30	29	27		0.883	1.310	-2603	29.75	15.00	16.3	17.6	18.9	20.2	21.5	22.9	24.2	25.5	26.8	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1
Пипер	Pepper	0	0	0	0	0	0	0	0	0	0	0	0	12																														
		0	0	0	0	0	0	0	0	0	0	0	0																															
		0	0	0	0	0	0	0	0	0	0	0	0		#DIV/0!	1.310	-2603	29.75	15.00	16.3	17.6	18.9	20.2	21.5	22.9	24.2	25.5	26.8	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1	28.1
Луцерка	Alfalfa	0	0	0	0	0	0	0	0	0	0	0	0	3.5																														
		0	0	0	0	0	0	0	0	0	0	0	0																															
		0	0	0	0	0	0	0	0	0	0	0	0						5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Цреши	Cherries	18	32	35	44	39	39	10	20	20	25	12	19																															
		72	65	72	84	83	88	88	89	85	97	105	96																															
		30	33	34	52	53	57	59	66	67	68	82	72		0.834	2.674	-5273	102.05	20.00	22.7	25.3	28.0	30.7	33.4	36.0	38.7	41.4	44.1	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7
Заболка	Apples	13	6	10	16	28	7	11	14	15	15	18	16	14																														
		19	21	18	21	22	24	25	22	24	28	28	27																															
		15	18	17	17	18	19	19	21	20	26	28	25		0.879	1.061	-2105	27.32	20.00	21.1	22.1	23.2	24.2	25.3	26.4	27.4	28.5	29.5	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
Крушки	Pears	29	16	24	41	30	30	19	25	12	19	22	18	20																														
		25	27	24	29	30	32	32	30	33	37	41	37																															
		21	24	23	29	29	25	26	28	35	44	51	43		0.832	2.326	-4629	46.73	50.00	52.3	54.7	57.0	59.3	61.6	64.0	66.3	68.6	70.9	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
Сливи	Plums	10	12	10	10	12	11	11	14	10	12	10	11																															
		27	26	26	31	33	35	32	36	34	36	44	38																															
		15	14	19	23	21	22	19	25	23	25	25	24		0.838	0.949	-1880	27.67	15.00	15.9	16.9	17.8	18.8	19.7	20.7	21.6	22.6	23.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
Ореви	Walnuts	40	58	69	70	67	67	164	169	52	56	75	61																															
		78	77	78	83	90	94	98	101	103	111	122	112																															
		39	55	57	51	71	72	63	69	80	82	85	82		0.917	3.936	-7819	93.32	60.00	63.9	67.9	71.8	75.7	79.7	83.6	87.6	91.5	95.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4

Анекс 46. Историски и проектирани приноси на земјоделските култури

Annex 46. Historical and projected yields of agricultural crops

			1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Agri.census(08&09)	Yields, Norm Agri. Institute	Yields,Irr Agri. Institute	Difference Agri. Institute
Пченица	Wheat1	MK	2,961	2,803	2,472	2,130	2,647	2,176	3,522	3,081	3,010	2,402	3,410	2,570	3,000	5,500	2,500
		EU	4,208	4,052	4,215	4,241	4,320	3,863	4,802	4,484	4,303	4,239	4,932				
		NC	3,013	2,739	3,086	2,974	2,968	2,372	3,418	3,151	3,216	2,951	3,963				
Рж	Rye	MK	1,887	1,642	1,412	1,759	1,807	1,365	2,295	2,004	2,193	1,669	2,527	1,619	2,500	4,500	2,000
		EU	2,728	2,758	2,885	2,979	3,067	2,780	3,389	3,113	2,986	3,094	3,369				
		NC	2,063	2,078	1,820	2,281	2,083	1,675	2,401	2,177	2,214	2,260	2,523				
Јачмен	Barley	MK	2,650	2,517	2,213	1,867	2,654	1,789	3,347	2,719	2,821	2,232	3,438	2,578	3,000	5,000	2,000
		EU	3,424	3,383	3,464	3,612	3,682	3,313	4,094	3,716	3,664	3,553	4,013				
		NC	2,531	2,400	2,393	2,770	3,065	2,015	3,072	2,642	2,836	2,562	3,310				
Овес	Oats	MK	1,302	1,182	1,095	1,150	1,526	1,085	1,715	1,553	1,747	1,350	1,854	1,457	1,500	2,700	1,200
		EU	2,832	2,750	2,894	2,897	3,000	2,898	3,271	2,980	2,870	2,780	3,136				
		NC	1,918	1,811	1,723	1,896	1,950	1,598	2,232	1,970	2,065	1,724	2,271				
Пченка	Maize	MK	4,373	4,093	3,382	3,450	4,140	4,060	4,326	4,491	4,649	3,836	4,099	806	5,000	9,000	4,000
		EU	6,027	6,234	5,813	6,190	6,543	5,417	6,790	6,984	6,149	6,151	6,863				
		NC	4,461	5,162	3,847	4,832	5,306	4,536	5,878	6,022	5,809	4,332	5,929				
Тутун	Tobacco	MK	1,268	1,189	973	1,154	1,070	1,127	1,193	1,498	1,436	1,287	1,001	667	1,200	3,000	1,800
		EU	1,865	1,894	1,807	1,868	1,974	1,960	1,925	1,924	1,874	1,851	2,028				
		NC	1,460	1,534	1,360	1,440	1,726	1,429	1,568	1,586	1,542	1,459	1,707				
Компир	Potato	MK	13,383	12,594	12,452	13,308	12,989	12,380	14,214	14,477	14,086	13,109	14,100	4,816	15,000	20,000	5,000
		EU	20,793	21,214	21,758	21,586	22,672	20,997	23,969	23,471	21,796	23,096	24,287				
		NC	12,295	13,223	11,616	13,540	13,661	12,994	16,063	14,905	15,558	15,461	17,117				
Кромид	Onion	MK												1,273	5,500	15,000	9,500
		EU	20,041	19,184	18,785	17,840	18,160	17,115	17,857	16,596	19,913	20,010	19,530				
		NC	5,544	5,448	5,659	4,799	5,045	5,348	6,023	4,802	7,409	7,264	6,803				
Домат	Tomatoes	MK	18,651	19,017	19,866	20,048	17,106	18,281	19,561	20,362	25,237	21,979	22,868	2,364	30,000	60,000	30,000
		EU	99,391	109,904	109,276	107,281	109,672	124,160	128,261	131,330	129,040	132,013	134,271				
		NC	21,551	20,903	20,272	20,895	20,340	22,321	25,570	23,782	24,060	24,636	29,526				
Пипер	Pepper	MK												2,250	20,000	40,000	20,000
		EU															
		NC															
Луцерка	Alfalfa	MK												1,930	12,000	22,000	10,000
		EU															
		NC															
Цреши	Cherries	MK	7,304	3,725	3,042	2,000	2,650	2,318	3,348	3,632	3,872	4,138	4,693	1,648	4,000	10,000	6,000
		EU	7,337	6,451	7,137	5,766	6,042	5,456	6,128	5,344	5,017	4,839	4,371				
		NC	4,031	4,133	4,465	4,356	3,833	4,366	3,660	4,887	5,072	4,212	4,031				
Јаболка	Apples	MK	11,067	8,106	9,469	4,465	7,036	6,882	9,157	9,580	10,647	15,209	11,621	7,436	20,000	50,000	30,000
		EU	16,807	16,800	18,428	15,125	16,920	16,388	18,289	16,961	17,678	17,414	18,313				
		NC	9,767	8,010	9,218	6,952	8,364	8,129	9,442	8,150	8,975	8,482	8,349				
Крушки	Pears	MK	10,538	4,917	6,392	3,250	4,278	4,271	4,100	4,680	4,864	4,575	4,589	4,634	15,000	40,000	25,000
		EU	32,380	25,315	28,519	20,547	21,973	27,486	24,284	22,104	22,064	26,998	20,012				
		NC	10,481	9,820	12,129	9,573	7,818	9,111	8,222	8,858	9,120	8,709	8,737				
Сливи	Plums	MK	7,789	9,363	7,807	4,433	5,298	5,104	5,193	5,051	5,408	5,446	5,471	4,950	10,000	25,000	15,000
		EU	6,924	11,128	13,268	14,646	11,378	14,093	14,549	12,351	13,026	11,850	13,739				
		NC	5,127	5,334	5,542	6,491	4,699	5,166	5,823	4,631	4,963	4,448	4,758				
Ореви	Walnuts	MK	2,018	2,224	2,146	1,099	1,087	1,038	1,148	1,128	1,105	957	973	1,279	3,500	8,000	4,500
		EU	3,484	3,384	3,985	3,646	4,339	5,182	4,925	4,782	4,620	3,620	3,829				
		NC	3,143	3,258	3,423	3,767	3,779	5,162	2,282	4,784	4,699	2,840	3,681				

Анекс 47. ЕКОНОМСКИ модел за Алтернатива 3

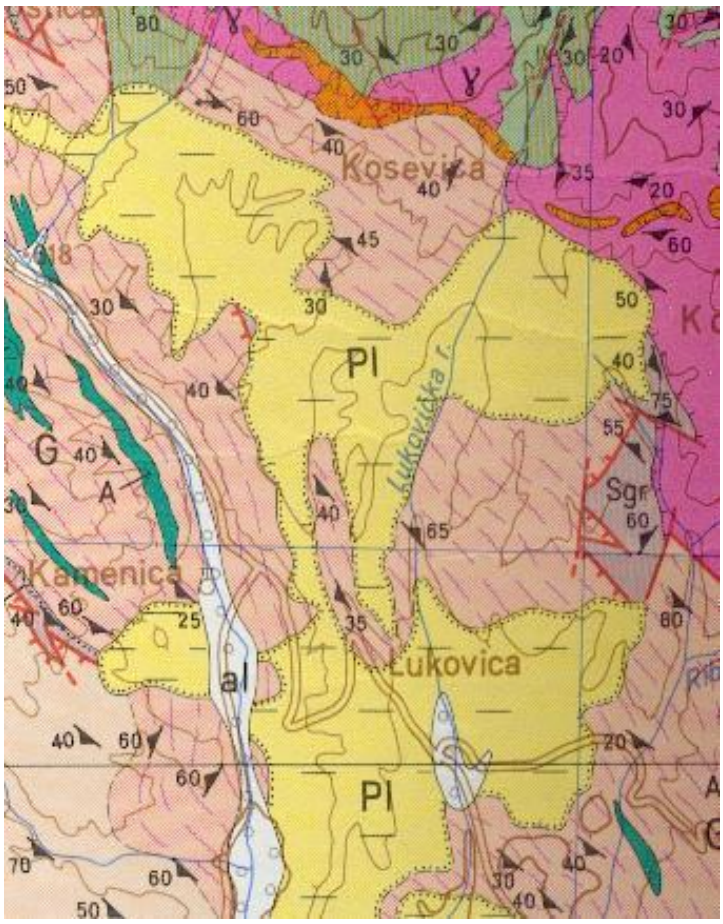
Annex 47. Economical Analysis of Alternative 3

Project Year		CF	1	2	3	4	5	6	7	8	9	10
Calendar Year (indicative)			2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
REVENUES												
Revenues from increased agricurtural production												
Wheat	euro	**1.00**	0	0	22,548	23,133	23,718	24,303	24,889	25,474	26,059	26,644
Barley	euro	**1.00**	0	0	11,165	11,527	11,888	12,250	12,611	12,972	13,334	13,695
Maize	euro	**1.00**	0	0	22,586	23,394	24,201	25,009	25,817	26,625	27,433	28,240
Tobacco	euro	**1.00**	0	0	19,457	19,137	18,818	18,498	18,179	17,860	17,540	17,221
Potato	euro	**1.00**	0	0	40,408	41,275	42,143	43,010	43,878	44,746	45,613	46,481
Other vegetables	euro	**1.00**	0	0	32,504	33,363	34,221	35,079	35,938	36,796	37,655	38,513
Tomatoes	euro	**1.00**	0	0	143,129	153,034	162,939	172,844	182,749	192,654	202,559	212,463
Pepper	euro	**1.00**	0	0	95,420	102,023	108,626	115,229	121,833	128,436	135,039	141,642
Alfalfa	euro	**1.00**	0	0	12,602	12,602	12,602	12,602	12,602	12,602	12,602	12,602
Cherries	euro	**1.00**	0	0	0	0	8,410	18,169	29,275	31,297	33,319	35,341
Apples	euro	**1.00**	0	0	0	0	31,887	66,447	103,680	107,690	111,700	115,711
Pears	euro	**1.00**	0	0	0	0	64,722	134,329	208,823	216,152	223,481	230,809
Plums	euro	**1.00**	0	0	0	0	124,414	260,788	409,123	427,064	445,005	462,946
Walnuts	euro	**1.00**	0	0	0	0	15,062	31,612	49,650	51,882	54,115	56,347
Total form increased Agri. Production			**0**	**0**	**399,818**	**419,487**	**683,651**	**970,170**	**1,279,046**	**1,332,249**	**1,385,452**	**1,438,655**
Other revenues												
Revenues from Energy Production	euro	**0.65**	0	0	22,282	14,151	18,180	17,246	11,822	12,028	16,325	16,921
Residual values (Dams)	euro	**0.88**	0	0	0	0	0	0	0	0	0	0
Residual values (Pumps)	euro	**1.00**	0	0	0	0	0	0	0	0	0	0
Residual values (Irr. System)	euro	**0.94**	0	0	0	0	0	0	0	0	0	0
Emissions saved due to the generation of electricity w	euro	**1.00**	0	0	1,592	3,189	3,977	2,612	3,468	3,396	2,401	2,517
Total Other revenues			**0**	**0**	**23,874**	**17,339**	**22,156**	**19,858**	**15,290**	**15,424**	**18,726**	**19,438**
TOTAL REVENUES			**0**	**0**	**423,692**	**436,827**	**705,807**	**990,028**	**1,294,336**	**1,347,673**	**1,404,178**	**1,458,093**
PROJECT COSTS												
Costs of increased agricurtural production												
Material costs	euro	**1.00**	0	0	3,583	3,672	3,764	3,858	3,955	4,053	4,155	4,259
Labour costs	euro	**0.75**	0	0	39,969	40,968	41,992	43,042	44,118	45,221	46,351	47,510
Indirect costs	euro	**1.00**	0	0	85,187	87,316	89,499	91,737	94,030	96,381	98,791	101,260
Total Costs of increased agricurtural production			**0**	**0**	**128,738**	**131,957**	**135,255**	**138,637**	**142,103**	**145,655**	**149,297**	**153,029**
Costs for water supplying												
Costs of water supplying of the population	euro	**1.00**	0	0	13,477	13,868	14,270	14,685	15,111	15,550	16,002	16,467
Costs of water supplying for irrigation	euro	**1.00**	0	0	64,195	56,144	71,148	80,154	73,699	92,043	91,144	76,574
Total Costs for water supplying			**0**	**0**	**77,671**	**70,012**	**85,419**	**94,838**	**88,810**	**107,593**	**107,145**	**93,041**
Investment costs												
Land Expropriation	euro	**1.20**	225,000	0	0	0	0	0	0	0	0	0
Dam cosntruction												
Civil works	euro	**0.86**	854,834	854,834	0	0	0	0	0	0	0	0
Equipment	euro	**1.00**	30,922	30,922	0	0	0	0	0	0	0	0
Small Hydro Power Plant (150kW)	euro	**1.00**	0	90,000	0	0	0	0	0	0	0	0
Small Pump Station & Intake Structure	euro	**1.00**	0	40,000	0	0	0	0	0	0	0	0
Pump Station												
Civil works	euro		0	0	0	0	0	0	0	0	0	0
Piping	euro		0	0	0	0	0	0	0	0	0	0
Objects & Equipment	euro		0	0	0	0	0	0	0	0	0	0
Irrigational System												
Civil works	euro	**0.93**	150,096	150,096	0	0	0	0	0	0	0	0
Piping	euro	**0.93**	293,102	293,102	0	0	0	0	0	0	0	0
Objects & Pipe Structures	euro	**0.93**	95,906	95,906	0	0	0	0	0	0	0	0
Irrigation Equipment		**1.00**	0	227,901	0	0	0	0	0	0	0	0
Working Capital Requirements	euro	**1.00**	0	0	11,675	0	0	0	0	0	0	0
Total Investment Costs			**1,649,860**	**1,782,761**	**11,675**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
O&M costs												
Salaries and allowances of O&M costs	euro	**0.75**	45,900	45,900	46,818	47,736	48,654	49,572	50,490	51,408	52,326	53,244
Maintance Costs												
Dams Annual Maintance costs (0.5%)	euro	**0.88**	9,608	9,608	9,608	9,608	9,608	9,608	9,608	9,608	9,608	9,608
SHPP Annual Maintance Costs (0.5%)	euro	**0.95**	428	428	428	428	428	428	428	428	428	428
Irr. Sysrem Annual Maintance costs (1%)	euro	**0.94**	10,936	10,936	10,936	10,936	10,936	10,936	10,936	10,936	10,936	10,936
Equipment Annual Maintance costs (6%)	euro	**0.93**	12,648	12,648	12,648	12,648	12,648	12,648	12,648	12,648	12,648	12,648
Pump Station Annual Maintance costs (3%)	euro	**0.93**	0	0	0	0	0	0	0	0	0	0
Running Costs												
Energy Consumption for Pumping	euro	**0.96**	5,837	6,899	6,684	5,649	6,900	7,414	6,993	9,107	9,371	8,162
Total O&M costs			**85,357**	**86,419**	**87,122**	**87,005**	**89,174**	**90,606**	**91,103**	**94,135**	**95,317**	**95,026**
Replacement costs												
Dam Equipment	euro	**1.00**	0	0	0	0	0	0	0	0	0	0
SHPP Equipment	euro	**1.00**	0	0	0	0	0	0	0	0	0	0
Pump Station Equipment	euro	**1.00**	0	0	0	0	0	0	0	0	0	0
Irr. System Object & Structures	euro	**1.00**	0	0	0	0	0	0	0	0	0	0
Irr. Equipment	euro	**1.00**	0	0	0	0	0	0	0	0	0	0
Other equipment	euro	**1.00**	0	0	0	0	0	0	0	0	0	0
Total replacement costs			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other costs												
Institutional setup and mngt.	euro	**1.00**	30,000	20,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Awareness raising campaign	euro	**1.00**	30,000	20,000	10,000	10,000	10,000	10,000	0	0	0	0
Insurance (0.5%)	euro	**1.00**	0	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746
Taxes and Other	euro	**1.00**	0	0	0	0	0	0	0	0	0	0
Total other costs			**60,000**	**42,746**	**22,746**	**22,746**	**22,746**	**22,746**	**12,746**	**12,746**	**12,746**	**12,746**
Total Project Costs			**1,795,218**	**1,911,926**	**327,952**	**311,719**	**332,594**	**346,827**	**334,762**	**360,129**	**364,505**	**353,842**
Net Benefits			**-1,795,218**	**-1,911,926**	**95,741**	**125,108**	**373,213**	**643,202**	**959,574**	**987,544**	**1,039,673**	**1,104,251**
Cummulative Net Benefits			**-1,795,218**	**-3,707,143**	**-3,611,403**	**-3,486,294**	**-3,113,081**	**-2,469,879**	**-1,510,305**	**-522,761**	**516,912**	**1,621,163**

Discount Rate	**5.0%**
ENPV	**7,349,667 €**
EIRR	**16.58%**

11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
26,644	26,644	26,644	26,644	26,644	26,644	26,644	26,644	26,644	26,644	26,644	26,644	26,644	26,644	26,644
13,695	13,695	13,695	13,695	13,695	13,695	13,695	13,695	13,695	13,695	13,695	13,695	13,695	13,695	13,695
28,240	28,240	28,240	28,240	28,240	28,240	28,240	28,240	28,240	28,240	28,240	28,240	28,240	28,240	28,240
17,221	17,221	17,221	17,221	17,221	17,221	17,221	17,221	17,221	17,221	17,221	17,221	17,221	17,221	17,221
46,481	46,481	46,481	46,481	46,481	46,481	46,481	46,481	46,481	46,481	46,481	46,481	46,481	46,481	46,481
38,513	38,513	38,513	38,513	38,513	38,513	38,513	38,513	38,513	38,513	38,513	38,513	38,513	38,513	38,513
212,463	212,463	212,463	212,463	212,463	212,463	212,463	212,463	212,463	212,463	212,463	212,463	212,463	212,463	212,463
141,642	141,642	141,642	141,642	141,642	141,642	141,642	141,642	141,642	141,642	141,642	141,642	141,642	141,642	141,642
12,602	12,602	12,602	12,602	12,602	12,602	12,602	12,602	12,602	12,602	12,602	12,602	12,602	12,602	12,602
35,341	35,341	35,341	35,341	35,341	35,341	35,341	35,341	35,341	35,341	35,341	35,341	35,341	35,341	35,341
115,711	115,711	115,711	115,711	115,711	115,711	115,711	115,711	115,711	115,711	115,711	115,711	115,711	115,711	115,711
230,809	230,809	230,809	230,809	230,809	230,809	230,809	230,809	230,809	230,809	230,809	230,809	230,809	230,809	230,809
462,946	462,946	462,946	462,946	462,946	462,946	462,946	462,946	462,946	462,946	462,946	462,946	462,946	462,946	462,946
56,347	56,347	56,347	56,347	56,347	56,347	56,347	56,347	56,347	56,347	56,347	56,347	56,347	56,347	56,347
1,438,655	**1,438,655**	**1,438,655**	**1,438,655**	**1,438,655**	**1,438,655**	**1,438,655**	**1,438,655**	**1,438,655**	**1,438,655**	**1,438,655**	**1,438,655**	**1,438,655**	**1,438,655**	**1,438,655**
13,837	15,974	16,160	16,999	9,958	22,979	11,855	9,519	13,276	16,056	15,101	11,316	11,928	14,088	11,139
0	0	0	0	0	0	0	0	0	0	1,356	1,356	0	0	1,717,189
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	10,691	0	0	0	4,864	4,864	0	0	273,406
3,516	3,749	3,151	3,735	3,878	4,184	2,512	5,939	3,137	2,577	3,677	4,446	4,182	3,134	3,303
17,353	**19,722**	**19,310**	**20,735**	**13,836**	**27,163**	**25,058**	**15,458**	**16,413**	**18,634**	**24,997**	**21,982**	**16,110**	**17,222**	**2,005,037**
1,456,009	**1,458,378**	**1,457,966**	**1,459,390**	**1,452,492**	**1,465,819**	**1,463,714**	**1,454,113**	**1,455,069**	**1,457,289**	**1,463,653**	**1,460,637**	**1,454,766**	**1,455,878**	**3,443,693**
4,365	4,474	4,586	4,701	4,818	4,939	5,062	5,189	5,318	5,451	5,588	5,727	5,871	6,017	6,168
48,698	49,915	51,163	52,442	53,753	55,097	56,475	57,887	59,334	60,817	62,338	63,896	65,493	67,131	68,809
103,792	106,387	109,046	111,772	114,567	117,431	120,367	123,376	126,460	129,622	132,862	136,184	139,588	143,078	146,655
156,855	**160,776**	**164,796**	**168,916**	**173,138**	**177,467**	**181,904**	**186,451**	**191,112**	**195,890**	**200,788**	**205,807**	**210,952**	**216,226**	**221,632**
16,945	17,438	17,944	18,466	19,003	19,555	20,124	20,304	20,485	20,667	20,852	21,038	21,226	21,415	21,607
95,426	64,616	65,926	77,532	66,466	36,042	97,314	84,316	73,628	90,004	74,295	105,549	69,980	126,915	97,580
112,371	**82,053**	**83,870**	**95,998**	**85,469**	**55,597**	**117,438**	**104,619**	**94,113**	**110,671**	**95,147**	**126,587**	**91,205**	**148,330**	**119,187**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
54,162	55,080	55,998	56,916	57,834	58,752	59,670	60,588	61,506	62,424	63,342	64,260	65,178	66,096	67,014
9,608	9,608	9,608	9,608	9,608	9,608	9,608	9,608	9,608	9,608	9,608	9,608	9,608	9,608	9,608
428	428	428	428	428	428	428	428	428	428	428	428	428	428	428
10,936	10,936	10,936	10,936	10,936	10,936	10,936	10,936	10,936	10,936	10,936	10,936	10,936	10,936	10,936
12,648	12,648	12,648	12,648	12,648	12,648	12,648	12,648	12,648	12,648	12,648	12,648	12,648	12,648	12,648
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10,478	7,293	7,651	9,110	7,678	4,095	10,869	9,445	8,271	10,142	8,395	11,962	7,955	14,467	11,157
98,260	**95,993**	**97,269**	**99,646**	**99,132**	**96,467**	**104,159**	**103,653**	**103,397**	**106,186**	**105,357**	**109,842**	**106,753**	**114,183**	**111,791**
0	0	0	0	0	0	0	0	0	0	30,922	30,922	0	0	0
0	0	0	0	0	0	0	0	0	0	0	36,000	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	103,682	103,682	0	0	0
0	0	0	0	0	0	227,901	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	**0**	**0**	**0**	**0**	**0**	**227,901**	**0**	**0**	**0**	**134,604**	**170,604**	**0**	**0**	**0**
10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746	2,746
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12,746	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**	**12,746**
380,231	**351,567**	**358,681**	**377,305**	**370,485**	**342,276**	**644,147**	**407,468**	**401,368**	**425,493**	**548,641**	**625,586**	**421,656**	**491,486**	**465,355**
1,075,778	**1,106,810**	**1,099,285**	**1,082,085**	**1,082,007**	**1,123,542**	**819,567**	**1,046,645**	**1,053,701**	**1,031,796**	**915,012**	**835,051**	**1,033,110**	**964,392**	**2,978,337**
2,696,941	**3,803,751**	**4,903,037**	**5,985,121**	**7,067,128**	**8,190,671**	**9,010,237**	**10,056,882**	**11,110,583**	**12,142,379**	**13,057,391**	**13,892,442**	**14,925,552**	**15,889,944**	**18,868,281**

ПРЕГЛЕДНА ГЕОЛОШКА КАРТА
OVERVIEW GEOLOGICAL MAP
M=1:100000



Легенда/Legend:





Анекс 48/ Annex 48
Прегледна геолошка карта/Overview geological map
M=1:100000

EXCAVATION CONDITIONS

To define excavation conditions, it was made categorization of the terrain according to the construction norms CN 200.

According to CN 200 following categories are present:

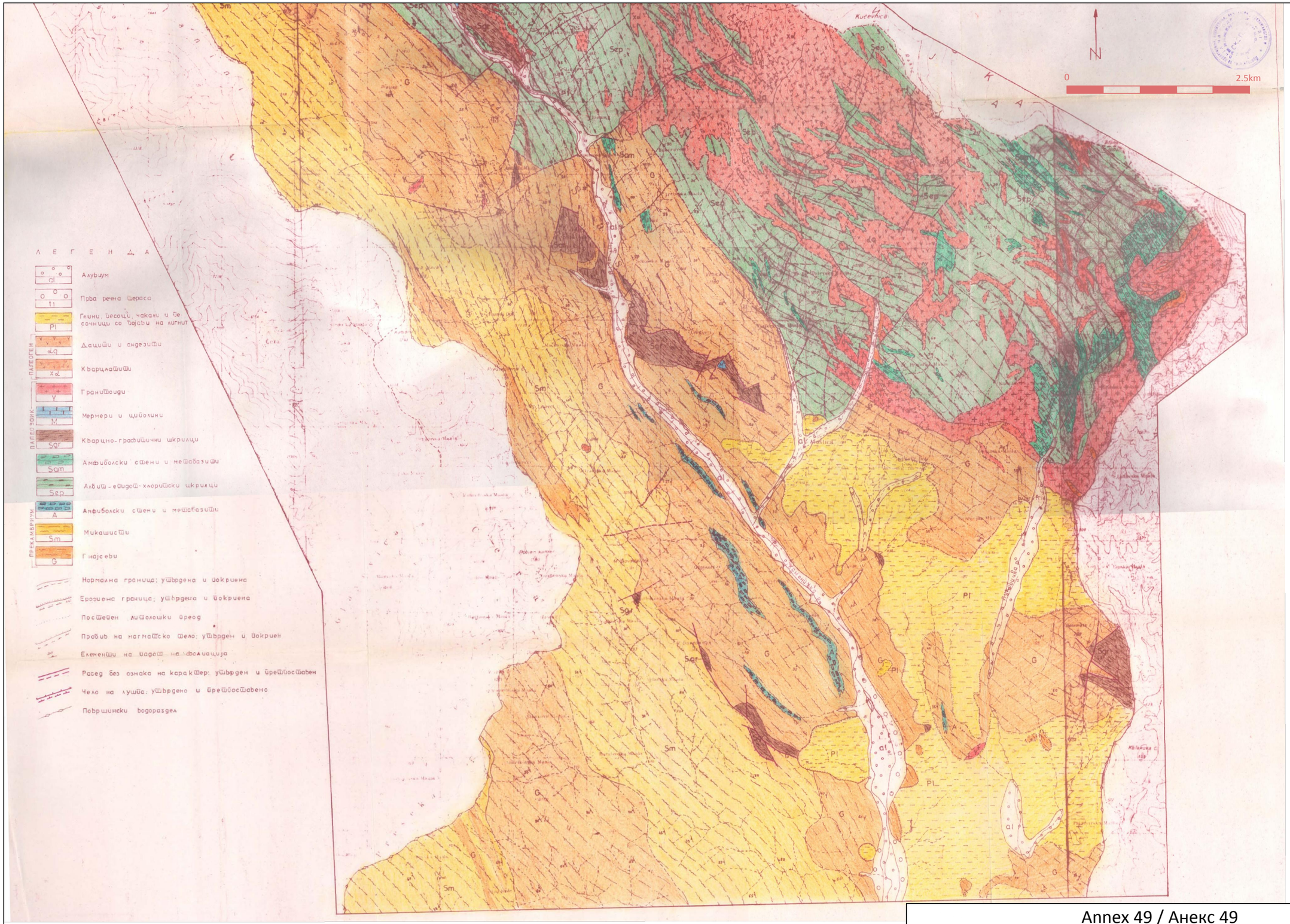
- **IV** category for pliocen (clay, sand, gravel) and quarternary proluvial and alluvial sediments (excavation by digging, because of the presence of blocks and boulders through the proluvial- alluvial sediments it is expected difficult excavation);
- **V** category for porphuroid granular gneisses (G), albite epidote chlorite schists, amphibole rocks and meta basic (Sam) (rippering and easy mining with locally blasting)
- **VI** category for granitoid (hard rippering and mining with locally blasting)

In accordance with this analysis it is estimate that surface zones built from deluvial, proluvial and alluvial sediments can be excavated with mechanization).

In case of dipper penetrating in the gneisses (G), albite epidote chlorite schists (Sep), amphibole rocks and meta basic can be applied with hard rippering, controlled mining with locally blasting of the mass, mining and finishing with pichammer.

General it is estimated that in case of penetrating in the base rock (without deluvial cover) in granitoids and gneisses 70% is by mining and 30% is by rippring with stronger bulldozers (D8, 9 or D10C).

ANNEX 48.1
EXCAVATION CONDITIONS

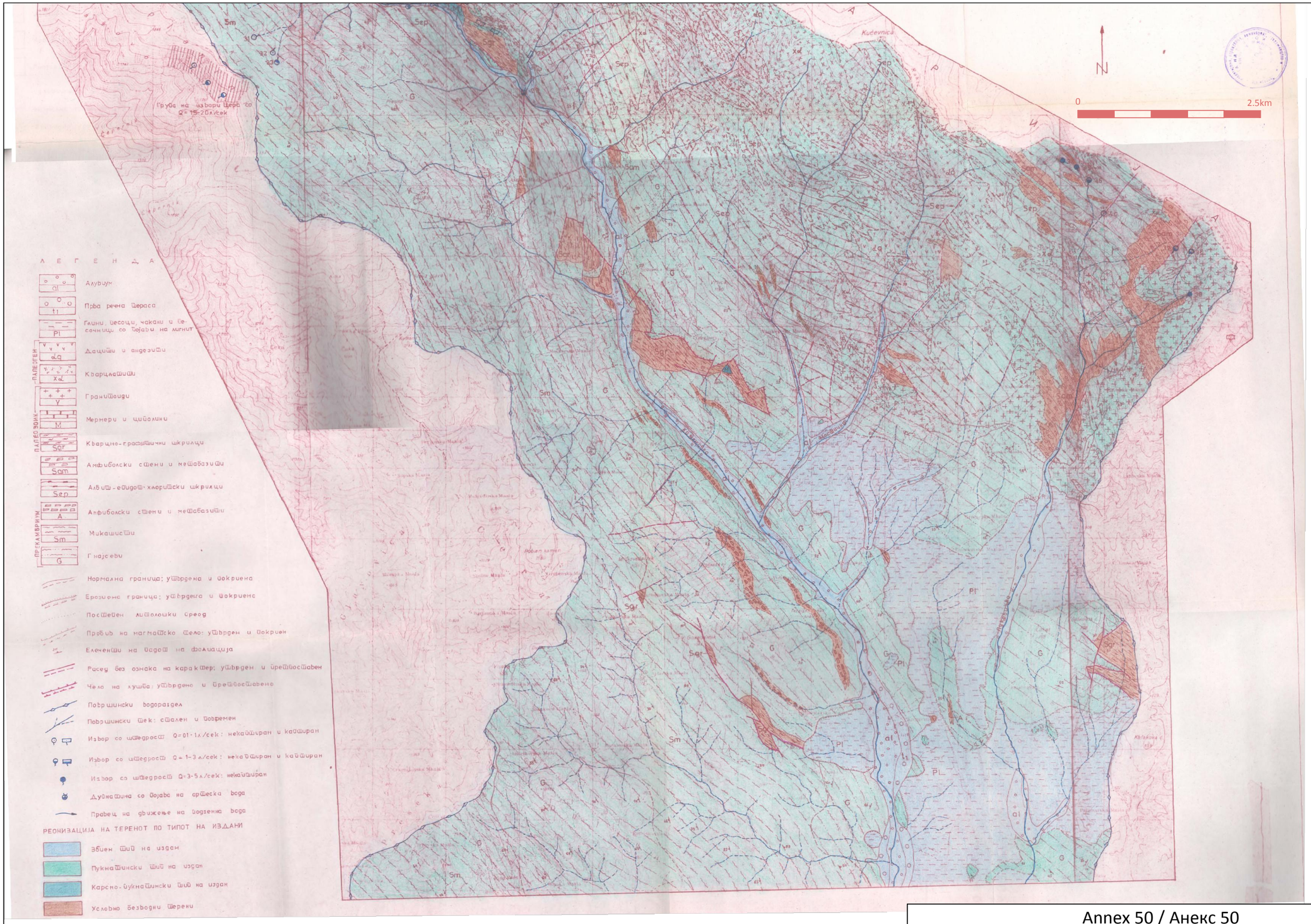


Annex 49 / Анекс 49

GEOLOGICAL MAP OF KAMENICKA AND LUKOVICKA WATERSHED

ГЕОЛОШКА КАРТА НА СЛИВНОТО ПОДРАЧЈЕ НА КАМЕНИЧКА И ЛУКОВИЧКА РЕКА

M=1:50000



Annex 50 / Анекс 50

HYDROGEOLOGICAL MAP OF KAMENICKA AND LUKOVICKA WATERSHED

ХИДРОГЕОЛОШКА КАРТА НА СЛИВНОТО ПОДРАЧЈЕ НА КАМЕНИЧКА И ЛУКОВИЧКА РЕКА

M=1:50000

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