# **REPUBLIC OF MACEDONIA**

# PUBLIC ENTERPRICE FOR STATE ROADS



# Environmental Impact Assessment Report for Reconstruction and Rehabilitation of the Local Road Network Project in Republic of Macedonia (VII tender) (Final draft)

Skopje, August 2014

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The subject of the Environment Impact Assessment Report is the reconstruction and rehabilitation of the following local roads (VIII) of the eight mountain regions in the Republic of Macedonia.

1. Municipality of Sv. Nikole (R-105 - v. Amzibegovo - v.Crnilishte, section 1), L=2,41 km

- 2. Municipality of Bosilovo (v. Bosilovo v. Radovo) L=2,53 km (I section 0,90 km)
- 3. Municipality of Shtip (M-6 v. Puhce), L=3,83 km (I section 1,53 km)

4. Municipality of Veles (for v. Otovica), L=0,82 km

5. Municipality of Centar Zhupa (for v.Gorenci), L=0,50 km

6. Municipality of Centar Zhupa (local roads through Centar Zhupa), L=1,51 km

7. Municipality of Krivogashtani (P-512-v.Korenica-v.Godivje) L=1,82 km (II section - 1,05 km)

8. Municipality of Delchevo (v.Trstija-v.Turija), L=2,00 km (I section - 0,8 km)

9. Municipality of Ohrid (for v.Velestovo), L=4,09 km (I section - 1,5 km)

10. Municipality of Prilep (Prilep-Markova Cheshma), L=1,42 km

11. Municipality of Kisela Voda (Mishko Mlhajlovski, Marko Cepenkov and ul.345), L=0,40 km

12. Municipality of Radovish (for v.Smilanci, II section), L=3,70 km (I section - 0,9 km)

13. <u>Municipality of Gjorche Petrov</u> (ul. 51 - v.Svilare and interchange III – v. Novo Selo – railway crossing), L=0,67 km

<u>14. Municipality of Kumanovo</u> (v.Dobroshane – v.Shupli Kamen), L=4,79 km (I section - 0,74 km)

<u>15. Municipality of Krushevo</u> (Krivogashtani – v.Buchin) (IV section – 1,94 km)

16. Municipality of Kriva Palanka (for v.Konopnica ), L=1,64 km (I section - 0,33 km)

17. Municipality of Mavrovo and Rostusha (P1202–v.Skudrinje), L=3,59 km

- 18. Municipality of Debar (Debar-v. Bomovo), L=3,52 km (III section 1,21 km)
- 19. Municipality of Chucher-Sandevo (Star Kachanichki Pat), L=2,66 km (I section 2,26 km)

20. Municipality of Jegunovce (P29274–v.Ratae), L=1,46 km

21. Municipality of Plasnica (P513 (v.Izhishte)-v.Preglovo), L=1,66 km (III section - 0,75 km)

22. Municipality of Valandovo (for v.Pirava), L=0,40 km

23. Municipality of Sopishte (v.Dolno Sonje–v.Gorno Sonje), L=1,04 km

24. Municipality of Kochani (P-519–v.Leshki), L=1,07 km (I section – 0,40 km)

25. Municipality of Resen (P1308–v.Krani), L=1,17 km

26. Municipality of Resen (v.Grnchari–Monastery Sv. Ilija), L=2,02 km

27. Municipality of Berovo (Berovo-Milina Crkva-v.Smojmirovo) L=1,12 km (Isection - 0,60 km)

28. Municipality of Bogovinje (Bogovinje – v.Selce Kech), L=1,29 km (I section – 0,82 km)

29. Municipality of Vrapchishte (for v.Dobridol), L=0,93 km

30. Municipality of Tearce (for v.Slatino), L=0,73 km

31. Municipality of Struga (v.Dolna Belica-v.Oktisi), L=2,59 km

32. Municipality of Brvenica (v.Dolno Sedlarce–Brvenica), L=1,90 km (II section – 0,90 km)

<u>33. Municipality of Brvenica</u> (from connection with R-404–entrance to v. Chelopek), L=1,87 km (I section – 0,61 km)

34. Municipality of Gostivar (v.Dolna Gjonovica-v.Srbinovo), L=4,06 km

35. Municipality of Gostivar (v.Cerovo–v.Simnica), L=3,08 km (I section – 1,12 km)

36. Municipality of Bitola (v. Gorno Orizari–v.Krklino), L=3,05 km (I section – 1,47 km)

37. Municipality of Bitola (v.Kazhani–v.Gjavato), L=2,72 km

38. Municipality of Kichevo (for v. Zhubrino with legs 1 and 2), L=1,02 km

<u>39. Municipality of Kichevo</u> (v.Oslomej-v.Shutovo), L=3,56 km (I section – 1,00 km)

40. Municipality of Sarai (R-402-v.Ljubin), L=1,67 km

<u>41. Municipality of Gazi Baba</u> (Singelik-Rashtak) (II section – 1,23 km)

42. Municipality of Karbinci (v.Radanje-v.Odzalija), L=2,45 km (II section – 0,70 km

43. Municipality of Prilep (v.Lenishte-Monastery Sv. Petka), L=0,88 km

<u>44. Municipality of Lozovo</u> (Lozovo -v.Milino), L=0,80 km

45. Municipality of Aerodrom, (Gorno Lisiche), L=1.66 km,

46. Municipality of Aerodrom, (str.Todor Changov), L=1.63 km,

Environmental Impact Assessment Report for the Reconstruction and Rehabilitation of the Local Road Network Project in Republic of Macedonia (VII tender)

# 1. General data

Name of the legal of natural entity	Public Enterprise for State Roads (PESR)	
carrying out specific activities		
Legal status	The PESR has been established in 2013 with the Law	
	on State Roads as the legal successor of the Agency	
	for State Roads	
Ownership	The PESR is in the ownership of the Macedonian	
	Government	
Seat of the legal entity (registered in	ul. Dame Gruev br.14, 1000 Skopje	
the central register)		
Location of the activities	46 roads	
Unique number of the legal entity	6839673	
Code of the primary activity according	64.99	
to National Classification of Activities		
Category of the activity which is subject	XI- Infrastructure designs	
to the requirement according to the		
regulations from Article 24, Par. 4 and	15. Reconstruction of highways and national roads	
5 from the Environmental Law.	Regulation for change of the regulation for activities	
	requiring development of reports, approved by the	
	expert agency in environmental affairs (Official	
	Gazette of the RM, No. 36/2012)	
Number of employees at the site of the	1	
required activitity		
Number of employees in the legal or		
natural entity conducting the given	325	
activity		
Poject capacity	All local roads in 8 planning regions in the RM with a	
	total length of around 86 km	
Name and surname of the contact	Sashka Bogdanova Ajceva	
person for approval of the report and its	Environmental Advisor	
function		
Contact number	02 3118044, ext.135, fax 02/ 3 220 535	

# 2. Type of report

New activity	
Existing activity	$\checkmark$
Extension of the existing activity	

# 3. Agency authorized for approval of the environmental impact assessment report

Name of agency	Ministry of Environment and Physical Planning Environmental Directorate
Address	Bul. Goce Delchev br. 8 zgrada na MRTV, 10 kat 1000 Скопје
Telephone	+ 389 23251-400

# 4. Description of the project

Vardar region:

- 1. Municipality of Lozovo (Lozovo v. Milino), L=0,80 km (asphalted, with broken pavement)
- 2. Municipality of Veles (for v. Otovica), L=0,82 km (dirt road with width of around 3,5-4 m)
- 3. Municipality of Sv. Nikole (R-105 v. Amzibegovo v. Crnilishte, section 1), L=2,41km (asphalt road which turns into a dirt road of around 3 m width in some sections)

Pelagonija region:

- Municipality of Prilep (v. Lenishte Monastery Sv. Petka), L=0,88 km (blanket course of 3,5 – 4 m in width)
- 2. Municipality of Bitola (v. Kazhani v. Gjavato), L=2,72 km
- 3. Municipality of Bitola (v.Gorno Orizari v. Krklino), L=3,05 km (I section 1,47 km)
- 4. Municipality of Resen (R1308 v. Krani ), L=1,17 km (asphalt pavement with visible surface damage and deformations)
- 5. Municipality of Resen (v. Grnchari Monastery Sv. Ilija ), L=2,02 km (dirt road with around 3 m width)
- 6. Municipality of Krushevo (Krivogashtani v. Buchin) (IV section 1,94 km) (asphalt road with around 3 m width)
- 7. Municipality of Prilep (Prilep Markova Cheshma), L=1,42 km (dirt road and in some stretches with larger deformations and surface water)
- Municipality of Krivogashtani (R-512– v. Korenica v. Godivje) L=1,82 km (II section -1,05 km) (asphalt pavement of around 3 meter width)

East region:

- 1. Municipality of Karbinci (v. Radanje v.Odzalija), L=2,45 km (II section 0,70 km) (with completed earth works and partial blanket course)
- Municipality of Berovo (Berovo Milina Crkva v. Smojmirovo) L=1,12 km (I section 0,60 km) (dirt road with around 3 - 5 m width)
- 3. Municipality of Kochani (R-519 v.Leshki), L=1,07 km (I section 0,40 km) (dirt road)
- Municipality of Delchevo (v.Trstija v.Turija), L=2,00 km (I section 0,8 km) (dirt road with around 3 - 3,5 m)
- 5. Municipality of Shtip (M-6 v.Puhche), L=3,83 км (I section 1,53 km) (dirt road with around 3 4 m width)

Skopje region:

1. Municipality of Saraj (R-402 – v. Ljubin), L=1,67 km (broken asphalt with 3 - 3,5 m width, continuing into a dirt road with 4-meter width)

- 2. Municipality of Gazi Baba (Singelic Rashtak ) (II section 1,23 km) (asphalt road with 5, 5 m width, very degraded and damaged)
- Municipality of Sopishte (v. Dolno Sonje v. Gorno Sonje), L=1,04 km (dirt road of 3-5 m width)
- 4. Municipality of Chucher Sandevo (Star kachanichki pat), L=2,66 km (I section 2,26 km) (dirt road with roadbed width of 8 m)
- 5. Municipality of Gjorche Petrov (ul. 51 v. Svilare and interchange III v. Novo Selo railway crossing), L=0,67 km (asphalt road of 4, 5 6 m width)
- 6. Municipality of Kisela Voda, reconstruction of pavement and sidewalks on the Mishko Mihajlovski street and street 345 (the asphalt pavement is with "spiderweb" cracks)
- 7. Municipality of Aerodrom,– (Gorno Lisiche road) , L=1.66 km, existing road damages with damages and deformations 6 m wide
- 8. Municipality of Aerodrom, (Todor Changov street), L=1.63 km, existing street with damages and deformations with width of about 4-7 m

Southwest region:

- 1. Municipality of Kichevo (for the v. Zhubrino with legs 1 and 2), L=1,02 km (dirt road with undefined width of 3, 5 7 m)
- Municipality of Kichevo (v. Oslomej v. Shutovo), L=3,56 km (I section 1,00 km) (dirt road with width of 3, 5 - 4 m)
- 3. Municipality of Struga (v. Dolna Belica v. Oktisi), L=2,59 km (asphalt pavement with undefined width of 4-5 m visible surface damage and deformations)
- Municipality of Plasnica (R513 (v.lzhishte) v. Preglovo), L=1,66km (III section 0,75 km) (asphalt pavement structure)
- 5. Municipality of Ohrid (for v. Velestovo), L=4,09 km (I section 1,5 km) (asphalt road with width of around 3,5 m)
- Municipality of Debar (Debar v. Bomovo) L=3,52km (III section 1,21km) (dirt road with wdth of 3 m)
- 7. Municipality of Centar Zhupa (for the v. Gorenci), L=0,50 km (asphalt road with width of around 3 m)
- 8. Municipality of Centar Zhupa (local roads through Centar Zhupa), L=1,51km (existing streets (1,2,3,4 and 5) are dirt roads μ with width of around 3,5 m)

Southeast region:

- 1. Municipality of Valandovo (for v. Pirava), L=0,40 km (unasphalted road with variable width)
- Municipality of Radovish (for the v. Smilanci, II section), L=3,70 km (I section 0,9 km) (dirt road with width of 3, 5 - 4 m)
- Municipality of Bosilovo (v. Bosilovo v. Radovo) L=2,53 km (I section 0,90 km) (dirt road with width of around 3 – 4 m; in some sections of the road the dirt road is deformed)

Northeast region:

- 1. Municipality of Kriva Palanka (for v. Konopnica), L=1,64 km (I section 0,33km) (dirt road with width of around 3, 5 4 m)
- Municipality of Kumanovo (v. Dobroshane v. Shupli Kamen), L=4,79 km (I section -0,74 km) (asphalt)

Polog region:

- Municipality of Brvenica (v. Dolno Sedlarce Brvenica), L=1,90 km (II section 0,90 km) (asphalt road with width of around 3,5 m)
- Municipality of Brvenica (from the connection wirh R-404 entrance to v. Chelopek), L=1,87 km (I section – 0,61 km) (asphalt pavement with visible surface damage and deformations with undefined width)
- 3. Municipality of Gostivar (v. Dolna Gjonovica v. Srbinovo), L=4,06 km (dirt road with around 4 m)
- 4. Municipality of Gostivar (v. Cerovo v. Simnica), L=3,08 km (I section 1,12 km) (dirt road with width of around 4 m)
- Municipality of Bogovinje (Bogovinje v. Selce Kech), L=1,29 km (I section 0,82 km) (asphalted between houses and walls)
- 6. Municipality of Vrapchishte (for v. Dobridol ), L=0,93 km (leg 1 asphalted width of 4 m, leg 2 dirt width of 3,5 m)
- 7. Municipality of Tearce (for v. Slatino), L=0,73 km (asphalted road with around 3 m width)
- 8. Municipality of Jegunovce (R29274 v.Ratae), L=1,46 km (asphalted road with around 4 m width)
- 9. Municipality of Mavrovo and Rostusha (R1202 v.Skudrinje), L=3,59 km (asphalted)

# 4.1. Location description

The reconstruction and rehabilitation of the local roads included with this environment impact assessment report will be carried out on the territory of the Republic of Macedonia in all of the eight planning regions.

What follows is an overview of each of the planning regions for implementation of the project as well as general information on the location of the local road sections.

# Skopje region

This region encompasses the Skopje valley with an area of 1,812 km<sup>2</sup> or 7.3% of the total area of Macedonia. The Skopje region consists of the following 17 (seventeen) municipalities: municipality of Aerodrom, Butel, Gazi Baba, Gjorche Petrov, Karposh, Kisela Voda, Saraj, Chair, Centar, Shuto Orizari, Sopishte, Studenichani, Zelenikovo, Petrovec, Arachinovo, Ilinden and Chucher Sandevo.

#### East region

This region encompasses the catchment area of the Bregalnica river with an area of 3,537 km<sup>2</sup> or 14.2% of the total area of Macedonia. The east region consists of the following 11 (eleven) municipalities: municipality of Shtip, Karbinci, Zrnovci, Cheshinovo – Obleshevo, Probishtip, Kochani, Makedonska Kamenica, Delchevo, Pehcevo, Vinica and Berovo.

#### Southeast region

This region encompasses the Strumica-Radovish and Gevgelija-Valandovo valleys, i.e. the catchment area of the Strumica river and the lower catchment area of the Vardar river with an area of 2,739 km<sup>2</sup> or 11% of the total area of Macedonia. The southeast region consists of the following 10 (ten) municipalities: municipality of Gevgelija, Bogdanci, Valandovo, Dojran, Novo Selo, Bosilovo, Vasilevo, Konche, Radovish and Strumica.

#### Northeast region

This region encompasses the catchment areas of the rivers Pcinja and Kriva reka with an area of 2,310 km<sup>2</sup> or 9.3% of the total area of Macedonia. The northeast region consists of the following 6 (six) municipalities: Lipkovo, Kumanovo, Staro Nagorichane, Rankovce, Kratovo and Kriva Palanka.

# Pelagonija region

This region encompasses the Pelagonija and Prespa valleys with an area of 4,717 km<sup>2</sup> or 18.9% of the total area of Macedonia. The Pelagonija region comprises of the following 9 (nine) municipalities: Resen, Bitola, Novaci, Mogila, Demir Hisar, Krivogashtani, Prilep, Dolneni and Krushevo.

#### Vardar region

This region encompasses the central part of Macedonia and the central catchment area of the Vardar river, the lower river flows of Vardar's tributaries Bregalnica and Crna Reka and the uppermost western part of Ovche Pole with an area of 4,042 km<sup>2</sup> or 16.2% of the total area of Macedonia. The Vardar region comprises of the following 9 (nine) municipalities: Sveti Nikole, Veles, Lozovo, Chashka, Gradsko, Rosoman, Negotino, Demir Kapija and Kavadarci.

#### Southwest region

This region encompasses the basin of the Ohrid lake and the catchment area of the Treska river with an area of 3,340 km<sup>2</sup> or 13.4% of the total area of Macedonia. The southwestern region comprises of the following 13 (thirteen) municipalities: Ohrid, Debarca, Struga,

Vevchani, Drugovo, Centar Zhupa, Kichevo, Oslomej, Zajas, Makedonski Brod, Vraneshtica, Debar and Plasnica.

# Polog region

This region encompasses the Polog valley, Mavrovo plateau, the mountain massif of Bistra and the Radika river valley with total area of the region of 2.416 km2 or 9.7% of the total area of Macedonia. The Polog region consists of the following 9 (nine) municipalities: Mavrovo and Rostusha, Gostivar, Brvenica, Vrapchishte, Zhelino, Bogovinje, Tetovo, Tearce and Jegunovce.

# 4.2. Technical – technological description of the activity

According to the project documentation, the following construction work will be carried out as a part of the activities for rehabilitation of the given roads:

The preparation work will consist of:

- Setup of the machinery required for rehabilitation of the road in the corresponding location;
- Clearing of the location from bushes and roots and
- Excavation of the topsoil

Activities on the road body that include:

- Excavation of soil;
- partial rock excavation (explosive blasting);
- soil improvement;
- construction of embankments;
- construction of substructure;
- construction of an inclination of the road with the superstructure;
- excavation of canals; and
- excavation of drainage canals.

The drainage works consist of:

- installation of drainpipes; and
- construction of culverts;

Works on the pavement structure including:

- construction of a blanket (wearing) course;
- construction of an asphalt course;
- construction of prefabricated concrete curbs;

- construction of gutters; and
- construction of shoulders.

The exact scope of construction works and activities will be defined in the detailed designs for each of the roads. These are mainly existing roads and there will be no construction of new sections. In some sections, open cut will be necessary solely for the purpose of widening of the existing roads up to the required width and there won't be any demolition of buildings during rehabilitation. The excavated topsoil will be deposited along the road in similar shapes.

The excavated soil and scraped asphalt will be disposed of in the local landfills, which will have to be previously approved by each of the concerned municipalities.

The borrow pits, which will be used as sources of material like gravel and soil for the construction of the roads will also be subject to approval by the municipalities.

The construction machinery necessary for implementation of the project is the following: bulldozers, padfoot drum vibratory soil compactors, compaction rollers, dredges, excavator, grader, finisher, dumping truck and diesel aggregate.

The asphalt is a mix containing a binding agent such as: bitumen for pavements, diluted bitumen, bituminous emulsions, pavement tar and rock material, filler, sand and crushed rock.

The bitumen is a mixture of hydrocarbons, is of brown, dark green or black color. It has great resistance to temperature variations and chemical influence and is water-impermeable. It's flammable at high temperatures and burns with thick smoke. It starts to get softer at 50 - 60 °C while at 100 °C it becomes liquid. In the construction of roads the so-called pavement bitumen is used, which is derived with processing of oil derivatives and as a bonding agent in the construction of pavements.

The bitumen is delivered in barrels of 100 I, which must be marked with oil paint for the type of bitumen it contains. In this case diluted bitumen is used, which is in fact pavement bitumen diluted by adding special dilution oils.

These oils for dilution of the bitumen can be or tar origin, oil derivatives, light mineral oils or a mixture of these, which after they're mixed evaporate gradually. The diluted bitumen is highly flammable and needs to be handled with care when working with it to ensure safety.

Tar is derived with dry distillation of organic matter such as hard coal, black coal and wood. Raw tar is a viscous liquid comprising of hydrocarbons, black in color and with specific odor. Pavement tar is used for surface finish and as a bonding agent of asphalt concrete.

Road tar is delivered in tin barrels or cisterns. With each delivery the distributor is to supply the buyer with the following data on the quality of the delivered tar:

- label on the type of tar;
- name of manufacturer;
- origin of raw materials;

- complete data on the recent factory tests for that particular type of tar with the same raw materials;

Each sold barrel containing road tar must have a clear and visible marking on the type of road tar contained therein. The marking on the type of tar must be written in oil paint.

Asphalt is an inert material with minor and controlled influence onto the environment compared to other materials used in infrastructure. Its components are neither biodegradable nor solvable. This is a stable material, which when handled properly, poses no danger to the environment.

The rest of the materials, tar, emulsions etc also pose no danger to the environment in situations when they are handled with properly. Proper use in terms of their storage on construction sites, application onto surfaces as well as disposal of packaging will eliminate all possible consequences.

The packaging of all of the components used in these techniques is either inert waste or is of multipurpose use and as such the Contractor is obliged to dispose of them from the construction site.

Based on the relevant parameters: traffic volume, climatic, topographic and geotechnical characteristics of the terrain, available resources (natural and artificial materials) as well as the corresponding technology for construction, there will be a design developed for selection, dimensioning and construction of the pavement structure for rehabilitation of the existing pavement and selection of the proper structure and dimensions of the new pavement structure (whose dimensioning will be defined in the Geotechnical report) in stretches/sections where complete replacement of the pavement is necessary due to severe damage.

The drainage system will be checked and measures will be proposed for its functionality, i.e. places with no drainage system will be provided with one. Canals will be installed along the entire length of the pavement and if need be, culverts as well.

Design elements:

- road rank regional road for mixed traffic;
- design speed: according to the elements of the existing condition of the alignment;

- the rest of the elements will be made compliant to the technical regulations and the specific site conditions and restrictions.

Based on the relevant parameters: traffic load, climatic, topographic and geotechnical characteristics of the terrain, available resources (natural and artificial materials) as well as the corresponding technology for construction, there will be a design developed for selection, dimensioning and construction of the pavement structure for rehabilitation of the existing pavement and selection of the proper structure and dimensions of the new pavement structure.

In order to define the damage and deformation of the pavement structure, its longitudinal and cross evenness, friction capacity, deformability etc, the following is to be carried out:

- Analysis of the surface drainage and drainage of riparian waters;

- Analysis of road structures, bridges and culverts, retaining and protection structures etc.

After all of the data for the existing condition of the road section per individual functional and structural units is collected, we move on to analysis and synthesis of the existing condition in order to divide the section into sectors of uniform characteristics (drawbacks) and to eventually determine the degree of rehabilitation per sectors. Cross sections will be designed for the road alignment at equidistance as well as profiles of the critical chainages in order to gain proper insight into the spatial position of the road and its relation to the traffic and technical infrastructure of the highway as well as the borders of the road stretch with the number of profile, chainage, required size of the roadbed elements, degree of abrasion, scraping, overlay, profiling and all of the needed data for construction in all of the points where topographic surveying was conducted, ground levels, finished road levels, levels for the left and right side of the road, cross sections, slope gradients, drainage elements etc. The final pavement cover – wearing course will be carried out together with the whole pavement structure along the given road section.

# Types of rehabilitation of the existing pavement structure

# Rehabilitation work - type I

The rehabilitation work conducted on the primary pavement structure in stretches where no reinforcement is found, i.e. where relatively small damage is detected, will include the following items:

- Mechanical milling and minimal profiling of the pavement area, cleaning of the scraped surfaces with mechanical brushing, compressor air-blowing and pouring diluted bitumen RB200 over all visible cracks with joint space larger than 3 mm.
- Construction of a new bituminized bearing course, BNS-22sA with the required thickness of 6 cm. In case of profiling, the minimum thickness of this course for the given stretch will be 6 cm.
- Construction of an asphalt-concrete course AB-11/16s with a polymer bitumen binder of 4.0 cm thickness. In order to avoid longitudinal construction joints, it'd be best if the asphalt concrete course was constructed along the entire width of one traffic lane, but due to heavy traffic which is impossible to divert, asphalting will be carried out longitudinally in two sections.
- Mandatory spraying with semi-permanent emulsion for the connection of the individual asphalt courses and coating of the vertical asphalt courses with diluted bitumen RB200.

The local damage of the pavement of type I, which indicates changes in the substructure are covered with rehabilitation type 2:

# Rehabilitation work - type II

The rehabilitation type II refers to the stretch, where with the new solution correction is to be made on the grade level by scraping in order to profile the asphalt surface in depth of more

than 3 mm or where significant and complex damage of the pavement structure has been registered that needs to be scraped out. This type of rehabilitation covers the following items:

- Mechanical scraping with profiling of the asphalt surface in depth of 4-6 cm, cleaning of the scraped surfaces with mechanical brushing and compressor dusting and in the end, pouring diluted bitumen RB 200 over the visible cracks larger than 3 mm which have not been fully eliminated in the removal of the damaged course.
- Construction of a bituminous bearing course BNS-22sA, 6 cm thick. In case of profiling, the minimum thickness of this course for the whole stretch is to be 6 cm.
- Construction of an asphalt-concrete course AB-11/16s with a polymer bitumen binder of 4.0 cm thickness. In order to avoid longitudinal construction joints, it'd be best if the asphalt concrete course was constructed along the entire width of one traffic lane.
- Mandatory spraying with semi-permanent emulsion for the connection of the individual asphalt courses and coating of the vertical asphalt courses with diluted bitumen RB200.

The local damage of the pavement of type II, which indicates changes in the substructure are covered with rehabilitation type IV:

# Rehabilitation work - type III

The rehabilitation type III refers to registered damage of the rehabilitated pavement structrure of minor degree or numerous registered rehabilitated stretches along the the entire section of the road with various types and degrees of damage of the rehabilitated pavement structrure. The rehabilitation work which covers this type envisages for milling and backfill of 4-11 cm with the following items:

- Mechanical milling, cleaning of the scraped surfaces with mechanical brushing and compressor dusting as well as pouring diluted bitumen RB 200 over the visible cracks larger than 3 mm.
- Construction of a leveling course BNS-22 in 4-11 cm thickness for filling up to the necessary profiled section with thickness from level – 10 cm to the design grade level for embedding a bearing course BNS-22sA in 6 cm thickness and asphalt-concrete course AB-11/16c with polymer bitumen binder in 4.0 cm thickness.
- Construction of a new bituminous bearing course BNS-22sA, 6 cm thick. In case of profiling, the minimum thickness of this course for the given stretch is to be 6 cm. Construction of an asphalt-concrete course AB-11/16s with a polymer bitumen binder of 4.0 cm thickness. In order to avoid longitudinal construction joints, it'd be best if the asphalt concrete course was constructed along the entire width of one traffic lane.
- Mandatory spraying with semi-permanent emulsion for the connection of the individual asphalt courses and coating of the vertical asphalt courses with diluted bitumen RB200

With the placement of the new grade level with the final wearing course, a leveling course BNS-22 shall be used in thickness that varies from profile to profile and depending on the geometrical characteristics of the road. In case during profiling that the required thickness of

the leveling course is more than 10 cm, the course will have to be laid in two layers. The local damage of the pavement structrure of type II, which indicates changes in the substructure are covered with rehabilitation type IV:

Rehabilitation works with local interventions in the subbase - type IV

This type of preparation is used in stretches that ask for subbase interventions – at least once rehabilitated sections where again (even though they were rehabilitated) more significant settlements were registered in the roadbase accompanied by other type of deformations in the pavement structure. The works covered with rehabilitation type IV are:

This type of rehabilitation includes the following activities:

- Demolition and removal of the existing asphalt courses in thickness that's quite variable depending on the thickness of the basic asphalt course and the number and thickness of the overlays (local and/or continuous in some stretches).
  - Demolition and removal of the existing blinding layer.
- Intervention (replacement of the existing material with good quality non-cohesive material and its proper compaction with the corresponding compacting equipment) in the bedding layer.
- Embedding of a new blinding layer composed of crushed rock material with grain size of (0÷60) mm and its proper compaction with the corresponding compacting equipment. The compressibility modulus of such a subbase is to be minimum 80 MPa.
- Construction of bituminous bearing layer/s BNS-22sA with thickness up to level -4 cm of the design grade level.
- Construction of an asphalt-concrete course AB-11/16s with a polymer bitumen binder of 4.0 cm thickness. In order to avoid longitudinal construction joints, it'd be best if the asphalt concrete course was constructed along the entire width of one traffic lane
- Mandatory spraying with semi-permanent emulsion for the connection "blinding layer -BNS" and the connection of the individual asphalt courses as well as coating of the vertical asphalt courses with diluted bitumen RB200

In case in the opening of the pavement structure that the condition of the blinding layer does not indicate wetting and need for intervention into the blinding layer, leveling (upgrade) of the roadbed will be carried out at level of design blinding layer with leveling course BNS-22 and then reinforced with the basic overlay for the given stretch.

With the placement of the new grade level with the final wearing course, a leveling course BNS-22 shall be used in thickness that varies from profile to profile and depending on the geometrical characteristics of the road.

The distribution of these types can be seen in the graphic appendix for the condition of the existing pavement in a special table for the types of overlay shown in different colors.

#### Drainage

The drainage of the alignments is in poor condition. Most of the canals are closed with sand and soil. The shoulders are in poor condition, which contributes to the insufficient drainage of the alignment. A part of the alignment culverts are not functional.

What follows is a technical description and location for each of the roads accordingly.

#### VARDAR REGION

#### **Municipality of Lozovo**

#### Lozovo – v. Milino, L=0,80 km

The local road Lozovo -v. Milino is a part of the road network in the municipality of Lozovo, which connects the municipality with the rest of the road network inside the village and with the neighboring municipalities and the greater area.

The reconstruction of a part of this local road will increase the rural development of the municipality, i.e. of the villages and the area where this road gravitates, which will benefit the local population and enable faster and safer transport of people and recourses. The beginning of the road is immediately after the village of Lozovo in the direction of the village of Milino, i.e. around 1.10 km from the roundabout in Lozovo.

The total length of the road envisaged for reconstruction, which is subject of this project, is around 1.17 km long.

The cross section of the road profile applied in this project is the following:

- pavement width 3.50 m
- shoulders from both sides of the road 2x0.75 = 1.50 m
- roadbed 5.00 m

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Figure 1 - Local road Lozovo - v. Milino

The slopes of the roadbed have been designed and constructed depending on whether the road is in embankment, excavation or cut as well as depending on the height of the embankment and the depth of the excavation. In an embankment, the slopes are designed with an inclination of 1:1.50, in excavation of up to 2.00 m depth the slope is 1:1. Considering that the road is being reconstructed, we can generally say that the size of the embankments and the excavations of the alignment are minimal.

The cross gradient of the pavement ranges from 2.50% to maximum gradient of 5% in curves with minimum horizontal radii. The road surface is twisted around the axis. In some places, the road is designed with a negative gradient or the so-called "counter-gradient" of a min. 2.50%. This is used in horizontal radii larger than 3xRmin, i.e. 3x25=75 m in order to provide driving

continuity and to take the water away from the pavement towards the lower side of the terrain. The shoulders are with a gradient of a min. 4% towards the outside of the road, for gradients larger than 4% the inside shoulder has the same gradient as the pavement. The cross section of the bedding is 4% for drainage of water that has possibly infiltrated the pavement. As can be seen from the horizontal solution and the graphic appendices – layouts in M=1:1000, the size of the horizontal elements applied, horizontal radii and clothoids has been chosen in such a way as to follow entirely the existing dirt road. This has been used in order to decrease as much as possible the scope of earthworks and to avoid any additional costs for expropriation. The application of minimum horizontal elements is also justified if you take into account the rank of the road and the traffic, which is relatively low.

The drainage of the storm water from the pavement asphalt surfaces will be carried out with construction of the longitudinal and cross section of the road. Water from the pavement will be collected in the canals and with the help of the newly-designed pipe culverts taken away to the closest recipients (water bodies). The collection of the side water is enabled through trapezoid culverts of 0.30 m width. The longitudinal grades of the canals mostly follow the grade level of the road. The pavement structure has been defined in the Terms of Reference:

- Blinding layer composed of crushed rock, d=10-25 (30) cm;

- Final layer BNHS 16. d=7 cm.

#### **Municipality of Veles**

#### Local road for v. Otovica, L=0,82 km

In order to get the optimum solution with the required elements, design documentation for reconstruction of the existing road needs to be developed, at a Basic Design level, which will be achieved with direct stake-out of the alignment on the site by using the roadbed and the corridor of the existing road in its natural size. Fixed points and lines will be: the connection around the center of the villages and all lines where the alignment is perpendicular to the existing roadbed.

In the marking of the alignment, attention should be paid to the required widening of the roadbed as well as to the leveling layout of the alignment by keeping in line with the specific conditions and limitations.

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Figure 2 - Local road for v. Otovica

# **Municipality of Sveti Nikole**

#### Local road R-105 – v. Amzibegovo – v. Crnilishte, section 1, L=2,41 km

The project envisages for development of technical documentation – Basic Design for reconstruction of the local road v. Amzibegovo – v. Crnilishte. This will allow for an access road from the v. Amzibegovo to v. Crnilishte since with its characteristics and above all, structural elements and pavement structure, the road is partially asphalted and with heavy damage; therefore, it does not meet the criteria for continuous flow of motor traffic, for which reconstruction and revitalization is necessary. This is a mixed traffic road with motor vehicles and agricultural vehicles.

The terrain of the alignment of the local road v. Amzibegovo – v. Crnilishte is flat and with relatively high vegetation. The elevations of the natural configuration of the terrain range from 240.4 to 276.5 m. The highest point is at level 279.5 m. The alignment is designed in such a way as to reduce the earthworks as much as possible.

The terrain is relatively stable, no high groundwater was registered, which would require any additional technical measures for their collection.

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Figure 3 - Satelite view of the local road Amzibegovo - Crnilishte

In order to get the optimum solution with the required elements, design documentation for reconstruction of the existing road needs to be developed, at a Basic Design level, which will be achieved with direct stake-out of the alignment on the site by using the roadbed and the corridor of the existing road in its natural size. Fixed points and lines will be: the connection around the center of the villages and all lines where the alignment is perpendicular to the existing roadbed.

In the marking of the alignment, attention should be paid to the required widening of the roadbed as well as to the leveling layout of the alignment by keeping in line with the specific conditions and limitations.

The beginning of the given road alignment is the existing road Sv. Nikole – Ovcho Pole, whereas the end is in Crnilishte up to the connection with the Peshirovo road. The exact length will be defined in the design. The existing road is of variable width of the roadbed from 3-5 m and width of the dirt road of 3 m. The road is not defined and in some stretches it is of variable location of the pavement.

The road doesn't have horizontal and vertical geometry formed and its protection and drainage regulated and therefore cannot be regarded as providing economic and safe traffic. The pavement drainage has not been solved, not only for the stormwater and surface water, but also for groundwater and water flows.

#### **DESIGN ELEMENTS:**

Road rank	Local
Design speed	V=30km/h
Pavement width	3,5 m
Shoulders	2 x 0,75 = 1.5m
Roadbed	5.00 m
Blinding layer	25 cm
Asphalt course BNHS – 16a	7.00 cm
Passing places at every 400-500 m	2.00m
Maximum longitudinal grade level	11.0 %
Minimum cross grade	2.5 %
Maximum cross grade	7.0 %
Maximum cross grade	7.0 %
Pavement structure	asphalt-concrete

The initial point of the asphalt road A(0+0.0) is the crossing with the local road Crnilishte – Peshirevo. The entrance to the Amzibegovo village is at chainage 1+633 while the exit at 2+257.87.

In the center of the village several dirt roads cut the design road from both sides. There will be no widening of the asphalt surface in the connection points. The required leveling will be achieved with additional earthworks at the very location during construction.

The final chainage of the asphalt road is at km 2+412.60 and is at the crossing with the regional road Ovche Pole – Sv. Nikole.

The change of grade will be rounded with vertical curves and radii that meet the proper visibility and vehicle dynamic conditions. There are a total of five vertical curves of which three are concave and two convex. The smallest radius of the vertical curves is 1162.29 m while the largest is 5042.87 m.

The longest distance in vertical direction is 1101.36 m.

The twisting of the road is around its axis. The longitudinal grade of the pavement is from 0.09 % to 2.97 %.

The cross sections of the road have been designed with pavement width of 3.50 m. In order to provide an economic solution the pavement will not be widened in the curves and there will be passing places at every 400-500 m of the road.

The bedding will be carried out with a minimum grade of 4%, which will solve the drainage of the infiltrated storm water. The road drainage will be solved with the construction of trapeze canals. The grade of the canals will follow the grade level of the road. At the lowest sections reinforced concrete culverts will be carried out. The plan is to construct a reinforced concrete pipe culvert  $\emptyset$  300 at chainage 0+394.53 and 0+766.60 m and  $\emptyset$  400 at chainage 1+807.73 m. The blinding layer will be of 30 cm thickness.

The asphalt course will be BNHS – 16a with thickness of 7 cm.

#### PELAGONIJA REGION

#### **Municipality of Prilep**

#### Local road from Lenishte to the monastery of Sv. Petka of L=0.88 km

The subject of this project is the development of a BASIC design for linear infrastructure with all of the required structural details and technical conditions for reconstruction of the municipal

road from Lenishte to the monastery of Sv. Petka from the exit of the village Lenishte to the entrance to the monastery of Sv. Petka.



Figure 4 - Topographic presentation of the local road from the village of Lenishte to the monastery Sv. Petka

The road bears the municipal designation of L600195528. Its significance has increased lately, with the construction of monuments and the extension of the monastery and its living quarters. The monastery is frequently visited by the people from the municipality and of the whole country, thus becoming an attractive tourist location. Not only the monastery complex, but the surrounding region of the village of Lenishte as well is found to be a source of interest for many people that choose this location for recreation in their spare time.

Design conditions and design elements

- Category of terrain valley mountainous
- Design speed V=30-40 km/h
- Pavement width 3.50 m'
- Shoulders 2\*0.75 м<sup>2</sup>
- Roadbed 5.00м
- Design vehicle motor vehicles
- Maximum grade level

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Figure 5 - Satelite view of the local road from the village of Lenishte to the monastery of Sv. Petka

For that purpose, the alignment of the road has already been driven through and blinding layer has been laid, but due to the unfinished structure, unconstructed canals and inappropriate culverts, the pavement structure has been significantly damaged, which contributes to even further damage. By clearing the terrain from vegetation etc, the entire blinding layer would be removed in some places. Also the existing canals need cleaning and shaping. The existing pipe culverts are virtually useless and need to be replaced by new ones while in some places according to the conditions of the terrain new pipe culverts are to be constructed. The alignment terrain is mixed, starting off with a valley and as we approach the monastery it becomes hilly. The alignment of the new road mainly follows the existing road, which has a blinding layer and is in a very poor condition and has been designed with the corresponding excavations and embankments to meet the requirements of the existing legislation and conditions for construction of this type of roads. The run-off of surface and storm water is small. The terrain is mostly without any topsoil, intact and stable with no signs of existing or potential landslides. There are no signs of high groundwater that would require support or special conditions for its collection. Canals and reinforced concrete pipe culverts will be constructed for the collection and drainage of the surface run-off.

# **Municipality of Bitola**

# v. Kazhani – v. Gjavato, L=2.72 km



Figure 6 - Local road v. Kazhani - v. Gjavato

Design conditions and design elements

- Category of terrain valley mountainous
- Design speed V=30-40 km/h
- Pavement width 3.50 m'
- Shoulders 2\*0.75 m<sup>2</sup>
- Roadbed 5.00 m
- Design vehicle motor vehicles
- Maximum grade level

The pavement structure has been chosen in such a way as to allow for efficient and safe traffic for this type of local road. The pavement structure has not been dimensioned since there was no investigation work conducted for this given terrain nor is there any data on traffic volume. The pavement structure will be the same as for other streets and roads of this rank, for which there was investigation work conducted and which have proven efficient in the exploitation

stage. The drainage of the pavement structure will consist of one gully, which will conduct water into the sewage. It will be installed next to the right pavement curb in line with the longitudinal and cross grades applied, which will allow for quality drainage of the pavement in all of its points.

# **Municipality of Bitola**

# Reconstruction of the local road from the v. Gorno Orizari to the v. Krklino Municipality of Bitola km 0+000,00 - km 3+048.75

This local road had previously contained a blinding layer, but it was washed down by torrential rain. The road now has altered longitudinal and cross profiles. It has many large pot holes, which at times of rain, fill up with water and create small ponds, making traffic unsafe. Since this road is shorter than the existing roads, it is of much significance to the locals, enabling a more efficient traffic connection between the villages as well as between the villages and the town of Bitola.

The terrain is mostly dirt and topsoil, intact and stable, with no signs of existing or potential landslides. Parts of the existing road have blinding layer laid. There are no signs of high groundwater that would require support or special conditions for its collection.

Surface water will be collected and drained with the help of earth and concrete canals, taking the water away to the existing creeks and dry ravines.



Figure 7 - Satelite view of v. Gorno Orizari – v.Krklino, Municipality of Bitola

The road mainly follows the alignment of the existing road, making expropriation unnecessary. When the alignment of the local road was designed, in order to provide efficient and safe traffic flow, curves with radii of R=70-600 m with clothoids L=20-70 m were used, which meet the criteria for the envisaged design speed of V=40 km/h. Only circular curves were applied of R=40.

One structure that will be kept in the reconstructed alignment of the local road is the M5 underpass, stretching from 1+230,99 m to 1+266,82 m. The existing alignment of the local road has altogether 3 box culverts of different width and length, which don't fit into the reconstructed road alignment. They're located at 0+775,50 – the first, the second at 1+600,00 and the third at 2+547,00. This is why replacement with new box culverts is necessary, which will correspond to the elements of the alignment. Aside from these, another box culvert is to be constructed at 2+993,00 in the dry ravine that the alignment goes through.

The pavement structure has been chosen in such a way as to allow for efficient and safe traffic for this type of local road. The pavement structure has not been dimensioned since there was no investigation work conducted for this given terrain nor is there any data on traffic volume. The pavement structure will be the same as for other streets and roads of this rank, for which there was investigation work conducted and which have proven efficient in the exploitation stage. At the beginning of the road alignment in the village of Gorno Orizari, the drainage of the pavement structure will be carried out with construction of one gully, which will conduct water into the sewage. It will be installed at km 0+080,00 next to the right pavement curb in line with the longitudinal and cross grades applied, which will allow for quality drainage of the pavement in all of its points.

At other sections drainage will be achieved with earth canals of 45/50/45 cm in size, with inside grades of 1:1.5 and outside grade of 1:1. In sections where there is not enough width from barrier to barrier or from structure to structure, there will be concrete canals constructed with thickness of wall of 10 cm. In sections where there is not enough width for canals either, gutters will be used to conduct surface water.

# **Municipality of Resen**

# R1308 – v. Krani, L=1,17 km

The existing road is of average width of 3.0 m. This project envisages for one-sided widening of the pavement lane to 3.5 m.

Design conditions and design elements:

- Road rank local road
- Category of terrain valley
- Design speed V=30-40 km/h
- Pavement width V= 3.50 m
- Shoulders 2 x 0.75 m
- Roadbed 5.00 m

- Design vehicle, buses/trucks
- Existing grade level

This road is municipal road and is of great significance to the locals since it improves the traffic connection between the settlements. This is an existing road with average width of 3 m, already asphalted and damaged with time. In some places it has pot holes and is in need of reconstruction. This reconstruction envisages for widening of the pavement with bituminous bearing course BNS 22, d=6 cm to a width of 3.5 m, patching up the pot holes, milling of the existing alignment asphalt and coating with emulsion for improving the bond with the new AB11 course with average thickness of d=4 cm.



Figure 8 - Local road R1308 - v. Krani

# **Municipality of Resen**

#### v. Grnchari – Monastery Sv. Ilija, L=2.02 km

Taking into account the requirements from the Client, according to the Terms of Reference the asphalted sections of the alignment have to be overlaid with BNHS 16 in average thickness of 7.0 cm while the rest will be new pavement structure of the following characteristics:

- BNHS 16 d= 7.00 cm
- blinding layer of crushed rock d=30.00 cm

The basic programme and design conditions are in line with the Terms of Reference, the rank of the road and the conditions on site.

- road rank	local
- lanes	2 x 3.00= 6.00 m
- shoulders 2x 0.5	1.00 m
- roadbed	7.00 m

The horizontal solution of the alignment is entirely in line with the existing condition of the road. The road axis is guided in such a way as to make full use of the existing pavement. Horizontal elements were applied onto the axis of the given section (lines, curves and clothoids) Environmental Impact Assessment Report for the Reconstruction and Rehabilitation of the Local Road Network Project in Republic of Macedonia (VII tender)



Figure 9 - Local road v. Grnchari - Monastery Sv. Ilija

In the sections of the road with not enough width, a blinding layer is to be laid of d=30.00 cm and on top of it bituminous bearing layer BNS 22 with d=6.00 cm, which would help even it with the existing pavement. A new BNHS 16 layer of d=7.00 cm will be placed on this pavement structure. In sections where new pavement is to be constructed, the bearing capacity of the blinding layer will have to be proven in construction and if need be, a new, improved blinding layer laid.

#### **Municipality of Krushevo**

#### Local road Krivogashtani - v. Buchin, IV section - 1,94 km

The project envisages for technical control of the Basic Design for reconstruction of the local road from the v. Krivogashtani to the v. Buchin from km. 0+000 to km. 7+096.35, municipality of Krushevo. The conditions on site are predefined with the existing local road, which is going to be reconstructed in relation to the horizontal, vertical solution and cross section. Based on the layouts, horizontal and vertical solutions were designed to meet the requirements. The structural elements of the cross profile for reconstruction of the given local road depend on the

specific conditions on site and spatial limitations. The pavement structure of the road has been dimensioned based on the estimate for the traffic volume and the on-site inspection. Hence, we feel that the proposed pavement structure will meet the requirements of the given road.

For efficient removal of potential surface run-off, earth canals will be constructed. In the case of maximum water that might damage the bedding, we propose that the bedding be constructed with a one-sided grade of min. 4%. Pipe culverts will also be used in the road alignment.



Figure 10 - Map of the local road Krivogashtani - v. Buchin

The village of Buchin is in the municipality of Krushevo, at the intersection of Krushevo, Demir Hisar, Bitola and Prilep. It is situated north of the Drevenik mountain, which is a branch of the Baba mountain. To the west there's Golem Kamen hill and to the north and east the Pelagonija valley. Crna river flows through the village and divides it in two. In the center of the village there's a special water canal that the locals use to irrigate their farmland. In terms of traffic connectivity and geographic location, one cannot but mention that the municipality and its most prominent district Krivogashtani is a real crossroad since all main roads that connect the closest towns meet here. Namely, east of Krivogashtani is the town of Prilep, which is 19 km away and to the west is Krushevo, 11 km away. To the south, i.e. to Demir Hisar there's a winding asphalt road going through many settlements leading to Bitola. Also to the north there's an asphalt road leading towards Ropotovo and continuing to Makedonski Brod. The climate in Krivogashtani, as in the whole of Pelagonija valley, is Mediterranean. Precipitation ranges from 700 to 900 ml per year. It is highest in spring and autumn while the first snow usually falls at the end of November or at the beginning of December.

# **Municipality of Prilep**

# Prilep – Markova Cheshma, L=1.42 km

The existing road is of average width of 3.0 m. This project envisages for one-sided widening of the pavement lane to 3.5 m.

Design conditions and design elements

- Road rank local road
- Category of terrain valley
- Design speed V=30-40 km/h
- Pavement width B= 3.50 m
- Shoulders 2 x 0.75 m
- Roadbed 5.00 m
- Design vehicle, buses/trucks
- Existing grade level

This road is municipal local road and is of great significance to the locals since it improves the traffic connection between the settlements. This is an existing road with average width of 3 m, already asphalted and damaged with time. In some places it has pot holes and is in need of reconstruction. This reconstruction envisages for widening of the pavement with bituminous bearing course BNS 22, d=6 cm to a width of 3.5 m, patching up the pot holes, milling of the existing alignment asphalt and coating with emulsion for improving the bond with the new AB11 course with average thickness of d=4 cm.

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Figure 11 - Local road Prilep – Markova Cheshma

# Municipality of Krivogashtani

#### Local road R-512 – v. Korenica – v. Godivje, L = 1.82 km (II section – 1.05 km)

The project envisages for development of technical documentation BASIC design for reconstruction and rehabilitation with all of the required structural details and technical conditions for reconstruction of the road Krivogashtani – Zhitovishte to the v. Korenica and v. Godivje.

The existing road is of average width of 3.0 m. This project envisages for one-sided widening of the pavement lane to 3.5 m.

Design conditions and design elements

- Road rank local road
- Category of terrain valley

- Design speed V=30-40 km/h
- Pavement width B= 3.50 m
- Shoulders 2 x 0.75 m
- Roadbed 5.00 m
- Design vehicle, busses/trucks
- Existing grade level

This road is municipal local road and is of great significance to the locals since it improves the traffic connection between the settlements. This is an existing road with average width of 3 m, already asphalted and damaged with time. In some places it has pot holes and is in need of reconstruction. This reconstruction envisages for widening of the pavement with bituminous bearing course BNS 22, d=6 cm to a width of 3.5 m, patching up the pot holes, milling of the existing alignment asphalt and coating with emulsion for improving the bond with the new AB11 course with average thickness of d=4 cm.

The widening will be carried out only from the right side of the road. This project also envisages for rehabilitation and cleaning of the existing canals and excavation of new ones in places where there are none as well as cleaning and replacement of the existing pipe culverts. Due to all of this and other reasons not mentioned, the project for reconstruction of the road from the intersection of Krivogashtani - Zhitoshe road to the v. Korenica and Godivje is justified and cost-effective. The terrain of the alignment is mostly flat. The alignment of the reconstructed road follows the existing road, which is asphalted and in relatively poor condition. The newly designed road follows entirely the existing road. In order to save on costs, the existing grade level has been kept for the most part and was overlaid with AB11course of 4 cm thickness. The cross grades do not match the existing condition of the road, which is very important for drainage and driving safety, but this design envisages for their correction by keeping in line with the legislation and the conditions for construction of such roads. The run-off of surface and storm water is small. The terrain is mostly without any topsoil, intact and stable with no signs of existing or potential landslides. There are no signs of high groundwater that would require support or special conditions for its collection. The categorization of the material according to GN200 is III and IV categories.

In the Basic Design the designed alignment follows the existing alignment of the old road. In some places the traffic and safety characteristics are to be improved. The existing road has undergone minimum corrections in order to fit the alignment better and get better technical solutions that would not increase the price for construction of the designed road (these corrections are within the widening from 3.0 m to 3.5 m). The widening of 0.5 m has been carried out from one side only along the right curb of the existing road by taking into account not to meddle with property ownership, i.e. not to go into other people's property. The horizontal curves have been designed without any clothoids and their radii have been chosen in such a way as to allow efficient and safe traffic flow. Circular curves have been used in the design of the road alignment according to the plan extract and the positive technical norms and regulations, which meet the criteria for the envisaged calculated speed of V=30-40 km/h. The

twisting of the pavement is in line with the technical norms and regulations for this type of roads and ranges from 2.5% in lines to 5% in curves with 30 m radius. Such a horizontal solution for the road alignment allows for efficient and safe traffic flow. The road alignment is mostly with grades that meet the regulations except in a few places of very short sections where the grade is smaller, but this is preconditioned by the existing situation, i.e. the existing grade level and changing it could complicate construction as well as increase price (drainage will be efficiently solved with the cross grade). The vertical solution was designed to be as cost-effective as possible. In the design process, special care was taken for the height levels of the existing terrain, for keeping the conditions on site in line with the technical norms and regulations. Also, in some places the longitudinal gradient of the grade level is in embankment or a mild cut, which provides protection from surface (storm) water, affecting the whole alignment from both sides, left and right. The changes of grade are rounded with vertical curves, whose radii meet the safety requirements as well as visibility and dynamic conditions. The drainage of the road has been solved with the cross and longitudinal grade. In order to keep costs to the minimum, the existing grade level has been kept as much as possible. In curves with radii smaller than 100 m, widening of the pavement was envisaged as well as passing places set 500 m apart. The road pavement is of one-sided grade of 2.5% and depends on the size of the radius and the speed. The road alignment is affected along its entire length from storm water. In times of rain, water starts flowing and is collected in earth canals and concrete culverts taken away to the existing ravines. In order to protect it from surface water, in places where possible the road alignment has been raised in relation to the surrounding terrain and in places of excavation, earth canals will be used for the protection against this kind of water. The earth trapezoid canals are of the following size: 35 cm at the bottom, 35 cm in height (min.). For efficient removal of potential surface run-off, earth canals will be constructed. In the case of maximum water that might damage the bedding, we propose that the bedding be constructed with a onesided grade of min. 4%.



Figure 12 - Satelite view of the local road Zhitoshe - Korenica - Godivje

In order to define the position of the marked alignment on site, the plan view and longitudinal elements, restrictions and natural conditions, final design of the alignment is developed with geometry details (lines, arches) onto a previously prepared layout. The alignment may thus be slightly moved in the plan view and cross section for optimization and adjustment to the restricting conditions. The pavement structure which is already asphalted is to be constructed out of AB11 in average thickness of 4 cm and milling of the existing asphalt to be performed beforehand as well as emulsion spraying for improving the bond between the old and new asphalt. The widening is to be carried out with a new course of BNS22, d=6 cm and then an entirely new final AB11 course of 4 cm thickness. In places where there's major damage, the pot holes are to be patched up first. The road starts from the intersection of the local road Krivogashtani – Zhitoshe, passes Korenica and continues towards the entrance to Godivje. The local road that connects these two settlements is already asphalted and of 3 m width. The project covers the whole reconstruction and rehabilitation of this local road. When designed, the existing road layout was used as well as all available layouts that provided the necessary information for the micro-location, geotechnical conditions, topographic layouts of the alignment and the surrounding site, existing technical norms and regulations as well as all the parameters and design conditions listed below.

The pavement structure has been chosen in such a way as to allow for efficient and safe traffic for this type of local road. The pavement structure has not been dimensioned since there was no investigation work conducted for this given terrain. The pavement structure will be the same as for other roads of this rank, for which there was investigation work conducted and which have proven efficient in the exploitation stage.

The following is to be carried out:

- Asphalting with bituminous bearing course BNS 22, d=6 cm for widening of 0.5 m from the right;
- Patching up pot holes with BNS 22, d=6 cm;
- Milling of the existing asphalt course;
- Coating with emulsion for a better bond between the old and new asphalt;
- Asphalting of pavement with AB11 along its entire width.

Preparation work consists of the following items:

- Removal of the remaining vegetation from the shoulders and canals;
- Milling of the existing asphalt course.

# EAST REGION

#### **Municipality of Karbinci**

#### Local road v. Radanje – v. Odzalija

The project envisages for the development of investment technical documentation at a Basic Design level for reconstruction of a part of the local road Radanje – Odzalija of section 1 of 2403.84 m length and section 2 of 333.28 m length.

The local road v. Radanje – v. Odzalija has been partially built, i.e. in some sections it is asphalted whereas the rest has been driven through and blinding layer has been laid. For the drainage of storm water there were several earth canals constructed along the road, but which due to the poor road maintenance are partially clogged up with soil deposits and blanket material. Along the entire alignment there are only two culverts constructed with a very small flow capacity since a part of the blinding layer is deformed. The width of the existing asphalt is 3.50 m. The annual average daily traffic is less than 500 vehicles.

When the elements of the cross profile, vertical solution and plan view were defined the existing condition and spatial restrictions were taken into consideration, by adjusting as much as possible the alignment elements to the spatial capacity and restrictions on site. Considering the on-site and traffic conditions, the design speed adopted is  $V_{des}$ =40 km/h. According to the Terms of Reference, Basic Design for reconstruction of the local road Radanje – Odzalija is to be developed in the sections that have not been asphalted by using entirely the plan view of the existing road. The beginning of section 1 is at 1+850.00 with 2119.84 m of length.



Figure 13 - Satelite view of the local road Municipality Karbinci Radanje - Odzalija

There are a total of 15 curves in this section, 13 of which are designed with clothoids and two are entirely circular. The pavement width is 3.5 m and the shoulder width 1.0 m. The axis is along the middle of the road. The alignment has been driven through and is partially covered with a blinding layer, but certain sections are to be repaired. The beginning of section 2 is at
6+353.00 with 333.28 m of length. There are a total of 5 curves in this section, 3 of which are designed with clothoids and two are entirely circular. The beginning of section 1 and 2 with the given chainages are the measured lengths from the beginning of the local road from the v. Radanje to section 1 and 2. The width of the pavement is 3.5 m and the shoulder width 1.0 m.

Due to all of the rough sections both in longitudinal and cross section, the grade level was corrected in such a way as to make minimal use of earth works and to fit together the sections of the road with blinding layer. The change of grade is rounded with vertical curves. The beginning and the end of the road, i.e. the existing asphalt pavements were taken as fixed points. The minimum grade level of section 1 is 0.62% while the maximum 14.13%. The minimum grade level of section 2 is 1.42% while the maximum 9.18%. The existing pavement structure is BNHS 16, d=7 cm measured at the asphalted sections of the road.

BNS-16	d=7 cm
Blinding layer – river gravel	d=25 cm
Total	d=32 cm

The blinding layer composed of river gravel will be used from Radanska river, which is in the immediate vicinity. The drainage of the storm water will be gravitational through canals and culverts, helping water drain from the roadbed. There will be reinforced concrete pipe culverts constructed into the roadbed of Ø1000. In section 1 there will be 5 reinforced concrete culverts of Ø1000. In section 2 there will be only one reinforced concrete culvert of Ø1000.



Figure 14 – Local road Municipality Karbinci Radanje - Odzalija

# **Municipality of Berovo**

# Local road Berovo – Milina Crkva - v. Smojmirovo, L=1.12 km (I section – 0.60 km)

For the local road Berovo - Milina Crkva - v. Smojmirovo, Municipality of Berovo in length of L=1115.32 m there was a Basic Design developed which defines the road alignment and its accompanying elements in line with the updated topographic layouts. In the making of the Basic Design and in line with the existing condition of the terrain and the updated topographic layouts and upon discussion and recommendation of the Client, the existing road alignment (dirt road) has been taken over for the connection with the local road network.

The alignment of the local road to the municipality of Berovo, which has been covered in the project, starts from absolute chainage km 0+000,00 at the intersection with Marshal Tito street and ends at km 1+115.32.

When the street was designed, all of the requirements such as design parameters, functionality, cost-effectiveness, safety etc. were taken into consideration as well as the recommendations from the Client for reaching the most optimal solution.

The alignment of the local road in the Municipality of Berovo is of variable width (dirt road). It has no storm drain for the collection of surface water. The drainage of the existing street has been solved with the cross and the longitudinal grades of the street.



Figure 15 - Satelite view of the local road Berovo – Milina Crkva – Smojmirovo

The street has been defined as a part of the local road network – local road with continuous traffic flow.

The basic design parameters of the street are:

Street width	. 4,0 m
Curbs	. 2 x 0,24/0,18/1,00
Design speed	30 km/h
Maximum longitudinal grade	1,53 %
Maximum transversal grade	2,0 %

In the process of designing, horizontal elements were applied that are in line with the regulations for the design of urban roads and the most optimum solution was defined as well. The elements of the horizontal solution have been arrived at from the alignment of the existing dirt road. The alignment of the local road consists of lines and curves formed with clean circular arches. The alignment in lines and curves follows the existing earth road. The street is fitted into the existing streets/intersections appropriately, i.e. is in line with the existing intersections (at the beginning and the end of the alignment).

The vertical solution of the local road in the municipality of Berovo is a result of the terrain configuration, by setting up vertical curves in the transitional locations. According to the conditions on site when fitting this road into the grade levels of the existing roads and meeting the minimum grades for drainage of asphalt pavement structures, the following ultimate values for the longitudinal grade were obtained: Imin= 0.10 % and Imax = 1.53 %.

The cross profiles have been designed in such a way as to meet the vehicle dynamic conditions, i.e. twisting of the alignment has been conducted in line with the design elements, which corresponds to the existing condition. Generally, the cross grade of the asphalt is 2.0% (one-sided). The cross profile of the street is defined with an asphalt pavement structure in the beginning and width of 4.00 m.

Size of the asphalt pavement structure:

- Bitumenous bearing wearing course BNHS 16 with d = 7 cm
- Blinding layer of d = 30 cm

The drainage of the street has been regulated with the longitudinal and cross grades of the street and its release in the lowest point through a drain on site. The roadbed is drained with a draining system, which releases the collected water at the same location with the storm water.

The horizontal and vertical solution are to meet the minimum grades (cross and longitudinal of the layers due to drainage).

- Bituminous bearing wearing course, envisaged as a part of the pavement structure as type BNHS 16, where the quality of the materials used in the production of the asphalt as well as the quality of the produced asphalt course are to meet the criteria prescribed with MKS U.E4.014;

Based on the project, the following conclusions and recommendations can be made:

- According to the situation on site, for which construction of the local road Berovo -

Milina Crkva – Smojmirovo, Municipality of Berovo is envisaged, Basic Design has been developed, defining the Alignment of the street and its accompanying elements, in line with the updated topographic layouts.

- Maintenance of the road is highly recommended as well as cleaning of the drainage elements, which will guarantee longer durability and functionality.
- Also annual inspection of the condition of the asphalt street and its accompanying elements is recommended, by keeping a record of all inspections, starting from the period when it's built.

# **Municipality of Kochani**

# Local road v. Leshki - regional road R-1309 Kochani - Ponikva

This project envisages for traffic connection of the v. Leshki with the regional road R-519 Kochani – Ponikva. The Leshki village has excellent conditions for agricultural development, farming and rural tourism. The construction of this road will open up possibilities for revitalization of this region and connection to the Macedonian road network.

According to the size of the traffic volume on this road, there were no special analysis and measurements conducted and it has now been brought down to a minimum of around 10 vehicles in 24 hours. The construction of this road is not expected to have the passage of more than 1,000 vehicles in 24 hours, which puts this road into the lowest category or technical category D. The configuration of the alignment terrain is hilly and mountainous. The soil category of the section of the local road is part IV and part V category. Based on the existing regulations, a design speed of V=40 km/h has been adopted. The construction of the road, subject of this project, will allow for the minimum required technical conditions for traffic flow on this type of roads. From the connection to the regional road R519 (Kochani – Ponikva) from 0+000.00 to 1+069.78 the road has not been asphalted and is subject of this project. From 1+069,78 to the v. Leshki the road has been asphalted and is operational. Special geologic technical investigations have not been carried out since the terrain is stable (mostly rocks) and no instabilities of the alignment are expected, which was immediately registered with the onsite visit.



Figure 16 - Topographic presentation of the local road from v. Leshki – regional road R-1309 Kochani – Ponikva

Technical elements of the road:

- design speed B=40 km;
- pavement width 3,50 m;
- shoulder width 2x0,75=1,50 m;
- gutter width 0,50 m;

The remaining road elements will be constructed in line with the current technical regulations and standards on road design.

# Pavement structure:

- asphalt-concrete BNHS 16 with d=7 cm;
- blinding layer for leveling 15-30 cm;

The surface water from the roadbed and the pavement lanes is drained through shoulders with canals and asphalt gutters in reinforced concrete culverts of Ø800 mm at 0+406.08, 0+758.93 and 0+941.20. Drainage PVC pipes of Ø150 mm have been envisaged along the alignment with asphalt gutters.

# **Municipality of Delchevo**

# Local road v. Trstija - v. Turija , L=2.00 km (I section - 0.8 km)

The project envisages for the development of technical documentation at a Basic Design level for construction of a part of the local road from v. Trstija to v. Turija, municipality of Delchevo. This road is a part of the local road network in the municipality of Delchevo and with its structural elements, profile and pavement structure of a dirt road does not meet the requirements of the local population for normal and safe traffic. The total length for construction of the local road is 2000.33 m. The existing local road is a dirt road in its entire length, 3.0 - 3.5 m wide, which means that it's very difficult for two vehicles to pass. There are 8 pipe culverts constructed on this road.



Figure 18 - Satelite view of the local road Drachevo - v. Trstija, v. Turija

# Design conditions and structural elements

The geometrical structural elements have been defined in line with the design speed of the road and the road category:

Road rank	local
Terrain class	mountainous, Vth
Design speed	30 km/h
Pavement width	2x1.75=3.5 m
Shoulder width	2x0.75 = 1.5 m
Canal width	0.30 m
Cross grade in line	2.5%
Roadbed	5.0 m

The road terrain can be defined as mountainous. The road stretches from 698.00 m to 733.00 m altitude. It will follow the already existing alignment, which is 3 to 5 m wide. The local road is aimed exclusively for lightweight traffic, i.e. for vehicles up to 3.5 tons of weight transporting food products for the local population. According to the traffic volume, the road is ranked as V class which means passage of at least 500 vehicles is expected in 24 hours. The design speed for this road class is 30 km/h. There were no geological tests of the soil conducted; however, the prospection of the dirt road revealed that the road passes through terrain of maximum IV category. In case soil of poor bearing capacity is encountered in the course of excavation, the Contractor is to take special measures for its improvement. The horizontal solution of the road alignment has been developed based on the geodetic layouts, where the axis of the local road was twisted. When choosing the elements for the horizontal solution, special care was taken to use the existing road as much as possible along the whole alignment and at the request of the municipality. Also the conditions on site dictate the use of curve radii smaller than the allowable Rmin=25 m for this type of road. The whole alignment of the road will follow the existing alignment. It starts from km 0+000.00 and ends at km 2+000.33. The horizontal solution envisages for the construction of a total of 31 curves. Taking into account the rank of the road, the curves will be designed with clothoids. The width of the road, pavement and shoulder altogether of 5 m width are enough for two vehicles to pass. Every curve depending on the radius will be widened. The elements applied in the horizontal solution for this road rank are in line with the rulebook on road design outside of settlements. The grade level was chosen in such a way as to follow the grade level of the existing dirt road, which changes at very short distances, all in order to save on earthworks as much as possible and get a cost-effective solution. The longitudinal grade level ranges from min. = 0.54% to max. = 10.91% (inclines and descents), which starts at 1+830.76 and ends at 1+865.83 in length of 35.07 m. The pavement has been twisted around its axis. The cross grade is one-sided. It will be of minimum allowable 2.5% in line and depending on the curve radius to the maximum allowable of 5%. The shoulders ate of 4% grade and 0.5 m width. The bedding will be constructed with min. grade of 4\$, which will solve the drainage of the infiltrated water. In sections in excavation and cuts, there will be earth canals constructed of 0.30 m base width.

The superstructure or the pavement structure will consist of the following parts:

- blinding layer	30 cm
- bituminous bearing course BNS 16 a	7 cm
- drain canals , bottom width	0.30 m

The width of the pavement lane is 3.50 m and the shoulder width 0.75 m.

The road will be drained with the cross grade of the shoulders and the earth canals as well as of the existing culverts, which will divert the water into the surrounding area.

# **Municipality of Shtip**

# A4 - v. Puhce, L=3.83 km (I section - 1.53 km)

The elements of the horizontal solution have been arrived at from the alignment of the existing dirt road. The alignment of the local road consists of lines and curves formed with clean circular arches. The alignment in lines and curves follows the existing dirt road. The street is fitted into the existing streets/intersections appropriately, i.e. is in line with the existing intersections (at the beginning and the end of the alignment).

The vertical solution of the local road is a result of the terrain configuration, by setting up vertical curves in the transitional locations. According to the conditions on site when fitting this road into the grade levels of the existing roads and meeting the minimum grades for drainage of asphalt pavement structures, the following ultimate values for the longitudinal grade were obtained: Imin= 0.10 % and Imax = 1.53 %.

The cross profiles have been designed in such a way as to meet the vehicle dynamic conditions, i.e. twisting of the alignment has been conducted in line with the design elements, which corresponds to the existing condition. Generally, the cross grade of the asphalt is 2.0% (one-sided). The cross profile of the street is defined with an asphalt pavement structure in the beginning and width of 4.00 m.

Size of the asphalt pavement structure:

- Bitumenous bearing wearing course BNHS 16 with d = 7 cm
- Blinding layer of d = 30 cm

The drainage of the street has been regulated with the longitudinal and cross grades of the street and its release in the lowest point through a drain on site. The roadbed is drained with a draining system, which releases the collected water at the same location with the storm water.



Figure 19 – Local road A4 – v. Puhce

## **SKOPJE REGION**

## **Municipality of Aerodrom**

## Rehabilitation of existing road – "Gorno Lisiche", L=1.662 km,

The street starts at the end of the boulevard 12 Makedonska Udarna Brigada and ends after the overpass in Gorno Lisice in proximity of the Sv. Petar and Pavle church. The street is around 6 m wide with sidewalks on both sides.

The grade level of the curbs does not follow the grade level of the pavement (most curbs have settled). The curbs after the overpass have been damaged and right next to them, at the same level with the pavement, there are two rows of stone blocks.

The visual inspection revealed that the asphalt surface is generally uneven and twisted with asphalted excavations, cross cracks, pot holes and larger damage especially evident after the overpass.



Figure - 20 Location of the existing road – "Gorno Lisiche", Municipality of Aerodrom

# **Municipality of Aerodrom**

# Rehabilitation of auxiliary street – "Todor Changov", L=1.632 km,

The on-site inspection revealed that the existing street is asphalt road with width of around 4-7 m. The pavement structure contains cracks and in some places there are deformations and pot holes.



Figure 21 Location of the auxiliary street – "Todor Changov" Municipality of Aerodrom

# **Municipality of Saraj**

# Local road R- 1206 - v. Ljubin, L=1.67km

The design envisages for the development of technical documentation at a Basic Design level for reconstruction of the local road from the regional road R-1206 to the village of Ljubin in length of around 1680,00 m. The road from the regional road R-1206 to the village of Ljubin is part of the local road network in the municipality of Saraj. The beginning of the alignment of the local road is from the existing regional road R-1206, more specifically from the intersection of the regional road connecting the dedicated entry and exit lanes to the Skopje - Tetovo highway, i.e. is a part of the Glumovo interchange. The end of the road alignment is at the mosque in the village Ljubin. The current road alignment is pavement with blinding layer (gravel sand material) in length of 1,100 m, while the rest of it, around 580 m is broken asphalt pavement with visible damages and deformations of the asphalt due to the construction of the sewage system and the frequent excavations and both, longitudinal and cross settlements of the asphalt pavement. The width of the road profile of the pavement with the blinding layer is 3.5 m in the area of the underpass up to 4.8 m in the open section of the alignment. The width of the local road with asphalt pavement ranges from 1.50 to 2.70 m. Therefore, Basic Design for construction and reconstruction is to be developed. The total length of the local road is 1.68 km.



Figure 20 - Satelite view of the local road Saraj – Ljubin

The development of this Basic Design is of great importance to the inhabitants of the Ljubin village since the construction of this, for many years, narrow and damaged road will enable faster and safer traffic communication with all parts of the Municipality. The on-site inspection reconnaissance of the road alignment, revealed that the pavement structure of L=1080 m (from km.0+027.54 to km.1+107.12) has been carried out of a layer of gravel and sandy material, while the rest of it in length of 570 m (from km.1+107.12 to km.1+654.00) consists of broken asphalt pavement and surface damage in the form of web-like cracks, small longitudinal and cross pot holes. The width of the road with pavement from gravel-sandy material is 3.5 m in the area of the underpass up to 4.8 m in the open section of the alignment. The width of the local road with asphalt pavement is 1.5 m to 2.70 m where it appears along the alignment through the settlement from the village of Ljubin. The on-site inspection of the local road revealed that the beginning of the alignment of 93.3 m is set between the exit lanes of the Skopje-Tetovo highway with physically separated, parallel raised curbs in relation to the existing alignment of the local road. At about 1,100 m is the beginning of the village where the road alignment is with asphalt pavement. From both sides of the pavement, there are various structures, concrete posts as part of the electric network as well as the new sewage system. In this section the asphalt pavement is of minimal width since there are high walls and steel fence from both sides of the road.



Figure 21 - Topographic layout of the local road Saraj - Ljubin

The defined geometric structural elements are in line with the design speed of the road:

-	Road rank	local IV - class
-	Terrain class	hilly
-	Design speed	40 (30) km/h
-	Pavement width	2x1.75 = 3.50 m
-	Shoulder width	2x0.50 = 1.00 m
-	Prefabr. concrete trench drain	2x0.40 = 0.80 m
-	Cross grade in line	2.50 %
-	Roadbed	4.50 m

Based on the assumed traffic volume up to an annual average daily traffic of 500 vehicles and lack of geotechnical investigation works at the location of the alignment, the following pavement structure is proposed:

Asphalt crouse of BNHS 16A Blinding layer of crushed stone	d=7.0 cm d=30.0 cm
	D= 37 0 cm

When the elements of the horizontal solution were developed, special care was taken for the new alignment to follow as much as possible the alignment of the existing road along its entire length. In the design of the new alignment, radii smaller than the ultimate were used in order for the alignment to fit into the existing road so as to avoid the use of private property, i.e. expropriation of land as well as to fit it into the existing structures and high buildings (in the urban section of the village).

Based on the defined alignment, the vertical solution of the road has been adopted from the grade level of the existing road as well as the local conditions and configuration of the terrain. In geometrical sense, the grade level comprises of inclines and descents as well as convex and concave curves. The twisting of the road with counter-grade is in line with the technical regulations for radii R=2.8×R<sub>min</sub>. Due to cost-effectiveness, insufficient width of the existing road

and avoiding expropriation, there won't be any increase of the width of the pavement in curves. In terms of the other elements of the cross profile, such as shoulders, concrete prefabricated trench drains were constructed with width of 0.50 and 0.40 m width.

The drainage of the storm water from the pavement structure will be carried out gravitationally with longitudinal and cross grades of the pavement. The storm water will be collected from the pavement through earth canals in the section with structures, whereas in the section where the alignment goes through the village, concrete prefabricated trench drains and gullies will be used. The collected water will be released into an existing drain at km.0+161.75, a part of it flowing freely onto the terrain and a part through trench drains in gutters to the closest sewage.

# Municipality of Gazi Baba

# Local road Singelic - Rashtak II section, 1.23 km

The project envisages for development of technical documentation at a Basic Design level for reconstruction of a local road from Singelic to the village of Rashtak at km 0+000,00 – km 9+393,73. The local road from the v. Singelic to v. Rashtak is part of the local road network in the municipality of Gazi Baba – Skopje and connects the settlements of Singelic, Stajkovci, Creshevo, Bulachani and Rashtak with the road network in the city of Skopje. The beginning of the alignment has been defined at the beginning of Singelic (bordering the construction area of Skopje) and ending at the location of the primary school in the center of Rashtak.

The local road is of 5.5 m pavement (asphalt) width with poor (degraded) final layer of variable cross grades and in some sections (like Rashtak) with very damaged asphalt final layer and does not allow for normal traffic flow. Therefore, its final asphalt layer needs to be reconstructed (rehabilitated). The length of the local road is around 10 km. The subject of the Basic Design is defining all of the elements (sizes) for reconstruction (rehabilitation) of the final asphalt layer of the local road and especially in line with the requirements from the Terms of Reference to envisage sidewalks in the settlements of Singelic, Stajkovci, Creshevo, Bulachani and Rashtak. The purpose of this project is to give a good quality and long-term solution, whose implementation will provide suitable motor and pedestrian traffic as well as provide conditions for normal and safe traffic flow.



Figure 22 - Satelite view of the local road from Singelic to Rashtak

The horizontal solution has been developed in line with the requirements from the Terms of Reference, i.e. entirely in line with the existing condition with horizontal elements, lines and horizontal curves with constant size of radii as well as completely defined traffic profile, with pavement width of 5.50 m. The beginning of the alignment 0+000,00 is at the beginning of the structure that goes across the drain canal and where the settlement of Singelic starts. The end of the alignment, subject of this Basic Design has been defined up to the center of Rashtak (primary school) at km.9+393,73, which makes the total length envisaged for reconstruction (rehabilitation) of the local road from v. Singelic to v. Rashtak with this Basic Design at 9.393,73 m.

The local road consists of two different parts, one flat and the other mountainous with a total of 152 vertices of the horizontal curves. The elements of the horizontal solution allow for normal traffic flow with speed of 30 km/h as well as pedestrian traffic in the settlements of Singelic, Stajkovci, Creshevo, Bulachani and Rashtak. The pavement structure has been defined with the cross grade ranging from 2% in line and curve, which in some sections varies due to damage (deformations). The new grade level has been defined by stripping the damaged final asphalt course in around 3 cm and overlaying it with asphalt course of up to 7 cm. By taking this into account, the grade level was designed in such a way as to follow the existing pavement with the planned overlay. A minimum longitudinal grade level of 0% has been defined from 0+371,89 to 0+384,57 whereas the maximum of 2,75% from 9+287,47 to 9+319,47. The cross grade of the pavement has been designed with 2% in lines and curves with the exception of curves smaller than 20 m, where it was designed with 7%.

Based on the elements given in the traffic profile as well as in the vertical solution, the following cross sections were developed:

In sections with sidewalks (in settlements) (km 0+000,00 - km1+723,50; km 3+796,20-4+844,40 and km 5+556,30 - km 7+093,50) - pavement 2 x 2,75 = 5,50 - sidewalks 2 x 1,<u>50 = 3,00</u> Total: 8,50 m

In the section from km.8+613,50 to km.9+393,73 sidewalk will be constructed from the right side (v. Rashtak) due to spatial restrictions and the configuration of the terrain. In sections where the local road goes through settlements, sidewalks will be constructed with width of 1.50 m. In sections between settlements the traffic profile is of the following structure.

- pavement	$2 \times 2,50 = 5.50$
<ul> <li>shoulders (stabilized)</li> </ul>	$2 \times 1,00 = 2,00$
Total:	7,50 m

Reconstruction (rehabilitation) of the final layer has been envisaged by stripping an average 3 cm from the existing pavement and overlaying it with asphalt BNHS 16A with average thickness of up to 7 cm.

The pavement structure of the sidewalks has been adopted with the following structure:

- behaton elements		6 cm
- sand		4 cm
- blinding layer of crushed rock		<u>15 cm</u>
T	otal:	25 cm

The cross grades have been defined with 2% (pavement and sidewalks) and 4% stabilized shoulders. The surface drainage of storm water has been carried out with the cross and longitudinal grades of the pavement with lateral release in the surrounding terrain.

# **Municipality of Sopishte**

# v. Dolno Sonje – v. Gorno Sonje, L=1.04 km

Taking into account the requirements from the Client, according to the Terms of Reference the asphalted sections of the alignment have to be overlaid with BNHS 16 in average thickness of 7.0 cm while the rest will be new pavement structure of the following characteristics:

- BNHS 16 d= 7.00 cm
- blinding layer of crushed rock d=30.00 cm

The basic programme and design conditions are in line with the Terms of Reference, the rank of the road and the conditions on site.

- road rank	local
- lanes	2 x 3.00= 6.00 m
- shoulders 2x 0.5	1.00 m
- roadbed	7.00 m

The horizontal solution of the alignment is entirely in line with the existing condition of the road. The road axis is guided in such a way as to make full use of the existing pavement. A total of 58 horizontal elements were applied onto the axis of the given section (lines, curves and clothoids)

In the sections of the road with not enough width, a blinding layer is to be laid of d=30.00 cm and on top of it bituminous bearing layer BNS 22 with d=6.00 cm, which would help even it with the existing pavement. A new BNHS 16 layer of d=7.00 cm will be placed on this pavement structure.

In sections where new pavement is to be constructed, the bearing capacity of the blinding layer will have to be proven in construction and if need be, a new, improved blinding layer laid.



Figure 23 - Local road from v. Dolno Sonje - v. Gorno Sonje

## **Municipality Chucher Sandevo**

## Local road Old Kachanichki road

The project envisages for development of the local road Chucher Sandevo – Kachanichki road. For connection of the accompanying structures which are located next to the bypass, i.e. next to the Old Kachanichki road (Kachanichko Dzade) – Municipality of Chucher – Sandevo with asphalt road, technical documentation is to be developed for the construction of a local road with an average length of 2.7 km. This local road is one of the most important roads for connection of the Municipality of Chucher – Sandevo and all of the other accompanying structures next to the road and their entry into the Skopje bypass. The Municipality of Chucher – Sandevo has started addressing this issue in order to build a local road with modern pavement structure.



Figure 24 - Satelite view of the local road Chucher - Sandevo, Kachanichki road

The following structural eler Leg 1	ments are to be adopted:
Pavement	2 x 3,00m = 6,00m
Shoulder	2 x 1,00m = 2,00m
Total pavement width	8,00m
Leg 2	
Pavement	2 x 3,00m = 6,00m
Shoulder	2 x 1,00m = 2,00m
Total pavement width	8,00m
Leg 3	
Pavement	$2 \times 250m = 500m$

Pavement	
Shoulder	2 x 0,75m = 1,50m
Total pavement width	6,50m

The subject of this project is the construction of a local road, i.e. an auxiliary street which will allow for connection of the industrial facilities with the national road that leads towards the Blace border crossing, i.e. connection with the Skopje bypass. The initial section or leg 1 is in the vicinity of the car dealership Maksima whereas the final one is in the vicinity of the bypass embankment. The second section or leg 2 starts at the other side of the bypass embankment and ends at the location of Suva Cheshma. The third, i.e. the final section or leg 3 starts from the bridge of the old Kachanichko Dzade (location Kula) and ends in the vicinity of the asphalt plant. The construction, i.e. the improvement of this road will increase the communication

between all newly-constructed facilities in the vicinity and connect them to the national road and with the rest of the villages in the municipality. This would be of great importance and will contribute to the faster development of the area and avoid all of illegal access roads to the bypass.

The whole section, which is subject to this design, comprises of three partially separated legs, which are dirt roads. This road is a part of the former Kachanichki road or also known as Kachanichko Dzade, which leads to the border crossing of Blace. At this moment, it will be used as an alternative section of the new road. The whole section is a dirt road that the new road will follow. Therefore, it will be improved and design documentation developed at a Basic Design level for a new section, which will follow the old one entirely and which will have only differential deviations from the old one so that the drainage can be carried out appropriately and all of the geometrical elements shaped accordingly. The horizontal solution has been defined with lines, circular curves and clothoids where necessary.

The design speed is 40 (30) km/h. All of the applied horizontal elements are within the allowable range for this road rank and are in line with the rulebook on road design for this particular design speed. The first leg starts at an intersection and ends with a line. The second leg starts with a line and ends with a line. The third leg starts at an intersection and ends at an intersection. The road pavement is widened in all of the curves along the alignment. The grade level of the alignment has been defined with geometrical elements, which are within the allowable range. The new alignment mostly follows the existing dirt road with only a slight rise of the grade level. This is in order to drain the substructure of the road properly. There is one vertical curve. All of the minimum and maximum requirements for the curve values have been met. The road is twisted around its axis and is within the allowable range for this road category. The minimum cross grade is 2.5% while the maximum cross grade is 5%.

When defining the corss profiles, the following elements are to be taken into consideration:

LEG 1 and 2 pavement for two-way traffic with two traffic lanes  $2 \times 3,00 = 6,00$  m shoulders  $2 \times 1,00 = 1,00$  m total pavement width 8,00 m LEG 3 pavement for two-way traffic with two traffic lanes  $2 \times 2,50 = 5,00$  m shoulders  $2 \times 0,75 = 1,50$  m total pavement width 6,50 m

The drainage of the road will be carried out through the cross and longitudinal grade of the road, collecting water from the left and right in earth canals and carrying it outside of the road belt according to the surface of the terrain so as not to cause damage to it. There were no drainpipes and gutters installed since this is not an urban area with neighboring structures in the immediate vicinity of the road and this type of drainage is the most viable solution for this road rank. The substructure has been drained with the corresponding grade and in line with the regulations on road design. Also the grade level has been adjusted accordingly to make

drainage more efficient. In the area of the alignment there is no presence of groundwater and high storm water, requiring special drainage. This is in fact flat and hilly region where the small quantity of storm water drains left and right of the road axis through canals and onto the terrain.

The pavement structure of the road is: Base layer of BNHS16 d= 7cm Blinding layer of crushed rock d = 25 cm Total: d = 32cm

The blinding layer is 25 cm thick since the blinding layer below the old pavement will not be taken out.

# Municipality of Gjorche Petrov, Municipality of Saraj

# Local road to v. Svilare from the connection with the local road at Stopanski Dvor to the borderline of the Municipality of Gjorche Petrov with the Municipality of Saraj

From the beginning of the alignment in the immediate vicinity of the intersection at Stopanski Dvor and up to km.0+460 the road is asphalted from 2.5 to 3.5 m, while the rest is partially graveled with undefined pavement width up to the very end at km.2+503.66.



Figure 25 - Satelite view of the local road Svilare and interchange III, Novo Selo

Taking into account the requirements from the Client, according to the Terms of Reference the asphalted sections of the alignment have to be overlaid with BNHS 16 in average thickness of 7.0 cm while the rest will be new pavement structure of the following characteristics:

- BNHS 16	d= 7.00 cm
- blinding layer of crushed rock	d=30.00 cm

The basic programme and design conditions are in line with the Terms of Reference, the rank of the road and the conditions on site.

- road rank	local
- lanes	2 x 3.00= 6.00 m
- shoulders 2x 0.5	1.00 m
- roadbed	7.00 m

The horizontal solution of the alignment is entirely in line with the existing condition of the road. The road axis is guided in such a way as to make full use of the existing pavement. A total of 58 horizontal elements were applied onto the axis of the given section (lines, curves and clothoids)

In the sections of the road with not enough width, a blinding layer is to be laid of d=30.00 cm and on top of it bituminous bearing layer BNS 22 with d=6.00 cm, which would help even it with the existing pavement. A new BNHS 16 layer of d=7.00 cm will be placed on this pavement structure.

In sections where new pavement is to be constructed, the bearing capacity of the blinding layer will have to be proven in construction and if need be, a new, improved blinding layer laid.

The remaining pavement structure from km. 0+460 to km. 2+503 will be carried out in line with the proposed structure in the ToR, consisting of:

- BNHS 16 d = 7.00 cm
- blinding layer of crushed rock d = 30.00 cm

# Municipality of Kisela Voda

# Reconstruction of pavement and sidewalks at the Mishko Mihajlovski street and street 345

The Mishko Mihajlovski street is in M3 Cvetan Dimov – 64, connects to the Marko Cepenkov street and ends at Emil Zola street. At the end of Mishko Mihajlovski from its left side it branches into 345 street. The width of the existing pavement of Mishko Mihajlovski street and Marko Cepenkov street is 5.00 m, it's asphalted road with two-sided cross grade and visible damage. From both sides of the street there are sidewalks with variable width constructed out of various materials, deformed and damaged with either damaged or no curbs. The width of the existing pavement of 345 street is 7.00 m, it's asphalted road with two-sided cross grade and visible surface damage. From both sides of the street there are sidewalks with variable width of the and in very poor condition.

According to the Terms of Reference, the reconstruction of these streets will require milling of the existing asphalt pavement from 0-3 cm and an overlay with asphalt concrete d=4 cm as well as construction of the existing pavements with behaton tiles, by keeping the existing widths of the pavements and sidewalks. All of these streets are of asphalt pavement and visible damage. There are sidewalks from both sides of the streets, of variable width, constructed out of concrete and clay behaton tiles. These are damaged and deformed with either damaged or no curbs.

The work activities consist of:

- Reconstruction of the existing pavement with milling from 0-3 cma and an overlay with asphalt concrete d=4 cm;
- Reconstruction of the existing sidewalsk which are to be laid with behaton tiles.

The pavement of the streets and sidewalks is to keep their initial width.

- Street rank		apartment
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- Design speed------V = 40-50 km/h
- Pavement ----- with existing width
- Sidewalks ------ with existing width

# SOUTHWEST REGION

## **Municipality Plasnica**

## v. lzhishte – v. Preglovo, L=1.66 km (III section 0.75 km)

#### **Design elements**

1.	Terrain category:	valley
2.	Design speed:	30 km/h
3.	Minimum radius:	25 m
4.	Maximum longitudinal grade :	12%
5.	Minimum convex radius:	100 m
6.	Minimum concave radius:	67 m
7.	Width of traffic lane:	2.0 m
8.	Shoulder width	0.5 m

All of the remaining and applied technical elements have been given in line with the technical regulations and standards on road design. The road alignment is mostly with grades, which meet the legislation on average.



Figure 26 - Local road v Izhishte – v. Preglovo

# **Municipality of Oslomej**

# Construction of a local road in the village of Zhubrino - Leg 1 - Leg 2, from km .0+000,00 to km.1+015,12

The Municipality of Oslomej is one of the thirteen municipalities in the southwestern part of RM. The Municipality is situated in the western part in the settlement of the same name. From the north there's the Municipality of Gostivar, from the east the Municipality of Makedonski Brod, from the south the Municipality of Vraneshtica, from the southweat is the Municipality of Kichevo and from the west the Municipality of Zajas. The Municipality of Solomej takes up a great part of the Kichevo field, which is why there are no significant differences in relief. When it comes to the climate, it's a more severe version of a moderate continental climate. The subject of this project is the development of a Basic D esign with all of the necessary structural details and technical conditions for the construction of a local road in the Zhubrino village. The basic leg is a road that connects the Jagol and Oslomej road from the west and the Tuin – Oslomej road from the east, which goes through the village. Also legs 1 and 2 are designed, which are connected to the basic leg that goes through the village.



Figure 27 - Local road in the Zhubrino village - Leg 1 - Leg 2

This road is municipal road and is of great significance to the locals since it improves the traffic connection between the settlements. This is an existing road with a blinding layer, which starts from the west from the road that connects Oslomej with Jagol up to the road that connects Tuin with Oslomej from the east while both legs connect to the basic leg at the location of the primary school and the municipal mosque in Zhubrino. The basic leg going through the village will be constructed with behaton tiles of 4.0 width whereas the other two legs of 3.0 m width. The road has been damaged with usage. In some places it has pot holes and is in need of reconstruction. This reconstruction envisages for laying a blinding layer onto the existing alignment, cleaning and shaping of the earth canals in places where they exist, construction of new ones, installation of new concrete gutters inside the settlements, cleaning of the existing concrete culverts and setting up new pipe culverts with concrete pipes as well as a new asphalt layer along the entire alignment.

# Design elements

According to the criteria ad conditions of the ToR, the following design elements have been adopted:

- Road rank
   local (group "C")
- Design speed V=30-40 km/h
- Pavement width B=3,20 m'
- Shoulders 2 x 0,75 м' (outside settlements)
- Gutters 2 x 0,75 м' (inside settlements)
- Roadbed
- 4,70м
- Design vehicle motor vehicles

All of the remaining and applied technical elements have been given in line with the technical regulations and standards on road design. The road alignment is mostly with grades, which meet the legislation on average. The road alignment is mostly with grades that meet the legislation (max 12%) on average. The grade level has been designed in such a way as to be entirely in excavation and embankment. In the course of design, special care was paid to the height levels of the existing terrain, for compliance with the conditions on site and the technical norms and regulations. Also in some places the longitudinal rise of the grade level is in embankment and mild cut, which will help provide protection from storm water, affecting the entire length of the road from both sides, left and right. The changes of grade are rounded with radii that meet the required safety standards and provide good visibility and vehicle-dynamic conditions. The longitudinal grade level ranges from i=0.35% - 2,50%. A higher grade can be found from 0+000 to 0+032.93 at i=2,50% at the section that connects to the Kichevo -Oslomej road.

The cross section of the profile contains:

- Roadbed width 4.7 m
- Pavement width 3.2 m
- Shoulder width 3.5 m
- Earth canal 0.33м3/м'
- Asphalt gutter 0.75 m

For cost-effectiveness, the pavement won't be widened in curves while the existing roadbed with be widened only in places used for passing (passing places) of the vehicles.

# **Municipality of Kichevo**

## v. Oslomej - v. Shutovo, L=3,56 km (I section – 1,00 km)

This terrain is characterized by the homogeneity of the relief. In general, the terrain along the alignment can be defined as mountainous. The configuration is non-homogenous with high cross and longitudinal grades. It's important to note that the existing cross grades are not greatly variable. The stretch of the local road goes through mountainous area overgrown with plants and vegetation. The terrain of the alignment is quite stable and appropriate for construction. The new road follows the alignment of the existing road along its entire length while the pavement structure will be constructed onto a naturally compacted base of soil

material, quite stable along the entire alignment, without any need for large-scale excavations and embankments. The concept of this project as technical documentation is standard.



Figure 28 - Local road v. Oslomej - v. Shutovo, L=3,56 km (I section – 1,00 km)

# **Municipality of Struga**

## Local road v. Dolna Belica – v. Oktisi, L=2.59 km

The local road from v. Dolna Belica to v. Oktisi, in length of L=2.59 km will connect the villages of Dolna Belica and Oktisi. The road will be drained through the cross and longitudinal grade, collecting water from the left and right of the road into earth canals and carrying it away from the road into the terrain so as not to cause damage. There were no drainpipes and gutters installed since this is not an urban area with structures in the immediate vicinity and the drainage chosen is much more viable option for this road rank. The drainage of the substructure has been carried out with the corresponding grade in line with the road design regulations. Also the grade level has been made compliant for better drainage. The area of the alignment is not known for high groundwater and storm water that would require special drain treatment. This is mostly a flat region where the small quantity of storm water drains left and right of the road axis through canals into the terrain.



Figure 28 - Local road v. Dolna Belica - v.Oktisi

## **Municipalaity of Ohrid**

## Local road for v. Velestovo, L = 4,09 km (I section - 1,5 km)

The project envisages for development of technical documentation at Basic Design level for widening with shoulders and overlay with asphalt of the road from the v. Velestovo with length of km.0+000, km.4+087.5. The current condition of the local road from the v. Velestovo is asphalted road with base constructed out of local blanket material. Due to the long period of exploitation and external influence, the pavement structure is quite worn and milled with many shallow settlements. In the horizontal and vertical sense, the road does not meet the requirements for safe and normal traffic flow since it doesn't meet the criteria for the minimum radii in the horizontal and vertical curves nor for the cross grades in lines and curves. The road pavement is 4.0 m wide and the road stretch is of variable width ranging from 5.0 to 7.0 m. The plan is to repair the small settlements and cambers in curves with asphalt BNS 22 of  $d_{max} = 20$ 

cm overlaying it with asphalt course BNHS 16a of d=7 cm. There are no installation ducts in the pavement structure.



Figure 29 - Satelite view of the local road Ohrid - v. Velestovo

According to the relief, the local road from v. Velestovo can be defined as mountainous terrain. According to the geological data, the terrain of the local road comprises of rocks of the III and IV categories. From a hydrological point of view, it can be said that the terrain doesn't have shallow groundwater, landslides or continuously wet locations.

The local road of Velestovo accommodates motor traffic consisting of light-weight vehicles and sometimes light-weight trucks.

# Design elements

- Category of terrain:	valley
- Design speed:	30 km/h
- Minimum radius:	25 m
- Maximum longitudinal grade:	12%
- Minimum convex radius:	100 m
- Minimum concave radius:	67 m
- Width of traffic lane:	2.0 m

# - Shoulder width:

#### 0.5 m

The length of the whole alignment is km.4+087.5. Due to the mountaneous terrain and the inability for change of the existing alignment, there are 10 curves. In some curves the pavement has been windened depending on the size of the radius. Chainage was marked every 20 m for each topographic profile.

All of the detailed points that were read on site were transferred onto the vertical solution, the grade level was defined by keeping in mind that one edge of the pavement is always at the same level as the grade level so as not to deviate from the current condition by much while the other edge of the pavement is defined depending on the minimum cross grade in line and curve. We took into consideration the minimum and maximum allowable grades of 0.2% and 12%, but due to the mountainous terrain and the great height difference in short distances, there are longitudinal grades greater than the maximum allowed of 17.8%, but which pose no problem since only motor vehicles and light-weight trucks traverse the road, whose upper limit for climbing cross grades is up to 30%. We also took into consideration the minimum convex radii of 100 m and the concave radii of 67 m. The cross grades in lines in curves and the twisting along the road axis have been drawn. All of the detailed points read from the plan view and the longitudinal profile were transferred onto the cross profiles and then the cross profiles were designed at every 20 m of topographic profile. The terrain levels and grade level have been marked on both sides of the road and the soil qualities in the profiles were calculated. The pavement structure of the local road from the v. Velestovo is to be constructed out of BNHS 16a asphalt with d=7 cm and BNS asphalt 22 with d<sub>max</sub>=20 cm, which will be used for filling the space up to the cambers in the curves and leveling the settlements. Shoulders are to be constructed out of blanket course with d<sub>min</sub>=7.0 cm. The pavement will be drained with the help of the longitudinal and cross grades.

## **Municipality of Debar**

## Local road Debar – v. Bomovo, L = 3.52 km (III section – 1,21 km)

The local road Debar – v. Bomovo is one of the connections of the municipal center Debar with the settlements in the area on the right bank of the river Crni Drim downstream of the HPP Sphilje. Bomovo is one of the settlements which after the construction of this road network has gotten closer to the municipal center for the purposes of revitalization of the area and utilization of its natural resources. The subject of this project is the section of the existing road from km 0+000,00 to the location of Poreni Fonove at km 3+524.07 and in line with the requirements of the Client. At the very beginning the horizontal solution fits with the already constructed street.

Along the alignment the horizontal flow has been defined by following the contours of the existing dirt road, which has been straightened and is easy to follow. The horizontal shaping of the alignment has been carried out with 24 circular curves with clothoids in the range of R 75-1500 m and L 20-100 m, thus providing higher quality for the local road and higher speed. The alignment has been laid out straight. It ends in the village where this road continues towards the abandoned houses of the Bomovo village, which will be another project in the future.



Figure 30 Topographic view of the local road Debar - Bomovo

This road will have the role of connecting the arable land left and right of the alignment and as a shorter distance to the other settlements on the bank of the Crni Drim river (Sushica – Konjari etc). The vertical solution of the design has been defined with the grade level in the longitudinal profile. This alignment element has been adjusted to the on-site conditions of the alignment with overlay of the superstructure. The grade level has been designed with lines of grades within 0.3 - 11 %, which is allowable range, while the changes of grade are circular with vertical radii of R 500-10000. The pavement in the horizontal curves has been twisted around the road axis with cross grades for V=40 km/h. The grade of the twisted ramps is 0.3% - 1.0%. The longitudinal profile has been given in M1:1000/100.

The drainage of the pavement has been solved with the longitudinal grades defined with the grade level and the cross grades defined with the twisting of the pavement. For further conveyance of the water left and right of the alignment, canals, trench drains and gutters were designed as a part of the cross profile of the road.



Figure 31 - Satelite view of the road Debar - Bomovo

# **Municipality Centar Zhupa**

# Local roads through Centar Zhupa, L=1,51 km

The preparation work consists of the following items:

• Cleaning and removal of the vegetation from the alignment in a layer of 15 cm since this is a road that has already been laid a blinding layer;

• Marking of the embankment toes;

The earthworks includes the following items:

• Open cut in line with the designed profiles and levels with previous inspection of the profiles. Since the designed slope grades in the cuts and embankments are not fixed, the Supervisor is advised to allow changes in the course of work depending on the conditions. The excavation will be made to bedding level with excavation accuracy of +-5 cm. It will be mechanical excavation in places where the conditions of the designed alignment allow it. If during work, estimate is made that the excavation will have to be larger (the height of the layer is bigger or smaller on site), the Supervising Engineer will register this change into the site diary and the Contractor will work in line with it. The excavated soil is mostly of the III and IV categories and only a small portion is V category. The excavated soil is deposited along the sides of the road in as similar form as possible. The cubature of the excavated soil will be confirmed by the Supervising Engineer by measuring the average thickness of the excavation and the areas of extracted soil.

After the excavation of the soil underneath the embankment, i.e. of soil up to the IV category, the roadbed is to be compacted in depth of 30 cm with the appropriate mechanical equipment. Compaction will be tested by extracting cylinders or with calibrated sand. Compaction will continue with adding gravel sand or rock material until the roadbed stabilizes and the proper results are achieved. This is carried out with the approval of the Supervisor and the work will not be paid separately, but payment is made per the quantity of the embedded gravel sand or rock material. After this is done, the next step is excavation of soil of the IV category in an open cut, where excavation is made in cuts and borrowpits, and in

line with the design levels. Before work is started, the Contractor shall inspect the designed profiles and in the case of any irregularities, will inform the Supervisor, who will make another inspection together with the Contractor. The changes made should be entered into the profiles and site diary. The changed profiles are carried out by the Contractor and Supervisor, while the correct profiles will be used for calculation. The design grades of the slopes in cuts and embankments in the cross profiles are not fixed so they might be subject to change in the course of work depending on the soil category and other geomechanical characteristics of the material. The section of the slope with the terrain is to be rounded.

Then the drain canal is to be excavated, by making sure that the slopes of the canals are formed in line with the cross profiles in the design. The excavated soil is to be used for the construction of embankments or disposed of into a landfill.

After work for the substructure has been completed, the next step is to construct the superstructure and lay the blinding layer by distributing and compacting crushed stone with vibrating equipment in a layer of 30 cm. The quality of the material for the blinding layer is to correspond to MK standards and to consist of hard and permanent particles mixed in their natural state and artificially with natural sand, silt additives, fillers and other material coming from approved sources so as to achieve a uniform mixture befitting Swiss regulations not only in terms of the particle-size distribution, but also in terms of the suitability for compaction into a stable base. The largest gravel grain in the blinding layer is to be 60mm.



Figure 32 - Local roads through Centar Zhupa

# **Municipality of Centar Zhupa**

#### Local road for v. Gorenci, L=0.50 km

The local road for the v. Gorenci is asphalted only half way. The basic programme and project conditions are in line with the Terms of Reference, the rank of the road and the conditions on site:

- road rank	local
- pavement lanes	2 x 3.00= 6.00 m
- shoulders 2x 0.5	1.00 m
- roadbed	7.00 m

The horizontal solution of the alignment completely matches the existing condition of the road. The road axis follows entirely the alignment of the old road.



Figure 33 - Local road to v. Gorenci

## SOUTHEAST REGION

## **Municipality of Valandovo**

## Local road to v. Pirava, L=0.40 km



Figure 34 - Local road to v. Pirava, L=0,40 km

# DESIGN ELEMENTS

According to the criteria ad conditions of the ToR, the following design elements have been adopted:

- Road rank
- Design speed
- local (group "C") V=30-40 km/h

<ul> <li>Pavement width</li> </ul>	B=3,50 m'
<ul> <li>Shoulders</li> </ul>	2 х 0,50 м'
<ul> <li>Roadbed</li> </ul>	4,50 m

Design vehicle motor vehicles

All of the remaining and applied technical elements have been given in line with the technical regulations and standards on road design. With the Basic Design the new alignment follows the old alignment. In some places the traffic and safety characteristics are to be improved. The existing road has been corrected only slightly so as to come up with better technical solutions, which will not affect the price for construction of the given road. The horizontal curves have been designed without any clothoids, while their radii have been chosen in such a way as to allow for efficient and safe traffic flow.

#### **Municipality of Radovish**

#### Local road for v. Smilanci, II section, L=3,70 km (I section - 0,9 km)

Technical elements of the road:

- design speed	B=40 km;
- pavement width	3,50 m;
- shoulder width	2x0,75=1,50 m;
- autter width	0.50 m:

All of the remaining road elements are to be carried out in line with the technical regulations and standards on road design.

Pavement structure:

- asphalt concrete BNHS 16 with d=7 cm;
- blinding layer for leveling 15-30 cm;

The roadbed and the lanes will be drained from surface water through shoulders by installing canals and asphalt gutters into reinforced concrete pipe culverts.

This terrain is characterized by the homogeneity of the relief. The configuration is nonhomogenous with high cross and longitudinal grades. It's important to note that the existing cross grades are not greatly variable. The stretch of the local road goes through mountainous area overgrown with plants and vegetation. The terrain of the alignment is quite stable and appropriate for construction. The new road follows the alignment of the existing road along its entire length and the new pavement structure will be constructed onto a naturally compacted base of soil material, quite stable along the entire alignment, without any need for large-scale excavations and embankments.


Figure 35 - Local road to v. Smilanci, II section

# **Municipality of Bosilovo**

#### v. Bosilovo – v. Radovo, L=2,53 km (I section - 0,90 km)

In the process of designing, horizontal elements were applied that are in line with the regulations for the design of urban roads and the most optimum solution was defined as well. The elements of the horizontal solution have been arrived at from the alignment of the existing road. The alignment of the local road consists of lines and curves formed with clean circular arches. The alignment in lines and curves follows the existing dirt road. The road is fitted into the existing roads appropriately, i.e. is in line with the existing intersections (at the beginning and the end of the alignment). The vertical solution of the local road is a result of the terrain configuration, by setting up vertical curves in the changes of grade, meeting the minimum

grades for drainage of asphalt pavement structures and ultimate values for the longitudinal grade.



Figure 36 - Local road from v. Bosilovo - v. Radovo

### NORTHEAST REGION

#### Municipality of Kriva Palanka

#### Local road for v. Konopnica, L=1,64 km (I section - 0,33 km)

This road is local and is of great significance to the locals since it improves the traffic connection of v. Konopnica. This road has already been driven through and has a blinding layer laid, but Is quite damaged so in certain times of the year (after heavy rain and snow) is almost unpassable with a regular vehicle. Also, the road lacks in earth canals for the most part of the alignment and the ones that do exist, need to be cleaned and shaped. The existing pipe culverts are almost useless and are to be replaced by new while in some places according to the conditions of the terrain, new ones are to be installed. A completely new blinding layer is to be laid along the whole alignment in thickness of 20 cm as well as a new asphalt layer.

In general, the soil layers meet the requirements for this type of road. The terrain of the road alignment is mostly mountainous. The alignment of the new road mostly follows the existing alignment, which has a blinding layer laid and is in a very poor condition, designed with the corresponding excavations and embankments for meeting the existing legislation and conditions for construction of this type of roads. The run-off of surface and storm water in some periods of the year can be quite high.

The terrain is mostly without any topsoil, intact and stable with no signs of existing or potential landslides. There are no signs of high groundwater that would require support or special conditions for its collection. Canals, reinforced concrete pipe culverts and concrete gutters at a given grade in settlements will be constructed for the collection and drainage of the surface run-off.

#### DESIGN ELEMENTS

According to the criteria ad conditions of the ToR, the following design elements have been adopted:

<ul> <li>Road rank</li> </ul>	local (group "C")
<ul> <li>Design speed</li> </ul>	V=30-40 km/h
<ul> <li>Pavement width</li> </ul>	B=3,50 m'
<ul> <li>Shoulders</li> </ul>	2 х 0,50 м'
<ul> <li>Roadbed</li> </ul>	4,50м
<ul> <li>Design vehicle</li> </ul>	motor vehicles

All of the remaining and applied technical elements have been given in line with the technical regulations and standards on road design.

With the Basic Design the new alignment follows the old alignment. In some places the traffic and safety characteristics are to be improved. The existing road has been corrected only slightly so as to come up with better technical solutions, which will not affect the price for construction of the given road. The horizontal curves have been designed without any clothoids, while their radii have been chosen in such a way as to allow for efficient and safe traffic flow. As a result of the conditions on site several curves were designed with radii of less than 30 m. The smallest radii can be found in two neighboring curves at 1+070.20 and

1+078.65 of 6 m, which was done because any other solution would increase investment costs drastically and could bring property issues on top of that.

The cross section of the profile consists of:

<ul> <li>Roadbed width</li> </ul>	4.50 m
- Pavement width	3.50 m
- Shoulder width	0.50 m
- Earth canal	0.33 m³/m'

For a more cost-effective solution, the pavement will not be widened in curves and the existing roadbed will be widened only in the passing places. The road pavement is of one-sided grade of 2.5 - 5 % depending on the size of the radius and speed. The cross section of the stabilized shoulders is 4% towards the outside of the road. The slopes have been formed with grades 1:1.5 in embankments and 1:1 in excavation.

The road alignment is affected along its entire length from storm surface water. In times of rain, water starts flowing and is collected in earth canals and concrete culverts taken away to the existing ravines. In order to protect it from surface water, in places where possible the road alignment has been raised in relation to the surrounding terrain and in places of excavation, earth canals will be used for the protection against this kind of water. The earth trapezoid canals are of the following size: 35 cm at the bottom, 35 cm in height (min.) and the slopes 1:1.5 and 1:1.

The following pipe culverts will be constructed (replaced) on the road alignment:

•	At km 0+021.62	Ø800
•	At km 0+751.51	Ø800
•	At km 1+041.24	Ø800
•	At km 1+140.72	Ø800
•	At km 1+488.13	Ø1000

The existing culverts are of  $\emptyset$ 300 and are to be replaced with new ones of  $\emptyset$ 800 so that they could be operational. The pipe culverts are of average length og 10 – 12 m'.

The following works are to be carried out:

- Cleaning of the remaining vegetation from the existing road;
- Laying and compacting of a bearing blinding layer for leveling with thickness of 20 cm;
- Asphalting with a new bituminous bearing wearing layer BNHS 16a, d=7 cm
- Canal shaping;
- Replacement of the existing culverts;
- Shoulders stabilized.

The preparation work consists of the following items:

• Cleaning and removal of the vegetation from the alignment in a layer of 15 cm since this is a road that has already been laid a blinding layer;

Marking of the toes of the embankments and the expropriation area with boards, setting up concrete posts on the alignment 10/10/50 cm which are placed at the beginning and the end of the curves or in longer lines at every 100 m' outside of the work area as well as setting up permanent bench marks at every 250 m' made up of concrete posts 10/10/50 with an installed

steel profile of Ø6 mm. After the marking is done with, the Supervisor will inspect the location and work can start upon his approval.



Figure 37 - Local road to v. Konopnica

# **Municipality of Kumanovo**

# Local road v. Dobroshane – v. Shupli Kamen, L=4.79 km (I section – 0.74 km)

The technical documentation envisages reconstruction of the existing local road from the village Dobreshane to the village Shupli Kamen. The technical documentation is on the main design level. Intervention is envisaged only for road grade level, i.e., the same is corrected because of damages on the pavement structure, as well as road settlement with time, i.e., exploitation of the same. A layout is carried out along the existing road axis and the grade level is corrected regarding it.

The technical documentation represents coordinates on the recorded axial points on the road for each change individually. The pavement structure will be scraped along its entire length in course of 4 cm. In places where the asphalt is dilapidated and deformed, i.e., the pavement structure is hardly damaged and will be entirely rehabilitated with asphalt-concrete AB11 of 4 cm and BNS22 of 10 cm, as well the required blanket course regarding the volume of the damage. The grade levels of the newly-envisaged streets are designed with minimal changes from the terrain existing condition in order to evade greater deleveling regarding the local objects and great excavations and embankments, and thus to unnecessary costly investment. The pavement has a variable width. The existing cross grade has been adopted.



Figure 36 - Satellite view on the local road Kumanovo V. Dobroshane - v. Shupli Kamen.

The following structure is envisaged for the pavement:

-4 cm AB 11

-10 cm BNS 22

- variable blinding layer according the required

The blinding layer will be constructed out of crushed rock with fraction of 0-60 mm.

#### **PELAGONIJA REGION**

#### **Municipality of Brvenica**

#### Reconstruction of the local road Dolno Sedlarce – Brvenica.

The given local road starts from the crossroad with the regional road R-2233 in the area of the village Dolno Sedlarce at km 0+00.00 and ends in the village Brvenica at the connection with the regional road R-2233 in the centre of v. Brvenica at km 1+904.50. The same represents a local road from the beginning of the village Dolno Sedlarce to the centre of the village Brvenica, which connects the two villages as well as other places.

The total envisaged length for reconstruction of this local road is 1,905 km from the place of Dolno Sedlarce to the centre of the village Brvenica. Subject of the project of the local road is reconstruction of the pavement in length of 1904.50 m, width of 4.00 m, and shoulders construction with width of  $2 \times 0.75$  m. The total length of the given local road is 1904.50 m. The

design will use the corridor on the existing local road between the two villages, and the design will keep the road elements horizontally and vertically, that is, the horizontal and vertical solution of the given local road is not changed. Also, the drainage of the local road will improve with straightening of the longitudinal and cross grades.

The given local road will adjust to the condition on site and will meet the following technical elements:

- calculated speed V= 30 (40) km/h
- pavement width 4.0 m<sup>1</sup>.
- shoulders width  $2 \times 0.75 \text{ m}^1$ .
- cross grade in line will be 2.5%.

The rest regarding the design will be according the effective regulations and will adjust to the conditions on site. Curves with radii from 14 to 25 m will internally widen the pavement for 1.00 m.

The following is proposed for the pavement structure:

- asphalt-concrete BNHS-16, d = 7 cm.
- shoulders  $2 \times 0.75 \text{ m}$  min d = 7 cm.

The given local road Dolno Sedlarce – Brvenica is a mixed traffic road with all types of motor vehicles, agricultural machines, as well as carts. This road represents main connection between the two villages, as well as a connection with the municipality centre Brvenica and further with the national road network.

Reconstruction of the local road in the villages Dolno Sedlarce and Brvenica will provide greater flow and safer driving on long term plan.



Figure 37 - Descriptive map of the local road Dolno Sedlarce - Brvenica 1:25 000

While designing the given road, attention will be paid that the existing road corridor will be maximally used and adjusted to the condition on site.

The following are the technical elements of this local road:

- road type local
- calculated road speed of 30 (40) km per hour
- pavement width is a traffic lane of 4.00 m<sup>1</sup>
- shoulders 2 x 0.75 m<sup>1</sup> = 1.50 m<sup>1</sup>
- roadbed 5.50 m<sup>1</sup>
- maximum longitudinal gradient of 3.0 %
- minimum cross grade in line is 2.50 %

The rest is in accordance with the valid regulations and concrete terrain conditions.

The village is situated in the region of Gorni Polog. Dolno Sedlarce is a dense valley village connected to the village Brvenica.



Figure 38 - Satellite view of the local road Dolno Sedlarce - Brvenica

#### **Municipality of Brvenica**

# From the connection with R-2233 – entrance of v. Chelopek, L = 1.87 km (I section = 0.61 km)

The given local road will adjust to the condition on site and will meet the following technical elements:

- calculated speed V= 30 (40) km/h
- pavement width 4.0 m<sup>1</sup>.
- shoulders width  $2 \times 0.75 \text{ m}^1$ .
- cross grade in line will be 2.5%.



Figure 39 - Local road with connection to R-2233 - entrance of the v. Chelopek

The pavement structure will consist the following:

- asphalt-concrete BHNS-16, d = 7 cm.
- shoulders  $2 \times 0.75$  m min d = 7 cm.

The given local road is a mixed traffic road with all types of motor vehicles, agriculture machines, as well as carts. This road represents the main connection between the two villages, as well as a connection with the municipality centre Brvenica and further with the national road network.

Reconstruction of the local road in the villages Dolno Sedlarce and Brvenica will provide greater flow and safer driving for a longer period of time.

#### **Municipality of Gostivar**

#### Local road v. Dolna Gjonovica – v. Srbinovo

Subject of this project assignment is defining the program and design conditions and parameters, as well as working basis for preparation of investment-technical documentation: Basic Design for municipality road of type IV v. Dolna Gjonovica – v. Srbinovo, municipality of Gostivar. Subject of this Basic Design is preparation of project documentation for the

municipality road v. Dolna Gjonovica – v. Srbinovo, which is a section that starts from the municipality road in v. Dolna Gjonovica next to the village entrance at km 0+00.00, and ends at km 4+056.79 in front of the entrance of v. Srbinovo, that continues in asphalt road through the village Srbinovo and towards Gostivar. This project documentation has improved the communication between the villages Dolna Gjonovica and Srbinovo.



Figure 40 - Satellite view on the local road v. Dolna Gjonovica - v. Srbinovo

The design elements are in accordance with the road type, the class on site and the design vehicles.

In the preparation of the investment-technical documentation for construction of the local road of type IV v. Dolna Gjonovica – v. Srbinovo the following design elements will be regarded:

Mountain terrain Calculated road speed of 30 km/h / 40 km/h Pavement width (in line) 1 x 3.50 = 3.50 m Shoulders width 2 x 0.75 = 1.50 m Passing places  $20+2 \times 10$ Roadbed 5.00 m Maximum longitudinal grade/gradient 15.00% (16%) Pavement - asphalt BHNS-16 d = 7 cm. Passing places at around 500 m Widening of 1.00 m into curves with small radii

Locals from the region and further use this unasphalted local road as a unique connection

between the v. Dolna Gjonovica and v. Srbinovo. From the performed terrain insight – road alignment field survey it is noted that along the alignment, the pavement structure in some places has visible surface damages and deformations of non-defined width and road of more than 5.00 m, and the pavement does not meet the requirements regarding bearing capacity, speed and traffic safety. Because of the difficult communication between the population and the increasing traffic frequency there is a need for road structure and modernization which will entirely meet all the requirements and will be economically justified.

A feature of the conditions on site, of course, is relief homogeneity. Generally, the character on site along the alignment can be distinguished as mountainous. The configuration is also non-homogenous with great longitudinal and cross grades. Of importance is to emphasize that the existing cross grades are not relatively variable. The stretch, where the existing local road lies, passes between hilly-mountainous lands with vegetation. The terrain, where this part of the alignment lies, is stable and suitable for construction. The newly-designed road along its length follows the existing road alignment, and the pavement structure of the road is constructed upon the existing one. The naturally dense base is of earth material, which is quite stable along the alignment without the need of great excavations and embankments. The concept of this project as a technical documentation is standard. It represents a book for construction solution for newly-designed local road v. Dolna Gjonovica – v. Srbinovo, which mainly follows the alignment of the existing road that usually contains appendices from the type of horizontally-vertically solution and cross profiles.

Subject of the project construction is the existing earth unasphalted municipality road v. Dolna Gjonovica – v. Srbinovo, where the alignment has been driven through for many years and there are visible damages along the road alignment as a result of atmospheric effects, as well soil layers. In order to provide conditions for maximum road traffic safety, geometrically structured elements from individual parts of the existing road have been also improved. The increasing traffic in the Republic of Macedonia imposes both modernization of the existing traffic network and construction of new roads in the region of the municipality of Gostivar. The design goal is establishing optimal technical, economical and traffic solution for the road alignment which will connect the village Dolna Gjonovica with the village Srbinovo, with the municipality centre of Gostivar, greater centres and municipalities from this part of the country. It should be noted that with the newly-designed road, the municipality of Gostivar will have better connection with the villages Dolna Gjonovica and Srbinovo.



Figure 41 - Topographic view on the local road Dolna Gjonovica - Srbinovo

The alignment of the newly-designed road is positioned in such a way to follow the existing road. The use of private property is avoided, i.e., expropriation of land. The beginning of the newly-designed municipality road is in the axle point T<sub>o</sub>, that is, the same joins the existing asphalt road to the village Dolna Gjonovica and in front of the entrance of the same separates to the right at km 0+000.00, and ends right in front of the village Srbinovo at km 4+065.79. The road pavement is formed from one traffic lane of 3.50 m = 3.50 m width, shoulders on both sides of the road of 0.75 m width or total of 5.00 m width. The ultimate radii of the horizontal curves for the calculated speed of 30 km/h total 50 m, and minimal radius of 15.00 m. In the design of the new alignment, radii smaller than the ultimate were used in order for the alignment to fit into the existing road so as to avoid use of private property, i.e., expropriation of land as well as to fit into the existing structures (e.g., reinforced concrete pipe culverts). It means that the reason for using smaller elements is from economic nature, and yet it is a question of a road with considerably small number of vehicles where the annual average daily traffic is less than 500 vehicles. The elements applied in the horizontal solution for the road of this type are satisfactory and in line with the rulebook on road design inside and outside of settlements.

The road grade level is determined according the already adopted criteria, i.e. the newlydesigned grade level follows the existing municipality road, minimum earth mass (economic criteria), avoiding expropriation of land and levelling fit into already constructed drainage objects.

# **Municipality of Gostivar**

# Local road Gostivar – v. Cerovo – v. Simnica, L – 3.08 km (II section 1.12 km)

The section starts from the municipality road to the v. Cerovo, right in front of the entrance of the village at km 0+000, and ends at km 3+084.38 in the centre of the village Simnica, where continues the asphalt road through the village Simnica to Gostivar.

The subject of construction in the project is existing earth unasphalted municipal road v. Cerovo – v. Simnica where the alignment has been driven through for many years and there are visible damages along the road alignment as a result of atmospheric effects, as well soil layers. In order to provide conditions for maximum road traffic safety, geometrically structured elements from individual parts of the existing road have been also improved. The increasing traffic in the Republic of Macedonia imposes both modernization of the existing traffic network and construction of new roads in the region of the municipality of Gostivar.

The design goal is establishing optimal technical, economical and traffic solution for the road alignment which will connect the v. Cerovo with the village Simnica, with the municipality centre of Gostivar, greater centres and municipalities from this part of the country. It should be noted that with the newly-designed road, the municipality of Gostivar will have better connection with the villages Simnica and Cerovo.

Locals from this region and further use this unasphalted local road as a unique connection between the v. Cerovo and v. Simnica. From the performed terrain insight – road alignment field survey it is noted that along the alignment, the pavement structure in some places has visible surface damages and deformations of non-defined width and road of more than 5.00 m, and the pavement does not meet the requirements regarding bearing capacity, speed and traffic safety.

Because of the difficult communication between the population and the increasing traffic frequency there is a need for road construction and modernization which will entirely meet all the requirements and will be economically justified.

To that end, the basic project for this road determines an optimal stretch, that is, an optimal alignment micro location from all aspects – topographic, traffic, spatial, geotechnical, economical, etc.



Figure 42 - Connection to asphalted road v. Cerovo - v. Simnica

A feature of the conditions on site, of course, is relief homogeneity. Generally, the character on site along the alignment can be distinguished as mountainous. The configuration is also non-homogenous with great longitudinal and cross grades. Of importance is to emphasize that the existing cross grades are not relatively variable. The stretch, where the existing local road lies, passes through hilly-mountainous lands with vegetation. The terrain, where this part of the alignment lies, is stable and suitable for construction. The newly-designed road along its length follows the existing road alignment, and the pavement structure of the road is constructed upon the existing one. The naturally dense base is of earth material, which is quite stable along the alignment without the need of great excavations and embankments.

Taking into consideration the current condition of the road from v. Cerovo – v, Simnica, the pavement structure is constructed upon new layer without replacement of the material from borrow pits, i.e. with levelling the earth mass and transportation of the excess material from the excavation at 5 km. Above this base, a blinding layer is to be laid with more than 30 cm thickness across the entire road length and roadbed width of 5.00 m. The asphalt embedding will be carried out on course from crushed rock material – gravel, which is compacted with a vibrating equipment and compaction of CRB > 10% should be reached. The pavement structure of the road is dimensioned according the traffic volume.



Figure 43 - Topographic map of the local road Gostivar – v, Cerovo – v. Simnica

According the known climate changes, the standard atmospheric precipitations have been adopted. For this area, that is, for the common conditions of the temperate continental Mediterranean climate, the criteria for the volume of the atmospheric water is rain that falls once in two years period of time. The atmospheric water from the pavement surface drainages with longitudinal and cross falls. The whole, the sum of the detailed solutions for the culverts, the gutters and the canals represent the drainage system of the road and objects. The culverts and the relative objects collect all the surface run-off from the pavement surface and the ravines. Concrete pipe culverts have been used for collecting the water from the local catchment areas, as well as the atmospheric water from the pavement surface along the road alignment.

#### **DESIGN ELEMENTS**

Calculated road speed	30 km/h
Pavement width 1x 3.50	3.50 m
Passing places (20 x 0.75)	1.50 m
Shoulders 2 x 0.75	1.50 m
Roadbed	5.00 m
Maximum longitudinal grade - gradient	14.84%
Maximum radius of horizontal curve	Rmin. 15 m
Widening into curves with small radii	1.00 m
Minimum radius on vertical curve	Rmin. 450 m
Pavement – asphalt BHNS-16	d=7 cm.

The beginning of the newly-projected municipality road is in the axle point  $T_0$ , that is,, the same joins the existing asphalt road to the village Cerovo and in front of the entrance of the same separates to the right at km 0+000.00, and ends right in front of the village Simnica at km 3+084.38. The road pavement is formed by one traffic lane of 3.50 m = 3.50 m width, shoulders on both sides of the road of 0.75 m width or total of 5.00 m width. The ultimate radii of the horizontal curves for the calculated speed of 30 km/h total 50 m, and minimal radius of 15.00 m.



Figure 44 - Topographic map of the local road Gostivar – v. Cerovo – v. Simnica

In the design of the new alignment, radii smaller than the ultimate were used in order for the alignment to fit into the existing road so as to avoid use of private property, i.e., expropriation of land as well as to fit into the existing structures (e.g., reinforced concrete pipe culverts). The road grade level is determined according the already adopted criteria, i.e. the newly-designed grade level follows the existing municipality road, minimum earth mass (economic criteria), avoiding expropriation of land and levelling fit into already constructed drainage objects. While changing the grade level, care has been taken of the before mentioned criterion, i.e. the road fitting into the existing local road and already formed crossroads, as well as road fitting into already constructed objects, such as pipe culverts along the alignment. High embankments also have been avoided for minimum expropriation of land. The levelling solution is conditioned by: adopted absolute level, the connection to the asphalted road to the v. Cerovo and the end of the road in the v. Simnica.



Figure 45 - Satellite view of the local road Gostivar - v. Cerovo - v. Simnica

#### Municipality of Bogovinje

#### Bogovinje – v. Selce Kech, L = 1.29 km (section I – 0.82 km)

Generally, the character on site along the alignment can be distinguished as mountainous. The configuration is also non-homogenous with great longitudinal and cross grades. Of importance is to emphasize that the existing cross grades are not relatively variable. The stretch, where the existing local road lies, passes between hilly-mountainous lands with vegetation. The terrain, where this part of the alignment lies, is stable and suitable for construction.



Figure 46 - Local road Bogovinje - v. Selce Kech

#### **Municipality of Vrapchishte**

#### Local road to the v. Dobridol, L = 0.93 km

Along the alignment, the horizontal flow is defined by following the contours of the existing earth road straightened and suitable for following. The horizontal shaping of the alignment is carried out with round curves with clothoids in the limits and clothoids which secure high standards for local roads and greater speeds.

The vertical solution transfers all the detailed points read on site, the grade level has been changed in such a way that one of the pavement curbs is always higher than the existing grade level so as it cannot deviate much from current condition, and the other pavement curb follows regarding the minimum cross grade in line and in curve. Consideration has been taken for the minimum and maximum allowed grades of 0.2% and 12%, but because of the mountainous terrain and overcoming great difference in height on short distance, there are longitudinal grades and even greater than allowed of 17.8%, but does not present a problem because the road is used by goods vehicle and light vehicles with upper limit of overcoming maximum cross grade of 30%.



Figure 47 - Local road to the v. Dobridol

# **Municipality of Tearce**

#### Local road in the v. Slatino, L = 0.73 km

The subject of this project is reconstruction and rehabilitation of the local road in the v. Slatino, municipality of Tearce. According the Client's request, this phase prescribes development of a Basic Project for reconstruction and rehabilitation of the local road v. Slatino, municipality of Tearce, where the lane is of 5.0 m width, and the next phase will prescribe development of a Basic Project, where, according the urban documentation for the settlement of Slatino, a width of 5.5 m is about to be reached. The road comes from the rank of available roads, which begins at the crossroad with the regional road R 1203 and continues through the village. This road is of great importance for the region as in future will be raised as an available street for the settlement. The existing condition of the road is asphalted road with around 3 m width, with asphalted structure with relatively damaged asphalt course from BNHS and approximate thickness of 4-6 cm. The road is hardly damaged until the end of the asphalt alignment, thus it is noted that the pavement will be broken and replaced with a new course of asphalt.



Figure 48 - Satellite view of the local road v. Slatino, municipality of Tearce

#### A. Design parameters:

Pavement width	5.0 m to 40 m
where due to unconstructed objects there is no possibility	for widening
Maximum longitudinal grade	12 (15)%
Minimum cross grade in line	2.0%
Design speed	30,00 km/h

According the cross grade of the road, one of the sides is envisaged for drainage canals along the length of the alignment. There are existing canals along the alignment and will be reconstructed in the early phase. The water from the drainage along the alignment is collected into the existing culvert at the beginning of the alignment which conveys it through the regional road.

#### **Municipality of Jegunovce**

#### Local road in R29274 - v. Ratae, L = 1.46 km

The vertical solution in the project is defined by constructed levelling in the longitudinal profile. This element of the alignment is adjusted to the conditions on site of the alignment from the existing road with known overlay for the thickness of the upper structure. The grade level is structured with directions with grades into the limits of 0.3% to 11% which is in the allowed limits, and the changes are curved into vertical radii of R 500-10000.

Designed longitudinal grades, defined by the grade level, and the cross grades, defined by pavement twisting provide drainage of the pavement surfaces. Canals, trench drains and gutters have been designed as part of the cross profile of the road with the purpose of further water running along the left and right side of the alignment.

Mountainous terrain Calculated road speed 30 km/h / km/h Pavement width (in line) 1 x 3.50 = 3.50 m Shoulders width 2 x 0.75 = 1.50 m Passing places 20+2 x 10 Roadbed 5.00 m Maximum longitudinal grade - gradient 15.00% (16%) Minimum radius of the horizontal curve Rmin = 7.50 m Minimum radius of the vertical curve Rmin = 500 m Pavement – asphalt BHNS16 d =7 cm. Passing places of around 500 m Widening of 1.00 m in curves with small radii



Figure 49 - Topographic map 1:25 000 v. Ratae, municipality of Tearce

#### Municipality of Mavrovo and Rostusha

#### R1202 – v. Skudrinje, L = 3.59 km

In the design of the new alignment, radii smaller than the ultimate were used in order for the alignment to fit maximally into the existing road so as to avoid the use of private property, i.e. expropriation of land as well as to fit it into the existing structures (e.g., reinforced concrete pipe culverts).



Figure 50 - Local road R1202 - v. Skudrinje

The design elements are in line with the road rank, the terrain class and the design vehicles.

Mountainous terrain Calculated road speed 30 km/h / 40 km/h Pavement width (in line) 1 x 3.50 = 3.50 m Shoulders width 2 x 0.75 = 1.50 m Passing places 20+2 x 10 Roadbed 5.00 m Maximum longitudinal grade - gradient 15.00% (16%) Minimum radius of the horizontal curve Rmin = 7.50 m Minimum radius of the vertical curve Rmin = 500 m Pavement - asphalt BNHS-16 d=7 cm. Passing places at around 500 m Widening of 1.00 m into curves with small radii

# 4.3 Raw Materials and Additional Materials

The subject of matters is constructed in such a way to cover the positions defined by technological process on the construction of object of this type, as well as Client's requests. The basic raw materials, which will be used for the construction of this road, will be: bitumen emulsion, reinforcement, sand, asphalt-bitumen course, oil for the construction machinery, etc.

The public communal enterprise of the corresponding municipality will undertake the produced waste during process/es realization and the Contractor will safely transport or dispose it or will be appropriately stored and appropriately used.

In the implementation of the project, that is, asphalt construction and similar materials, existing asphalt bases with ecological work licence according the national legislation will be used.

The quantities and the type of construction material will be determined in the Basic Project in line with the performed geotechnical investigations. During the construction activities, small quantity of building waste (removed asphalt course, earth material from culverts' cleaning) will be generated. The Contractor will follow the Law on waste management and all of the activities will be according the Client and the Public Communal Enterprises.

The Constructor of the envisaged rehabilitative activities will prepare a plan for organization of activities, which will define the time, the dynamics and the way of realization of construction activities: supply of construction material, way of implementation, quantity of construction material, etc. In the plan, the Constructor should define the locations of the relative installation (installation for asphalt, available roads, etc.) and determine whether there are any sensitive areas nearby where additional measures for decreasing the effects will be envisaged.

# 5. Description of the Environment around Projects' Location

This chapter of the Environmental Impact Assessment Report describes the current condition of the environment from the viewpoint of natural-geographic characteristics of the area, climate-meteorological conditions of the area and the conditions in the media and environmental areas, air, water, soil, noise, waste... Having in mind the fact that investment projects are envisaged on already existing roads, there is no danger that the realization of the envisaged investment will have additional negative influence upon certain endangered vegetative and animal species.

# 5.1 Location

The project for reconstruction and/or rehabilitation of local roads in the Republic of Macedonia (total of 47 sections) will be implemented in all of the seven Plan regions on the entire territory of the Republic of Macedonia. The Republic of Macedonia is situated into South-eastern

Europe and takes the central part of the Balkan Peninsula. The territory of the Republic of Macedonia spreads over 25.713 km<sup>2</sup>. On north it borders with Serbia and Kosovo, on east with Bulgaria, on west with Albania and on south with Greece. It is situated between 40°51' and 42°22' north latitude and between 20°27' and 23°02' east longitude.

The length of the borders with the neighbouring countries totals around 748 km. The Republic of Albania is on the west with border length of 151 km, the Republic of Greece is on the south with border length of 228 km, the Republic of Bulgaria is on the east with border length of 148 km and the Republic of Serbia (including Kosovo) is on the north with border length of 221 km.



Figure 51 - Map of the location of the Republic of Macedonia

# North-eastern Region

The north-eastern region includes municipalities in the uppermost north-eastern part of the Republic of Macedonia along the border with Kosovo, Serbia and Bulgaria, that is, the drainage basins of the rivers Pchinja and Kriva. The total area of this region is 2310 km<sup>2</sup> or 9.3% of the total area of the Republic of Macedonia. *Kumanovo and the region*, which gravitates towards it, is located in the northern part of the Republic of Macedonia. The northernmost parts of this territory has Kozjak north of the v. Mglince, in the valley of Mala River, and the southernmost is located the area of the v. Zhivinje. The distance from the uppermost northern to the southernmost part in the Kumanovo region totals 43 km air-line, and in the east-west distance is 50.4 km. Kumanovo area is separated from the adjacent areas with old vast mountains. The branches of Skopska Crna Gora, which are known under the name Karadak in this region, rise in the west. The slopes of Ruen are in the north, while the slopes of the Kozjak Mountain are inclined towards the Trgovishka area. The German mountain is in the east along with the Slavishka Valley, while in the southern and the south-eastern parts are the hilly terrains of the

Gradishka Mountain which is separated from the Skopje Valley and Ovche Pole with the wavy Kumanovo Field. The Kumanovo area (the old municipality of Kumanovo), where nowadays exist five units of the local government (Kumanovo, Staro Nagorichane, Lipkovo, Orashac and Klechovce) spread over 1212 kilometers square area, which represents 4,71% of the territory of the Republic of Macedonia. In this area lie 110 settlements mainly settled with ethnically heterogeneous population. The Kozjak Mountain generally lies between the largest two rivers in this area, Pchinja and Kriva River. The Bislimska Canyon of the Pchinja River is a place rich of natural beauty. Because of the strength of the rocks it separates, in certain places the canyon looks like a canyon with great number of caves on the rocky sides. Beside the two mentioned rivers, the Kumanovo area contains underground waters, mineral sources, as well as artificial accumulations. Beside the rivers Pchinja and Kriva, more significant rivers in this area are Kumanovska River, which arise from the Lipkovska and Kojnarska River, than Slupchanska, Otljanska and Matejachka River. In the region of Lipkovo, there are two accumulations on the Lipkovska River. In the region of Kumanovo there is couple of mineral sources. The most popular are those at the village Proevce, than in Lipkovo, at the v. Stranovac, in Klechovce, etc. So far, the healing waters of these sources are used n the v. Proevce with the Kumanovo spa and the exploataton of the mineral waters in the v. Proevce and Klechovce. The lowest recorded temperature in Kumanovo and the Kumanovo area is 24°C. The average annual amount of precipitation is 549.3 mm on square meter. The most common wind that blows in these areas is the north one, and then the north-western. The northern wind is mostly present in January, June and July, and the north-western from May to October. The average annual insolation in Kumanovo is 2,200 hours. The natural resources in Kumanovo are various. Beside waters, one feature is the fertile soils, various vegetation and deposits of metallic and non-metallic ores. From the metallic deposits, one of the popular deposits is the antimone-arsen deposit at the v. Lojane, while the non-metallic are the basalt and clay reserves at the v. Mlado Nagorichane. At the v. Lipkovo are used the travertine, and at the v. Beljakovce are the opaline breccia deposits, that is marble at Vuksan. Kriva Palanka is a town located in the north-eastern part of the Republic of Macedonia, situated under the slopes of Osogovo Mountains on the both coasts of Kriva River. Near the town, there is the national border Deve Bair crossing with the Republic of Bulgaria. It is 60 km remote from Kumanovo and 100 km from Skopje in eastern line. Kriva Palanka has temperate continental climate with temperate cold winter, temperate warm summer, fresh spring and relatively warm autumn, due to the geographical disposition and of certain influences comming from the Aegean Sea via Kriva River. The high parts of the Osogovo region are affected by the mountainous climate. The average annual temperature is 10.2°C. During the year, the hottest month is July with an average value of 20.0°C. The coldest month is January with an average of -0.3°C. The average annual temperature hesitation is 20.30°C. In comparison with the surrounding areas, the Kriva Palanka area gets significant amount of precipitation. This is due to the absolutely great altitude which represents natural water vapour condenser which is carried by the western and southern winds. The average date of the first snow cover in this area is November 30. The areas over 1700 m above sea level have quite low average annual temperatures, therefore the peaks of Ruen and Carev Vrv are under snow cover from October until early June. Ruen remains under the snow cover even in July.

# **Eastern Region**

The eastern region encompasses the drainage basin of the river Bregalnica and occupies total area of 3537 km<sup>2</sup> or 14.2% of the total area of the Republic of Macedonia. The municipality of Kochani is situated in the eastern part of the Republic of Macedonia, on the northern side of the Kochani Valley and occupies the two banks of the Kochani River, where it leaves the Osogovo region and spreads its valley. The town is situated on the south of the base of the Osogovo Mountains. At 8 km to the south, the fertile Kochani Valley is enclosed by the mountain Plachkovica. The total area of the municipality of Kochani is around 382 km<sup>2</sup>. The municipality of Kochani has population of 38.092 inhabitants. The municipality is consisted of 28 settlements, and the town of Kochani is an administrative centre. The municipality of Shtip is situated in the middle drainage basin of the river Bregalnica in the heart of Eastern Macedonia. The area of Shtip has mainly mountainous and hilly location, with the exception of the Kochani, Ovche Pole and Lakavica Valleys with the valleys of the rivers Bregalnica and Lakavica. The average height difference in total between the mountainous ridges and planes along the river flows is 1,300 m, and the average sea level is 250 m. The sea level of the municipality is 300 m. It is situated on an area of 893 km<sup>2</sup> (town area: 13.5 km<sup>2</sup>), as of the last census, it has population of 47,796 inhabitants (number of town inhabitants: 42,625) in 71 settlements. The municipality of Shtip spreads in the middle drainage basin of the river Bregalnica and is the centre of the Eastern mountainous region. It borders with seven municipalities, such as: Radovish, Konche, Negotino, Gradsko, Lozovo, Sv. Nikole and Karabinci. The municipality of Karabinci takes wide are in the middle drainage basin of the river Bregalnica and spreads on the north-western slope of the Plachkovica Mountain, via the wide valley of the river Bregalnica to the north-west of the hilly morphological terrain of the Ovche Pole. The municipality borders with the municipalities of Radovish, Shtip, Sveti Nikole, Probishtip, Cheshinovo-Obleshevo and Zrnovci. The territory of the municipality covers an area of 259 km<sup>2</sup> and is enlisted in the middle-sized municipalities in the Republic of Macedonia. The average population density is small and totals 15.52 inhabitants per km<sup>2</sup> as of the census from 2002. It has 29 settlements and all of them are rural. The municipality of Berovo, situated in the Berovo Valley, takes the easternmost part of the Republic of Macedonia; to the south it borders the municipalities of Novo Selo, Bosilovo and Vasilevo, to the west with the municipalities of Radovish and Vinica, to the north with Delchevo and Pehchevo, to the east with the national border with the Republic of Bulgaria. The total area of the municipality of Berovo is 595 km<sup>2</sup>, and is situated on average sea level of 800 m. The municipality has 13,941 inhabitants in 9 settlements, out of which Berovo is the only town. The municipality of Delchevo is a municipality in the Eastern Macedonia. The centre of the municipality is the city of Delchevo. The geographical area totals 423 km<sup>2</sup> and has around 17,713 inhabitants. Delchevo has 22 settlements, such as: the town of Delchevo and the villages: Bilga, Vetren, Virche, Vratislavci, Gabrovo (the Delchevo region), Grad (the Delchevo region), Dramche, Dzvegor, Iliovo, Kiselica, Kosovo Dabje, Nov Istevnik, Ochipala, Poleto, Razlovci, Selnik, Stamer, Star Istevnik, Trabotivishte, Turija and Chiflik (the Delchevo region). At 164 km east of Skopje, in the base of the Golak Mountain, spread on the two banks of the river Bregalnica lays the pearl of the Eastern Macedonia, the town of Delchevo. It is the biggest settlement in the Pianec region, which covers an area of 585 km<sup>2</sup>

between the Osogovo Mountain (to the north) and Malesh Mountain (to the south). The town lies at 590 m to 640 m above sea level. Although it is in the easternmost part of the country, Delchevo has a relatively good geographical position and good traffic connections. It is the crossroad for the Eastern Macedonia. Via Pehchevo (27 km) and Berovo (34 km) it is connected to Strumica to the south and via Makedonska Kamenica (22 km) and Kochani (48 km) to Shtip to the north-west. Vinica is 39 km to the west, and the national border "Arnautski Grob" is 11 km to the east. All the rural settlements and the recreation centre Golak are connected to the town via asphalted roads from regional and local type, while a modern magistral road is constructed to the national border. The farthest settlement from the municipality centre is the historical village Razlovci (17.5 km). The climate in the municipality of Delchevo is continental eastern-European with modified pluviometric regime. The annual temperature in Delchevo is 10.7°C with absolute minimum of -26°C and absolute maximum of 37°C, while in the mountains the average annual temperature falls to 3.5°C. The warmest month is August, and the coldest January. Spring is always colder than the autumn. The dowdiness is not great, thus sunny and light days predominate during the year. The average annual precipitations in Delchevo are 548 mm, and in the mountains above 1,600 m above sea level it reaches 1,000 mm. Precipitations, although relatively low, have favourable schedule in the vegetation period (April-September) and totals more than 50% from the total annual precipitations. The vegetation period with temperature higher than 10°C lasts 191 days during the year. This favourable climate provides existence of various plants and at the same time presents quite favourable natural condition for tourism development in this area.

# **Polog Region**

This encompasses the Polog Valley, the Mavrovo Plateau, the mountain massif Bistra and the valley of the river Radika. The total area of the region is 2,416 km<sup>2</sup> or 9.7% from the territory of Macedonia. The Polog Region is composed of the following 9 (nine) municipalities: municipality of Mavrovo and Rostusha, municipality of Gostivar, municipality of Brvenica, municipality of Vrapchishte, municipality of Zhelino, municipality of Bogovinje, municipality of Tetovo, municipality of Tearce and municipality of Jegunovce.

*Municipality of Brvenica* – a municipality in the north-west of Macedonia. The centre of the municipality is the village of Brvenica. The municipality exists as an individual one since 1996 and contains 10 villages next to Suva Gora. The population in the municipality is mainly Macedonian and Albanian. Brvenica is a rural municipality and borders with the municipalities of Tetovo, Bogovinje, Zhelino, Gostivar, Vrapchishte and Makedonski Brod. The Vardar River flows through the municipality. Besides the Vardar River, significant geographical forms in the municipality are the Polog Valley and the Suva Gora Mountain, which lies through the entire municipality. The Kozjak Lake is part of the municipality. Brvenica belongs to the rural municipalities and contains 10 settlements organized into 11 local communities, such as: Brvenica, Dolno Sedlarce, Gorni and Dolni Chelopek, Miletino, Radiovce, Blace, Stenche, Volkovija, Tenovo and Gurgurnica. Six of these local communities are valley, four are hilly and one is mountainous. **The municipality of Gostivar** is a municipality in the north-west part of

the Republic of Macedonia. On the territory of the municipality is located the biggest Macedonian river Vardar. The centre of the municipality is the town of Gostivar. The area of the municipality is predominated by rich nature, favourable geographical position, 500 m above sea level, the first ripple of the river Vardar. For one to come in Gostivar from Ohrid, Skopje or Tetovo, the modern highway is used which passes through the fertile Polog Field. Actually, all the communications, road or railway, provide fast circulation. The airport in Ohrid is 100 km to the south, and the distance from the airport in Skopje is 90 km. Gostivar is a municipality which covers an area of around 650 km<sup>2</sup>. The town represents administrative, political, business and cultural environment for about 80,000 inhabitants, out of which 36,000 live in the town. Here live Macedonians, Albanians, Turkish people, Roma people and others. The municipality of Vrapchishte is a municipality in the Western Macedonia. The centre of the municipality is Vrapchishte. The municipality of Vrapchishte is situated in the Polog Region in the Republic of Macedonia. Here are the villages: Vranovci, Vrapchishte, Galate, Gradec, Gorjane, Dobri Dol, Gjurghevishte, Zubovce, Kalishte, Lomnica, Negotino – Polog region, Novo Selo, Pozharane, Senokos and Toplica. The municipality of Bogovinje is a municipality in the north-west of Macedonia. The municipality of Tearce is a municipality in the Western Macedonia. The centre of the municipality is the village of Tearce. According the census of 2002, the municipality of Tearce has 22,454 inhabitants, out of which: Macedonians 2,739 (12.20%), Albanians 18,950 (84.39%), Turkish people 516 (2.30%), Roma people 67, Serbs 14, people from Bosnia and Herzegovina 1, other nationalities 167. The municipality of Jegunovce is a municipality in the Western Macedonia. The centre of the municipality is the village of Jegunovce. With the new territorial planning of the Republic of Macedonia since 2005, the municipality of Vratnica becomes part of the municipality of Jegunovce. According the census of 2002, the municipality had 5,963 Macedonians (55.26%), 4,652 Albanians (43.11%), 109 Serbs (1.00%), 41 Roma people (0.37%), and others. The municipality of Jegunovce is situated in the Polog Region in the Republic of Macedonia. The municipality encompasses Belovishte, Vratnica, Zhilche, Jazhince, Jegunovce, Kopanice, Orashje, Podbrege, Preljubishte, Raotince, Ratae, Rogachevo, Sirichino, Staro Selo, Tudence and Shemshevo. Actually, morphologically it is situated between the west slope of the limestone mountain Zheden and the southern slope of Shar Mountain, that is, it is situated on wide alluvial plateau of the Vardar River. With the new territorial organization of the mountains since August 16, 2004 in the Republic of Macedonia, in the frames of this municipality enters the former municipality of Vratnica. According its location, the municipality of Jegunovce is of great significance for the economical and strategically position because on broaden belt and across one pass it is connected with RS in the Kosovo part. A regional road passes through it, which is of great international importance. Also, here passes the railway Skopje - Tetovo - Kichevo. It borders the municipalities of: Tearce, Zhelino, and Saraj, as well with the national border line with Serbia in the Kosovo part. The municipality of Jegunovce covers an area of 174 km<sup>2</sup>.

# Vardar Region

This region is located into the central part of Macedonia and covers the middle drainage basin of the Vardar River, the lower flows of the tributaries Bregalnica and Crna River and the end western part of Ovche Pole. It encompasses an area of 4,042 km<sup>2</sup> or 16.2% of the territory of Macedonia. The municipality of Veles is located in the north-eastern part of the Vardar region. Veles covers the areas around the main water flows Babuna, Topolka and Otovica which belong to the basin of the Vardar River. The municipality borders the municipalities of Chaska and Zelenikovo to the west, the municipality of Petrovec to the north, and the municipalities Gradsko, Lozovo and Sveti Nikole to the east. It occupies a total area of 428 km<sup>2</sup>. The number of inhabitants that live in Veles totals 55,108, out of which 43,716 live in the centre of the municipality of Veles, and the rest live in the other settlements of the municipality. The municipality of Sveti Nikole is situated in the Ovche Pole in the north-eastern part of the Republic of Macedonia. It lies in the central part of Ovche Pole, borders with Probishtip, Kumanovo and Petrovec, Veles and Shtip, and it covers an area of 480 km<sup>2</sup>. The total number of inhabitants in the municipality of Sveti Nikole totals 18,497, with 34 rural settlements. The municipality of Lozovo is a municipality in the Central Macedonia. The centaur of the municipality is the village of Lozovo. The municipality of Lozovo is situated in the Vardar region in the Republic of Macedonia. This municipality has the villages: Adzibegovo, Adzimatovo, Bekirlija, Dorfulija, Gjuzemelci, Karatmanovo, Kishino, Lozovo, Milino, Saramzalino and Kjoselari. The municipality of Lozovo is placed in the central part of the Republic of Macedonia and takes part of the fertile plateaus of the Ovche Pole. The beautiful green spaces and golden wheat fields give a special beauty of this area and attract the attention of each visitor. The territory of the municipality of Lozovo spreads on an area of 165 km<sup>2</sup>, which includes 11 settlements. The ethnical structure is mostly composed of Macedonian population, and there is a small number of Turkish, Vlach, Albanian and other population. Regarding the geographical position, 10 settlements are plateau and only one is hilly. The average population density is 16.1 inhabitants per km<sup>2</sup>. The municipality has 2,858 inhabitants, out of which 941 in Lozovo. There are 11 settlements, such as: Lozovo, Dorfulija, Kratmanovo, Milino, Kjoselari, Saramzalino, Adzimatovo, Gjuzemelci, Kjishino, Bekirlija and Adzibegovo. The magistral road Veles – Strumica passes through the central place, as well the railway Veles – Kochani which enables the municipality to be connected to the other territorial units. It borders with four neighbouring municipalities, such as: Sveti Nikole, Veles, Shtip and Gradsko. The municipality of Lozovo is under southern Mediterranean-climate influence which is very feeble, while the modified temperate continental influence predominates. The average precipitation is 472 mm/m<sup>2</sup>. The most common wind is the north-west with average speed of 6 km/h. The warmest period of the year is July-August with maximum temperature of 41°C, and the coldest is January-February with temperature of -18°C. The total agricultural area of the municipality totals 16,331 ha, where the greatest part takes the cultivated land.

# Pelagonija Region

This region encompasses the Pelagonija and the Prespa Valleys, it covers an area of 4,717 km<sup>2</sup> or 18.9% of the territory of Macedonia. The Pelagonija Region is composed of the following 9 (nine) municipalities: municipality of Resen, municipality of Bitola, municipality of Novaci, municipality of Mogila, municipality of Demir Hisar, municipality of Krivogashtani, municipality of Prilep, municipality of Dolneni and municipality of Krushevo.

The municipality of Prilep covers an area of 1,194.44 km<sup>2</sup> and has density population of 69.27 inhabitants per km<sup>2</sup>. The municipality borders municipality of Chashka and Dolneni to the north, Kavadarci to the east, Krivogashtani, Mogila and Novaci to the west and Greece to the south. In this municipality enter 58 villages: Alinci, Belovodica, Berovci, Beshishte, Bonche, Veprchani, Veselchani, Vitolishte, Volkovo, Vrpsko, Galichani, Golem Radobil, Golemo Konjari, Gugjakovo, Dabnica, Dren, Dunje, Erekovci, Zhivovo, Zagorani, Kadino Selo, Kalen, Kanatlarci, Klepach, Kokre, Krushevica, Krstec, Lenishta, Lopatica, Mazhuchishte, Mal Radobil, Malo Konjari, Malo Ruvci, Manastir, Marul, Nikodin, Novo Lagovo, Oreovac, Peshtani, Pletvar, Podmol, Polchishte, Prilepec, Prisad, Rakle, Selce, Smolani, Staro Lagovo, Toplica, Trojaci, Topolchani, Trojkrsti, Carevikj, Chanishte, Chepigovo, Chumovo, Sheleverci and Shtavica. For the development of the agriculture, great importance have the temperature limits, the spring and the autumn minimum. The maximum precipitations in April totals 78.9 mm and in October 45.5 mm. The summer minimum appears in July and totals 18.9 mm. The average water deposition during the vegetation period of the plants (from May to September) totals 181.3 mm. This average is ideal for cultivation of some crops, especially for tobacco, while other plants species, which need greater amount of humidity, have to be watered. Winds, as ecological feature, take special place in the agriculture production. The north-western wind blows with maximum speed of 22.5 m/sec and with average annual frequency of 303 promile regarding the winds from all sides and silences. South-eastern wind blows with average speed of 3.8 m/sec, and its frequency is 136 promiles. The western wind has frequency of 92 promiles, and the northern of 81 promiles. The smallest frequency has the south-eastern wind – 16 promiles. Bitola is a town in the south-western part of Macedonia. It is administrative, cultural, economical, industrial, educational and scientific centre for this part of Macedonia. The town has average annual air temperature of 11.1°C, but with great declinations in certain years: from 10.1°C in 1975 to 13.1°C in 1952. The coldest month is January with average monthly temperature of -0.6°C, but with absolute minimum temperature of -30.4°C. The warmest month is July with average monthly temperature of 22.2°C, and with absolute maximum temperature of 41.2°C. The absolute annual air temperature fluctuation is 71.6°C, which is a feature of the continental climate. The temperature has a characteristic of a continental climate, and the precipitates of a dry modified Mediterranean or mountainous climate, which, at moments, has breakouts of hot air masses from North Africa, i.e. Sahara. The average annual amount of precipitation is 601 mm, with values from 338 mm to 879 mm. The municipality of Resen is situated in the Prespa Valley in the south-western part of the Republic of Macedonia and covers an area of 739 km<sup>2</sup>. It is separated on land with 562 km<sup>2</sup> and water with 177 km<sup>2</sup>, represents a special spatial unit, which is geographically covers around the transaction of the 41° north latitude and 21° east longitude. The municipality of Resen borders the municipalities of Ohrid, Bitola and Demir Hisar. In the municipality of Resen are recorded 44 toponims of places, out of which 43 are rural, 39 active and 4 inactive, and one urbanized environment. The municipality of Resen is situated in the Prespa Valley and is limited with the mountains Baba (the highest peak is Pelister with 2,600 mm) to the east and Galichica (2,235 m) to the west. Plakenska and Bigla (1,933 m) Mountains are to the north and on the Albanian part with Gorbach (1.750) and somewhat lower branches of Galichica to the south. The Prespa Valley is situated between the two national parks Pelister and Galichica, that is, the two national parks are situated on its territory. The Prespa Valley has the two lakes, the Small and the Big Prespa Lakes. In the waters of the Big Lake is situated the trijunction of the Macedonian, Albanian and Greek national borders. North of the lake is placed the Ezerani Nature Park on an area of 1,917 ha, out of which 1,066 ha are land, while 851 ha are water surface. The relationship of the land and water surface is relative because the level of the Prespa Lake varies considerably during the year and especially on longer periods. The protected area is a home to about 200 bird species, out of which 62 species are enlisted in the protected species according the Bern Convention, and three of them are in the European Red List of world endangered species. Characteristic representative of the avifauna in the Prespa Lake is the pelican (Pelecanus crispus). The pelican is one of the largest birds which live on water, mainly in the warmer regions, and one can find it only on the two Prespa Lakes. The unique colony of the great white pelican (Pelecanus onocrotalus) in the European Union is found in Prespa. Natural rarity represents the Golem Grad Island situated in the Big Prespa Lake and covers an area of 1 km<sup>2</sup>. The island has rich forest vegetation with greatest representation of the foya which is an endemic species. The island had 7 churches, out of which only the cave church of St. Peter is time-honoured. The island is an archaeological locality with leftovers from houses, necropolis from the Roman period and the medieval period, rich reservate of endemic plants, as well as natural rarity protected by Law and isolated habitus with minimum influence by humans. It enters in the frames of the Galichica National Park. The agricultural land represents a resource not only for the existence of the population from the Prespa region, which mostly cultivates orchards and types of tourism. The forest on the area of the municipality of Resen represents a natural resource characterized with significant presence, both in the mountainous areas and in the hilly areas. The last few years, the forest areas and thickets in the Prespa region are increased due to the organized system for forestation and the natural re-vegetation of forests. The municipality of Krushevo is a municipality in the Western Macedonia. The centre of the municipality is the town of Krushevo. The municipality of Krushevo spans in the south-western part of Macedonia. In the frames of the municipality, the town of Krushevo has a central location and represents administrative, economical and cultural centre. Its neighbouring municipalities are Krivogashtani and Dolneni to the east, Makedonski Brod and Plasnica to the north, Dugovo to the west, Demir Hisar to the south-west and Mogila to the south. The municipality and the town of Krushevo are connected to the co-regional roads R 516 (Prilep (connection to R 526)-Krushevo-Sladunjevo (connection to R 416)) and R 517 (Krushevo (connection to R 516)-Pusta River-Cer (Prostranje) (connection to R 416)), which join the magistral roads M4 and M5. The municipality of Krushevo is situated in mainly hillymountainous area with 600 to 1,800 m above sea level. The municipality covers the southern branches of the Bushova Mountain, part of the Drevenichka Mountain and part of the Pelagonija Field with the plateau of the Crna River. The highest level of the Krushevo Mountain and the branches of the Bushova Mountain is the peak Golomanec 1,664 m. The town of Krushevo is located on 1,350 m above sea level, while the entire area, north and north-west of Krushevo, and is located on 1,500 to 1,700 m above sea level. From the southern parts of the Krushevo Mountain arise the Zhaba and Zhureshnica Rivers, which enable the mountain in that part to be distinguished with deep ravines and occasional flows. The Bushova Mountain has meridional direction of spacing, which from the peak Musica, 1,791 m, to the west connects to the Kozjak Mountain, 1,762 m, and continues to the west connecting with the Baba Sach Mountain, 1,747 m. To the north-east, the mountain connects across the pass Barbaras to the Jakupica Mountain. To the south, there is a small connection to the Drvenechka Mountain, and through it geographically connects to Bigla. The municipality of Krushevo covers small part from the Pelagonija, i.e. the Prilep Field, which spans from the riverbed of Crna River to Sazhdevo.

# South-eastern Region

This region encompasses the Strumica-Radovish and the Gevgelija-Valandovo Valleys, that is, the drainage basin of Strumica River and the lower drainage basin of the Vardar River. Its area is of 2,739 km<sup>2</sup> or 11% of the territory of the Republic of Macedonia.

The municipality of Valandovo is situated in the south-eastern part of the Republic of Macedonia. It is placed south of the Demir Kapija Canyon, east of the Vardar River and test and north of the mountainous branches of Plavush and Belasica. Territorially, it borders municipality of Konche to the north, municipality of Strumica to the east, municipalities of Dojran and Bogdanci to the south-east, and Gevgelija to the west. It borders with the Republic of Greece to the east. Valandovo is a crossroad of many important roads leading to Skopje, Gevgelija, Dojran and Strumica. The highway Gevgelija-Skopje passes through this municipality. Near the municipality, there are three national borders. The distance from the national border Dojran with the Republic of Greece is 26 km, Bogorodica is 30 km, and the national border Novo Selo to the Republic of Bulgaria is 48 km. The municipality of Valandovo is relatively big municipality with 331 km<sup>2</sup>. According the rate of the sea level with average 226 m, it belongs to the lowest municipalities in the Republic of Macedonia. The average height rate in the Valandovo Field is 82 m. The modified Mediterranean climate, 290 sunny days, average temperature of 14.5°C and absorbed heat energy of more than 4,000° annually are only part of the indicators for the extraordinary climate conditions of this municipality. According the terrain configuration, the area of the municipality can be divided into two parts: hilly-mountainous and valley. The hilly-mountainous part covers around 20.8 km<sup>2</sup> or 63% of the total area of the municipality, such as: the total northern side of the town surrounded with the Plavush Mountain, Belasica to the east and Pogana to the south. The valley part covers an area of 12.3 km<sup>2</sup> or 37% of the area of the municipality and lies from the base of Belasica, i.e. the Anska River source, along its length until its flow into the Vardar River. The municipality of Radovish is a municipality in the South-eastern Region of the Republic of Macedonia, with an area of 608 km<sup>2</sup> and 28,244 inhabitants. The centre of the municipality is the town of Radovish. The settlements

in the municipality are the town of Radovish and the surrounding villages: Ali Koch, Ali Lobasi, Buchim, Voislavci, Damjan, Drzhani, Durutlija, Zleovo, Injevo, Jargulica, Kalauzlija, Kalugjerica, Karalobosi, Karadzalar, Kozbunar, Kodzalija, Novo Selo, Oraovica, Papavnica, Pogulevo, Podaresh, Pokrajchevo, Prnalija, Raklish, Sarigjol, Smilanci, Suldurci, Supurge, Topolnica, Kjoselija, Hudaverlija, Cheshme Maale, Shaintash, Shipkovica and Shturovo. The municipality of Radovish is situated into the south-eastern part of the Republic and covers the northwestern part of the wide Strumica-Radovish Valley, that is, the upper drainage basin of Radovish River. The northern part belongs to the Rhodopes zone, Plachkovica and Goten Mountains, the southern part to the Smrdesh Mountain, the hilly side of the area Juruklak (Jurukluk) or Damjan Field is on the south-east, and the alluvial plateau of the Radovish River is situated on the north-west. The municipality of Radovish has good gravitational-contact and functional connections in north-west – south-east direction, that is, Shtip and Strumica, out of which the town of Radovish is only 35, that is, 30 km away. The town of Radovish is situated in the central part of the municipality, 380 m above sea level, and represents municipality administrative centre with a good location for economy development. As an administrative centre it serves the inhabitants of the municipality of Konche because all of the national institutions, which function on regional level, are located in the town of Radovish. The territory of the municipality of Radovish with 608 km<sup>2</sup> is enlisted into the middle large municipalities. The municipality of Bosilovo is located into the middle part of the fertile Strumica Field, between the Ograzhden and Belasica Mountains with an area of 150 km<sup>2</sup>. The municipality of Bosilovo has a total of 14,260 inhabitants with 16 settlements or a total of 3,744 households. Through its middle part passes the Strumica and the Turija River, which later flow into the Struma River in the Republic of Bulgaria. The municipality as a local self-government is formed in 1996, and as an old municipality functions since 1963. It borders the neighbouring municipalities of Vasilevo, Novo Selo and Strumica forming Strumica micro region.

# **Skopje Region**

This region encompasses the Skopje Valley, and its surface is 1,812 km<sup>2</sup> or 7.3% of the total area of Macedonia. The Skopje region is composed of the following 17 (seventeen) municipalities: municipality of Aerodrom, municipality of Butel, municipality of Gazi Baba, municipality of Gjorche Petrov, municipality of Karposh, municipality of Kisela Voda, municipality of Saraj, municipality of Chair, municipality of Centar, municipality of Shuto Orizari, municipality of Sopishte, municipality of Studenichani, municipality of Zelenikovo, municipality of Petrovec, municipality of Arachinovo, municipality of Ilinden and municipality of Chucher-Sandevo.

*The municipality of Gazi Baba* is located in the northern part of the Republic of Macedonia and covers the eastern part of the Skopje Valley and the city of Skopje. Greater part of the territory in the central, south-western and the southern part (65% of the total territory) is in the valley of cultivated surface with couple of heights, in the northern part of the municipality, at the Gazi Baba forest-park and in the central part of the locality Kamnik, and the mountainous part (Skopska Crna Gora) in the eastern part of the municipality. It borders the municipalities of: Butel and Chair to the north, Centar and Aerodrom to the west, Ilinden and Petrovec to the

south, and Arachinovo and Lipkovo to the east. The radius of expansion of the municipality in east-west direction totals 10 km, and north-south 15 km. The territory of the city of Skopje, and in that unit the municipality of Gazi Baba, is under the influence of two climate types: modified Mediterranean and temperate continental. It causes cold continental and wet winter periods, as well warm continental and dry Mediterranean summer periods. The average annual air temperature is +12.2°C. The minimum absolute annual air temperature is -22.2°C, and the maximum +40°C. The annual relative air humidity is 70%. The average annual number of clear days is 70, and cloudy ones 107. The average annual volume of precipitations is 516.1 mm/m<sup>2</sup>, the average annual number of rainy days is 112, foggy 81 and black ice 0.6. Above the territory of Skopje, thus the territory of the municipality of Gazi Baba, three winds blow: Povardarec, Yugo and north-west wind. The Povardarec blows from the Shar Mountain along the Vardar River towards the southern parts of the Republic of Macedonia. It is dry during the summer, and during the winter and autumn it is followed by rains. The Yugo blows from the opposite direction of Povardarec. It is warm and often followed by rain. The wind that blows from Kachanik towards Skopje along the Lepenec River Valley is similar to Povardarec. The average wind speed is a maximum of 29-30 km/h, an average of 14-21 km/h and a minimum of 1-5 km/h. The municipality has a total area of 92 km<sup>2</sup>, and the majority of it belongs to the rural part with 65% of cultivated land out of the whole area. According to the 2002 census, the municipality has 72,222 inhabitants, and regarding the number of inhabitants presents one of the largest municipalities in the city of Skopje and the Republic of Macedonia. The municipality of Sopishte, listed in middle big municipalities according the surface, is located into the central part of the Republic of Macedonia. It covers an area of 223.53 km<sup>2</sup>. Geographically, the municipality covers the south-western part of the Skopje Valley along the Makrova Sushica River and its connection to the Treska River under the slopes of Vodno. The physicalgeographical conditions of the municipality are quite variable, where some of them (climate, vegetation and wildlife) arise as promoters for municipalities' development, and others (hydrological-hydrographical features) as inhibitors. Besides the hilly-mountainous character and the peripheral orientation regarding the Skopje Valley, the municipality of Sopishte still has favourable geographical position; above all, due to the direct vicinity to Skope, the precipitations are greater in intensity regarding the Skopje Valley and range between 600 and 1,000 m according the sea level. The average annual insolation is between 45-50%, but regarding the Skopje Valley it is significantly greater in December, which positively affects the municipalities due to their suntrap position. On the whole, the space is characterized with transition of temperate continental and mountainous climate. Karshijak has the most favourable features, which due to its suntrap position has smaller temperature oscillations, greater rainfalls, more intense insolation and a small frequency of fogs, thus 11 out of the 13 settlements are located in this part. The municipality of Chucher Sandevo is a municipality in the Northern Macedonia. The centre of the municipality is the village of Chucher Sandevo. The municipality of Chucher Sandevo is a rural municipality situated under the slopes of Skopska Crna Gora. It is inhabited with population of mixed ethnicity, predominantly Macedonians, Serbs and Albanians. The municipality lies on the slopes of Skopska Crna Gora, north of Skopje. It covers an area of 235 km<sup>2</sup> and has 8,493 inhabitants. There are more villages in the municipality, of which the biggest are Brazda, Gluvo, Sandevo, Mirkovci, Chucher, Banjani,
Gornjani, Kuchevishta, Pobozhje and others. Besides these settlements, the municipality has three greater weekend settlements: Brodec (Skopje region), Senora and Goliovo. *The municipality of Gjorche Petrov* is situated in the Skopje plan region. In the region of the v. Kuchkovo, there is a travertine stone pit. From the mineral raw materials, of great importance for the municipality is the extraction of sand from the bank of Lepenec, but there are no data on the quantity. The total agricultural surface in the municipality is 4,587 ha, part of it is in the private, and part in the social sector. In the structure of this surface, greatest percent of the cultivated land are fields (45.35%) and pastures (48.48%). The municipality does not have large forest areas. The total surface covered with forests is 1,010 ha, mainly oak and hornbeam.

### South-western Region

This region encompasses the basin of the Ohrid Lake and the drainage basin of the Treska River. It covers area of 3.340 km<sup>2</sup> or 13.4% of the territory of Macedonia. The south-western region is consisted of the following 13 (thirteen) municipalities: municipality of Ohrid, municipality of Debarca, municipality of Struga, municipality of Vevchani, municipality of Drugovo, municipality of Centar Zhupa, municipality of Kichevo, municipality of Oslomej, municipality of Zajas, municipality of Makedonski Brod, municipality of Vraneshtica, municipality of Debar and municipality of Plasnica.

The municipality of Kichevo is a municipality in the Western Macedonia. The centre of the municipality is the town of Kichevo. According the draft-decision on change for territorial organization in 2013, the municipalities of Zajas, Drugovo, Vraneshtica and Oslomej joined the municipality. The Kichevo Region is situated in the western part of the Republic of Macedonia, in the Kichevo Valley, which represents clearly shaped natural unit surrounded by high mountains. It belongs to the upper drainage basin of the Treska River, the northern side reaches the fold Strazha, on the western side raises the Bistra Mountain, on the southern side along the Treska River it spreads to Ilinska Mountain, and on the eastern side it reaches the northern part of Poreche. Bigger river, besides Treska, is Zajas River which flows in the town between Kitino Kale and the settlement Bichinci. The river flows another smaller river known as Sushica, as the name implies, it is periodical with changeable flow during the summer. With the new territorial organization of 1996, the Kichevo Region is divided into 5 municipalities: municipality of Kichevo, municipality of Drugovo, municipality of Zajas, municipality of Oslomej and municipality of Vraneshtica. Above Kichevo is the beautiful hill Krushino with rich nature, clean air and vegetation which represents a great place for relaxation. The Kichevsko Kaleis one of the town's symbol, and nearby is the famous Kichevo Monastery or the monastery dedicated to the Holy Mother of God-Immaculate, which in the past represented important centre for the development of the literacy in this part of Macedonia, and today represents a wonderful place with spiritual peace tamed from the beautiful location, the clean air and the vegetation. This monastery is often visited place. The municipality of Struga is a municipality in the Western Macedonia. The centre of the municipality is the town of Struga. The municipality is widened in 2004 when the former municipalities of Delogozhdi, Veleshta, Labunishta and Lukovo joined the old municipality of Struga. The municipality of Struga is situated into the south-western region in the Republic of Macedonia. Here are the town of Struga and the villages: Bezovo, Bidzevo, Bogojci, Boroec, Brchevo, Burinec, Veleshta, Vishni, Vranishte, Globochica, Gorna Belnica, Gorno Tateshi, Dolna Belica, Delogozhdi, Dobovjani, Dolno Tateshi, Draslajca, Drenok, Zagarchani, Zbazhdi, Jablanica, Kalishta, Koroshishta, Labunishta, Lakaica, Livada, Lozhani, Lokov, Lukovo, Mali Vlaj, Misleshevo, Mislodezhda, Modrich, Moroishta, Nerezi, Novo Selo, Oktisi, Radozhda, Radolishta, Frangovo, Shum, Piskupshtina, Podgorci, Poum, Prisovjani, R'zhanovo, Selaci, Tashmarunishta, Toska and Dzepin. The municipality of Ohrid is a municipality in the Western Macedonia. The centre of the municipality is the town of Ohrid. The municipality of Ohrid is situated in the south-western part of the Republic of Macedonia and is located on the north-eastern coast of the Ohrid Lake on 695 m above sea level. It is situated between the high mountains Jablanica and Mokra Mountain to the west and Galichica to the east. Ohrid encompasses an area of 389.93 km<sup>2</sup> with a total of 28 settlements and population of 55,749 inhabitants. It borders municipalities of Debarca and Resen, and with the Republic of Albania to the south. The Galichica Mountain with its height (the highest top – Vir, 2,288 m), represents dominant relief appearance (horst) placed between the basin of the Ohrid Lake to the west and the Prespa Lake to the east. The Ohrid-Prespa region is characterized with quite heterogeneous orography, which imposes modifying of the climate general characteristics, while the great water natural accumulations, the Ohrid and the Prespa Lakes, are special climate modificators that determine a special regime on some meteorological elements. Because of the open area, via the Crn Drim Valley to the north, cold air masses find their way during the winter months and lower the air temperature, while during the summer the influences are Mediterranean. According the census of 2002, in the municipality of Ohrid live 55,749 inhabitants, out of which 47,344 (85%) Macedonians, 2,962 (5.3%) Albanians, 2,268 (4%) Turkish people, 323 (0.5%) Vlachs, 69 (0.1%) Roma people, others: 2,388 (4.2%). Ohrid is a town in the south-western part of Macedonia with 42,033 inhabitants. The Ohrid Lake carries its name. Ohrid and the Ohrid Lake are one of the main tourist places in Macedonia. Due to the great number of churches and monasteries, the town is familiar as the Balkan and European Jerusalem. Ohrid is famous as "the city of light", which is a verbatim translation of its old name, Lihnid. The municipality of Debar is situated in the Western Macedonia. The centre of the municipality is the town of Debar. According the census of 2002, the municipality had population of 19,542 inhabitants, out of which the majority are Macedonians and Albanians. The municipality of Debar is located in the Western Macedonia, part of the South-western Region. The municipality is situated in the Debar Region and has a total area of 142.67 km<sup>2</sup>. It borders Albania to the east, Centar Zhupa and Struga to the south, Drugovo to the east and Mavrovo and Rostusha to the north. The municipality contains the Deshat and Korab Mountains and the Debar Lake. Main economic subject in the municipality is the Shpilje HPP. The town population has interest in commerce, manufacturing and services, and the rural population with farming, agriculture and forestry. The municipality of Centar Zhupa is a municipality in the Western Macedonia. The centre of the municipality is the village of Centar Zhupa. The municipality is situated into the Debar region and encompasses 23 villages, out of which some are totally resettled. The municipality is located into the Western Macedonia, part of the South-western Region. The municipality is in the Debar region and has a total area of 107.21 km<sup>2</sup>. To the north, east and west, the municipality borders municipality of Debar, and to the south with Struga. Stogovo Mountain and the Debar Lake are placed in this municipality. Main commercial object in the municipality is Shpilje HPP. The population mainly is interested in commerce, farming, agriculture and forestry. However, good part of the population is resettled in abroad and the funds sent by the expatriates are important for the population's economy. According the census of 2002, the municipality has a total of 6,519 inhabitants with population density of 60.81 inhabitants per km<sup>2</sup>. The municipality of Plasnica is a municipality in Western Macedonia. The centre of the municipality is the village of Plasnica. The municipality of Plasnica is situated into the medium part of the Western Macedonia and spreads over the northern and north-western slopes of Bushava Mountain and Sach Mountain. The territory of the municipality of Plasnica has an area of 54.30 km<sup>2</sup>. The municipality borders the municipality of Makedonski Brod to the north-east, the municipality of Krushevo and the village of Sopotnica to the south-east, and the municipality of Vraneshtica to the west. The municipality has 4 settlements located in the upper flow of the Treska River: Plasnica, Preglovo, Lisichani and Dvorci. The territory of the municipality is under the influence of the temperate continental climate, which characterizes with cold and rainy winters and dry and warm summers. On the high mountains, there is mountainous climate with short and cold summers and long and snowy winters. The warmest month with average month temperature is July with 20.0°C. The coldest months are January with average month temperature of 0.6°C, and December with average month temperature of 2.1°C. The extreme temperatures range from 38.9°C in August to -25.9°C in February. The annual period with sunny hours is 2,263 hours or 6.2 hours daily.

# 5.2 Geological, Geological-hydrological, geomorphologic and pedological characteristics of the location

## 5.2.1 Geological Characteristics

Generally taken, the territory of the Republic of Macedonia has four geotectonic regions or units: Western-Macedonian zone (WMZ), Pelagonija Massif (PM), Vardar Zone (VZ) and Serbian-Macedonian Massif (SMM) (see Cartographic Appendix 6).

### Western-Macedonian Zone (WMZ)

The Western-Macedonian Zone is a special geotectonic unit into the Republic of Macedonia and spreads over its western parts. As a geological unit it covers from Serbia in the north to Greece in the south. The western side is limited by the Merdita Zone in Albania, and to the east it borders the Pelagonija Massif.

The most represented lithological units in the Western-Macedonian Zone are the Palaeozoic and Triassic schist, while the Jurassic and Palaeogene rock formations and the Neogene sediments are less represented. Also, there is representation of the Triassic limestones and Devon marbled limestones, which are a medium for accumulation of underground water.

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**Cartographic Appendix 1.** Figure 52 Geological Map of the Republic of Macedonia: 1. Neogene; 2. Volcanites; 3. Cretaceous; 4. Gabbro-Diabases; 5. Triassic; 6. Granitoides; 7. Palaeozoic; 8. Rifey-Cambrian; 9.Marbles; 10. Gneiss; 11. Faults.

The Palaeozoic in the Western-Macedonian Zone consists of lower and upper complex. The spilite-keratophyre formations and their tuffs are disseminated in the lower complex, and in the surroundings of Makedonski Brod were found graphite-containing schists. Low-metamorphic sediments represented with phylite, sand and alverolite layers, as well as quartzites and limestones which appear in the upper Paleozoic complex as limit parts, and also there are metamorphic basic rocks embedded into the sediments. An important feature of the upper Paleozoic complex is the appearance of effusive equivalents of acid magmatism which later are metamorphosed into quartz-porphyry. The appearance of iron and manganese into the Western-Macedonian Zone probably is related to this magmatic phase.

Typical for the eastern parts of this zone are the granite magmatic intrusions in the Palaeozoic period which was the reason for the creation of batholitic bodies, which appear as granite massifs at Krushevo and the Pelister region. The Palaeozoic represents a typical geosynclinal complex which starts with spilite-keratophyre formation, where the Mesozoic complex discordantly lies over the Palaeozoic.

Compared to the Vardar Zone, Triassic sediments of the Western-Macedonian Zone transgressively lie over the Palaeozoic formations, thus covering large areas. Lower parts of the Triassic sediments contain green-gray sandstones, alevrolites, claystones and reddish

hornfels. Vertically, they continuously change with the limestones, out of which a part have dolomite content. In the Triassic sediments a basic magmatism is developed presented with diabases and diabase-hornfels formation rocks.

From the Jurassic period up to now, the Western-Macedonian Zone is characterized by elevation and transformation in the continental land. The Jurassic formations are disseminated as volcano-sedimentary formation (sandstones, claystones, alevrolites and hornfels). Also, this zone contains large ultrabasic massifs (serpentinized peridotites and dunites, gabbro-diabases and diabases).

In the frames of this zone are disseminated a couple of undiscovered depressions (Polog, Kichevo, Ohrid-Struga, Debar, Prespa, Demir Hisar) filled with Neogene sediments.

### Pelagonija Massif (PM)

The Pelagonija Massif is a crystal nucleus with continental type of crust, which, like the Serbian-Macedonian Massif, in mainly built of the oldest pre-Cambrium formations. This geotectonic unit is separated from the neighbouring units with deep regional faults. To the north it is limited with the Kjustendil-Skopje-Debar fault, to the east it borders the Serbian-Macedonian Massif, and to the west with the Western-Macedonian Zone. To the south it continues in Greece where sinks into the Aegean basin.

From stratigraphic-litologic aspect, the Pelagonija Massif (often known as Pelagonija horst anticlinorum) consists of complex dislocated pre-Cambrium metamorphic crystal rocks (gneiss, gneiss-granite, mica, cipolini and marbles), as well regionally metamorphic complexes with included big masses of polygenetic granite and smaller masses of andesites.

Couple of typical series of rocks are disseminated into the Pelagonija Massif. The northern part of the massif contains of four series. Two of them (gneiss and mica series) belong to the lower metamorphic complex, while the rest (mixed and marbles series) consist of part of the lower metamorphic complex. In the frames of the Pelagonija Massif is the greatest neotectonic depression into the Republic of Macedonia with 65 km of length, and average width of 15 km. This neotectonic depression is filled with Miocene, Pliocene and Quaternary sediments.

## Vardar Zone (VZ)

The Vardar Zone is the greatest and quite significant line structure of the Balkan Peninsula, which from the territory of the Republic of Macedonia continues into Small Asia (Izmir – Ankara Zone). As a special structure unit is located between the Serbian-Macedonian Massif to the east and the Pelagonija Massif, and partly the Western-Macedonia to the west.

Different explanations regarding genesis of this zone argue that it was created during the Alpine period due to the Grenville crust, when it finally gets the current form.

According the available geological data, since the time of formation in the Triassic period, the Vardar zone has geosynclinal character. During the Triassic and Jurassic, besides the

sedimentation processes, processes of intensive imprints of the basic magma are very specific, which is characteristic for the whole region of the internal Dinarides. Intensive tectonic processes towards the end of the Jurassic determined the structural forms of the Vardar Zone.

The development of the Vardar Zone in the period after the Jurassic probably is related to the collision processes between the Dinarides-Hellenides and Carpathian-Balkanides, thus compression periods were manifested through orogeny shrinkage and pulling, especially in the western parts of the zone. On the other hand, relaxation periods (extension) effected the grabens formation and Tertiary volcanism (Quaternary, Oligocene). At the end of the Eocene appeared the elevation processes, thus this zone along with the other parts of the Republic of Macedonia form the continental crust.

From structure-geological viewpoint, the Vardar Zone consists of deep fault structures and blankets with orientation NNW – SSI, as well as relict detritus of ocean crust type (gabbro, diabases, spilites and melaphires) and ultramaphites (serpentised ultrabasites) which were tectonically carried out longitudinal to the fold structures. This implies that ophiolite complexes (product of the Jurassic ocean crust) are significant part of the Vardar Zone composition. During the Jurassic tectonic-magmatic activity, there was magma intrusive with acid and intermediate composition leading to formation of number granitoide complexes, especially in the eastern part of the Zone.

The following evolution phase of this Zone is during the Neogene tectonic-magmatic processes resulting in formation of volcanic and volcanic-intrusive complexes that are almost uniformly distributed in the region occupied by the Zone itself.

The Vardar Zone consists of three subzones: internal zone, central and outer subzone. The eastern and western subzones are of special interest for the Neogene formation and distribution, especially for the polymetallic ore deposits. Products of this magmatism (andesites, latines, dacites, quartzalites, rhiolties and their pyroclastics) are distributed at the contact of the Vardar Zone and the Serbian-Macedonian Massif. From structural point, this subzone is characterized by lower intensity of rocky masses folding, but at the same time there is a break of remarkable folded structures and blanket structures. The western subzone is characterized by Pliocene tectonic-magnetic activity which is most expressed in the region of the Kozhuf and Kozjak Mountains.

During its evolution process, the Vardar Zone underwent multiple openings and closings. These endogene cycles often were followed by intensive tectonic-magnetic processes which resulted with formation of intrusive and volcano-intrusive complexes enriched with various mineral raw materials.

The Vardar Zone has some neotectonic depressions (Skopje, Kumanovo, Tikvesh, Ovche Pole depressions) filled with Neogene sediments.

### Serbian – Macedonian Massif (SMM)

The Serbian-Macedonian Massif is very significant structure in Macedonia from structuralgeological and metalogenetic aspect. This geotectonic unit is located in the eastern parts of the Republic of Macedonia and has north-south direction. This massif starts in the north of Belgrade and spans to the south in Greece, where sinks into the Aegean Sea, while it borders Carpathian-Balkanides to the east and the Vardar Zone to the west.

Generally, this zone is built of metamorphites from the Precambrium, Rifey-Cambrium and Palaeozoic age and consists of upper and lower metamorphic complexes with different lithology content, metamorphizam degree and evolution period.

The lower metamorphic complex contains gneiss (with fitted large granite bodies), schists, as well smaller masses built of amphibolites, ophiolites, quartzites and marbles. The upper metamorphic complex transgresivelly lies upon the lower metamorphic complex and consists of volcano-sedimentary component which is partly metamorphosed to the greenschist facies. Among them prevails the chlorite, amphibolites-biotite, chlorite-sericite and quartz schists.

The appearance of certain magmatic complexes is controlled by regional fault zones which generally control the appearance of magmatic processes, and thus the distribution of the ore bodies.

The presence of radial disjunctive structures is related to the imprint of certain magmatic complexes so that they form volcanic structures characteristic for the Serbian-Macedonian Massif. Besides the disjunctive structures, broadly represented are the applicative structures which appear in antiform and synform shapes, and also as folded layers with different intensity. At some places there are domes which are probably product of the deformations in the crystal slope under the influence of the intrusions of the magmatic bodies.

The Serbian-Macedonian Massif has couple of neotectonic depressions (Kochani, Strumica, Delchevo, Slavishka depressions) filled with Neogene sediments.

### 5.2.2 Basic hydro-geological characteristics of the terrain

The development of the hydrographic network is always in interaction with the groundwaters analysed from quantitative and qualitative features of the underwater and surface waters viewpoint.

According the hydrologic map of the territory of the Republic of Macedonia, four areas of drainage basins have been identified: 1) Vardar, 2) Strumica, 3) Crn Drim and 4) Binachka Morava. The surface waters which flow in the territory of the Republic of Macedonia are the rivers: Lepenec, Pchinja and Eleshka, and waters which flow out the territory are the rivers: Vardar, Strumica, Crn Drim, Cironska and Lebnica.

The characteristics of the prevailing rivers have been presented in Table 4. Data on the flow, water level, suspended alluviums and temperature have been measured in the measuring

stations for surface waters. There is a total of 97 stations, such as: 20 stations in the drainage basin of the Crn Drim River, 5 in the Strumica River and 82 stations in the Vardar River.

Table 1. Characteristics of the main rivers in the Republic of Macedonia (Use and Protection of Waters
and Water Management Infrastructure, 1998, EC, 2002) [84], [86].

River	Drainage Basin	Area of Drainage Basin [km <sup>2</sup> ]	River Length [km]	Average Annual Flow [m <sup>3</sup> /s]
Vardar	<b>ar</b> Vardar		301	63 – 145 <sup>a)</sup>
Treska	Treska Vardar		139	24.2 <sup>b)</sup>
Lepenec Vardar		770	75	8.7
Pchinja Vardar		2841	137	12.6 <sup>C)</sup>
Bregalnica Vardar		4344		12.2 <sup>d)</sup>
Crna River Vardar		4985	228	29.3 <sup>e)</sup>
Boshava	Vardar	468	52	23.4
Crn Drim Crn Drim		3359	45	52.0 <sup>f)</sup>
Radika	Radika Crn Drim		1	19.3
Strumica	Strumica Strumica		1	4.2 <sup>g)</sup>
Binachka Morava	Binachka Morava	44	1	

a) 63 in Skopje, 145 in Gevgelija; b) at its own mouth in the Vardar River; c) at Katlanovska Banja; d) in Shtip; e) at Rasimbegov Bridge; f) at Shpilje HPP; g) at Novo Selo. Length of river network and flow density into the water management areas

Table 2. Length of river network and flow density into the water management areas [84], [86].

Water Management Area	River Drainage Basin	Length of River Network [km]	Drainage Density [km/km2]
Polog – Debar region	Crn Drim	082.92	0.31
Debar region	Crn Drim	326.32	0.42
Debar region – Struga region	Crn Drim	400.17	0.27
Prespa	Crn Drim	150.31	0.20
Polog	Vardar	473.15	0.33
Treska	Vardar	550.46	0.27
Pelagonija	Vardar	872.83	0.28
Skopje region	Vardar	288.52	0.18
Middle Vardar	Vardar	854.98	0.33

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Water Management Area	River Drainage Basin	Length of River Network [km]	Drainage Density [km/km2]
Middle and Lower Crna River	Vardar	795.93	0.41
Lower Vardar	Vardar	394.07	0.36
Pchinja	Vardar	574.85	0.25
Upper Bregalnica	Vardar	508.36	0.48
Middle and Lower Bregalnica	Vardar	847.02	0.26
Dojran	Vardar	/	/
Strumica	Strumica	451.17	0.30



Figure 53 - Water management areas in the Republic of Macedonia [84], [86].

The total drainage length totals 7,637 km, while the drainage density (flow density) totals 0.30 km/km<sup>2</sup>. The drainage density of the Vardar, Crn Drim and Strumica River are almost identical. Small variations are visible in the drainage densities compared to the water management areas (Table 5). The larges drainage density is in the water management area of Upper Bregalnica, while the zero drainage density is in the water management area of Dojran, where there are no surface waters (rivers).

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Figure 54 - Hydrographical network map of the Republic of Macedonia.

### 5.2.3 Geomorphologic Terrain Characteristics

Morphologically, the terrain of the Republic of Macedonia is mainly mountainous, where 3 morphological units can be distinguished: Western Macedonia, Povardarie and Eastern Macedonia.

The Western Macedonia, as a morphological unit, is mainly mountainous area, where mountainous peaks are elevated, with quite sheer sides and with more than 2,500 m height,

often unavailable in certain parts. This is the case with the Shar Mountain massif with 50-60 km in length, with the peaks: Titov Peak (2,748 m), Bistra, Crn Peak (2,584 m), Ljuboten (2,496 m), and others. To the west, towards the national border with the Republic of Albania elevates the Korab mountainous massif (2,764 m), which is the highest peak in Macedonia, and to the south joins Jablanica (2,259 m). Between the Ohrid and Prespa Lakes is Galichica (2,288 m), which to the north joins the Ilinska Mountain, which via the Treska River valley transfers into the Bistra massif (2,011 m), and to the west via Debarca depressions is related to the Stogovo mountainous massif (2,242 m) and Karaorman.

East of this terrain is the Bushava Mountain (1,721 m), and to the north continues in the Porechje, where the Pesjak Mountain elevates, which continues to Suva Gora (1,852 m).

Often, the mountains in the Western Macedonia are mutually intersected with valleys. So, Baba along with Pelister (2,600 m) is separated from the Selechka Mountain with the Pelagonija Valley with N – S direction, with length of 65 km, width of around 15 km and 600-700 m above sea level. To the north is the Polog Valley, which separates Shara and Suva Gora. Besides these valleys, in Western Macedonia are many small depressions filled with young sediments, such as: Debar, Kichevo, Ohrid-Struga, Prespa Valleys and others.

The carbonate terrains in Western Macedonia have various rocky morphological shapes – rocky fields, sinkholes, depressions, etc.

The Povardarie occupies the central part of Macedonia, where valley wavy terrains and planes predominate, such as: Skopje Valley (230 - 260 m), Ovche Pole (250 - 400 m), Valandovo Valley (80 m), Gevgelija Valley (60 - 70 m) etc. In the middle area of the Povardarie there are some remarkable individual high hills: Bogoslovec and others.

In the western part of the Povardarie elevate: Klepa Mountain (1,149 m), Vitachevo upland (800 – 900 m) and Kozhuf Mountain, and to the left side of the Vardar River are: Skopska Crna Gora (1,651 m), Gradesh Mountain and Plaush.

The terrain in Eastern Macedonia is mainly with mountainous appearance, with various morphological shapes, especially the easternmost parts, or reefs (represent the national Macedonian-Bulgarian border). In this morphologic unity, high mountainous areas are mutually divided with low mountainous massifs, plateaus and neodepressions. In the southern part elevates the remarkable Belasica horst, which north side sinks – Strumica Valley, and to the south is the Dojran Valley, filled with Neogene layers. Beside the national border with the Republic of Bulgaria spread more mountainous massifs: Osogovo, Ograzhden, Maleshevo, and more to the west are the mountains: Golak, Plachkovica and others.

The western part of Eastern Macedonia is characterized by various morphological forms. Thus, in the volcanic Kratovo-Zletovo area appear distinctive volcanic forms: volcanic craters, piles, necks, dykes, etc. Also, Eastern Macedonia has greater Neogene depressions: Berovo-Delchevo, Kochani, Slavishka depressions and others with deposited lake sediments.

The relief structure is quite developed and characterizes with different relief forms. The relief is composed of mountains, hills, uplands, plateaus, river valleys and other smaller relief shapes. The territory belongs to two geographic units: Rhodope and Shar mountainous area. The

Rhodopes mountainous area is divided into three geographical units: Eastern-Vardar group of mountains and valleys, Povardarie part of Macedonia and Western-Vardar group of mountains and valleys. Greatest part of the space (75%) represents the mountainous relief. There are 45 mountainous hills with more than 2,000 m above sea level, and the highest peak is Golem Korab with 2,764 m above sea level. In the plane relief (18%) are 15 valleys. They are mostly represented along the valley of the Vardar River, and the largest is the Pelagonija Valley, which plane covers an area of 1,570 km<sup>2</sup>. The lowest point in the Republic of Macedonia is the riverbed of Vardar at the national border with Greece and totals 44 m above sea level. According the above mentioned, the following classification could be made for the Republic of Macedonia:

Rhodopes mountainous area:

Eastern-Vardar group of mountains and valleys:

• Mountains: Belasica, Ograzhden, Maleshevo Mountains, Plachkovica, Osogovo, German, Kozjak and Skopska Crna Gora.

• Valleys: Strumica-Radovish, Maleshevo, Delchevo, Kochani, Ovche Pole, Kumanovo and Kriva Palanka Valleys.

#### Povardarie

- Valleys: Skopje, Veles, Tikvesh, Gevgelija-Valandovo and Dojran Valleys.
- Canyons: Taor, Veles and Demir Kapija Canyon.

West-Vardar group of mountains and valleys:

• Mountains: Kozhuf, Nidze, Selechka, Babuna, Jakupica, Baba, Plakenska, Bukova, Suva Gora and Zheden.

• Valleys: Pelagonija and Mavrovo.

Shar mountainous area:

• Mountains: Shar Mountain, Bistra, Stogovo, Karaorman, Galichica, Korab, Deshat and Jablanica.

• Valleys: Polog, Prespa, Ohrid-Struga, Debar and Mavrovo Valleys,

## 5.2.4 Physical – Mechanical Characteristics of Materials and Their Classification

Materials mapped during the field investigation works have been laboratory examined for determination of certain classifying, compressor and bearing characteristics (granulometric composition, specific weight, natural humidity, atterberg limits, maximum compaction, optimal humidity and California bearing ratio – CBR).

Alluvial sediments have good physical – mechanical characteristics, are enlisted in terrains that are good construction basis for any kind of objects, and the sand and grit from these sediments

are used as a construction material. The fluvial terraces (younger and older) have unfavorable physical – mechanical characteristics, soft consistent condition and are compressive, watersaturated and loose born, which make them a weak basis for building objects. Proluvial sediments also have unfavorable physical – mechanical characteristics. According the rulebook on categorization of earthworks excavation GN200, all types of rocky masses, which arise at the investigated field, belong to the III (third) category and the excavation is mechanical.

### 5.2.5 Basic Tectonic and Seismotectonic Terrain Characteristics

The seismic activity of the broader territory of the investigated area is a consequence of tectonic and neotectonic processes from the geological history of the field, and part of them are active even now. The result of these processes is the different morphological forms, which arise on the described territory. The terrain is characterized with the existence of elevated and sinked blocks which are mutually limited with folds and folded zones. In the formation of the mentioned morphostructures, main part had the intensive radial movements, which carried along the neotectonic longitudinal folds, and to a smaller degree along the old re-activated folded structures. The investigated area, regarding the seismic activity, as well regarding the macroseismic manifestations, is under great influence of the Vardar seismogene zone. During the geologic history, the terrain of the Republic of Macedonia was subjected to great number of earthquakes. Some of these manifestations had quite great intensity, so they left major consequences to the engaged areas from the aspect of human victims and destroyed material goods. The territory of the Republic of Macedonia is a segment from the Alpine-Himalayan belt in the eastern Mediterranean orogeny zone. It is characterized with considerable neotectonic processes which arise from the intensive seismic activity, which is mainly controlled by earthquakes with epicenters formed outside their border.

The area according the seismic analyses principally belongs in the seismic zone from third order (with seismic intensity Io<VII8), that is, region with small to meaningless seismic activity, in which occurred earthquakes with magnitude of M<5.5. While, small part around Resen belongs in the seismic zone from second order (with seismic intensity Io=VII- VIII) in which occurred earthquakes with magnitude of M=5.5-6.0.

### 5.2.6 Region Characteristics (Landscape)

The creation of the complete landscape of the terrain, where the given section pass, besides the natural condition of the terrain formation, considerably depend on the anthropogenic influence of the environment.

The Republic of Macedonia has 1,244,000 ha agricultural land or 48.4% of its total territory. The ratio between the arable land area (612,000 ha) and area under pastures (630,000 ha) is 49%:51%. This balance was relatively stable for longer period, but in the last 30 years the total agricultural land has been permanently decreasing. The structure of the arable land is dominated by ploughland and gardens covering 512,000 ha or 84%. At European level,

Macedonia belongs to the group with medium availability of agricultural land or 0.25 ha ploughland, that is, 2.3 ha per agricultural inhabitant.

Areas under fallows and uncultivated ploughland amount to 140,000 ha or 23% of the total arable land. The leading position in the structure of planted arable land areas (348,000 ha in 2001) belongs to grains covering 220,000 ha (63%), including mainly wheat – 117,000 ha (53%) of the areas under grains), with annual production of 245,000 tons, or 2,132 kg/ha.

Industrial crops occupy 6% of the area under ploughland and gardens (at global level, such areas range between 15-17% of planted areas), led by tobacco represented on 20,310 ha (annual production of 23,217 tons). Next are areas under sunflower (6,000 ha), sugar beet (2,000 ha) and poppy. Fibrous crops (cotton, lin, hemp) are not represented.

Vegetable crops are represented at 56,000 ha, or 16% of planted arable land with rather rich assortment of products in line with agro-ecological conditions, enabling rationale utilization of natural resources and yield of marketstable surplus.

Vineyards occupy 28,000 ha, out of which 90% are grown by intensive systems. Fruit growing is represented only on 2.7% (16,000 ha) of arable land, with total of 8 million fruit trees. Macedonia has a total area of 25,713 km<sup>2</sup>, out of which 25% belong to pastures, 25% to arable land, meadows, vineyards and orchards, 8% to forests, 2% to lakes, 2.5% to the urban and industrial land. It is considered that 38% of the areas are under erosion. The total annual production of alluvium averages 17 million/m<sup>3</sup>, out of which 7.5 millions in the form of silt and via flows is carried out of Macedonia. The economical damage from the erosion is enormous. The arable land is the most affected from the erosion and the medium annual land loss amounts around 308,000 m<sup>3</sup>. Depending on the erosion intensity, the condition in the Republic of Macedonia is the following:

- I category (extremely high) 687.96 km<sup>2</sup> or 2.77%
- Il category (high) 1,832.41 km<sup>2</sup> or 7.38%
- III category (middle) 8,893.25 km<sup>2</sup> or 27.78%
- IV category (low) 7,936.08 km<sup>2</sup> or 31.98%
- V category (very low) 7,463.47 km<sup>2</sup> or 30.09%

### 5.2.7 Existing Water Resources

### Rivers

The total annual available resources of surface waters – rivers in the Republic of Macedonia have been estimated on 6,372,000,000 m<sup>3</sup> (202.3 m<sup>3</sup>/s). The greatest part of these resources is in the drainage basin of the Vardar River (72%) and, to a lesser degree, in the drainage basin of the rivers Crn Drim (26%) and Strumica (2%). (European Economic Commission, 2002)

River Drainage Basin	Surface Water Resources ×10 <sup>6</sup> [m <sup>3</sup> /year]
Vardar	4,600
Strumica	132
Crn Drim	1,640
Total	6,372

#### Table 3 Surface water resources [84], [86].

The volume related to the sources amounts around 0.9 billion  $m^3$  or around 30  $m^3$ /s. According the data for the 1995-1996 period, 1,5 – 1,7 billion  $m^3$  (50  $m^3$ /s) of surface and underground water (80% of the surface water and 20% of the underground waters and natural springs) have been used annually for different purposes. Thus, about a fourth of the total available water resources have been used.

The characteristics of the biggest river are presented in Table 7. The average annual flow for the Vardar River for the 1960 – 1961 period, measured by measuring stations is: 63 m<sup>3</sup>/s in Skopje and 144.9 m<sup>3</sup>/s in Gevgelija, and the specific flow of the same profiles is 6.5 l/s/km<sup>2</sup>. The average annual volume of run-offs in Gevgelija is around 4,6 billion m<sup>3</sup>.

#### Lakes

The Republic of Macedonia has three big natural lakes, couple of small glacial lakes and 24 bigger artificial lakes, which characteristics are given in Table 8. From the natural lakes, the most attractive are: Ohrid, Prespa and Dojran Lakes. All are shared with the neighbouring countries. The Ohrid Lake is the greatest and has an area of 358 km<sup>2</sup>; out of which 230 km<sup>2</sup> belong to Macedonia, and the rest to Albania. The lake is hydrologically connected to the upper Prespa Lake, which has total area of 275 km<sup>2</sup>, out of which 191 km<sup>2</sup> belong to the Republic of Macedonia, and the rest to Greece and Albania. The smallest, Dojran Lake, has a total area of 44 km<sup>2</sup> and is shared with Greece (Macedonian part totals 27 km<sup>2</sup>). The three lakes at the territory of the Republic of Macedonia cover total area of 448 km<sup>2</sup>.

No.	Dam	Terminatio n Year	Туре	Dam Height [m]	Dam Crown [m]	<i>V</i> [m <sup>3</sup> ]	Accumulati on <i>V</i> [m <sup>3</sup> ]	Accumulati on <i>F</i> [km <sup>2</sup> ]
1.	Matka	1938	VAC	29.50	64.0	3.000	3.550.000	0.25
2.	Mavrovo	1952	Т	62.00	210.0	705,000	357,000,0	13.70
3.	Lipkovo	1958	VRC	37.00	203.0	13,000	1,750,000	2.25
4.	Gradche	1959	VRC	43.00	150.0	7,852	2,400,000	0.19
5.	Mladost	1962	VAC	35.00	60.0	2,560	8,000,000	0.84

Table 5 Greater artificial lakes in the Republic of Macedonia.

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6.	Globochica	1965	Е	90.00	200.0	998,000	58,000,00	2.70
7.	Vodocha	1965	Т	48.75	185.0	316,000	26,730,00	1.94
8.	Prilep	1966	VM	36.00	403.6	25,500	6,000,000	0.54
9.	Tikvesh	1968	E	113.50	338.0	2,722.19	475,000,0	14.00
10.	Kalimanci	1969	E	92.00	240.0	1.389.03	127,000,0	4.23
11.	Shpilje	1969	Е	112.00	330.0	2,699.17	520,000,0	13.20
12.	Ratevo	1972	VAC	53.00	194.0	21.700	10,500,00	0.57
13.	Turija	1972	E	93.00	417.3	1,978.00	48,000,00	0.16
14.	Glazjnja	1972	VAC	80.80	344.0	163.362	26,045,00	0.96
15.	Mantovo	1975	Т	35.50	138.0	261.000	47,500,00	/
16.	Paljurci	1977	Т	22.50	386.0	185.000	2,000,000	/
17.	Strezhevo	1982	E	95.00	632.0	4,219.00	120,000,0	4.33
18.	Suvodol	1982	E	25.00	250.0	1,740.00	2,500,000	/
19.	Mavrovica	1982	Т	29.00	360.0	400,000	2,800,000	0.05
20.	Podles	1985	VAC	22.50	182.0	6.600	310,210	0.05
21.	Kozjak	2004	E	126.00	300.0	3,340.00	550,000,0	14.00
22.	Lisiche	2004	E	42.00	150.0	3,300.00	20,000,00	2.50
23.	Sveta Petka	2012						
24.	Knezhevo	2012						

### 5.2.8 Climate Terrain Characteristics

The Republic of Macedonia is situated in South-eastern Europe, in the central part of the Balkan Peninsula. Our country has more types of climate characteristics depending on the location, the area and the sea level.

The Pelagonija Valley has temperate continental to continental climate. The Mediterranean climate is felt along the lenght of the Vardar River, downriver of Veles, and especially downriver of the Demir Kapija Canyon. Also, the Mediterranean climate is felt in the Strumica-Radovish Valley, around the Dojran Lake and in the Gevgelija area. In Ovche Pole and the Kochani Valley prevails the continental climate with warm and almost waterless summers and cold winters with small volume of rains. The Skopje region has temperate continental climate with some elements of the Mediterranean climate. The Polog Valley has temperate continental climate, and generally, Western Macedonia in the lower parts has temperate continental climate, while the upper places are characterized with mountainous climate, with cold and rainy winters.

The water depositions are non-uniformly distributed and are bigger in the western part of the country. For example, in the planes, the water deposition annually amounts between 400 and 600 mm/year, in the valleys' peripheries around 500-700 mm/year, while in the mountainous parts it could be maximally up to 1,300 mm/year. The annual temperature average ranges from  $10 - 14^{\circ}$ C, depending of the region.

The plant blanket of the territory of the Republic of Macedonia is various and depends on the climate, hydrographical, geological, morphological and pedological characteristics. The forested areas in the Republic of Macedonia principally are on 700 m heights above sea level and those terrains have greater annual precipitation. In Ovche Pole, from hydrogeological aspect, an interesting feature are the salty soils which decreases the fertility of those terrains

and the underground water often is of salt taste. Generally, the vegetation has determined role in keeping the air and earth humidity and it is usual that the underground water is more common in the forested terrains.

### Continental-Sub-Mediterranean area

The climate in this area is a combination of the sub-Mediterranean east-continental climate influences. Sub-Mediterranean influences are most expressed in the southernmost part, and then are increasing in all directions, especially towards north, and with increasing sea level. Those influences come from the Aegean Sea and are weaker than in the sub-Mediterranean area. The influence of the continental climate increases with the openness of the relief towards it, with the closeness to the higher mountains, with increasing sea level and the remoteness of the Aegean Sea. If we compare it to the previous area, we will note obvious climate changes due to the continental climate presence. That results in the following consequences: decreased precipitations and increased aridity, changed pluviometric regime and increased temperature, especially the winter one, etc.

The average temperatures range from 11.8 to  $13.6^{\circ}$ C (average of  $12.7^{\circ}$ C) and are lower from the Mediterranean area for  $1.5^{\circ}$ C. The amplitudes are increased due to the influence of the continental climate: for example, the average annual temperature is  $21.8^{\circ}$ C –  $22.3^{\circ}$  and is higher for 1°C. The absolute maximum temperatures ( $39.8^{\circ}$ C –  $43.5^{\circ}$ C) and medium maximum temperatures ( $17.5^{\circ}$ C –  $19.2^{\circ}$ C) are lower. The absolute minimum (from - $17.8^{\circ}$ C to - $19.2^{\circ}$ C) and the medium minimum temperatures ( $6.0^{\circ}$ C –  $7.5^{\circ}$ C) are especially lower. In this area, the absolute amplitude is increased under the influence of the continental climate ranges between ( $59.6^{\circ}$ C –  $68.0^{\circ}$ C). The number of tropical days is decreased to 14.4 and totals from 40.7 to 62.1), as well the number of the summer between 58.4 and 82.4. Also interesting is the temperature distribution according the seasons, namely this area is generally colder compared to the sub-Mediterranean one.

Soil temperature is lower for  $1.4^{\circ}C$  and totals  $13.2 - 14.7^{\circ}C$  (average of  $14.0^{\circ}C$ ). This area is characterized with the least precipitation, with different rainfall regime and with the most arid character compared to all the other areas.

The annual precipitation ranges from 460 - 583 mm (average of 507 mm) and is for 143 mm lower than the sub-Mediterranean. The rainfall regime is a combination of sub-Mediterranean and continental: May and November have maximum rainfalls, and in August the both regimes overlap. Under the influence of the continental climate, the rainfall percent is greater in the warmer half of the year (from April to September) for 6.3% and totals 37.1 - 51.9%, while the relative rainfall hesitations decreased for 3.2% and varies from 5.3 to 8.0%. The number of days with snow cover is increased from 8 to 17, which is a result of a colder winter. Increasing the influence of the Mediterranean climate increases the insolation to 138 hours/year. The number of the clear days is especially decreased and ranges between 73 and 115 (average of 93).

The region is characterized with highly expressed aridity. The annual dry index is low and ranges from 19.7 - 25.4. The index is especially low in July, August and September, when it

totals 10 - 15. The high values of evapotranspiration (708 - 781 mm annually) testify about the aridity. The evapotranspiration ratio to the annual precipitation in this area amounts of 1:0.68.

### Warm Continental Area

The warm continental climate predominates in this area. Some of the valleys of this area feel the loose Mediterranean influences from the Adriatic Sea, as well as similar influences of the great lake masses. These influences are weaker on the thermal regime, but are stronger on the pluviometrical regime. Some valleys with higher sea level and with the proximity of higher mountains feel the week influence of the mountainous climate (cold masses falling from the mountains in the valleys). Parts of the valleys often have temperature inversion in winter. The average annual temperature is lower for 1.8°C and totals of 10.9°C. The annual temperature volumes are lower for 660°C compared to the continental – sub-Mediterranean zone. The annual amplitudes range from 18.8°C to 22.3°C and are higher than those in the previous area. The extreme temperatures are also lower: absolute maximum temperatures range from 36.5°C to 41.5°C, while average absolute temperatures range from 15.5°C to 17.5°C. The absolute minimums under the zero are present in the other months, other than the three summer ones. They range from -17.2°C to -29.4°C. Also, the minimum temperatures are lower and range from 3.7° to 6.3°C. The absolute amplitudes range from 53.9°C – 70.6°C. As a result of the lower temperatures, the number of tropical (9.5 - 34.7) and warm days (63 - 103) is decreased, while the number of ice days is increased for 10 and totals from 61 to 101 (average of 82). Also interesting is the temperature distribution according the seasons, namely this area is principally colder than the continental – sub-Mediterranean. The average ice period is 5 days longer and totals 159 days. The temperature sum in the vegetation period (above 10°C) is lower for 315°C and totals 2,798 - 3,627°C.

The soil temperature in depth of 20 cm is lower than the other zones and ranges from 11.1 - 12.8°C), while in depth of 50 cm ranges from 12.3 - 13.1°C. In depth of 30 cm, the average soil temperature in the three winter months is less than 5°C, and even deeper than that in two months. In that period, all the pedogenetic processes are weaker.

The precipitation ranges from 515 - 890 mm (average of 700 mm), or around 200 more than the continental – sub-Mediterranean area. The rainfall regime is modified continental: the maximum rainfall is in May, while the minimum is in August, or even September. The rainfall percentage in winter is low (22.6%), while the relative rainfall hesitation is high (4.8%). The number of days with snow cover is doubled from 17 to 33. Compared to the above mentioned, this area shows far lower degree of aridity. The dry index ranges from 25.0 to 40.8. The evapotranspiration has decreased from 744 to 671 mm annually and ranges from 622 – 701 mm. The evaporation-rainfalls ratio is 1:96.

## 5.2.9 Constant Travelling and Municipal Infrastructure

### Traffic

The current total length of the road network in Macedonia is 10,600 km:

- out of which 6,830 km or 64,5% are local roads
- out of which 2,820 km or 26.5% are regional roads, and

The length of the modernized roads is 5,100 km.

The most significant highway is the international E-75 highway. It starts in Ostend – Belgium, passes through Brussels – Ninberg, Vienna – Budapest – Belgrade – Thesalloniki to Athens in Greece. The total length in Macedonia is 201 km. It passes through the central part of the country, along the Vardar River and presents the main artery of the road network in the country.

• Length of the existing railway is 920 km, with 168 railway stations.

• It is connected to Greece and Serbia via railway, while the construction of the railway to Bulgaria is in progress since 1999.

• Macedonia has two international airports, one in Ohrid and in Skopje, with some international connections.

• It also has national and recreation aviation centres in Bitola, Shtip, Kumanovo, Skopje and Prilep.

• The Alexander the Great Airport in Skopje is used by 90% of the passenger, and St. Paul-the Apostle Airport in Ohrid is used by 10% of the passengers.

### Telecommunications

- Telecom operators: 3 (98% digitalization) Macedonia Telecom, ONE, VIP
- Telephone lines in use: 498.910 (2007)
- Mobile operators: 3 (T-Mobile Macedonia, ONE and Vip).
- Telephones mobiles: 1,261 million
- Internet users: 392,671
- Available Internet services:
- Dial-up approach via PSTN with speed of 56kb/s
- Access via ISDN network with 64 kb/s or 128kb/s
- Access via pre-paid
- Access via rented lines
- Broadbent access via ADSL and cable Internet
- -Optical access

# **1.2.10** Biodiversity (Flora and Fauna) of the Area Planned for Project Construction and Existence of Protected Areas

The extensive list of plants and animal species inhabit the area longitudinally of the given sections. These flora and fauna are systematized in different groups according the vegetation type and density, the orographic type and characteristics of the habitat, the natural/anthropogenic genesis of the vegetation, the presence or absence of human settlements or objects and the water springs. The given area has the following groups of biotypes:

□ forests and low vegetation (natural and anthropogenic);

 $\Box$  open areas, such as grass areas, grass areas with bushes, fields, etc. (natural and anthropogenic);

□ pastures and waters as environment;

 $\hfill\square$  agriculture areas, such as orchards, fields, gardens; and

□ rural environments (ancient villages), as well urban and industrial environments.

The grass areas cover a small region, but are important because of their dominant vegetation and rich fauna. Additionally, fields under uncultivated ploughland and meadows have important values on the biological diversity. The cultivated fields (ploughlands, orchards, vineyards, gardens) are less important regarding the inhabitants of the significant flora and fauna.

The vegetation world in the surroundings of the road of unsettled parts distinguishes with agricultural crops. The rest of the vegetation is mainly short-stem vegetation, and the higher parts are with deciduous trees. Certain flora is obvious in parts of the terrain without anthropogenic influences. Greatest part of the unconstructed section surfaces around the settlement are planted with industrial agricultural crops: wheat, bean, corn, potato, cabbage, pepper, fodder, etc.

The Polog Valley is 300-600 m above sea level. It is a real resource for agro-production with developed agricultural production.

The sub-mountain continental-mountainous area is situated on 1,100 - 1,300 m above sea level, represented with the community of sub-mountainous beech forest, Festuco heterophyllae – Fagetum. Under the sub-mountainous continental – mountainous area are developed forests, which belong to the cold and warm continental mountainous area, and on 1,600 to 1,700 m height above sea level are forests from the sub-Alpine mountainous area.

The beech (Fagus sylvatica) is absolutely dominant in the beech forest communities on the trees floor. The sub-mountainous beech forest on the bushes floor has bushes from beech and fir-tree, and the grass floor is poorly developed, with the presence of the following plants: Anemone nemorosa, Dentaria bulbifera, Brachypodium sylvaticum, Asperula odorata, Rubus sp., Actaea spicata and Pteridium aquilinum.

The oak forests, on 1,100 m height above sea level, cover the lowlands and hills. The average annual temperatures in this region range from  $9 - 14.2^{\circ}$ C, and annual rainfalls from 500 - 850

mm. Dominant soil type are the cinnamon forest soils, but are locally represented by other types (terra rossa, chernozem, pseudogley, lesivated soils, brown forest soils and others).

In this region, climate zonal are the oak woods, mixed (orographic-edafic and hidrologically conditioned) forest communities with willows, poplars, platanus, sweet chestnut, alder and others. From the vertebral fauna, typical inhabitants in this region are the ponto-Mediterranean and Syriac arboreal elements, such as the wormsnake (*Typhlops vermicularis*), the cat snake (*Telescopus fallax*), the whip snake (*Coluber gemonensis*), the eastern spadefoot toad (*Pelobates syriacus balcanicus*), the green woodpecker (*Picus viridis*), the hedgehog (*Erinaceus concolor*), the dear (*Dama dama*), the least weasel (*Mustela nivalis*) and others.

## 6. **Project Influence on the Environment**

The preparation of the Environmental Impact Assessment Report has an aim to locate and determine potential hazardous influences on the environment as a result from the project activities carried out through the rehabilitation and/or reconstruction of the given sections on the local roads. This chapter has for its aim to assess the potential influences on the local roads. The asphalt has the least influence on the environment out of any construction material used in the infrastructure construction. The asphalt components aren't soluble or biodegradable, so they don't leak out with the surface or underground waters even in the worst conditions. Asphalt-containing materials are 10-60% recyclable, while the asphalt used for road asphalting is 100% recyclable and can be used for couple of times, thus helping the decreasing of the fuels for its production thereby the hazardous influences on the environment if it is used for the envisaged purpose.

The following are the projects' influences on individual media of the environment. The influence of this type of project activities is a sublimate from three types of activities:

 Preparative phase – preparation works (preparation of the given sections for rehabilitation/reconstruction);

Construction phase – rehabilitation/reconstruction of the given sections;

• Operative phase (traffic flow along the given section and maintaining the same in functional condition).

From the previously described activates, which will be carried out during the activities, that is, rehabilitation/reconstruction of the given sections, the sources of emissions in the basic media and areas in the environment have been monitored from aspect of their influences on the environment.

### 6.1 Emissions

In the preparative phase, during the terrain preparation, the following emissions are expected:

appearance of fugitive emission of dust from the cleaning of the given section;

- exhaust fumes from the constructive machinery;
- communal, organic waste (vegetation);

In the constructive phase, that is, rehabilitation/reconstruction of the given sections of the local roads, the following emissions are expected:

- appearance of fugitive emission from the construction of works;
- exhaust fumes from the constructive machinery;
- communal, organic waste (vegetation);
- wastewater from the construction workers;
- noise and vibrations from the work of the constructive machinery.

In the exploitation phase the following emissions are expected:

- exhaust fumes from mobile sources of pollution (cars);
- atmospheric wastewater;
- noise.

### 6.1.1 Air Emissions

According the Law on ambient air quality (Official Gazette of the Republic of Macedonia No. 67/04; 92/07; 47/11, 59/12, 163/13); and the by-laws which emanate from it, the air emissions have been classified into: emissions from kettles, point emissions from stationary and mobile sources and potential and fugitive emissions.

There will be emission of hazardous pollutants in the air in the rehabilitation/reconstruction process and in the exploration of the sections local roads implied in the Assessment Report.

In the rehabilitation/reconstruction process of the given sections, emissions that will arise in the air are: fugitive emissions of dust in the on site cleaning and vegetation removal, emissions of dust in the loading and transportation of the excavated material, emissions of exhaust fuels from mobile sources of pollution – construction machinery and fugitive emission of volatile organic components from the deposition of the bitumenn emulsion and the asphalt mixture.

From the above mentioned influences, the fugitive dust has the greatest meaning according the influences on the environment. The dust created from the mechanical operations of the combustion of the machinery's oil, in the on site preparation influences the local and distant environment depending on the volume (aerodynamical diameter of the particles), as well as the meteorological conditions in the period of the activities. The influence of the emissions of the fugitive dust produced by the construction machinery will be additionally enhanced because it will be followed by emissions of the exhaust fumes from the construction machinery.

The fine dust, that is, the visible particles with diameter of  $D \le 2.5 \mu m$ , which will be created in the oil combustion in the motor vehicles, will be transferred to greater distance and have

chemical composition, that is, they contain organic compounds and heavy metals, which have negative influence on human's health and the environment.

The influences of the fugitive emission of volatile organic components from the deposition of the bitumen emulsion and the asphalt mixture will have lesser influence because these are easily vaporized compounds, stay in the air for short period, does not transmit and imitate.

Gases and the present polluters imitate themselves in the ambient air through the system for carrying away the waste gases of the traffic materials and the construction machinery on site. The quantity and content of the exhaust fumes depends on more parameters, such as the type and age of the vehicle, its performances, type of used oil, oil characteristics in the distributive network, presence of additives, degree of oil combustion, etc.

The total oil combustion creates  $SO_2$ ,  $CO_2$ ,  $H_2O$ , aromatic hydrocarbons, and if catalizators are used,  $Pb_2O_3$  and other matters arise. The incomplete oil combustion creates CO, hydrocarbons, suspended dust, etc. In long term exposition of the mentioned toxic matters, the same have hazardous influence after human's health. Thus, the smoke influences the airways and skin, the lead on the respiratory and on the whole nerve system, but also the blood system and bones. The particles which appear in the oil combustion process have cancerous influence.

The following is tabulated view of the limit values of the pollution matters from the construction machines, according the directive 97/68/EC:

Motor Power	CO (g/kWh)	HC(g/kWh)	NOx(g/kWh)	PT(PM)
				(g/kWh)
130 ≤ P ≤ 560	5.0	1.3	9.2	0.54
75 ≤ P ≤ 130	5.0	1.3	9.2	0.7
37 ≤ P ≤ 75	6.5	1.3	9.2	0.85

Table 6 Limit values for pollution matters emitted from the construction machines (Directive 97/68/EC)

The meteorological and geomporphological conditions influence the concentration of emitted air polluters in the region, that is, the ambient air pollution.

With the construction/reconstruction, the application and maintenance of these roads would not essentially change the air quality having in mind the fact that these roads are currently in use.

It could be assumed that due to mainly rural character of the regions where the projects are envisaged, the basic concentrations are probably lower than 50% of the existing standard on air quality. Thus, the influence on traffic is compared to the half of the existing standard on air quality. With the exception of  $NO_2$ , even the maximum calculated concentration of contaminates is under the basic level. Therefore, there is no influence on any susceptible area of the environment.

As a conclusion, additional emission of contaminants into the air of these roads would not have any greater influence on the environment.

## 6.1.2 Emissions into Waters and Sewerage

Water pollution in the rehabilitation of given sections could be physical, chemical and biological. The physical pollution is manifested through the presence of coarse particles from earth debris, sand, coarse particles from the pneumatics' friction, failure debris, etc. The physical pollution from liquid matters is the presence of fats and oils. The coarse particles with the rinsing of the road surface deposit into the gutters and sewers which can cause obstruction of the same, while the fats and oils come to surface and go to the recipient. Here they create a film and the inlet of oxygen in the water flow is blocked which constrains the natural creation of the bioworld in the recipient.

The chemical pollution begins as a result of the dissolution of the present air pollutants. These pollutants are result of the exhaust fuels from cars, emissions from the polluting components of the nearby industrial and manufacturing capacities, solution of separate components from the local land, application of agro-chemical materials and pesticides, animal and vegetation waste. The chemical pollution can be manifested as highly acid, low acid neutral environment and all the variations from highly base to highly acid environment.

The biological pollutions are result of the decay of organic substances which serve as food to different microorganisms. They can be result of thrown food from negligent participants in the traffic disseminated by the wind, leaves and other biodegradable waste and other substances present in the local environment.

The mechanical dirt from the rinsing of the land during heavy rains and the running of surface waters will fill the beds and puddle the waters which will decrease the penetration of sunlight into the great deep and the change of the life conditions in the aquifer. The change of the quality of the surface and underground waters will influence even the usual application of different purposes by the population and industrial capacities.

The most dangerous pollutants for the surface and underground waters are hardly degradable components of the organic substances and hazardous metals.

The influence on water resources at given locations are expected primarily in the rehabilitation/reconstruction phase when attention should be paid to avoid any influence of the oil and fats and their seeping into the surface and underground waters.

The emission of these substances can have serious effects on the surface and underground water quality and on the water flora and fauna. One should not construct any dams or similar constructions in waters that will improve the access to the construction location during the construction phase.

Some influences can occur during the application phase due to pollution of run-offs discharged into the surface water bodies. Oils, rubber waste, coarse particles and salt or other agents used for unfreezing during the winter period could be discharged through the surface run-offs. Therefore, each potentially contaminated surface run-off should be constrained to flow into the rivers or springs. Besides that, there is a great possibility of polluting these water bodies due to traffic accident. Thus, high standards for protection should be implemented, especially near

highly susceptible places (e.g., near a surface water body). Additionally, certain sections should have additional strong amortization fenders so as to avoid any pollution of the surface waters in case of accidents. Passing of each water flow will probably result with partial lost of the river vegetation and efforts should be made to decrease each influence on the river banks.

The main influence on the underground water during the construction phase is related to the potential decrease of the water level, especially on places near the underground level. This influence should be estimated in the project details and an effort should be made to decrease the need of pulling underground water put so as to meet the design needs. The total weakening of the hydrological regime due to design activities will take only certain road sections and will occur only during the construction phase.

As a conclusion, uniquely significant influence on waters will be mainly because of the surface dischargeable contaminated water with pollutants discharged of the normal road traffic. This could be considered as a small influence.

### 6.1.3 Waste genaration

During the performance of the construction works on the road, it is expected from the workers to create solid communal waste, as well inert biodegradable and dangerous waste from the preparative and construction works. Biodegradable waste (debris from branches, leaves, roots, etc.) will be created during the preparative works on site. This waste should not end up in the water flows because its degradation will cause water eutrofication. The inert waste consists of earth, stones, asphalt, concrete, etc. The inert waste does not cause chemical pollution of the environment, but due to its coarseness it disfigures the area. The dangerous waste will principally be represented by the oil derivatives, grease and oilers, unless the same is not properly handled and authorized company for management with this type of waste does not remove it, it pollutes the whole media and areas of the environment, principally of the soil, the underground and surface water flows and it influences toxically on the whole living world. The coarse communal waste from the workers will consist of organic waste from food leftovers, plastic, paper, glass, metal. This waste, unless properly removed from the location, will pollute and disfigure the terrain. For communal waste and inert waste management, which would not be reused, the Contractor of the construction works should negotiate a contract with a PCE for its collection and disposal. For management with the dangerous waste, the Contractor of the construction works should negotiate a contract with specialized company for dangerous waste management, for its collection and sage management. During the exploitation, theoretically, waste production is not expected. Creating hard waste in this phase can arise by people who use the roads and it will belong to the category of hard communal waste. Types of waste, which will be created during construction activities in the rehabilitation and reconstruction of the given local road sections, as well the way of management of different types of waste, are given in the following table:

Phase	No.	Type of waste	Number from the List of waste types (Official Gazette No. 100/2005)	Quantity of waste on annual level expresse d in tones or litters	Way of management with waste (processing, storing, transferring, removal and other)	Name of the legal person that manages waste and the location where the waste is removed (dump)
Preparatory and	1	Mixed communal waste	20 03 01	Could not be determin ed <sup>1</sup>	Temporary disposal in PVC bags to its removal in rubbish bins located nearby	Municipalit y PCE
constructio	2	Earth material	17 05 06	Could not be determin ed	Temporary disposal in PVC bags to its removal in rubbish bins located nearby	Municipalit y PCE
on phase	3	Polluted soil from eventually discharge of oil from the construction machinery	17 05 05*	Could not be determin ed	Storage to appropriate location until transporting to a dump for construction waste	Municipalit y PCE
	4	Construction debris (depending on the Basic Project)	17 03 02	Could not be determin ed	Storagetoappropriatelocationuntil transporting to adumpforconstruction waste	Municipalit y PCE

Table 7	Types of waste a	and quantities	expected to be	e created with	project realization
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\*Dangerous waste according the List of waste types (Official Gazette No. 100/05)

In the rehabilitation/reconstruction process of the local roads sections, which are subject of analysis of this Assessment Report, will generate mixed communal waste from the workers and waste as a result of the construction activities. According the Law on waste management (Official Gazette of the Republic of Macedonia No. 68/04, 71/04, 107/07, 102/08, 143/08, 09/11; 47/11, 124/10, 51/11, 123/12, 147/13, 163/13) types (Official Gazette No. 100/05), the creators of the waste are obliged, to the greatest extent possible, to avoid creating waste and to reduce the harmful influences of waste on the environment, life and health of people. The creators of commercial wastes are obliged to negotiate a special contract on waste collection and transportation with the Provider of the service on the territory of the municipality. The waste will be transported with special vehicles used for waste transportation and the same will be

<sup>&</sup>lt;sup>1</sup> The quantity of produced communal waste will depend on the number of performers of the construction actions in construction, the time period of performance and the time needed for project realization

disposed to the nearest damp according after the approval from a competent organ (e.g. the municipality or PCE). It is forbidden to throw away or dispose waste next to the roads and in their surroundings.

### 6.1.4 Soil Emissions

Influences on soils in the rehabilitation/reconstruction process of the local roads of this Assessment Report are expected to be insignificant or medium regarding the implementation of the appropriate measures for soil protection during the construction.

During the terrain preparation for rehabilitation/reconstruction, the environment will undergo major changes which directly or indirectly will influence the soil.

The soil as a natural resource quickly reacts to different influences that can lead to its accelerated degradation, so the realized influences cannot be stopped or removed. Those influences affect the soil quality, that is: reduce the content of the organic substance, contamination of the soil, the soil gets salty, it loses the biodiversity, it is used for different purposes, etc. These influences on the soil quality during the rehabilitation of the road are result of the construction activates which are part of this first phase and can be expected from:

- the emission of dust from the process of on site cleaning;
- the emission of exhaust fumes from the construction machinery present on site;

- Seepage of oils and lubricants from the construction machinery engaged for design of the construction activities that besides their influence on soil will pollute the underground waters through seeping and filtrating.

### 6.1.5 Noise, Vibrations and Non-ionizing Radiation

In the rehabilitation/reconstruction process of the given sections, the maximum allowed noise level will be surpassed.

The noise, which will arise during the rehabilitation/reconstruction, comes as a result of the action of the construction machinery which will be engaged in the construction phase, that is, the supply and transport vehicles of construction materials and machinery for realization of the construction activities. The uniqueness of the influence principally depends on the type of equipment, type of technical regularity of the construction machinery.

Of greatest importance for the noise influence on the environment itself is the remoteness from the settlements, geological conditions and terrain configuration.

Meteorological conditions have great influence on noise intensity and air strikes. The wind direction and speed influence the air strikes, while the wind speed and temperature influence the acoustic dispersion in function of the height and configuration on site.

The wind influences the sound intensity; the increase of the sound intensity almost always follows the wind direction. The wind influence on the noise intensity is highest in the winter period. Of greatest importance for the noise influence on the environment are the location and

### the remoteness from the closest receptors – households, etc.

In Table 8 is given the list of noise, vibrations and non-ionizing radiation sources.

Emission	Type of	Equipment –	Emitted noise	Intensity of	Emission
source	emission	machinery with	intensity (dB)	emitted	periods
	(noise,	description of	expressed by	vibrations and	(number of
	vibration or	the maximum	equipment	non-ionizing	hours per
	non-ionizing	power	demonstrative value	radiation	day
	radiation)				-
Heavy	Noise (84 dB)	Earthmover,	1	/	8
vehicles		dreadger,			
		trucks			

Table 8 List of noise, vibrations and non-ionizing radiation sources

The limit values of the basic environmental noise indicators have been determined in the Rulebook on the limit values of environmental noise levels (Official Gazette of the Republic of Macedonia No.147/08). According the level for noise protection, the limit values of the basic environmental noise indicators caused by different sources should not be higher than the values given in the following table:

Table 9 Noise levels by areas

Area differentiated by the protection	Noise level expressed in dB (A)			
degree from noise	Ld	Lv	Ln	
First degree area	50	50	40	
Second degree area	55	55	45	
Third degree area	60	60	55	
Fourth degree area	70	70	60	

Legend: -Ld - day (period from 7:00 am to 7:00 pm) -Lv – early night (period from 7:00 pm to 11:00 pm) - Ln – late night (period from 11:00 pm to 7:00 am)

According the literature data and the comparable analysis it is concluded that the noise level in the construction phase will surpass the limit values, that is, the noise will cause negative influence on the environment. The noise intensity and its influence on the environment will depend on the volume and the time duration of the construction activities.

The areas according the protection degree from noise are determined in the Rulebook on the locations of measuring stations and measuring points (Official Gazette of the Republic of Macedonia No. 120/08).

• Area of I degree for protection against noise is an area intended for tourism and

recreation, an area in the surrounding of health institutions for medical treatment and an area of national parks and natural preserve;

• Area of II degree for protection against noise is an area primarily intended for residence, that is residential zone, an area in the surroundings of objects intended for educational activity, objects for social protection intended for accommodation of children and elderly and objects for primary health care, an area for playgrounds and public parks, areas with public green spaces and recreational spaces and areas of local parks.

• Area of III degree for protection against noise is an area where an undertaking in the environment is allowed in which the noise will be less, that is where there are objects with protected facilities, handicraft and similar manufacturing activities (mixed area), an area intended for agricultural activity and public centres with management, commercial, hospitality activities and services.

• Area of IV degree for protection against noise is an area where undertakings in the environment are allowed, which can cause disturbance from noise, an area without apartments, intended for industrial or handicraft or other similar manufacturing activities, transport activities, storage activities and services and communal activities that create higher noise.

In the operative phase, the noise is expected to arise as a result of the application of motor vehicles which will use the local roads in rehabilitation/reconstruction. By rehabilitation/reconstruction of the given sections, the level of the present existing noise from the motor vehicles is expected to increase, even to a certain degree it is expected decrease due to the current road condition and dilapidation of the same.

In most of the cases, local road sections are outside the settlements, therefore the noise influence on receptors is in the allowed limits range.

In construction of activities, vibrations will appear due to the movement of the construction and transport machinery.

## 6.1.6 Biodiversity (flora and fauna)

Generally, eutrofication of water ecosystems and modified vegetation communities with air pollution and clearing the vegetation represents a major problem for the environment along the local roads, while soil pollution with heavy metals or organical polluters will be restricted next to the roads. The influence on the local cultivated areas is possible from the aspect of waste throwing and emergence of damage. Another influence related to the construction works is the presence of birds' nests (e.g. hawks) from the exhaust fumes, noise and presence of heavy machinery which is used for rehabilitation operations and in come degree, from the increased traffic after the termination of the road.

The noise, air pollution and the presence of vehicle traffic could decrease the number of birdsresidents in radius of hundreds of meters. Therefore, it is expected significantly decreased number of birds nearby the road sections. Increased traffic, especially in areas with bushes located near the road could also influence directly on bird species. In order to avoid unnecessary loosing of biotypes, the building site needs to be limited to the minimum necessary surface for road works and disposal/storage of materials/equipment needs to be carried in the limits of the building site. Removal of biotype elements of the building site during the construction phase, after the termination of the road works needs to be returned in the original condition. Removal of bushes and trees, which is supposed to be minimal, has to be done outside the mating period for birds.

Seeing that this is only about rehabilitation and/or reconstruction of existing local road sections of small dimensions, it is expected influences on the biodiversity to be minimal and limited principally in the rehabilitation/reconstruction phase.

### 6.1.7 Influences on the landscape

Additional storage areas of the construction material will be needed and also for temporary storage of the excavated soil which will reduce the area's value. The excavated soil or construction material should not be permanently left near the roads or another area to be destroyed.

Seeing the fact that existing local roads have been rehabilitated/reconstructed, as well the fact that projects does not envisage additional activities around the roads, additional influences on areas are not expected.

### 6.1.8 Social impacts

It is expected from the construction works to have positive socio-economic influences.

Great number of workers could be engaged for carrying the total construction works. These workers will be on the building site only during the works, so there is no need for construction of temporary barracks for their accommodation. The available labour has to be taken into consideration so as to meet the required unskilled labour for the project. Still, certain qualified stuff has to be engaged for performing the technical works and monitoring.

Generally, reconstructed/rehabilitated local roads can be expected to contribute for the positive socio-economic benefit for all regions through increased possibilities for employment, as well through improved access, lower transportation costs and better market of goods and services. Of course, positive socio-economic benefits, which arise from this project, will be greater than the negative influences on the nature and the environment.

## 7. Program for Environmental Protection

The system for management with environmental protection represents a system of measures for avoiding, mitigation or improvement of the environmental media. More projects have potential to cause negative influences on the environment. Those influences could range from insignificant to highly significant and from short term to long term.

Almost all influences could be reduced through implementation of effective improvement/mitigation measures.

The effective mitigation measures are those designed for reducing the existing or envisaged influences from individual activities. The mitigation measures could be effective if only implemented properly and if their implementation is being monitored to assure that the measures results with the planned effect.

Generally, the principle for effective and efficient work gives the following effects:

Economic effects – Savings of raw materials, energy, waste costs, emissions, increased productivity, innovation.

Ecologic effects – decreased hazardous emissions, waste, application of ecologic raw materials, renewable materials and fuel, reducing the wastewaters, ecologic certificates and standards.

Social effects – increasing the safety at work and health protection of employees, continued education, information.

Good planning of activities during the rehabilitation of the given section will minimise the risk of environmental pollution.

### 7.1 Measures for Protection against Air Pollution

In the preparatory and constructive phase, the expected influences from the emissions in the air will be local and with application of the following protection measures it is expected to be minimized:

• In order to decrease the emission from exhaust fumes, application of standardarized oils for the machinery and turning of the machinery's motors while not in use is recommended.

• Measures for dust reduction – application of sprayers that do not contain chemicals, and are water-based;

• Route planning and factor of loading and unloading are of great importance for reducing the fuel consumption and emission of exhaust fumes and fugitive dust emission.

## 7.2 Measures for Protection against Water Pollution

In the process of local roads rehabilitation and reconstruction, the wastewater will be produced in the realization of construction activities, in keeping the hygiene of employees on the location itself and atmospheric wastewater. The quantity of wastewater to be produced is envisaged to be minimal so that the same would not contaminate the environment, which requires additional analysis.

The collected water will be drained on appropriate sites on the local terrain.

Water will be applied for the sprayer in the preparatory and constructive phases (in order to decrease the dust from the earth eexcavation and leveling), and the quantity, also the quality, would not decrease the ecological balance in the surroundings of the given location.

## 7.3 Measures for Improvement for Communal Waste Management

Waste management, which will be produced in the construction activities, should be in line with the Law on waste management (Official Gazette of the Republic of Macedonia No. 68/04, 71/04, 107/07, 102/08, 143/08, 09/11; 47/11, 124/10, 51/11, 123/12, 147/13, 163/13); Chapter II – Waste Management, which defines the obligations of the waste producer according to which the same should be managed regarding Article 26:

- 1. The producer or owner has the following obligations regarding the waste:
- a) selection
- b) classification according the List of waste
- c) determining waste characteristics
- d) controlling the influences of waste on the environment and people's health
- e) storing it on places intended for that purpose and

f) processing the waste, and unless its processment is technically impossible and economically unprofitable, to hand it over to a legal entity or natural person who has a license for collecting, transporting, processing, removal and/or export of waste.

2. If the waste has one or more hazardous characteristics, the creator and/or owner is obliged to classify it in a category of hazardous waste and to treat it as such.

In order to improve the way of waste management in the process of realization of construction activities, according the legal legislation in the area of waste management, the following measures are being recommended:

Selection and classification on all types of waste according the Law on waste management (Official Gazette of the Republic of Macedonia No. 68/04; 71/04; 107/07; 102/08; 143/08; 124/09; 09/11 μ 51/11);

• In order to manage a communal waste, a Contract should be made and hand it over to a legal entity or natural person, who has a License for storing, treatment and processing of

waste according Article 32 of the Law on waste management (Official Gazette of the Republic of Macedonia No. 68/04; 71/04; 107/07; 102/08; 143/08; 124/09; 09/11 и 51/11);

For further handling with the selected waste from the construction activities (construction debris), the Constructor should act in line with Article 45 of the Law on waste management (Official Gazette of the Republic of Macedonia No. 68/04; 71/04; 107/07; 102/08; 143/08; 124/09; 09/11 μ 51/11);

• For further handling with the selected waste of packing (temporary stored on different packing on precisely determined and marked location), the Contractor should act in line with Paragraph 2 Article 30 of the Law on management of packaging and packaging waste (Official Gazette of the Republic of Macedonia No. 161/09);

• Regular servicing of the vehicles and mechanization during the realization of the construction activities in order to avoid eventual spill of the motor oil and/or fuel. The service is to be performed on authorized places for that purpose;

• The soil polluted with waste oils and/or fuels (hazardous waste) in eventually incidental spill from the mechanization needs to be removed and hand it over to a Waste Oil Collector (who has a License for collecting and transporting hazardous waste), a contract will be negotiated according the Rulebook on actions and way of collection, transportation, processing, storage, treatment and disposal of waste oils, the way of evidence management and data delivery (Official Gazette of the Republic of Macedonia No. 156/07).

## 7.4 Measures for Soil Protection

The most serious pollution on soil and indirectly on underground waters could be cases with spill of fuel, oil, lubricants from the machinery and the vehicles and chemicals used in construction.

Also, the spilled fuel, oils, lubricants and some chemicals, which are used in the construction, during high outdoors temperatures are easily-volatile, but also flammable liquids, which can cause fire.

Because of the mentioned influences, the following measures are recommended:

- Control of the operability of the construction machinery and transportation vehicles;

- Cessation of the working activities during uncontrollably spill of fuel, oil, lubricants and chemicals;

- Placing appropriate number of mobile toilets along the alignment.

The same will be emptied by an authorized company which has an obligation to carry the faeces into a sewerage system or wastewater treatment plant, which will provide sustainable wastewater management and the same are minimized and is avoided potential soil contamination;

In order to preserve the environmental surfaces during spraying the emulsions in the

asphalting, the recommendation is careful keeping and handling with the bitumen emulsion and the asphalt mass and their deposition only on envisaged surfaces.

## 7.5 Measures for Protection against Noise and Vibrations

During the realization of the earth and construction works, the limit values of the basic noise indicators due to the construction machinery, motor vehicles and application of explosives will be surpassed.

The noise which will appear in the preparatory and the construction phase, and will be a result from the work of the machinery and the transportation activities, will have negative, but short term influence on the susceptible auditory receptors and the living organisms nearby the local roads.

The whole machinery, engaged in the activities, and all the transportation vehicles should be technically operable, which is a prerequisite for the reduced noise.

Also, as a basic measure for decreasing the negative influences due to the increased noise intensity, the recommendation is turning of the motors of the vehicles and the construction machinery at moments when they do not operate.

It is recommendable for the construction activities to be carried only during the daytime with a certain time dynamic.

## 7.6 Measures for Biodiversity Protection

The most important measures for biodiversity protection can give the following recommendations:

- > Forbidden entrance in areas outside the building site.
- > Do not leave waste and old things on site.
- > Do not destroy, take or damage trees and animals.
- > Do not step on young trees and plants, except in the areas of the building site.
- > Carefully with fire and cigarettes (disposal on appropriate places).

### 7.7 Risk Management (in Case of Failures, Accidents or Emergencies)

The appearance of failure is unplanned or unusual situation caused by negligence, force majeure, in cases of partly or totally losing control of the production process or manipulation,

which is spatially and timely limited, and the same could have hazardous influence on people's health and the environment.

For cessation of eventual occurrence of failures along the alignment in the rehabilitation process of the given section, the following is recommendable:

- Contractors of the construction actions on the location intended for rehabilitation of the given section should be equipped with adequate equipment for personal protection according the weather (working suit, helmet, gloves, etc.);

- Preparation of Plan for Safety and Health at Work in workers who work on temporary mobile building sites according the Rulebook on minimum requests for safety and health at work on temporary mobile building sites (Official Gazette of the Republic of Macedonia No.105.08);

- Placing fire extinguishers in vehicles and machinery for use during the rehabilitation;

- Marking and securing the location according the legal provisions in the area of safety and health at work;

- Placing traffic signs for speed limit of vehicles, etc. according the valid provisions and standards and the Rulebook on traffic signs, equipment and road signalization (Official Gazette of the Republic of Macedonia No. 56/08, 47/10);

Realization of the envisaged measures is necessary in order to avoid eventual break of failures, principally fires of large scale which would have negative influence both in the working place and the environment due to: emission of hazardous air pollutants, material damages and human victims.

Table 10 Tabulated view of the envisaged measures – Plan for environmental management

Environmental Impact Assessment Report for the Reconstruction and Rehabilitation of the Local Road Network Project in Republic of Macedonia (VII tender)

No.	Measure description	Measure goal expressed by reducing the environmental influences	<i>Time schedule for realization of improvement plan in 5 years period</i>	In-charged	Legal obligation		
SOIL MANAGEMENT							
1	Cessation of the working activities in case of uncontrolled spill of fuel, oil, lubricants or chemicals, sanding and removal of the polluted soil layer, thus the polluted material will be treated as hazardous material	Decreasing the possibility for soil degradation and biogenesis	During the rehabilitation of the given section	Contractor	Law on waste management (Official Gazette of the Republic of Macedonia No. 68/04, 71/04, 107/07, 102/08, 143/08, 09/11; 47/11, 124/10, 51/11, 123/12, 147/13, 163/13);		
2	Placing of mobile toilets along the alignment and negotiating a Contract with an authorized company that will collect the deposit and transport it to a wastewater treatment plant	Avoided contamination of soil and underground water with coliform bacteria	Before the beginning of the construction activities in preparatory phase	Contractor	Law on waste management (Official Gazette of the Republic of Macedonia No. 68/04, 71/04, 107/07, 102/08, 143/08, 09/11; 47/11, 124/10, 51/11, 123/12, 147/13, 163/13);		
AIR MANAGEMENT							
1	Application of standatized fuels for the machinery and turning off the machinery motors	Decreasing the emission of exhaust fumes in the atmosphere	During the rehabilitation of the given section	Contractor	Law on ambient air quality (Official Gazette of the Republic of Macedonia No. 67/04; 92/07; 47/11, 59/12, 163/13);		
2	Application of water-based sprayer	Reduction of dust along the municipality road	During the rehabilitation of the given section	Contractor	Law on ambient air quality (Official Gazette of the Republic of Macedonia No. 67/04; 92/07; 47/11, 59/12, 163/13);		
WATER MANAGEMENT							
No.	Measure description	Measure goal expressed by reducing the environmental influences	<i>Time schedule for realization of improvement plan in 5 years period</i>	In-charged	Legal obligation		
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1	Barrels and casks with working materials (oils, fuel, etc.) should be placed in certain enclosed safe areas in the rehabilitation site; All the barrels and casks with working materials (oils, fuel, etc.) should have faucets for controlling the inflow and should be properly marked.	Avoided contamination of surface and underground waters	During the rehabilitation of the given section	Contractor	Law on waters (Official Gazette of the Republic of Macedonia No. 4/98, 19/00, 42/05, 46/06, 6/09, 87/08, 06/09, 161/09, 83/10, 51/11, 44/12, 23/13, 163/13);		
2	Places for storage of fuel, oil or other liquid chemicals should be removed from the drainage pipes towards the surface waters.	Avoided contamination of surface and underground waters	During the rehabilitation of the given section	Contractor	Law on waters (Official Gazette of the Republic of Macedonia No. 4/98, 19/00, 42/05, 46/06, 6/09, 87/08, 06/09, 161/09, 83/10, 51/11, 44/12, 23/13, 163/13);		
	WASTE MANAGEMENT						
1	Appropriate management with communal waste created at the on site itself (selection and classification), than collecting into bags which should be afterwards tied and disposed in the nearest rubbish bins.	Appropriate approach towards the way of waste management, realization on one of the key principles for sustainable management with communal hard waste	During the rehabilitation of the given section	Contractor	Law on waste management (Official Gazette of the Republic of Macedonia No. 8/04, 71/04, 107/07, 102/08, 143/08, 09/11; 47/11, 124/10, 51/11, 123/12, 147/13, 163/13); Article 26, Article 43, Article 44 and Rulebook on the general rules for		

No.	Measure description	<i>Measure goal expressed by reducing the environmental influences</i>	<i>Time schedule for realization of improvement plan in 5 years period</i>	In-charged	Legal obligation	
		"Responsibility of the owner"			management with communal and other types of non-hazardous waste (Official Gazette of the Republic of Macedonia No. 147/2007), Article 9, Article 10, Article 11	
	Biodegradable waste (debris from branches, leaves, roots, etc.) should not end up into the water flows because its degradation will cause waters eutrofication.	Removal of approved location for that purpose	During the rehabilitation of the given section	Contractor	Law on waste management (Official Gazette of the Republic of Macedonia No. 68/04, 71/04, 107/07, 102/08, 143/08, 09/11; 47/11, 124/10, 51/11, 123/12, 147/13, 163/13);	
	The inert waste consists of earth, stones, asphalt, concrete, etc. The inert waste does not chemically pollute the environment, but due to its coarseness disfigures the area.	Removal of approved location for that purpose	During the rehabilitation of the given section	Contractor	Law on waste management (Official Gazette of the Republic of Macedonia No. 68/04, 71/04, 107/07, 102/08, 143/08, 09/11; 47/11, 124/10, 51/11, 123/12, 147/13, 163/13);	
2	Sanding of eventually spilled motor oil	Appropriate approach towards the way of waste management	During the rehabilitation of the given section	Contractor	Law on waste management (Official Gazette of the Republic of Macedonia No. 68/04, 71/04, 107/07, 102/08, 143/08, 09/11; 47/11, 124/10, 51/11, 123/12, 147/13, 163/13);	
NOISE MANAGEMENT						

No.	Measure description	<i>Measure goal expressed by reducing the environmental influences</i>	<i>Time schedule for realization of improvement plan in 5 years period</i>	In-charged	Legal obligation		
1	Turning off the motors of the vehicles and the construction machinery in moments when there is no need of their engagement, performance of the construction activities – by day and with determined time dynamic	Decreasing the noise and influences of the same on the environment	During the rehabilitation of the given sections	Contractor	Law on protection against environmental noise (Official Gazette of the Republic of Macedonia No. 79/07;47/11, 163/13); and Rulebook on the limit values of environmental noise levels (Official Gazette of the Republic of Macedonia No.147/08)		
2	Limiting the working time by day, notifying the locals on the working activities	Decreasing the noise and influences of the same on the environment	During the rehabilitation of the given sections	Contractor	Law on protection against environmental noise (Official Gazette of the Republic of Macedonia No. 79/07;47/11, 163/13); and Rulebook on the limit values of environmental noise levels (Official Gazette of the Republic of Macedonia No. 147/08)		
	BIODIVERSITY (FLORA AND FAUNA) PROTECTION						
	No entrance in areas outside the building place. Waste and old things should not be left on	Appropriate approach towards the way of	During the rehabilitation of the given sections	Contractor	Law on environment (Official Gazette of the Republic of		

No.	Measure description	Measure goal expressed by reducing the environmental influences	<i>Time schedule for realization of improvement plan in 5 years period</i>	In-charged	Legal obligation			
	site. Trees and animals should not be destroyed, taken or damaged. Young trees and plants should not be stepped, except in the limits of the building site. Careful management with fire and cigarettes (disposed on appropriate places).	protection of the biodiversity (flora and fauna)			Macedonia No. 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/13, 187/13 и 42/14 );			
	RISK MANAGEMENT							
1	Plan for safety and health at work for workers working on temporal mobile building sites.	Reducing the possibility for incident cases	Before the beginning of the rehabilitation of the given section	Contractor	Law on safety and health at work (Official Gazette of the Republic of Macedonia No. 92/07, 136/11, 136/11, 23/13, 25/13, 137/13, 164/13 and all the codes derived from the Law.)			
2	Placing of traffic signs for allowed speed of vehicle movement, etc.	Reducing the possibility for incident cases	During the rehabilitation of the given section	Contractor	Rulebook on traffic signs (Official Gazette of the Republic of Macedonia No. 56/08).			

## 7.8 List of Legal Regulations and Measures for Environmental Protection

Law on environment (Official Gazette of the Republic of Macedonia No. 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/13, 187/13 μ 42/14 );

• Decree on modifying the decree for services and activities for which an Assessment Report is obligatory, and the organ for conduction on professional works in the environmental area is authorized for its approval (Official Gazette of the Republic of Macedonia No. 36/2012), that is the Ministry of Environment and Physical Planning (Official Gazette of the Republic of Macedonia No. 80/09);

Law on waters (Official Gazette of the Republic of Macedonia No. 4/98, 19/00, 42/05, 46/06, 6/09, 87/08, 06/09, 161/09, 83/10, 51/11, 44/12, 23/13, 163/13);

Law on waste management (Official Gazette of the Republic of Macedonia No. 68/04, 71/04, 107/07, 102/08, 143/08, 09/11; 47/11, 124/10, 51/11, 123/12, 147/13, 163/13);

• Rulebook on the general rules for management with communal and other types of nonhazardous waste (Official Gazette of the Republic of Macedonia No. 147/07);

• Rulebook on the form and content of the register for waste management, the form and content of the forms for waste identification and transport and the content of the template for annual reports of waste management (Official Gazette of the Republic of Macedonia No. 07/06);

• Law on management of packaging and packaging waste (Official Gazette of the Republic of Macedonia No. 161/09, 161/09, 17/11, 47/11, 136/11, 6/12, 39/12, 163/13);

Law on nature protection (Official Gazette of the Republic of Macedonia No. 67/04, 14/06, 84/07, 35/10, 47/11, 148/11, 59/12, 13/13, 163/13, 41/14)

 Rulebook on actions and way of collection, transportation, processing, storage, treatment and disposal of waste oils, the way of evidence management and data delivery (Official Gazette of the Republic of Macedonia No. 156/07);

 Rulebook on liquid fuel quality (Official Gazette of the Republic of Macedonia No. 88/07, 81/09);

Law on public roads (Official Gazette of the Republic of Macedonia No. 84/08; 52/09; 114/09; 23/11, 53/11, 44/12, 168/12, 163/13, 187/13, 39/14, 42/14);

• Rulebook on technical elements for construction and reconstruction of public roads and road objects (Official Gazette of the Republic of Macedonia No. 110/09);

Law on traffic road safety (Official Gazette of the Republic of Macedonia No. 54/07; 86/08; 98/08; 64/09, 161/09, 36/11, 51/11, 114/12, 27/14 );

 Law on ambient air quality (Official Gazette of the Republic of Macedonia No. 67/04; 92/07; 47/11, 59/12, 163/13);

• Decree on the limited values for polluting substances levels and types and alert thresholds, deadlines for achieving values, margins and marginal value tolerance, target value

and long term objectives (June 22, 2005);

 Rulebook on the maximum allowed concentrations and quantities for other hazardous substances released in the air from various sources of pollution (Official Gazette of the Republic of Macedonia No. 03/90);

 Law on protection against environmental noise (Official Gazette of the Republic of Macedonia No. 79/07;47/11, 163/13);

• Rulebook on the limit values of environmental noise levels (Official Gazette of the Republic of Macedonia No. 147/08);

 Law on protection of cultural heritage (Official Gazette of the Republic of Macedonia No. 20/04 μ 115/07, 18/11, 23/13, 137/13, 38/14, 44/14);

 Law on animal protection and welfare (Official Gazette of the Republic of Macedonia No. 113/07, 136/11);

Law on spatial and urban planning (Official Gazette of the Republic of Macedonia No. 51/05, 37/07, 24/08, 91/09, 18/11, 51/05, 37/07, 24/08, 91/09, 18/11, 53/11, 144/12, 55/13, 163/13, 42/14);

Law on construction (Official Gazette of the Republic of Macedonia No. 130/09; 18/11; 36/11, 12/12, 144/12, 25/13, 163/13, 18/11, 27/14, 28/14, 42/14);

• Law on security and health at work (Official Gazette of the Republic of Macedonia No. 92/07, 136/11, 136/11, 23/13, 25/13, 137/13, 164/13 and all the rulebooks derived from the Law.)

## 8. Resume and Conclusion

According the Law on construction of the Republic of Macedonia, Article 24, Paragraph 4 of the Law on environment (Official Gazette of the Republic of Macedonia No. 53/05, 81/05, 24/07 µ 159/08) and the Decree on services and activities for which the production of an Environmental Impact Assessment Report is mandatory, the Assessment Report is prepared and delivered. All the aspects for potential environmental influences during the Local Roads Reconstruction and Rehabilitation (VII tender) and their exploaitation were detailed in the Environmental Impact Assessment Report.

Generally, the Local Road Reconstruction and Rehabilitation (VII) and their exploitation would not have any significant negative influences on the environmental quality. There are possible insignificant influences which arise from the way of management with: air, soil, waste, noise and risks.

For that purpose, a Program for Environmental Protection has been prepared where the activities for surpassing the possible disadvantages, as well timeframe for their implementation have been suggested. With implementation of the suggested measures of the Program, an integrated environmental protection will be achieved. The Contractor needs to carefully carry all the measures as implied in the Assessment Report and in the Programme on Environmental Protection, to be consistent in their practice due to elimination of possible weakening of the environmental quality.

In all construction activities, the Constructor needs to act according the Project on construction organization, principally taking care of citizens' safety, material goods and environment.

Also, it should be noted that in the realization of this project one should keep to the contracted technical conditions regarding the construction, as well orderly performing the works, according the contracted conditions and obligations, as well the legal provisions and regulations for carrying this type of works. The Client – PE for State Roads of the Republic of Macedonia has prescribed technical conditions for realization on this type of works, which are a constituent from Constructor's contracted conditions. The Constructor needs to conform to all the prescribed contracted conditions and to preserve all the procedures. In the realization, the embedded materials, according the technical conditions, need to be supported by attests and certificates which will prove the quality and approved by a supervisor.

The working activities in the Local Roads Reconstruction and Rehabilitation in the Republic of Macedonia (VII tender) and their exploitation, does not have significant negative influences on the environmental media. Operations and processes realized do not present a big source of environmental pollution. Due to the great number of uncertainties and unpredictable situations, the recommendations for elaboration and additional assessment (in case of available roads, material borrows, etc.) need to be followed.

From the elaboration of conditions, activities, raw materials and the technological process, it can be concluded that localized limited environmental influences could be expected. Other minor short term influences cannot be totally avoided. Of the realized on site perceptions, data on activities and technological process in progress, using the cognizance of the appropriate legislative regulative, the conclusion is that the Local Roads Reconstruction and Rehabilitation (VII tender) and their exploitation in the concerning areas: air, water, soil, hard waste and noise, would not endanger the environment, nor it will cause short term or long term negative environmental influences.

Based on the expected influences, all serial mitigation measures and their avoidance are suggested. The Client is obliged to conform to and meet the Program of Environmental Protection in Local Roads Reconstruction and Rehabilitation (VII tender) and their exploitation.

## 9. **DECLARATION**

With this declaration we apply for the approval of the Environmental Impact Assessment Report according to Article 24 of the Law on Environment and the regulations that derive from it and under full moral, material and criminal responsibility we confirm that information given in this request is true, reliable and complete.

Public Enterprise for State Roads,

(In the name of the organization),

Data:2014

Name of the signatory: Aleksandar Stojanov

Position in the organization: Investment Manager Assistant

The Assessment Report was revised and checked by: Jozhe Jovanovski



Assessment Report prepared by<sup>1</sup>: CEI Makedonija AD Skopje

Signature:

Position of the legal entity: engineer in charge



<sup>1</sup>Is filled in case if the Assessment Report is prepared by another person, and not by the person who delivered the Assessment Report